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as Top Priority
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News and Views
in Science, Research and Medical Technology
Dear Colleagues,

Over the past decades, joint replacement surgery and orthopaedic patient care have achieved a high level of sophistication in the Western countries. Today, the art and science of arthroplasty are spreading all over the world. Countries like China, India and Indonesia are advancing very fast. In these countries, there is tremendous growth potential for joint replacement, which will create a benefit for the whole healthcare system.

This procedure will be a catalyst for the development of modern hospital facilities and technologies with a positive balance of cost and clinical value. What we need to strengthen this trend is a well-structured methodology for transferring established know-how and promising innovations from the West to the East, based on a variety of meetings, with comprehensible curricula and a cost-effective organization. If that can be accomplished, the benefits to both patients and surgeons in the emerging countries will be significant.

The Chinese Orthopaedic Association (COA) is dedicated to educating orthopaedic surgeons on different levels of experience, relying on the experience of local and international faculty. Led by Prof. Yan Wang, the COA has worked out an impressive strategy for improving the quality of care at an affordable cost. Similar activities are taking place in other countries like India, Indonesia and Brazil.

The Hip Society’s Rothman-Ranawat Fellowship, created in 2012, is a new contribution to the efforts of our colleagues in emerging countries. Its objective is to support the education of 4 of the best candidates worldwide in the art and science of treating hip disorders and performing hip replacements. Of course, in order to advance joint replacement in the emerging countries, the collaborative effort of all parties involved is required.

Sincerely,
Chitranjan S. Ranawat, MD

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COA and WOA Place Access to High-Quality Orthopaedic Care as Top Priority

CeraNews asked Prof. Yan Wang, the president of the 7th International Congress of the Chinese Orthopaedic Association (COA) and the founding chairman of the World Orthopaedic Alliance (WOA), a non-profit organization with members from over 70 countries and regions, about the current status and the future of orthopaedics in China.

Prof. Wang, from your perspective as the president of the 7th International Congress of the Chinese Orthopaedic Association, what has the COA achieved?

The COA annual meeting is, of course, just a concentrated expression of our academic exchange with the outside world and our achievements in the field of orthopaedics. At present, there are around 100,000 orthopaedic surgeons in China and, with a registered membership of more than 50,000, the COA is the largest orthopaedic association in the world. Over the past year, the COA was heavily involved in pushing forward the advancement of orthopaedic surgery in China and carried out quite a few far-reaching measures.

Can you give us some examples?

From 2011 to 2012, the COA specialty groups re-elected a recently formed group of microscopic prosthetics and developed two new working groups. There are currently a total of 15 COA specialties, ranging from the Youth Working Committee and the committees for fields like arthroplasty or spine to the committee for combining traditional Chinese and Western medicine. As to education, more than 300 orthopaedic surgeons in China were selected for advanced study or training in 30 top orthopaedic centers in China. 180 orthopaedic surgeons from rural areas were sponsored to attend the COA annual meeting. Standard surgery procedure videos were created in various subspecialties for continued medical education.

The COA was also involved in creating an arthroplasty register. Where are you standing today?

The COA annual meeting is, of course, just a concentrated expression of our academic exchange with the outside world and our achievements in the field of orthopaedics. At present, there are around 100,000 orthopaedic surgeons in China and, with a registered membership of more than 50,000, the COA is the largest orthopaedic association in the world. Over the past year, the COA was heavily involved in pushing forward the advancement of orthopaedic surgery in China and carried out quite a few far-reaching measures.

Sincerely,
Chitranjan S. Ranawat, MD
How about cooperation with the industry and with international partners?

The Ministry of Science and Technology approved the establishment of a National Biomedical Materials Industry Alliance, which will strengthen cooperation among the academic and industrial spheres in terms of the research and development of related biomaterials, prosthesis design and clinical investigation.

Internationally, the COA enhanced cooperation with a number of international societies, such as the AAOS, AO Trauma and AO Spine, to set up a program known as the COA Combined International Travelling Fellowship. As is the case with the COA-AO Trauma Travelling Fellowship, the COA has so far sponsored 20 young orthopaedic surgeons from low-tier city hospitals by providing them with three-month training sessions in international AO centers. Although we have definitely achieved a lot, we still have an enormous amount to do.

You are involved in promoting the exchange of scientific knowledge and collaboration with international orthopaedic associations. How could cooperation between experts in China and Western countries help the global demands in arthroplasty to be met and further progress to be achieved?

The exchange of scientific knowledge and collaboration between experts in China and Western countries is critical to us, and the COA has made it a high priority. Of course, as I have mentioned before, the ultimate goal of this kind of communication and cooperation is to ensure that Chinese orthopaedic surgeons contribute much more to the knowledge and levels of expertise in the field of arthroplasty and to meet our patients’ growing demands for high-quality medical services.

Chinese patients are eager for medical care with evidence-based, cost-effective and upgraded technology to form the basis of a high quality of life. Orthopaedic surgeons not only deliver this kind of service directly but also play a key role in the academic-industrial alliance to develop new implants. The establishment of a National Biomedical Materials Industry Alliance is one example of how we are aiming to achieve this endeavor.

Prof. Yan Wang is the current president of the Chinese Orthopaedic Association (COA) and the director of the Orthopaedic Hospital 301 at the General Hospital of the Chinese People’s Liberation Army. He holds a great number of professional positions, including President of the Chinese Speaking Orthopaedic Society (CSOS), Founding Chairman of the Arthroplasty Society in Asia (ASIA), Deputy Editor of the Journal of Arthroplasty (JOA), Honorary Member of the Hip Society, Honorary Chairman of the Chinese Hip Society, and Active Member of the Association of Bone and Joint Surgeons (ABJS). He is also the Chairman of the Chinese Spine Society, Deputy Editor of SPINE, Active Fellow of the Scoliosis Research Society (SRS), Active Member of the National Ankylosing Spondylitis Society (NASS), and Editorial Board Member of Clinical Biomechanics.

Prof. Wang has worked as an orthopaedic surgeon specializing in arthroplasty of the hip and knee and spinal deformity surgery, and has conducted basic research in various fields, including implant development and musculoskeletal repair.
medical device companies to improve orthopaedic services. The WOA’s mission is to work with government departments, medical device companies, surgeons and hospitals to create an innovative, comprehensive and cost-effective pattern of thinking that is targeted to suit local cultures. It also aims to promote medical education, clinical practice and product research and development.

In your experience what are the main differences regarding orthopaedics and arthroplasty in China compared with Western countries?

As an emerging country with a huge population, musculoskeletal diseases are putting an enormous burden on us. What’s more, we still have a long way to catch up with the latest developments in orthopaedics. Although more than 30 years have passed since arthroplasty was introduced to China, we are still lagging behind the developed countries in terms of practice guidelines, scientific evidence and so on. This has led to huge diversity and has even caused some confusion in clinical practice. These circumstances have resulted in increased arthroplasty failure rates and an accordingly high revision rate. As opposed to limiting their pain, these effects bring added suffering to patients, not to mention the waste of medical resources and the increase in medical expenses.

What is the COA planning to do?

We currently want to focus on four tasks. The first is perfecting the Chinese Joint Registry System. Secondly, we are going to establish a hospital certification system for arthroplasty. The third task is standardizing the procedure guidelines for arthroplasty. Last but not least, we are accelerating research and development of domestic implants.

You mentioned the Chinese Joint Certification and Registry System. According to your longstanding experience, how has arthroplasty developed in China over the past few decades and what do you expect for the future?

The differences introduced to medical services in China are huge. In order to counter the issues in the field observed by monitoring arthroplasty in China, the COA called on the government to establish the Chinese Joint Registry System to regulate joint replacement surgery. This has allowed surgeons to obtain national epidemiological data to improve the overall level of medical services in Chinese orthopaedics.

In 2012, our Hip and Knee Replacement Management System was formally introduced to improve patient care. The Chinese Joint Registry and Information System was officially launched under the leadership of the COA Joint Registry Working Committee. 27 major hospitals have already been commissioned for the registry system and this year will see the registry being made obligatory in qualified hospitals. Certification systems form the basis for modern surgery standardization.

Almost all major foreign manufacturers have already come to China with their cutting-edge technology and products, one example being BIOLOX®delta ceramics. On the other hand, Chinese-based companies have begun to voice their ability and desire to play a major role in pushing forward the development of this field. We are very pleased to see more and more Chinese orthopaedic surgeons, who have already performed countless joint replacements, many of which are very complicated, conduct basic and clinical studies, and publish their findings in international and domestic peer review journals. In the future, we will be able to

China – orthopaedic facts and figures

According to COA statistics, 3% of more than 1.3 billion people in China have osteoarthritis and the number will increase steadily due to the rapidly aging population. It is estimated that the number of people who are 60 years or older will reach 243 million by 2020, then accounting for 18% of the country’s population. Based on the data of the International Osteoporosis Foundation, 69.4 million Chinese over the age of 50 suffer from osteoporosis, which causes 687,000 hip fractures every year. The expense of treating hip fractures is expected to exceed 12.5 billion USD in 2020 and skyrocket to 264.7 billion USD by 2050.

Since the 1980s, China witnessed the fast advance of arthroplasty. The number of procedures performed every year increased from very few to around 250,000 in 2012, according to a conservative estimation. There is no sign of breaking this trend, and the growth rate is expected to rise to about 20% a year in the near future. The number of arthroplasty procedures in the Orthopaedic Hospital 301 is around 2,500 a year, and the share of BIOLOX®delta ceramics in total hip arthroplasty is approximately 75%.
make more contributions to the knowledge and levels of expertise in the fields of arthroplasty and orthopaedic surgery.

What awaits orthopaedic surgeons at the 8th International COA Congress in Beijing this year?

The 8th International COA Congress will be held in Beijing on November 7–10, 2013. Many international orthopaedic organizations have already promised to continue providing instructive courses and lectures during the COA 2013. These include the AAOS, CCJR, SRS, AO Spine, AO Trauma, HSS, COFAS, ASIA, IOSM and many others. It is a great pleasure to announce that the first World Congress of the WOA will be held at the Chinese National Convention Center in Beijing on November 8-10, 2013, during the coming International Congress of the COA. The event will bring together global leaders of orthopaedics and industry in order to engage in a most fruitful experience. This combined convention will surely be a monumental event that sets the scene for future international orthopaedic congresses. The combination of history and modern life make Beijing a fantastic city. Participants will enjoy the unique experience of attending a world-class academic conference in this amazing location. We are looking forward to seeing our colleagues from all around the world. Beijing welcomes you!

Prof. Wang, thank you very much for speaking with us.

The 8th International COA Congress is set to take place on November 7–10, 2013 in Beijing, China. www.coachina.org/2013/en/
Highlights of the 7th Annual Meeting of the Chinese Orthopaedic Association (COA)

Beijing (China), November 15-18, 2012

The annual meeting of the COA has become the second largest orthopaedic congress in the world and is supported by an increasing number of international organizations. For the first time, the meeting of the Current Concepts in Joint Replacement (CCJR) and an EFORT course were held in conjunction with the COA in Beijing. At the CCJR meeting, Aldo Toni (Italy) reported on excellent 17-year results with more than 9,000 CoC THA.

A number of Chinese experts presented their clinical experiences with ceramic bearings at the COA congress. They repeatedly noted that accurate surgical techniques and correct component positioning play an increasingly important role in ensuring successful clinical outcomes.

CeraNews gives an overview of the latest results.

**Study:**

CoC showed highest survival rate after 17-year follow-up

Aldo Toni (Italy) presented the outcome of 9,981 primary CoC THA that were performed from 1994 to 2011 at the Rizzoli Orthopaedic Institute (Bologna, Italy). The survival rate with the endpoint of all revisions was 94.3% for CoC, 90.5% for MoM and 86.3% for conventional polyethylene in combination with metal or ceramic femoral ball heads. He concluded that CoC showed the highest long-term survival rate.

“Ceramic-on-ceramic THA showed best survivals with progressively lower incidence of risks of fracture. They are the gold standard for active patients.”

- Aldo Toni (Italy)
In: CCJR, a short course (proceedings)
16 November 2012, p. 5

**Study:**

Encouraging early results with CoC (BIOLOX®delta)

In a retrospective study, Jiying Chen et al. (China) analyzed 1,851 CoC THA (BIOLOX®delta) that were performed between 2009 and 2012. 132 patients (177 THA) obtained a minimum follow-up of 2 years. Noises occurred in 5 hips (2.8%). They concluded that the early outcome of BIOLOX®delta CoC THA in this series is encouraging.

Yonggang Zhou et al. (China) reviewed 1,206 CoC THA (BIOLOX®delta, 36mm in 1,168 hips, 32mm in 1 hip, 28mm in 37 hips). There were 1,084 primary THA and 122 revision cases. The mean age was 53.7 (23-71) at the time of surgery. The mean follow-up was 22.3 months. No infection, ceramic fracture or signs of loosening were observed. Noises were observed in 4 cases and disappeared. Dislocations occurred in 2 cases. The authors concluded that the early outcome of CoC THA is encouraging and announced that a mid-term follow-up will provide further results.

Wanshou Guo et al. (China) evaluated 115 CoC THA (BIOLOX®delta, 32mm, 36mm) after implantation in 90 patients (72 male, 18 female) between 2010 and 2011. The same type of prosthesis was implanted in each case. A 32mm femoral ball head was used in 22 hips (19%) and a 36mm ball head diameter in 93 hips.
The mean age was 44 (22-69) years at the time of surgery. The main diagnoses were osteonecrosis of the femoral head (84.3%) and developmental dysplasia of the hip (8.6%). The mean follow-up was 13 (10-16) months.

No cases of osteolysis, squeaking and infection were observed in this early follow-up period. The mean HHS improved from 49.5 preoperatively to 94 postoperatively (p<0.05). Dislocation occurred in one patient with abnormal muscle tension.

The authors concluded that the early outcome of the CoC THA with excellent joint stability and remarkable improvement of ROM is very encouraging. They recommended accurate surgical techniques to achieve excellent long-term results.

Dislocation is a common complication of THA. Xisheng Weng et al. (China) evaluated 106 CoC THA (BIOLOX® delta) after implantation in 106 patients (69 male, 37 female) between 2010 and 2012. The mean age was 50.8 (19-81) years at the time of surgery. Dislocation occurred in 4 cases (3.8%). All patients with dislocation were successfully managed by a conservative treatment in 2 cases and a reoperation in 2 cases. The hips were stable at latest follow-up.

Based on the results of this retrospective review, the authors recommended accurate surgical techniques to avoid hip instability in CoC THA.

Jianchun Zeng et al. (China) evaluated 87 patients with CoC THA (BIOLOX® delta, 36mm) after primary surgery between 2008 and 2011. The same type of prosthesis was implanted in each case. The main diagnoses were osteonecrosis of the femoral head (n=39) and osteoarthritis (n=35). The mean age was 50.4 (28-56) years at the time of surgery. The mean follow-up was 18.6 (6-38) months. The mean HHS improved significantly from 57±7.2 preoperatively to 93.5±3.7 postoperatively.

Noises occurred in 2 cases and disappeared spontaneously after a while. No cases of dislocation, ceramic fracture or signs of loosening were observed.

The authors concluded that the early outcome of BIOLOX® delta ceramic bearings is encouraging. They emphasized that accurate surgical techniques and correct component positioning as well as a correct handling of the ceramic components are essential to achieve excellent long-term results.

Hong Zhang et al. (China) reported that the low wear rates associated with CoC bearing couples have made them a popular bearing for younger patients in China, but the risk of early failure due to ceramic fractures is still a concern. She retrospectively evaluated the complication rate of 2,311 CoC THA (BIOLOX® forte).

Ceramic component fractures occurred in 2 cases (0.1%) due to an incompletely seated insert in one case and fracture of a ceramic femoral ball head after trauma in the other. No cases of femoral ball head fracture were observed in this study.

The incompletely seated ceramic insert is explained by an intraoperative technical error. This problem has already been reported in the literature.

The authors concluded that accurate surgical technique, correct positioning of the implanted prosthesis and safe handling of the ceramic components play a significant role as preventive measures for avoiding ceramic fractures and achieving excellent long-term outcomes.

Yuchi Zhao et al. (China) reported the results of wear measurement in 8 patients (5 male, 3 female) who received a bilateral THA simultaneously. The
mean age was 52 (45-60) years at the time of surgery. A 10-year follow-up was obtained. The mean linear wear for MoP was 0.25±0.10mm/year. In contrast, the significantly lower mean linear wear rate for CoP was 0.14±0.06mm/year.

**Study:**

Clinical performance of CoC vs MoP – No clear trend after short-term follow-up

Liqing Yang et al. (China) compared the clinical outcome of 22 CoC cementless THA in 20 patients and 22 MoP cementless THA in 22 patients. The implantations were performed between 2007 and 2010. No failures of the bearing couples were observed. There were no significant differences in the clinical and functional outcomes after a minimum follow-up of 6 months. The authors pointed out that CoC is the optimal bearing for young patients due to the outstanding wear resistance.

**Meta-analysis:**

Clinical performance of CoC vs MoP – CoC is a safe and effective treatment after 8-year follow-up

The safety and effectiveness of CoC THA compared to MoP THA were investigated by Lei Tian et al. (China). The meta-analysis was based on 4 studies involving 1,547 CoC THA and 352 MoP THA in the period from 1990 to 2011. The mean age of the patients was 53 (39-65) years at the time of surgery. The mean follow-up was 8 (5.4-12.5) years. On the basis of the results of this meta-analysis, the authors concluded that CoC THA is a safe and effective treatment for middle-aged patients in the mid-term follow-up period.

**Study:**

Clinical performance of CoC vs MoP – Higher survivorship for CoC in active patients < 50 years old after 5-year follow-up

Junying Sun et al. (China) performed a retrospective analysis of 82 THA, which were performed between 1995 and 2005. Based on the age and activity level, the patients were divided into 2 groups. In group A, there were 21 patients with 22 CoC THA and 18 patients with 20 MoP THA. These patients had a high activity level and were under 50 years. In group B, there were 21 patients with 21 CoC THA and 19 patients with 19 MoP THA. They were 50 years or older and had a lower activity level. The minimum follow-up was 5 years for both groups. In group A, MoP THA had to be revised in 3 cases (7.5%). No failures were detected in the CoC group. In group B, there were no significant differences in the clinical and functional outcomes after 5 years. In group A, the Kaplan-Meier survivorship analyses showed significantly better results for CoC THA than for MoP THA.

**Pre-clinical testing:**

Zongmin Jin (China) gave an interesting overview on the current status of pre-clinical laboratory testing of artificial joints. There is a number of Chinese initiatives to develop appropriate standards and scientific evaluation methods in close collaboration between experts from national and international institutions.

The presentation of Zongmin Jin can be downloaded via QR code. 
http://www.ceramtec.com/biolox/media-library/ceranews-plus/
The COA annual meeting has become a significant orthopaedic academic event in the world of orthopaedics. In 2012, more than 15,000 orthopaedic surgeons from 49 countries attended the congress. 15,352 papers were submitted by scientists worldwide. There were 2,505 presentations, 111 courses, 527 guest speeches, 1,785 free paper presentations and 82 case discussions. Additionally, 2,425 posters were shown. 137 international orthopaedic organizations and 170 president line chairmen or directors of national and international orthopaedic organizations participated in the meeting. 22 international orthopaedic organizations, including the AAOS, EORTC, CCJR, AO Spine, HSS, ORS, ASIA, FFN, ASBMR, APSFAS and CSOS, delivered related instruction courses and lectures, which were warmly welcomed by the audience. Additionally, about 210 foreign and domestic companies presented their products and services in the scientific exhibition on an area of 25,000m². There were 39 satellite meetings held during the congress.

The 8th International Congress of the Chinese Orthopaedic Association (COA) will be held together with the 1st World Congress of the World Orthopaedic Alliance (WOA) in Beijing on November 8-10, 2013.

New Solutions With Ceramics

CeramTec Medical Engineering is focused on product development beyond the hip joint

In the field of hip arthroplasty, ceramics have been a reliable and successful material for many years. For which other fields of application do doctors wish to have implants and components made of this wear-resistant and biocompatible material? CeramTec put this question to medical professionals worldwide. Their responses (see table) have confirmed our resolve to set up a new business unit to develop ceramic products for new fields of application.

The feedback from the doctors reveals a very clear trend: wherever bones and joints are being treated or replaced, there is great interest in ceramic alternatives to implants and instruments made of metal. Furthermore, we are receiving requests for ceramic options from the orthopaedic industry more and more often. Even patients from around the world are contacting us directly to find out about treatment options with ceramic components. Their growing interest is apparently related to a certain loss of confidence due to the public debate about problems with metal-on-metal wear couples.

Sales of hip components are continuing to develop well; in 2012 we delivered more than a million units. CeramTec has now decided to vigorously pursue the development of new medical products. This is the most important task of the new Medical Engineering Division in Lauf near Nuremberg. At this CeramTec production site, more than 500 employees are involved in the manufacturing of high performance ceramics.

Medical Engineering has its roots in the Medical Products Division, which has made BIOLOX® ceramics the worldwide standard for hip arthroplasty. In fact, the majority of the team comes from this business unit; I myself have worked there for almost 10 years. One thing that both units have in common is that we always regard our work as a close cooperation with doctors as well as implant manufacturers. Possible fields of application for future products include the shoulder and the small joints, the spine, surgical instruments, dentistry and bone replacement materials. Our focus is primarily on the following issues:

- Development of new products for new fields of application of bioceramics
- Reduction of wear and prevention of osteolysis (joints)
- Improved imaging/prevention of artefacts (spine)
- Prevention of the microbiological colonization of implants
- Development of new materials

The new products are to be marketed as OEM solutions. Our developers are already working at a fast pace. In the dental field, for instance, we are working on a comprehensive technology platform for ceramic dental implants. In the spine segment, the team is focusing primarily on the development of ceramic cages. Solutions for total disk arthroplasty and spacers are further fields of focus. For spine and trauma, the first prototypes have already been produced; for shoulder arthroplasty, the first very promising projects have been started.

You can find further information about Medical Engineering in the image brochure “BIOLOX® Family – The Future in your Hand”, which you can order via the response fax or online.

http://www.ceramtec.com/markets/medical-technology/

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**Percentages, n=246 / Possible applications for ceramics**

<table>
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<tr>
<th>Highly interested</th>
<th>Interested</th>
<th>Not interested</th>
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<tr>
<td>Small joints in ceramics (ankle, shoulder, finger, etc.)</td>
<td>64</td>
<td>22</td>
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<td>Surgical instruments in ceramics:</td>
<td>31</td>
<td>59</td>
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<tr>
<td>Applications for traumatology in ceramics</td>
<td>72</td>
<td>19</td>
</tr>
<tr>
<td>Spinal applications in ceramics</td>
<td>49</td>
<td>48</td>
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CeramTec has surveyed practicing surgeons in various specialties to identify which new applications for bioceramics are of particular interest to them.
Steven M. Kurtz has expertise in the clinical performance of polyethylene, ceramic, and metal-on-metal hip implants. His professional career has involved the evaluation of medical device technologies, from a combined analytical, experimental and clinical perspective. His research activities have emphasized real-world clinical performance of medical devices, including orthopaedic, spine and cardiovascular implants, as assessed by human implant retrieval specimens and national health care databases; mechanical behavior of synthetic biomaterials; contact mechanics of artificial joints; and structural evaluation of bone-implant systems.

Steven M. Kurtz is active in many professional societies, including the American Academy of Orthopaedic Surgeons, the American Association of Hip and Knee Surgeons, the Knee Society and the American Society for Testing and Materials. He has edited five books and written over 150 journal articles and 400 conference abstracts.

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Taper Corrosion Update: What is the Role of Ceramic Femoral Ball Heads?

by Steven M. Kurtz, MD, PhD

“If you would understand anything, observe its beginning and its development.”

– Aristotle

Taper corrosion is not a new issue in orthopaedics, but until recently it was a problem we thought had been solved.

The metallic biomaterials we use in hip and knee implants, namely cobalt- and titanium-based alloys, are among the most corrosion-resistant materials for implant use and have a largely successful clinical track record spanning many decades. In the 1980s and 1990s, researchers studied in detail corrosion at the modular femoral ball head-stem junction.1,6 These early studies helped identify the corrosion products from modular connections in metallic stems, as well as establish the corrosion mechanism, which is now recognized to be a complex mechanically assisted crevice corrosion process (for more details, see the accompanying article by Robert Streicher in this issue p. 14). However, all of this mechanistic, basic science research was almost exclusively based on cobalt chrome (CoCr) alloy femoral ball heads on either cobalt-based or titanium-based alloy femoral stems.

With the growing concern about taper corrosion in modular large-head, metal-on-metal hip designs,7,8 two-piece, modular femoral stems,9 and, most recently, metal-on-polyethylene hip designs10, there is increased awareness of the issue of metal debris release in contemporary modular connections and the potential for rare complications, including adverse local tissue reactions (ALTR). Until recently, the literature has been largely silent on the topic of taper corrosion used in conjunction with ceramic femoral ball heads. The purpose of this article is to briefly summarize some of the key studies examining taper corrosion with ceramic femoral ball heads in modular hip systems, and to share an evolving perspective on this topic based on our group’s recent research.

When surveying the issue of taper corrosion products in the 1990s, researchers including Urban, Gilbert, Jacobs and colleagues studied a broad range of hip implant designs, with an emphasis on modular connections in which both the femoral ball head and stem tapers were metallic.3,6,11,12 However, one of the samples in their collection was an Autophor hip, an early CoCr alloy stem with an alumina femoral ball head, fabricated from first-generation BIOLOX® ceramic. Based on this single ceramic retrieval, and their larger collection of metallic components, Urban and colleagues11 observed that, “the products of corrosion identified at the modular junctions of all of the various prostheses examined were similar regardless of the implant design or materials coupled, even when a ceramic femoral ball head was employed.” After this early research established the basic mechanism of taper corrosion, the issue of modular taper corrosion largely faded from the forefront of orthopaedic consciousness, replaced by the problem of osteolysis and aseptic loosening due to polyethylene wear, which dominated orthopaedic meetings and literature in the 1990s.

In 2004, Hallab and colleagues from Rush (Chicago) published an in-vitro study explicitly directed at comparing taper corrosion using ceramic femoral ball heads with cobalt chrome alloy femoral ball heads.13 The authors theorized that fretting would be more severe between a ceramic femoral ball head and metal stem, and hypothesized that ceramic femoral ball head...
systems would release more debris than metal femoral ball heads. To test their hypothesis, they selected CoCr femoral ball heads and CoCr stems by a single manufacturer. The ceramic femoral ball heads were zirconia, manufactured by a supplier that has since withdrawn from the orthopaedic market. Unexpectedly, the researchers found that the CoCr stems with CoCr femoral ball heads released 11 times greater Co and 3 times greater Cr than the stems fitted with zirconia femoral ball heads. Although the research findings refuted their original hypothesis, the authors cautioned against overgeneralizing their results to other designs and implant systems, and concluded that, “ultimately, it will be through careful evaluation of clinical performance and implant retrieval analysis that the relative performance of ceramic-metal modular junctions will be ascertained”.

Retrieval Study
Our group began to study the hip implant retrieval collection at the Implant Research Center at Drexel University to compare taper corrosion in ceramic femoral ball head systems with metal femoral ball head systems. As we reported at the Alternative Bearings Mini-Symposium at AAHKS (November, 2012), our ongoing research thus far suggests that ceramic femoral ball heads help to mitigate corrosion of the femoral stem, but we are still working to quantify the magnitude of the reduction. The problem is challenging, because so many factors influence taper corrosion, including the implantation time, lateral offset, metallurgical condition of the stem, and surface finish of the taper, to name a few. Furthermore, because ceramic femoral ball head retrievals are so rare, especially with long implantation times, we partnered with the hip implant retrieval program from Case Western Reserve University under the direction of Clare Rimnac to help ensure we had a broad sample size from a variety of hospitals and clinical settings.

We carefully matched implants in the two 50-implant cohorts (100 patients total) to account for all the variables influencing taper corrosion and to focus on the difference between ceramic-metal and metal-metal tapers. First of all, we excluded from the study any hip implant systems with modularity besides the head-neck interface. This means that there were no ceramic femoral ball heads with metal sleeves in the study, nor were there modular necks or modular stems. All of the hip implants in the ceramic femoral ball head cohort were from ceramic-on-polyethylene or ceramic-on-ceramic bearings. The hip implants from the metal femoral ball head cohort were all from metal-on-polyethylene bearings. The stems included a variety of cobalt and titanium-based alloys from the major manufacturers, and both the stem design and offset were matched between the ceramic and metal femoral ball head cohorts. The ceramic femoral ball heads were all BIOLOX® forte or BIOLOX® delta femoral ball heads produced by CeramTec. The stem tapers in each cohort were scored from 1 (mild) to 4 (severe) by three independent observers for evidence of fretting and corrosion using a scale adapted by Goldberg and associates for retrieved metal tapers.

Although the research described in this article is still ongoing, we have observed significantly less corrosion among the stems in the ceramic femoral ball head cohort as compared with the metal femoral ball head cohort (Figs. 1-3). The median fretting and corrosion score was 2 for the metal stems mated to a ceramic femoral ball head (Figs. 1), as compared to the metal stems mated with a CoCr femoral ball head, which had a median score of 3 (Fig. 2). We are currently looking to quantify the metal debris release from these tapers using advanced metrology techniques, including analysis with a Talyrond high precision roundness machine (Taylor Hobson).

Ceramic femoral ball heads significantly reduce taper corrosion at the neck-stem interface when compared with CoCr femoral ball heads.

— S. Kurtz, MD, PhD
Summary
This research has important implications for metal debris generation in modular hip systems. Thus far, ceramic femoral ball heads have been studied almost exclusively in terms of their ability to reduce wear at the articulating surface.

The evidence is growing that, in addition to wear reduction, ceramic femoral ball heads also play a role in mitigating taper corrosion. Expect future updates on the status of this research at conferences in the coming year.

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References

As our retrieval research continues, access to explanted ceramic femoral ball heads and stem pairs with over 10 years in vivo, as well as ceramic femoral ball heads incorporating metallic sleeves (e.g., BIOLOX®OPTION femoral ball heads) would be extremely useful.

If you are interested in collaborating with our multi-institutional retrieval research program by providing explanted devices and associated (de-identified) clinical data, please do not hesitate to contact the author (skurtz@drexel.edu).

We have established protocols for shipping of retrieved implants internationally, and currently collaborate with over 12 clinical centers in the U.S. and Europe.
Introduction

Metals used in orthopaedics are biocompatible high strength alloys and mainly used for structural components of implants. Depending on their composition they can be inert like stainless steel and CoCr alloys or can attract osteogenic cells like titanium and its alloys. For medical devices three metals and alloys in various compositions are used, namely Fe-based alloys (SUS), CoCr alloys (Stellite) and Ti and its alloys. For the articulation of artificial joints, CoCr alloys are used almost exclusively.

Since the early 1970s, there has been an increase in implants consisting of modular components. Especially hip implants with exchangeable femoral ball heads using a Morse taper, which also allowed for the introduction of ceramic articulation to THA, and have a proven track record. However, any modularity poses some risk as the contact area between two components exhibits an increased susceptibility to fretting, corrosion and wear debris generation.

Recently 3 presentations have reported about fretting and corrosion with a focus on the behaviour of ceramic and/or CoCr femoral ball heads in modular total hip arthroplasty (THA).

Definitions

Mechanically initiated interface deterioration (wear, fretting and fretting wear)

**Wear** is defined as surface damage characterized by progressive loss of material due to relative motion between opposing surfaces.

**Fretting** is a specific type of relative movement and is defined as a mechanism that is a low amplitude, oscillating, sliding movement between two mechanically joined parts under load. Several authors have analyzed the necessary magnitude of motion needed to create this phenomenon and it has generally been defined as being very low, between 1 and 100 µm. Given the magnitude of loading in the body, all modular junctions of prostheses are susceptible to fretting.

**Fretting wear** is the removal of material from contacting surfaces through fretting action.

Chemical initiated interface deterioration (corrosion and crevice corrosion)

**Corrosion** in the engineer’s definition is the visible destruction of a structure and, in final consequence, the loss of function, while for a chemist it is an irreversible surface reaction of a material with its environment in a way that the material is consumed and its dissolved species become part of the environment. It is described as a surface degradation due to electrochemical interactions producing metallic ions and salts and applies only to metallic materials. Only noble metals like gold have a surface which is self-protecting from corrosion, while all other metals and alloys in air spontaneously rely on a reaction with oxygen, forming a more or less protective (passivation) oxide layer, shown in Figure 2.
Any violation of this oxide film will lead to immediate corrosion (ion flow) until the film is formed again. The time to rebuild a protective oxide layer again is called repassivation time. It is dependent on the metal composition and the availability of oxygen and takes only milliseconds, for Ti6Al4V about 60 ms.

### Classification of corrosion phenomena

**Eight distinct forms of corrosion have been defined**

1. **Uniform or general corrosion** refers to the inevitable corrosion to which all metals immersed in electrolytic solutions are condemned. It is the uniform removal of material from surfaces, a phenomenon for all metals. Alloys used for implants have a high resistance against uniform corrosion, making it a very slow, visibly undetectable process.

2. **Galvanic or two-metal corrosion** is the dissolution of metals driven by macroscopic differences in electrochemical potentials, usually as a result of dissimilar metals in proximity. This form of corrosion needs 3 conditions, of which all have to be met:
   a. Two different metals
      (= different corrosion resistances)
   b. Physical (conductive) contact
      (for electron transfer)
   c. Aqueous (electrolytic) environment
      (for ion transfer)

3. **Fretting corrosion (and erosion)** is corrosion assisted by mechanical action: the passive layer of a metal or alloy is permanently damaged, leading to accelerated corrosion of the unprotected surface. It is defined as deterioration at the interface between contacting surfaces as the result of corrosion and a slight oscillatory slip between two surfaces. Fretting currents consist of dissolution and repassivation reaction.

4. **Crevice corrosion** is the localized corrosion of a metal surface at, or immediately adjacent to, an area that is shielded from the full environment of close proximity between the metal and the surface of another material. Crevices can appear as narrow cracks, e.g., after the overload of a metallic device, or as small gaps between interfaces of modular components. The conditions in the crevice are different from the environment, leading to a small galvanic element and local corrosion.

5. **Pitting corrosion** is a form of localized, symmetric corrosion in which pits form on the metal surface. It is initiated by mechanical stress, such as scratches or tribological loads.

6. **Intergranular corrosion** is a form of galvanic corrosion due to impurities and inclusions in an alloy. It is a local attack, initiated by grain boundaries whose composition and structure differ strongly from the grains. Corrosive attacks can be intensified by galvanic effects between grains and grain boundaries. Intergranular corrosion is more likely for cast alloys than for wrought alloys.

7. **Selective leaching** is a form of corrosion that results from chemical differences not within grain boundaries but within the grains themselves and is defined as the removal of specific components of an alloy from the device’s surface, initiated by weakly bound or readily solvable elements and/or aggressive media. Leaching is more likely for multiphase alloys with grains of different composition and structure than for single-phase materials. Leaching can be a process accompanying the passivation of a surface. Solvable elements, such as Fe or V, leave the surface and lead to a higher concentration of corrosion resistant elements, such as Cr or Ti, thus protecting against further corrosive attacks.
8. Stress corrosion and corrosion enhanced fatigue are phenomena in which a metal in a certain environment, especially those rich in chlorides, is subjected to stress and falls at a much lower level than usual as a result of corrosion.\(^\text{14}\)

General or uniform corrosion cannot be avoided. However, for modern implant materials, it is an extremely slow process (some ng per cm\(^2\) and per day). Taking account only of general corrosion, the lifetime of an implant exceeds by far the life of the patient. All other forms of corrosion can be avoided or reduced by appropriate choice of materials, designs and handling. If corrosion cannot be avoided, care has to be taken to limit it as much as possible.

Corrosion is – like wear – a system property and multifactorial. It depends on the material: metal type – composition, structure, homogeneity, impurities, defects, electropotential, repassivation capacity etc.; the manufacturing process; the surface conditions, especially roughness; the design (dimensions and tolerances), especially for modular connections like a Morse taper, and the surrounding environment, especially load, motion and pH\(^5\) and the complex interplay of metallurgical, chemical, electrical, and tribological factors.\(^{12,15,16}\)

Corrosion and Fretting for Biomaterials

Ti and Ti alloys are prone to fretting wear but their electrodynamic potential, and, therefore, their corrosion resistance is high: around 6V. CoCr alloys are harder and less susceptible to fretting and wear but their corrosion potential is much lower, around 400mV. Stainless steel alloys in general have a similar hardness but a lower corrosion resistance, around 350mV for ISO 5832-1 and 800mV for ISO 5832-9 steel, and their fretting resistance is less than for CoCr alloys.

Due to the high corrosion resistance of the metals and alloys used in orthopaedics, several types of corrosion are uncommon. The two main forms of corrosion observed for orthopaedic implants are fretting initiated crevice corrosion and fretting corrosion. Pitting corrosion has been only observed for stainless steels and was the reason for polishing stems, as surface roughness also influences the amount of corrosion.

Gilbert et al.\(^\text{17}\) presented a hypothesis of mechanically assisted crevice corrosion to explain how mechanical loading can result in fretting of the modular taper interface, fracture of the passive oxide films, repassivation and crevice corrosion. This still seems to be the consensus today. They suggested that mechanical loading of the prosthesis accelerates fretting and crevice corrosion processes, resulting in the release of metal ions and the production of wear debris. Although fundamentally a crevice corrosion problem, mechanical fretting and wear also contribute by disrupting the atomically thin, protective oxide layers that border the crevice environment.\(^{12,15,18}\) When the underlying metallic substrate is exposed to the in-vivo saline fluid environment by mechanical damage, rapid oxidation or repassivation of the metal surfaces alters its voltage and acidifies the solution trapped in the taper crevice.

However, several authors of articles on fretting and corrosion of modular implants assume that corrosion issues are design and, therefore, manufacturer related.\(^\text{19}\) Of course the intraoperative assembly of modular components – clean, dry, impaction\(^{20,21,22}\) – is as important for any material combination, although the consequences for metal or ceramics, for example, are obviously different.

A potential additional risk is that over the years surgeons have started to mix components from various suppliers\(^\text{23}\) and not all tapers are created equally.

Summary

Corrosion and wear are system properties and, therefore, complex and multifactorial. Metallic biomaterials corrode in the human body in general, although at a very low rate. Several other forms of corrosion have been identified technically and some of them can be observed also in orthopaedics. Their causes and consequences have been analyzed in detail. For long-term implants like THA the modular connections have been identified as a primary source of concern and the mechanism of fretting-induced crevice corrosion has become popular. Apart from several other factors, the usage of appropriate materials and compliant designs and a careful assembly of intended components are the best methods to avoid extensive corrosion with its potential consequences.
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Modular Taper Junctions as a Potential Source of Increased Metal Debris

Intraoperative findings and retrieval analyses show the evidence of increased metal wear at the large metal ball head/trunnion interface. Some authors1-3 have reported that adverse reactions to metal debris (e.g., metallosis, pseudotumours, chronic inflammatory lesions, local tissue reactions) may take several years to develop. Metal debris from taper junctions appears to have a greater potential to stimulate adverse immune responses.
Clinical Data With Ceramics

Study:
Clinical performance of CoC THA after 20-year follow-up

Synder et al. (Poland) evaluated 220 THA after implantation of cementless full ceramic threaded cups (alumina, BIOLOX® first generation, 32mm) in 188 patients (101 female, 87 male) between 1985 and 1999. The main diagnoses were dysplastic coxarthrosis (36.8%) and idiopathic coxarthrosis (27.3%). The mean age of the patients at surgery was 44.5 (20–70) years. The mean follow-up was 19.6 (12.3–26.7) years. The authors reported very good results in 39.5% of the patients, good results in 43.6% and satisfactory results in 9.1%. No cases of squeaking and infection were observed. A revision for aseptic loosening was required in 16 cases. Poor results (7.8%) were mostly obtained in patients with advanced dysplastic coxarthrosis. The survival rate (Kaplan-Meier) with the endpoint of all revisions was 86.4%. Similar findings were published by Petsatodes et al.*


Study:
CoC in patients ≤ 30 years old – no cases of osteolysis after 15-year follow-up

Kim et al. (Korea) evaluated 127 cementless CoC THA (BIOLOX® forte, 28mm) in 96 patients. The mean age at the time of surgery was 24 ± 5 (19–30) years. The main diagnoses were osteonecrosis of the femoral head (54.3%) and developmental dysplasia of the hip (20.5%). The mean follow-up was 14.8 (10–16) years. No cases of aseptic loosening, migration, squeaking or ceramic fracture were observed. One acetabular component (0.8%) was revised because of recurrent dislocation. The survival rate (Kaplan-Meier) with the endpoint of aseptic loosening was 100%. The authors concluded that the alumina CoC bearing couple exhibits excellent clinical results in this young and highly active patient population.

“... Our results with the use of alumina-on-alumina ceramic bearings in patients thirty years of age or younger suggest that cementless acetabular and femoral components provide outstanding midterm fixation and substantial pain relief well into the second decade after surgery and provide a high rate of survivorship without evidence of osteolysis. ”

- Kim et al. (Korea)
In: J Bone Joint Surg-Am 2012;94(17):1574

Study:
CoC in patients ≤ 30 years old – no cases of osteolysis after 11-year follow-up

In a retrospective study, Yoon et al. (Korea) reported on the results after 75 cementless CoC THA (alumina, BIOLOX®forte, 28mm) in 62 patients (37 male, 25 female). The main diagnosis was osteonecrosis of the femoral head (51%). The mean age at the time of surgery was 24 (18–30) years. The mean follow-up was 11.5 (10–13.5) years. The survival rate (Kaplan-Meier) with the endpoint of all revisions was 98.9%. The authors identified noises in 16% of all cases (clicking 13%, squeaking 3%). However, noises could not be reproduced. A ceramic
fracture of the insert occurred in one patient and was associated with constant instability and recurrent subluxation. The patient already had an unstable hip preoperatively as a result of inadequate hip muscle tone after spinal cord injury.

No cases of wear-related osteolysis were observed. No acetabular or femoral component showed radiographic signs of loosening. The survival rate (Kaplan-Meier) with the endpoint of aseptic loosening was 100%.


The findings of our study suggest alumina-on-alumina bearings are associated with high implant survivorship after 10 years in young patients.

- Yoon HJ et al. (Korea) In: Clin Orthop Relat Res 2012; 470:3533

Study:

Clinical performance of CoC vs CoXPE in patients <61 years old – No clear trend yet after 5-year follow-up

In a prospective randomised controlled study, Beaupre et al. (Canada) compared the clinical and radiographic outcome of 48 CoC and 44 CoXPE cementless THA. The mean age at the time of surgery was 51.3 years in the CoC group and 53.6 years in the CoXPE group. Alumina ceramic inserts and femoral ball heads were used in the CoC group, the ball head diameter being mainly 32mm. 28mm femoral ball heads were mainly used in the CoXPE group. CoC and CoXPE THA provided excellent short-term results. No failures of the bearing couples were observed. There were no significant differences in the clinical and functional outcomes after 5 years postoperatively. The authors reported that a long-term evaluation is under way.


Study:

Comparison of the clinical performance of CoC, MoM and MoP after 8.5-year follow-up

Milosev et al. (Slovenia) evaluated outcomes obtained retrospectively from 411 THA in 395 patients. They reported on the results of their follow-up examination of 202 CoC (BIOLOX®forte), 199 MoP, and 68 MoM (low-carbon) THA. The metal and ceramic inserts were used with a sandwich cup in which an additional layer of polyethylene is placed between the metal cup and the insert. In all cases a 28mm femoral ball head was used. The mean age at the time of surgery was 60 years in the CoC and MoM groups and 71 years in the MoP group. The mean follow-up was 8.5 (6.9–10.5) years. The main diagnosis was osteoarthritis.

The authors reported that the revision rate for aseptic loosening was significantly higher for the MoM group compared to the MoP and CoC groups. The difference in survival between the MoP group and the CoC group was not significant. In the MoP group, 1 revision was due to aseptic loosening. In the MoM group, 5 revisions were due to aseptic loosening and 1 revision to dislocation. In the CoC group, 2 revisions were due to aseptic loosening and 4 revisions to fracture of ceramic components. Unfortunately, the authors pre-

CoM and MoM are associated with an equivalent increase in serum metal ion levels at 6- and 12-months follow-up

Only limited data are available on the clinical performance of the CoM bearing couple. The femoral ball head is made of zirconia toughened alumina ceramic (BIOLOX®delta). Now, in a prospective randomised controlled study Schouten et al. (New Zealand) compared serum levels of cobalt and chromium of 41 CoM* and 36 MoM THA at 6 and 12 months (bedding-in phase) postoperatively. 36mm femoral ball heads were mainly used. The study identified an association between higher acetabulum inclination (>55°) and higher serum metal ion levels.

This study confirms the importance of correct acetabular component implantation for bearing couples. The authors noted that a follow-up at 2 and 5 years (steady state phase) will provide further results.


Study:

Comparison of the clinical performance of CoC, MoM and MoP after 8.5-year follow-up

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* CoM articulation, Pinnacle® CoMplete Acetabular Hip System, DePuy Orthopaedics Inc.
sented no data on the cup positioning and retrieved components. Therefore, the reasons for loosening failures in all 3 bearing couples and ceramic fractures in the CoC group remain unclear.


Study:

Comparison of the clinical performance of CoC, MoXPE and MoP – No clear trend yet after 5-year follow-up. No significant wear in the CoC group

In a prospective randomised controlled study, Nikolau et al. (Canada) compared the clinical and radiographic outcome of 34 CoC, 36 MoP and 32 MoXPE cementless THA in 91 patients. The main diagnosis was osteoarthritis (66%). In all cases a 28mm femoral ball head was used. The mean age at the time of surgery was 52.7 (19–64) years. 97 THA in 87 patients could be reviewed.

There were no statistical differences in the clinical and functional outcomes after 5 years. No failures due to aseptic loosening could be detected. In the CoC group, 3 of 34 patients (8.2%) reported squeaking. No radiological abnormalities could be detected and no patient required a revision due to squeaking. Significant differences were recorded for the mean annual linear wear rate. The CoC bearing couples demonstrated the lowest wear rate. The mean annual liner wear rates were 0.0067mm/year in the CoC group, 0.059mm/year in the MoXPE group and 0.151mm/year in the MoP group.


Case Report:

Metal wear-related complications – MoP after revision of a ceramic fracture is contraindicated

In rare cases of ceramic component fracture, surgeons have the option of using a specially designed ceramic revision ball head system in articulation with a ceramic, PE or XPE insert.* Based on the results of testing and clinical findings, the use of a MoP bearing after a ceramic component fracture is contraindicated. Poor results have been reported in the literature when revision surgery was performed for ceramic fracture with MoP bearings. Ceramic particles can be embedded in the PE articulation surface and cause abrasive wear of the metal femoral ball head. Most of these publications reported massive metal wear and destruction of the metal femoral ball head. This can lead to extensive periprosthetic metallosis, elevated blood cobalt levels and, in severe cases, metal wear-related cobalt toxicity.

Recently, such an exceptionally rare case of symptomatic metal wear-related cobalt toxicity was described by Zywiel et al. (Canada). The patient developed symptoms of cobalt toxicity beginning 6 months after revision of a fractured ceramic component to a MoP bearing couple. He died from cobalt-induced cardiomyopathy. The authors pointed out that the patient’s serum cobalt level was approximately 10 times higher than those previously reported for systemic toxicity after treatment of a ceramic fracture with a MoP bearing couple. The implant retrieval analysis showed a loss of 28.3 g of the mass of the metal femoral ball head. The authors noted that symptoms of cobalt toxicity have also been reported in patients with failed MoM bearing couples, patients with third-body wear of metal (CoCrMo) components and, in one case of mismatch, of a metal femoral ball head with a ceramic insert.


Literature:


Hintner M et al. What an orthopaedic surgeon should know: Selection of a bearing couple in case of revision after a fractured ceramic component. Semin Arthro 2013 (in press)


Review:

Update on bearings

The 11th Winter Meeting organized by Ranawat Orthopaedics New York, in Bengaluru, January 17-19, 2013, was designed to provide up-to-date information in arthroplasty and non-arthroplasty options as well as in bearing surfaces. The course chairman Chitranjan S. Ranawat pointed out that in Asia, especially in India and China, there is tremendous growth potential in joint replacement procedures. He demanded that the aim of education must be to ensure the highest quality of care for millions of individuals suffering from arthritis.

Cera News gives an overview of the bearings session.

MoM bearings

There is more than 20 years of clinical experience with 2nd generation MoM bearings in hip arthroplasty. Over that time, the benefits and risks have been identified. It was pointed out that with hip resurfacing and conventional THR a significant number of patients have runaway wear due to malposition and adverse reactions to metal ions. The incidence rates given in this meeting range from 10 to 20% and rising. The major risk of MoM bearings is the increased exposure to metal particles and ions and associated biological reactions. The risks related to metal ion exposure can be minimized by careful patient selection, an accurate surgical technique, correct component positioning and monitoring of serum ion levels. Currently, there is still no alternative bearing for hip resurfacing.

Cross-linked polyethylenes (XPE)

The experience with XPE demonstrated significantly reduced wear compared to conventional PE. XPEs have a short clinical history compared to hard/hard bearings and conventional PE. Long-term results do not exist. Recent developments are focused on further reduction of wear rates and oxidation as well as an improvement of mechanical properties to reduce fracture risk. Roberto Binazzi (Italy) expressed some concerns regarding the small wear particles. The caveat here is that scientists and surgeons do not yet know a lot about the biologic activity of XPE wear particles. It is important to recognize that the aim of improved clinical performance and long-term implant survival will be influenced not only by wear rates but also by the biological behaviour of the wear particles. It will therefore be important to understand the biological behaviour of XPE particles in comparison to conventional PE, ceramic and metal particles. Therefore, more investigation and long-term follow-up is needed to provide results.

CoC bearings

There is nearly 40 years of clinical experiences with ceramics. The tribologic and biological properties of ceramics have been well studied. Despite the excellent clinical performance and high biocompatibility, there are still some concerns regarding ceramic fracture and noises. Based on a patient questionnaire, Ranawat reported 23% of the patients answering yes to the question “Do you have any noise in your hip?”, of which 40% reported squeaking. Only 3% were able to reproduce the noise in front of the surgeons. It is known that a number of factors may be responsible for noises in hard/hard bearings: component malposition, component as well as soft tissue impingement, lubrication deficiency, design of the hip implant system, etc. The most common causes for fractures of ceramic inserts are essentially incorrect handling, for instance, misaligned insertion of the insert, etc. Binazzi noted that surgeons should know the proper insertion and correct handling of ceramic inserts. An accurate surgical technique, correct positioning of the prosthesis and safe handling of the ceramic components play a significant role in avoiding ceramic failure and achieving excellent mid- and long-term outcomes, even if cost remains an issue as Binazzi mentioned.

“CoC remains the bearing of choice for young and active patients.”

- Chitranjan S. Ranawat, MD (USA)
Heinz Mittelmeier Research Award for Study Investigating Wear in Total Knee Arthroplasties

J. Philippe Kretzer, PhD, of Heidelberg University Hospital was awarded the Heinz Mittelmeier Research Award in October 2012 at the German Congress of Orthopaedics and Trauma Surgery (DKOU) in Berlin. He received the honor from the German Society of Orthopaedics and Orthopaedic Surgery (DGOOC) for his study “Wear in total knee arthroplasty – just a question of polyethylene?”. The prize, which is endowed with an award of 5,000 euros, was donated by CeramTec.

The goal of the study was to determine the amount of metal particles (cobalt, chromium, molybdenum and titanium) in the wear debris of total knee arthroplasties. J. Philippe Kretzer was able to show that these metal particles, in addition to the polyethylene particles, account for a total of 12% and thus constitute a significant portion of the overall wear. Because metal particles and ions may negatively impact clinical outcomes, particularly in patients with hypersensitivity, he pointed out that non-metallic materials (e.g., ceramics or sufficient coatings) may be considered as an alternative treatment for those patients.

Abstract of the study:

Wear in total knee arthroplasty – just a question of polyethylene?

Biological reactions against wear particles are a common cause for failure in total knee arthroplasty. So far, wear has been mainly attributed to polyethylene. However, the implants present large metallic surfaces, potentially also leading...
to metal wear products. Therefore it was aimed to determine the local release of cobalt, chromium, molybdenum and titanium in total knee arthroplasty. Implants were subjected to physiological loadings and motions for $5 \times 10^6$ walking cycles in a knee wear simulator. Polyethylene wear was determined gravimetrically, and the release of metallic wear products was measured using high resolution-inductively coupled plasma-mass spectrometry. A polyethylene wear rate of $7.28 \pm 0.27\text{mg}/10^6$ cycles was determined and the cumulative release of metals measured $1.63 \pm 0.28\text{mg}$ for cobalt, $0.47 \pm 0.06\text{mg}$ for chromium, $0.42 \pm 0.06\text{mg}$ for molybdenum and $1.28 \pm 0.14\text{mg}$ for titanium.

For other metallic implant devices it is well known that metal wear products are able to interact with the immune system potentially leading to immunotoxic effects. In this study approx. 12% of the whole wear products were metallic and it is believed that these particles and ions may become clinically relevant in particular for patients who are sensitive to these materials. Non-metallic materials (e.g., ceramics or sufficient coatings) may be considered as an alternative treatment for those patients.

The award-winning J. Philippe Kretzer, PhD, is congratulated by arthroplasty pioneer and the award’s eponym, Heinz Mittelmeier, MD, PhD.

Source: Starface GmbH

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**Call for papers**

The German Society for Orthopaedics and Orthopaedic Surgery (DGÖOC) will once more be awarding the Heinz Mittelmeier Research Award with a 5,000 euro endowment in 2013. The research prize, which is donated by Ceram-Tec GmbH, is awarded to clinicians, engineers or scientists up to 40 years old for outstanding contributions to research and development in the field of bioceramics and problems associated with arthroplasty wear and tear, as well as with regard to clinical results from ceramic implants.

Submissions to the DGÖOC must be postmarked by August 31, 2013, or before.

The prize will be awarded at the German Congress for Orthopaedics and Trauma Surgery (DKOU), to be held October 22–25, 2013, in Berlin.

**For further details on the application process:**

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Does increased weight result in increased risk of ceramic fracture?

A study led by Michael Morlock, PhD, at Hamburg-Harburg Technical University (Germany) has shown that higher weight alone does not increase the risk of ceramic fractures.

A detailed report by the author on the results of this study will appear in the next issue of CeraNews.

Histopathological differential diagnostic considerations for problems related to implant allergies

Veit Krenn, MD, PhD, (Trier, Germany), Reference Pathologist for the Implant Allergy Working Group at the German Society for Orthopaedics and Orthopaedic Surgery (DGÖOC), has developed the international consensus classification for arthroplasty pathology. The expanded consensus classification categorizes pathological changes, thus permitting greater safety and making it possible to draw conclusions regarding insufficiency etiology and mean survival of the joint replacement.

In the next issue of CeraNews, Krenn will be presenting the differential diagnostic approach which can indicate to the surgeon how to proceed when selecting the required tests, classifying the results and treating patients.

EFORT Tribology Day –Tribology update in hip and knee arthroplasty

Tribology Day, chaired by Karl Knahr, MD, PhD, will be held on June 6 during the 14th EFORT Congress (Istanbul, June 5-8, 2013). The focus will be on the state of affairs with regard to materials and wear-related problems in hip and knee arthroplasty.

Download the program via the QR code.

BIOLOX®DUO approved in Japan

The ceramic bipolar system BIOLOX®DUO has been approved for use in Japan since December 2012. The company distributing the system there is Robert Reid. With this approval it is possible for the first time in Japan to treat patients with a ceramic bipolar system. Bipolar systems are used for approximately half of all hip arthroplasties in Japan.

BIOLOX®DUO can be combined with any stem approved for 28mm BIOLOX®forte or BIOLOX®delta femoral ball heads.

We will be reporting on clinical experiences with BIOLOX®DUO in one of the forthcoming issues.

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**Insertion instrument for BIOLOX® inserts received CE marking**

In the “Facts and figures” section of CeraNews 2/2012, we introduced a new insertion instrument which was developed specifically to permit BIOLOX® ceramic inlays to be inserted safely into the metal shells. In mid-November 2012, the instrument, which is manufactured and distributed by OHST in Rathenow (Germany), received the CE marking. Therefore the insertion instrument can now be used in clinical practice.

We will be reporting on clinical experience with the insertion instrument for BIOLOX® inlays in one of the forthcoming issues.

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**News and Views**
Please send me more information:

- **CeraFacts**
  - USB stick media library (animations, live surgeries and videos)

- **Safety Reminder** (A4)
  - What a surgeon should bear in mind when implanting BIOLOX® inserts and BIOLOX® femoral ball heads

- **Information** (A4)
  - on the inserter instrument for BIOLOX® inserts

- **Bearing couple selection for revisions after a ceramic fracture** (A4)

☐ I am interested in scientific papers on ceramics in arthroplasty. Please contact me via phone/e-mail.

☐ I am interested in new medical applications for ceramics. Please send me the brochure “BIOLOX® Family – The Future in your Hand” and contact me via phone/e-mail.

☐ I would like to receive CeraNews regularly.

☐ I would like to receive CeraNews via e-mail (PDF).

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