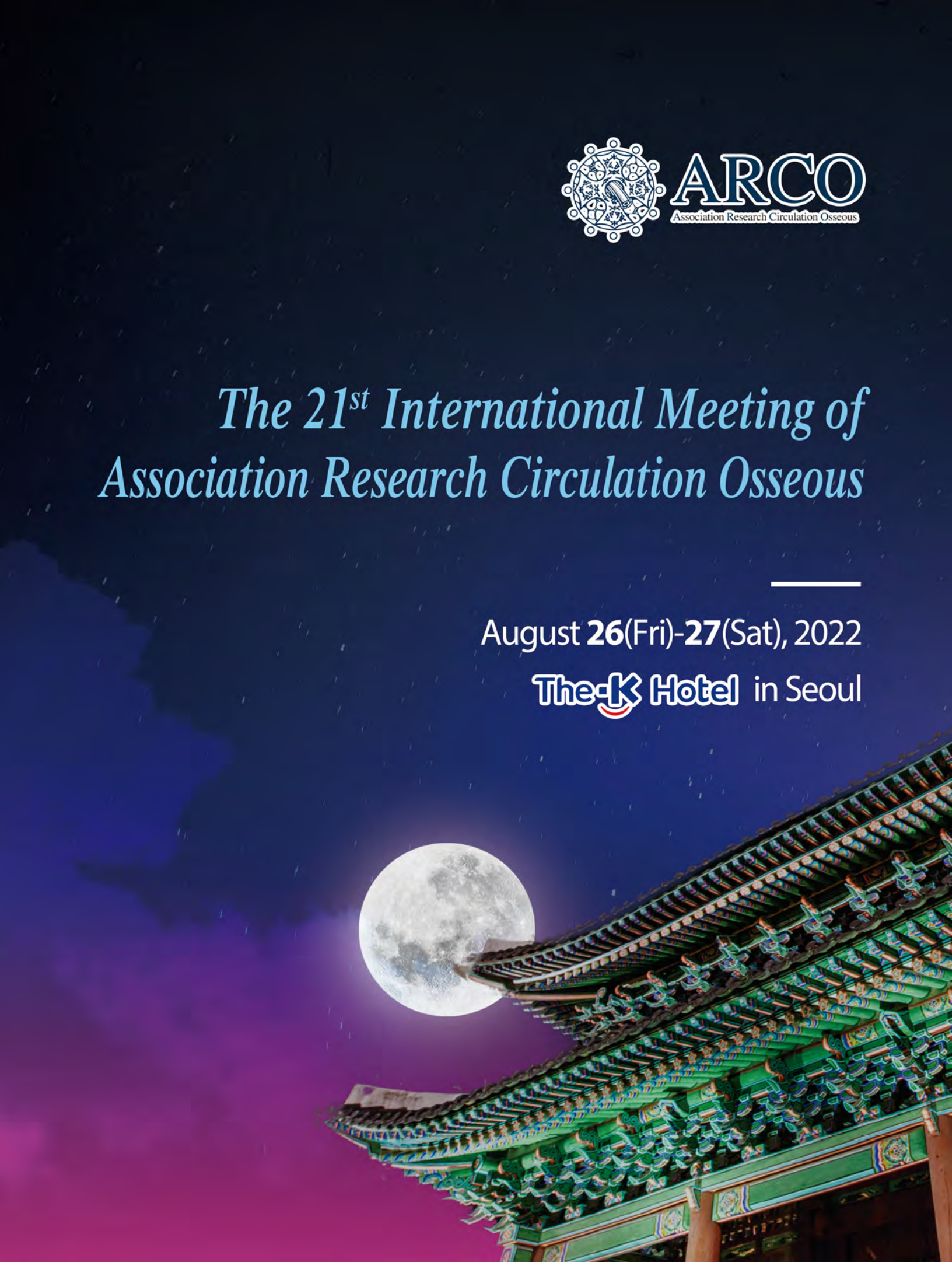
ARCO
Association Research Circulation Osseous

The 21st International Meeting of Association Research Circulation Osseous

August **26**(Fri)-**27**(Sat), 2022

The-K Hotel in Seoul



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•주성분: 나프록센 500밀리그램, 에스오메프라졸마그네슘삼수화물 22.3밀리그램 •적응증(효능·효과) : 비스테로이드성 소염진통제(나프록센 등)와 관련한 위궤양 및/또는 십이지장궤양의 발생 위험이 있으면서 저용량 나프록센 또는 다른 비스테로이드성 소염진통제에 의해 충분하지 않은 환자에서의 골관절염, 류마티스성 관절염, 강직성척추염의 증상 치료 •용법·용량 : 성인 1일 2회, 1회 1정(나프록센 500mg/에스오메프라졸 20mg)씩 경구투여한다. 이 약은 쪼개거나 씹거나 부수지 말고 물과 함께 그대로 삼켜서 복용한다. 식전 최소 30분 전에 복용하는 것을 권장한다. •주요 사용상의 주의사항 1. 경고 1) 매일 세잔 이상 정기적으로 술을 마시는 사람이 이 약이나 다른 해열진통제를 복용해야 할 경우 반드시 의사 또는 약사와 상의해야 한다. 이러한 사람이 이 약을 복용하면 위장출혈이 유발될 수 있다. 2) 심혈관계 위험: 이 약을 포함한 비스테로이드성 소염진통제는 중대한 심혈관계 혈전 반응, 심근경색증 및 뇌졸중의 위험을 증가시킬 수 있으며, 이는 치명적일 수 있다. 이러한 위험은 빠르면 치료 시작 첫 주에 발생할 수 있으며 투여 기간에 따라 증가될 수 있다. 심혈관계 혈전 위험의 증가는 높은 복용량에서 일관되게 관찰되었다. 심혈관계 질환 (예를 들면 비조절성 고혈압, 울혈성심부전, 허혈성 심질환, 말초동맥질환 및/또는 뇌혈관질환)이 있는 환자 및 심혈관계 질환의 위험 인자 (예를 들면 고혈압, 고지혈증, 당뇨병 및 흡연)가 있는 환자에서는 더 위험할 수도 있으므로 신중하게 고려한 이후에 이 약으로 치료하여야 한다. 의사와 환자는 이러한 심혈관계 증상의 발현에 대하여 신중히 모니터링하여야 하며, 이는 심혈관계 질환의 병력이 없는 경우에도 마찬가지로 적용된다. 환자는 중대한 심혈관계 독성의 징후 및/또는 증상 및 이러한 증상이 발현되는 경우 취할 조치에 대하여 사전에 알고 있어야 한다. 3) 위장관계 위험: 이 약을 포함한 비스테로이드성 소염진통제는 위 또는 장관의 출혈, 궤양 및 천공을 포함한 중대한 위장관계 이상반응의 위험을 증가시킬 수 있으며, 이는 치명적일 수 있다. 나프록센 단독투여에 비하여 이 약이 위궤양 발생을 유의하게 감소시켰으나, 궤양 및 그와 관련된 합병증은 여전히 발생된다. 이러한 이상반응은 투여 기간 동안에 경고 증상 없이 발생할 수 있다. 고령자는 중대한 위장관계 이상반응의 위험이 더 클 수 있다. 투여 기간이 길어질수록 중대한 위장관계 이상반응의 발생 가능성이 증가될 수 있으나 당기 투여시 이러한 위험이 완전히 배제되는 것은 아니다. 이 약을 투여하는 동안 위장관계 궤양 또는 출혈의 증상 및 징후에 대하여 신중히 모니터링 하여야 하며, 중증의 위장관계 이상반응이 의심되는 경우 즉시 추가적인 평가 및 처료를 실시하여야 한다. 비스테로이드성 소염진통제를 중증의 위장관계 이상반응이 완전히 배제될 때까지 투여 중단하는 것도 치료법이 될 수 있다. 고위험군의 환자에게는 비스테로이드성 소염진통제와 관련 없는 다른 대체 치료제를 고려하여야 한다. 2. 다음 환자에는 투여하지 말 것 1) 나프록센, 에스오메프라졸, 치환기인 벤즈이미다졸 및 이 약의 구성성분에 과민증이 있는 환자 2) 아스피린이나 기타 비스테로이드성 소염진통제(COX-2 저해제 포함)의 투여에 의하여 천식, 비염, 코의 용종, 두드러기, 알레르기 반응 또는 그 병력이 있는 환자 (이러한 환자에서 비스테로이드성 소염진통제 투여후 치명적인 중증의 아나필락시양 반응이 드물게 보고되었다.) 3) 활동성 소화성 궤양 환자 4) 위장관출혈, 뇌혈관출혈, 기타 출혈질환 환자, 심한 혈액이상 환자 5) 중증 간장애 환자(예 Childs-Pugh 등급 C) 6) 중증의 심부전 환자 7) 중증의 신장애 환자 (크레아티닌 클리어런스 30mL/분 미만) 8) 심한 고혈압환자 9) 관상동맥 우회로술(CABG) 전후에 발생하는 통증의 치료 10) 임신 말기 3개월 기간에 해당하는 임부 11) 아타자나비어, 넬피나비어 투여환자 12) 릴피비린 함유제제를 투여중인 환자 (6.상호작용 참조) •개정년월일 : 문헌작성연월일 : 2019년 5월 1일 ※보다 자세한 사항은 제품설명서 전문을 참조하시기 바랍니다. •수입(수입자) : 한국아스트라제네카, 서울시 강남구 영동대로 517 아셈타워 21층 TEL(02)2188-0800 www.astrazeneca.co.kr ※ 보다 자세한 정보는 아스트라제네카 (02-2188-0800)로 문의하시기 바랍니다.

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1. Hawkey CJ. Nonsteroidal anti-inflammatory drug gastropathy: Gastroenterology 2000 Aug;119(2):521-35

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ARCO
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The 21st International Meeting of Association Research Circulation Osseous

August **26**(Fri)-**27**(Sat), 2022

The-K Hotel in Seoul

WELCOME MESSAGE

Dear Colleagues,

ARCO 2022 meeting will be held on August 26 and 27 in Seoul. Last ARCO meeting was held in Dalian, China in 2019. During recent 3 years, there has been much progress in osteonecrosis research.

We prepared comprehensive program for education as well as presentation of invaluable studies.

The meeting will cover Perthes' disease and osteonecrosis of the knee and shoulder as well as osteonecrosis of the femoral head.

In 2014, ARCO published a textbook 'Osteonecrosis', which has been downloaded by more than 100,000 times. Now ARCO is preparing the second edition based on presentations in the ARCO 2022 meeting and recent studies on osteonecrosis.

ARCO 2022 meeting will be a platform to exchange our experience and update our knowledge.

Please join ARCO 2022 meeting and enjoy Seoul, the city of K-culture.

Shin-Yoon Kim
President of ARCO and
Congress Chair of ARCO 2022 Meeting

Yong-Chan Ha
Asian Vice President of ARCO
and Secretary General of ARCO 2022 Meeting

Jung-Wee Park
Assistant Secretary General of
ARCO 2022 Meeting

WELCOME ADDRESS

WELCOME Address for the 21st International Meeting of ARCO in Seoul

Dear ARCO Members, Colleagues and Friends

It's great honor for me to give a welcome address as ARCO president.

Since 2019 international ARCO meeting in Dalian, China, due to COVID-19 pandemic, our routines of daily life including academic meeting had not been performed normally.

Still we are not free from COVID-19 pandemic completely, but we organized the 21st ARCO international meeting in Seoul successfully. I would like to express my sincere appreciation to organizing committee, ARCO board members, past president and Lynne Jones.

International ARCO meeting has a 50 years history. About this, professor Cui, the 1st past president will mention in detail in opening remarks.

In this meeting, we will touch the pathogenesis, epidemiology, diagnostic criteria, staging, classification, surgical or nonsurgical treatment including stem cell therapy of osteonecrosis of femoral head, pediatric LCP diseases, ON at shoulder, knee, ankle, and wrist.

We will share the nation-wide cutting edge knowledge, basic sciences, and clinical researches.

Also we will have hot discussions about many unanswered or unsolved problems on osteonecrosis.

I expect the meeting can provide update information and global standard clinical guidelines for orthopedic specialists and general practice doctors.

We will have a ceremony to give inaugural ARCO Lifetime Achievement Award to Drs. Lynne Jones and Kyung-Hoi Koo for their significant contributions and long-time commitment to ARCO.

Congratulations to Drs. Jones and Koo !!!.

I would like to thank the Korean Hip Society, Korean Society for Bone and Mineral Research, and many pharmaceutical and industrial companies for their cooperation and financial support.

Korea is not a past country of calm but most dynamic country in the world.

Seoul is a hot place and center of K- art and K-culture.

Enjoy the meeting and Korea, Seoul.

Thank you so much, ありがとうございます。, 谢谢 xièxiè , Danke sehr, Merci,

Shin-Yoon Kim, MD. PhD.

President of ARCO

Congress chairman of the 21st International ARCO Meeting

OPENING REMARK

Dear ARCO President, Program Chairs, Members, Colleagues and Friends:

I am so honored and privileged for being asked to give this opening remarks. It gives me great pleasure to welcome you all to the 21st International Meeting of ARCO in this beautiful city, Seoul. It has been a long three years since our last meeting in Dalian, China. During this unprecedented time, ARCO has continued to work tirelessly to advance knowledges and to conduct cutting edge research to improve care of patients with osteonecrosis. While we are still feeling the effects of the Covid-19 pandemic on our practices, patients and routines of our daily life, this meeting is magically become a reality in Seoul. I would like to thank our organizing committee members, especially to Dr. Shin-Yoon Kim, President of ARCO and Congress Chair, Dr. Yong-Chan Ha, Vice President of ARCO for Asia and Secretary General, Dr. Jung-Wee Park, Assistant Secretary General for their hard work in bringing this together.

In 1973, the First International Symposium on Bone Circulation was organized by Drs. Paul Ficat and Jacques Arlet and was held in Toulouse, France. In December of 1989, a handful of surgeons and researchers met to establish the ARCO and held the first international meeting in London. Thirty-three years later, we are here because those who came before us, such as Drs. David Hungerford, Gwo-Jaw Wang, Marvin Steinberg, Yoichi Sugioka, to mention a few, who trained and influenced generations of orthopaedic surgeons and scientists. It is now upon us to engage, to participate, to work together to make our association special and to move our profession forward.

Dr. Kim and his colleagues has done an outstanding job developing this year's symposia and sessions. From bench to the bedside, many cutting edge basic science and clinical researches will be presented. Many topics will generate great discussions. This will be a great opportunity for us to learn from each other and to really get into some critical discussions about current status in diagnosis and treatment of osteonecrosis.

Osteonecrosis continues to be a challenging clinical problem with many questions unanswered. As leaders in the field of osteonecrosis and bone circulation from different country, region and continent, you have the power to influence your respective orthopaedic communities to improve ARCO membership and work force to discover new approaches and to overcome challenges in diagnosis and treatment of the disease. Our meeting is small enough that each opinion expressed can be heard. What we each bring, the ideas that we share, in both formal and informal settings, can create great opportunities for collaborations among our members.

There are many global issues facing our countries and specialty today, yet this extraordinary association continues to connect us across continents and countries, and across differences in political and health systems. We are not able to achieve this without our members' and your participation and dedication. Therefore, I want to thank you and would like to specially acknowledge two of our

leader members, Drs. Lynne Jones and Kyung-Hoi Koo for their significant contributions and long-term commitment to the ARCO, their outstanding research and scholarship, and the high impact they have made on clinical practice and research in the field of bone circulation and osteonecrosis. They will receive the inaugural ARCO Lifetime Achievement Award at this meeting, congratulations to Dr. Jones and Dr. Koo!

Finally, my best wishes for you and your family, please stay safe and enjoy the meeting!

Quanjun Cui, MD

The 1st Past President of ARCO
GJ Wang Professor of Orthopedic Surgery, University of Virginia, USA

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The 21st International Meeting of Association Research Circulation Osseous

PROGRAM

August 26(Fri.), 2022

08:50-08:55	*Welcome Address*	**Shin-Yoon Kim** (Kyungpook National Univ., Korea)
08:55-09:00	*Opening Remark*	**Quanjun Cui** (Univ. of Virginia, USA)

09:00-10:30 Session I. Pathogenesis, Basic Research and Epidemiology

Moderators: **Wolf Robert Drescher** (Rummelsberg Hosp., Germany)
Lynne Jones (Johns Hopkins Univ., USA)

09:00-09:20	*Pathogenesis of non-traumatic osteonecrosis of the femoral head*	**Kyung-Hoi (Kay) Koo** (Seoul National Univ., Korea) / 16
09:20-09:30	*Prevalence of osteonecrosis of the femoral head: A nationwide epidemiologic analysis in Korea*	**Joo-Hyoun Song** (The Catholic Univ. Korea, Korea) / 18
09:30-09:40	*Osteonecrosis: Will advanced imaging lead to etiologic insights?*	**Edward Cheng** (Univ. of Minnesota, USA) / 20
09:40-09:50	*Epidemiology: Japan perspective*	**Wataru Ando** (Osaka Univ., Japan) / 21
09:50-10:00	*Epidemiology: China perspective*	**Zhao Dewei** (Dalian Univ., China) / 23
10:00-10:10	*Epidemiology: Taiwan perspective*	**Mel S. Lee** (Chang Gung Memorial Hosp., Taiwan) / 25
10:10-10:30	*Discussion*	

10:30-10:50 Coffee Break

10:50-12:00 Session II. LCP

Moderators: **Soon Hyuck Lee** (Seoul Red Cross Hosp., Korea)
Taek Rim Yoon (Chonnam National Univ., Korea)

10:50-11:05	*Treatment strategy of Late-onset LCP*	**Soon Hyuck Lee** (Seoul Red Cross Hosp., Korea) / 28
11:05-11:20	*Classification of residual stage LCP and long term prognosis*	**Moon Seok Park** (Seoul National Univ., Korea) / 30
11:20-11:35	*Manangement of redisual deformity of LCP*	**Jong Sup Shim** (Sungkyunkwan Univ., Korea) / 31
11:35-11:45	*Arthroscopic treatment of LCP sequelae*	**Jungmo Hwang** (Chungnam National Univ., Korea) / 34
11:45-11:55	*Outcome of THA in patients diagnosed with LCP sequelae*	**Kyung Hag Lee** (National Medical Center, Korea) / 35
11:55-12:00	*Discussion*	

12:00-13:10 Lunch & Luncheon Symposium

Moderators: **Young-Hoo Kim** (SeoNam Hosp., Korea)
Ye Yeon Won (Ajou Univ., Korea)

12:00-12:20 *Mirabo cup and M stem: Solution for inguinal pain, thigh pain, neck-liner impingement, instability and ceramic liner malseating*
Kyung-Hoi (Kay) Koo (Seoul National Univ., Korea) /

12:20-13:10 Lunch and Poster Tour

13:10-14:10 Session III. Diagnostic Criteria, Staging and Classification

Moderators: **Takashi Sakai** (Yamaguchi Univ., Japan)
Nobuhiko Sugano (Osaka Univ., Japan)

13:10-13:20 *Diagnostic criteria* **Woo Lam Jo** (The Catholic Univ. Korea, Korea) /
13:20-13:30 *ARCO staging* **Byung-Ho Yoon** (Ewha Womans Univ., Korea) /
13:30-13:40 *ARCO classification* **Quanjun Cui** (Univ. of Virginia, USA) /
13:40-13:55 *AI deep learning* **Geun Young Lee** (Chung-Ang Univ., Korea) /
13:55-14:10 *Discussion*

14:10-16:00 Session IV. Free Paper 1

Moderators: **Zhao Dewei** (Dalian Univ., China)
Yong-Chan Ha (Seoul Bumin Hosp., Korea)

14:10-14:17 *Dietary intake of vitamin E and cryptoxanthin are inversely associated with osteonecrosis of the femoral head: A multicenter case-control study in Japan*
Wakaba Fukushima (Osaka Metropolitan Univ., Japan) /

14:17-14:24 *Autocrine activity of exosomes in glucocorticoid-induced injury of bone microvascular endothelial cells identified by protein array*
Fuqiang Gao (China-Japan Friendship Hosp., China) /

14:24-14:31 *Extracellular vesicles from BMSCs prevent Glucocorti-coid-Induced BMECs injury by regulating autophagy via the PI3K/Akt/mTOR pathway*
Fuqiang Gao (China-Japan Friendship Hosp., China) /

14:31-14:38 *Delivery of MiR335-5p-Pendant tetrahedron DNA nanostructures using an injectable heparin lithium hydrogel for challenging bone defects in steroid-associated osteonecrosis* **Donghai Li** (Sichuan Univ., China) /

14:38-14:45 *Low intensity band on FS T2WI of MRI indicates the changing from asymptomatic to symptomatic in necrotic femoral head* **Min-Cong He** (GRIOTCM, China) /

14:45-14:52 *Sagittal pelvic posture in standing position might be associated with collapse progression in post-collapse stage osteonecrosis of the femoral head*
Mingjian Xu (Kyushu Univ., Japan) /

14:52-14:59 *Prediction of femoral head avascular necrosis following femoral neck fracture: "pin-tract sign" of 99mTc-HDP pinhole bone scan after metallic fixation* **Yoon-Vin Kim** (The Catholic Univ. of Korea, Korea) /

14:59-15:06 *Bilateral bone marrow edema syndrome and/or subchondral stress fracture of the femoral head* **Hong Seok Kim** (Seoul National Univ., Korea) /

15:06-15:13 *Multifocal osteonecrosis: Diagnostic value of bone scintigraphy* **Bum-Jin Shim** (Kyungpook National Univ., Korea) /

15:13-15:20 *Development and validation of a machine learning-based nomogram to predict collapse of femoral head necrosis based on CT and x-ray* **Kaiqiang Tang** (Beijing Univ., China) /

15:20-15:27 *Multidirectional hypertrophy of the femoral head cartilage in Legg-Calve-Perthes disease* **Hidenao Tanaka** (Kyushu Univ., Japan) /

15:27-15:34 *The effect of aging on bone repair against ischemic osteonecrosis in a mouse model* **Ryosuke Yamaguchi** (Kyushu Univ., Japan) /

15:34-16:00 *Discussion*

16:00-16:20 Coffee Break

16:20-17:30 Session V. Surgical trend of ONFH

Moderators: **Edward Cheng** (Univ. of Minnesota, USA)
Shin-Yoon Kim (Kyungpook National Univ., Korea)

16:20-16:30 *Surgical trend in Korea* **Jung-Wee Park** (Seoul National Univ., Korea) /

16:30-16:45 *Surgical trend of hip and knee osteonecrosis in US* **Stuart Goodman** (Stanford Univ., USA), **Lynne Jones** (Johns Hopkins Univ., USA) /

16:45-16:55 *Surgical trend in Japan* **Shinya Kaneko** (Fukuoka Univ., Japan) /

16:55-17:05 *Surgical trend in China* **Zhao Dewei** (Dalian Univ., China) /

17:05-17:15 *Surgical trend in Taiwan* **Mel S. Lee** (Chang Gung Memorial Hosp., Taiwan) /

17:15-17:30 *Discussion*

17:30-17:40 General Meeting, Presentation of Appreciation Plaque, Picturing

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PROGRAM

August 27(Sat.), 2022

08:00-09:00 Session VI. Conservative Treatment in ONFH

Moderators: **Stuart Goodman** (Stanford Univ., USA)
Chen Chung-Hwan (Kaohsiung Medical Univ., Taiwan)

08:00-08:15 *Which Osteotomy for Osteonecrosis of the Femoral Head?*
Young-Kyun Lee (Seoul National Univ., Korea) /

08:15-08:30 *Vascularized fibular grafts in ONFH*
Seung-Hoon Baek (Kyungpook National Univ., Korea) /

08:30-08:45 *Does Bisphosphonate Prevent Femoral Head Collapse from Osteonecrosis?*
Hong Seok Kim (Seoul National Univ. Hosp., Korea) /

08:45-09:00 *Stem cell; is it effective?* **Woo Lam Jo** (The Catholic Univ. Korea, Korea) /

09:00-09:20 Coffee Break

09:20-10:50 Session VII. Free Paper 2

Moderators: **Myung-Rae Cho** (Daegu Catohlic Univ., Korea)
Yong-Chan Ha (Seoul Bumin Hosp., Korea)

09:20-09:27 *Implantation of autologous bone marrow-derived stem cells for treatment of osteonecrosis of the femoral head* **Bum-Jin Shim** (Kyungpook National Univ., Korea) /

09:27-09:34 *The efficiency of genetically-modified mesenchymal stromal cells combined with a functionally-graded scaffold for bone regeneration in corticosteroid-induced osteonecrosis of the femoral head (ONFH) in rabbits*
Stuart Goodman (Stanford Univ., USA) /

09:34-09:41 *Umbilical cord derived-preosteoblast cells (CF-M801) to treat osteonecrosis of the femoral head* **Hyun Sook Park** (CEFO Co, Korea) /

09:41-09:48 *Explore the biomechanical effect of sclerotic bone volume on early osteonecrosis of the femoral head: A cohort finite element study*
Zhihong Fu (Beijing Univ., China) /

09:48-09:55 *Application of denosumab in patients with osteonecrosis around core decompression: A pilot study* **Chung-Hwan Chen** (Kaohsiung Medical Univ., Taiwan) /

09:55-10:02 *Biomechanical analysis of a novel osteochondral graft specific for the femoral head*
Patrick Morgan (Univ. of Minnesota, USA) /

10:02-10:09 *Total hip arthroplasty outcomes before or after renal transplantation*
Quanjun Cui (Univ. of Virginia, USA) /

10:09-10:16 *Postoperative longitudinal assessment of quality of life in patients with osteonecrosis of the femoral head: A multicenter study*
Takashi Sakai (Kinjo Gakuin Univ., Japan) /

10:16-10:23 *A minimum 15-year follow-up study after THAs using contemporary ceramic bearings in young patients with osteonecrosis of femoral head less than fifty*
Seung-Hoon Baek (Kyungpook National Univ., Korea) /

10:23-10:30 *The early outcome of dual mobility cup total hip arthroplasty for the ARCO IV femoral head necrosis with Parkinson's disease*
Junming Wan (Sun Yet-sun Univ., China) /

10:30-10:50 *Discussion*

10:50-12:10 Session VIII. ON of Other Joints

Moderators: **Sang-Soo Lee** (Hallym Univ., Korea)
Joo Han Oh (Seoul National Univ., Korea)

10:50-11:05 *ON around the knee* **Chong Bum Chang** (Seoul National Univ., Korea) /
11:05-11:20 *ON of the humerus* **Joo Han Oh** (Seoul National Univ., Korea) /
11:20-11:35 *ON around the ankle* **Kyoung Min Lee** (Seoul National Univ., Korea) /
11:35-11:50 *ON around the wrist* **Hyun Sik Gong** (Seoul National Univ., Korea) /
11:50-12:10 *Discussion*

12:10-12:20 *Closing Remark* **Shin-Yoon Kim** (Kyungpook National Univ., Korea)

12:20-13:30 Lunch

2022 ARCO (Korea Session)

13:30-13:40 *Opening Remark* **Yong-Chan Ha** (Seoul Bumin Hosp., Korea)

13:40-14:20 Session 1. Updating Osteonecrosis of the Femoral Head

Moderators: **Shin-Yoon Kim** (Kyungpook National Univ., Korea)
Yoon-Je Cho (Kyung Hee Univ., Korea)

13:40-13:50 *Change of treatment trends of osteonecrosis of femoral head*
Yong-Chan Ha (Seoul Bumin Hosp., Korea) /

13:50-14:00 *Osteonecrosis micmicking joint infection* **Tae Young Kim** (Konkuk Univ., Korea) /

14:00-14:10 *Future perspectives: Stem cell therapy*
Shin-Yoon Kim (Kyungpook National Univ., Korea) /

14:10-14:20 *Discussion*

14:20-15:10 Session 2. Total Hip Arthroplasty

Moderators: **Joo-Hyoun Song** (The Catholic Univ. Korea, Korea)
Seung-Hoon Baek (Kyungpook National Univ., Korea)

14:20-14:30	*How to prevent dislocation: approach, cup positioning, repair*	**Chan-Ho Park** (Yeungnam Univ., Korea) /
14:30-14:40	*How to prevent PJI: 2018 ICM guideline*	**Seung-Hoon Baek** (Kyungpook National Univ., Korea) /
14:40-14:50	*Complex THA*	**Jae-Young Lim** (Inje Univ., Korea) /
14:50-15:00	*Ceramic THA: is it life-long?*	**Jung-Taek Kim** (Ajou Univ., Korea) /
15:00-15:10	*Discussion*	

15:10-16:10 Session 3. Osteoporosis and Related Problems

Moderators: **Doo-Hoon Sun** (Daejeon Sun General Hosp., Korea)
Kee Haeng Lee (The Catholic Univ. Korea, Korea)

15:10-15:20	*Treatment of intertrochanteric fracture*	**Jae-Hwi Nho** (Soonchunhyang Univ., Korea) /
15:20-15:30	*Treatment of femoral neck fracture*	**Kyung Soon Park** (Chonnam National Univ., Korea) /
15:30-15:40	*Secondary prevention*	**Yong-Han Cha** (Eulji Univ., Korea) /
15:40-15:50	*Treatment of atypical femoral fracture*	**Ki-Choul Kim** (Dankook Univ., Korea) /
15:50-16:00	*Diagnosis and management of sarcopenia*	**Jun-Il Yoo** (Gyeongsang National Univ., Korea) /
16:00-16:10	*Discussion*	

16:10-16:40 Break

16:40-18:00 Session 4. Special Lecture

16:40-17:00	*Introduction*	**Kyung-Hoi (Kay) Koo** (Seoul National Univ., Korea) /
17:00-17:30	*Sapience*	**Seung-Beom Han** (Korea Univ., Korea) /
17:30-18:00	*Monticello and Pax Americana*	**Kyung-Hoi (Kay) Koo** (Seoul National Univ., Korea) /

POSTER

P-01 *Outcomes of total hip arthroplasty after failed free vascularized fibular grafting for osteonecrosis of the femoral head* **Yoon-Vin Kim** (The Catholic Univ. of Korea, Korea) /

P-02 *The interaction of risk factors for osteonecrosis of the femoral head* **Tetsuro Tani** (Osaka Police Hosp., Japan) /

P-03 *Morphological analysis of articular surface of the femoral head with osteonecrosis* **Noriko Yamamoto** (Kyushu Univ., Japan) /

P-04 *Objective to evaluate the value of CT texture analysis in evaluating the efficacy of hip-protection therapy for osteonecrosis of the femoral head* **Yawei Dong** (Beijing Univ., China) /

P-05 *Comparison of different bone grafts combined with modified core decompression for the treatment of ARCO II stage femoral head necrosis* **Junming Wan** (Sun Yet-sun Univ., China) /

P-06 *Femoral head and neck fenestration through a direct anterior approach combined with compacted autograft for the treatment of early stage nontraumatic osteonecrosis of the femoral head: A retrospective study* **Qiuru Wang** (Sichuan Univ., China) /

P-07 *High-energy focused extracorporeal shock wave prevents the occurrence of glucocorticoid-induced osteonecrosis of the femoral head: A prospective randomized controlled trial* **Fuqiang Gao** (China-Japan Friendship Hosp., China) /

P-08 *Quantitative magnetic resonance imaging of femoral head articular cartilage change in patients with hip osteonecrosis treated with extracorporeal shock wave therapy* **Fuqiang Gao** (China-Japan Friendship Hosp., China) /

P-09 *Bioinformatics and system biology approach to identify the influences of COVID-19 infections to corticosteroid-induced osteonecrosis of the femoral head disease patients* **Wen-Sheng Zhang** (GRIOTCM, China) /

P-10 *Differential expression of Piezo1 in osseous tissue of steroid-induced and alcohol-induced osteonecrosis of the femoral head* **Tengfei Wei** (Guangzhou Univ., China) /

P-11 *Association between magnitude of femoral head collapse and quality of life in patients with osteonecrosis of the femoral head* **Makoto Iwasa** (Osaka Univ., Japan) /

P-12 *Prediction matrix for collapse progression in osteonecrosis of the femoral head* **Takeshi Utsunomiya** (Kyushu Univ., Japan) /

P-13 *Tissue engineered bone regeneration for the large osteonecrosis of femoral head in weight-bearing portion: an observational study* **Ji-Woon Lee** (Kyungpook National Univ., Korea) /

Session I.
Pathogenesis, Basic Research and Epidemiology

August 26(Fri.), 2022 09:00-10:30

MODERATORS

Wolf Robert Drescher

Rummelsberg Hosp., Germany

Lynne Jones

Johns Hopkins Univ., USA

Session I. Pathogenesis, Basic Research and Epidemiology

Pathogenesis of non-traumatic osteonecrosis of the femoral head

Kyung-Hoi (Kay) Koo

Seoul National Univ., Korea

[CURRICULUM VITAE]

Professor, Department of Orthopaedic Surgery, Seoul National University College of Medicine and Seoul National University Bundang Hospital, Seongnam, South Korea.

Dr. Koo is a professor of Department of Orthopaedic Surgery, Seoul National University Bundang Hospital, South Korea. He is a musculoskeletal radiologist as well as an orthopaedic surgeon. During last 30 years, he has exclusively performed hip surgeries. He is interested in femoral head osteonecrosis and has actively participated in ARCO since 1994. He was President of ARCO from 2012 to 2015 and published a textbook "Osteonecrosis" with Michael A. Mont and Lynne C. Jones in 2014. This book has been chapter downloaded by more than 120,000 times. Since 1997, he has used ceramic-on-ceramic bearings in total hip arthroplasty and has been instrumental in bringing ceramic-on-ceramic total hip arthroplasty. He has published over 300 peer-reviewed articles and more than 10 book chapters regarding femoral head osteonecrosis and total hip arthroplasty. He was an editor of the Bone and Joint Journal from 2015 to 2018 and currently, he is an editor of the Journal of Arthroplasty.

[ABSTRACT]

Osteonecrosis of the femoral head (ONFH) is a condition in which part of the femoral head becomes necrotic associated with a disruption of the blood supply. The necrosis usually involves the weight-bearing dome of the femoral head. There has been considerable progress made on our comprehension concerning the pathogenesis of the non-traumatic ONFH during the last 3 decades. However, most studies report fragmentary knowledge, and an integrated explanation of the pathogenesis has not been established. Thus, the Association Research Circulation Osseous (ARCO) task

force members have systematically reviewed the up-to-date knowledge representing a consensus on the pathogenesis of ONFH in April 2020.

In most cases, ONFH is associated with multiple factors including genetic predispositions as well as the exposure to risk factors. Any of the risk factors can play a role in the development of ONFH and contribute to its pathogenesis in most cases. The hereditary predisposition explains why only some of the high-dose corticosteroids users and alcohol abusers acquire the disease, while others do not. Indeed, an ischemic event does not always lead to ONFH. The progression is generally dependent on the restoration of vascular perfusion and the creeping substitution of dead bone by new bone.

The pathogenesis can be summarized as below.

1. Fat cell hypertrophy in the marrow space and intra-osseous hypertension
2. Marrow necrosis
3. Osteocytic death and formation of a sequestrum in case of thrombophilia/hypofibrinolysis and impaired angiogenesis
4. Reparative process at the margin of the sequestrum
5. Saponification of necrotic bone and subsequent fracture
6. Secondary osteoarthritis of the hip

Session I. Pathogenesis, Basic Research and Epidemiology

Prevalence of osteonecrosis of the femoral head: A nationwide epidemiologic analysis in Korea

Joon Soon Kang, Sohee Park, Joo Hyoun Song, Yung Yul Jung, Myung Rae Cho, Kee Hyung Rhyu

The Catholic Univ. Korea, Korea

[CURRICULUM VITAE]

1988	MD, The Catholic University of Korea
1996	MS, The Catholic University Graduate School
2000	PhD, The Catholic University Graduate School
1996-2000	Instructor/Orthopaedics St. Vincent's Hospital, The Catholic University of Korea
2008-2010	Executive Secretary of Korean Musculoskeletal Transplantation Society
2010-2012	Executive Secretary of Korean Hip Society
2010-2014	Chief Director of Department of Orthopaedics, St. Vincent's Hospital, The Catholic University of Korea
2013-	Professor, Department of Orthopaedics, St. Vincent's Hospital, The Catholic University of Korea
2015-2020	Chief of Department of PI(Performance Improvement) St. Vincent's Hospital, The Catholic University of Korea
2020-	councilor of Korean Hip Society

[ABSTRACT]

This study was performed to estimate the prevalence of osteonecrosis of the femoral head in Korea. Using medical claims data from the Korean National Health Insurance Corporation, all individuals treated under a diagnosis of osteonecrosis of the femoral head were identified for each year from 2002 to 2006. Among them, the number of true cases was estimated using a randomly collected validation sample of 382 patients for which the actual diagnosis was investigated by

authors. The estimated yearly prevalence per 100 000 population ranged from 20.53 (20.13 ≤ 95% confidence interval ≤ 20.94) in 2002 to 37.96 (37.42 ≤ 95% confidence interval ≤ 38.51) in 2006.

The average estimated number of annual prevalent cases was 14 103, indicating 28.91 per 100 000 average prevalence over a 5-year period. Males predominated. We found that 32.4% had history of alcohol abuse, and 14.6% was related to steroid. Bilateral involvement was noticed in 37%. Besides arthroplasty, decompression was the most frequently performed joint-preserving procedure. We believe that the results serve as important baseline for understanding the disease.

Session I. Pathogenesis, Basic Research and Epidemiology

Osteonecrosis: Will advanced imaging lead to etiologic insights?

Edward Cheng

Univ. of Minnesota, USA

[CURRICULUM VITAE]

CURRENT POSITION

1. Professor, Mairs Family Endowed Chair, Orthopedic Surgery, University of Minnesota
2. Head, Section of Adult Reconstruction and Tumor
3. Disease Team Lead, Bone and Soft Tissue Service Line, Masonic Cancer Center, University of Minnesota
4. Lead, Musculoskeletal Service Line, Acute care, MHealth-Fairview Health system
5. Director, Adult Reconstruction Fellowship

1981	B.S., Northwestern University Evanston, IL
1983	M.D., Northwestern University Medical School Chicago, IL
1984	Internship General Surgery, Northwestern University McGaw Medical Center
1985	Residency General Surgery, Northwestern University McGaw Medical Center
1986	Research Fellowship Orthopaedic Oncology, Massachusetts General Hospital
1988	Residency Combined Orthopaedics and Surgery Program, Harvard University (Brigham and Women's Hospital/Massachusetts General Hospital) Boston, MA
1989	Chief Resident Orthopaedic Surgery, Beth Israel Hospital, Boston, MA
1990	Fellowship Orthopaedic Oncology, Massachusetts General Hospital
1990	Fellowship Pediatric Orthopaedic Oncology, Boston Children's Hospital Medical Center
2015-present	Voting Staff, Methodist Hospital
2015-present	Affiliate, Children's Hospitals and Clinics, Minneapolis
1997-present	Staff Surgeon, Orthopaedic Surgery Service, University of Minnesota Medical Center, Fairview
1990-present	Staff Physician, University of Minnesota Physicians, Orthopaedic Surgery Clinic, University of Minnesota Hospital and Clinic

Epidemiology: Japan perspective

Wataru Ando[1,2], Kazuma Takashima[2], Keisuke Uemura[2], Hidetoshi Hamada[3], Nobuhiko Sugano[3]

[1]Department of Orthopaedic Surgery, Kansai Rosai Hospital, Japan.
[2]Department of Orthopaedic Surgery, Osaka University Graduate School of Medicine, Japan.
[3]Department of Orthopaedic Medical Engineering, Osaka University Graduate School of Medicine, Japan.

[CURRICULUM VITAE]

Department of Orthopaedic Surgery, Kansai Rosai Hospital
Department of Orthopaedic Surgery, Osaka University Graduate School of Medicine

1993-1999	Osaka University Medical School
2003-2007	PhD course; Osaka University Graduate School of Medicine
1999-2000	Orthopaedic Resident, Osaka University Hospital
2000-2001	Anesthetic Resident, Osaka University Hospital
2001-2003	Orthopaedic Resident, Osaka National Hospital
2007-2010	POSTDOCTORAL FELLOWSHIP. McCaig Centre for Joint Injury and Arthritis Research, University of Calgary (Dr. David A Hart, Dr. Cyril B Frank)
2010-2018	Orthopaedic staff doctor, Kansai Rosai Hospital
2018-2021	Senior lecture, Osaka University Graduate School of Medicine
2021-2021	Associate professor, Osaka University Graduate School of Medicine
2022-present	Orthopaedic chief doctor, Kansai Rosai Hospital

[ABSTRACT]

Osteonecrosis of the femoral head (ONFH) is a rare and multifactorial disease and several epidemiological studies to identify the risk factors were conducted in Japan.

The Japanese Investigation Committee (JIC) for ONFH has conducted a nationwide hospital-based sentinel monitoring system where newly-diagnosed ONFH patients were reported every year from the 37 participating hospitals since 1997. This data demonstrated the temporal trends in characteristics such as sex, age, and associated factors. The recent data which were reported from 2019 to 2011 showed that the male-to-female ratio was 1.53 and there was a single peak in males in their 40s and females in their 60s. The proportion of each history was 61% for systemic steroid use, 58% for habitual alcohol intake.

The JIC also conducted nationwide epidemiologic surveys of ONFH every decade since 1995. The targets in each survey were selected from all orthopedic departments in all hospitals in Japan by stratified random sampling according to inpatient bed numbers and hospital characteristics. The estimated annual number of prevalent cases during the year was increased from 5.9 patients/100,000 population in 1995 to 18.2 patients/ 100,000 population in 2015. ONFH is not a fatal disease and postoperative patients may have been accumulated over time.

Other epidemiological data were collected from the online registration system for a designated intractable disease (DID) launched by the Ministry of Health, Labor, and Welfare, Japan. Patients diagnosed with DID can be applied for medical expense subsidies in each prefecture. The DID data in which a total of new 15,049 cases of ONFH were registered from 2004 to 2013 revealed that no clear region was identified for the steroids, while alcohol-associated ONFH incidence varies geographically in Japan, suggesting that they have regional characteristics.

To monitor the change of the disease characteristics in future, multifaceted and continuous epidemiological surveys are impportant.

Session I. Pathogenesis, Basic Research and Epidemiology

Epidemiology: China perspective

Zhao Dewei

Dalian Univ., China

[CURRICULUM VITAE]

Affiliated Zhongshan Hospital of Dalian University : Honorary Dean
The Orthopedic Medical Research Center of Dalian University : Director

1974-1977	Nanjing Railway Medical College, Bachelor Degree
1978-1994	Qiqihaer Railway Center Hospital, Associate Chief Physician
1994-2003	Affiliated Zhongshan Hospital of Dalian University, Director of orthopedics
1998-2001	Dongbei University of Finance and Economics, Master Degree
1999-2003	Affiliated Zhongshan Hospital of Dalian University, Vice Dean
2002-2005	Southern Medical University, Doctorate Degree
2003-2021	Affiliated Zhongshan Hospital of Dalian University, Dean
2010-2015	Dalian University, Vice President
2020-Today	Affiliated Zhongshan Hospital of Dalian University : Honorary Dean
	The Orthopedic Medical Research Center of Dalian University : Director

[ABSTRACT]

Osteonecrosis of the femoral head (ONFH) is a common and refractory disease in orthopaedic clinics. The aetiological factors of ONFH can currently be divided into two major categories: traumatic and nontraumatic; however, the specific pathological mechanism of ONFH is not completely clear. Facing the complex pathogenic mechanism of ONFH, in addition to the etiological composition of ONFH, there are many fields worth studying. The basic research on the pathogenesis of femoral head necrosis by Chinese scholars is now summarized and reported.

1. Research progress on the pathogenesis of traumatic ONFH
   (1) The etiological theory of traumatic ONFH
   (2) Prevention of traumatic ONFH

2. Research progress on the pathogenesis of non-traumatic ONFH
   (1) Glucocorticoid associated osteonecrosis of the femoral head (GA-ONFH)
      1. Epidemiological study of GA-ONFH
      2. Pathogenesis of GA-ONFH
   (2) Alcohol associated osteonecrosis of the femoral head (AA-ONFH)
      1. Epidemiological study of AA-ONFH
      2. Pathogenesis of AA-ONFH

3. Progress in pathological staging and treatment of non-traumatic ONFH
   (1) Progress in vascular pathological staging
   (2) Advances in prevention and treatment

4. Outlook

Chinese scholars have carried out a lot of research work on the basic research and treatment of ONFH, not only established the basic diagnosis, treatment and evaluation system of ONFH, but also provided epidemiology, etiology, diagnostic criteria, pathological staging, prevention and treatment options. Based on the changes in the intraosseous blood supply at different stages, the corresponding nonsurgical and surgical treatments are recommended, which has made outstanding contributions to the prevention and treatment of ONFH.

Session I. Pathogenesis, Basic Research and Epidemiology

Epidemiology: Taiwan perspective

Mel S. Lee

Chang Gung Memorial Hosp., Taiwan

[CURRICULUM VITAE]

Superintendent, Paochien Hospital, Professor Department of Orthopedic Surgery, Taiwan

1987	M.D., Taipei Medical University, Wu-Hsin St., Taipei.
2001	Ph.D., Graduate Institute of Clinical Medicine, Chang Gung University
2021-	Superintendent, Paochien Hospital
2013-2014	Vice-Superintendent, Chang Gung Memorial Hospital, Chiayi, Taiwan.
2015-2016	Executive Vice Superintendent, Kaohsiung Chang Gung Memorial Hospital
2016-2017	Superintendent, Kaohsiung Chang Gung Memorial Hospital

[ABSTRACT]

Nontraumatic osteonecrosis of the femoral head (ONFH) affects the hips of young adults who may or may not have risk factors such as alcohol exposure, steroid use, or coagulation disorders. It has been estimated that there are around 360,000 to 540,000 new cases per year in Taiwan, Hong Kong, and China. Based on the National Health Insurance Research database in Taiwan, 18% of the hemiarthroplasty and 47% of the total hip arthroplasty were performed under the diagnosis of ONFH. Of them 79% to 84% were male patients at the age around 50 years. The demographic characteristics are similar in Asian countries but very different from the western countries that ONFH accounts for 3% THA patients in UK and 10% in USA. In Taiwan, hemiarthroplasty had been done for many early collapsed hips in the past because a prior peer-review program was implemented for insurance coverage. Surprisingly, the 9-year survival rate of 94% and the 6-year revision rate of 3.6% in hemiarthroplasty patients were better than the 79% survival and the 7.2% revision in THA patients in registry data. The major cause of revision in THA

patients was the high incidence of osteolysis related to the conventional polyethylene. With the advancement of bearing surface and the regulatory modification, hemiarthroplasty lost its popularity for ONFH currently.

The most common risk factors are alcohol in 58% and steroid in 13% patients. Bilateral hip involvement is around 78%. With a mean follow-up of 13 months, 60% of the asymptomatic hips may progress and need THA. The accumulated dose of corticosteroid is highly associated with the development of ONFH. In patients with autoimmune disorders who have taken corticosteroid, around 1% of them may develop ONFH. With the prednisolone equivalent daily dose of 30 mg, the hazard ratio is 9.4.

Idiopathic ONFH was attributed to 27% patients whom no known risk factors could be identified. However by using the 1 million population data of the National Health Insurance Research Database, ONFH patients might have underlying coagulopathy because they had higher incidence of unprovoked venothrombotic events, cerebrovascular events, and cardiovascular events as compared with sex- and age-matched controls. Single nucleotide polymorphisms of FV, MTHFR, and eNOS as well as miRNA biomarkers also suggest the possible links of coagulopathy, cell proliferation, osteogenic differentiation to the genetic predilection in Taiwanese patients. Whether these findings can be attributed to the higher incidence of ONFH in Taiwan are of interests and warrant further studies.

Session II.
LCP

August 26(Fri.), 2022 10:50-12:00

MODERATORS

Soon Hyuck Lee

Seoul Red Cross Hosp., Korea

Taek Rim Yoon

Chonnam National Univ., Korea

Session II. LCP

Treatment strategy of Late-onset LCP

Soon Hyuck Lee

Seoul Red Cross Hosp., Korea

[CURRICULUM VITAE]

Emeritus Professor, College of Medicine, Korea University
Chief Staff, Department of Orthopedic Surgery, Seoul Red Cross Hospital

1991-2022	Professor, Depart. of Orthop. Surg., College of Medicine, Korea University
1994-1995	Traveling fellow, Nuffield Orthopaedic Centre, Oxford, UK
2009-2014	Editor-in-Chief Journal of Korean Orthopedic Ultrasound Society
2012-2019	Editor-in-Chief Journal of Korean Orthopedic Association
2009-2010	President Korean Society of Bone and Soft Tissue Transplantation
2010-2011	President Korean Pediatric Orthopedic Society
2011-2012	President Korean A.S.A.M.I.
2015-2016	President Korean Orthopedic Ultrasound Society
2015-2017	President Korean Society of Independent Medical Examiner

[ABSTRACT]

Legg-Calvè-Perthes disease, reported by Arthur Legg, Jacque Calvè, and Georg Perthes respectively in 1910, is a childhood hip condition in which the blood supply to the capital femoral epiphysis is interrupted, causing osteonecrosis that lead to progressive deformity of the femoral head and secondary degenerative osteoarthritis in later life. The etiology of LCP disease have been unclear. The predominant opinion is that LCP disease is caused by a combination of genetic and environmental factors. Interruption of the blood supply to the capital femoral is temporary; complete re-vascularization of the epiphysis occurs over a period of 2-4 years. During the process of revascularization the necrotic bone is completely replaced by healthy new bone. Osteoclastic bone

resorption is the principal repair response after revascularization. In the area of bone resorption, appositional new bone formation is delayed while these areas are being replaced with fibrovascular tissue. Therefore, the mechanical properties of the femoral head are compromised Mechanical loading causes fracture and deformity of the femoral head. The shape of the femoral head plays an essential role in the prognosis. Treatment is needed in susceptible children to prevent the femoral head from getting deformed.

The treatment of LCP disease remains controversial but is dependent mainly on the age and the stage of the disease. The extent of epiphyseal involvement and the degree of femoral head deformity are also considered. The treatment aimed at preventing femoral head deformation must be instituted at the early part of the disease. Treatment at the later stage is not preventive but salvage in nature. The choice between operative and nonoperative treatment is based on the concept of containment. Containment involves maintaining the femoral head within the acetabulum throughout the entire evolution of the disease, thereby protecting the vulnerable segment of the epiphysis from being subjected to deforming forces. Operative methods such as femoral, pelvic or combined osteotomy, shelf acetabuloplasty, core decompression and arthrodisastasis are suggested. The clinical onset of LCP disease usually occurs in children between the ages of 4 and 8 years. Patients in whom the disease presents before the age of 8 years have a substantially better outcome than those in whom it presents after 8 years. Late presenting LCP disease in adolescent patients has been associated with poor results. Because the late-onset LCP present different natural course and prognosis, treatment strategy for them should be different.

Session II. LCP

Classification of residual stage LCP and long term prognosis

Moon Seok Park

Seoul National Univ., Korea

[CURRICULUM VITAE]

1992-1999	M.D., College of Medicine, Seoul National University, Seoul, Korea
2002-2004	M.S., Orthopaedic Surgery, College of Medicine, Seoul National University, Seoul, Korea
2005-2011	Ph.D., Microbiology and Immunology, College of Medicine, Seoul National University, Seoul, Korea
1999-2000	Intern, Seoul National University Hospital
2000-2004	Resident, Department of Orthopaedic Surgery, Seoul National University Hospital
2004-2007	Clinical fellow, Department of Orthopaedic Surgery, Seoul National University Bundang Hospital
2007-2012	Assistant Professor, Department of Orthopaedic Surgery, Seoul National University Bundang Hospital
2012-2017	Associate Professor, Department of Orthopaedic Surgery, Seoul National University Bundang Hospital
2017-	Professor, Department of Orthopaedic Surgery, Seoul National University Bundang Hospital

[ABSTRACT]

Session II. LCP

Manangement of redisual deformity of LCP

Jong Sup Shim

Sungkyunkwan Univ., Korea

[CURRICULUM VITAE]

1977-1983	Seoul National University, College of Medicine (M.D.)
1991-1996	Seoul National University, College of Medicine (Ph. D)
1983	Seoul National University Hospital (Internship)
1984-1988	Seoul National University Hospital (Residency in Orthopedic Surgery)
1991-1992	Seoul National University Children's Hospital (Fellowship in Ped. OS)
2009-2013	Director, Division of Education and Training, Samsung Medical Center, Seoul
2014-2016	Director, Division of Patient Experience Management, Samsung Medical Center, Seoul
2013-2017	Chairman, Department of Orthopedic Surgery, Samsung Medical Center, Seoul,
2015-2016	President, Korean ASAMI
2016-2017	President, Korean Pediatric Orthopedic Society (KPOS)
2010-2021	APPOS (Asian Pacific Pediatric Orthopedic Society) (Board Member, National delegate)
Present	Professor, Department of Orthopedic Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea

[ABSTRACT]

About 50% of Legg-Perthes patients require aggressive treatment, and if treatment is not done appropriately, it leaves residual deformity. Moreover, when the patient is older or if the avascular segment of the head is large, the possibility of residual deformity increases, no matter what treatment is performed in the early stages. There is a wide variety of the types of residual deformities, including femoro-acetabular impingement (FAI), osteochondral lesion, subluxation, and joint deformation (coxa magna, coxa vara, coxa breva). In addition, joint movement may be limited due to hinged abduction or intra-articular incongruity. Leg-length discrepancy or abnormal knee angle

(esp. genu valgum) of the lower extremities can occur as residual deformity.

1) Incongruity-FAI

The primary indication for surgical treatment of FAI is persistent pain despite conservative therapy, with radiographic and physical examination findings consistent with FAI. FAI can be treated arthroscopically or by open procedure (surgical dislocation and chondroplasty).

2) Osteochondral lesion

In a few cases of LCPD, hip pain appears late in adolescence after the patient has been asymptomatic for several years. Complaints of locking, catching, or crepitation can indicate the presence of an osteochondral lesion in the femoral head. Radiographs may demonstrate a lucent area in the central part of the head; however, it is often difficult to differentiate a loose body from softened cartilage and fibrous tissue. To help establish the diagnosis, MRI or arthrography should be performed. If the contrast material surrounds the defect, it is most likely a loose fragment. If the conservative treatment is not satisfactory, surgery can be considered. The hip may also be approached through an arthrotomy; however, to visualize the central fragment, the surgeon may need to dislocate the joint.

3) Subluxation

The persistent extrusion of the femoral head from acetabulum can occur by coxa magna or subluxation in residual stage. In that situation, the hip joint with eccentric stress result in early degenerative arthritis. The shelf operation, Chiari osteotomy or head reduction operation can be performed in that situation.

4) Hinged abduction

Deformity with flattening of the femoral head result in hinged abduction. If hip abduction is limited by the deformed femoral head, valgus osteotomy with or without acetabular procedure is needed. Femoral head reduction osteotomy allows for reshaping of the femoral head with the goal of improving head sphericity, containment, and hip function.

5) Indirect long-term effect on the lower extremity

Growth arrest of proximal femur by avascular necrosis result in coxa vara with greater trochanter overriding and leg-length discrepancy. If coxa vara is severe, valgus osteotomy of the proximal femur or trochanteric distal transfer is an optional surgery to correct the deformity and to reduce the T- gait.

Long standing coxa vara sometimes result in secondary genu valgum in the knee joint. If the

mechanical axis is normal range, coxa vara can be compensated with hidden genu valgum. However, if valgus osteotomy of the proximal femur is performed, hidden genu valgum will appear exaggerated. So, in that situation, valgus osteotomy of the proximal femur needs varus osteotomy of the distal femur to normalize the mechanical axis at the same time.

Leg length equalization may be needed, if the leg length discrepancy is severe (usually more than 2 cm).

Session II. LCP

Arthroscopic treatment of LCP sequelae

Jungmo Hwang

Chungnam National Univ., Korea

[CURRICULUM VITAE]

Assistant Professor
Department of Orthopedic Surgery, Chungnam National University Hospital, Daejeon, Korea

[ABSTRACT]

Background: The residual hip deformities after Legg-Calvé-Perthes disease (LCPD) cause mechanical symptoms and are associated with a pathomechanical environment that can feature femoroacetabular impingement (FAI).

Purpose: To evaluate the clinical and radiological outcomes in residual or healed LCPD after arthroscopic treatment.

Patients and methods: We retrospectively reviewed patients with LCPD amongst patients with FAI who underwent arthroscopic treatment between January 2009 and June 2013. We determined LCPD through 3-dimensional computed tomographic scans and simple radiography of the hip joint. The clinical outcomes were rated using a visual analogue scale pain score (VAS), the modified Harris Hip Score (mHHS) and hip range of motion (ROM) preoperatively and at the 2-year follow-up. All radiographs were assessed using the Tönnis classification system preoperatively and at the final follow-up of each patient. There were 23 patients (14 men, 9 women) with mean age 26.4 (range, 16-49) years undergoing arthroscopic treatment for FAI symptoms because of residual or healed LCPD.

Results: At the 2-year follow-up, the mean VAS had improved significantly from 6.7 to 2.1, the mean mHHS had improved significantly from 62.6 to 87.4, and hip flexion and external rotation had improved significantly from 88.7° to 106.5° and from 20.4° to 33.5°, respectively (all $p<0.001$). The Tönnis osteoarthritis grade had not changed in any patient at the latest follow-up.

Conclusions: Arthroscopic treatment for sequelae of LCPD relieved symptoms and improved range of motion, making arthroscopic treatment a good option for the sequelae of LCPD.

Session II. LCP

Outcome of THA in patients diagnosed with LCP sequelae

Kyung Hag Lee

National Medical Center, Korea

[CURRICULUM VITAE]

1995-2001	Bachelor Degree: Seoul National University College of Medicine
2008-2010	Master degree: Seoul National University College of Medicine, Orthopedic surgery
2010-2017	Doctoral degree(PhD): Seoul National University College of Medicine, Orthopedic surgery
2018-2021	Master degree, Korea National Open University, Education
2009-2011	Seoul National University Bundang Hospital Fellow (Hip, Knee Fellowship: KooKH)
2011-2012	Seoul National University Hospital Fellow (Spine, Trauma Fellowship)
2011-2013	Seoul National University Trauma Center, Orthopedics
2013-	National Medical Center, Orthopedic Surgery & Traumatology
2021	Head of Department of Orthopedic surgery
2016-	International interchange director, Korean Society of Traumatology

[ABSTRACT]

Legg-Calve-Perthes (LCP) disease is an avascular necrosis of the femoral head in childhood, which results in early arthritis especially in Stülberg class III, IV, and V patients. Anatomical deformity in proximal femur includes head flattening, shortened neck, increased anteversion, coxa vara, and trochanteric overhanging. Deformity in acetabulum includes shallow and retroverted orientation. Therefore, in performing total hip arthroplasty (THA) in LCP patients, these anatomical deformities should be considered in surgical planning, Moreover, leg length discrepancy exists, which can result in postoperative nerve injury after lengthening, and the patients undergoing THA are typically young, which can have a negative impact on the long term result of THA performed in this patient population.

Literature review was performed. In the literature, various implants including monobloc, modu-

lar and custom-made femoral stems, various fixation methods including cementless, hybrid, and all cemented techniques, and various articulation including metal on poly, ceramic on poly, metal on metal, and ceramic on ceramic was used. Results included complications including intraoperative femoral fracture, dislocation, nerve palsy, and heterotrophic ossification (H.O.), and long-term survival rate was also reported.

The incidence of intraoperative fracture was 8.2% in monobloc group and 0% in modular /custom-group. Bicontact stem showed high fracture rate. Most of the fractures were treated with cerclage wiring and the fracture was not associated with long term failure. The incidence of acute dislocation was 0.6% in monobloc group and 2% in modular/custom-made group. In modular group, the direction of dislocation was posterior. The incidence of nerve palsy was 2.3% and most recovered spontaneously, and there was one case of acute revision (cup medialization and stem downsizing). The incidence of heterotrophic ossification was 5.5% and only one case was removed with operation. Long term result was not different compared with AVN group and primary OA group, and acetabular revision rate was higher than femoral revision, and the cup loosening was associated with cup design (P-M cup) and articulation (metal on poly).

In conclusion, conventional, monobloc stem was sufficient in most cases. When using conventional stem, care should be taken to prevent intraoperative femoral fracture, and the fracture is related to some specific stem design. Sciatic nerve palsy is frequent, and be cautious in lengthening the limb. H.O. can be observed, which does not need additional treatment in most cases. Survival of THA is good as OA/AVN, and as the implant design and articulation improves, the result will be better in the future.

Lunch & Luncheon Symposium

August 26(Fri.), 2022 12:00-13:10

MODERATORS

Young-Hoo Kim

SeoNam Hosp., Korea

Ye Yeon Won

Ajou Univ., Korea

Lunch & Luncheon Symposium

Mirabo cup and M stem: Solution for inguinal pain, thigh pain, neck-liner impingement, instability and ceramic liner malseating

Kyung-Hoi (Kay) Koo

Seoul National Univ., Korea

[CURRICULUM VITAE]

Professor, Department of Orthopaedic Surgery, Seoul National University College of Medicine and Seoul National University Bundang Hospital, Seongnam, South Korea.

Dr. Koo is a professor of Department of Orthopaedic Surgery, Seoul National University Bundang Hospital, South Korea. He is a musculoskeletal radiologist as well as an orthopaedic surgeon. During last 30 years, he has exclusively performed hip surgeries. He is interested in femoral head osteonecrosis and has actively participated in ARCO since 1994. He was President of ARCO from 2012 to 2015 and published a textbook "Osteonecrosis" with Michael A. Mont and Lynne C. Jones in 2014. This book has been chapter downloaded by more than 120,000 times. Since 1997, he has used ceramic-on-ceramic bearings in total hip arthroplasty and has been instrumental in bringing ceramic-on-ceramic total hip arthroplasty. He has published over 300 peer-reviewed articles and more than 10 book chapters regarding femoral head osteonecrosis and total hip arthroplasty. He was an editor of the Bone and Joint Journal from 2015 to 2018 and currently, he is an editor of the Journal of Arthroplasty.

[ABSTRACT]

Unsolved problems of cementless total hip arthroplasties (THAs) are iliopsoas tendinitis, thigh pain, neck-liner impingement, instability and ceramic liner malseating in case of ceramic-on-ceramic THA.

In a previous study, iliopsoas tendinitis Iliopsoas impingement has been reported in 2.4% (24/1000). The incidence was up to 22.2% in THA for secondary osteoarthritis due to DDH.

Protruded metal shell outside the acetabulum seems to be the cause of iliopsoas tendinitis and persistent groin pain after THA.

Most metal shells are hemispherical and anterolateral portions might be protruded especially in dysplastic or shallow acetabulum.

The outer wedge of Mirabo cup is chamfered. Thus, the cup is completely seated inside the acetabulum usually with no protrusion, and reduces iliopsoas tendinitis.

Thigh pain is an annoying problem after seemingly uneventful THA. The incidence of thigh pain ranged from 5% to 27%.

Micromotion at the stem tip-cortical bone interface and stress concentration at the stem tip have been known as the etiologies of thigh pain. Long stem with distal fit, high elasticity modulus of the stem, and extensive coating have been suggested as the risk factors for thigh pain. Thus, many manufactures developed short length titanium stems with proximal coating. However, stem thickness is a major determinant of elasticity modulus of the stem. M stem, a tapered short length titanium stem with proximal coating, is much thinner and the elastic modulus is much low compared to other short stems.

Stem neck-liner impingement leads to stem-neck notching, excessive wear/failure of PE liner, and ceramic liner fracture. In a recent study, the impingement incidence was 11% (49 of 456). M stem has slimmed-neck geometry and minimizes neck-liner impingement.

Instbility: dislocation/psedosubluxation is frequent in THA of dysplastic hips. M stem: dual offset system and the high-offset M stem prevents dislocation.

Ceramic liner malseating is the major reason for ceramic liner fracture. a low inner taper angle (10°) of metal shell is a risk factor for malseating of the ceramic liner. In Mirabo cup, the inner taper angle is 18° and there is actually no risk of liner malseating.

MEMO

Session III.
Diagnostic Criteria, Staging and Classification

August 26(Fri.), 2022 13:10-14:10

MODERATORS

Takashi Sakai

Yamaguchi Univ., Japan

Nobuhiko Sugano

Osaka Univ., Japan

Session III. Diagnostic Criteria, Staging and Classification

Diagnostic criteria

Woo Lam Jo

The Catholic Univ. Korea, Korea

[CURRICULUM VITAE]

1999-2005	Bachelor of Medicine, Medical College of Catholic University, Seoul, Korea
2007-2009	Bachelor of Statistic, Korea national open university
2013-2017	Master/Doctor's Course of Orthopaedics, Medical College of Catholic University, Seoul
2005-2006	Internship Medical College of Catholic University, Seoul
2009-2013	Resident of Orthopaedics, Medical College of Catholic University, Seoul
2013-2014	Fellowship, hip and knee Surgery, Yeouido St. Mary's hospital, Seoul, Korea
2014-2016	Clinical professor, hip Surgery, Bundang Seoul national university of Korea.
2016-2017	Fellowship, hip and pediatric orthopaedic Surgery, Seoul St. Mary's hospital, Seoul, Korea
2017-2019	Clinical Assistant professor, hip and pediatric orthopaedic Surgery, Seoul St. Mary's hospital, Seoul, Korea
2020-present	Assistant professor, hip and pediatric orthopaedic Surgery, Seoul St. Mary's hospital, Seoul, Korea

[ABSTRACT]

Various techniques have been used for the diagnosis of osteonecrosis of the femoral head, but no single method has been shown to be superior.

Imaging diagnosis of osteonecrosis can use various modalities such as plain radiograph, magnetic resonance imaging (MRI), computed tomography (CT), radionuclide examination, and PET-CT. Plain radiograph and MRI is frequently used as diagnostic purpose for the examination. When it shows unilateral osteonecrosis on plain radiograph, radionuclide examination is used to determine whether there is involvement of the contralateral femoral head or not.

In 1986, the Japanese Investigation Committee for osteonecrosis proposed diagnostic criteria that

consisted of patient history, symptoms, radiographic signs, bone scan findings, and histologic findings. These criteria were revised in 1990 to include MRI findings.

1. Collapse of the femoral head without joint-space narrowing or acetabular abnormality on x-rays (including crescent sign)
2. Demarcating sclerosis in the femoral head without joint space narrowing or acetabular abnormality
3. "Cold in hot" on bone scans Low-intensity band on T1-weighted images (bandlike pattern)
4. Trabecular and marrow necrosis on histology.

Plain radiographs can be figured with simple examining and can also be used to classify according to classic classifications. However, there is a weakness that sensitivity might decrease on preradiographic stage. MRI is expensive, but has relatively high sensitivity and specificity so that it makes detection on early diagnosis stage possible. CT is more delicate than a plain radiograph but it has a lower sensitivity than MRI and is not appropriate to apply on preradiographic stage. Radionuclide examination has a high sensitivity but also has a high false positive rate as well. Positron emission tomography-computed tomography (PET-CT) is not used to diagnose osteonecrosis but patients who are examined by PET-CT for osteonecrosis can show local uptake of FDG. In this case, discrimination between osteonecrosis of the femoral head and metastasis is needed.

X-ray

In osteonecrosis (ON) of the femoral head shown at preradiographic stage on a plain radiograph, the sensitivity is relatively low that dead bone can be seen as normal with no shaded area. However, plain radiograph may be helpful to grasp the overall structure of the surrounding area and can be used as an imaging examination for the progress of the lesion with repeated examinations.

MRI

MRI is considered the method of choice for detecting and staging ON due to its multiplanar imaging, excellent soft tissue contrast, and ability to discriminate fat from other tissues in the bony marrow

CT

CT shows diagnostic findings on advanced stage but less sensitive on preradiographic stage. On the advanced stage, the subchondral fracture or collapse is more clearly visualized than radiographs and the extensive sclerosis on the living bone can be accompanied.

Bone scan

used for the early diagnosis of ON at the femoral head. Bone scans can detect ON earlier than conventional radiography, they are not sensitive as MRI.

SPECT

Single photon emission computed tomography (SPECT) may improve radionuclide sensitivity for the diagnosis of ON. SPECT can contribute to the accurate diagnosis of ON by identifying photopenic defects on serial images that may not be evident on bone scans.

PET-CT

Positron emission tomography (PET) scans provide a real-time image of physiology based on the type of radiolabeled marker used.

Session III. Diagnostic Criteria, Staging and Classification

ARCO staging

Byung-Ho Yoon

Ewha Womans Univ., Korea

[CURRICULUM VITAE]

1998-2000	College of Natural Sciences, Hanyang University, BA
2000-2004	College of Medicine, Hanyang University, MS
2005-2007	Post Graduate School, Cha University, MD
2007-2017	Post Graduate School, Cha University, Ph. D
2012-2014	Department of Orthopaedic Surgery, Seoul National University Bundang Hospital, Fellowship
2014-2019	Department of Orthopaedic Surgery, Inje University, Seoul Paik Hospital, Assistant Professor
2019-2021	Department of Orthopaedic Surgery, Inje University, Seoul Paik Hospital, Associate Professor
2021-present	Department of Orthopaedic Surgery, Mokdong Hospital, Ewha Womans University, Associate Professor

[ABSTRACT]

Conventional staging systems include those described by Marcus and coauthors, Ficat and Arlet, and Steinberg and associates but after the widespread use of MRI for the diagnostic workup of osteonecrosis in the late 1980s, there has been an adoption of classification, which is based on MRI, easy to understand, and valid to compare treatment results.

In 1991, the Association Research Circulation Osseous (ARCO) developed the first international classification system based on the system of Ficat and Arlet and that of Steinberg et al University of Pennsylvania classification). The original ARCO classification was composed of 7 stages of disease progression with a subdivision of location and size of the necrotic lesion. Because this classi-

fication was not practical or easy to apply in clinical and research settings, ARCO tried to simplify the original classification.

In 1994. The modified ARCO classification system had 5 stages with the same subdivisions as the 1991 classification; with the original stages III and IV integrated into stage III and the original stages V and VI integrated into stage IV. Unfortunately, this modified version has not been widely used, and only the staging without the subdivisions has been used because of several reasons. First, the system appears to be too complicated for practical use. Second, stage 0 lesions, was poorly defined and did not always result in osteonecrosis. Third, stage III lesions with minimal collapse of the femoral head do not always progress to more advanced stages, and they might have better prognosis than lesions with definite collapse after joint-preserving treatments.

In 2013, ARCO held an international consensus meeting with the goal of revising the classification system once again. Unfortunately, consensus was not achieved despite intensive discussion because of a disagreement about the lesion size/extent subdivisions that are closely related to the prognosis of ONFH. Under these circumstances, in October 2018, another attempt, was undertaken to revise the 1994 classification system of ONFH using a Delphi approach.

Our revised staging system offer reproducibility and accuracy in judging disease progression, while being clinically relevant to the treatment options. In addition to enabling the diagnostic information, our new system also provide the basis for the compilation of clinical and epidemiological statistics. Now our revised classification system widely accepted in various fileds and convinced by citiation numbers from 2020-2022.

60 citations in Web of Science (SCIE)

71 citations Pubmed

97 citations in Google Scholar searched at 08-Aug-2022

Session III. Diagnostic Criteria, Staging and Classification

ARCO classification

Kyung-Hoi Koo, Michael A Mont, Quanjun Cui, Jeremy T Hines, Byung-Ho Yoon, Wendy M Novicoff, Yun Jong Lee, Edward Y Cheng, Wolf Drescher, Philippe Hernigou, Shin-Yoon Kim, Nobuhiko Sugano, De-Wei Zhao, Yong-Chan Ha, Stuart B Goodman, Takashi Sakai, Lynne C Jones, Mel S Lee, Takuaki Yamamoto, Young-Kyun Lee, Yusuhn Kang, James Burgess, Dennis Chen, Nicole Quinlan, Jian Zhong Xu, Jung-Wee Park, Hong-Seok Kim

Univ. of Virginia, USA

[CURRICULUM VITAE]

Dr. Quanjun Cui is the G.J. Wang M.D. Professor of Orthopaedic Surgery and Vice Chair for Research. Dr. Cui received his medical degree from Henan Medical University with Honors in China and then completed residency and Fellowship training in Adult Reconstruction at the University of Virginia. He Also completed an AO fellowship at the University of Bern in Switzerland. He is a board-certified orthopaedic surgeon and specializes in total hip and knee replacement, osteonecrosis, computer-aided and minimally invasive surgery for total hip and knee arthroplasty.

Dr. Cui has written over 150 papers and book chapters and has edited 9 text books. He has served as faculty member for several national and international instruction courses including AAOS Instruction Courses, Advances in Arthritis, Arthroplasty and Trauma, and Advances in Surgical Technology. Dr. Cui has also served as Program Chair and Faculty Member at state, national and international meetings. He is a board member and reviewer for several prestigious journals including the Journal of Arthroplasty, and the Journal of Orthopaedic Research. Dr. Cui is a fellow of the American Academy of Orthopaedic Surgeons and the American Orthopaedic Association (AOA). He served as President of the Virginia Orthopaedic Society in 2017-2018 and President of ARCO in 2020-2021.

[ABSTRACT]

Background: The Association Research Circulation Osseous developed a novel classification for early-stage (pre-collapse) osteonecrosis of the femoral head (ONFH). We hypothesized that the novel classification is more reliable and valid when compared to previous 3 classifications: Steinberg, modified Kerboul, and Japanese Investigation Committee classifications.

Methods: In the novel classification, necrotic lesions were classified into 3 types: type 1 is a small lesion, where the lateral necrotic margin is medial to the femoral head apex; type 2 is a medium-sized lesion, with the lateral necrotic margin being between the femoral head apex and the lateral acetabular edge; and type 3 is a large lesion, which extends outside the lateral acetabular edge. In a derivation cohort of 40 early-stage osteonecrotic hips based on computed tomography imaging, reliabilities were evaluated using kappa coefficients, and validities to predict future femoral head collapse by chi-squared tests and receiver operating characteristic curve analyses. The predictability for future collapse was also evaluated in a validation cohort of 104 early-stage ONFH.

Results: In the derivation cohort, interobserver reliability (k = 0.545) and intraobserver agreement (63%-100%) of the novel method were higher than the other 3 classifications. The novel classification system was best able to predict future collapse ($P < .05$) and had the best discrimination between non-progressors and progressors in both the derivation cohort (area under the curve = 0.692 [0.522-0.863], $P < .05$) and the validation cohort (area under the curve = 0.742 [0.644-0.841], $P = 2.46 \times 10\text{-}5$).

Conclusion: This novel classification is a highly reliable and valid method of those examined. Association Research Circulation Osseous recommends using this method as a unified classification for early-stage ONFH.

Session III. Diagnostic Criteria, Staging and Classification

AI deep learning

Bomin Kim[1], Guen Young Lee[2], Sung-Hong Park[1]

[1]Department of Bio and Brain Engineering, Korea Advanced Institute of Science and Technology, Korea
2Department of Radiology, Chung-Ang University Gwangmyeong Hospital, Korea

[CURRICULUM VITAE]

1996-2004	M.D., Ewha Womans University, College of Medicine, Seoul, Korea
2006-2008	M.S., Department of Radiology, Ewha Womans University College of Medicine, Seoul, Korea
2009-2012	Ph.D., Department of Radiology, Ewha Womans University College of Medicine, Seoul, Korea
2003-2004	Internship, Catholic University Medical Center, Seoul, Korea
2004-2008	Residency, Department of Radiology, Ewha Womans University Mokdong Hospital, Seoul, Korea
2008-2009	Fellowship, Section of Musculoskeletal Imaging & Spine Pain Intervention, Department of Radiology, Seoul National University Bundang Hospital, Gyeonggi-do, Korea
2009-2011	Fellowship, Section of Musculoskeletal Imaging, Department of Radiology, Korea University Ansan Hospital, Gyeonggi-do, Korea
2011-2015	Clinical Assistant Professor, Section of Musculoskeletal Imaging & Spine Pain Intervention, Department of Radiology, Seoul National University Bundang Hospital, Gyeonggi-do, Korea
2015-2016	Clinical Assistant Professor, Section of Musculoskeletal Imaging, Department of Radiology, Chung-Ang University Hospital, Seoul, Korea
2016-2017	Clinical Associate Professor, Section of Musculoskeletal Imaging, Department of Radiology, Chung-Ang University Hospital, Seoul, Korea
2017-2020	Assistant Professor, Section of Musculoskeletal Imaging, Department of Radiology, Chung-Ang University Hospital, Chung-Ang University College of Medicine, Seoul, Korea
2020-2022	Associate Professor, Section of Musculoskeletal Imaging, Department of Radiology, Chung-Ang University Hospital, Chung-Ang University College of Medicine, Seoul, Korea
2021-2022	Visiting Professor, Department of Bio and Brain Engineering, Korea Advanced Institute of Science and Technology (KAIST), Daejeon, Korea.
2022-present	Associate Professor, Section of Musculoskeletal Imaging, Department of Radiology, Chung-Ang University Gwangmyeong Hospital, Chung-Ang University College of Medicine, Seoul, Korea

[ABSTRACT]

Introduction: We claim that deep-learning based MR-only ONFH staging with only a small number of data can be done via self-supervised learning, which is our major contribution.

Method:

Data Preparation and Preprocessing

MR images with 4 different protocols (T1COR TSE, T2DixonWCOR TSE, T1AXI TSE, T2SAG TSE) and CT images were obtained from 48 patients and categorized to 4 levels based on ARCO staging system. Every MR and CT image was first aligned with each other using SimpleITK library, cropped to two 16x80x80 shaped patches containing FH region. Excluding those with misalignment or total hip arthroplasty, the number of hips in each protocol varied from 78 to 87. All of them were used for self-supervised learning and about half of them (39 hips) were used for staging.

Overall Process

The overall process is composed of three steps:1) self-supervised learning, 2) staging, and 3) combining. We built an encoder-decoder network that performed MR-to-CT translation. The encoder part using U-net and followed the VGG-11 architecture was extracted and used as a feature embedding network for staging. A CNN network took the feature embedding of each input image from the encoder and performed a 4-way classification. The output was the probability distribution for each stage. Both steps were performed for each MR protocol and combined via soft-voting.

Training and Evaluation

We used leave-one-out validation due to the lack of data. Area under the curve (AUC) was reported for evaluation of classification models.

Results: Self-supervised learning significantly improved performance when more data was available. The final staging result was obtained by combining all four probability distributions from each protocol, resulting in AUC of 0.81.

Conclusion: Translation-based self-supervised learning can provide a powerful way to learn representations for MR-only ONFH diagnosis when number of labeled data is not enough.

Session IV.
Free Paper 1

August 26(Fri.), 2022 14:10-16:00

MODERATORS

Zhao Dewei

Dalian Univ., China

Yong-Chan Ha

Seoul Bumin Hosp., Korea

Session IV. Free Paper 1

Dietary intake of vitamin E and cryptoxanthin are inversely associated with osteonecrosis of the femoral head: A multicenter case-control study in Japan

Wakaba Fukushima[1], Takuaki Yamamoto[2], Takashi Sakai[3], Wataru Ando[4], Tetsuro Tani[5], Nobuhiko Sugano[6]

[1]Department of Public Health, Osaka Metropolitan University Graduate School of Medicine, Osaka, Japan,
[2]Department of Orthopaedic Surgery, Fukuoka University Faculty of Medicine, Fukuoka, Japan,
[3]Department of Orthopedic Surgery, Yamaguchi University Graduate School of Medicine, Yamaguchi, Japan,
[4]Department of Orthopaedic Surgery, Kansai Rosai Hospital, Hyogo, Japan,
[5]Department of Orthopaedic Surgery, Osaka Police Hospital, Osaka, Japan,
[6]Department of Orthopaedic Medical Engineering, Osaka University Graduate School of Medicine, Osaka, Japan

Introduction: Some studies have shown that osteonecrosis of the femoral head (ONFH) is prevented by administration of vitamin E, a well-known potent antioxidant, to a rabbit model affected by steroid-associated ONFH. Although it can be hypothesized that dietary intake of nutrients with antioxidant activity may reduce the risk of ONFH, such a relationship has not been examined. We aimed to evaluate the association between dietary intake and ONFH among Japanese, with focusing on nutrients with antioxidant activity.

Methods: From June 2010 to March 2016, we recruited 121 incident ONFH cases who were diagnosed with Japanese Investigation Committee criteria and 213 age- and sex-matched controls (109 from orthopaedic departments and 104 from other departments) in a multicenter hospital-based case-control study. Daily intake of vitamin E, as well as carotenoids and other selected nutrients (α-carotene, β-carotene, cryptoxanthin, retinol, vitamin C, vitamin D, and vitamin K), were estimated using a validated diet history questionnaire. Logistic regression model was used to calculate odds ratio (OR) and 95% confidence interval (CI) for ONFH.

Results: Intake of vitamin E and cryptoxanthin were inversely associated with ONFH. Multivariate ORs (95%CIs) of highest tertile were 0.36 (0.17-0.78) and 0.33 (0.15-0.73), respectively, with significant dose-response relationships (p for trend: <0.01 for each). These findings were robust under several sensitivity analyses, and also observed in subjects without systemic steroid use

during the previous year. There was no significant inverse relationship in subjects with systemic steroid use, although the OR point estimate of highest tertile was still below unity for vitamin E intake (0.44).

Conclusion: Dietary intake of vitamin E and cryptoxanthin may reduce the likelihood of developing ONFH. The potential benefits of vitamin E on steroid-associated ONFH deserve to be further investigated.

Session IV. Free Paper 1

Autocrine activity of exosomes in glucocorticoid-induced injury of bone microvascular endothelial cells identified by protein array

Fuqiang Gao, Wei Sun

Centre for Osteonecrosis and Joint-Preserving & Reconstruction, Orthopaedic Department, China-Japan Friendship Hospital, China

Glucocorticoid could induce injury and apoptosis of bone microvascular endothelial cells (BMECs) in the femoral head and the application of icariin showed a protective effect. However, the impact of autocrine exosomes during these processes is still to be confirmed. In this study, exosomes were extracted from BMECs treated with hydrocortisone or hydrocortisone plus icariin by super-speed centrifugation. Exosomes secreted by BMECs could ameliorate glucocorticoid-induced endothelial cellular injury, improve cell viability, decrease cell apoptosis, and promote cell migration and angiogenesis compared with the blank control. Although icariin treatment would not significantly change the size and total protein content of BMECs-derived exosomes, expression of exosome-carried vascular endothelial growth factor (VEGF) and transforming growth factor β1 (TGF-β1) was enhanced and numerous miRNAs involved in cell proliferation and apoptosis were up-regulated (e.g., hsa-miR-1469 and hsa-miR-133a-5p) or down-regulated (e.g., hsa-miR-10b-5p) ($p < 0.05$). 29 differentially expressed inflammatory factors were detected between the exosomes secreted by the Icariin-treated and the Model groups. To sum up, the present study indicates that autocrine exosomes could significantly improve glucocorticoid-induced injury of BMECs. Icariin intervention could reinforce these effects and may act as a promising drug for improving glucocorticoid-induced injury of BMECs. In vivo or animal studies are still required to better understand the function of BMEC-derived exosomes.

Session IV. Free Paper 1

Extracellular vesicles from BMSCs prevent Glucocorti-coid-Induced BMECs injury by regulating autophagy via the PI3K/Akt/mTOR pathway

Fuqiang Gao, Wei Sun

Centre for Osteonecrosis and Joint-Preserving & Reconstruction, Orthopaedic Department, China-Japan Friendship Hospital, China

Osteonecrosis of the femoral head (ONFH) is a common clinical disease with a high disability rate. Injury of bone microvascular endothelial cells (BMECs) caused by glucocorticoid administration is one of the important causes of ONFH, and there is currently a lack of effective clinical treatments. Extracellular vesicles derived from bone stem cells (BMSC-EVs) can prevent ONFH by promoting angiogenesis and can inhibit cell apoptosis by regulating autophagy via the PI3K/Akt/mTOR signaling pathway. The present study aimed to investigate the effect of extracellular vesicles de-rived from bone marrow stem cells (BMSC) on a glucocorticoid-induced injury of BMECs and possible mechanisms. We found that BMSC-EVs attenuated glucocorticoid-induced viability, an-giogenesis capacity injury, and the apoptosis of BMECs. BMSC-EVs increased the LC3 level, but decreased p62 (an autophagy protein receptor) expression, suggesting that BMSC-Exos activated autophagy in glucocorticoid-treated BMECs. The protective effects of BMSC-EVs on the gluco-corticoid-induced injury of BMECs was mimicked by a known stimulator of autophagy (ra-pamycin) and could be enhanced by co-treatment with an autophagy inhibitor (LY294002). BMSC-EVs also suppressed the PI3K/Akt/mTOR signaling pathway, which regulates cell au-tophagy, in glucocorticoid-treated BMECs. In conclusion, the results indicate that BMSC-EVs prevent the glucocorticoid-induced injury of BMECs by regulating autophagy via the PI3K/Akt/mTOR pathway.

Session IV. Free Paper 1

Delivery of MiR335-5p-Pendant tetrahedron DNA nanostructures using an injectable heparin lithium hydrogel for challenging bone defects in steroid-associated osteonecrosis

Donghai Li, Pengde Kang

Department of Orthopaedics Surgery, West China Hospital, Sichuan University, Chengdu, Sichuan, People's Republic of China

Corticosteroids-induced Dickkopf-1 (DKK1) upregulation and Wnt signaling inhibition result in bone metabolism disorder and steroid-associated osteonecrosis (SAON). Implanting biomaterials to regulate the Wnt pathway is a promising method to repair challenging bone defects associated with SAON. Here, tetrahedral DNA nanostructures (TDNs) are fabricated as gene carriers to deliver MiR335-5p, which targets DKK1 translation. Heparin lithium hydrogel (Li-hep-gel) is synthesized to act as a lithium and MiR@TDNs delivery agent. Finally, the repair effects on challenging bone defect in SAON using a MiR@TDNs/Li-hep-gel composite are assessed in vivo. The results reveal that MiR@TDNs are absorbed by bone mesenchymal stem cells (BMSCs) and increase cell viability and reduce apoptosis. Moreover, MiR@TDNs promote alkaline phosphatase expression and calcium nodular deposition, decrease lipid droplet expression of BMSCs, and improve vascular endothelial growth factor secretion and vascular-like structure formation in vitro. After MiR@TDNs/Li-hep-gel is implanted into the SAON model, the internal bone defect of osteonecrosis is repaired with a large area of new bone accompanied with neovascularization and reduced empty lacunae. In conclusion, MiR@TDNs/Li-hep-gel can provide dual delivery of lithium and MiR@TDNs, which synergistically upregulate the Wnt signaling pathway, enhancing bone regeneration in challenging bone defects, and can be potentially used in SAON repair.

Session IV. Free Paper 1

Low intensity band on FS T2WI of MRI indicates the changing from asymptomatic to symptomatic in necrotic femoral head

Min-Cong He, Qiu-Shi Wei

Guangdong Research Institute for Orthopedics and Traumatology of Chinese Medicine, Guangzhou, China

Background: The aim of this study was to assess the relationship between the low intensity band on fat-suppressed T2-weighted images (FS T2WI) of magnetic resonance imaging (MRI) and the instability the necrotic femoral head.

Methods: This study reviewed 246 patients (322 hips) with osteonecrosis of the femoral head (ONFH) in the Association Research Circulation Osseous (ARCO) stage II. These hips were divided into symptomatic and asymptomatic groups. Low intensity band on fat-suppressed T2WI, Bone marrow edema (BME), and joint effusion were evaluated using MRI. Subchondral fracture was assessed by CT. Odds ratios (ORs) and P value were calculated between these four parameters and symptoms.

Results: In all 322 hips, 193 hips (59.94%) were categorized as symptomatic and 129 hips (40.06%) as asymptomatic. The low intensity band on fat-suppressed T2WI showed the highest OR with regard to the presence of symptom (low intensity band on fat-suppressed T2WI: 22.987, BME: 19.535, subchondral fracture: 8.17, $P<0.001$). Finally, 28 of 156 (17.95%) symptomatic hips with the low intensity band on fat-suppressed T2WI eventually underwent surgical intervention at a mean interval of 3.53 months after MRI examination, while 2 of 109 (1.835%) asymptomatic hips without the low intensity band on fat-suppressed T2WI underwent surgical intervention after MRI examination.

Conclusions: The low intensity band on fat-suppressed T2WI of MRI is a sensitive and constant signal to indicate the instability inside the necrotic femoral head, which is closely related to the presence of symptoms and collapse of the femoral head.

Session IV. Free Paper 1

Sagittal pelvic posture in standing position might be associated with collapse progression in post-collapse stage osteonecrosis of the femoral head

Mingjian Xu, Goro Motomura, Satoshi Ikemura, Ryosuke Yamaguchi, Koichiro Kawano, Noriko Yamamoto, Hidenao Tanaka, Yusuke Ayabe, Yasuharu Nakashima

Department of Orthopaedic Surgery, Graduate School of Medical Sciences, Kyushu University, Japan

Introduction: To assess whether sagittal pelvic posture in the standing position correlates with progression of femoral head collapse in osteonecrosis of the femoral head (ONFH).

Methods: We investigated 107 patients (107 hips) diagnosed with Association of Research Circulation Osseous (ARCO) stage III ONFH at the first visit and who subsequently underwent surgical treatment. By a 2D-3D matching method, the sagittal pelvic posture in the standing position before surgery was quantified as the angle formed by the anterior pelvic plane and the vertical z-axis in the sagittal view (APP angle). An APP angle < 0^{o} indicated posterior pelvic tilt. Progression of collapse was calculated as collapse speed: [(collapse extent just before surgery) - (collapse extent at first visit)] / (time from first visit to surgery). The following factors potentially associated with collapse speed were evaluated: sex, age, BMI, etiology, pelvic incidence, contralateral hip condition, time interval between the first visit and surgery, size of necrotic lesion, location of necrotic lesion, and APP angle.

Results: The factors significantly associated with collapse speed were size of necrotic lesion, location of necrotic lesion, and APP angle. APP angle showed a negative correlation with collapse speed ($r = -0.40$, $p < 0.0001$). After stratifying by size of necrotic lesion (< 50% and ≥ 50% involvement) and location of necrotic lesion (JIC type C1 and C2), a significant negative correlation was observed between APP angle and collapse speed in each group.

Conclusion: Our results suggest that sagittal pelvic posture in the standing position before surgery might be associated with progression of femoral head collapse in ONFH.

Session IV. Free Paper 1

Prediction of femoral head avascular necrosis following femoral neck fracture: "pin-tract sign" of 99mTc-HDP pinhole bone scan after metallic fixation

Yoon-Vin Kim, Kee-Haeng Lee, Jong-Ho Noh, Jae-Young Lee

The Catholic University of Korea, Bucheon Saint Mary's Hospital, Korea

The objective of this study was to evaluate the predicting value of 99mTc-hydroxydiphosphonate (HDP) pinhole bone scan in development of osteonecrosis of femoral head (ONFH) in patients with femoral neck fracture after cannulated screw fixation. Pinhole bone scan of patients with metallically fixed femoral neck fracture from 2001 to 2015 were retrospectively reviewed. Initial pinhole bone scan was obtained within 2-3 weeks after surgery. Findings of initial pinhole bone scan were divided in to 4 groups. Group CU included cold defect in affected femoral head, group HU with no cold defect. Group PP with increased uptake along the inserted screws and group PN with no increased uptake along the inserted screws. More than 6 months of follow-up with pinhole bone scan and clinico-radiological evidence for ONFH was reviewed. 72 patients (mean age 54.01 years, male 22, female 50) were included. 19 patients were in group CU, 53 in group HU. 60 patients were in group PP, 12 in group PN. During the follow-up, 13 patients were diagnosed as ONFH. 9 (47.36%) patients in group CU developed ONFH and 4 (7.5%) in group HU. 4 (6.66%) patients in group PP developed ONFH and 9 (75%) in group PN. To predict ONFH of femoral head followed by neck fracture, many imaging techniques with variable results were known. In this study, cold defect in early postoperative pinhole bone scans could predict ONFH, and loss of increased uptake along screw inserted site could be a strong indicative sign of ONFH. Further evaluation with a larger population is necessary.

Session IV. Free Paper 1

Bilateral bone marrow edema syndrome and/or subchondral stress fracture of the femoral head

Hong Seok Kim[2], Hee Joong Kim[1], Jeong Joon Yoo[2]

[1]Yeson Hospital, [2]Seoul National University, Korea

Introduction: Bone marrow edema syndrome (BMES) and subchondral stress fracture (SSF) occur infrequently in the femoral heads. Their clinical and radiologic findings are quite similar to each other. Therefore, it could be speculated that two disease entities were relying on the spectrum of the same disease. The purpose of this study is to retrospectively evaluate the bilateral development of BMES and/or SSF, which is a much rarer situation.

Methods: Between 2009 and 2020, a total of 15 cases of bilateral BMES and/or SSF of the femoral head were presented in our clinic. There were 11 women and 4 men with a mean age of 37.0 years (range, 20.1-61.3 years) at the time of diagnosis. Their radiologic images were retrospectively reviewed. Depending on the evidence of fracture line, the cases were divided into 3 groups: SSF, suspicious SSF (SSSF), and BMES.

Results: There were 9 cases of bilateral SSF, 3 cases of SSF/SSSF, 3 cases of SSF/BMES, and no cases of bilateral BMES. Three patients were military recruits and both hip pains developed during the military training period. Four patients had a systemic disease that weakened their bone strength. In four female patients, hip pains developed around delivery. All patients had bone marrow edema found in both femoral heads on MR images. The osteonecrosis of the femoral head had not developed subsequently in any cases.

Conclusions: The results of this study highly support the suggestion that BMES is a minor form of subchondral bone injury and is on the same spectrum as the SSF disease entity.

Session IV. Free Paper 1

Multifocal osteonecrosis: Diagnostic value of bone scintigraphy

Bum-Jin Shim, Shin-Yoon Kim, Seung-Hoon Baek, Jae-Hyub Kim, Ji-Woon Lee

Department of Orthopedic Surgery, Kyungpook National University Hospital, Korea

Background: Multifocal osteonecrosis (ON), defined by the involvement of 3 or more anatomic sites, is observed only in around 3% of all ON patients. Although magnetic resonance imaging (MRI) is the most sensitive and specific imaging modality for the diagnosis, it does not cover all joints because of the high cost. The purpose of this study was to investigate the diagnostic value of bone scintigraphy (BS) as a screening test for the multifocal osteonecrosis.

Methods: We identified 417 patients who underwent BS for the diagnosis of ON of the femoral head from January 2010 to December 2021. We retrospectively reviewed BS, X-ray, and MRI data of all patients and identified those with multifocal ON. Eventually, a total of 32 patients with multifocal ON were enrolled. The sensitivity, specificity, accuracy, positive predictive value (PPV), and negative predictive value (NPV) of BS were calculated. Also, scintigraphic findings were compared with X-ray and MRI to demonstrate the diagnostic value of the BS.

Results: Of 32 patients, BS indicated multiple ON in 25 patients. A total of 174 ON sites were identified by BS and MRI or X-ray. BS had a sensitivity of 0.63 and a specificity of 0.77 in detecting multifocal ON. The accuracy was 0.70, the PPV was 0.77, and the NPV was 0.64. Scintigraphic findings were not well correlated with MRI findings, especially in the early stage of the ON, and MRI had more sensitivity than BS to diagnosis of ON.

Conclusion: BS appears to be a simple, inexpensive, and helpful tool for the patients with suspected multifocal ON. Nevertheless, BS had a relatively low sensitivity and NPV for diagnosing multiple ON. Therefore, the results from BS should be compared with clinical findings including patients' underlying comorbidities and X-ray or MRI findings.

Session IV. Free Paper 1

Development and validation of a machine learning-based nomogram to predict collapse of femoral head necrosis based on CT and x-ray

Kaiqiang Tang[1], Weiheng Chen[1], Jigao Sun[2], Taixian Li[1], ZhiHong Fu[1], Yawei Dong[1], Xiangyu Li[1], Jun Zhou[1]

[1]The Third Affiliated Hospital of Beijing University of Chinese Medicine, China, [2]Department of Orthopedics, Dongfang Hospital Beijing University of Chinese Medicine, China

Purpose: To develop and validate a nomogram model for predicting the risk of femoral head necrosis collapse.

Methods: A total of 113 patients (155 hips) with ARCO stage II were included in the study, which were split into two groups based on 1-year follow-up outcomes: a collapsed group of 66 hips and a non-collapsed group of 89 hips. Two orthopedic surgeons gathered morphological information from the images and used Mimics software to extract the volume of sclerotic bone and soft tissue inside the femoral head and read grayscale values. The training set consisted of 120 hips (collapsed 51 hips and non-collapsed 69 hips) from 2012 to 2017, and the validation set consisted of 35 hips (collapsed 15 hips and non-collapsed 20 hips) after that. The machine learning algorithm was used to identify potential independent predictive factors, form a nomogram, analyze its performance in the training and validation sets, and use calibration curves to assess its recognition ability.

Results: Tables 1 and 2 show that sclerotic band in the middle 1/3 of the weight-bearing surface (OR 0.189, 95%CI: 0.041-0.756, P=0.023), cystic degeneration below the weight-bearing surface (OR 20.832, 95%CI: 5.459-104.719, P<0.001), sclerotic bone volume (OR 0.596, 95%CI: 0.326-0.955, P=0.05), and femoral head minimum gray value (OR 0.983, 95% CI: 0.967-0.996, P=0.029) were four independent predictive factors for collapse. With an accuracy of 0.836, sensitivity of 0.860, and specificity of 0.804, the nomogram prediction model performed exceptionally well in both the training and validation sets (AUC 0.938; 95%CI: 0.896-0.979).

Conclusion: Nomograms based on morphological, 3D reconstruction, and gray value features showed excellent collapse prediction, which will aid clinical prediction of collapse risk and guide individualized decision-making.

Session IV. Free Paper 1

Multidirectional hypertrophy of the femoral head cartilage in Legg-Calve-Perthes disease

Hidenao Tanaka[1], Ryosuke Yamaguchi[1], Tomoyuki Nakamura[2], Akifusa Wada[3], Goro Motomura[1], Takeshi Utsunomiya[1], Noriko Yamamoto[1], Yusuke Ayabe[1], Kosei Sakamoto[1], Yasuharu Nakashima[1]

[1]Department of Orthopaedic Surgery, Graduate School of Medical Sciences, Kyushu University,
[2]Department of Orthopaedic and Spine Surgery, Fukuoka Children's Hospital,
[3]Department of Othopaedic Surgery, Saga Handicapped Children's Hospital, Japan

Backgrounds: The treatment concept for Legg-Calvé-Perthes disease (LCPD) is "containment" of the collapsed femoral head into the acetabulum, and its effectiveness is associated with future femoral head sphericity. Recent basic researches indicated cartilage hypertrophy following ischemia, which may improve the sphericity of the affected femoral head. On the other hand, detailed clinical assessments on the degree and characteristics of cartilage thickness in LCPD patients has not been reported. The purpose of this study was to analyze the femoral head cartilage thickness changes in LCPD patients.

Methods: 55 children (mean age: 6.2 years) with unilateral LCPD were included. Measurements were performed using MRI images obtained at least a month after the onset. The baseline at the metaphysis end, vertical bisector and 45 degrees bisectors were drawn in each femoral head. Ten aspects were defined as lateral (L), superolateral (SL), superior (S), superomedial (SM), medial (M) in coronal section, and anterior (A), superoanterior (SA), superior (S), superoposterior (SP), and posterior (P) in sagittal section. The diameter and cartilage thickness of the femoral head were measured, and differences/ratio between affected/unaffected side were calculated and analyzed based on the age.

Results: Although the diameter of the femoral head was significantly correlated with the age, the cartilage thickness was individually varied. The difference/ratio of the articular cartilage thickness of affected/unaffected side were 1.64mm/1.47 in L, 0.43mm/1.19 in SL, 0.66mm/1.27 in S, 0.23mm/1.14 in SM, 0.80mm/1.22 in M, 0.76mm/1.25 in A, 0.67mm/1.31 in SA, 0.66mm/1.29 in S, 0.68mm/1.30 in SP, 1.03mm/1.31 in P with statistical significances in all aspects. Patients with 6 years and older showed significantly more horizontal cartilage hypertrophy compared to patients under age 6 in coronal section.

Conclusion: Multidirectional hypertrophy of the femoral head cartilage was observed in LCPD patients, which may be associated with future femoral head morphology.

Session IV. Free Paper 1

The effect of aging on bone repair against ischemic osteonecrosis in a mouse model

Ryosuke Yamaguchi[1], Nobuhiro Kamiya[2], Gen Kuroyanagi[3], Yinshi Ren[4], Harry Kim[5]

[1]Department of Orthopaedic Surgery, Kyushu University,
[2]Sports Medicine, Tenri University,
[3]Department of Orthopaedic Surgery, Nagoya City University,
[4]Center for Excellence in Hip, Scottish Rite Hospital for Children,
[5]Center for Excellence in Hip, Scottish Rite Hospital for Children, Japan

Introduction: Age at onset is one of the most important predictors of outcome following ischemic osteonecrosis (ON). Currently, there is no well-established animal model to study the effects of age on the repair process following ischemic ON. The purpose of this study was to further advance a murine model of ischemic ON using four age groups of mice to determine the effects of aging on revascularization and bone repair following ischemic ON.

Methods: Ischemia was surgically induced in the distal femoral epiphysis of four age groups of skeletally immature and mature mice; juvenile (5 weeks), adolescent (12 weeks), adult (22 weeks), and middle age (52 weeks). Mice were euthanized at 2 days or 4 weeks post-ischemia surgery to evaluate the extent of ON, revascularization, and bone repair.

Results: Terminal deoxynucleotidyl transferase-mediated dUTP nick-end labeling staining showed extensive cell death in the epiphysis of all four age groups at 2 days post-ischemia surgery. At 4 weeks, the juvenile mice followed by the adolescent mice had significantly greater revascularization and repair of the necrotic marrow space, increased osteoblast and osteoclast numbers, and increased bone formation rates compared to the adult and middle-age mice. Faster revascularization and bone healing were observed in the skeletally immature mice compared to the skeletally mature mice following ischemic ON.

Conclusion: The findings resemble the clinical observation of aging on bone repair following ischemic ON. The mouse model may serve as a useful tool to investigate the mechanisms underlying the age-related impairment of bone repair in adolescent and adult ON and to develop novel therapeutic strategies.

Session VI.
Conservative Treatment in ONFH

August 27(Sat.), 2022 08:00-09:00

MODERATORS

Stuart Goodman

Stanford Univ., USA

Chen Chung-Hwan

Kaohsiung Medical Univ., Taiwan

Session V. Surgical trend of ONFH

Surgical Treatment Trend of Femoral Head Osteonecrosis in South Korea: An Analysis Using Nationwide Claim Database

Jung-Wee Park

Seoul National Univ., Korea

[CURRICULUM VITAE]

2008-2014	College of Medicine, Seoul National University
2017-Now	Seoul National University Graduate School
2014-2015	Intern, Seoul National University Hospital
2015-2019	Resident, Department of Orthopaedic Surgery, Seoul National University Hospital
2019-2020	Department of Orthopaedic Surgery, Seoul National University Bundang Hospital, Clinical Fellowship
2020-2021	Department of Orthopaedic Surgery, Chung-Ang University Hospital, Clinical Fellowship
2021-2021	Department of Orthopaedic Surgery, Seoul National University Bundang Hospital, Clinical Fellowship
2021-Now	Department of Orthopaedic Surgery, Seoul National University Bundang Hospital, Clinical Assistant Professor

[ABSTRACT]

Background: Osteonecrosis of the femoral head (ONFH) involves young or middle-aged adults, and its incidence is increasing along with increasing use of steroids in the management of organ transplantation and adjuvant therapy for malignant neoplasms. To date, no pharmacological agent has been proven to prevent or retard the disease progression, and surgical procedures including joint-preserving procedures and hip arthroplasties are main treatments for the disease. Although ONFH is the most or second common disease for hip arthroplasty in East Asian countries, the trend of the surgical procedures in this area remains unknown. Thus, we evaluated the surgical trend of the disease in South Korea.

Methods: We identified patients with ONFH from the Korean Health Insurance Review and Assessment (HIRA) database, a nationwide medical claim database of South Korea, between January 2007 and December 2018, and calculated the proportions of surgical procedures: total hip arthroplasty (THA), hemiarthroplasty (HA), core decompression/multiple drilling, femoral osteotomy, and vascularized bone graft, at each year.

Results: The total number of procedures increased from 3,824 in 2007 to 6,929 in 2018. Overall, the rate of THA (86%) was far greater than other procedures. From 2007 to 2018, the percentage of THA among the procedures increased from 80% to 91%, while that of joint preserving procedures decreased from 11% to 5%.

Conclusion: Total number of surgical procedures performed for ONFH has increased and the percentage of THA has increased while that of joint preserving procedures decreased from 2007 to 2018 in South Korea.

Session V. Surgical trend of ONFH

Surgical trend of hip and knee osteonecrosis in US

Mitchell K. Ng[1], Adam Gordon[1], Nicolas S. Piuzzi[2], Che Hang Jason Wong[1], Lynne C. Jones[3], Stuart Goodman[4], Michael A. Mont[5,6]

[1]Maimonides Medical Center, Department of Orthopaedic Surgery, Brooklyn, NY
[2]Cleveland Clinic Foundation, Department of Orthopaedic Surgery, Cleveland, OH
[3]Johns Hopkins School of Medicine, Department of Orthopaedic Surgery, Baltimore, MD
[4]Stanford University, Department of Orthopaedic Surgery, Stanford, CA
[5]Northwell Health Orthopaedics, Lenox Hill Hospital, New York, NY
[6]Sinai Hospital of Baltimore, Rubin Institute for Advanced Orthopedics, Baltimore, MD

[CURRICULUM VITAE]

Stuart B. Goodman is the Robert L. and Mary Ellenburg Professor of Surgery, and Professor with Tenure in the Department of Orthopaedic Surgery at Stanford University. He has a courtesy appointment in the Department of Bioengineering, and is a Fellow of the Institute of Chemistry, Engineering and Medicine for Human Health (ChEM-H) at Stanford University. He was Chief of Orthopaedic Surgery at Stanford University from 1994-2002. Dr. Goodman received his BSc, MD and MSc (Institute of Medical Science) from the University of Toronto, and his PhD in Orthopedic Medical Science from Lund University in Sweden. He is a Fellow of the Royal College of Surgeons (Canada), the American Academy of Orthopaedic Surgeons and the American College of Surgeons. Dr. Goodman's clinical practice concentrates on adult reconstructive surgery. His clinical research interests center on the outcome of surgery for primary and revision total joint replacement, juvenile arthritis, and osteonecrosis of the hip and knee. His basic science interests center on biocompatibility of orthopaedic implants, inflammation, and musculoskeletal tissue regeneration and repair. Dr. Goodman is a member of numerous academic organizations including former Chairman of the AAOS Biological Implants Committee, and a former member of the AAOS Biomedical Engineering Committee. He is a member of the Hip Society (American, European and International), Knee Society, AAHKS, and ARCO, a consultant to the Orthopaedic and Rehabilitation Devices Advisory Panel of the FDA, and former vice-chairman of the Musculoskeletal Tissue Engineering study section at NIH. Dr. Goodman is on the editorial board

of the Journal of Orthopaedic Research (Associate Editor), Clinical Orthopaedics (Deputy Editor), Biomaterials (Associate Editor), Journal of Arthroplasty, Journal of Biomedical Materials Research, Bone and Joint Research, Journal of Orthopaedic Translation, and other journals, and reviews manuscripts in the fields of orthopaedic surgery, arthritis, bioengineering and biomaterials. Dr. Goodman has published over 580 peer-reviewed manuscripts in medical and bioengineering journals. Dr. Goodman and co-workers have received awards for their research from the Society for Biomaterials, Orthopaedic Research Society, the American Orthopaedic Association, Western Orthopaedic Association, and the Association of Bone and Joint Surgeons. Dr. Goodman was awarded the Clemson Award for Basic Research from the Society For Biomaterials in May 2000. He was the President of the Society For Biomaterials (2001-2) and served on the Board of Directors of the Orthopaedic Research Society. Dr. Goodman served as Co-Chair for the 1995, 2000 and 2007 NIH/AAOS-sponsored workshops on Implant Wear. Dr. Goodman was recognized as a Fellow, Biomaterials Science and Engineering (FBSE) by the International Union of Societies, Biomaterials Science and Engineering in May 2004, a Fellow of the Japanese Society of the Promotion of Science in 2011, a Fellow of the American Institute of Medical and Biological Engineers in 2012, a Fellow of the International Combined Orthopaedic Research Societies in 2016, and a Fellow of the Orthopaedic Research Society in 2021. He is a council member of the NIH National Institute of Arthritis, Musculoskeletal and Skin Diseases since 2021.

[ABSTRACT]

Introduction: Osteonecrosis (ON) continues to be an important musculoskeletal condition in the United States that affects approximately 20,000 new patients annually. Although joint preserving operations are preferable in this younger population in their prime years of working life, unfortunately many patients are diagnosed too late, when the affected joint is already collapsed and therefore not salvageable. We report the current treatment of osteonecrosis of the hip and knee in the USA for the decade 2010 to 2020 from a large nationwide database of patients.

Methods: We identified patients diagnosed with osteonecrosis ON of the femoral head (ONFH) or knee (ON-K) who underwent surgery between January 1st, 2010, and October 31st, 2020, using the Pearl Diver database. We grouped the surgeries according to whether they were joint-preserving versus joint-sacrificing. Linear regressions were performed to evaluate yearly trends and differences in volume of procedures over time.

Results: For ONFH, the number of operative procedures declined from 2010 to 2020 in a total of 64,739 patients. Joint-preserving procedures increased from 8.6 to 11.2% during this period. THA was the most common procedure (57,033; 88.1%) compared to hemiarthroplasty (3,875; 6.0%), core decompression (2,730; 4.2%), bone graft (467; 0.7%), and osteotomy (257; 0.4%). For ON-K,

8,269 patients underwent surgical procedures. TKA was the most common procedure (7,062; 85.40%), followed by UKA 853; 10.32%) and core decompression (354; 4.28%). For ON of the hip and knee, patients who were <50 years of age had increased rates of joint-preserving rather than joint- sacrificing procedures.

Conclusion: ONFH and ON-K are serious musculoskeletal conditions that afflict younger patients in their prime of life. Unfortunately, despite well-established methods for diagnosis and newer procedures for joint preservation, most of these patients are treated by joint replacement and not joint preservation. Special effort should be directed to the early identification of ON and consideration of joint-preserving procedures in high-risk groups.

Surgical trend in Japan

Shinya Kaneko[1], Yasuhiko Takegami[2], Taisuke Seki[3], Wakaba Fukushima[4], Takashi Sakai[5], Wataru Ando[6], Nobuhiko Sugano[6]

[1]Department of Orthopaedic Surgery, Tokai Central Hospital, Gifu, Japan.
[2]Department of Orthopaedic Surgery, Nagoya University Graduate School of Medicine, Nagoya, Japan.
[3]Department of Orthopedic Surgery, Aichi Medical University Medical Center, Aichi, Japan.
[4]Department of Public Health, Osaka City University Graduate School of Medicine, Osaka, Japan.
[5]Department of Orthopedic Surgery, Yamaguchi University Graduate School of Medicine, Yamaguchi, Japan.
[6]Department of Orthopaedic Medical Engineering, Osaka University Graduate School of Medicine, Osaka, Japan.

[CURRICULUM VITAE]

Tokai Central Hospital / Graduate School of Medicine, Nagoya University

2000-2006	MD, Kanazawa University School of Medicine
2017-2021	PhD, Nagoya University Graduate School of Medicine
2020-	Manager of Rehabilitation Department, Tokai Central Hospital
2017-2020	Graduate student, Graduate School of Medicine, Nagoya University
2011-2017	Medical Staff in Orthopaedic surgery, Tokai Central Hospital
2006-2011	Junior & Senior Resident, Okazaki City Hospital

[ABSTRACT]

Introduction: Osteonecrosis of the femoral head (ONFH) often progresses to arthropathy, resulting in pain and functional loss of daily activities. Various surgical treatments have been per-

formed, including joint-preserving and joint-replacing procedures. The most appropriate procedure and at what type and stage of ONFH these procedures had been argued. We attempted to clarify the trend in surgical operations with respect to the age of patients, type classification, and stage of ONFH over a period of 15 years by using the multi-center sentinel monitoring system in Japan.

Methods: We evaluated the hips of 3844 patients using this system in three phases of every five years from 2003 to 2017. The diagnosis, type, and stage classification of ONFH were determined based on the 2001 criteria that was established by the Japanese Ministry of Health, Labour and Welfare. We classified the surgical procedures as osteotomy (OT), hemiarthroplasty (Hemi), and total hip arthroplasty (THA). We assessed the trend in age, type classification, and stage of ONFH over three time periods: the "early" period, 2003-2007; the "middle" period, 2008-2012; and the "late" period, 2013-2017. First, we calculated the total number of procedures for ONFH. Second, we analyzed the type and stage of ONFH. Third, we examined the gender and age distribution (16-39 years; 40-60 years; over 60 years) for each type of surgery.

The Jonckheere-Terpstra test was employed to test the trends of the continuous variables across the three time periods (early/middle/late). We used the Cochran-Armitage test to evaluate the trends in the proportion of two levels of characteristics across three time periods (early/middle/late). For all analyses, $P < 0.05$ was considered statistically significant.

Results: As all surgery, the proportion of patients aged 16-39 years decreased ($P < 0.001$), and the proportion of patients aged over 60 years of age increased ($P < 0.001$). The proportion of patients who underwent OT decreased from early to middle and late periods (early, 317/947 (33.5%); middle, 396/1659 (23.9%); and late, 176/1167 (15.1%)); the proportion of patients who underwent Hemi decreased from early to middle and late periods (early, 158/947 (16.7%); middle, 173/1659 (10.4%); and late, 68/1167 (5.8%)) and the proportion of patients who underwent THA significantly increased from early to middle and late periods (early, 443/947 (46.8%), middle, 1066/1659 (64.3%); and late, 919/1167 (78.7%)).

Regarding the type of classification, the proportion of patients with types C1 and C2 who underwent OT and Hemi decreased from early to middle and late periods, and the proportion of patients who underwent THA significantly increased over time.

Regarding the stage, the proportion of patients with stages 3A, 3B, and 4 who underwent OT and Hemi decreased from 2003 to 2017, and the proportion of THA increased over the three time periods in all stages.

Conclusion: In Japan, the proportion of younger patients underwent surgery for ONFH decreased and that of older patients increased significantly. The proportion of patients who underwent OT for ONFH decreased, while that of THA increased over time.

Session V. Surgical trend of ONFH

Surgical trend in China

Zhao Dewei

Dalian Univ., China

[CURRICULUM VITAE]

Affiliated Zhongshan Hospital of Dalian University : Honorary Dean
The Orthopedic Medical Research Center of Dalian University : Director

1974-1977	Nanjing Railway Medical College, Bachelor Degree
1978-1994	Qiqihaer Railway Center Hospital, Associate Chief Physician
1994-2003	Affiliated Zhongshan Hospital of Dalian University, Director of orthopedics
1998-2001	Dongbei University of Finance and Economics, Master Degree
1999-2003	Affiliated Zhongshan Hospital of Dalian University, Vice Dean
2002-2005	Southern Medical University, Doctorate Degree
2003-2021	Affiliated Zhongshan Hospital of Dalian University, Dean
2010-2015	Dalian University, Vice President
2020-Today	Affiliated Zhongshan Hospital of Dalian University : Honorary Dean
	The Orthopedic Medical Research Center of Dalian University : Director

[ABSTRACT]

Osteonecrosis of the femoral head (osteonecrosis of the femoral head, ONFH) is a common refractory disease in orthopedics. Once the femoral head collapses, most patients will inevitably undergo hip arthroplasty. Hip preservation surgery is suitable for patients with osteonecrosis of the femoral head in the early stage of venous stasis or in the middle stage of arterial ischemia, including core decompression, proximal femoral osteotomy, surgical dislocation, vascularized or non-vascularized bone transplantation and 3D printed tantalum umbrella support technique to provide guarantee for early recovery and long-term good osseointegration of patients with osteo-

necrosis of the femoral head.

The pathomorphological of osteonecrosis of the femoral head can be divided into three stages: venous stasis, arterial ischemia, and arterial occlusion. It should be treated by stages according to the blood circulation.

1. Venous stasis stage : Core decompression or combine with the emergence and application of magnesium powder, PRP, BMSCs, growth factor.

2. Arterial ischemia stage: Vascularized bone grafting transplantation combine 3D printing tantalum umbrella support technology.

3. Arterial occlusion stage: For complex hip joint replacement, use of integrated 3D printed tantalum prosthesis.

There are many kinds of hip-preserving surgery for osteonecrosis of the femoral head. Core decompression alone can reduce the pressure in the medullary cavity of the necrotic femoral head, but it is only suitable for patients with early osteonecrosis of the femoral head. Bone grafting can not only provide effective mechanical support for necrotic femoral head, but also provide a good environment for the formation of new bone. Vascularized bone transplantation can also provide new blood supply for necrotic femoral head and has a good long-term effect. with the popularization and improvement of microsurgical technology, vascularized bone transplantation will be more widely used in the treatment of osteonecrosis of the femoral head.

Hip replacement is the best treatment for patients with complete osteonecrosis of the femoral head, including artificial femoral head replacement and total hip arthroplasty. For complex hip joint revision cases such as infection and bone defect after replacement, the use of integrated 3D printed tantalum prosthesis for one-stage revision replacement with antibiotics achieved good clinical results.

Session V. Surgical trend of ONFH

Surgical trend in Taiwan

Mel S. Lee

Chang Gung Memorial Hosp., Taiwan

[CURRICULUM VITAE]

Superintendent, Paochien Hospital, Professor Department of Orthopedic Surgery, Taiwan

1987	M.D., Taipei Medical University, Wu-Hsin St., Taipei.
2001	Ph.D., Graduate Institute of Clinical Medicine, Chang Gung University
2021-	Superintendent, Paochien Hospital
2013-2014	Vice-Superintendent, Chang Gung Memorial Hospital, Chiayi, Taiwan.
2015-2016	Executive Vice Superintendent, Kaohsiung Chang Gung Memorial Hospital
2016-2017	Superintendent, Kaohsiung Chang Gung Memorial Hospital

[ABSTRACT]

By 2030, the projected cases of THA in Taiwan will be 18,000 per year. Based on the National Health Insurance Research database in Taiwan, 49% to 62% of the total hip arthroplasty were performed under the diagnosis of ONFH. Of them 79% to 84% were male patients at the age around 50 years. Before 2005, hemiarthroplasty had been done for many early collapsed hips because a prior peer-review program was implemented for the Taiwan national health insurance coverage. Surprisingly, the 9-year survival rate of 94% and the 6-year revision rate of 3.6% in hemiarthroplasty patients were better than the 79% survival and the 7.2% revision in THA patients in registry data. The major cause of revision in THA patients was the high incidence of osteolysis related to the conventional polyethylene. With the advancement of bearing surface and the regulatory modification, hemiarthroplasty lost its popularity for ONFH currently. Lee et al. reviewed 25,337 reimbursed cases of ONFH who had been operated between 1997 and 2004 and found 57% had THA, 33% had hemiarthroplasty, 6% had core decompression, and 4% had various joint preservation surgeries.

Non-operative treatments including bisphosphonates are not effective. Shockwave therapy in early cases had 74% to 83% success rate with or without the addition of bisphosphonate. Clinical success rate of core decompression was between 56% and 70.8%. Core decompression augmented with bone grafting had various results. Prodense grafting showed early resorption and failed in 89.5% of cases. Phemister procedure with allograft had 65.5% survival at 14 years. Impaction grafting with a wire coil had 62% to 73% survival at 9.1 years. Vascularized iliac grafting had 80% success rate in precollapse case but only 25% in segmental collapse cases. Transtrochanteric rotational osteotomy is not popular. Small series was reported, and the overall survival was 60%.

In summary, hemiarthroplasty had been advocated but lost its popularity currently. THA is now the most performed procedure. Joint preservation surgery accounts for 10% of patients only in whom core decompression is most performed. Based on these data, surgeons in Taiwan should aware the importance of early diagnosis to recommend joint preservation procedures for pre-collapse ONFH.

Session VI.
Conservative Treatment in ONFH

August 27(Sat.), 2022 08:00-09:00

MODERATORS

Stuart Goodman

Stanford Univ., USA

Chen Chung-Hwan

Kaohsiung Medical Univ., Taiwan

Session VI. Conservative Treatment in ONFH

Which Osteotomy for Osteonecrosis of the Femoral Head?

Young-Kyun Lee

Seoul National Univ., Korea

[CURRICULUM VITAE]

Graduated from College of Medicine, Seoul National University
Professor, Department of Orthopaedic Surgery, Seoul National University Bundang Hospital
Visiting Scholar, Department of Orthopaedic Surgery, Stanford University Medical Center
Assistant Professor, Department of Orthopaedic Surgery, Seoul National University Bundang

General Secretary of Korean Society of Sarcopenia
General Secretary of Korean Society for Bone and Mineral Research
Member of Clinical Practice Guideline Committee for Korean Orthopaedic Association
Member of Steering Committee of Korean Society for Patients Blood Management
National Faculty of AO Trauma Korea

Associated Editor of Journal of Bone Metabolism
Editorial board member of the Journal of Arthroplasty
Editorial board member of the World Journal of Orthopedics
Editorial board member of International Journal of Orthopaedics
Editorial board member of EC Orthopaedics

[ABSTRACT]

Osteonecrosis of femoral head (ONFH) usually affects young adults and frequently leads to collapse od femoral head and subsequent osteoarthritis of the hip. ONFH commonly requires total hip arthroplasty (THA). As alternatives to THA, several osteotomies of the proximal femur have been introduced to preserve the hip joint and to postpone THA.

Among them, transtrochanteric curved varus osteotomy (TCVO) and transtrochanteric rotational osteotomy (TRO) are well-known joint preserving procedures for osteonecrosis of the femoral head. These techniques move the necrotic portion from the weight-bearing region to a non-weight-bearing region.

TCVO was introduced in 1971 by Nishio and Sugioka. In TCVO, a curved osteotomy is made between the greater and lesser trochanters. Then the femoral head is rotated into a varus position. TRO was introduced in 1978 by Sugioka. In this technique, the femoral head fragment is rotated anteriorly after the greater trochanter is osteomized.

The aim of this lecture was to provide an up-to-date guide for the osteotomy of femoral head osteonecrosis, in terms of indication, clinical results, and risk factors for failure.

Session VI. Conservative Treatment in ONFH

Vascularized fibular grafts in ONFH

Seung-Hoon Baek

Kyungpook National Univ., Korea

[CURRICULUM VITAE]

1992-1994	Premedical Course, Liberal Arts and Science College, Kyungpook National University
1994-1998	Bachelor of Medical Science, College of Medicine, Kyungpook National University (M.D.)
1999-2001	Course for Master of Medical Science (MSc), Graduate School of Medicine, Kyungpook National University
2004-2006	Course for Master Of Business Administration (MBA), Graduate School of Business Administration, Kyunghee University
2006-2015	Course for Doctor of Medical Science (PhD), Graduated School of Medicine, Kyungpook National University
1998-1999	Internship, Kyungpook National University Hospital, Daegu, Korea
1999-2003	Residency, Department of Orthopedic Surgery, Kyungpook National University Hospital, Daegu, Korea
2003-2006	Military Doctor, Army Captain (62nd Division), Korea
2006-2007	Clinical Fellow, Clinical Fellowship in Service of Joint replacement and reconstruction, Department of Orthopedic Surgery, Kyungpook National University Hospital, Daegu, Korea
2007-2007	Clinical Instructor, Clinical Fellowship in Service of Joint Replacement and Reconstruction, Department of Orthopedic Surgery, Kyungpook National University Hospital, Daegu, Korea
2007-2008	Clinical Assistant Professor, Clinical Fellowship in Service of Knee surgery and Sports medicine, Department of Orthopedic Surgery, Kyungpook National University Hospital, Daegu, Korea
2008-2008	Clinical Assistant Professor, School of Medicine, Catholic University of Daegu, Daegu, Korea
2008-2011	Assistant Professor, Department of Orthopedic Surgery, Catholic University of Daegu, Daegu, Korea
2012-2012	Vice Chief, Madi-Pyunhan Hospital, Daegu, Korea

2012-2013	Exchange Scholar, Bioengineering Laboratory, Department of Orthopaedics, Massachusetts General Hospital and Harvard Medical School, Boston, MA, USA
2013-2017	Assistant Professor, Department of Orthopedic Surgery, Kyungpook National University, Daegu, Korea
2014-2014	Research fellow, Department of Orthopaedic Surgery, Fukuoka University Medical School, Fukuoka, Japan
2015-2016	Exchange Scholar, Bioengineering Laboratory, Department of Orthopedics, Massachusetts General Hospital and Harvard Medical School, Boston, MA, USA
2017	Visiting Doctor, Department of Orthopedic Surgery, McMaster University Medical Centre
2017-present	Associate Professor, Department of Orthopedic Surgery, Kyungpook National University, Daegu, Korea
2019	Visiting Doctor, Steadman Philippon Research Institute
2022	Chairman, Department of Orthopedic Surgery, Kyungpook National University Hospital, Daegu, Korea

[ABSTRACT]

Osteonecrosis of femoral head (ONFH) usually affects younger patients.[1,2] Joint preserving options in these young population includes electrical stimulation, multiple drilling, core decompression, osteotomy, pedicle bone grafting and non-vascularized or vascularized fibular grafting (VFG).[3-10] Among these, VFG demonstrated the survivorship with the endpoint as conversion to arthroplasty ranging from 60%-93% at long-term follow-up (Table 1).[11-13]

Senior surgeon (SYK) in our institution compared VFG with Non-VFG for large ONFH lesion and reported short-term results[14]; The mean Harris hip score improved in 70% of those with VFG and 35% of those with non-VFG ($p < 0.05$). In VFG group, the femoral head collapsed in 10% of those with stage-IIC and in 54% of those with a larger lesion (stage IIIC or IVC), and 13% of VFG group underwent total hip arthroplasty (THA). In non-VFG group, the femoral head collapsed in 50% of those with stage-IIC and 85% of those with a larger lesion, and 22% of non-VFG group underwent THA. The rates of radiographic progression and the mean dome depression were significantly less in VFG group ($p<0.05$). The authors concluded VFG was more effective than non-VFG for the prevention of head collapse in a matched population with a Steinberg Stage-IIC or larger osteonecrotic lesion.

In this presentation, the extended study with longer follow-up duration from previous one will be demonstrated. Then we will compare this with outcomes after THA using ceramic bearings in those with ONFH younger than fifty years. Finally, the results after THA in those who underwent

a previous VFG or non-VFG procedure will be provided. After all, we may resume to recognize the potential value of VFG in young patients with ONFH at the time point of 2022 ARCO meeting.

Table 1. Summary of long-term outcome after vascularized fibular grafting

Authors	Year	Hips	Age (range) *years*	Follow-up (range) *years*	Survival rate
Judet and Gilbert	2001	68	35 (20-64)	18 (15-22)	74%
Yoo et al	2008	124	36 (13-63)	14 (10-24)	93%@10Y 83%@20Y
Eward et al	2012	63	32 (12-40)	14 (11-26)	75%@10Y 60%@15Y

References

1. Mont MA, Jones LC, Hungerford DS. Survival analysis of hips treated with core decompression or vascularized fibular grafting because of avascular necrosis. J Bone Joint Surg Am. 2000 Feb;82(2):290-1.
2. Urbaniak JR, Coogan PG, Gunneson EB, Nunley JA. Treatment of osteonecrosis of the femoral head with free vascularized fibular grafting. A long-term follow-up study of one hundred and three hips. J Bone Joint Surg Am. 1995 May;77(5):681-94.
3. Ficat RP. Idiopathic bone necrosis of the femoral head. Early diagnosis and treatment. J Bone Joint Surg Br. 1985 Jan;67(1):3-9.
4. Song WS, Yoo JJ, Kim YM, Kim HJ. Results of multiple drilling compared with those of conventional methods of core decompression. Clin Orthop Relat Res. 2007 Jan;454:139-46.
5. Drescher W, Furst M, Hahne HJ, Helfenstein A, Petersen W, Hassenpflug J. Survival analysis of hips treated with flexion osteotomy for femoral head necrosis. J Bone Joint Surg Br. 2003 Sep;85(7):969-74.
6. Lee YK, Park CH, Ha YC, Kim DY, Lyu SH, Koo KH. Comparison of Surgical Parameters and Results between Curved Varus Osteotomy and Rotational Osteotomy for Osteonecrosis of the Femoral Head. Clin Orthop Surg. 2017 Jun;9(2):160-8.
7. Mont MA, Einhorn TA, Sponseller PD, Hungerford DS. The trapdoor procedure using autogenous cortical and cancellous bone grafts for osteonecrosis of the femoral head. J Bone Joint Surg Br. 1998 Jan;80(1):56-62.
8. Zhao D, Cui D, Wang B, Tian F, Guo L, Yang L, et al. Treatment of early stage osteonecrosis of the femoral head with autologous implantation of bone marrow-derived and cultured mes-

enchymal stem cells. Bone. 2012 Jan;50(1):325-30.
9. Sugioka Y, Hotokebuchi T, Tsutsui H. Transtrochanteric anterior rotational osteotomy for idiopathic and steroid-induced necrosis of the femoral head. Indications and long-term results. Clin Orthop Relat Res. 1992 Apr(277):111-20.
10. Hernigou P, Beaujean F. Treatment of osteonecrosis with autologous bone marrow grafting. Clin Orthop Relat Res. 2002 Dec(405):14-23.
11. Eward WC, Rineer CA, Urbaniak JR, Richard MJ, Ruch DS. The vascularized fibular graft in precollapse osteonecrosis: is long-term hip preservation possible? Clin Orthop Relat Res. 2012 Oct;470(10):2819-26.
12. Judet H, Gilbert A. Long-term results of free vascularized fibular grafting for femoral head necrosis. Clin Orthop Relat Res. 2001 May(386):114-9.
13. Yoo MC, Kim KI, Hahn CS, Parvizi J. Long-term followup of vascularized fibular grafting for femoral head necrosis. Clin Orthop Relat Res. 2008 May;466(5):1133-40.
14. Kim SY, Kim YG, Kim PT, Ihn JC, Cho BC, Koo KH. Vascularized compared with non-vascularized fibular grafts for large osteonecrotic lesions of the femoral head. J Bone Joint Surg Am. 2005 Sep;87(9):2012-8.

Session VI. Conservative Treatment in ONFH

Does Bisphosphonate Prevent Femoral Head Collapse from Osteonecrosis?

Hong-Seok Kim

Seoul National Univ. Hosp., Korea

[CURRICULUM VITAE]

2007-2010 School of Engineering, Johns Hopkins University, B.S.
2011-2015 College of Medicine, Seoul National University, M.D.
2020-present Graduate School, Seoul National University, Ph.D.
2015-2016 Seoul National University Hospital, Intern
2016-2020 Department of Orthopaedic Surgery, Seoul National University Hospital, Resident
2020-2021 Department of Orthopaedic Surgery, Seoul National University Bundang Hospital, Fellow
2021-2021 Department of Orthopaedic Surgery, Seoul National University Hospital, Fellow
2021-2022 Department of Orthopaedic Surgery, Seoul National University Hospital, Clinical professor
2022-present Department of Orthopaedic Surgery, Seoul National University Hospital, Assistant professor

[ABSTRACT]

The Anabolic Effect of Bisphosphonate

Bisphosphonate inhibits osteoclast activity by suppressing the activity of farnesyl pyrophosphate synthetase. Some studies analyze that bisphosphonates increase proliferation, stimulate differentiation toward the osteoblastic lineage, and enhance mineralization in stem and osteoblastic lineage cells. Recent studies suggest that bisphosphonate promotes the osteogenesis of osteoblasts and bone marrow mesenchymal stem cells.

Application of Bisphosphonate in Osteonecrosis of the femoral head

The osteonecrosis of the femoral head is a devastating disease frequently leading to the collapse

of the femoral head and to the osteoarthritis of the hip. The common pathway leading to the arthritic change of the femoral head is an imbalance of the rates of osteoclastic bone resorption and osteoblastic bone regeneration.

Some authors studied that bisphosphonate exhibits the potential to prevent further collapse of the femoral head, even within extensive necrosis, by suppressing bone resorption in the necrotic region. Lai et al. suggested that alendronate appeared to prevent early collapse of the femoral head in the hips with Steinberg stage-II or IIIC nontraumatic osteonecrosis. A longer duration of follow-up is needed to confirm whether alendronate prevents or only retards collapse. Nishii et al. showed that the alendronate group showed a greater decrease of biochemical marker of bone resorption than biochemical marker of bone formation. The alendronate group showed a lower frequency of collapse of the femoral head and reported less hip pain than the control group. Agarwala et al. showed that bisphosphonate treatment lead to an improvement in the clinical function, a reduction in the rate of collapse and a decrease in the requirement for total hip replacement, compared with the findings of other studies in which no treatment was given. Ma et al. recently reported that core decompression with local administration of zoledronate and enriched bone marrow mononuclear cells could relieve pain, delay the progression of collapse, which might be an effective and safe method for hip preservation of early and mid-term ONFH.

The others, however, concluded that there was no significant pharmacological function of bisphosphonate in terms of the need for THA, disease progression, and life quality. Chen et al. conducted a two-year multicenter, prospective, randomized, double-blind, placebo-controlled study, showing that alendronate has no obvious effect on preventing the necessity for THA, reducing disease progression, or improving life quality. Lee et al. reported similar result by a prospective, randomized, open-label, multicenter study In this study, zoledronate for Steinberg stage-I or II osteonecrosis of the femoral head, with a medium to large necrotic area, did not prevent the collapse of the femoral head or reduce the need for total hip arthroplasty. Two recent meta-analyses also concluded that the use of bisphosphonates showed no definitely significant efficacy in treating the osteonecrosis of the femoral head.

Further study for the medical treatment using bisphosphonate in osteonecrosis is still required.

References

1. Chen CH and Wang GJ. Alendronate in the Prevention of Collapse of the Femoral Head in Nontraumatic Osteonecrosis. In: Koo K-H, Mont MA, Jones LC, editors. Osteonecrosis. Heidelberg, New York, Dordrecht, London: Springer; 2014. p. 265-271.
2. Lai KA, Shen WJ, Yang CY, Shao CJ, Hsu JT, Lin RM. The use of alendronate to prevent early collapse of the femoral head in patients with nontraumatic osteonecrosis. A randomized clin-

ical study. J Bone Joint Surg Am. 2005;87(10):2155-2159. doi:10.2106/JBJS.D.02959
3. Nishii T, Sugano N, Miki H, Hashimoto J, Yoshikawa H. Does alendronate prevent collapse in osteonecrosis of the femoral head?. Clin Orthop Relat Res. 2006;443:273-279. doi:10.1097/01.blo.0000194078.32776.31
4. Agarwala S, Shah S, Joshi VR. The use of alendronate in the treatment of avascular necrosis of the femoral head: follow-up to eight years. J Bone Joint Surg Br. 2009;91(8):1013-1018. doi:10.1302/0301-620X.91B8.21518
5. Chen CH, Chang JK, Lai KA, Hou SM, Chang CH, Wang GJ. Alendronate in the prevention of collapse of the femoral head in nontraumatic osteonecrosis: a two-year multicenter, prospective, randomized, double-blind, placebo-controlled study. Arthritis Rheum. 2012;64(5):1572-1578. doi:10.1002/art.33498
6. Lee YK, Ha YC, Cho YJ, et al. Does Zoledronate Prevent Femoral Head Collapse from Osteonecrosis? A Prospective, Randomized, Open-Label, Multicenter Study. J Bone Joint Surg Am. 2015;97(14):1142-1148. doi:10.2106/JBJS.N.01157
7. Ma HY, Ma N, Liu YF, et al. Core Decompression with Local Administration of Zoledronate and Enriched Bone Marrow Mononuclear Cells for Treatment of Non-Traumatic Osteonecrosis of Femoral Head. Orthop Surg. 2021;13(6):1843-1852. doi:10.1111/os.13100
8. Li D, Yang Z, Wei Z, Kang P. Efficacy of bisphosphonates in the treatment of femoral head osteonecrosis: A PRISMA-compliant meta-analysis of animal studies and clinical trials. Sci Rep. 2018;8(1):1450. Published 2018 Jan 23. doi:10.1038/s41598-018-19884-z
9. Yuan HF, Guo CA, Yan ZQ. The use of bisphosphonate in the treatment of osteonecrosis of the femoral head: a meta-analysis of randomized control trials. Osteoporos Int. 2016;27(1):295-299. doi:10.1007/s00198-015-3317-5

Session VI. Conservative Treatment in ONFH

Stem cell; is it effective?

Woo Lam Jo

The Catholic Univ. Korea, Korea

[CURRICULUM VITAE]

1999-2005	Bachelor of Medicine, Medical College of Catholic University, Seoul, Korea
2007-2009	Bachelor of Statistic, Korea national open university
2013-2017	Master/Doctor's Course of Orthopaedics, Medical College of Catholic University, Seoul
2005-2006	Internship Medical College of Catholic University, Seoul
2009-2013	Resident of Orthopaedics, Medical College of Catholic University, Seoul
2013-2014	Fellowship, hip and knee Surgery, Yeouido St. Mary's hospital, Seoul, Korea
2014-2016	Clinical professor, hip Surgery, Bundang Seoul national university of Korea.
2016-2017	Fellowship, hip and pediatric orthopaedic Surgery, Seoul St. Mary's hospital, Seoul, Korea
2017-2019	Clinical Assistant professor, hip and pediatric orthopaedic Surgery, Seoul St. Mary's hospital, Seoul, Korea
2020-present	Assistant professor, hip and pediatric orthopaedic Surgery, Seoul St. Mary's hospital, Seoul, Korea

[ABSTRACT]

Osteonecrosis of the femoral head (ONFH) is a debilitating disease in orthopedics, frequently progressing to femoral head collapse and osteoarthritis. Early intervention prior to collapse is key to a successful outcome in joint-preserving procedures.

Mesenchymal stem cells have been used as an adjunct to core decompression to improve clinical success in the treatment of pre-collapse hips. Several studies have shown that the implantation of mesenchymal stem cells can improve Harris hip scores and radiographic findings; clinical results have been closely related to the numbers and concentration of mesenchymal stem cells transplanted.

We investigated whether multiple drilling and stem cell implantation in the treatment of ONFH

would improve clinical and radiographic results compared with conventional core decompression and bone graft. We also evaluated the effects of the stage of osteonecrosis, lesion size and location and risk factors on the clinical outcome of this procedure using survivorship analysis.

Marrow was aspirated from the posterior iliac crests with the patient in the lateral position under general anesthesia. After deep insertion of a beveled needle into spongy bone, the marrow was aspirated into a 50-ml plastic syringe. The needle was moved toward the surface through the same insertion site, and successive aspirations were performed, turning the needle 451 after each aspiration. The marrow was aspirated in small fractions to reduce the degree of dilution by peripheral blood. Using the same skin opening, several perforations were made in the iliac crest. All aspirates were pooled in plastic bags containing cell culture medium and anticoagulant solution. The pooled aspirates were then filtered to separate cellular aggregates and fat. The aspirated material was reduced in volume to increase the stem cell content. This was done by removing some of the red blood cells and the plasma in such a way as to retain only the nucleated cells: mononuclear stem cells, monocytes and lymphocytes. The marrow was concentrated in a cell separator. A 5-min centrifugation was used to force the polynuclear cell layer, which was heavier because of the volume of its nuclei, to the periphery, where it was collected and separated from the remainder of the marrow. The leukocyte layer was removed at a flow rate of 100 ml/min for 40-50 s. The lighter red cells, without nuclei, were in the center and were recovered with the plasma. All that remained was the mononuclear layer containing the stem cells. This centrifugation method reduced a 150-ml bone marrow aspirate to a concentrated myeloid suspension of approximately 30 ml of stem cells; this suspension was poured into a syringe for reinjection.

We found that multiple drilling and stem cell implantation produced outcomes comparable to those of other core decompression techniques. Multiple drilling and stem cells implantation did not change the natural course of ONFH. Significant differences in outcome were observed in patients who had more cells transplanted, as opposed to patients with fewer progenitor cells in the iliac crest and fewer transplanted cells.

Session VII.
Free Paper 2

August 27(Sat.), 2022 09:20-10:50

MODERATORS

Myung-Rae Cho

Daegu Catohlic Univ., Korea

Yong-Chan Ha

Seoul Bumin Hosp., Korea

Session VII. Free Paper 2

Implantation of autologous bone marrow-derived stem cells for treatment of osteonecrosis of the femoral head

Ji-Woon Lee, Shin-Yoon Kim, Seung-Hoon Baek, Sang-Woo Son, Bum-Jin Shim

Department of Orthopedic Surgery, Kyungpook National University Hospital, Korea

Introduction: Since the introduction of core decompression (CD) with autologous bone marrow-derived stem cells implantation for the treatment of osteonecrosis of the femoral head (ONFH), there have been many reports showing promising results. However, due to high heterogeneity among studies, ideal patient and efficacy remain uncertain. Therefore, the purposes of this study were to report the outcomes of autologous bone marrow-derived stem cells implantation in the treatment of ONFH and to analyze the factors that influence the outcomes.

Methods: 18 consecutive patients (22 hips) diagnosed with ONFH between September 2013 to July 2020 were prospectively enrolled in this study. From all participants, bone marrow was collected and specially processed in the institution (Sewon Cellontech, Seoul, Korea). After osteoblasts (Ossron™) was prepared, we performed CD with autologous cultured osteoblast injection. Association Research Circulation Osseous (ARCO) classifications, Japanese Investigation Committee (JIC) classification, and modified Kerboul necrotic angle on magnetic resonance imaging were evaluated at preoperative and at last follow-up.

Results: The preoperative stage of ONFH was ARCO 2 in 17 hips and ARCO 3a in 5 hips. The mean age was 36±8 years and the mean follow-up period was 3.9±2.9 years. 16 hips showed ARCO 2 and 6 hips showed ARCO 3a. Femoral head collapse was progressed 14/22 hips and 4/22 hips needed THA. In ARCO 2, 10/16 hips collapsed while 4/6 hips collapsed in ARCO 3a. There were no significant changes in JIC classification in all patients (B: 1 hip, C1: 5, C2: 16). Modified Kerboul necrotic angle improved in 5 patients, all of which were ARCO 2. Age did not affect the progression of ONFH stage.

Conclusion: The implantation of autologous bone marrow-derived stem cell with core decompression showed promising outcomes on preventing early-stage ONFH. However, stem cell therapy did not produce significant improvement of ARCO 3a.

Session VII. Free Paper 2

The efficiency of genetically-modified mesenchymal stromal cells combined with a functionally-graded scaffold for bone regeneration in corticosteroid-induced osteonecrosis of the femoral head (ONFH) in rabbits

Stuart Goodman

Stanford Univ., USA

Introduction: Core decompression (CD) with mesenchymal stromal cells (MSCs) is a promising treatment for early-stage ONFH. We developed a 3-dimensional printed, functionally-graded scaffold (FGS) for cell delivery. We investigate the efficacy of cell-based treatments using genetically-modified MSCs that over-express PDGF-BB (PDGF-BB-MSCs) or genetically-modified MSCs that co-over-express IL-4 and PDGF-BB and are preconditioned with tumor necrosis factor-alpha and lipopolysaccharide for 3 days (IL-4-PDGF-BB-pMSCs) with the FGS for treating steroid-induced ONFH.

Methods: Twenty-four male mature NZ rabbits received 20 mg/kg of methylprednisolone acetate IM 4 weeks before surgery. There were 4 groups: 1) the CD, 2) the IL-4-PDGF-BB-pMSC, 3) the FGS+PDGF-BB-MSC, and 4) the FGS+IL-4-PDGF-BB-pMSC. One million cells in 200 μl of HG ± the FGS were inserted in the tunnel. Rabbits were euthanized 8 weeks post-op. Micro CT and histological analyses [hematoxylin and eosin (H&E) staining, tartrate-resistant acid phosphatase (TRAP) staining, and CD31 staining for endothelial cells] were performed.

Results: Outside the CD, in the IL-4-PDGF-BB-pMSC groups, BMD was higher when combined with the FGS. In the area surrounding the tunnel, the percentage of empty lacunae was significantly lower in the IL-4-PDGF-BB-pMSCs and FGS+PDGF-BB-MSCs groups compared to the CD group. Osteoclast density was significantly increased in the area surrounding the tunnel in the IL-4-PDGF-BB-pMSCs and FGS+PDGF-BB-MSCs groups compared to the CD group. In the area surrounding the bone tunnel, the FGS+PDGF-BB-MSC group had significantly greater CD31 positive microvessel formation than the CD group.

Discussion and Conclusions: The effects of PDGF-BB-MSCs and IL-4-PDGF-BB-pMSCs were more pronounced in the area surrounding the bone tunnel than in the subchondral bone, suggesting a paracrine effect. IL-4 and PDGF-BB released at appropriate doses and time points, in combination with the FGS, may constitute an important adjunctive therapy to CD for early stage ONFH.

Session VII. Free Paper 2

Umbilical cord derived-preosteoblast cells (CF-M801) to treat osteonecrosis of the femoral head

Hyun Sook Park

CEFO Co, Korea

Osteonecrosis of the femoral head (ONFH) is a disease in which bone necrosis is caused by poor blood circulation in the femur. We developed CF-M801, allogenic osteoblast cell therapy, which is pre-osteoblasts differentiated from umbilical cord mesenchymal stem cells (MSC) by optimizing the stiffness of hydrogels in three dimensions. CF-M801 is distinguished from their undifferentiated MSC and from their differentiated osteocytes and has the dual function of osteogenesis and angiogenesis, necessary for bone regeneration. We confirmed the efficacy of CF-M801 using the bone defect models of goat and mouse and the safety of toxicity, biodistribution, and tumorigenicity. We determined potency markers of CF-M801 reflecting their functions as osteogenicity, osteoinductivity, osteoconductivity, and angiogenicity. The competitiveness of CF-M801 is that the final drug product is supplied in frozen status and in more than 10,000 doses from a single donor. In phase 1 clinical trial, we confirmed the toxicity (DLT) and investigational efficacy in three doses.

This research was supported by a grant of the Korea Health Technology R&D Project through the Korea Health Industry Development Institute (KHIDI), funded by the Ministry of Health & Welfare, Republic of Korea (grant number : RS-2022-00070285)

Session VII. Free Paper 2

Explore the biomechanical effect of sclerotic bone volume on early osteonecrosis of the femoral head: A cohort finite element study

Zhihong Fu, Weiheng Chen, Kaiqiang Tang, Yawei Dong, Xiangyu Li, Taixian Li

The Third Affiliated Hospital of Beijing University of Chinese Medicine, China

Objective: To explore the effect of sclerotic bone volume on the maximum stress on femoral head surface(MSFHS) of early osteonecrosis of the femoral head (ONFH) and to offer a biomechanical basis for early ONFH collapse prevention and therapy.

Methods: From 2018 to 2021, we followed up on 23 ONFH patients (30 hips) treated in our institution. The internal sclerotic bone of the femoral head were reconstructed using Mimics software after the CT image data of the patients were uploaded. The calculation model was meshes, different material properties were dispersed according to Hounsfield's unit distribution, and a stress of 2.5 times the average body weight (1500N) was evenly applied in the Ansys software to assess femoral head's surface stress distribution. The effect of various sclerotic bone volume on the MSFHS and collapse risk of the femoral head was investigated using correlation and logic regression analysis.

Results: According to the follow-up results one year later, patients were divided into collapse group (15 cases) and non-collapse group (15 cases). The average volume of sclerotic bone in collapse group was 1476.64±1095.86mm^3, and the MSFHS was 43.53±8.59MPa, while in non-collapse group its results were 3266.66±1381.51mm^3 and 29.86±5.11MPa. The volume of sclerotic bone was negatively connected with the MSFHS (rs=-0.632, P<0.001) and the collapse risk (rs=-0.587, P<0.001), according to correlation analysis. The MSFHS dropped by 11.71% (OR=0.88, 95%CI: 0.85-0.92, P<0.001), and the collapse risk decreased by 83.72% (OR=0.16, 95%CI: 0.02-0.49, P<0.05) for every 1cm^3 increase in sclerotic bone volume, according to logic regression analysis.

Conclusion: The larger volume of sclerotic bone, the smaller surface maximum stress, which leads to less stress concentration and lower risk of collapse. The results provide a biomechanical basis for clinical treatment and collapse prevention of early ONFH. Key words: Osteonecrosis of the femoral head; Sclerotic bone; Finite element analysis; Biomechanics

Session VII. Free Paper 2

Application of denosumab in patients with osteonecrosis around core decompression: A pilot study

Chung-Hwan Chen, Sung-Yen Lin, Je-Ken Chang, Cheng-Jung Ho, Hsuan-Ti Huang, Jhong-You Li, Yu-De Su

Kaohsiung Medical University, Taiwan

Introduction: Osteonecrosis (ON) is one of the major debilitating skeletal disorders. Most patients with ON of the femoral head eventually need surgery, usually total hip arthroplasty (THA), within a few years of onset. Previous reports showed that alendronate and zoledronate cannot significantly reduced the incidence of collapse of the femoral head in the osteonecrotic hip. Due to the inaccessibility of bisphosphonates to the necrotic area, we infer denosumab may work differently with bisphosphonates because denosumab can inhibit osteoclasts directly unrelated to accessibility to the necrotic area.

Methods: A retrospective study was performed. From December 2016 to April 2019, patients who diagnosed as stage IIC and IIIC in University of Pennsylvania System and received core decompression were enrolled. There were 88 hips in 60 patients whose data were assessed for the study results. All patients received denosumab is under the diagnosis of osteoporosis or osteopenia. Denosumab were used 1 week around core decompression, 5 and 10 months after surgery. All patients received follow-up at least 3 years.

Results: Twenty-six patients received denosumab and thirty-six patients did not receive denosumab. In the denosumab group. Twelfth in 16 patients with unilateral ON and all 10 patients with bilateral ON did not receive THA. The rate of THA for patient number and hip number are 15.8% and 11.1%. In the non-denosumab group, 4 in 16 patients with unilateral ON receive THA. Five in 15 patients with bilateral ON receive bilateral THA and 3 patients with bilateral ON receive unilateral THA. The rate of THA for patient number and hip number are 35.2% and 32.6%.

Conclusion: Denosumab may reduce the possibility of THA after core decompression in patients with stage IIC and IIIC ON. A large RCT is required to answer this question.

Session VII. Free Paper 2

Biomechanical analysis of a novel osteochondral graft specific for the femoral head

Patrick Morgan, Edward Cheng

Department of Orthopedic Surgery, University of Minnesota, USA

Purpose: The purpose of this study was to evaluate the biomechanical competence of the proximal femur when the head is completely resurfaced with an osteochondral dome.

Methods: Twenty-six paired, fresh-frozen, human, cadaveric hips had the femoral head of one femur completely resurfaced with an osteochondral dome prepared from the contralateral side. The strength of the transplanted dome and the procedure's effect on the axial stiffness of the recipient femur were evaluated with an Instron Electromechanical Testing System instrumented with 6-Axis Load Cell. Staged loading through the ipsilateral acetabulum simulated walking and jogging. Each stage evaluated both the quasi-static kinetics during a single load control cycle and dynamic kinetics over 100 cycles of a displacement-controlled protocol.

Results: In all specimens, the donor dome met or exceeded the peak load of walking (238 ± 0.3 % body weight). No difference between resurfaced and intact femora was found in the quasi-static axial stiffness during walking (p value = 0.8445). Dynamic axial stiffness throughout the jogging cyclic testing (1522.7 ± 188.41 N/mm) was within one standard deviation measured for intact femurs (1643 N/mm). The viscoelastic properties observed mimicked the viscoelastic properties of the native head.

Conclusions: The biomechanical competence of a femoral head completely resurfaced with an identical osteochondral shell is comparable to a native femur. Statement of Clinical Significance: Approximately 10% of total hip replacements in the United States are performed for osteonecrosis of the femoral head representing over 25,000 procedures per year. This study suggests that an allograft resurfacing may represent an alternative to total hip in this young patient population.

Session VII. Free Paper 2

Total hip arthroplasty outcomes before or after renal transplantation

Quanjun Cui

Univ. of Virginia, USA

Session VII. Free Paper 2

Postoperative longitudinal assessment of quality of life in patients with osteonecrosis of the femoral head: A multicenter study

Yuko Uesugi[1], Takashi Sakai[2], Wataru Ando[3], Taisuke Seki[4], Shinya Hayashi[5], Junichi Nakamura[6], Yutaka Inaba[7], Daisuke Takahashi[8], Michiaki Takagi[9], Yasuharu Nakashima[10], Naohiko Mashima[11], Tamon Kabata[12], Akihiro Sudo[13], Tetsuya Jinno[14], Satoshi Nagoya[15], Kengo Yamamoto[16], Satoshi Nakasone[17], Takuaki Yamamoto[18], Nobuhiko Sugano[19]

[1]Department of Nursing, Kinjo Gakuin University,
[2]Department of Orthopaedic Surgery, Yamaguchi University Graduate School of Medicine,
[3]Department of Orthopaedic Surgery, Osaka University Graduate School of Medicine,
[4]Department of Orthopaedic Surgery, Nagoya University Graduate School of Medicine,
[5]Department of Orthopaedic Surgery, Kobe University Graduate School of Medicine,
[6]Department of Orthopaedic Surgery, Chiba University Graduate School of Medicine,
[7]Department of Orthopaedic Surgery, Yokohama City University Graduate School of Medicine,
[8]Department of Orthopaedic Surgery, Hokkaido University Faculty of Medicine and Graduate School of Medicine,
[9]Department of Orthopaedic Surgery, Yamagata University Graduate School of Medicine,
[10]Department of Orthopaedic Surgery, Kyushu University Graduate School of Medical Sciences,
[11]Department of Orthopaedic Surgery, Ehime University Graduate School of Medicine,
[12]Department of Orthopaedic Surgery, Kanazawa University Faculty of Medicine,
[13]Department of Orthopaedic Surgery, Mie University Graduate School of Medicine,
[14]Department of Orthopaedic Surgery, Dokkyo Medical University Saitama Medical Center,
[15]Department of Orthopaedic Surgery, Sapporo Medical University,
[16]Department of Orthopaedic Surgery, Tokyo Medical University School of Medicine,
[17]Department of Orthopaedic Surgery, Ryukyu University Graduate School of Medicine,
[18]Department of Orthopaedic Surgery, Fukuoka University Faculty of Medicine,
[19]Department of Orthopaedic Medical Engineering, Osaka University Graduate School of Medicine, Japan

Introduction: Osteonecrosis of the femoral head (ONFH) recognized as a rare disease and the effects of surgical treatment on the quality of life (QOL) assessments in patients with ONFH are rarely reported. The present multicenter study aimed to elucidate the postoperative longitudinal QOL in ONFH cases with minimum five year follow-up.

Methods: A total of 77 patients which were undergone surgical treatment were included from the in the present study. Males were 45 patients and females were 32 patients. The average age at

registration was 46.1 years. Total hip arthroplasty was performed for 55 hips, and femoral osteotomy was for 22 hips. Self-assessment QOL questionnaires, including the Japanese Orthopaedic Association Hip Disease Evaluation Questionnaire (JHEQ), Oxford Hip Score (OHS), and the short form 12 items version 2 (SF-12v2), were investigated preoperatively, at 6 months, 1 year, 2 years and 5 years postoperatively.

Results: All items of the JHEQ scores, OHS and physical component summary (PCS) of SF-12v2 were significantly improved from preoperative to 6 months postoperatively while mental component summary (MCS) and role/social component summary (RCS) of SF-12v2 were not. RCS were significantly improved at 1 year postoperatively. The pain VAS reached to plateau at 6 months postoperatively, while the JHEQ movement and OHS, scores were continuously improved from 6 months to 1 years, 2 years, and 5 years postoperatively with significant difference. Hip joint condition and movement of the JHEQ scores were continuously improved from 6 months to 5 years postoperatively.

Conclusion: The surgical treatment for ONFH improved the pain early after surgery. Conversely, the physical function was gradually improved up to 5 years.

Session VII. Free Paper 2

A minimum 15-year follow-up study after THAs using contemporary ceramic bearings in young patients with osteonecrosis of femoral head less than fifty

Seung-Hoon Baek, Shin-Yoon Kim, Bum-Jin Shim, Sang-Woo Son, Ji-Woon Lee

Department of Orthopedic Surgery, Kyungpook National University Hospital, Korea

Introduction: Total hip arthroplasties (THAs) with ceramic bearings are widely performed in young patients. However, there have been few literatures regarding the long-term outcomes after THAs using contemporary ceramic bearings in young patients. Therefore, we aim to show the long-term clinical and radiographic outcomes of ceramic bearing THAs in young patients with osteonecrosis of the femoral head less than fifty.

Methods: 60 consecutive patients (71 hips) were prospectively enrolled in this study and 11 patients (11 hips) were excluded. Patient medical records and radiographs were retrospectively reviewed at a minimum of 15 years follow-up. The mean follow-up period was 16.6 years (15 to 19) and the mean age was 39.8 years (18 to 49). All patients underwent cementless THA using same prostheses and a 28-mm third-generation alumina head. The clinical evaluations included HHS and questionnaires including noise around the hip joint. The radiographic evaluations included notching, cup inclination, cup anteversion, stress-shielding and osteolysis. Complications such as ceramic fracture, and dislocation were reviewed. Survivorship free from revision at 15 years was estimated using Kaplan-Meier method.

Results: Average HHS improved from 55.3±12.7 preoperatively to 94.0±5.2 at the last follow-up ($p<0.001$). Bearing-related complications occurred in 39 hips (65%); ceramic head fracture (1 hip), notching (18 hips, 30%), noise (23 hips, 38%), osteolysis (8 hips, 13%), and dislocation (3 hips, 5%). Notching was observed more frequently in patients with clicking ($p=0.015$), lower inclination ($p=0.013$) and anteversion angle of the cup ($p=0.034$). One hip was revised because of ceramic head fracture. The estimated survivor rate was 98.3% with revision for any cause as the endpoint at fifteen years.

Conclusion: Cementless THA using contemporary ceramic bearings showed a promising long-term outcomes in young patients less than fifty. However, we remain concerned about high rate of bearing-related complications including osteolysis and clicking that associated with radiographic notching.

Session VII. Free Paper 2

The early outcome of dual mobility cup total hip arthroplasty for the ARCO IV femoral head necrosis with Parkinson's disease

Junming Wan, Yanqing Hu, Jiachun Li, Hanzhong Liu, Shenghui Huang

Department of Joint Surgery, The Seventh Affiliated Hospital, Sun Yet-sun University, Japan

Objective: This study aims to explore the early outcomes of dual mobility cup total hip arthroplasty for the ARCO IV femoral head necrosis with Parkinson's disease.

Methods: Total 25 patients with the ARCO IV femoral head necrosis with Parkinson's disease (9 male and 16 female), with age of (70.20±6.94)years old, were treated with dual mobility cup THA from January 2019 to June 2019. The operative duration, intraoperative blood loss, postoperative blood loss complications were recorded. All patients were followed up postoperatively. Visual analogue scule(VAS), Harris hip score(HHS) and Mayo hip score (MHS) were recorded to evaluate the improvement of pain and recovery of hip.

Results: Patients were postoperative follow-up with an average of(13.55±0.99)months. The mean operative duration was (1.36±0.25)h; the mean blood loss was (275.00±77.17)ml and the mean postoperative blood loss was(236.11±76.32)ml; The X-ray of the postoperative hip showed that the prosthesis was in good position, the force line recovered satisfactorily, and the joint prosthesis was in close contact with the bone contact surface without any gaps. The mean VAS scores ranged from(5.61±0.97) preoperatively to(0.11±0.12) ($t=26.92$, $P < 0.001$) at 12 months postoperatively. The average HHS ranged from (3.77±1.40) points preoperatively to (91.83±4.88) points ($t=-86.73$, $P < 0.001$) at 12 months postoperatively. The average MHS was (89.10±5.22) points at 12 months postoperatively. None of the patients had any complications related to surgery.

Conclusion: The preliminary clinical result of dual mobility cup THA is satisfactory for the hip reconstruction, increasing the stability of the hip, and restoring the function of the postoperative hip.

Session VIII.
ON of Other Joints

August 27(Sat.), 2022 10:50-12:10

MODERATORS

Sang-Soo Lee

Hallym Univ., Korea

Joo Han Oh

Seoul National Univ., Korea

Session VIII. ON of Other Joints

ON around the knee

Tae Woo Kim[1], Chong Bum Chang[2]

Department of Orthopaedic Surgery, [1]SMG-SNU Boramae Medical Center, [2]Seoul National University Bundang Hospital, Korea

[CURRICULUM VITAE]

Professor with Tenure, Department of Orthopaedic Surgery, Seoul National University College of Medicine
Chief, Department of Orthopedic Surgery & Joint Reconstruction Center, Seoul National University Bundang Hospital
Director, Management Innovation Office, Seoul National University Bundang Hospital
Chairman, Insurance and Policy Committee, Korean Knee Society

[ABSTRACT]

Introduction: Unlike hip joints, subchondral bone necrosis following subchondral insufficiency fracture (SIF) is more common and problematic than secondary osteonecrosis in the knee joint. SIF of knee, usually combined with knee osteoarthritis, is one of the leading causes of knee arthroplasty or high tibial osteotomy. However, strategy to predict surgical progression of knee SIF, and appropriate criteria to determine surgical treatment have not yet been well established.

Purpose: The purpose of this study was to develop prediction model for surgical progression of knee SIF based on the demographic and radiologic risk factors.

Methods: A total of 200 patients diagnosed as knee SIF with magnetic resonance imaging (MRI) from 2010 to 2020 in a single center were reviewed retrospectively. Patients who had knee arthroplasty or HTO were regarded as surgical progression of knee SIF. Patient demographics, limb alignment, and MRI findings such as size and location of SIF, subchondral plate injury, extrusion ratio of meniscus, chondrosis, and bone marrow edema were evaluated as risk factors. A prediction model for surgical progression of knee SIF were developed by multivariable logistic re-

gression, and cut-off value of each risk factor were evaluated using the receiver operating characteristic (ROC) curve and validated with area under the curve (AUC).

Results: Size of lesion, collapse or deformation of subchondral plate, chondrosis, and extrusion ratio of meniscal tear were identified as the risk factors for surgical progression of knee SIF. The prediction model developed with four significant risk factors showed satisfactory performance (AUC=0.938). The cut-off values of lesion size, meniscal extrusion ratio, and chondrosis for surgical progression of knee SIF were 9 mm (AUC=0.851), 45% extrusion (AUC=0.814), and ICRS grade 3 of chondrosis (AUC=0.834), respectively.

Conclusion: Large-size, and subchondral plate injured knee SIF, especially combined with high grade chondrosis and large meniscal extrusion were at high risk of surgical progression. This model can be helpful to predict whether patients with knee SIF would need surgical treatment or not.

Session VIII. ON of Other Joints

ON of the humerus

Joo Han Oh

Seoul National Univ., Korea

[CURRICULUM VITAE]

Former Chairman, Department of Orthopedic Surg, Seoul National University Bundang Hospital
Secretary General, 2016 13th International Congress of Shoulder Elbow Surgeons
Former President of Korean Shoulder and Elbow Society (2019-2021)
Chairman of Medical Advisory Committee
Korean Baseball Organization
Korean Skating Organization
Basic Science Editor of JSES
Editorial Board of AJSM

[ABSTRACT]

Osteonecrosis, previously termed avascular necrosis (AVN) or aseptic necrosis is characterized by necrosis of the bone tissue and bone marrow. Humeral head is the 2nd most common site of osteonecrosis, but it has been unrecognized for a long time because there is no significant weight load on the shoulder. Osteonecrosis of humerus was first reported by Bornstein and Plate in 1911 and it was first described by Heiman and Freiberger in 1960 for their correlation with cortico-steroid therapy. Cruess developed classification of osteonecrosis of humerus by modifying the Ficat and Arlet classification of hip. Anatomically, 2 main vessel, anterior and posterior humeral circumflex artery, feeds humeral head. AHCA was known to be predominant for humeral head and PHCA supplies GT and posteroinferior part of humeral head.

No definite single etiology was established, but there were several known risk factors. Risk factors are largely divided into traumatic and nontraumatic causes. Trauma leads to humeral head osteonecrosis by disrupting the vascular supply. It is especially common in patients with internal

fixation of the fracture. Risk of osteonecrosis was known as 0-25% for three-part proximal humerus fracture and 0-77% for four-part fractures. Also, in trauma, several combined factors affect the risk of necrosis such as age, fracture location, combined dislocation, and presence of medial hinge. In nontraumatic factors, corticosteroid is known to be one of common cause of osteonecrosis. The exact mechanism of how corticosteroid leads to osteonecrosis is unknown, but fat accumulation theory is most accepted one. Also, there may be the individual predisposition toward osteonecrosis among patients regarding corticosteroid. Sickle cell disease is also known to be common cause of osteonecrosis. Abnormally shaped RBC causes hemolytic anemia and cause vascular occlusion which leads to tissue ischemia and infarction. Alcohol is another risk factor, but exact mechanism is unknown. There seems to be a dose response relationship, and there is likely a multifactorial relationship between them. Dysbaric osteonecrosis is seen in deep sea divers, tunnel workers. Abrupt decompression of intravascular nitrogen causes bubble to be formed which cause local ischemia and occlusion. Furthermore, more risk factors are known such as Gaucher disease, tuberculosis, and HIV.

Osteonecrosis of humeral head can be diagnosed by physical and radiological examinations. Although very early stage of osteonecrosis may be undetectable on plain radiograph, early osteonecrosis shows cystic and/or sclerotic changes in the humeral head. MRI is the modality of choice for patients with a suspicious history. Band-like hypo-intense zones on T1-weighted images is specific MRI finding and it is known to be 99% sensitive and specific for detecting early shoulder necrosis.

Osteonecrosis of the humeral head is frequently classified using Cruess classification. Stage 1 is characterized by normal radiographs and abnormal MRI. Stage 2 includes sclerotic or osteopenic change with maintained sphericity. Stage 3 is characterized by crescent sign, stage 4 has collapse with articular surface destruction and stage 5 shows arthritic change in glenoid.

Treatment of osteonecrosis differs among stages of disease. For early stages (I or II), nonoperative treatment can be chosen. It includes avoiding risk factor, medication, and physical therapy. Arthroscopic debridement and core decompression were also thought to be effective for early-stage disease, but the clinical outcomes are still on debate. For late stages (III, IV, or V), with the collapse of articular surface, arthroplasty is known to be the most effective treatment option. Hemiarthroplasty, anatomical total shoulder arthroplasty, and reverse total shoulder arthroplasty can be the option and it should be decided considering the integrity of rotator cuff, arthritic change of glenoid. With proper indication, arthroplasty is effective treatment option for humeral head osteonecrosis.

Reference

1. Heimann WG, Freiberger RH. Avascular necrosis of the femoral and humeral heads after high-dosage corticosteroid therapy. N Engl J Med, 1960, 263: 672-675
2. Hasan S, Romeo A. Nontraumatic osteonecrosis of the humeral head. J Shoulder Elbow Surg, 2002, 11: 281-298.
3. Patel S, Colaco HB, Elvey ME, Lee MH. Post-traumatic osteonecrosis of the proximal humerus. Injury, 2015, 46: 1878-1884.
4. Hernigou P, Hernigou J, Scarlat M. Shoulder Osteonecrosis: Pathogenesis, Causes, Clinical Evaluation, Imaging, and Classification. Orthop Surg, 2020, 12: 1340-1349.

Session VIII. ON of Other Joints

ON around the ankle

Kyoung Min Lee

Seoul National Univ., Korea

[CURRICULUM VITAE]

1995-2001	M.D., College of Medicine, Seoul National University, Seoul, Korea
2005-2010	M.S., Orthopaedic Surgery, College of Medicine, Seoul National University, Seoul, Korea
2010-2012	Ph.D, Orthopedic Surgery, College of Medicine, Seoul National University, Seoul, Korea
2001-2002	Intern, Seoul National University Hospital
2002-2006	Resident, Department of Orthopaedic Surgery, Seoul National University Hospital
2006-2009	National Health Doctor (Alternative Military Service)
2009-2011	Clinical fellow, Department of Orthopaedic Surgery, Seoul National University Bundang Hospital
2011-	Clinical Assistant Professor, Department of Orthopaedic Surgery, Seoul National University Bundang Hospital
2016-2017	Visiting Scholar, Department of Radiology (skeletal radiology), UC San Diego
2017-	Clinical Associate Professor, Department of Orthopaedic Surgery, Seoul National University Bundang Hospital

[ABSTRACT]

Ankle joint is a very complex joint composed of multiple small bones and osteonecrosis around this joint represents unique challenges in the management, which leads to different strategies from those of other joints.

Avascular necrosis (AVN) of the talus is developed by various traumatic and non traumatic causes that interrupt the blood supply to this bone. The extent of AVN is determined at the initial trauma or exposure. Conservative treatment is a period of nonweightbearing while surgical treatment includes various options such as core drilling, bone grafting, and fusion. Joint replace-

ment is not usually considered due to poor bone stock in this condition but total talar prosthesis is an emerging surgical option for talar AVN.

Müller-Weiss disease (MWD) is considered to be caused by impaired blood supply to the lateral 1/3 of navicular which is accompanied by excessive compressive force to this part. This condition is characterized by paradoxic flatfeet (flatfoot with hindfoot varus). Conservative treatment with the use of rigid insoles is effective, and surgical treatment includes calcaneal osteotomy and talo-navicular fusion.

AVN of tibial plafond is a rare condition that can be occur following rotation ankle fractures. According to the patients' symptoms and the degree of joint collapse, treatment option includes limited weightbearing, medication, percutaneous drilling, bone grafting, arthrodesis and total ankle replacement arthroplasty.

Session VIII. ON of Other Joints

ON around the wrist

Hyun Sik Gong

Seoul National Univ., Korea

[CURRICULUM VITAE]

Professor, Department of Orthopedic Surgery, Seoul National University Bundang Hospital

1996	College of Medicine, Seoul National University (M.D.)
2006	Postgraduate School, Orthopedic Surgery, Seoul National University (Ph.D.)
2013-2014	Visiting research professor, Department of Orthopedic Surgery, Stanford University

[ABSTRACT]

Kienböck's disease is one of the most common and important conditions involving osteonecrosis around the wrist, although other carpal bones, such as the scaphoid, capitate, trapezium, etc are known to be affected. Viennese radiologist Rober Kienböck first described "traumatic malacia of the lunate" in 1910. He theorized that the disease is caused by a compromised lunate blood supply and also by some trauma. Since then, many studies have suggested that the pathogenesis is multifactorial, and proposed etiologic factors include trauma, disruption of venous outflow and local vascular anatomy, lunate anatomy and ulnar variance, and repetitive mechanical loading.

Kienböck disease affects individuals aged 20 to 40 years old most commonly and presents with dorsal wrist pain and limited wrist motion. The classification system suggested by Lichtman et al in 1977 and further modified in 1993, which was based on radiographic findings of disease progression, has been a standard for treatment algorithm for this condition. Since then, attempts have been made to incorporate contrasted magnetic resonance imaging and articular cartilage degeneration to further define the disease status. With this added concept of classification and some recently introduced surgical options, treatment of Kienböck disease now includes nonoperative modalities, minimally invasive techniques, arthroscopy, reconstructive procedures (e.g., various osteot-

omies, vascularized bone grafts, and limited wrist fusions), and salvage options (e.g., proximal row carpectomy, wrist fusion, and arthroplasty).

In this presentation, the life of Robert Kienböck with his remarkable career is briefly introduced to honor and respect many contributions he made to this field. In addition, the new concept of treatment algorithm and an emerging theory of different disease progression according to age are discussed.

References

1. Chochole M. Robert Kienbock: the man and his work. J Hand Surg Eur Vol. 2010;35(7):534-7.
2. Kienböck's disease. Advances in diagnosis and treatment. Lichtman DM and Bain G eds. Springer. 2016.
3. Lichtman DM, Pientka WF 2nd, MacLean S, Bain G. Precision Medicine for Kienböck Disease in the 21st Century. J Hand Surg Am. 2022;47(7):677-684.

2022 ARCO (Korea Session)
Session 1.
Updating Osteonecrosis of the Femoral Head

August 27(Sat.), 2022 13:40-14:20

MODERATORS

Shin-Yoon Kim

Kyungpook National Univ., Korea

Yoon-Je Cho

Kyung Hee Univ., Korea

Session 1. Updating Osteonecrosis of the Femoral Head

Change of treatment trends of osteonecrosis of femoral head

Yong-Chan Ha

Seoul Bumin Hosp., Korea

[CURRICULUM VITAE]

1988-1990	Premedical School, Gyeongsang National University
1990-1994	Gyeongsang National University, College of Medicine
1994	Medical Doctor (License number: 53794)
1998-2000	Gyeongsang National University, Graduate School
2000	Master of Science
2005-2008	Cheju National University, Graduate School
2008	Doctor of Philosophy
1994-1995	Internship, Gyeongsang National University Hospital
1995-1999	Resident, Department of Orthopaedic Surgery, Gyeongsang National University Hospital
2002-2003	Lecturer, Department of Orthopaedic Surgery, Jeju National University, College of Medicine
2003-2007	Assistant Professor, Department of Orthopaedic Surgery, Gyeongsang National University, College of medicine
2007-2009	Assistant Professor, Department of Orthopaedic Surgery, Seoul National University Bundang Hospital
2009-2014	Associate Professor, Department of Orthopaedic Surgery, Chung-Ang University, College of Medicine
2014-2020	Chairman and Professor, Department of Orthopaedic Surgery, Chung-Ang University, College of Medicine
2020-2022	Professor, Department of Orthopaedic Surgery, Chung-Ang University, College of Medicine
2022-present	Vice president, Department of Orthopaedic Surgery, Seoul Bumin Hospital

[ABSTRACT]

Osteonecrosis of the femoral head (ONFH) is a common progressive disease typically characterized by reduction in vascular supply, bone metabolism disorder, and necrosis of the subchondral bone and eventually resulting in bone collapse of the femoral head. In South Korea, more than 60% of indication of THRA is related with osteonecrosis of femoral head. The prevalence of osteonecrosis of the femoral head in Korea was assessd using medical claims data from the Korean National Health Insurance Corporation, from 2002 to 2006. The estimated yearly prevalence per 100 000 population ranged from 20.53 (20.13 <or= 95% confidence interval <or= 20.94) in 2002 to 37.96 (37.42 <or= 95% confidence interval <or= 38.51) in 2006. The average estimated number of annual prevalent cases was 14 103, indicating 28.91 per 100 000 average prevalence over a 5-year period. Males predominated. Causal factors of osteonecrosis were alcohol abuse (32.4%), and steroid(14.6%). Treatment options of osteonecrosis of femoral head are various such as arthroplasty, core decompression, osteotomy, stem cell thearpy et al. However, recent studies are trends in the management of osteonecrosis of the femoral head (ONFH) identified an increasing rate of total hip arthroplasties (THAs) and a decreasing rate of joint-preserving procedures.

Session 1. Updating Osteonecrosis of the Femoral Head

Osteonecrosis micmicking joint infection

Tae Young Kim

Konkuk Univ., Korea

[CURRICULUM VITAE]

1998	M.D. School of Medicine, Gyeongsang National University, Korea.
1999	Internship, School of Medicine, Ajou University, Korea.
2003	Residency, Department of Orthopaedic Surgery, School of Medicine, Ajou University, Korea.
2009	M.S. Department of Orthopaedic Surgery, School of Medicine, Korea University Postgraduate School, Korea
2015	PhD. Department of Orthopaedic Surgery, School of Medicine, Chung-Ang University Postgraduate School, Korea
2006-2007	Clinical Instuctor, Department of Orthopaedic Sugery, School of Medicine, Seoul National University, Korea.
2007-2008	Fellowship, Department of Orthopaedic Sugery, School of Medicine, Korea University, Korea.
2008-2013	Assisstant Professor, Department of Orthopaedic Sugery, School of Medicine, Hallym University, Korea.
2013-2018	Associate Professor, Department of Orthopaedic Sugery, School of Medicine, Hallym University, Korea.
2018-2019	Associate Professor, Department of Orthopaedic Sugery, School of Medicine, Konkuk University, Korea.
2019-present	Professor, Department of Orthopaedic Sugery, School of Medicine, Konkuk University, Korea.

[ABSTRACT]

If pus-like fluid gushes from the joint during the THA, and an automated WBC count of the joint fluid shows leukocytosis, orthopaedic surgeons make a diagnosis of septic arthritis and delay THA owing to fear of infection developing after the arthroplasty. Surgeons may treat these patients with debridement or resection arthroplasty and subsequent use of antibiotics. Accordingly, hospital stays are prolonged, medical costs are increased, and patients have substantially greater physical limitations and a reduction in their health-related quality of life.

Orthopaedic surgeons make a diagnosis of septic arthritis when joint fluid appears turbid and the WBC count is elevated in cell counting of joint fluid even without clinical symptoms of septic arthritis because these symptoms might not be evident in the early stage of infection or low-grade infection.

Liquefied fat of bone marrow is yellow and turbid and may simulate pus. In collapsed femoral head ON of the Ficat Stage III or IV lesion, marrow fat leaks into the hip through the osteochondral defect Lipid or cholesterol crystals in body fluids can cause a spurious elevation of WBCs in the automated cell count. This artifact can occur in the automated WBC count of hip fluid containing marrow fat from an osteonecrotic femoral head and an erroneous diagnosis of septic arthritis can be made.

This spurious elevation of WBCs in fat-contaminated body fluid is well known to physicians in the laboratory department. However, most orthopaedic surgeons are unaware of the spurious infection. In collapsed femoral head ON of the Ficat Stage III or IV lesion, the marrow fat may leak into the joint space through the osteochondral crack at the surface of the necrotic femoral head, appeared like pus, and caused an artifactual leukocytosis in the automated cell count. The fat cell membrane might have been ruptured in several fat cells and fat globules were released from the fat cells. Some shrunken fat cells and released fat globules, which were similar in size to leukocytes, might have been counted as leukocytes.

However, concomitant septic arthritis of the hip can occur in patients with femoral head ON, especially when the patient is immune compromised or has sickle cell anemia. Therefore, microscopic examination of the smear must be performed to avoid a false diagnosis of septic arthritis.

References

1. Motomura G, et al., Pathol Res Pract. 2005;200:807-811.
2. Er TK, et al., Clin Chem Lab Med. 2008; 46:1054-1055.
3. Kim TY et al., Clin Orthop Relat Res. 2012 Mar;470(3):877-82.

Session 1. Updating Osteonecrosis of the Femoral Head

Future perspectives: Stem cell therapy

Shin-Yoon Kim

Kyungpook National Univ., Korea

[CURRICULUM VITAE]

Kyungpook National University, College of Medicine, Bacheolor. 1983
Kyungpook National University, College of Medicine, Postgraduate School of medicine, Master. 1986
Department of Orthopedic Surgery, Yeungnam University, postgraduate school of medicine
Department of Orthopedic Surgery, Ph.D. 1996
Internship- Kyungpook National University Hospital, 1983
Residency- Kyungpook National University Hospital,
Department of Orthopedic Surgery, 1984-1988
Faculty Appointment: Assistant Professor, Kyungpook National University and Hospital,
Department of Orthopedic Surgery, 1993-1997
Associate Professor, 1997-2002
Professor, 2002-now
Chairman, 2005-2014

Fellowship Appointment: Clinical and Research Fellow, 1996-1998
University of Pittsburgh, Medical Center and Musculoskeletal Research Center

[ABSTRACT]

Bone regeneration is required for benign bone tumor, bone defect after trauma, periprosthetic bone loss around joint replacement, spinal fusion, and osteonecrosis. Autogenous bone graft is ideal and safe from adverse reactions. Osteonecrosis of the femoral head (ONFH) leads to secondary osteoarthritis after collapse, necessitating total hip arthroplsty in many cases. However, to preserve and use its own head is far better than artificial joint. There are many options to preserve its own

head including observation, core decompression, multiple drilling, nonvascualrized bone grafting, vascularized bone grating, transtrochanteric rotational osteotomy, cell therapy with or without scaffolds or growth factors, and combined therapy. Each option has a theoretical rationale and principal. The prognosis of ONFH depends largely on the lesion size, location, and staging.

Especially, ONFH with large or lateral-located lesion is challenging due to difficulty of regeneration. We introduce novel tissue engineering technique using ex vivo expanded bone marrow stromal cell seeded on calcium metaphosphate (CMP) scaffold to regenerate dead bone for these challenging cases. Ten milliliters of bone marrow was aspirated from iliac crest and mononuclear cells were collected. These cells were expanded and differentiated to osteoblast-lineage cells using osteogenic media and autologous serum for 2-4 weeks ex vivo. Porous bead-form scaffolds were made of CMP and cells were seeded in a density of million/ml^3 into 20 to 30 beads for 1 hour. The necrotic area was curetted and the beads were implanted through core tract in 9 hips (Steinberg IIc in 5 hips and IVc in 4 hips which involved greater than 30% of whole head; JIC classification C1 in 4 hips, and C2 in 5 hips which involved weight bearing area). The tract was blocked with a CMP rod. The age of patients ranged from 16 to 37. Associated factors were; steroid in 4, idiopathic in 3, alcoholic in 1 and traumatic in 1 hip, respectively. Kerboul combined necrotic angle was more than 200° in all hips. We compared preoperative and annual radiographs and MRI images to check dome depression of femoral head and signal change of osteonecrotic area. Follow-up period ranged from 8 to 14 years. Two IIc lesions progressed and were converted to THA at two and six years postoperatively. We could get clinical and radiographic success in 7 hips (78%). Follow-up radiographs and MRI showed partial or nearly complete regeneration of necrotic bone, prevention of collapse, and reduction in necrotic lesion. This can be a good strategy for bone regeneration of unmet need as in a human model (Figure 1).

Fig. 1. Preopertive left hip radiograph shows osteonecrosis of femoral head with dome depression and moderate osteoarthritic change(left) Thirteen years follow-up radiograph shows preserved own femoral head with regeneration, re-trabeculation, and .smooth joint margin.

References

1. Kim SY, Kim YG, Kim PT,et al. Vascularized compared with nonvascularized fibular grafts for large osteonecrotic lesions of the femoral head. J Bone Joint Surg Am. 2005;87: 2012-59.
2. Eui Kyun Park, Shin-Yoon Kim, Suk Young Kim., Et al Cellular biocompatibility and stimulatory effects of calcium metaphosphate on osteoblastic differentiation of human bone marrow-derived stromal cells. Biomaterials, 25: 3403-3411, 2004.

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2022 ARCO (Korea Session)
Session 2.
Total Hip Arthroplasty

August 27(Sat.), 2022 14:20-15:10

MODERATORS

Joo-Hyoun Song

The Catholic Univ. Korea, Korea

Seung-Hoon Baek

Kyungpook National Univ., Korea

Session 2. Total Hip Arthroplasty

How to prevent dislocation: approach, cup positioning, repair

Chan-Ho Park

Yeungnam Univ., Korea

[CURRICULUM VITAE]

2001-2007	College of Medicine, Soonchunhyang University, MD
2011-2017	Post Graduate School, Soonchunhyang University, MS
2017-2021	Post Graduate School, Soonchunhyang University, PhD
2007-2008	Soonchunhyang University Hospital, Intern
2008-2012	Department of Orthopaedic Surgery, Soonchunhyang University Hospital, Resident
2012-2015	Military Service, The Forces Medical Command, Military Doctor
2015-2016	Department of Orthopaedic Surgery, Soonchunhyang University Hospital, Clinical Fellow
2016-2017	Department of Orthopaedic Surgery, Seoul National University Hospital, Clinical Fellow
2017-2022	Department of Orthopaedic Surgery, Yeungnam University Medical Center, Assistant Professor

[ABSTRACT]

Dislocation is one of the complications after total hip arthroplasty patients in which the patient complains of severe discomfort. Surgeons should try not to make this complication and pay attention to several factors during operation.

Although dislocation is multifactorial, the important thing is to find exact cause of the dislocation. According to the time of dislocation, it can be divided into early and late dislocation, and the causes are different accordingly. The causes of early dislocation are implant position, surgical approach and soft tissue repair. One of them, implant position is the most important factor of early dislocation. Acetabulum and femur have anatomical anteversion about 20 degrees. Posterior dislocation can occur if the surgeon places the implant with retroversion. If a cementless stem is used, we focus on adjusting the anteversion of the acetabulum because we can hardly ad-

just the anteversion angle of the femur. The concept of combined anteversion is introduced recently to adjust acetabular cup anteversion according to the femoral stem anteversion to reach the target combined anteversion.

Recently, the problem of anterior dislocation has also been raised due to sagittal imbalance in patients with degenerative kyphosis. In such patients, it is better to differentiate the type of sagittal imbalance and adjust the implant position more carefully or use a dual mobility implant.

Other causes of dislocation include surgical approaches and soft tissue repair. There are various surgical approaches for total hip arthroplasty such as posterior, lateral, anterior approach. Although surgeons prefer to use a familiar approach, the literature in the past has reported that dislocation rates vary depending on the approach. In particular, the dislocation rate was higher in the posterior approach in which the posterior capsule and short external rotator were incised compared to other approaches. Therefore, firm repair of the joint capsule and soft tissue is very important in the posterior approach because posterior capsule and external rotator act as joint stabilizer.

As mentioned above, once the exact cause is identified, appropriate treatment should be given accordingly. Although conservative treatment can be performed, if there is a problem with the position of the implant, revision surgery is required. It is important to appropriately control the various factors for dislocation in primary total hip arthroplasty so that revision surgery is not necessary as much as possible.

Session 2. Total Hip Arthroplasty

How to prevent PJI: 2018 ICM guideline

Seung-Hoon Baek

Kyungpook National Univ., Korea

[CURRICULUM VITAE]

1992-1994	Premedical Course, Liberal Arts and Science College, Kyungpook National University
1994-1998	Bachelor of Medical Science, College of Medicine, Kyungpook National University (M.D.)
1999-2001	Course for Master of Medical Science (MSc), Graduate School of Medicine, Kyungpook National University
2004-2006	Course for Master Of Business Administration (MBA), Graduate School of Business Administration, Kyunghee University
2006-2015	Course for Doctor of Medical Science (PhD), Graduated School of Medicine, Kyungpook National University
1998-1999	Internship, Kyungpook National University Hospital, Daegu, Korea
1999-2003	Residency, Department of Orthopedic Surgery, Kyungpook National University Hospital, Daegu, Korea
2003-2006	Military Doctor, Army Captain (62nd Division), Korea
2006-2007	Clinical Fellow, Clinical Fellowship in Service of Joint replacement and reconstruction, Department of Orthopedic Surgery, Kyungpook National University Hospital, Daegu, Korea
2007-2007	Clinical Instructor, Clinical Fellowship in Service of Joint Replacement and Reconstruction, Department of Orthopedic Surgery, Kyungpook National University Hospital, Daegu, Korea
2007-2008	Clinical Assistant Professor, Clinical Fellowship in Service of Knee surgery and Sports medicine, Department of Orthopedic Surgery, Kyungpook National University Hospital, Daegu, Korea
2008-2008	Clinical Assistant Professor, School of Medicine, Catholic University of Daegu, Daegu, Korea
2008-2011	Assistant Professor, Department of Orthopedic Surgery, Catholic University of Daegu, Daegu, Korea
2012-2012	Vice Chief, Madi-Pyunhan Hospital, Daegu, Korea

2012-2013 Exchange Scholar, Bioengineering Laboratory, Department of Orthopaedics, Massachusetts General Hospital and Harvard Medical School, Boston, MA, USA
2013-2017 Assistant Professor, Department of Orthopedic Surgery, Kyungpook National University, Daegu, Korea
2014-2014 Research fellow, Department of Orthopaedic Surgery, Fukuoka University Medical School, Fukuoka, Japan
2015-2016 Exchange Scholar, Bioengineering Laboratory, Department of Orthopedics, Massachusetts General Hospital and Harvard Medical School, Boston, MA, USA
2017 Visiting Doctor, Department of Orthopedic Surgery, McMaster University Medical Centre
2017-present Associate Professor, Department of Orthopedic Surgery, Kyungpook National University, Daegu, Korea
2019 Visiting Doctor, Steadman Philippon Research Institute
2022 Chairman, Department of Orthopedic Surgery, Kyungpook National University Hospital, Daegu, Korea

[ABSTRACT]

The number of periprosthetic joint infection (PJI) after total hip arthroplasty continues to increase, threatening the final success of the surgery, causing unnecessary morbidity and a huge socioeconomic burden. This issue was highlighted by the Center for Disease Control as they developed and updated the surgical site infection prevention guidelines according to the International Consensus Meeting (ICM) on PJI in the year of 2013.

A second ICM expanded to all fields of orthopedic surgeries as an ICM on Musculoskeletal Infection, was held in Philadelphia, PA in 2018. Over 800 delegates around the world participated in the Delphi process to generated the Consensus Statements (questions and responses/recommendations), which were voted on by 540 delegates in real time at the meeting. The questions related to the today's topic, "*How to prevent PJI: 2018 ICM guideline*" are followings:

1. General Assembly Section, Prevention	**2. Hip and Knee Section, Prevention**
1.1 Host Related (Local)	2.1 Host Related
1.2 Host Related (General)	2.2 Risk Mitigation
1.3 Host Risk Mitigation (Local)	2.3 Antimicrobials (Systemic)
1.4 Host Risk Mitigation (General)	2.4 Antimicrobials (Local)

1.5 Risk Mitigation (Local) 1.6 Risk Mitigation (General) 1.7 Antimicrobials (Systemic) 1.8 Antimicrobials (Local) 1.9 Surgical Site Preparation 1.10 Operating Room Anesthesia 1.11 Operating Room Personnel 1.12 Operating Room Environment 1.13 Operating Room Surgical Attire 1.14 Operating Room Surgical Field 1.15 Antiseptic Irrigation Solution 1.16 Operating Room Surgical Technique 1.17 Blood Conservation 1.18 Wound Management 1.19 Postoperative Factors 1.20 Hospital Environment	2.5 Operating Room Environment 2.6 Surgical Technique 2.7 Prosthesis Factors 2.8 Postoperative Issues

Due to limited time available, several questions with their responses and refined rationales will be provided with an overview summary and discussion will be available. For detail, I highly recommend to visit the following website and download the full-text articles.

https://www.ors.org/icm-2018-general-assembly

https://www.arthroplastyjournal.org/issue/S0883-5403(18)X0012-6

https://icmphilly.com/document/icm-2018-hip-and-knee-document

Reference

1. Javad Parvizi, Thorsten Gehrke (Ed). Proceedings of the Second International Consensus Meeting on Musculoskeletal Infection J Arthroplasty, 2019;34(Suppl 2):S1-S496.

Session 2. Total Hip Arthroplasty

Complex THA

Jae-Young Lim

Inje Univ., Korea

[CURRICULUM VITAE]

2004-2010	School of Medicine, Ajou University
2010	Medical Doctor (License number: 103808)
2013-2016	Inje University, Graduate School
2016	Master of Science
2016-2019	Inje University, Graduate School
2021	Doctor of Philosophy
2010-2011	Intern, Ajou University Hospital
2011-2015	Resident, Department of Orthopaedic Surgery, Inje University Haeundae Paik Hospital
2015	Orthopaedic Surgeon
2015-2018	Dedicated doctor, Military service, Department of Orthopaedic Surgery, Daegu & Busan Military Manpower Administration
2018-2019	Clinical Fellow ship, Department of Orthopaedic Surgery, Inje University Haeundae Paik Hospital
2019-2020	Clinical Fellow ship, Department of Orthopaedic Surgery, Chung-Ang University Hospital
2020-Now	Assistant Professor, Department of Orthopaedic Surgery, Inje University Haeundae Paik Hospital

[ABSTRACT]

Nowadays, total hip arthroplasty (THA) has been standard surgery for many hip diseases. However, some cases remain complex and hard because those patients have comorbidities, such as neuromuscular disease or dysmorphic bone status, except for medical problems.

Neuromuscular patients need more additional procedures than standard total hip arthroplasty surgery, such as tenotomy or the use of constrained type implants.

To obtain stable hip biomechanics in case of dysmorphic bone status such as abnormal lateral offset, coxa vara, ankylosis, dysplasia, congenital hip dislocation, or post-traumatic change, specific techniques or implants must be needed.

In patients with high lateral offset and normal femoral neck-shaft angle, lateralization of the acetabular cup with bone graft in the acetabulum or trochanteric osteotomy with lowering of gluteal attach site might be considered. In patients with coxa vara, original biomechanics is not suitable with arthroplasty. Special implant with modular neck or customized neck would be considered. Moreover, short neck cutting might be considered with trochanteric osteotomy for lengthening the gluteus muscle. In case of arthrodesis, if the cause of arthrodesis is infection, preoperative evaluation for remnant infection must be evaluated. Moreover, the status of the gluteus muscles must be accessed by EMG or MRI. Significant weakness of the gluteus muscles could be a contraindication of THA. Congenital hip dysplasia can be challenging case because of three problems. The position and coverage of the acetabular cup must be considered, and a specific or modular femoral stem should be prepared with an osteotomy if necessary. Finally, soft tissue release and femoral shortening osteotomy should be considered to lowering the femoral head into the acetabular cup. In cases of acetabular dysplasia with bone defect or post-traumatic deformity after acetabular fracture, the cup should be firmly fixed with care, even through bone graft or additional internal fixation. Previous internal fixation hardware is rarely an obstacle during surgery. The goal of the treatment for acetabular protrusio is to restore a normal center of rotation and prevent progressive protrusion. Prior to surgery, bone graft and reinforcement rings should be prepared. Femoral deformities due to congenital or post-trauma or osteotomy must be evaluated to restore hip normal biomechanics. Fixation of implants should restore anteversion, length and the lever arm.

In complex cases, THA may be difficult and complicated, but it can be overcome well if there is a thorough preoperative planning.

Session 2. Total Hip Arthroplasty

Ceramic THA: is it life-long?

Jung-Taek Kim

Ajou Univ., Korea

[CURRICULUM VITAE]

Assistant Professor Department of Orthopedic Surgery, Ajou University School of Medicine

[ABSTRACT]

To answer the request for alternative bearing to the metal on polyethylene bearing, ceramic-on-ceramic (CoC) articulation was developed by Boutin and Heinz Mittelmeier in 1970.

Alumina has a very low friction coefficient, high hardness, and wettability of the surface and it is biocompatible. In vivo, its material properties are not affected by ageing.

In vitro studies have shown that CoC articulation offers the benefit of significantly reducing volumetric wear. Histological analysis of long-term retrievals indeed found wear debris in individual macrophages, but the inertness of such debris does not trigger the granulomatous reaction necessary to induce osteolysis. CoC bearings also provide another advantage that wear is not directly dependent on the head diameter. This allows surgeons to select a larger diameter head or this type bearing in the patients who only accommodate a small size of acetabular cup with fewer concerns compared with polyethylene liners.

Excellent long-term clinical results have been reported for alumina CoC, with a cumulative survival rate of 99% at ten-year follow-up, and with 96.0% survival after 16 years. Good results have also been reported in young patients (< 30 years) at a minimum follow-up of 10 years.

As the brittle nature of the alumina components sometimes leads to the catastrophic consequences of bearing fracture, a new composite ceramic Biolox Delta was introduced in the early 2000s.

An in vitro study found that 4th generation CoC delta provides decreased wear rate compared to 3rd generation CoC even under microseperation conditions. Mid- to long-term follow-up studies of Delta ceramic have been published, with a survival rate of 99.7% for a mean of 66.5 months. The

Australian Registry reports a CoC survival of92.8% at 15 years, supporting the excellent results.

Despite the excellent records for wear, CoC bearings have some drawbacks.

The first limitation of ceramics is the risk of fracture with the brittleness of the material. With modern ceramics, studies report only occasional occurrence of fracture of the head, with a higher risk of occurrence in the short neck 28-mm head. Liner fracture is also rarely reported with a possible mechanism of impingement between neck and liner. The second disadvantage of CoC bearings can be the occurrence of noises such as squeaking. Similar to ceramic liner fractures, there is a great variety of incidence (from 0% to 35%) among different metal back manufacturers reported in the literature. Several risk factors have been identified, such as age, obesity, activity level and acetabular component positioning.

The latest-generation CoC bearings have shown excellent wear results with the advantage of a decrease in the thickness of acetabular components. However, the risk of fracture and noise are remaining problems to be solved.

References

1. Al-Hajjar, M., Fisher, J., Tipper, J. L., Williams, S. & Jennings, L. M. Wear of 36-mm BIOLOX(R) delta ceramic-on-ceramic bearing in total hip replacements under edge loading conditions. Proc Inst Mech Eng H 227, 535-542 (2013).
2. Ha, Y. C., Kim, S. Y., Kim, H. J., Yoo, J. J. & Koo, K. H. Ceramic liner fracture after cementless alumina-on-alumina total hip arthroplasty. Clin Orthop Relat Res 458, 106-110 (2007).
3. Ha, Y. C. et al. Cementless alumina-on-alumina total hip arthroplasty in patients younger than 50 years: a 5-year minimum follow-up study. J Arthroplasty 22, 184-188 (2007).
4. Kang, B. J., Ha, Y. C., Hwang, S. C., Lee, Y. K. & Koo, K. H. Midterm results of large diameter Biolox forte ceramic head on delta ceramic liner articulation in total hip arthroplasty. J Arthroplasty 29, 2412-2414 (2014).
5. Kim, H. S. et al. Third-Generation Ceramic-on-Ceramic Total Hip Arthroplasty in Patients with Osteonecrosis of the Femoral Head: A 10- to 16-year Follow-up Study. J Bone Joint Surg Am 104, 68-75 (2022).
6. Kim, H. S. et al. High Risk of Neck-liner Impingement and Notching Observed with Thick Femoral Neck Implants in Ceramic-on-ceramic THA. Clin Orthop Relat Res 480, 690-699 (2022).
7. Konan, S., Alazzawi, S., Yoon, B. H., Cha, Y. H. & Koo, K. H. A focused update on preventing ceramic fractures in hip arthroplasty: is the 'cup' half full? Bone Joint J 101-B, 897-901 (2019).
8. Koo, K. H. et al. Isolated fracture of the ceramic head after third-generation alumina-on-alumina total hip arthroplasty. J Bone Joint Surg Am 90, 329-336 (2008).
9. Koo, K. H. et al. Revision of ceramic head fracture after third generation ceramic-on-ceramic total hip arthroplasty. J Arthroplasty 29, 214-218 (2014).
10. Lee, Y. K. et al. Could larger diameter of 4th generation ceramic bearing decrease the rate of

dislocation after THA? J Orthop Sci 21, 327-331 (2016).
11. Lee, Y. K., Ha, Y. C. & Koo, K. H. Comparison between 28 mm and 32 mm ceramic-on-ceramic bearings in total hip replacement. Bone Joint J 96-B, 1459-1463 (2014).
12. Lee, Y. K. et al. Mid-term results of the BIOLOX delta ceramic-on-ceramic total hip arthroplasty. Bone Joint J 99-B, 741-748 (2017).
13. Lee, Y. K. et al. Alumina-on-alumina total hip arthroplasty: a concise follow-up, at a minimum of ten years, of a previous report. J Bone Joint Surg Am 92, 1715-1719 (2010).
14. Lee, Y. K. et al. Effect of Inner Taper Angle of Acetabular Metal Shell on the Malseating and Dissociation Force of Ceramic Liner. J Arthroplasty 32, 1360-1362 (2017).
15. Lee, Y. K. et al. Use of ceramic-on-ceramic bearing in total hip arthroplasty for posttraumatic arthritis of the hip. J Orthop Surg (Hong Kong) 27, 2309499019836378 (2019).
16. Lee, Y. K. et al. Cementless total hip arthroplasty with delta-on-delta ceramic bearing in patients younger than 30 years. Hip Int 31, 181-185 (2021).
17. Lee, Y. K., Lee, J. C., Ha, Y. C. & Koo, K. H. Effect of neck length on third-generation ceramic head failure; finite element and retrieval analysis. J Orthop Sci 19, 587-597 (2014).
18. Lee, Y. K. et al. Preventing ceramic liner fracture after Delta ceramic-on-ceramic total hip arthroplasty. Arch Orthop Trauma Surg 141, 1155-1162 (2021).
19. Park, C. H., Ha, Y. C., Lee, Y. K. & Koo, K. H. Using Ceramic-on-Ceramic Bearings in Total Hip Arthroplasty Necessitating 44- or 46-mm Metal Shells. Orthopedics 41, e354-e359 (2018).
20. Rieker, C. B. Tribology of total hip arthroplasty prostheses: What an orthopaedic surgeon should know. EFORT Open Rev 1, 52-57 (2016).
21. Yoo, J. I., Ha, Y. C., Kim, D. H., Lee, Y. K. & Koo, K. H. Total Hip Arthroplasty Using Hybrid Ceramic Bearing: A Minimum 10-Year Followup Study. Indian J Orthop 53, 637-640 (2019).
22. Yoo, J. J. et al. Contemporary alumina-on-alumina total hip arthroplasty performed in patients younger than forty years: a 5-year minimum follow-up study. J Biomed Mater Res B Appl Biomater 78, 70-75 (2006).
23. Yoo, J. J. et al. Alumina-on-alumina total hip arthroplasty. A five-year minimum follow-up study. J Bone Joint Surg Am 87, 530-535 (2005).
24. Yoo, J. J. et al. Revision total hip arthroplasty using an alumina-on-alumina bearing surface in patients with osteolysis. J Arthroplasty 28, 132-138 (2013).
25. Yoon, B. H., Lee, Y. K., Ha, Y. C. & Koo, K. H. Contemporary ceramic total hip arthroplasty in patients with cerebral palsy: does it work? Clin Orthop Surg 7, 39-45 (2015).
26. Yoon, B. H. et al. Incidence of Ceramic Fracture in Contemporary Ceramic-on-Ceramic Total Hip Arthroplasty: A Meta-analysis of Proportions. J Arthroplasty 35, 1437-1443 e1433 (2020).
27. Yoon, H. J., Yoo, J. J., Yoon, K. S., Koo, K. H. & Kim, H. J. Alumina-on-alumina THA performed in patients younger than 30 years: a 10-year minimum followup study. Clin Orthop Relat Res 470, 3530-3536 (2012).
28. Zagra, L. & Gallazzi, E. Bearing surfaces in primary total hip arthroplasty. EFORT Open Rev 3, 217-224 (2018).

MEMO

2022 ARCO (Korea Session)
Session 3.
Osteoporosis and Related Problems

August 27(Sat.), 2022 15:10-16:10

MODERATORS

Doo-Hoon Sun

Daejeon Sun General Hosp., Korea

Kee Haeng Lee

The Catholic Univ. Korea, Korea

Session 3. Osteoporosis and Related Problems

Treatment of intertrochanteric fracture

Jae-Hwi Nho

Soonchunhyang Univ., Korea

[CURRICULUM VITAE]

1998-2004	Bachelor's Degree, Medical School Soonchunhyang University College of Medicine, Seoul, Korea
2006-2008	Master's Degree, Graduate School, Soonchunhyang University College of Medicine
2010-2014	Philosophy Doctoral Degree, Graduate School, Soonchunhyang University College of Medicine
2004-2005	Internship Soonchunhyang University Hospital, Seoul, Korea
2005-2009	Residency Department of Orthopaedic Surgery, Soonchunhyang University Hospital, Seoul, Korea
2009-2011	Fellowship Department of Orthopaedic Surgery, Soonchunhyang University Hospital, Seoul, Korea
2011-2012	Fellowship Department of Orthopaedic Surgery, Seoul National University Bundang Hospital, Seongnam, Korea
2020-2021	Visiting Scholar Department of Radiology, University of California San Diego
2012-2016	Assistant Professor MD, PhD Department of Orthopaedic Surgery, Soonchunhyang University Hospital Cheonan, Cheonan, Korea
2016-2018	Assistant Professor MD, PhD Department of Orthopaedic Surgery, Soonchunhyang University Hospital Seoul, Seoul, Korea
2018-present	Associate Professor MD, PhD Department of Orthopaedic Surgery, Soonchunhyang University Hospital Seoul, Seoul, Korea

[ABSTRACT]

Intertrochanteric fractures are one of the most common and fatal fractures in elderly patients. The prevalence of intertrochanteric fractures in Korea is known to be 26.8 per 100,000 people in 2010. As the population ages, the number of hip fractures is expected to increase to about 4.5 million per year worldwide by 2050. Accordingly, the number of unstable intertrochanteric fractures is increasing significantly.[1-4]

Intertrochanteric fractures are metaphyseal fractures, and the patients have been widely treated by osteosynthesis until now. However, the optimal treatment for unstable intertrochanteric fractures in elderly patients remains controversial. Traditionally, intertrochanteric fractures were operated with a sliding hip screw with a side plate. In the early 1990s, a new method of an intramedullary nail in the proximal femur with an interlocking screw in the femoral head was introduced.[5,6] However, treatment of unstable intertrochanteric fracture in osteoporotic elderly patients remains a challenge because internal fixation is technically difficult and often fails to maintain stable fixation in this type of fracture.[7] In cases of unstable intertrochanteric fracture in the elderly, osteoporosis and comminution often result in delayed full weight-bearing and a high rate of complications that are treated with internal fixation including compression hip screw(CHS) and intramedullary nailing.[5,8]

Recently, many reports in the literature consider that prosthetic replacement is the preferred treatment for selected unstable comminuted intertrochanteric fractures in the elderly.[9,10] However, unlike a femoral neck fracture, an intertrochanteric fracture has a good blood supply, ensuring bone healing in the case of proper fixation. Also, arthroplasty has a number of disadvantages, including greater blood loss, increased operation time and greater soft tissue injury, which are especially important issues in elderly patients.[11]

Therefore, various treatment methods for intetrochanter fractures will be introduced and discussed in this presentation

References

1. Mundi, S., et al., Similar mortality rates in hip fracture patients over the past 31 years: A systematic review of RCTs. Acta orthopaedica, 2014. 85(1): p. 54-59.
2. Yoon, B.-H., et al., Epidemiology of proximal femoral fractures in South Korea. Archives of osteoporosis, 2013. 8(1): p. 1-5.
3. Cooper, C., et al., Secular trends in the incidence of hip and other osteoporotic fractures. Osteoporosis international, 2011. 22(5): p. 1277-1288.

4. Suh, Y.S., et al., Clinical and Radiologic Outcomes among Bipolar Hemiarthroplasty, Compression Hip Screw and Proximal Femur Nail Antirotation in Treating Comminuted Intertrochanteric Fractures. Hip Pelvis, 2015. 27(1): p. 30-5.
5. Anglen, J.O. and J.N. Weinstein, Nail or plate fixation of intertrochanteric hip fractures: changing pattern of practice. A review of the American Board of Orthopaedic Surgery Database. J Bone Joint Surg Am, 2008. 90(4): p. 700-7.
6. Parker, M.J., T.R. Bowers, and G.A. Pryor, Sliding hip screw versus the Targon PF nail in the treatment of trochanteric fractures of the hip: a randomised trial of 600 fractures. J Bone Joint Surg Br, 2012. 94(3): p. 391-7.
7. Zhang, B., K.-y. Chiu, and M. Wang, Hip arthroplasty for failed internal fixation of intertrochanteric fractures. The Journal of arthroplasty, 2004. 19(3): p. 329-333.
8. Chen, Y.T., et al., Diaphyseal locking hip arthroplasty for treatment of failed fixation of intertrochanteric hip fractures. J Arthroplasty, 2008. 23(2): p. 241-6.
9. Lee, Y.K., et al., Cementless bipolar hemiarthroplasty using a hydroxyapatite-coated long stem for osteoporotic unstable intertrochanteric fractures. J Arthroplasty, 2011. 26(4): p. 626-32.
10. Choy, W.S., et al., Cementless bipolar hemiarthroplasty for unstable intertrochanteric fractures in elderly patients. Clin Orthop Surg, 2010. 2(4): p. 221-6.
11. Shen, J., et al., Bipolar hemiarthroplasty compared with internal fixation for unstable intertrochanteric fractures in elderly patients. J Orthop Sci, 2012. 17(6): p. 722-9.

Session 3. Osteoporosis and Related Problems

Treatment of femoral neck fracture

Kyung Soon Park

Chonnam National Univ., Korea

[CURRICULUM VITAE]

2003	Undergraduate Chonnam University Medical School, Gwang-ju, Korea
2004-2010	Graduate Chonnam University Medical School, Gwang-ju, Korea
2011	Ph.D degree (The enhancing effect of salicylideneamino-2-thiophenol on osteogenic differentiation via MAPK signaling pathway)
2003-2004	Internship Chonnam University Hospital
2004-2008	Residency Chonnam University Hospital
2008	Board Certification Korean Board of Orthopedic Surgery
2008-2009	Orthopedic fellow Chonnam University Hospital
2009-2010	Clinical full time instructor Chonnam University Hospital
2010-2011	Full time instructor Chonnam National University Medical College
2012-	Assistant professor Chonnam National University Medical College
2012-2013	Clinical fellowship Kurume University Orthopedic Department, Japan
2016-2021	Associate professor Chonnam National University Medical College
2017-2018	Director, Planning and Chonnam National University Bitgoeul Hospital
2018-2020	Research fellowship Wake Forest Institute for Regenerative Medicine
2021-	Professor Chonnam National University Medical College
2020-	Head of a department Chonnam National University Hwasun Hospital

[ABSTRACT]

Introduction: Femoral neck fractures account for 50% of all hip fractures. As of 2016, 71.4% of patients with femoral neck fractures in Korea were the elderly over the age of 70, and low-energy injuries mainly due to falls and slipping were common. In addition, as the elderly population increases, the proportion of patients over 80 years of age is also increasing. Once a fracture occurs, it is difficult to move due to pain, and if you lie down for a long time, complications may occur and become fatal. Therefore, surgical treatment is recommended early after injury. Surgical treatment options for femoral neck fractures include the two concepts of surgical fixation versus arthroplasty. However, various surgical treatment options remain controversial and continue to be the subject of ongoing investigations. Accordingly, we will review and summarize the recommended surgical treatment methods along with overall important considerations in the treatment of femoral neck fractures in the elderly population.

Main subject: The definition of a geriatric patient is generally a person over 80 years of age or over 70 years of age with multimorbidity. It also refers to elderly patients over the age of 65, but rather than the age of the patient, it is recommended to determine whether the elderly are elderly or not based on the body age by synthesizing existing diseases and conditions. When the femur neck fracture is anatomically divided, there are many femoral mid-cervical fractures in the elderly. Clinical classification is largely divided into Garden, Pauwels, and AO standards, and the Garden stage is the most used. Garden I and II are non-displaced types, and Garden III IV is unstable with displacement. In general, neck fractures can be diagnosed with only x-rays, and if a lesion is suspected even though it is not visible on x-rays, it is recommended to make a definitive diagnosis through CT or MRI.

Preoperative management of femoral neck fracture: Comprehensive geriatric assessment should be used to establish a patient treatment plan, which shows better results in fracture treatment. In addition, sufficient pain control and delirium prevention are required, and block should be considered if pain is not controlled with drugs. Elderly patients with neck fractures should be given adequate fluids, and the treatment of asymptomatic UTIs are not recommended because there is no evidence to date that they reduce postoperative infections. Many elderly patients with hip fractures are receiving anticoagulant or antiplatelet therapy, and surgical treatment should not be delayed for reasons such as restoration of platelet function. Preoperative tranexamic acid is recommended to be administered to reduce bleeding during surgery. Preoperative traction should not routinely be used for patients with a hip fracture.

Surgical treatment: For femoral neck fractures, surgical treatment is preferred, and non-operative treatment of femoral neck fractures is not recommended except for non-ambulatory patient or pa-

tient having very short life expectancy. It is recommended that the surgery be performed within at least 48 hours. Internal fixation is usually recommended for stable (impacted/non-displaced) femoral neck fractures in Garden I & II, but arthroplasty is recommended for patients with a significant risk of failure after fixation, such as osteoarthritis of the hip and chronic renal failure. The internal fixation method is still controversial, but some papers recommend using it with the superiority of Novel Fixation Implants such as FNS. Garden I & II also has a limitation that Garden stages rely exclusively on the AP radiograph. In lateral view, posterior tilt ≥ 20° was a risk factor for fixation failure. Therefore, it is recommended to perform internal fixation after recovering it through additional reduction or to do arthroplasty. In patients with unstable (displaced) femoral neck fractures, arthroplasty is recommended over fixation. unipolar or bipolar hemiarthroplasty can be equally beneficial. In biologically young & active patients, and in who have hip arthrosis, total hip arthroplasty is the implant of choice. Hemiarthroplasty is recommended in the elderly with sarcopenia, the loss of proprioception, and an increased risk of fall, and impaired cognitive function.

Conclusion: The proportion of the elderly population in femoral neck fractures is increasing. Femoral neck fracture in the elderly causes many social costs and complications, so it is important to treat it early and properly. Comprehensive geriatric assessment and pain control of the patient before surgery are important, and surgery should not be delayed because of taking antithrombotic drugs. Although there is still controversy, internal fixation is usually recommended for stable femoral neck fractures, and posterior tilt in hip lateral x-ray should be referred to in treatment. For unstable (displaced) femoral neck, arthroplasty is recommended, and implant should be selected according to the patient's physical condition. Rehabilitation should be done after the patient's surgery, and pain control and multidisciplinary treatment are important.

Session 3. Osteoporosis and Related Problems

Secondary prevention

Yong-Han Cha

Eulji Univ., Korea

[CURRICULUM VITAE]

Graduated from Chungnam National University Medical School
Graduated from Graduate School of Medicine, Eulji University

2017- Assistant professor of Daejeon Eulji Medical Center

[ABSTRACT]

According to Statistics Korea in 2020, it was reported that the average life expectancy in Korea reached 83.5 years. Due to the increase in life expectancy, the proportion of the elderly over 65 in the Korean population is expected to rise from 13% in 2015 to over 35% in 2050. An increase in the elderly population causes an increase in the medical costs spent on them, which is a socio-economic burden in many developed countries, and the same is true in Korea.

Among musculoskeletal diseases, osteoporosis and osteoporotic fractures are one of these major medical problems, and it is estimated that about 22.4% of Koreans aged 50 and over are osteoporotic patients. If osteoporosis is not properly treated, the risk of osteoporotic fractures increases, and patients who have fractures have an increased risk of complications as well as an increased risk of death. Therefore, it is important not only to treat osteoporosis, but also to restore function by appropriate treatment to osteoporotic fracture patients, as well as reducing the risk of complications and preventing re-fracture.

Fracture Liaison Service is a service that provides multidisciplinary services to patients who have fractured in age 50 or older to properly treat and prevent subsequent fractures, and it consists of primary treatment and secondary prevention. Primary treatment refers to the proper treatment of fractures that have occurred, and secondary prevention is to prevent subsequent fractures

by providing multidisciplinary services such as fracture risk assessment, exercise, education, and osteoporosis treatment. In particular, preventing hip fractures is one of the main goals.

The reasons why secondary prevention is important are as follows. Among osteoporotic fractures, hip fractures have a higher risk of death and complications and the highest per capita medical cost compared to other fractures. In addition, the mortality rate of subsequent hip fracture as well as the risk of subsequent fracture after hip fracture is higher compared to other fractures. Studies in the United States, Australia, and Scoltland have reported that 50% of patients who have experienced a hip fracture had experienced another fracture prior to a hip fracture, which is called a signal fracture and an opportunity to prevent, evaluate and intervene in the next fracture. This would mean that intervention is achieved in about half of all hip fracture patients.

There is no institution that implements coordinator-based FLS in Korea yet. In the future, policy support is also needed for FLS to be established.

Session 3. Osteoporosis and Related Problems

Treatment of atypical femoral fracture

Ki-Choul Kim

Dankook Univ., Korea

[CURRICULUM VITAE]

2001	Dankook University College of Medicine, Bachelor of Medicine
2009	Dankook University Graduate School of Medicine
2018	Dankook University Graduate School of Medicine, Ph.D.
2002-2003	Intern Dankook university hospital
2003-2007	Residant Orthopedic surgery of Dankook university hospital
2007-2008	Fellow Orthopedic surgery of Dankook university hospital
2008-2009	Fellow Orthopedic surgert of Seoul National university Bundang hospital
2009-2011	Orthopedic doctor Orthopedic surgery of Pohang St. MARY'S hospital
2011-2013	Clinical assitant professer Orthopedic surgery of Dankook university hospital
2013-2019	Assistant professer Orthopedic surgery of Dankook university hospital
2019-	Associate professer Orthopedic surgery of Dankook university hospital

[ABSTRACT]

1. Introduction & Epidemiology

- Bisphosphonate (BP) is a useful anti-resorptive agent which decreases the risk of osteoporotic fracture by about 50%.
- However, the longer the patient takes BP, the higher the risk of AFF.
- Prolonged suppression of bone remodeling by BP causes frozen bone.
- Atypical Femur Fracture(AFF)
  : Fractures were caused by minor injuries and were associated with periosteal callus at the lateral femoral cortex.
- The incidence of AFF increases significantly when the patient takes BP for 4 years or more

than 4 years

2. Diagnosis

1) Symptoms: Prodromal symptoms such as dull pain and tenderness over the lateral aspect of the thigh
2) X-ray
   → Simple radiogram often reveals a beak or flare like periosteal and/or endosteal callus in the lateral femoral cortex.
3) Bone scan, MRI
   → the patient complains of prodromal symptoms, then bone scan or magnetic resonance imaging (MRI) examination can identify tiny lesions in the lateral aspect of the femur which was not detected by X-ray.

- Criteria for the diagnosis of AFF

Table 1. American Society of Bone and Mineral Research (ASBMR) task force 2013 revised case definition of AFFs

To satisfy the case definition of AFF, the fracture must be located along the femoral diaphysis from just distal to the lesser trochanter to just proximal to the supracondylar flare.
In addition, at least four of five Major Features must be present. None of the Minor Features is required but have sometimes been associated with these fractures.
Major features
The fracture is associated with minimal or no trauma, as in a fall from a standing height or less
The fracture line originates at the lateral cortex and is substantially transverse in its orientation, although it may become oblique as it progresses medially across the femur
Complete fractures extend through both cortices and may be associated with a medial spike; incomplete fractures involve only the lateral cortex
The fracture is noncomminuted or minimally comminuted
Localized periosteal or endosteal thickening of the lateral cortex is present at the fracture site ("beaking" or "flaring")
Minor features
Generalized increase in cortical thickness of the femoral diaphyses
Unilateral or bilateral prodromal symptoms such as dull or aching pain in the groin or thigh
Bilateral incomplete or complete femoral diaphysis fractures
Delayed fracture healing

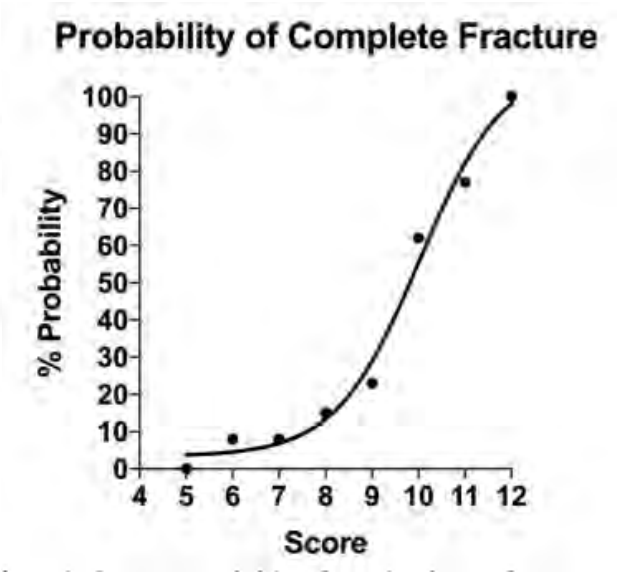
3. Risk Factors

- Risk factors for occurrence of complete fracture in incomplete AFF

1) Subtrochanteric location
2) Functional pain(severe or aggravated by limb function),
3) Intact contralateral femur
4) Radiolucent line (50% of diameter of the femur)

Table 2. Scoring System

Variable	Score 1	2	3
Site	Others	Diaphyseal	Subtrochanteric
Pain	None	Mild	Functional
Contralateral	Complete	Incomplete	Intact
Radiolucent line	Focal change	<1/2	>1/2



- A score of 7 or less may be treated conservatively
- A score of 7 is suggestive(probability of fracture, 8%) of an impending fracture,
- A score of 8 is diagnostic (probability of fracture,15%).
- A score of 9 or more is obtained, the probability of fracture warrants prophylactic fixation.

4. Treatment

1) Medical treatment
   - BP should be stopped immediately
   - Calcium and vitamin D (1,000 to 2,000 IU) should be administered.
   - Daily subcutaneous injection of PTH is recommended if the patient can afford it.

2) Surgical treatment
   - Intramedullary nailing is the treatment of choice for AFF
   - Prophylactic femoral nailing is indicated when the dreaded back line is visible in the lateral cortex, especially in the subtrochanteric area.

   *Caution during nailing
   - excessive femoral bowing, which is often associated with AFF, is an obstacle during femoral nailing.

   → causes iatrogenic fracture and straightening of the femur

5. Recommendation

- Careful examination of the contralateral femur is recommended because of the high incidence of bilateral lesions

Reference

1. Kyu Hyun Yang, Byung Woo Min, Yong-Chan Ha, Atypical Femoral Fracture: 2015 Position Statementof the Korean Society for Bone and Mineral Research, J Bone Metab 2015;22:87-91
2. Byung-Woo Min, Kyung-Hoi Koo, Youn-Soo Park, Chang-Wug Oh, Seung-Jae Lim, Joon-Woo Kim, Kyung-Jae Lee, and Young-Kyun Lee, Scoring system for identifying impending Complete Fractures in Incomplete Atypical Femoral Fracture, J Clin Endocrinol Metab 102: 545-550, 2017

Session 3. Osteoporosis and Related Problems

Diagnosis and management of sarcopenia

Jun-Il Yoo

Gyeongsang National Univ., Korea

[CURRICULUM VITAE]

1998-2001	ChungNam Science High School
2001-2003	College of Natural Sciences, ChungBuk National University, BA
2003-2007	College of Medicine, Chung-Buk National University, MD
2010-2012	Post Graduate School, Chung-Buk National University, MS
2016-2018	College of Medicine, Chung-Ang University, PhD
2007-2008	Chung-Buk National University HospitalIntern
2008-2012	Department of Orthopaedic Surgery, Chung-Buk National University Hospital, Resident
2012-2015	Military Service: Army aviation command, Icheon, Kyeonggi-Do, Chief of ER
2015-2017	Department of Orthopaedic Surgery, Seoul National University Bundang Hospital, Clinical fellow
2017-present	Department of Orthopaedic Surgery, Gyeongsang National University Hospital, Associate professor

[ABSTRACT]

1. Definition

In 2020, in the position paper update of the Asian Working Group for Sarcopenia (AWGS), Chen et al. defined sarcopenia as age-related loss of skeletal muscle mass and skeletal strength and/or decreased physical performance; for each country the definition for elderly was those aged more than 60 or 65 years.

Current definitions and diagnostic criteria for sarcopenia are the result of significant research and a long period of debate among researchers. However, for patients with hip fractures, muscle

viability based on operating room findings, contractions, and fat degeneration shown by numerous computed tomography (CT) and magnetic resonance imaging (MRI) images taken by orthopedic surgeons does not often match with existing criteria for diagnosis of sarcopenia.

2. Causes and epidemiology

A review of epidemiology studies in Asian countries that used AWGS 2014 criteria reported a prevalence of sarcopenia ranging from 5.5% to 25.7%, with a male predominance (5.1%-21.0% in men vs 4.1%-16.3% in women)6). According to the AWGS 2014 criteria, the prevalence of sarcopenia in patients with hip fractures in Japan was 81.1% for males and 44.7% for females, while a domestic study conducted in 2016 reported a prevalence of 68.2% for males and 44.3% for females.

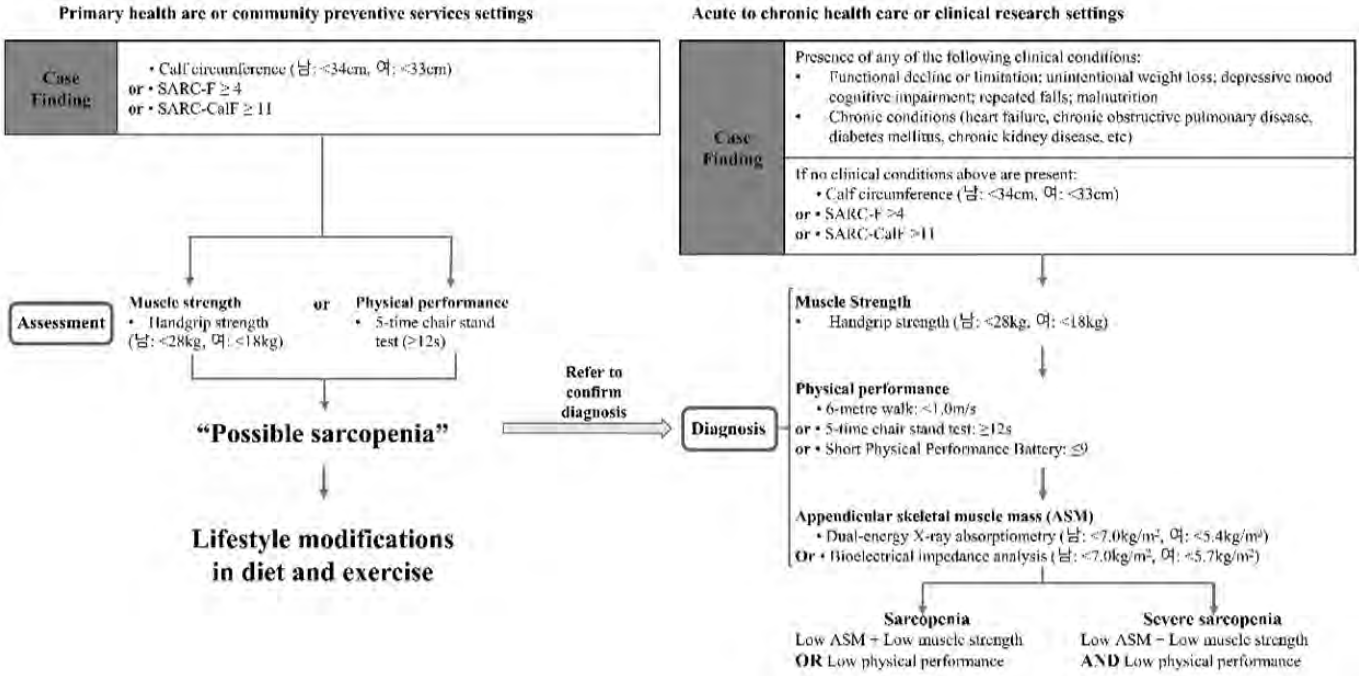
Authors (Reference)	Study design	Regions	Population	Mean age (yr)	Definition	Cut-off of muscle mass (appendicular muscle kg/ht^2) by DXA	Prevalence (%)
Hida, 2013 (13)	Case-control	Japan	357:2,511	82.7 (F), 80.3 (M)	Japanese criteria	6.87 (M), 5.46 (F)	81.1 (M), 44.7 (F)
Di Monaco, 2012 (14)	Case series	Italy	591	79.7	New Mexico Elder Health Survey	<2 SD in a young reference group	95 (M), 65 (F)
Gonzalez, 2015 (15)	Case series	Spain	479	78.3 (F), 75.3 (M)	EWGOSP	<2 SD in a young reference group	12.4 (M), 18.3 (F)
Yoo, 2016	Case-control	Korea	359:1,614	78.3 (F), 75.3 (M)	AWGS	7.0 (M), 5.4 (F)	68.2 (M), 44.3 (F)
					EWGOSP	<2 SD in a young reference group	80.5 (M), 47.1 (F)

3. Diagnosis

Criteria for diagnosis of sarcopenia vary among the guidelines for international associations. In general, diagnosis of sarcopenia is based on evaluation of the following three factors: muscle mass, strength, and physical performance6). The AWGS published revised guidelines in 2019.

Diagnostic Criteria for Sarcopenia according to the Different Consensus Group

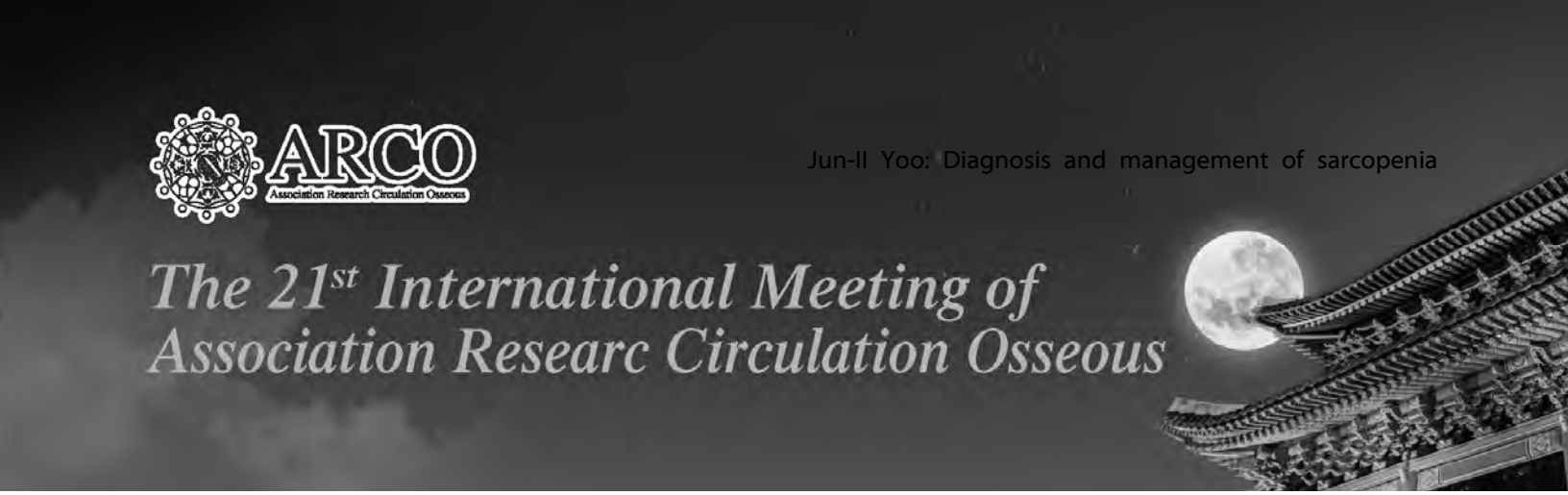
	Loss of muscle mass	**Loss of muscle strength**	**Loss of physical performance**
EWGSOP	ALM/heigh^2 (DXA) ≤ 7.26 kg/m^2 (M) ≤ 5.5 kg/m^2 (F) SM/height^2 (BIA) ≤ 8.87 kg/m^2 (M) ≤ 6.42 kg/m^2 (여)	Grip strength: < 30 kg (남) < 20 kg (여)	SPPB ≤ 8 Gait speed < 0.8 m/s
EWGSOP2	ASM/height^2 ≤ 7.0 kg/m^2 (남) ≤ 6.0 kg/m^2 (여) ASM < 20 kg (남) < 15 kg (여)	Grip strength: < 27 kg (남) < 16 kg (여) Chair stand >15s for five rises	SPPB ≤ 8 Gait speed < 0.8 m/s TUG ≥ 20s
IWGS	ALM/height2 (DXA) ≤ 7.23 kg/m2 (남) ≤ 5.67 kg/m2 (여)		Gait speed < 1.0 m/s
AWGS	ALM/height^2 (DXA) ≤ 7.0 kg/m^2 (남) ≤ 5.4 kg/m^2 (여) SM/height^2 (BIA) ≤ 7.0 kg/m^2 (남) ≤ 5.7 kg/m^2 (여)	Grip strength: < 26 kg (남) < 18 kg (여)	Gait speed < 0.8 m/s
AWGS 2019	ALM/height^2 (DXA) ≤ 7.0 kg/m^2 (남) ≤ 5.4 kg/m^2 (여) SM/height^2 (BIA) ≤ 7.0 kg/m^2 (남) ≤ 5.7 kg/m^2 (여)	Grip strength: < 28 kg (남) < 18 kg (여)	Gait speed <1.0m/s 5-time chair stand test: ≥12s SPPB ≤9
FNIH Sarcopenia project	ALM/BMI (DXA) ≤ 0.789 (남) ≤ 0.512 (여)	Grip strength: < 26 kg (남) < 16 kg (여)	Gait speed < 0.8 m/s



5. Conclusion

To date, family medicine and internal medicine fields have been responsible for defining, researching, and development of treatments for sarcopenia, focusing mainly on diabetes and metabolic diseases. Therefore, application of current guidelines for diagnosis of sarcopenia which differ according to continent to patients with hip fractures in the orthopedic field is difficult. The purpose of this review was to understand the recent consensus on the definition and diagnosis of sarcopenia and to highlight the importance of research and future research opportunities on the management of sarcopenia in patients with hip fractures by orthopedic surgeons. The global prevalence of sarcopenia in patients with hip fractures is statistically significant. Despite establishment of various therapeutic and diagnostic criteria for osteoporosis in the clinical field, there are no clear, useful diagnostic criteria for sarcopenia in the clinical field. In particular, few studies on the evaluation and treatment of sarcopenia in patients with hip fractures have been reported. In addition, the quality of life of postoperative patients with hip fractures could be significantly improved by development of precise assessment for muscle regeneration and rehabilitation in the operating room.

MEMO



2022 ARCO (Korea Session)
Session 4.
Special Lecture

August 27(Sat.), 2022 16:40-18:00

Session 4. Special Lecture

Introduction: Mentors of Kyung-Hoi (Kay) Koo

Kyung-Hoi (Kay) Koo

Seoul National Univ., Korea

[CURRICULUM VITAE]

Professor, Department of Orthopaedic Surgery, Seoul National University College of Medicine and Seoul National University Bundang Hospital, Seongnam, South Korea.

Dr. Koo is a professor of Department of Orthopaedic Surgery, Seoul National University Bundang Hospital, South Korea. He is a musculoskeletal radiologist as well as an orthopaedic surgeon. During last 30 years, he has exclusively performed hip surgeries. He is interested in femoral head osteonecrosis and has actively participated in ARCO since 1994. He was President of ARCO from 2012 to 2015 and published a textbook "Osteonecrosis" with Michael A. Mont and Lynne C. Jones in 2014. This book has been chapter downloaded by more than 120,000 times. Since 1997, he has used ceramic-on-ceramic bearings in total hip arthroplasty and has been instrumental in bringing ceramic-on-ceramic total hip arthroplasty. He has published over 300 peer-reviewed articles and more than 10 book chapters regarding femoral head osteonecrosis and total hip arthroplasty. He was an editor of the Bone and Joint Journal from 2015 to 2018 and currently, he is an editor of the Journal of Arthroplasty.

[ABSTRACT]

Kyung-Hoi (Kay) Koo is a professor of Department of Orthopaedic Surgery, Seoul National University Bundang Hospital, South Korea. He is a musculoskeletal radiologist as well as an orthopaedic surgeon. During last 30 years, he has exclusively performed hip surgeries. He is interested in femoral head osteonecrosis and has actively participated in ARCO since 1994. He was President of ARCO from 2012 to 2014 and published a textbook "Osteonecrosis" with Michael A. Mont and Lynne C. Jones in 2014. This book has been chapter downloaded by more than 120,000

times. Since 1997, he has used ceramic-on-ceramic bearings in total hip arthroplasty and has been instrumental in bringing ceramic-on-ceramic total hip arthroplasty.

He has published over 300 peer-reviewed articles and more than 10 book chapters regarding femoral head osteonecrosis and total hip arthroplasty. He was an editor of the Bone and Joint Journal from 2015 to 2018 and currently, he is an editor of the Journal of Arthroplasty.

He deeply thanks to his mentors: Drs. Young-Min Kim, Yoich Sugioka, John Paul Jones Jr, David Hungerford, Gwo-Jaw Wang, and Young Hoo Kim.

Session 4. Special Lecture

Sapiens by Yuval Noah Harari

Seung-Beom Han

Korea Univ., Korea

[CURRICULUM VITAE]

Professor, Department of Orthopedic surgery. Korea University Medical Center
Vice President, Korea University Medical Center.

1991	Korea University College of Medicine
2001	Korea University College of Medicine PhD
2006-2007	Visiting Scholar Thomas Jefferson University, USA.
2019-present	Board of trustees, Korean Hip Society
2018-present	Board of trustees. KOA

[ABSTRACT]

What we call "the classic" is a something contains a new insight which no one has ever have. "Sapiens by Yuval Harari" will be a definitive classic book in modern history text, since it contains new insight about human history which preexisting history book has never adressed.

In this book, Yuval Harari sought the reason why an animal of no significance which lived a corner Africa became a dominant species on earth. He picked three revolutions as a cause of this phonomenon: 1) the cognitive revolution, 2) the agricultural revolution, 3) the scientific revolution. Beside the three revolutions, He also pointed out "unification of humankind" which was conducted by "money", "Imperialism" and "religion" as an important event of human regime on earth.

Additionally, Harari is an so amazing story teller that it is very hard to stop reading this text, so interesting and so provocative.

In this presentation, we also think about skeletal evidences regarding development of bipedal walking and how hominid could survive on wild world surrounded by unfriendly environment.

Session 4. Special Lecture

Monticello and Pax Americana

Kyung-Hoi (Kay) Koo

Seoul National Univ., Korea

[ABSTRACT]

Monticello was the primary plantation of Thomas Jefferson (April 13, 1743 - July 4, 1826). He was a statesman, diplomat, lawyer, architect, philosopher, and the third president of the United States from 1801 to 1809. He was the principal author of the Declaration of Independence, Jefferson was a proponent of democracy, republicanism, and individual rights, motivating American colonists to break from the Kingdom of Great Britain and form a new nation. He made the United States a republic instead of a Kingdom.

Pax Americana is a term applied to the concept of peace in the world after the end of World War II in 1945, when the United States[4] became the world's dominant economic and military power.

MEMO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POSTER

POSTER

Outcomes of total hip arthroplasty after failed free vascularized fibular grafting for osteonecrosis of the femoral head

Yoon-Vin Kim, Kee-Haeng Lee, Joo-Hyoun Song, Young-Wook Lim, Woo-Lam Jo, Se-Won Lee

The Catholic University of Korea, Bucheon Saint Mary's Hospital, Korea

Total hip arthroplasties (THA) after vascularized fibular grafting (VFG) is a technically demanding procedure with reported poorer outcomes compared to primary THA without prior VFG in patients with osteonecrosis of the femoral head (ONFH). The purpose of this study was to compare the outcomes of THA after VFG with primary THA without prior VFG. THAs after VFG performed by single arthroplasty surgeon with a single type of THA instrument were enrolled in the study. A control cohort of patients was created by 1:1 matching according to age, gender, and ASA score from the institutional database of patients who were diagnosed with ONFH and received primary THA without prior VFG, and received THA by the same surgeon and instrument. Early and late outcomes were compared between the two groups. From 172 ONFH hips treated by VFG, 24 hips were included in the study group. 24 primary THA hips were included in the matching cohort. The median time of follow-up after THA was 5.333 years and 4.375 years respectively. No significant difference was noted in stem position. The THA after VFG group had a significantly longer duration of operation time and higher EBL than the primary THA group, but the difference in blood transfusions was insignificant. There were two cases of intraoperative femur fractures in the THA after VFG group, which required fixation by circlage wiring cables. There was no difference of HHS at the last follow-up between the two groups. There were no cases of revisions in both groups. THA after VFG has increased blood loss and prolonged operation time compared to primary THA without prior VFG. However, complete removal of the residual fibular bone graft enables correct positioning of the femoral stem and can have evenly excellent long term outcomes.

POSTER

The interaction of risk factors for osteonecrosis of the femoral head

Tetsuro Tani[1], Wataru Ando[2], Wakaba Fukushima[3], Keisuke Uemura[4], Hidetoshi Hamada[5], Nobuhiko Sugano[6]

[1]Osaka Police Hospital, Japan
[2]Department of Orthopaedic surgery, Kansai Rosai Hospital, Hyogo, Japan,
[3]Department of Public Health, Osaka Metropolitan University Graduate School of Medicine, Osaka, Japan,
[4]Department of Orthopaedic Surgery, Osaka University Graduate School of Medicine, Osaka, Japan,
[5]Department of Orthopaedic Medical Engineering, Osaka University Graduate School of Medicine, Osaka, Japan,
[6]Department of Orthopaedic Medical Engineering, Osaka University Graduate School of Medicine, Osaka, Japan

Aims: Steroid administration, alcohol intake, and smoking were associated with osteonecrosis of the femoral head (ONFH). It is still unclear whether there was an interaction among these risk factors. The aims of this study are the investigation of risk factors for ONFH development based on current epidemiological data and biological interaction among these risk factors in a case-control study.

Materials and Methods: To investigate the interaction, we conducted a case-control study which consist of 123 patients and 217 controls (mean age 46 years, 214 men and 156 women). Patient information was collected using a self-administered questionnaire. Odds ratio (OR) and its 95% confidence interval (CI) of steroid administration during the previous year (yes vs no), alcohol intake (< 320g/ week or ≥ 320g /week vs never-drinking), and smoking (< 20 cigarettes/day or ≥ 20 cigarettes /day vs never-smoker) were calculated using a conditional logistic model. The biological interaction among these factors was investigated using the synergy index.

Results: OR for systemic steroid administration, alcohol intake ≥ 320g /week and smoking ≥ 20 cigarettes /day were 9.3 (95%CI: 4.5-19.2), 4.3 (1.6 - 11.6), and 3.0 (1.3-6.9) in multivariate analysis, respectively. OR for the subjects who were drinkers with ≥ 320g /week and smokers with ≥ 20 cigarettes /day was 13.7 (4.2 - 45.0) in comparison to neither drinker nor smoker. (Synergy index: 10.6, 95%CI: 1.1 – 102.0).

Conclusion: The risk estimate of alcohol intake and smoking were similar for ONFH development, with statistically significant biological interaction.

POSTER

Morphological analysis of articular surface of the femoral head with osteonecrosis

Noriko Yamamoto, Goro Motomura, Ryosuke Yamaguchi, Takeshi Utsunomiya, Hidenao Tanaka, Yusuke Ayabe, Kosei Sakamoto, Yasuharu Nakashima

Department of Orthopedic Surgery, Graduate School of Medical Sciences, Kyushu University, Japan

Introduction: Articular surface irregularities are often observed in collapsed femoral heads with osteonecrosis, while effects of the degree of collapse on the articular surface are poorly understood. The purpose of this study was to determine the morphological characteristics of articular surface of femoral heads with osteonecrosis.

Methods: Seventy-six surgically resected femoral heads with osteonecrosis were used in this study. For each femoral head, measurement of the degree of subchondral bone collapse and macroscopic assessment of articular surface irregularities were performed on every 2-mm coronal slice of high-resolution micro-CT. For femoral heads with less than 3-mm collapse, articular surface irregularities were quantitatively assessed based on the number of negative curvature points that was automatically counted using a software, and the correlation with the degree of collapse was examined. In femoral heads with less than 1-mm collapse, articular cartilage abnormalities were examined histologically.

Results: Articular surface irregularities were macroscopically observed in 68 femoral heads (89%), mainly at the lateral boundary of the necrotic lesion. The mean degree of collapse with articular surface irregularities was significantly larger than that without irregularities ($p<0.0001$). The cutoff point for the degree of collapse with articular surface irregularities at the lateral boundary was 1.1 mm. Quantitative evaluation (n=28) showed that the degree of collapse was positively correlated with the number of negative curvature points ($r=0.95$, $p<0.0001$), which was significantly more evident in the anterior and central regions of the femoral head than in the posterior region ($p=0.0037$ and $p<0.0001$, respectively). Histological examination of articular cartilage above the necrotic lesion (n=8) revealed cell necrosis in the calcified layer and abnormal cellular arrangement in the deep and middle layers.

Conclusion: Articular surface irregularities of the necrotic femoral head depended on the degree of collapse, and articular cartilage was already altered even in the absence of gross irregularities.

POSTER

Objective to evaluate the value of CT texture analysis in evaluating the efficacy of hip-protection therapy for osteonecrosis of the femoral head

Yawei Dong, Weiheng Chen, Kaiqiang Tang, Zhihong Fu, Xiangyu Li, Jiaming lin, Rui Quan

The Third Affiliated Hospital of Beijing University of Chinese Medicine, China

Objective: The purpose of this study is to evaluate the value of CT texture analysis in predicting the efficacy of TCM hip-protection therapy for osteonecrosis of the femoral head(ONFH) and to provide ideas for evaluating clinical efficacy.

Methods: A total of 37 patients (49 hips) who were diagnosed with ONFH and received TCM hip-protection therapy for 6 months were included. The SF-36 scores before and after treatment were recorded and the CT data before treatment were obtained. The regions of interest (ROC) of ONFH were delineated by 3D slicer and then the texture data of the two groups were obtained. Finally the area under the operating characteristic ROC curve (AUC) was used to analyze the evaluation value of the texture data parameters for clinical efficacy.

Results: According to the improvements of SF-36 scores before and after treatment, the patients were divided into clinically marked group (34 hips) and general efficacy group (15 hips). The SF-36 scores of the clinically marked group was 96.7±3.3 before treatment and 100.7±3.9 after treatment. The other group was 100.3±3.7 before treatment and 96.4±5.3 after treatment. After CT texture analysis, a total of 5 texture features have statistical differences (Large Area High Gray Level Emphasis, Small Dependence Low Gray Level Emphasis, Large Dependence High Gray Level Emphasis, Idn and Small Area Low Gray Level Emphasis). ROC curve analysis manifests that the AUC values of the five CT texture features are 0.72, 0.70, 0.69, 0.68, and 0.68, which are all larger than 0.65, and the AUC value of joint prediction based on the five features reaches 0.83, which has a higher predictive value.

Conclusion: CT texture analysis technology has important predictive value in evaluating the efficacy of TCM hip-protection therapy for ONFH, and is worthy of adoption in relevant clinical departments.

POSTER

Comparison of different bone grafts combined with modified core decompression for the treatment of ARCO II stage femoral head necrosis

Junming Wan[1], Yanqing Hu[1], Jiachun Li[1], Yuqing Zeng[2], Haiyong Ren[2]

[1]Department of Goint Surgery, The Seventh Affiliated Hospital, Sun Yet-sun University, [2]Tongde Hospital of Zhejiang Province, China

Purpose: Treatment of ONFH at an early stage is a challenging issue. The modified core decompression combined with bone graft implantation remains controversial. This study aimed to compare the early-middle outcomes of different bone grafts.

Methods: 182 patients (192 hips) with ONFH at the ARCO II stage were randomly divided into four groups. The free fibular graft (FFG), free vascularized fibular graft (FVFG), autologous iliac bone (ABG), and β-tricalcium phosphate bioceramics graft (β-TCPG). Each group was treated with modified core decompression and bone graft implantation. The operation time and blood loss were recorded. The outcome was evaluated by Harris hip score and VAS score (before, 14d after surgery, and at the last follow-up). The radiographic progression was evaluated at least 36 months follow-up.

Results: All cases were successful without any complications. The patients were followed up for 42 to 48 (44.62 ± 1.81) months. There were statistically significant differences in operation time ($P < 0.01$) and blood loss ($P < 0.01$). The Harris hip score in each group was improved significantly from pre-operation to last follow-up (all $P < 0.01$). At the last follow-up, the difference in Harris hip score in each group was not statistically significant ($P=0.984$). The VAS scores in each group were decreased significantly from pre-operation to14d after surgery (all $P < 0.01$). At 14d after surgery, the difference in VAS score in each group was not statistically significant ($P=0.59$). At the last follow-up, 3 hips collapsed on femoral head in FFG group, 2 in FVFG group, 2 in ABG group, and 3 in β-TCPG group.

Conclusion: The four different bone grafts showed satisfactory early-middle outcomes. As compared to other bone grafts, the β-TCP bioceramics graft has the advantages of shorter operation time and lesser blood loss. It may be a choice as a bone graft for the treatment of ONFH at an early stage.

POSTER

Femoral head and neck fenestration through a direct anterior approach combined with compacted autograft for the treatment of early stage nontraumatic osteonecrosis of the femoral head: A retrospective study

Qiuru Wang, Pengde Kang

Department of Orthopaedics Surgery, West China Hospital, Sichuan University, Chengdu, Sichuan, People's Republic of China

Background: This study aimed to evaluate the effect of femoral head and neck fenestration combined with compacted autograft (light bulb procedure) through a direct anterior approach for early stage nontraumatic osteonecrosis of the femoral head.

Methods: We conducted a retrospective cohort study investigating 66 hips undergoing the light bulb procedure through the direct anterior approach (light bulb group) and 59 hips undergoing traditional core decompression (control group). Visual analog scale pain scores and range of hip motion were evaluated before discharge to assess the quality of functional recovery. Follow-up was conducted at 6 weeks, 3 months, 6 months, and annually after surgery until 4 years. The clinical effectiveness was evaluated by Harris hip score and the University of California Los Angeles activity-level score. Patients were followed up with postoperative X-ray and computed tomography. Survival was compared between the 2 groups by radiographic progression and receiving total hip arthroplasty.

Results: There was no significant difference in quality of functional recovery between the 2 groups. There were no significant differences in clinical outcomes within 1 year after surgery. Patients in the light bulb group had significantly better Harris hip scores and University of California Los Angeles activity-level scores from 2 years after surgery to the end of follow-up. During the 4-year follow-up, significantly fewer patients in light bulb group had radiographic progression (22.7% vs 44.1%) or received total hip arthroplasty (15.2% vs 30.5%).

Conclusions: The light bulb procedure through a direct anterior approach offers significantly better results for the treatment of early stage nontraumatic osteonecrosis of the femoral head compared with traditional core decompression.

POSTER

High-energy focused extracorporeal shock wave prevents the occurrence of glucocorticoid-induced osteonecrosis of the femoral head: A prospective randomized controlled trial

Fuqiang Gao, Wei Sun

Centre for Osteonecrosis and Joint-Preserving & Reconstruction, Orthopaedic Department, China-Japan Friendship Hospital, China

Background: Studies have shown that high-energy focused extracorporeal shock wave therapy (HF-ESWT) has a certain therapeutic effect on glucocorticoid-induced osteonecrosis of the femoral head (ONFH). This study aimed to observe the efficacy and safety of HF-ESWT as a precautionary measure to reduce the probability of glucocorticoid-induced ONFH.

Methods: A prospective randomized controlled trial was designed to evaluate whether HF-ESWT (Group A) can significantly prevent the incidence of glucocorticoid-induced ONFH relative to a control group without shockwave intervention (Group B). MRI was used to assess whether all participants experienced ONFH at 3, 6, and 12 months after the intervention. Continuous scoring was used to evaluate the intervention results: the 10-cm visual analog scale (VAS) was used to evaluate pain, and the hip Harris score (HHS) was used to evaluate the function of the hip joint. Any adverse events were recorded.

Results: 153 patients (89 females and 64 males) who had been allocated to group A (75 patients) or Group B (78 patients) were included in the final analysis. The patients were 45.0±13.0 years old. There were significant differences between the two groups in MRI diagnosis of ONFH patients (2 cases in Group A, 9 cases in Group B; $p=0.034$). Significant differences in functional results were measured at 6 months ($p<0.05$) and 12 months ($p<0.05$). However, there was no difference in the functional results measured at 3 months and the VAS at any point.

Conclusions: Our study suggests that HF-ESWT may be successfully used to reduce the probability of early development of glucocorticoid induced ONFH. Pain and hip dysfunction are common clinical manifestations when ONFH is unavoidable. However, HF-ESWT may be recommended for the prevention and intervention of ONFH high-risk populations receiving high-dose glucocorticoid therapy.

POSTER

Quantitative magnetic resonance imaging of femoral head articular cartilage change in patients with hip osteonecrosis treated with extracorporeal shock wave therapy

Fuqiang Gao, Wei Sun

Centre for Osteonecrosis and Joint-Preserving & Reconstruction, Orthopaedic Department, China-Japan Friendship Hospital, China

Background: Multiple reports have demonstrated the therapeutic potential of extracorporeal shock wave (ESWT) in osteonecrosis of the femoral head (ONFH). However, few studies reported the changes in hip articular cartilage after the intervention. This study aimed to investigate the effect of ESWT on femoral head cartilage using a novel technique-quantitative T2-mapping magnetic resonance imaging.

Methods: A total of 143 eligible patients with unilateral early-stage ONFH were randomized into the ESWT group and control group. Seventy-three patients in the ESWT group received two sessions of ESWT with oral drug treatment, while seventy patients in the control group received oral drug treatment only. The visual analog pain scale (VAS) and Harris hip score (HHS) at 3 months, 6 months, and 12 months follow-up were used as the clinical evaluation index. The radiological evaluation index used the T2 mapping values, necrotic size, and China-Japan Friendship Hospital (CJFH) classification.

Results: A total of 143 patients (62 females and 81 males) were included finally, and the characteristics before treatment were comparable between the two groups. At the last follow-up (12 months), the T2 values and ΔT2 changes in the ESWT group were all smaller than that in the control group ($p=0.042$; $p=0.039$), while the CJFH classification of ONFH and necrotic lesion size were not statistically significant. At the 3 months and 6 months, the VAS in the ESWT group were all lower than that in the control group ($p=0.021$; $p=0.046$), and the HHS in the ESWT group were all higher ($p=0.028$; $p=0.039$). However, there were no significant differences in the VAS and HHS at 12 months between ESWT and the control group.

Conclusions: ESWT is an effective treatment method for early-stage, non-traumatic ONFH. Furthermore, it could delay the injury of femoral head cartilage during the progression of ONFH.

POSTER

Bioinformatics and system biology approach to identify the influences of COVID-19 infections to corticosteroid-induced osteonecrosis of the femoral head disease patients

Wen-Sheng Zhang, Qiu-Shi Wei

Guangdong Research Institute for Orthopedics and Traumatology of Chinese Medicine, China

The ongoing pandemic of coronavirus disease 2019 (COVID-19) has made a serious public health threat worldwide with millions of people at risk in a growing number of countries. corticosteroid-induced osteonecrosis of the femoral head (ONFH) is a debilitating disease primarily affecting younger, active populations. Corticosteroid use is the most common cause of ONFH. The effect of corticosteroid in the treatment of COVID-19 has been recognized by some experts. The use of corticosteroid may lead to ONFH, and the correlation between corticosteroid treatment and ONFH in COVID-19 patients was analyzed from the perspective of bioinformatics, so as to provide options for the prevention and treatment of corticosteroid-related ONFH in patients recovering from COVID-19.As a result, the epidemic is still going through its frightening phase, and corticosteroid therapy for COVID-19 is a risk factor for ONFH. Therefore, transcriptome analysis was performed to examine common pathways and molecular biomarkers in corticosteroid-induced ONFH and COVID-19 to help understand the association between corticosteroid-induced ONFH and COVID-19 patients. In this study, Gene Expression Omnibus (GEO) data sets (GSE123568 and GSE147507) were used to detect differentially expressed genes (DEGs) in patients with corticosteroid-induced ONFH and COVID-19 infection. There are 13 commonly used DEGs were identified in the 2 datasets. Protein-protein interaction (PPI) was constructed using a variety of combinatorial statistical methods and bioinformatics tools, and hub genes and key modules were identified from this PPI network. In addition, we performed a functional analysis under ontological terms and pathway analysis and found some common links in the progression of corticosteroid-induced ONFH for COVID-19 infection. Transcription-gene interactions, protein-drug interactions and co-regulatory networks with common DEGs-miRNAs were also identified in the dataset.

POSTER

Differential expression of Piezo1 in osseous tissue of steroid-induced and alcohol-induced osteonecrosis of the femoral head

Tengfei Wei[1], Qiushi Wei[1], Xiaoming He[1], Yurou Wei[2], Zhiwei Zhan[2], Mincong He[1], Wei He[1]

[1]The Third Affiliated Hospital of Guangzhou University of Chinese Medicine, [2]Guangzhou University of Chinese Medicine, China

Background: Progression of femoral head necrosis can cause collapse. Piezo1 may be a mechanosensitive protein that senses femoral head collapse due to osteonecrosis of the femoral head (ONFH).

Objective: To observe the differential expression of Piezo1 in osseous tissue of patients with steroid- and alcohol-induced ONFH. METHODS: Thirty patients who underwent total hip arthroplasty due to ONFH from August 2020 to April 2021 were enrolled, and their femoral head samples (a total of 30, all were ARCO III stage; 20 males, 10 females; 15 cases in the steroid-induced ONFH group and 15 cases in the alcohol-induced ONFH group), clinical and imaging data were collected. The morphological and structural changes of bone specimens in necrotic area were observed by hematoxylin-eosin staining. The semi-quantitative expression of Piezo1 protein in osseous tissue was detected by western blot. The localization expression of Piezo1 protein in osseous tissue was detected by immunohistochemistry.

Results and Conclusion: Hematoxylin-eosin staining showed that bone structure disorder, bone marrow necrosis and a large number of empty bone lacunae were found in the necrotic area of the steroid- and alcohol-induced ONFH groups. The results of western blot assay showed that the expression of Piezo1 in the necrotic, sclerotic and normal area of the femoral head in steroid-induced ONFH group was higher than that in the alcohol-induced ONFH group($P<0.05$). The immunohistochemical results showed that the positive expression of Piezo1 in the necrotic, sclerotic and normal area in the steroid-induced ONFH group was more obvious than that in the alcohol-induced ONFH group. All these findings indicate that Piezo1 may be a mechanosensitive protein that senses ONFH collapse and may be involved in the process of osteogenic repair. The differential expression of Piezo1 in osseous tissue of patients with steroid- and alcohol-induced ONFH may be related to their different repair characteristics of bone formation.

POSTER

Association between magnitude of femoral head collapse and quality of life in patients with osteonecrosis of the femoral head

Makoto Iwasa[1], Nobuhiko Sugano[1], Wataru Ando[2], Keisuke Uemura[3], Hidetoshi Hamada[4], Masaki Takao[5]

[1]Department of Orthopaedic Medical Engineering, Osaka University Graduate School of Medicine,
[2]Department of Orthopaedic Medical Engineering, Osaka University Graduate School of Medicine,
[3]Department of Orthopaedic Surgery, Osaka University Graduate School of Medicine,
[4]Department of Orthopaedic Medical Engineering, Osaka University Graduate School of Medicine,
[5]Department of Orthopaedic Surgery, Osaka University Graduate School of Medicine, Japan

Introduction: Osteonecrosis of the femoral head (ONFH) is assumed to result from bone ischaemia, but its pathogenesis remains unclear and often results in progressive collapse of the femoral head, leading to reduced quality of life (QOL). Hip function reflects QOL and patient-reported outcome measures have been emphasised for QOL assessment. The magnitude of femoral head collapse (MFHC) is one of the criteria for staging osteonecrosis of the femoral head. However, the relationship between MFHC and QOL has not been studied in detail. The present study aimed to clarify the relationship between MFHC and hip pain or functional quality of life (QOL) scores in patients with ONFH.

Methods: Seventy patients with ONFH who had femoral head collapse without osteoarthritic changes were divided into four groups based on MFHC by 1 mm. Pain was assessed using the visual analogue scale (VAS). QOL was evaluated using patient-reported outcome measures, such as the Japanese Orthopaedic Association Hip-Disease Evaluation Questionnaire (JHEQ), Oxford Hip Score (OHS), and Short Form-12 Health Survey, version 2 (SF-12v2). We also explored the relationship between MFHC and QOL.

Results: Pain score and satisfaction score in the VAS, JHEQ pain subscale, JHEQ movement subscale, and JHEQ total score were significantly associated with MFHC, and no significant differences were found between groups in any subscale or total score for OHS and SF-12v2.

Conclusion: In patients with ONFH, differences in MFHC by 1 mm increments were associated with deterioration of some pain VAS and QOL outcomes. This suggests that treatment of femoral head collapse at an early stage may be beneficial in preventing pain catastrophising.

POSTER

Prediction matrix for collapse progression in osteonecrosis of the femoral head

Takeshi Utsunomiya, Goro Motomura, Ryosuke Yamaguchi, Satoshi Hamai, Taishi Sato, Shinya Kawahara, Daisuke Hara, Kenji Kitamura, Yasuharu Nakashima

Department of Orthopaedic Surgery, Graduate School of Medical Sciences, Kyushu University, Japan

Introduction: Collapse progression is directly related to the poor prognosis of osteonecrosis of the femoral head (ONFH). However, predictive methods that could determine whether collapse progresses or not in patients with ONFH have not been well-established. This study proposes a prediction matrix for assessing the probability of collapse progression in osteonecrosis of the femoral head (ONFH).

Methods: We recruited 57 hips with post-collapse ONFH from 49 consecutive patients, who were conservatively followed for more than one year (12 - 103 months). The location of the lateral necrotic boundary was assessed based on the Japanese Investigation Committee classifications on anteroposterior radiographs. The location of the anterior necrotic boundary with respect to the acetabulum on lateral radiographs was classified as follows: Anterior-area I (two hips), which occupied the medial one-third or less of the weight-bearing portion of the acetabulum; Anterior-area II (17 hips), which occupied the medial two-thirds or less of the weight-bearing portion; and Anterior-area III (38 hips), which occupied greater than the medial two-thirds of the weight-bearing portion. A prediction matrix for assessing the probability of collapse progression (≥1 mm) was created based on the combination of Type and Anterior-area classifications.

Results: Collapse progression was confirmed in 40 of 57 hips (70.2%) during the follow-up period. Among hips with Type B or C1, collapse progression occurred more frequently in hips with Anterior-area III (21 of 24 hips: 87.5%) than in hips with Anterior-area I or II (3 of 17 hips: 17.6%, $P < 0.0001$). The prediction matrix clearly showed that hips with either Type C2 or Anterior-area III showed a higher risk of collapse progression.

Conclusion: Based on the location of the necrotic boundary using biplane radiographs, this prediction matrix could predict collapse progression easily and precisely.

POSTER

Tissue engineered bone regeneration for the large osteonecrosis of femoral head in weight-bearing portion: An observational study

Bum-Jin Shim, Shin-Yoon Kim, Seung-Hoon Baek, Chang-Bae Choi, Ji-Woon Lee

Department of Orthopedic Surgery, Kyungpook National University Hospital, Korea

Introduction: Osteonecrosis of the femoral head with large lesion in weight-bearing portion usually progress to arthritis within short period and lead to hip replacement. We report long-term study using tissue engineered bone regeneration for these challenging conditions to preserve the femoral head.

Methods: Bone marrow was aspirated from iliac crest and mononuclear cells were collected. These cells were expanded ex vivo and differentiated to osteoblast lineage cells using sequential osteogenic media and autologous serum for 2-4 weeks. Porous bead-form scaffolds were made of calcium metaphosphate (CMP) and cells were seeded in a density of million/ml^3 into 20 to 30 beads for 1 hour. The necrotic area was curetted and the beads were implanted through core tract in 9 hips of 7 patients who had large lesion (Steinberg IIc in 5 hips and IVc in 4 hips) in weight bearing area (Japanese Investigation Committee C1 in 4 hips, and C2 in 5 hips). The tract was blocked with a CMP rod. The age of the patients ranged from 16 to 37. Associated factors were; steroid in 4 hips, idiopathic in 3 hips, alcoholic in 1 hip, and traumatic in 1 hip. Kerboul combined necrotic angle was more than 200° in all hips (range, 200° to 380°). Minimum follow-up period was ten years (range, 10 to 11 years).

Results: Two hips with IIc lesion progressed to IVc with dome depression>2mm and were converted to THR. The other 7 hips did not progress to advanced to osteoarthritis radiographically. Follow-up radiographs and MRI showed evidence of partial regeneration of necrotic bone and partial signal change to normal marrow image.

Conclusion: Tissue engineered bone regeneration using the bone marrow expanded osteoblast lineage cells ex vivo and CMP scaffold was very promising strategy to preserve of femoral head for osteonecrosis with large lesion in weight-bearing area.

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1) BMJ 2011;342:C7086 / N Engl j Med 2005;352:1071-80 2) Am J Gastroenterol, 2005;100(12):2650-7 / Aliment Pharmacol Ther 2010; 32:401-413