

CeraNews



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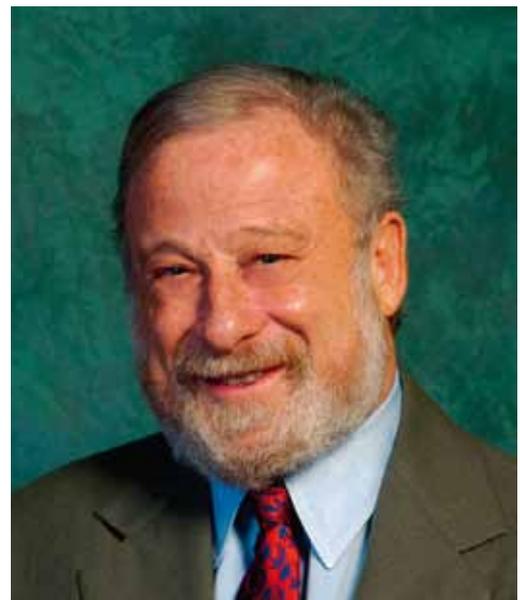
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A. Seth Greenwald, D. Phil. (Oxon)



Heinrich Wecker,
Managing Director
Marketing and Sales
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Dear Reader,

More than 250 experts from over 20 countries around the world participated in the 13th BIOLOX® Symposium in Edinburgh last September. It was a very successful event, offering the opportunity for getting first hand information from top specialists of the medical and engineering sciences. The open exchange of the latest findings in clinical studies and laboratory research made the meeting an excellent learning experience. The Edinburgh Symposium was also a place for open discussions summarizing what we already know and identifying what we don't know in many areas of hip arthroplasty.

Improving quality and patient outcome in Total Hip Replacement requires an extensive evaluation of the existing clinical data in order to fully assess the strengths and weaknesses present. Total Joint Arthroplasty has to be evidence based in order to achieve the best results possible. We have come a long way on this road. Yet, there's something missing: The soundest foundation for evidence based joint replacement is provided by national registers. It's hard to understand why they are lacking in the countries that have the highest implantation numbers, and are also some of the most advanced and richest countries in the world.

Scandinavian countries, Australia and Britain have taken the lead. They are being followed by a number of other countries, some in Eastern Europe some of which I would not have foreseen as the most likely candidates for demanding efforts of this kind. Thus, they are actually overtaking the efforts of some of the biggest and most resourceful nations possessing a far greater potential for providing the comprehensive data required for these registers. We need these resourceful nations to follow the efforts of the pioneering countries and to contribute to the overall knowledge base the vast amount of patient data that they can contribute.

*Yours sincerely,
Heinrich Wecker*

Identify the pros and cons

As the developer and organizer of the Current Concepts in Joint Replacement (CCJR) educational meetings, Dr. A. Seth Greenwald is one of the most prominent figures in international orthopaedics. He is also head of the Orthopaedic Research Laboratories (ORL) in Cleveland, Ohio. Working in translational research and education for more than 40 years he lived through the development of joint replacement from its inception. CeraNews asked him about the most important trends in arthroplasty and his plans for the future.

You work as a researcher, author, speaker, teacher and organizer. Which of these roles do you enjoy most?

I have greatly enjoyed and continue to find satisfaction in my role as an orthopaedic educator not only through publications and lecturing, but also in the evolution of the Current Concepts in Joint Replacement (CCJR) meetings. I also embrace the research work in our laboratory, which has evolved from basic science studies to what I now call translational research, focusing on the optimization of implant designs and the evaluation of orthopaedic devices and materials to ensure their safety and mechanical integrity as a prelude to FDA approvals. Last but not least, I love the camaraderie and connectivity of the people in our lab, many of whom had been among my students over the last 25 years.

Which were the major trends in hip replacement in the USA over the past three decades?

Arthroplasty patients have become and are becoming younger. In the past this surgery was indicated for patients over 60 years old. Currently, the average age is somewhere between 50 and 60. More than a million primary and revision knee and hip arthroplasties are performed per year, roughly 60% of these are knee replacements. Approximately 15% of all hip replacements ultimately will require a revision, mainly as a result of aseptic loosening, component damage, infection, and dislocation. These numbers are going to rise further, as the osteoarthritic process is becoming more prominent in younger people and because the baby boomers are becoming senior citizens who want to maintain their lifestyles which often include high activity levels. This will place very high demands on the implants and materials used, particularly their wear resistance. A biological solution for osteoarthritis looms on the horizon, but it was also in discussion when I began researching in orthopaedics 40 years ago. I'm sure we'll need joint replacement for a long time to come.

Which of the many advances in the field of orthopaedic surgery over past years do you consider to be “transforming advances”?

The most significant transforming advance in hip reconstruction was Charnley’s low friction concept. The problem of wear that his implants produced over time triggered many important advances including the development of new bearing materials. Biological fixation and the recognitions of the advantages of modularity in total joint replacement was another transforming step. The same is true for the recognition of the technical proficiency of the surgeon as a major component to ensure longevity in joint replacement. This has led to a continued development of better instrumentation, computer assisted surgery and robotics, and most recently patient-specific implants. One of the more important advances in ceramic manufacture is the attempt to reduce inclusions, reduce grain boundaries to improve strength, and improved quality assurance of manufactured ceramic components through proof testing.

Why have bearings in hip and knee arthroplasty played an increasingly important role at recent Current Concepts in Joint Replacement meetings?

We want to discern the influences that different bearing couples have on clinical outcome and to identify the pros and cons. It has become clear how important materials processing, surface roughness, component size, and tolerance influence outcome.

What do you think about noises in THR?

It seems to me, that the squeaking phenomenon has been “oversqueaked”. A number of recent papers have identified certain types of femoral stems and acetabular cups as a having an influence on its incidence. It has also to do with component positioning, especially with the inclination of the cup and the version of the femoral stem. If their placement is less than ideal, this can lead to edge loading, impingement, and dislocation. Not to forget the potential role of a third body, that can accelerate damage of the bearing surfaces and alter the lubrication mechanism. I believe that these are some of the causalities for noises that can occur in hard-on-hard bearing couples. Further, despite the rigidity of ceramics, small deformations can occur in some cup designs which has been suggested in a recent JBJS publication which may also contribute to changes in component clearances. These are features that surgeons should consider as measures to prevent noises in THR.

Are you concerned about the recent reports on complications with metal-on-metal?

There are aspects of material reactivity in the body that have not yet been fully understood. Although metal-on-metal bearing usage is currently promi-



**A. Seth Greenwald,
D. Phil. (Oxon)**

nent in the US, the spate of recent publications describing tissue reactions inclusive of pseudotumors and ALVAL’s has led to a reexamination of their use. My personal impression is that the increased population use of these devices has contributed to the growing awareness of these problems. Trying to identify the spectrum of tissue reactivities ensuing from metal-on-metal articulation is one of the subjects to be discussed at the upcoming CCJR meeting in May in Las Vegas.

You have conducted studies about wear couples and the longevity of implant materials. Which materials can improve longevity?

Surface roughness is lower in ceramics than with metal, and we realize the lowest wear rate with ceramic-on-ceramic couples. There are mixed reports about ceramic-on-polyethylene vs. metal-on-polyethylene wear rates. Crosslinked polyethylenes have performed satisfactorily when used in combination with either. A concern of crosslinked polys is their relative reduction in mechanical properties particularly fracture toughness which can influence liner integrity in modular cups particularly at locking mechanism sites or when used with large diameter heads which result in reduced liner thickness. Any area of these cups where you experience a radical change in curvature can create a stress riser. Once you get an initiated crack as a result of a stress riser in a crosslinked poly, it will propagate very quickly.

What are your plans for the Current Concepts in Joint Replacement meetings?

The Current Concepts in Joint Replacement (CCJR) meetings have matured into the largest international hip, knee, and shoulder arthroplasty continuing medical educational events for orthopaedic surgeons and allied health professionals. Almost 2000 participants from 60 countries attended the last meeting in December. It is interesting that these international events occur in the United States and there is interest in extending these activities to the EU and Asia. The countries of Asia represent an emerging giant where a huge growth of arthroplasty use is anticipated.

Why did you introduce live surgery sessions?

You can learn an awful lot by looking at a surgical video, but its occurrence is edited and always go as planned. In a live surgery they don't. Seeing how a colleague adopts to the unexpected in the OR is a great learning experience which has been very much appreciated by the audience. In this setting, the trained surgeon picks up very quickly a lot of details which provide useful ideas for their own practice and are captured on a DVD for further study. The surgeries represent emerging product technologies and techniques which contribute to the educational value of the meeting.

What are the most important arthroplasty trends in the US?

There is a growing body of information cautioning surgeons on the use of large diameter femoral heads despite their obvious advantage in assisting hip stability. There is a continuously increasing trend to minimally invasive surgery which perhaps is better described as smaller incision surgery. In THA, this has created a need for smaller components which are emerging. Modular necks in femoral stem design contribute to device utility and are finding employment in achieving optimal biomechanical restoration in THA. I also see great emphasis on efforts to improve instrumentation with the aim of helping the surgeon to place the implant in the optimal position. I expect intensive focusing on more effective patient education. And of course, there will be continuous efforts to improve the behavior of articulating couples. The continuing development of crosslinked polyethylene technologies and the latest generation of ceramics will promote in-vivo longevity.

Which role will the regulatory process play for the development of arthroplasty?

The FDA product approval process is under increased scrutiny in the US. There have been accusations that the FDA has been too quick and not careful enough in granting medical device approvals. This is not true for orthopaedic products. Any improvement in medical technology will be heavily dependent on the cost and the pathway through which the manufacturer has to go to obtain regulatory approval for a new product. If the current review process, particular to 510k product approval, changes so as to make the process more costly and difficult to realize, it will result in a decline in new products reaching the patients they are intended for in a timely manner.

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EFORT Report 2009

News from the field of clinical practice and tribology

The annual EFORT congress is a major event for specialists in the areas of orthopaedics and traumatology. The congress in Vienna, which took place from the 3rd to the 6th of June 2009, was attended by 6,400 physicians and researchers. The program included 23 satellite symposia and instructional courses directed by leading European specialists, 640 independent presentations, 1,700 electronic posters, numerous workshops and industry-sponsored events, and an industry exhibition featuring 133 participants. The ExMEx Forum (Experts Meet Experts) was one of the highlights of the EFORT congress with high-caliber speakers from science and industry and a well-focused program.

The most important topics in the area of arthroplasty included the following:

- Hip resurfacing and large diameters
- Implant safety and durability
- Alternative materials for bearing couples
- Bearing couple surfaces and wear-related complications

Bearing couple materials and large diameters

Robert Streicher (Switzerland) outlined the advantages and disadvantages of various bearing couple materials. Citing various studies, he pointed out that today's patients are significantly more active than patients in years past. Evidence for this development can be seen in measured load cycles of up to 3.5 million per year. Streicher also suggested that the trend is going toward larger bearing couple diameters because they offer enhanced joint stability and increased range of motion.

Enrique Gomez-Barrena (Spain) also discussed the trend towards larger bearing couple diameters aiming at maximizing hip-implant survival. Gomez-Barrena explained that young patients need a wear-resistance factor that is 10 times greater than that for older patients owing to increased activity levels, life expectancy and range of motion. Highly crosslinked polyethylene can only meet this demand to a limited extent because it exhibits a lower resistance to mechanical stress despite its improved tribological behavior compared to conventional polyethylene.

After comparing wear rates exhibited by modern bearing couples, **John Fisher** (UK) determined that the rate for hard-on-hard bearing couples decreases as their diameter size increases, which does not apply to hard-on-soft bearing couples even when XPE is used. Fisher also explained why implant position represents an important variable in wear behavior irrespective of the bearing couple used. Calling atten-

tion to the metal ion problem, Fisher suggested that MoM bearing couples can react especially unfavorably to suboptimal positioning.

15-year results for ceramic-on-polyethylene and metal-on-polyethylene THA

Stéphane Descamps (France) presented the 15-year results of a prospective, randomized study in which the wear rates in 37 CoP THAs and 37 MoP THAs were compared. A 28mm BIOLOX[®] forte femoral ball head was used in all cases. The wear rate for CoP (0.058mm/year linear, 35.7mm³/year volumetric) was significantly lower than that for MoP (0.102mm/year linear, 62.8mm³/year volumetric). This corresponds to a reduction in head penetration of 44% (p=0.0004). By way of concluding his talk, Descamps concluded that these results are comparable to results obtained in earlier studies of CoP and MoP at a follow-up of more than 10 years.

3–7 years clinical results with ceramic-on-ceramic THA

Mustafa Alnaib (UK) reported on functional and clinical outcome following CoC THA in 148 consecutive patients (72 females, 76 males). The average age was 54 (26–64) years. The follow-up was 3–7 years after surgery. Osteolysis was not observed. The authors concluded that the midterm results are equivalent or better compared to other implants and that they also demonstrated a lower incidence of fractures in the new generation of implants.

Long-term experience with ceramic-on-ceramic and ceramic-on-polyethylene bearing couples

Laurent Sedel (France) reported extensively on the excellent biocompatibility and the comprehensive 30-year clinical data that are now available for CoC bearings (alumina). Sedel suggested that while ceramic fracture, stripe wear and squeaking are discussed in the literature, their clinical significance remains minimal. Out of 1,500 ceramic components implanted within the last 5 years, he has observed no fractures. Sedel expressed his view that the CoC bearing couple is the best option for young patients on account of its minimal wear rates and because of the absence of limitations when it comes to sports activities.

Thomas Pandorf (Germany) presented a report based on data relating to more than 5 million ceramic components (BIOLOX[®]) implanted throughout the world in the last 30 years. The use of CoP bearing couples has enabled a two to five-fold reduction in

the revision rate compared to MoP bearing couples. According to Pandorf, clinical results confirm that CoC bearing couples continue to show the lowest rates of wear, and thereby the lowest osteolytic potential.

Using the example of a cup system, **Daniel Del-fosse** (Switzerland) described the development of the CoP bearing couple. He outlined how improved materials and advances in cup design have contributed to improvements in the survival rates for this hip system.

The biological behavior of ceramic-on-ceramic bearing couples

Nicola Baldini (Italy) presented a study of 30 explanted CoC THAs (BIOLOX® 32mm, BIOLOX®*forte* 28mm) that was carried out to determine whether foreign-body reactions to ceramic wear debris can lead to the periprosthetic bone resorption that has been observed in conventional MoP THAs. The analysis included 11 male patients and 19 female patients. The average age of the patients at the time of primary surgery was 56 and the age range was 31–74. At revision surgery, the average age was 65 and the age range was 39–86. The average service life of the explants had been 8 years and ranged from 1–17. The main reasons for revision were mechanical instability and inaccurate implant positioning. The clinical, radiological and histological findings were evaluated in all cases and the explants were subjected to an examination. Wear debris particles were largely absent. In the few cases the particles were observed, their volume was minimal. No evidence of foreign-body reaction or inflammation was observed. No cases of extensive osteolysis or cytotoxic effects were found. The investigation showed extraordinarily minimal wear rates in the CoC bearing couples and no negative biological reactions to the released ceramic particles. The few wear particles detected were inert and insoluble. The study indicates that the tribological risks have been overcome. The results offer additional confirmation of results obtained from earlier investigations conducted by various work groups.

See box "For more information", p. 7

The "real" XPE wear

Brian Derbyshire (UK) discussed his theory that the real wear in XPE inserts is determined by the penetration rate, as measured in most studies, and a number of additional parameters, including the direction of penetration, the head size and the initial clearance. Using a numeric analysis, Derbyshire determined what he referred to as the "true" wear and showed why merely specifying a penetration rate or a wear rate is not sufficient when it comes to comparing the wear behavior of XPE inserts from

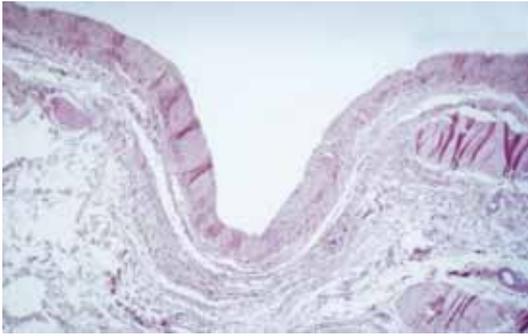
various studies. The RSA method is the only method that offers a degree of precision allowing to also determine the direction of wear and the actual wear volume.

Do metal ions represent a risk to the fetus?

The starting point for the investigations carried out by **Bhabra Gevdeep** (UK) were the study results of Ziaee et al., which demonstrate that metal ions pass through the placental barrier. Significantly elevated levels of cobalt and chromium were measured in the umbilical cord blood of pregnant women with MoM bearing couples (Ziaee et al. JBJs. 3B; 301-5; 2007). Moreover, the British MHRA (<http://www.mhra.gov.uk/>) has called for an investigation of transplacental toxicity and an evaluation of the risk to the fetus. In conducting its investigations, Gevdeep's research group used a proven in vitro model. The authors have presented the following findings: CoCr nanoparticles and ions can indeed pass through the intact placental barrier and cause DNA damage and chromosomal changes (tetraploidy). A bystander effect caused by the presence of additional substances may worsen the damage. The metal ion concentrations that cause the damage are comparable to those that were measured in vivo. The DNA and chromosome damage are caused by an intercellular signal transmission within the placental barrier.

Metal-on-metal Hip Resurfacing – Higher incidence of asymptomatic pseudotumours than expected

Gill Harinderjit (UK) reported on the incidence of asymptomatic pseudotumours in 80 patients (48 male, 32 female) with 115 MoM hip resurfacing arthroplasties. The mean age was 56 years. The mean follow-up was 61 (13–88) months. Pseudotumours were found in 6 patients (1 male, 5 female) with solid and cystic masses. The incidence of asymptomatic pseudotumours was 8%. The study also shows an incidence of 15% in females. Histological examination of solid masses showed extensive necrosis and diffuse lymphocyte infiltration. These findings suggest a lymphocyte-mediated hypersensitivity reaction. The presence of asymptomatic pseudotumours was associated with increased serum and hip aspirate cobalt and chromium levels and inferior Oxford Hip scores. The mechanism is still unclear and may be due to hypersensitivity reaction against metals or cytotoxic effects. The incidence of asymptomatic pseudotumours during 6 years after surgery was significantly higher than the reported incidence of symptomatic pseudotumours. It is still unclear if asymptomatic pseudotumours will develop into symptomatic pseudotumours over long periods of time.



Neocapsule of an autopsy specimen of a patient with ceramic-ceramic couple after 8 years in vivo showing no ceramic particles, smooth synovial surface and moderate fibrosis.

Source: Bos I, Institute of Pathology, University of Lübeck (Germany)

For more information on the biological behavior of ceramics:

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Metal-on-metal Hip Resurfacing – Is the lymphocyte response to metal ions increased in patients with pseudotumours?

David Murray (UK) and his study group investigated in an ethics approved study the incidence and level of hypersensitivity reaction to metals in patients with pseudotumours. There was no significant difference in the incidence or level of lymphocyte reactivity in patients with pseudotumours compared to non-pseudotumour patients. Murray concluded that patients with MoM hip resurfacing arthroplasty have an enhanced lymphocyte response to metal ions, reflecting exposure and immune reactivity. Patients with pseudotumours have a similar proliferative response to patients without pseudotumours, which suggest that type IV hypersensitivity may not be the cause of the pseudotumours.

Wear in metal-on-metal bearing couples

Kamali Azad (UK) investigated the wear of various MoM bearing couples in a hip simulator programmed to stop and restart every 100 steps at the usual 0.5 Hz step frequency. Serum ion levels were elevated by 71% in two bearing couples whose alloys had been subjected to a double heat treatment.

1–10 years clinical results with MoM THA

Rainer Kotz (Austria) reported on different results with 28mm MoM THA. First he compared the results of 50 patients (31 female, 19 male) with cementless MoM THA and 50 patients (39 female, 11 male) with cementless CoP THA 1 year after surgery. The mean age of the MoM group was 58.3 (16–81) years. The mean age of the CoP group was 62 (26–87) years. The MoM articulation generated a systemic cobalt release. The median serum cobalt level of MoM (1.1 µg/l) was significant increased compared to CoP (< 0.15 µg/l, below detection limit). Kotz concluded that chronic renal failure restricts the cobalt elimination in urine.

Rainer Kotz stated that the issue of a systemic release of metal ions from a high-carbon MoM bearing couple will remain unresolved so long as there is no reference value. He also pointed out that the main problems associated with MoM bearing couples had primarily been observed in the case of large diameters.

He investigated cup inclination and serum metal levels in 309 patients (172 females, 137 males) with a follow-up of 4.3 years after surgery. The mean serum cobalt level was 1.6 µg/l. The mean serum chromium level was 2.3 µg/l. No statistically significant correlation could be observed between cup inclination and elevated serum cobalt and chromium levels in 3 groups (55–63°, 44–46°, 23–37°) of 20 patients.

However, in 3 young (37, 47, 55 a) and active (HHS 100, UCLA 6,7 and 9) female patients with inclination angles from 58° to 63° a 3 to 16-fold elevated serum cobalt level and a 4.5. to 16-fold elevated serum chromium level could be found. Kotz also reported on 10-year results of 105 MoM cases in 54 female patients (mean age of 57 years) and 44 male patients (mean age of 54 years). 80 patients were available at clinical follow-up. 22 blood samples of patients with unilateral THA and in absence of any other metallic implants were investigated. The median serum cobalt level was 0.75 (0.3–50.8) µg/l. No increase of serum metal ions could be observed when compared to 5 years data.

Claude Rieker (Switzerland) reported on results with 792 retrieved MoM components after 435 revisions (412 femoral heads, 380 cups). In 98.3% of the cases 28mm femoral heads were retrieved and in 1.7% of the cases 32mm femoral ball heads. The mean follow-up was 53 months. The mean wear rate was 28.3 µm in the first year after surgery (run-in wear), 10.5 µm/year in the second year and 5.8 µm/year after the second year.

Furthermore he presented clinical and radiological data published between 2006 and 2008 pertaining to MoM bearing couples in combination with various cemented and cementless cup systems. Rieker pointed out that allergic reactions (e.g. to bone cement) were rare and were not only associated with MoM components.

Metal ion levels in a ceramic-on-metal bearing couple

In a randomized, prospective study, **Graham Isaac** (UK) compared CoM bearing couples and MoM bearing couples of the same implant type. The diameter of the heads was 28mm. The median Cr and Co levels are lower with the CoM bearing compared with the MoM at all measurements points following implantation. In the CoM group, the median 12 months Cr and Co values were 0.43µg/l and 0.72µg/l respectively. The comparable values for MoM are 0.68µg/l and 0.83µg/l. In agreement with predictions from hip simulator studies, CoM bearings in this study produced lower levels of metal ions than comparable MoM bearings at all time points (3m, 12m, >24m). Isaac concluded that the difference is less than that predicted in the laboratory and is much more pronounced with Cr than with Co.*

* For more information about CoM see CeraNews 03/2008

Surface-treated CoCr alloy

Azad Hussain (UK) described the behavior of a CoCr alloy whose surface was treated with a 5µm coating of a niobium-zirconium alloy. Hussain emphasized that the treatment does not represent a

coating in the usual sense. When used in combination with XPE, the material enables significantly lower wear rates than are seen in MoP and CoP components. Hussain pointed out that while the material is scratch resistant and harbors no risk of fracture, it cannot be used in hard-on-hard bearing couples.

Improving surgical quality

Vasireddy Aswinkumar (UK) reported on a quality-control study with equally weighted criteria of 1,143 THAs (128 revisions) that was carried out from 2005 to 2007. Significant deviations turned up when comparing the results for the participating surgeons. Aswinkumar concluded that good training programs can lead to improved surgical outcomes.

New patient questionnaire

After referring to a lack of relevant German-language questionnaires for hip patients, **Florian Naal** (Switzerland) reported on the development and validation of such a questionnaire at Schulthess Hospital in Zurich on the basis of the Oxford Survey. The Schulthess questionnaire is comprised of 5 questions that are to be answered by patients immediately prior to and immediately after surgery, as well as at 6 months post surgery.

The Schulthess hip score (SHS) questionnaire

Während der letzten vier Wochen...
(During the past four weeks...)

- 1) Hatten Sie bei Belastung oder Bewegung Schmerzen in der Hüfte?
(Did you have any pain in your hip when weight-bearing or moving?)
- 2) Mussten Sie wegen Ihrer Hüfte hinken?
(Did you have to limp because of your hip?)
- 3) Hatten Sie wegen Ihrer Hüfte Schwierigkeiten beim Einkaufen, oder bei Haushalts- und Gartenarbeiten?
(Did you have any difficulty doing the shopping, housework or gardening because of your hip?)
- 4) Hatten Sie wegen Ihrer Hüfte Einschränkungen bei Freizeitaktivitäten oder beim Sport?
(Did your hip limit you during leisure activities or sports?)
- 5) Hatten Sie wegen Ihrer Hüfte Probleme bei alltäglichen Bewegungen wie z. B. Aufstehen, Hinsetzen, Bücken, oder Anziehen?
(Did you have any difficulty with everyday movements such as standing up, sitting down, bending, or getting dressed because of your hip?)

Naal FD, Impellizzeri FM, Sieverding M, Munzinger U, Mannion AF, Leunig M. Validation of the cross-culturally adapted Oxford Scores for use in German-speaking patients with osteoarthritis of the hip or knee. Presentation (F247). EFORT, Vienna 2009

The presentation is available for download under <http://www.efort.org/cdrom2009/FreePaperContent.asp?pid=F247>

Acronym:

MHRA – Medicines and Healthcare products Regulatory Agency
<http://www.mhra.gov.uk/>

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www.efort.org/cdrom2009/

THA materials vs. size: Costs and benefits

During the last congress in Vienna, EFORT held a special symposium on the question of “THA Tribology Materials vs. Size: Cost/Benefits?” that addressed the latest generation of bearing surfaces. EFORT Scientific Reporter Firas Al Dabouby summarized the talks and discussions. CeraNews features his report with his permission.

Bearing surfaces

In the symposium “THR Tribology Materials vs. Size: Cost/Benefits?”, which addressed the latest generation of bearing surfaces, Robert Streicher, MD, discussed the new aspects of the different bearing surfaces now available. He said the ceramic-on-ceramic combination has the advantages of being scratch resistant and having a wear rate, that leads to less osteolysis and a lower incidence of revision. Disadvantages of the coupling, he noted, include being brittle and the subjective patient complaints of clicking and squeaking. Metal-on-metal (MoM) has the problem of producing increased serum ion levels. Ceramic-on-metal (CoM) has the advantage of having a lower wear rate than MoM, he said. Another new bearing surface he mentioned – ceramic-on-composite – utilizes materials that should be compliant and resistant, but this needs further evaluation.

Polyethylene concerns

Concerning conventional polyethylene (PE) and the problem of wear particles and osteolysis, he mentioned the role of vitamin E as an antioxidant factor that will affect the oxidation of PE during manufacturing and storage. Another presenter, Enrique Gomez-Barrena, said there are generations of PE that differ in techniques of production and storage. The aim, he said, is to assure the mechanical stability and improve the wear resistance properties. Gomez also mentioned the role of vitamin E as an antioxidant and the future possible introduction of free-radical scavengers in the manufacturing process of PE.

Hard-on-hard bearings

John Fisher spoke about the evolution of hard-on-hard bearings. His main point was to stress the importance of insuring optimal function and maximum survivorship of the implant. Studies show that ceramic-on-ceramic bearings have a low wear rate. The new ceramic-on-ceramic delta has increased toughness compared to traditional ceramic-on-ceramic. Fisher said that MoM has the problem of corrosive wear and increased serum ion levels, a problem that can be solved by using CoM bearings that are more stable than ceramic-on-ceramic bearings because large femoral ball heads can be used. However, the problem with hard-on-hard bearings is that we have to optimize the cup position, the abduction angle and femoral ball head position – offset – otherwise the wear rate will be higher, he said.

New solutions?

Leali Paolo Tranquilli started his session by discussing the factors that affect tribology in total hip replacement. The first factor, he said, is the size of the artificial femoral ball head and its relation to the stability; more stability and a better range of motion can be achieved by using larger femoral ball heads. However, this has the disadvantage of producing more wear that will lead to osteolysis. So the concepts of wear and osteolysis as well as stability and range of motion will control all our efforts to produce bearing surfaces that achieve our goals, he said. He also discussed the existing forms of bearing surfaces available for use and the important aspects that we have to consider in order to choose the appropriate implant. The overall conclusion of the symposium was that there is a continuous development of materials and biomechanical aspects of THA. The aim is to obtain durable and resistant implants that will decrease the rate of revisions due to implant-related factors. We are currently on the way to this aim; however, we need to reach further points.

by Firas Al Dabouby, MD, EFORT Scientific Reporter

Focus on the hip

Clinical results and practice on the 13th BILOX[®] Symposium, Edinburgh, September 4th–5th 2009



Congress president
Justin P. Cobb, MD
Imperial College
London (UK)

Patient and disease specific hip arthroplasty

In his opening keynote, congress president **Justin P. Cobb** (UK) drew a comparison to the automobile industry where an average of 3 to 4 failures per million possible failures represents a normal result. While Cobb suggested that this figure leaps to around 40,000 failures per million in the field of orthopedic surgery, he went on to point out that both mistakes and their opposite, precision, are less plainly detectable in surgery than in automobile manufacturing. Surgical precision is defined, among other things, by indication-specific, patient-specific and implant-specific factors. Using the example of accurate cup positioning, Cobb pointed out that the truly safe zone comprises only a fraction of the Lewinnek safe zone. Although a standard deviation of 2.5° might qualify as “very precise,” a study involving simulated surgical procedures performed by medical interns and experienced specialists has shown rather sobering results. Particularly when operating under difficult conditions, such as combined hip dysplasia and osteoarthritis, safe zone positioning was more of an exception than the rule, with the experienced surgeons showing only slightly better results than the interns. The real challenge, Cobb suggests, is to increase positioning accuracy and thereby achieve the truly safe zone.

Bearing systems – What have we learned?

In the second keynote **Robert Streicher** (Switzerland) expressed the view that increased activity levels among both young and old patients have introduced new problems. He went on to suggest that dislocation rates have increased, the issue of joint stability has taken on greater significance and the problem of noise development has not been solved. He cited a study in which noise development was seen in 3% of 143 hip resurfacing procedures involving MoM components. The analysis of 2,240 CoC THAs (BILOX[®] forte) performed since 1998 revealed no cases of osteolysis and no ceramic fractures. Noise development was seen in 0.5% of the cases. The lower rates of friction and improved lubrication associated with the new generation of nano-ceramic (BILOX[®] delta) can be expected to bring improvements in these areas. Streicher pointed out that BILOX[®] delta has shown even lower rates of wear in hip simulation tests than the already minimal rates of wear shown by BILOX[®] forte. Streicher also suggested that XPE, especially in combination with ceramic femoral ball heads, will likely remain below the osteolysis threshold. In contrast, scratched metal femoral ball heads in combination with XPE will lead to high rates of wear. The size of

the particles and their long-term biological behavior represent unsolved problems for this combination of components. According to Streicher, there is a clear trend towards large femoral ball head diameters.

Premise for a successful surgery

Daniel J. Berry (USA) suggested that patient populations are becoming increasingly diverse and that the components selected by surgeons should reflect this diversity, a situation that will ultimately present opportunities for a broad range of bearing-couple variants. The decision is made on the basis of the surgeon’s conviction in light of patient-specific factors, implant availability (in the USA) and technical factors, including size, offset and stability. In Berry’s view, surgeons are continually influenced by the latest clinical results. For instance, reports on inflammatory reactions have led to considerable uncertainty with respect to MoM bearing couples. According to Berry, there is no such thing as the best bearing couple. He suggests that it is more important to understand the advantages and disadvantages of each bearing, to take account of patient-specific factors and to arrive at a decision together with the patient.

Larger femoral ball head diameter affects the dislocation rate

In a large, randomized, controlled multicenter study, **Donald Howie** (Australia) compared the rates of dislocation for 28mm and 36mm bearing couples during the first postoperative year. The study results, drawn from 532 patients (274 patients with 28mm bearing couples and 258 patients with 36mm bearing couple), showed a significant difference in the dislocation rates (4.4% for the 28mm bearing couples and only 0.8% for the 36mm couples). Howie concluded that the reduction in the dislocation rate justifies taking a custom approach to size selection.

Clinical results with large diameters: CoC vs MoM – a 3-year follow-up

Raghu Raman (UK) presented the results of a 3-year, matched-pair analysis of 104 patients (64 men and 40 women) with CoC bearing couples (36mm) and 104 patients (64 men and 40 women) with MoM bearing couples with large femoral ball head diameters (at least 42mm). The average age in the CoC group was 53.1 years (29–68 years) and the average age in the MoM group was 54.9 years (32–71 years). No differences between the groups were observed in scores and activity level. One revision in the MoM group became necessary on account

of ALVAL. The survival rate for the CoC group was 100% and 98% for the MoM group. Raman described the CoC bearing couple with large femoral ball head diameter as “very good, if not the best solution” for young patients, complex primary implantation and revision. He also prefers to use them for old patients who show a strong wish a reduced risk of dislocation.

17-year follow-up of CoC THA (32mm)

Using his medical center’s register, **Aldo Toni** (Italy) has compiled data on 7,005 CoC bearing couples (BIOLOX®, BIOLOX®forte, BIOLOX®delta). During the period from 2006 to 2008, 686 CoC bearing couples (BIOLOX®delta) were implanted. His 17-year follow-up investigation of 147 patients treated consecutively with a 32mm CoC bearing couple (BIOLOX®forte) between 1990 and 1991 revealed no cases of osteolysis, not even among those patients whose replacements showed increased wear as a result of suboptimal positioning (fig. 1a–3).



Male patient, 52 years, after implantation of a CoC THA (left) and 15 years later (right), no signs of osteolysis

Source: Aldo Toni, Istituti Ortopedici Rizzoli, Bologna (Italy)



CoC THA 21 years after implantation (1984–2005), no osteolytic changes

CoC THA 15 years after implantation (1987–2002), no osteolysis

Source: Aldo Toni, Istituti Ortopedici Rizzoli, Bologna (Italy)

Toni suggested that these results support the claim that the use of CoC couples will help to minimize the risk of osteolysis. He also pointed out that there were no cases of noise development or fracture. He also called attention to the problem of false osteolysis positives, pointing out that it is necessary to first

examine the preoperative X-rays to avoid mistaking older bone defects for cases of postoperative osteolysis. None of the more than 7,000 implanted CoC bearings showed signs of wear-related osteolysis (fig. 4a–c).



The problem of “false osteolysis”

Source: Aldo Toni, Istituti Ortopedici Rizzoli, Bologna (Italy)

Toni concluded that claims of osteolysis in connection with ceramic components are likely to be matters of fairy tale.



Ceramic debris in the capsule, no reactive tissue

Source: Aldo Toni, Istituti Ortopedici Rizzoli, Bologna (Italy)

10-year survival rate of CoC compared to MoP

J. Wesley Mesko (USA) reported on a comparison of CoC and MoP bearing couples in patients whose activity levels are well above average, including many whose work involved physical labor and many who continued to participate regularly in contraindicated sports such as alpine skiing and tennis. 9 surgeons performed 930 CoC THAs (BIOLOX®forte) in 848 patients. The revision rate after an average follow-up period of 5.9 years was 2% (19 revisions). No cases of osteolysis were observed and radiolucent lines was observed only in very few cases on the femoral side. Noise development was also rare and not reproducible. In contrast, the revision rate in the control group of 120 patients with 123 MoP bearing couples at an average follow-up of 7.8 years was 8.1% (10 revisions). The revision rate for MoP couples was therefore 4 times higher than for CoC couples. The 10-year survival rate was 97.2% for the CoC THAs and only 92.1% (p=0.0007) for the MoP THAs. Wesley concluded that the long-term safety of CoC alumina bearings is demonstrated by the low incidence of revision in comparison to MoP.

Outcome of CoC THA (28mm, 32mm) in patients under 50

The superior capsulotomy technique presented by [Stephen B. Murphy](#) (USA) was developed primarily to enable tissue-preserving THA. The first step in the procedure is to prepare the femoral canal. Then the femoral ball head is resected without dislocating the hip. Murphy suggested that in addition to making it easier to perform the anatomical reconstruction, the technique is also very easy to carry out and is “safer than conventional surgery.” Using an instrument landing pad and guide wires, Murphy and colleagues have also developed a method that allows one to achieve results that are comparable to those of CT-assisted navigation, while adding only three additional minutes to surgery. Here, Murphy evaluated the results in 196 patients and 231 CoC bearing couples at 2–11 years. The average age of the patients at the time of surgery was 41 (18–50) years. The femoral ball head diameters were 32mm (69%) and 28mm (31%). X-rays revealed no osteolysis or loosening.



CoC THA 10 years after implantation, no osteolysis
 Source: Stephen B. Murphy, New England Baptist Hospital, Boston (USA)

Murphy concluded that the bearing couple is extraordinarily reliable in young patients and that the results are to be assessed as successful. Moreover, the tissue-preserving surgical technique in combination with accurate implant positioning – with or without CT navigation – contributed to the complete absence of dislocation.

10-year follow-up of CoC THA with various diameters

[Francesco Benazzo](#) (Italy) reported on the results of a 10-year study of 511 CoC bearing couples (46 bilateral) in 465 patients with an average age of 68.4 (18 years to 80). A high percentage of the patients showed hip dysplasia. A modular stem, a sandwich cup and various femoral ball head diameters (28, 32, 36, 40mm) were used. A total of 1 subluxation and 5 dislocations were observed. According to Benazzo, the use of a narrower neck had since solved the impingement problems (sandwich cups) observed in South Korea. Benazzo referred to the modular stem as a

solution that is often necessary, especially in cases of dysplasia, and that requires precise preoperative planning. When using larger offsets, the cup angle should be steeper and show a smaller degree of anteversion. In light of the very low complication rates and not a single case of aseptic loosening, Benazzo described the CoC bearing couple as the first choice for primary THA.

CoC bearing couples for dysplastic hips – follow-up of 5 to 10 years

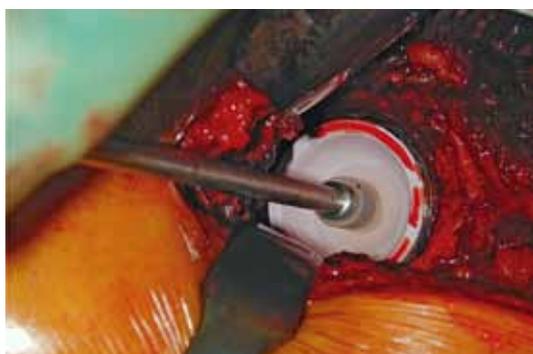
[Atsushi Kusaba](#) (Japan) described hip dysplasia as one of the most common indications for hip arthroplasty in Japan and also pointed out that bone and soft-tissue regeneration do not proceed as well among Asians as among Caucasians. A total of 1,498 cementless CoC bearing couples (BILOX[®]forte) have been implanted at Kusaba’s clinic since 1998. A total of 161 patients (159 women, 2 men) with hip dysplasia and 177 hip replacements were evaluated. The average patient age was 60 (41 years 82). The follow-up period was 5 to 10 years. All of the replacement hips were stable during the observation period. No dislocations and no osteolysis were observed. Although one patient reported noise development, it was not reproducible. Insert fracture was observed in 2 cases in which the metal cup had been damaged owing to the use of unsuitable surgical instruments. Kusaba pointed out that such failures can be avoided by ensuring proper handling and component implantation. With reference to all THAs examined at 10 to 11 years, the revision rate for the CoC bearing couples was significantly lower (3 insert fractures per 1,498 THAs or 0.2%) than that for the MoM bearing couples (8 cases of metallosis per 508 THAs or 1.6%).

9-year follow-up of CoC THA (28mm)

[Nobuhiko Sugano](#) (Japan) reported on the continuation of a comparative study of CT-based hip navigation. The average follow-up is 9 years (8–11 years). Between 1998 and 2001, a total 180 cementless CoC THAs (BILOX[®]forte, 28mm) were performed in 143 consecutive patients. The indication of hip dysplasia in 83% of the cases was typical for Japan. The follow-up examinations included 52 patients (59 hips) whose procedures involved navigation and 91 patients (111 hips) who received conventional treatment. No dislocations and aseptic loosening were observed in the navigated group and there were also no revisions. No cups were positioned outside the Lewinnek safe zone. In the group receiving conventional treatment, 8 cups were positioned outside the safe zone. One cup had to be revised 3 years after primary surgery on account of impingement and later aseptic loosening. The dislocation rate did not correlate with a cup position outside the Lewinnek safe zone. Sugano suggests that the real safety zone is significantly smaller.

Cup positioning in CoC THA

From 2004 to 2009, **Mark Emerton** (UK) implanted 327 CoC bearing couples (BIOLOX[®]*delta*) in 313 patients, including 312 THAs with femoral ball head diameters of 36mm. The average patient age at the time of surgery was 53 years (37–72 years). No cases of dislocation were observed, although the patient population included very active patients and a number of athletes who practice extreme sports. Emerton emphasized the importance of accurate cup positioning, pointing out specifically that the cup should not be placed at an angle that is as steep as that of the natural acetabulum, as doing so is likely to lead to excessive stress.



CoC THA (BIOLOX[®]*delta*), liner placement

Source: Mark Emerton, Chapel Allerton Hospital, Leeds (UK)

For Emerton, the transversal ligament is the most important anatomical landmark as he aims to secure an angle of less than 45° and a position parallel to the transverse ligament. According to Emerton, the anterior rim of the cup should be positioned in the anterior wall and the surgeon should secure the greatest possible bone-implant contact. Emerton suggested that the practice of sub-milling 2mm, as he was once taught to do, poses an unacceptable positioning risk. This is why he mills on a one-to-one basis normally using blunt cutters that can no longer achieve the reference value. Emerton also pointed out the necessity of properly aligning the ceramic insert.

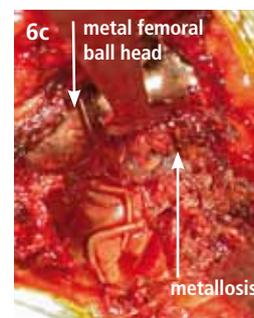
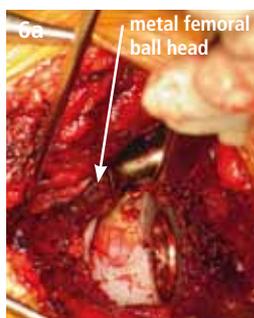
How to avoid excessive cup angles

Philipp Lubinus (Germany) offered a demonstration of how to avoid excessive cup angles. Here, it is crucial to determine the median angle of the acetabulum in relation to the horizontal reference line, which effectively indicates the real angle of the bony structures. Whenever possible, unfavorable anatomical circumstances are to be improved. Lubinus pointed out that the load bearing area of force transmission in the joint comprises only a relatively small part of the overall bearing surface and that this area is even smaller in artificial joints because of their reduced dimensions. The size of this area will decrease further as the inclination increases. Specifically, the area of load bearing in

a 28mm bearing couple at 40° is 9cm² and only 6.3cm² at 60°. In unfavorable situations, hip forces of up to 200 kg pro cm² can be reached. At 120 kg, polyethylene undergoes permanent deformation on account of cold flow. The combination of a steep angle and dislocation will destroy the cup insert. Lubinus recommends a practice of checking body weight, cantilevers and cup angle precisely prior to surgery as well as determining whether the given anatomical situation can be improved. He also recommended using the largest possible femoral ball head so as to achieve optimal force distribution.

Revision strategy and 2-year follow-up with ceramic revision femoral ball heads (BIOLOX[®]OPTION system)

Jean-Yves Lazennec (France) reported on initial clinical and radiological results from a study of the BIOLOX[®]OPTION system, as well as on his revision strategy for cups when the stem is well fixed and is to remain in place. In such cases, Lazennec usually uses the BIOLOX[®]OPTION system, which involves placing a ceramic femoral ball head made of BIOLOX[®]*delta* with a titanium sleeve on the used, but largely intact stem taper. Before executing the procedure, it is necessary to precisely determine the taper type on the basis of the documentation. When revising MoM bearing couples, Lazennec leaves the old femoral ball head on the stem until the acetabular reconstruction is complete (fig. 6a–c).



When revising a MoM bearing couple, the metal femoral ball head stays on the stem until the cup implantation is completed. This procedure protects the stem taper against intraoperative damage. Source: Jean-Yves Lazennec, CHU Pitié-Salpêtrière, Paris (France)

Doing so protects the stem taper against intraoperative damage. The study involved an evaluation of 42 revisions, including 16 MoM bearing couples and 26 bearing couples with polyethylene inserts. A 32mm femoral ball head had been used in 26 cases and a 36mm femoral ball head in 16 cases. No osteolysis, fractures or noise development were observed in the follow-up period of 2 to 3 years. Four dislocations were attributed to an excessively low offset in the remaining stems. Lazennec concluded that one should pay special attention to such factors, especially in light of the fact that the titanium sleeves in the BIOLOX[®]OPTION system permit to correct the offset.



Revision of a MoM bearing couple with a BILOX[®]OPTION system (revision femoral ball head made of BILOX[®]delta with a titanium sleeve) and a ceramic liner (BILOX[®]delta).
 Source: Jean-Yves Lazennec, CHU Pitié-Salpêtrière, Paris (France)

Long-term results of cemented all-poly sockets with ceramic and metal femoral ball heads

Peter Kay (UK) presented data on 1,434 cemented MoP THAs carried out in young patients with an average age of 41 years (of 12–50 years) between 1962 and 1990. Some of the THAs were performed by John Charnley himself. The revision rate at 20 years was 17%, with 70% of the revisions being carried out between 8 and 20 years after primary surgery. The main reason for revision was wear-related cup loosening (11.7%), followed by stem loosening (4.9%) and stem fractures (1.5%). In response to the problem of wear, surgeons at Kay’s clinic have been using ceramic femoral ball heads (alumina) with chemically linked polyethylene since 1986. Minimal wear was observed in 17 patients at a follow-up of up to 18 years. Kay concludes that the combination of ceramic femoral ball heads and cemented all-polyethylene cups represents a proven solution for both primary surgery and revision. He anticipates improved results from the use of new highly cross-linked polyethylene materials.

Wear performance of CoXPE (28mm) – 6-year clinical results

Christian Hendrich (Germany) presented data indicating that the wear rate in 28mm CoP bearing couples (BILOX[®]forte) is 64% lower than in 28mm MoP bearing couples. With reference to a 6-year prospective study involving 43 patients (age of 54 ± 9 years), Hendrich went on to suggest that the use of the 28mm CoXPE bearing couples will reduce wear by a further 58%, although the long-term performance of XPE is still unknown.

In-vitro and in-vivo safety of BILOX[®]delta femoral ball heads (22.2mm)

Moussa Hamadouche (France) suggested that while the opportunities to use ceramic femoral ball heads with small diameters have been limited so far, the market introduction of the alumina matrix composite BILOX[®]delta has changed the

situation. His research group has now investigated BILOX[®]delta femoral ball heads with a diameter of 22.2mm in vitro and in vivo. Even after artificial aging, the burst strength remained clearly above the 46 kN specified in the ISO standard. The contact point test with simulated micro-separation also showed that the material properties were far superior to the specified values. In a prospective, randomized study, 55 patients (21 men and 34 women) with an average age of 60.2 ± 9.7 (34–75) years were treated consecutively with a 22.2mm BILOX[®]delta femoral ball head and a cemented full-polyethylene cup (partially highly cross-linked). No bone resorption, osteolysis, loosening or fractures were observed during the follow-up period of 1–2 years. In a comparable study of femoral ball heads made of zirconia ceramic* and full-polyethylene cups of the same type that were used to treat the 55 patients, 34.5% of the cases showed osteolysis and bone resorption at 32 months.

* not manufactured by CeramTec AG

Behavior of ceramics (BILOX[®]delta) in vitro and in vivo

Ian Clarke (USA) investigated the behavior of BILOX[®]delta in vitro and in vivo. Various simulator tests have confirmed the superior hardness, fracture resistance and wear resistance of this ceramic material. Components aged several decades in a simulator also show only very minimal changes in their material properties and they exhibit no significant difference in their rates of wear when compared to brand new components. An investigation of 1–7 year old retrievals confirmed Clarke’s laboratory results: BILOX[®]delta is significantly more wear resistant than BILOX[®]forte. This also applies especially in the case of stripe wear. Here, Clarke assumes a 6-fold higher resistance against potential effects. He pointed out that stripe wear – also in metal components (CoCr) – is very often observed in connection with a titanium transfer on the femoral ball head. This also corresponds in such cases to frequent impingement at the metal cup.



Daniel J. Berry, MD and Alister J. Hart, MA, FRCS (Orth) during discussion



Among the auditorium: Immediate Past President of the EFORT Karl-Göran Thorngren, MD (left) with speaker Karl Knahr, MD, Orthopaedic Hospital Speising

Tribological testing of CoC (BIOLOX®delta)

Anthony Unsworth (UK) presented further results that confirm the excellent material properties of CoC bearing couples made of BIOLOX®delta. The wear rates are negligible and friction measurements indicate that the bearing couples operate in a state that approaches full-fluid film lubrication. However, proteins from bovine serum were shown to adhere to the bearing surfaces, and this increased the friction beyond the level associated with full-fluid film lubrication. No difference in terms of lubrication, friction or wear was observed for the tested clearances of 100 and 150 µm.

The influence of positioning and function on the wear of CoC THA (BIOLOX®delta, 28mm)

Mazen Al-Hajjar (UK) reported on laboratory investigations in which CoC bearing couples (BIOLOX®delta) were subjected to various conditions. A simulator was used to reproduce standard and steep cup angles as well as a standard gait and one involving microseparation. Neither the different cup angles nor the microseparation had an impact on wear. While stripe wear was observed in the case of microseparation combined with dynamic femoral ball head lateralization – an arrangement designed to replicate femoral ball head-cup rim contact at heel strike – the wear rate was still less than 10% of the rate seen in bearing couples made of alumina ceramic (BIOLOX®forte) exposed to the same unfavorable conditions.

Superior long-term stability of BIOLOX®delta

Giuseppe Pezzotti (Japan) has conducted investigations with an autoclave to simulate the aging process of BIOLOX®delta femoral ball heads. One hour in the autoclave corresponds to 3.9 years in vivo. Even under extreme conditions (10 hours or more in the autoclave) the smoothness of the component surfaces had hardly changed. The reasons for this enormous stability include the so-called oxygen vacancies in the material structure.

Patient characteristics in metal implant allergy

Peter Thomas (Germany), who jointly directs the implant-allergy research team working group of the German Society for Orthopedics and Orthopedic Surgery (DGOOC) with Marc Thomsen, provided a detailed description of the cellular processes at work in allergic reactions. He pointed out that one should look at the entire pattern, and not exclusively at gamma-interferon, when it comes to inflammatory cytokines. Thomas suggested that the corrosion of osteosynthetic material alone can trigger eczema formation. With regard to a proper clinical response to implant allergies, he referred the opinion issued jointly in 2008 by the working group, the German Contact Allergy Group (DKG) and the German Society for Allergology and Clinical Immunology (DGAKI).^{*} In the case of planned hip arthroplasty, surgeons are advised to select the broadly available CoP bearing couple. In knee arthroplasty, surgeons should be advised to consider the so-called alternative materials.

^{*} Thomas P., Schuh A., Ring J., Thomsen M. Orthopädisch-chirurgische Implantate und Allergien (Orthopedic Surgical Implants and Allergies) Orthopädie 1;2008:1–14

Wear-related complications in MoM HR and their diagnostics

Alister J. Hart (UK) presented various cases of hip pain after MoM hip resurfacing. It turned out that only 20% of the cups examined were inside the Lewinnek safe zone. Hart pointed out that an X-ray will not suffice for diagnostic purposes because the large femoral ball head covers the rim of the cup. This is why deviations averaging 20° and ranging up to 50° show up when comparing X-ray and CT images. In addition to affecting bone substance, wear-related complications can lead to large and irreversible soft-tissue injuries. In light of this, Hart recommends the use of 3D-CT scans for patients who experience pain following the implantation of a MoM bearing couple. Soft tissue lesions requiring treatment can be detected using MARS MRI. Hart pleaded not to let these injuries become irreversible.

BIOLOX® Award

It is a tradition to present the BIOLOX® Award at the BIOLOX® Symposium. In 2009 two studies were distinguished. Alexander Dickinson (fig. 1, left, with Karl Billau, CeramTec) was awarded for the “Development of a Ceramic Acetabular Cup Design for Improved in-vivo Stability and Integrity” that he conducted in cooperation with Martin Browne, Jonathan Jeffers and Andy Taylor. Jeremy Oakley (fig. 2, left, with congress president Justin P. Cobb) received the award for his work “The Early Clinical Results of Alumina Matrix Composite Ceramics in Primary Cementless Total Hip Arthroplasty”.



Failure rate for MoM HR compared to other implant types

According to **Johann Henckel** (UK), the clinical failure rate for MoM bearing couples is 5 times higher than for MoP bearing couples (43% vs. 9%) in Great Britain (National Arthroplasty Register). The revision rate for MoM hip resurfacing is twice as high as the revision rate for other implant types. While it is often not possible to determine the reasons for failure, clear correlations are seen between hip pain with MoM implants and high levels of cobalt and chrome in the blood, excessive angles, asymptomatic osteolysis and soft-tissue damage that is detectable via MRI. After the run-in phase, i.e. around one year after surgery, the level of metal ions in the blood offers a good indication of the possibility of implant failure. Henckel is convinced that this represents a cost-effective method of examination and can improve response times in problematic cases.

Is there an influence of the bearing couple material on the incidence of radiolucent lines?

Gerald Pflüger (Austria) conducted a study to determine whether the use of CoC, CoXPE and CoPE bearing couples has an impact on the development of radiolucent lines in cementless fixed hip stems. A total of 839 minimally-invasive THAs with a non-cement stem were examined. The average age of the patients with CoC implants was 62, that of the patients with CoXPE was 66 and that of the patients with CoPE was 79. The femoral ball head diameters were 28, 32 and 36mm. Using the results for 401 THAs at 1 to 3.5 years, Pflüger was able to show that the bearing couple, femoral ball head diameter, neck length, offset and cup position (angle of anteversion) had no impact on radiolucent lines, which was observed in 73 patients (18.2%), with the rates for younger patients tending to be higher. Radiolucent lines did not have an impact on the HHS. Pflüger pointed out that while we do not know the real cause of radiolucent lines, he has observed no cases of it ever since he started using hydroxyapatite-coated stems.

Retro-acetabular bone remodelling after THA

Rocco Pitto (New Zealand) reported on his study of retroacetabular bone density using three-dimensional QCT scans. This method permits to investigate cortical and spongy bone separately. Increased stress to the acetabular rim results after the implantation of a pressfit cup. The density of the spongiosa behind the cup decreases while the corticalis remains largely unchanged. Pitto interprets the change as an indirect sign of bony ingrowth and at the same time a harbinger of osteolytic developments in light of the fact that the weakened bone is more susceptible to wear-related reactions triggered by polyethylene particles. While he suspected that a progressive reduction in bone density is also an early indicator of cup migration and loosening, he conceded that this has not as yet been confirmed by long-term studies.

How important it is to use clean taper fixations

Thomas Pandorf (Germany) called attention to the fact that the relevant arthroplasty register in England cites ceramic femoral ball head fracture as the least likely cause of hip replacement failure. The main cause of this rare occurrence was identified as the contamination of or damage to the stem taper, which has also been confirmed by a laboratory study. Wet tapers show a drop in the friction coefficient at the taper attachment to 90% and scratched tapers show a drop to 20%. It is essential to make sure that the ceramic insert remains flush with the cup rim when it is put in place as tilting will significantly lower the component's burst strength. However, this is also a very rare complication.

Noises in THA

Norbert Hoffmann (Germany) described a test developed in Hamburg to measure the susceptibility of hip implant systems to the phenomenon of squeaking. Squeaking in hip replacements is thought to result from a certain dynamic behavior exhibited by the assembled components that ultimately derives



Some of the speakers joined for this photo.

from the interaction of various frequencies and combinations of system parameters. One such parameter that may be responsible for the occurrence of reproducible squeaking is the friction between the ceramic surfaces. Two CoC bearing couples with different material compositions, geometry and diameters were investigated using the finite-element method. While parameter ranges, which could be described as conducive to noise development, were found for both systems, rather high friction coefficient values have to be reached to generate a sufficiently high degree of system vibration. The fact that the coefficient level varies in the two systems suggests that the susceptibility of particular systems to squeaking may also vary.

Claire Brockett (UK) presented the results of an in vitro study on the subject of squeaking in MoM hip replacements. In addition to normal conditions, the study included an investigation of situations in which foreign particles were placed between the components of the hip replacements. Such particles – including ceramic particles and Porocoat metal beads – roughened the bearing surfaces and increased the likelihood of noise development. Brockett concluded that third body damage may play a role in noise development.

Karl Knahr (Austria) drew a distinction between different types of noise phenomena and played recordings of some of them. In addition to squeaking and clicking, he identifies cringing and crating. In a prospective, randomized study, he showed that these phenomena occur in all bearing couples (including hard-on-soft) and far more frequently than thought. Nonetheless, he suggested that the phenomenon of squeaking is less dire than portrayed. The noise involved is usually lower than background noise and therefore not clinically relevant. That being said, all conspicuous noise development should be taken seriously because it might be an indicator of improper implant positioning and an early indicator of loosening.

Olivier Guyen (France) described the impact of joint lubrication on noise development. Guyen's

At the Symposium in Edinburgh, **Saiji Kondo** and **Atsushi Kusaba** (Japan) took the occasion of paying tribute to the lifework of **Yoshikatsu Kuroki**, a pioneering surgeon in the field of arthroplasty who also played a key role in the introduction of ceramic bearing couples to Japan. Having performed nearly 7,700 hip arthroplasties, Kuroki has implanted more than 4,600 ceramic femoral ball heads and 1,800 ceramic-on-ceramic bearing couples.

Yoshikatsu Kuroki, MD
General Hospital Ebina, Institute for Joint Replacement and Rheumatology, Kanagawa (Japan)



research group investigated the behavior of CoC bearing couples in a simulator when exposed to various conditions, including normal movement, micro-separation, extreme stress and metal transfer on the femoral ball head. While squeaking always developed in the absence of lubrication, it disappeared when lubrication was applied. Squeaking developed despite lubrication only when a streak of titanium was applied to the femoral ball head. Here, the metal particles tear the lubricating film. This observation corroborates reports suggesting that the occurrence of squeaking in certain implant designs (e.g. with protruding metal rims or short necks) is especially high.

Christian Hendrich (Germany) pointed out in this context that noise development can be counteracted by encouraging the patient to adopt a more alkaline diet. The podium discussion, which focused on implant diameters and implant positioning, revealed considerable consensus on the decisive advantages of large diameters. **Rocco Pitto** (New Zealand) pointed out that data drawn from registers in Australia and New Zealand indicated that dislocation was the most common reason for revision. Moreover, these cases revealed a high rate of re-revision. These statistics prompted his hospital to switch from constrained implants to large diameters. **Daniel Berry** (USA) described patients with a defective abductor as the most difficult group to treat.



Lively discussion with Atsushi Kusaba, MD, Raghu Raman, MD, Gerald Pflüger, MD, Francesco Benazzo, MD and J. Wesley Mesko, MD

Further applications and outlook

Preliminary results with a ceramic bipolar system

Antonio Olmeda (Italy) emphasized that there is no proof that THA represents the best treatment for patients with femoral neck fractures. He suggested that the bipolar hemiprosthesis offers a number of clear advantages, including shorter surgery times, reduced trauma, bone conservation and additional retreat options. Olmeda presented early clinical and radiological results from a study of 219 ceramic bipolar implants (BIOLOX®DUO) for femoral neck fractures. After a follow-up period of at least 6 months, the clinical results and the survival rates did not differ from those of other procedures. Scarcely any surgical complications and no implant-related problems were observed. Olmeda concludes that the ceramic bipolar system (BIOLOX®DUO) can postpone THA by more than 10 years and reduce the overall costs of treating femoral neck fractures.

Initial fixation of a cup system with a pre-mounted ceramic insert

Jim Holland (UK) reported on laboratory tests on a cup that is outfitted with a pre-mounted ceramic insert*. The design permits the surgeon to work with comparatively low wall thicknesses and to thereby achieve large interior diameters despite relatively low exterior dimensions. The friction-related torsion transmitted from the bearing couple to the metal cup was investigated in the laboratory. The torsion in test models featuring different femoral ball head sizes and exposed to different loads was roughly one-third of that of the MoM control bearing.

* DeltaMotion® System, Finsbury Orthopaedics

A duocenter study on outcome of a knee system with a ceramic femoral component

Rainer Bader (Germany) presented interim clinical and radiological results of a prospective study conducted at two university hospitals in 40 knee THA patients (24 women, 16 men) treated with a ceramic femoral component.* The average patient age is 67.6 ± 5.7 (52–75) years. No implant-related complications were observed at a follow-up of 12–24 months. Scores (HSS, WOMAC and SF-36) showed considerable improvement. No cases of migration, osteolysis or implant loosening were observed. **Luca Giorgini** (Italy) expanded upon this discussion by announcing the upcoming third body wear tests with ceramic components to be carried out in an external laboratory. He indicated that ceramic components are expected to bring better wear results than CoCr components.

* Multigen Plus total knee system, Lima Lto, San Daniele, Italy

Acronyms used in this issue:

ALVAL = Aseptic Lymphocytic Vasculitis Associated Lesion

CoC = ceramic-on-ceramic

CoM = ceramic-on-metal

CoP = ceramic-on-polyethylene

HR = hip resurfacing

HRA = hip resurfacing arthroplasty

MARS MRI Scan = Metal Artifact Reduction Sequence Magnetic Resonance Imaging Scan

MoP = metal-on-polyethylene

MoM = metal-on-metal

PT = pseudo-tumour

ROM = range of motion

THA = total hip arthroplasty

UHMWPE = ultra high molecular weight polyethylene

QCT Scan = Quantitative Computed Tomography Scan

XPE = crosslinked polyethylene

“Polyethylene Cyst” and other complications associated with the osteolytic effect of wear particles after Metal-on-Polyethylene THA

Wear and the resulting osteolysis following total hip arthroplasty with a metal-on-polyethylene bearing (MoP THA) can result in uncommon effects and manifest itself in many different ways. The studies cited here report unusual presentations of intrapelvic cyst masses and femoral neuropathy.

Sherman et al. (USA) reported on the catastrophic failure of a MoP THA in a 85-year-old male patient. The metal femoral ball head component penetrated completely through both the PE insert and metal shell, resulting in extensive metallosis and component loosening. The patient had undergone the THA approximately 18 years before the evaluation. He had not had any follow-up in the years after surgery. The authors reported that osteolysis and metal debris extended into the proximal femur over a course of approximately 10 to 12cm. The authors concluded that the recognition of this rare complication may change the clinical outcome. They explained that recognizing the conditions present in this case may be important in order to avoid attempted closed reduction that may, as in this reported case, lead to periprosthetic fracture, necessitating additional operative intervention with the associated morbidity.

Sherman RA, Damron TA. Penetration of a Metallic Femoral Head Through the Acetabular Shell. *J Arthroplasty* 24(7); 2009:1143e7–1143.e10

Fokter et al. (Slovenia) presented a case of intrapelvic compression of the femoral nerve caused by a cystic mass containing wear debris from a MoP THA. They reported on a 58-year-old male patient with an uncemented MoP THA (32mm femoral ball head, stainless steel) who developed thigh pain, weakness and numbness in the surrounding area 13 years after implantation. The PE insert was fractured and the articular surface of the cup was damaged. Plain radiographs showed substantial wear. An abdominopelvic CT scan showed a large intrapelvic cystic mass (13cm). Necrotic debris and abundant foreign body granulation tissue were found. 80mm of thick, grayish-green fluid was removed. During removal of the cyst, a defect of the medial acetabular wall was observed. Upon incising the pseudocapsule, the authors found large thick black masses around the neck of the prosthesis. The authors suggested to look carefully for symptoms of nerve involvement in addition to radiographic signs of PE wear and osteolysis during follow-up.

Fokter SK, Fokter AR, Takač I. Case Report: Femoral Neuropathy Secondary to Total Hip Arthroplasty Wear Debris. *Clin Orthop Rel Res* 467(11);2009:3032–3035

Lin et al. (Singapore) reported on the case of a 75-year-old male patient with a presentation of a large pelvic mass 20 years after primary THA. The patient presented a left iliac fossa mass associated with left hip pain of 6 months duration and a left leg shortened in length by 7cm. Abdominal and pelvic CT scans demonstrated a large fluid collection in the left iliac fossa, measuring roughly 8.5 x 9.5 x 10cm. This left iliac fossa pelvic mass was related to aseptic loosening of the acetabular cup. Histological examination of specimens revealed chronic inflammation and histiocytic reaction. Severe osteolysis was noted over the acetabulum, with loosening of the PE cup. One year after hip revision, the pelvic mass was no longer present and the leg-length discrepancy had been reduced to 2cm.

Lin KHB, Lo NN. Failure of Polyethylene in Total Hip Arthroplasty Presenting as a Pelvic Mass. *J Arthroplasty* 24(7);2009:1144e.13–1144.e15



Male patient, 65 years old, showed instability in his right hip joint in combination with moderate discomfort. He had received a cemented MoPE THA 3 years earlier. He was diagnosed with signs of impingement, massive polyethylene wear and osteolysis.

Source: CeramTec AG

Further publications described patients with a loose total hip who have large osteolytic masses in the pelvis and lower abdomen, groin area, and even on inside of the thigh. For more information see the box below.

For more information:

Farrington WJ, Lewis P, Eachern Mac AG. Giant synovial cyst causing femoral occlusion following a hip replacement. A case report and review of the literature. *Hip Int* 12(4);2002:394–396

Hananouchi T, Saito M, Nakamura N, et al. Huge pelvic mass secondary to wear debris causing ureteral obstruction. *J Arthroplasty* 20;2005:946.

Thienpoint E, Vernaeve H. Reactive pelvic cyst following total hip arthroplasty. A case report. *Acta Orthopaedica Belgica* 69(3); 2003:292–294

Hisatome T, Yasunaga Y, Ikuta Y, Takahashi K. Hidden intrapelvic granulomatous lesions associated with total hip arthroplasty. *J Bone Joint Surg Am.* 85(4);2003:708–710

Clinical results with ceramics

Long-term results of cementless ceramic-on-polyethylene THA

Suckel et al. (Germany) presented long-term results of 320 consecutive cementless CoP THAs in 303 patients, with a follow-up of 15 (15–17) years. The same prosthesis system and a 32mm ceramic femoral ball head were used in all cases. The mean age of the patients was 67 (29–99) years at the time of surgery. Clinical and radiological examinations were available for 97 hips, phone interviews and radiological examinations for 4 hips and phone follow-ups for 49 hips. The median HHS was 88. The survival rate (Kaplan-Meier method) for the cup/insert was 98% and for the stem/femoral ball head 98% after 17 years. The rate of aseptic loosening was 2% for the cup and 1% for the stem.

Suckel A, Geiger F, Kinzl L, Wülker N, Garbrecht M. Long-term Results for the Uncemented Zweymüller/Alloclassic Hip Endoprosthesis. A 15-Year Minimum Follow-Up of 320 Hip Operations. *J Arthroplasty* 24(6);2009:846-853

Aldinger et al. (Germany) retrospectively evaluated the clinical and radiographic results of 326 patients (354 hips) with cementless CoP THA (BIOLOX®, 32mm) performed between January 1985 and December 1989. The mean age of the patients was 57 (13–81) years at the time of surgery. The mean follow-up was 17 (15–20) years. 87 patients (89 hips) died and 8 patients (8 hips) were lost to follow-up, leaving 240 patients (257 hips) for evaluation. The median HHS was 80. The Kaplan-Meier survival analysis was used. Taking revision for any reason as the endpoint the survival rate of the stem was 88% (84–92%) at 17 years. Osteolysis is mainly dependent on PE wear. The authors found a low revision rate of the stem for aseptic loosening. The survival rate was 94% (91%–97%) at 17 and 20 years respectively.

Aldinger PR, Jung AW, Breusch SJ, Ewerbeck V, Parsch D. Survival of the Cementless Spotorno® Stem in the Second Decade. *Clin Orthop Rel Res* 467(9);2009:2297–2304

Medium and long-term results of cementless ceramic-on-ceramic THA in younger and active patients

Aldrian et al. (Austria) reported on excellent clinical and radiological results of 107 consecutive uncemented CoC (BIOLOX®*forte*) THAs in 106 patients with a mean follow-up of 7.6 (7.1–8.3) years. A 28mm ceramic femoral ball head was used. The average age of the patients at surgery was 64.6 ± 11.7 (21–88) years. The mean HHS was 90.4 + 11.1 (84.7–99.2).

The radiological evaluation did not show any signs of osteolysis, loosening or protrusion. The authors concluded that considering certain criteria for ceramic hip implants regarding implant positioning, design and handling, CoC bearings can be used with a low risk of revision surgery and they may also reduce the risk of aseptic loosening in young and active patients.

Aldrian S, Nau T, Gillesberger F, Petras N, Ehall R. Medium-term analysis of modern ceramic-on-ceramic bearing in THA. *Hip International* 2009;19(1):36–40

Kim et al. (Korea) evaluated a consecutive series of 93 primary cementless CoC (BIOLOX®*forte*) THAs in 64 patients (93 hips) younger than 45 years with osteonecrosis of the femoral ball head. A 28mm ceramic femoral ball head was used. There were 55 male (84 hips) and 9 female (9 hips) patients. The average age at the time of surgery was 38.2 (24–45) years. The average follow-up was 11.1 (10–13) years.

The mean HHS improved from preoperative 52.9 (22–58) to 96.1 (85–100) at the final follow-up. No hip had aseptic loosening or revision. Radiographs and computerized tomographic (CT) scans demonstrated no acetabular or femoral osteolysis in any hip. The survival rate with aseptic loosening as the endpoint was 100% at 11.1 years.

Kim YH, Choi Y, Kim JS. Cementless total hip arthroplasty with ceramic-on-ceramic bearing in patients younger than 45 years with femoral-head osteonecrosis. *International Orthopaedics*, published online on 26 Sept. 2009

Metal-on-metal bearing surfaces: latest findings

Until now, there has been very little data collected over a long postoperative period on ion concentrations in the serum in patients with MoM wear couples. This is the subject of the two studies described below.

Hartmann et al. (Germany) analyzed the concentrations of chrome, cobalt and molybdenum in the serum of 95 patients with hip resurfacing and in 89 patients with a 28mm MoM wear couple THA, on average 5.5 years after implantation. The results of both cohorts were compared with those of 130 patients with no endoprosthesis. In the case of the molybdenum concentrations, no significant difference from the control group was identified in either cohort. However, in the patients with hip resurfacing and in those with the 28mm MoM wear couple, increased concentrations of chrome and cobalt were identified in the serum. At 4.81 µg/l (3.02–9.09), the concentration of chrome in the hip resurfacing cohort was considerably higher than in the 28mm MoM THA cohort, where a concentration of 2.04 µg/l (1.05–3.33) was measured. The mean concentration for the cohort with no endoprosthesis was 0.00 µg/l. No correlation between metal ion concentrations and cup inclination, level of activity (UCLA) and BMI of the patients could be proven.

Hartmann A, Petermann M, Krummenauer F, Günther KP, Witzleb WC. Medium-term metal ion concentrations after hip resurfacing (BHR) and Metal-on-metal wear couple. Abstract, German Congress of Orthopaedics and Traumatology, October 21–24, 2009

In a retrospective 10-year study, **Preuss et al.** (Germany) investigated the metal ion concentrations (Co, Cr, Mo, Ni) in the plasma and urine of 56 patients (27 male, 29 female, aged 69 ± 7) with 58 MoM THA. 6 patients died after 71 ± 34 (3–118) months. No patients died of a malignant or local tumor. So far 5 patients are free of tumors after colon, mammary, prostate and kidney carcinoma. 4 patients had to undergo a revision after 72 ± 32 (36–111) months due to aseptic loosening and received a CoP wear couple. 10 years after the primary implantation of the MoM THA, considerably increased metal ion concentrations (Co, Cr, Ni) in the plasma and urine were measured. No correlations between metal ion concentrations, age, sex and life span of the prosthesis were found. In the opinion of the authors, the lack of a correlation between high metal ion concentrations, hip joint function, postoperative pain and quality of life suggests that higher metal ion concentrations do not have a causal pathogenic effect on functional long-term results and the monitoring of abrasion. They call for long-term analyses of possible toxic carcinogenic effects.

Preuss N, Schaser KD, Weimann A, Rauhut F. Analysis of ion concentrations and clinical results after primary hip arthroplasty with MoM wear couple: 10-year follow-up study. Abstract, German Congress of Orthopaedics and Traumatology, Berlin, October 21–24, 2009

In clinical analyses, increased metal ion concentrations were identified in the serum, whole blood or urine of patients with metal-on-metal wear couples. Until now, there has been very little data on metal ion concentrations in the erythrocytes.

From April 2003 to July 2007, Mazoochian et al. (Germany) carried out an inductively coupled plasma mass spectrometry (ICP-MS) on 27 patients (18 male, 9 female) with correctly implanted and functioning resurfacing prostheses with no signs of loosening, luxation, fracture or osteolysis, in order to analyze the metal ion concentrations (Co, Cr, Mo, Ni) in the serum, urine and erythrocytes 6 and 12 months after surgery. The mean age of the patients was 51 years. In a control group of 27 patients without implants, with a mean age of 48 years, metal ion concentrations in the serum and the erythrocytes were also measured. There were significant differences between the patient group and the control group. The metal ion concentrations were considerably increased in those with prostheses; up to three times as high as in the control group. Cobalt ions constituted the primary form of metal ion contamination in the patients. Chrome ions were identified in the serum and urine. The concentration of molybdenum ions was only significantly increased in the serum. No significant accumulation of chrome ions was measured in the erythrocytes.

The authors concluded that these results have no clinical relevance as long as the patient remains healthy. Cobalt and molybdenum are eliminated via the kidneys. Chrome tends to be eliminated slowly and to accumulate in the body. Kidney dysfunction restricts the elimination of ions, which can lead to an up to 100-fold increase in ion concentrations in the body in the case of chronic renal insufficiency. The authors point out that the carcinogenic potential of metal ions, particularly of Cr⁶⁺, has not been sufficiently clarified.

Mazoochian F, Kiefl J, Michalke B, Jansson V. Measurement of metal ions in the serum, urine and erythrocytes in hip resurfacing patients. Abstract, German Congress of Orthopaedics and Traumatology, Berlin, October 21–24, 2009
Mazoochian F. Measurement of metal ions in the serum, urine and erythrocytes in hip resurfacing patients. Symposium on the tolerance of biomaterials in humans, Clinic for Dermatology and Allergology, LMU Munich, November 18, 2009

Using a new procedure, Nüchtern et al. (Germany) isolated metal particles from the periprosthetic tissue of revised MoM endoprostheses. It was shown that predominantly small particles of 50 to 200 nm can be identified in lymph-infiltrated tissue. The authors concluded that such particles can trigger an allergic reaction and can thus cause early failure of MoM endoprostheses.

Nüchtern J, Siebert K, Pflüger G, Junk-Jantsch S, Rüter W, Lohmann CH. Analysis of metal abrasive particles in correlation with the tissue reaction of MoM endoprostheses by enzymatic digestion of periprosthetic tissue. Abstract, German Congress of Orthopaedics and Traumatology, Berlin, October 21–24, 2009

There is still little information on the clinical and radiological outcome of revision after MoM Hip Resurfacing which is the subject of this study.

Eswaramoorthy et al. (UK) reported on a series of 29 failed HR (28 patients) that were revised to a conventional stemmed primary THA. The mean follow-up was 5 (1.7–11.7) years. The mean age at HR was 50.9 (21–65) years with a mean time to revision of 42 (4–102) months. The rate of revision of HR was 11% for women and 2% for men. 20 women (21 hips) and 8 men (8 hips) were involved. The mean age at revision was 54.4 (21–70) years. Indications for revisions were pain without radiological evidence of failure in 11 hips, suspected loosening of the femoral component in 7 hips, femoral neck fractures in 4 hips, suspected loosening of the acetabular and femoral component in 2 hips, infection in 1 hip and a mass in the groin in 1 hip. The original resurfacing acetabular component was retained in only 10 hips in which the femoral component was revised to a stemmed implant with a metal femoral ball head. 19 acetabular components and all femoral components were revised. In 18 cases, a CoC bearing couple was used. The acetabular component was revised in all of the 11 patients presenting with pain without radiological signs of loosening. The authors described that histological examinations of the synovial tissue showed lymphocytic infiltration with foreign body giant cells and haemosiderin-laden histiocytes consistent with metal sensitivity. The patient with a mass in the groin was reported by Boardman et al.* In this case a CoC THA was implanted 4.5 years after primary HR.

The results of the HR revision group were compared with those of a control group of age-matched patients. The authors concluded that the outcome of the HR revision group was comparable with that of the stemmed primary THA group. No patient required a re-revision.

Eswaramoorthy VK, Biant LC, Field RE. Clinical and radiological outcome of stemmed hip replacement after revision from metal-on-metal resurfacing. JBJS (Br) 2009;91-B:1454–8

*Boardman DR, Middleton FR, Kavanagh TG. A benign psoas mass following metal-on-metal resurfacing of the hip. J Bone Joint Surg (Br) 2006;88-B:402–404

The Impact of Sociodemographic Factors and Patient Training

In an earlier issue of CeraNews (Interview 2/2009), we spoke with Klaus-Peter Günther (Dresden, Germany) about the impact of patient-specific factors on THA outcomes. Two working groups have now presented further findings.

Multivariate evaluation of patient-specific benefits as a result of hip replacement – association between sociodemographic factors and functional outcome

Objectives: The benefits of hip replacement have been demonstrated by recently published meta-analyses. However, while Cochrane's review offers assessments of large samples of patients with hip osteoarthritis, the question arises as to the identification of patient subgroups that can be expected to show disproportionate benefits and that therefore may be prioritized in the context of surgical planning.

Methods: The current investigation is based on a longitudinal study initiated in 2005 to document patient-specific outcomes of hip surgery. In addition to sociodemographic factors, functional scores (WOMAC) and health-related quality of life scores (EuroQol) were determined for each patient preoperatively and six months after surgery. The degree to which these scores increase (%) is used as a measure of the patient-specific benefits of surgical intervention. Six-month follow-up investigations were carried out in 516 patients who had undergone hip replacement surgery by July 2007. The patients (54% women) had an average age of 63 years and an average BMI of 27 kg/m² at the time of surgery (36% above 29kg/m²). At the time of surgery, 21% of the patients lived alone, 25% were employed at least half-days and 21% reported having a college or university degree. Multiple logistic regression models were used to correlate the six-month changes in the WOMAC index [%] to the sociodemographic factors of the study volunteers. A rise in the index value of at least 50% was defined as an "excellent" surgical outcome. Likelihood ratio tests were utilized to create the regression models and adjust them for interactions with preoperative WOMAC and EuroQol statements.

Results: The presence of obesity (LR p=0.043) and employment on a half-day basis or more (p=0.028) were identified as multivariately significant independent determinants of a minimum WOMAC index increase of 40%. Of the patients with a BMI of > 29kg/m², 33% showed a minimum WOMAC increase of 40% compared to 27% of the patients with a lower BMI. This small increase was also found in 31% of the non-employed patients compared to 25% of

the employed patients. In addition to the previously mentioned preoperative factors, educational background showed a clear statistical significance in terms of its interaction with the increase in the WOMAC index (interaction p<0.001): On average, patients with a college or university degree showed a WOMAC benefit value of 51% before surgery compared to 42% in patients with lower qualifications and, accordingly, a smaller increase in the WOMAC value of 37% compared to 43%. Neither the age of the patients at the time of surgery (LR p=0.972), nor their gender (p=0.944) nor their marital status (p=0.136) proved to be statistically significantly associated with the increase in the WOMAC benefit value. The presence of obesity and the lack of employment presented themselves as independent determinants of patient-specific benefits for the demanding target criterion of a WOMAC minimum increase of 50%.

Krummenauer F, Witzleb WC, Günther KP. Meeting Abstract WI42-95, German Congress of Orthopaedics and Traumatology, Berlin, October 21-24, 2009

Impact of interdisciplinary patient training on pain and knowledge in patients after knee replacement surgery

Objectives: The degree to which patients are interested in receiving more information about the medical services they are offered continues to grow. Patient training programs give patients an opportunity to improve their understanding of the surgical procedures they are to undergo and represent a prerequisite for a more participatory involvement in decision making. Moreover, the provision of focused information about a planned course of treatment makes it easier for patients to play a constructive role during treatment and rehabilitation phases. In the context of a prospective study, we examined the impact of an interdisciplinary patient training program on patient treatment satisfaction and quality of life.

Methods: A total of 128 patients were divided up into two patient groups depending on their preference for participating in an interdisciplinary patient training program or refraining from doing so. The program was used to offer the one group of patients more information about osteoarthritis in the knee, the various surgical alternatives for treating it, various methods of inducing anesthesia, postoperative pain



therapy and postoperative physical therapy. The patients were then asked to fill out a WOMAC questionnaire and a separate questionnaire concerning the degree to which they were satisfied with their treatment. The study encompassed 70 untrained (Group I) and 58 trained patients (Group II). The average age of the patients in Group I was 69, with the specific ages ranging from 46 to 85. The average age of the patients in Group II was 70, with the specific ages ranging from 53 to 80. Of the patients in Group I, 54% were female. Of the patients in Group II, 59% were female.

Results: The WOMAC scores showed a significant increase in patient-specific quality of life in both patient groups. The trained group of patients showed somewhat lower impairment prior to surgery (46%) compared to the untrained group (44%). In the course of 3 months, the average WOMAC score for the trained patients increased to 83% versus 82% for the untrained patients. The trained group showed a smaller incidence of pain 3 months after surgery, with 67% reporting no pain when walking on level ground compared to 60% for the untrained group and 32% reporting no pain when climbing stairs compared to 21% for the untrained group. All of the patients who showed lower postoperative WOMAC scores were untrained. The training program was effective at raising general patient knowledge of matters relating to their treatment, i.e. as demonstrated by rehabilitation phase data and consultation with the surgeon. The increased patient knowledge exhibited by the trained group was associated with a lower degree of satisfaction when it came to postoperative explanations of X-rays and surgeon responses to direct patient inquiries. Patient knowledge can be positively influenced in the framework of interdisciplinary patient training programs. The quality-of-life data indicate that trained patients profit from their training. Patients who have a better understanding of the relevant issues tend to have higher expectations when it comes to postoperative care and consultation. Patient dissatisfaction here points to a need for further action.

Kirschner S, Meier V, Voigt H, Lützner J, Günther KP. Meeting Abstract WI42-1271, German Congress of Orthopaedics and Traumatology, Berlin, October 21-24, 2009

A Day for Tribology

Tribology and its clinical aspects is still one of the key issues in arthroplasty. EFORT has decided to hold a "Tribology Day" at each of its future congresses. The event will allow high-caliber experts to focus on comprehensive discussions in this field. The EFORT organization's Scientific Committee made the following statement (reprint courtesy of EFORT):

"Just the fact alone that the aggregate expertise of Europe gathers here has catapulted the annual EFORT Congress into one of the world's most significant meetings in orthopedics and traumatology over the past decade," notes Professor Karl Knahr, Chairman of the General Orthopedics Department at the Vienna-Speising Orthopedics Hospital and President of the 2009 EFORT Congress in Vienna. "Still, the very abundance of offerings also poses a challenge for us to shape that diversity into a practical, spacious and timely order – one that makes available to the participants as much additional quality as possible. One such new element is the Tribology Day which takes place for the first time at the Madrid Congress. In a single day and in a single hall, comprehensive expertise on the theme of abrasion in endoprosthetics will be conveyed to all medical target groups and will cover current but not yet completed developments."

As a matter of fact, after the enormous progress of micro-invasive surgery of recent years, it is above all the development in materials that – by reducing the need for reoperations – holds the key to further improvements that will benefit patients as well as medical insurers. However, many promises already vaunted as breakthroughs were not able to be sustained or have not been as yet sufficiently substantiated.

"For example, we would like industry to provide joint ball heads as large as possible – but as yet there are no studies as to whether or not these really cause less abrasion than the conventional smaller ones," Professor Knahr regretted. "Likewise, we are just as unsure as to whether metal-ceramic pairing really will offer a better option. And the initial hopes that highly polymerized polyethylene as a socket surface would produce no abrasion have meanwhile turned out to be unrealistic. There is not yet any long-term data on Vitamin E-treated polyethylene surfaces, and the hasty succession of various generations of these new types of materials shows overly clear that an optimal solution has not yet been found."

The Tribology Day at the EFORT Congress in Madrid this June should thus bring forth, above all, a clear

review of the situation and an update on the latest developments, namely for "beginners" as well as for experienced specialists, according to Professor Knahr.

At the beginning of the day, two prominently studied basis lectures will provide physicians in training – above all those who wish to take the European Specialist Medical Examination – a penetrative overview of the state of expertise. Michael Morlock, Professor of Engineering Science and Director of the Institute of Biomechanics at the University of Hamburg-Harburg, will give an introduction to biomechanics. John Fisher, among other things Deputy Vice Chancellor at the University of Leeds and, as professor, Director of the Institute of Medical & Biological Engineering, will provide a close-up analysis of abrasion problems connected to hip prosthesis.

The second half of the morning session is reserved for free lectures. "There are two highlights in the afternoon as well," Professor Knahr anticipates. "On the one hand the materials scientist Christina Doyle is organizing a symposium on the theme of Tribology, with the emphasis on practical basic research. Dr. Doyle, among other things, is guest professor at the University of Exeter's School of Engineering and at the Material Research Institute of Surrey. On the other hand, renowned industry representatives have declared themselves ready to introduce the respective states of development in the areas of metal-metal, ceramic-metal, metal-ceramic and polyethylene-metal ceramic pairings."

The day concludes with an especially interesting session of lectures covering a greater scope than the 3-minute morning presentations. They will involve two experts discussing their areas of specialty before opening discussion to the broader audience. Professor Knahr: "We can expect from that some especially well grounded results in a particularly provocative spirit."

More information on the EFORT:
www.efort.org/madrid2010

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AE Masterkurs Hüfte
Ofterschwang, Germany
- **March 6–9**
56th Annual Meeting of the
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New Orleans, USA
- **March 9–13**
AAOS
New Orleans, USA
- **March 12–13**
NZA CME
Nelson, New Zealand
- **March 19–20**
Endoprothetik Forum
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Journées d'Orthopédie de Fort de France
Martinique, France
- **April 16–18**
53rd Spring Congress of the Korean
Orthopaedic Association (KOA)
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- **April 29–May 2**
58. Jahrestagung der VSO
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NOF
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- **May 5–7**
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Annual Meeting of JOA
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