

THE HIP SOCIETY

*Thirty-Ninth Open Meeting of
The Hip Society*



*Seventeenth Combined Open Meeting of
The Hip Society and the
American Association of Hip and Knee Surgeons
(AAHKS)*



Final Scientific Program

Saturday, February 19, 2011
San Diego Marriott Hotel & Marina
Salon 1
San Diego, California



Schedule-at-a-Glance

San Diego Marriott Hotel and Marina Salon 1

8:00–8:04 am	Welcome
8:05–9:15 am	Symposium I – FEMORAL COMPONENT FIXATION
9:15–9:55 am	Symposium II – NEW SURFACES FOR BONE INGROWTH
10:08–10:23 am	<i>Break</i>
10:15–11:00 am	Symposium III – UPDATE ON BEARING SURFACES
11:00–11:43 am	Symposium IV – UPDATE ON INFECTIONS
11:43 am–12:00 pm	Presidential Guest Speaker - <i>Mr. Richard N. Villar, MD</i>
12:00–12:50 pm	<i>Lunch (The Hip Society Business Meeting and Luncheon – Room: Columbia – Members only may attend; registration required)</i>
12:50–1:00 pm	Highlights of Hip Research from ORS 2011
1:00–1:30 pm	The Hip Society Awards
1:30–2:15 pm	Symposium V – CONTROVERSIAL TOPICS IN HIP SURGERY 2011
2:15–2:25 pm	Highlights of Hip Papers presented at AAHKS 2010 Annual Meeting
2:25–3:00 pm	Symposium VI – NON-ARTHROPLASTY TREATMENT OF EARLY ARTHRITIS
3:00–3:15 pm	<i>Break</i>
3:15–4:17 pm	Symposium VII – COMPLICATIONS AFTER TOTAL HIP ARTHROPLASTY
4:17–5:00 pm	Symposium VIII – CURRENT TOPICS IN REVISION TOTAL HIP ARTHROPLASTY
5:00 pm	<i>Adjourn</i>

(Full scientific program schedule listed on pages 3-7)

General Information

- **COURSE OBJECTIVES:** The objectives of the Open Meeting of The Hip Society are to provide up-to-date information on the treatment of hip problems including non-arthroplasty options and the latest surgical techniques as well as the current thinking on bearing surfaces. Other objectives deal with the difficult primary THA and complication management including an update on revision THA.
- **COURSE DESCRIPTION:** This course is divided into eight symposia covering femoral component fixation, new surfaces for bone ingrowth, bearing surfaces, infections, controversial topics in hip surgery, non-arthroplasty treatment of early arthritis, complications after THA and revision THA. There will also be a presentation of The Hip Society Award papers, a special Presidential Guest Speaker, and summary of hip subject highlights from meetings of the Orthopaedic Research Society, American Academy of Orthopaedic Surgeons, and the American Association of Hip and Knee Surgeons.
- **CREDIT HOURS:** The American Academy of Orthopaedic Surgeons designates this education activity for a maximum of 7.75 *AMA PRA Category 1 Credits*™. Physicians should only claim credit commensurate with the extent of their participation in the activity.

The Goals and Mission of The Hip Society

1. To advance knowledge of the hip joint in health and in distress.
2. To provide a forum to stimulate the exchange of knowledge concerning education, research, and treatment of disorders of the hip.
3. The Hip Society has an open meeting that has wide geographic distribution. It is open to orthopaedic surgeons and engineers who have an interest in hip surgery. The ratio is 96% orthopaedic surgeons who attend the meeting. There are orthopaedists from many countries who attend the annual meeting.
4. The Hip Society presents a full-day program which is divided into symposia and a session of award papers. The Summer Meeting consists of papers that are presented from a local community to the membership of The Hip Society. There are a total of two meetings per year.

Important



Please **complete and return your evaluation form** to The Hip Society registration table at the conclusion of the program.



Please **silence all your electronic devices** while inside the session room.

Thank you for your cooperation!

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Scientific Program

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Scientific Abstracts

SYMPOSIUM I: FEMORAL COMPONENT FIXATION

8:05-8:13 am

Cylindrical, Fully-Porous Coated Components: Tried and True

Charles A. Engh, Sr., MD

C. Anderson Engh, Jr., MD

Anderson Orthopaedic Research Institute, Alexandria, VA

The first porous-coated femoral component approved for use without cement was released in 1983. Today, there are many implants with a similar amount of porous coating. The hallmark of these porous-coated implants are a cylindrical shape distally and a triangular metaphyseal shape. Extensively coated components gain initial stability in the femoral diaphysis.

Since 1982, we have used extensively porous-coated femoral components in all patients. Our oldest series of patients is a consecutive non-selected group of 211 hips that have been followed for a mean of 20 years. Combining the loose and the revised, there is only a 3% femoral failure. Currently we are following 6,714 hips with a mean follow-up of 7 years (0-29yrs.) The mean age of these patients is 62 years old (15-97yrs.) 1% of hips have been revised, 39 for failure of ingrowth, 10 for infection, 7 stem fractures, and 3 at the time of a periprosthetic fracture. We have studied patients with disease processes not originally thought to work well with noncemented techniques, including rheumatoid arthritis, avascular necrosis and patients over 65.

Despite the good results, the main concern is that proximal bone loss secondary to the stress shielding caused by a stiff extensively porous-coated femoral component will lead to difficulty at the time of revision. At a mean 14 years, we have not seen any adverse clinical consequences that can be attributed to proximal stress shielding, though the longer term consequences of adaptive femoral remodeling need to be followed. In our patients, extensive proximal bone loss secondary to stress shielding is a radiographic sign of bone ingrowth that occurs in 25% of cases. In the remaining 70-75% of cases, lesser degrees of proximal bone loss occur which confirm bone ingrowth.

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Cylindrical, Proximal Coated Titanium: It Works

Aaron G. Rosenberg, MD, FACS

Midwest Orthopaedics at Rush University Medical Center, Chicago, IL

The past several decades have seen bone in-growth cementless femoral components varied by substrate material, implant shape, in-growth surface type and extent, as well as the use of supplementary fixation adjuncts (collars, coatings and mechanical stabilizing features). All of these features have been employed to improve some perceived deficiency in implant performance; component stability, in-growth reliability, clinical performance, and bone stock maintenance. The number of implant variations as well as the multiple outcome measures (in addition to the purely clinical) make evaluation of all of these variables quite complex. ^(2, 5)

None the less, several styles of cylindrical, proximally coated titanium stems have been evaluated at intermediate follow-up with clinically excellent results. Additional benefits may also include ease of insertion with a lowered fracture risk in comparison to tapered stems, as well as a reduction in thigh pain, adverse bone remodeling, and difficulty in removal. ^(1, 3, 4, 6, 7)

References

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Short-Stem Components: Past and Present

Roger H. Emerson, MD

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Short-stemmed femoral components have recently become available from several manufactures in the US. Surgeon skepticism about short stems has prevailed in the past because stem length has been equated with stem stability, and substantial contact with the diaphysis of the femur has been a feature of almost all bone ingrowth designs. Despite this, the first short stem available in the US market was a product that has been used since 1985 and clinical results have been published.

Experience has revealed that longer stems diminish normal femoral bone stock, contribute to non-physiologic loading, are more difficult to revise, and may contribute to thigh pain, and are more difficult to use in some less invasive surgical approaches, leading to increased interest in shorter stems.

Three general categories of shorter stems based on canal contact are in the literature. 1) Very short stems, cervico-trochanteric, which do not contact the metaphysis, and are the least stable and most dependent on the status of the under lying bone. 2) Intermediate length stems, cervico-metaphyseal, designs which preserve much of the native femoral neck and extend into the upper metaphysis. The product is in this category of stem. 3) Longer short stems, meta-diaphyseal, basically shorter versions of standard stems, which completely fill the metaphysis, with some support from the upper diaphysis. A routine femoral neck resection is done. Most of the recent short stem offerings are in this group.

The published clinical outcomes with short stems, while sparse at this time, is favorable. There is some data published on survivorship, mechanical stability and bone density. The product hip has 98.2% 10 yr survivorship for mechanical loosening, and DEXA data showing increased calcar density.¹ The product B stem has RSA data showing minimal migration, consistent with longterm clinical success.² Stulberg and Dolan have reported 2-4 year follow-up with a custom 100 mm stem, with an average Harris score of 93 and no subsidence or loosening.³

Personal experience with one short -stem design, with over 500 cases and no revisions for stem failure, leads me to conclude that surgeons who perceive a benefit for their patients from a shorter stem will be attracted to these stems and that their use will increase in the coming years.

References

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Tapered Stems
A “Procrustean Hip”
Richard H. Rothman, MD, PhD

James Edwards Professor
The Rothman Institute and
Thomas Jefferson University, Philadelphia, PA

History

Tapered stems first captured the attention of the orthopaedic community in the 1980's based on the design and clinical outcome studies of Zwymuller. The early generations of tapered stems were monoblock construction with chrome cobalt alloys. They frequently had a grit blasted surface and sharp edges and produced outstanding clinical results. These were followed by a second generation of tapered stems that were modular and constructed of titanium and its alloys. Ultimately, a third generation of tapered stems evolved, which were modular, titanium alloys, but had further evolution of the surface with plasma spray, hydroxyapatite coating, and some variation in length and architecture to better accommodate to the interior of the femur. The designs improved as the data bases for measuring the internal dimensions of the proximal femur improved.

Cement versus Cementless

The outcomes for cemented versus cementless femoral components are outstanding with contemporary designs and techniques. The majority of the worldwide orthopaedic community is shifting to cementless fixation more because of its ease, simplicity and utility rather than outcomes. Simplicity brings with it a shorter operative experience and thus less blood loss, less bacterial contamination of the wound, and lower rates of thromboembolism. Additionally, a simple procedure is less likely to allow error and human performance remains one of the last barriers to perfection in hip surgery.

Outcomes

With three decades of data available, the safety, efficacy and durability of tapered stems is well documented. The ideal data is prospective, randomized and controlled. Ideally, the author is not the designer and the data are reproduced worldwide. An excellent example is the prospective randomized study by Bourne and co-workers in Canada, who demonstrated a zero mechanic failure rate at the end of two decades. Both the British and Australian hip registries also document superlative performance of most tapered stems.

For Whom?

In the past, it was generally felt that cementless fixation was ideal for young males with good quality bone. It has now been demonstrated in several series that even compromised bone such as found in rheumatoid arthritis and octogenarians are productive of good outcomes using tapered stems. The exception to the use of the usual tapered stem is the severe CDH patient and revision surgery with distortion of anatomy and loss of bone stock. However, for the vast majority of primary hips, tapered stems are a strategy productive of good long-term outcomes as demonstrated by long-term data from a variety of centers world-wide.

Low-Modulus Components: Saving Bone?

Andrew H. Glassman, MD, MS

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Saving bone in the context of this presentation equates to the avoidance of stress mediated bone resorption, or “stress shielding”. There are three major determinants of stress shielding. One is the patient’s pre-operative bone mineral density, which is beyond surgeon control. The next important factor is the rigidity of implant fixation to host bone. Simply stated, significant stress shielding does not occur unless the stem is well fixed to bone and therefore load sharing. Thus, stress shielding occurs to some extent with all well-fixed (*e.g.* successful) stems. Finally, the role of femoral component design has been long recognized. With regard to stress shielding, the most important stem characteristic is its stiffness.

Contemporary composite technology was utilized to develop a stem that was significantly less stiff along its entire length as compared to similarly shaped all-metal components, predictably achieved rigid implant fixation via bone ingrowth, and demonstrated long-term mechanical integrity. The stem features a solid cobalt chromium core covered with a polymeric layer enclosed by an extensive porous coating of titanium fiber metal. Clinical trials with the original iteration of the stem were initiated in the United States and abroad in 1994. Favorable results of that multi-center study, in terms of implant fixation, preservation of bone mineral density, and excellent clinical results, were presented to this Society in 2001, and again in 2006. Minimum 10-year follow-up of 106 patients within the original study were published in 2009. DEXA evaluation in these and several other published studies demonstrate a significant reduction in stress shielding as compared to similarly sized and shaped implants fabricated of solid metal, including proximally porous coated titanium stems. In addition, the author’s personal experience with the second-generation composite stem will be presented, including semi-quantitative radiographic evaluation of adaptive remodeling in 110 stems. Analysis of this single-surgeon study at short-term follow-up also reveals significantly less stress shielding than that previously reported for solid metal stem designs.

Clinically, stress shielding is usually associated with bone ingrowth and a favorable clinical result. To date, no data suggests a correlation between stress shielding and a risk of adverse events such as femoral shaft or trochanteric fracture, or osteolysis. However, in the event that a well-fixed stem requires removal for late infection or other cause, significant stress shielding complicates removal and compromises the bone stock remaining for reconstruction.

Cemented Components: Still needed?

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Introduction/Background

Since the early 1960's, cemented femoral fixation has been considered the "gold standard". Cementless femoral fixation has emerged as an alternative and has become popular in younger patients; however, it is still controversial in older patients and has not been fully studied in patients older than 75 years of age. Our hypothesis is that non-cemented THA is a safe and an effective mode of femoral fixation in this older age group.

Materials & Methods

A matched pair analysis of 75 years of age and older patients who underwent primary THA during period of 1998 – 2006 by a single surgeon was performed. 77 patients (77 hips) were identified who underwent non-cemented THA during this period. These patients were matched with 77 other patients (77 hips) that underwent cemented or hybrid THA during same period, based on age, sex, Charnley class and BMI. Non-cemented fixation was performed in patients with ASA III and IV.

Clinical evaluations were performed on initial evaluation and during each visit. Patients were accessed for level of thigh pain at rest and during activities, and functional status. Harris Hip Scores, Patient Administered Questionnaire (PAQ) and radiographic evaluation were used.

Results

154 patients (77 hips in each group, 49 males and 28 females) were included in the final analysis. Average age at the time of the procedure in cemented and non-cemented group was 80.2 and 80.5 years respectively. The mean follow up in cemented and non-cemented group was 8.1 ± 1.6 and 8.5 ± 1.5 years respectively. At the last visit, pre-operative scores improved in all patients.

There was no difference between the two groups in terms of mortality, cardiac events or fatal pulmonary embolism. There were no intra-operative fractures. Five patients (8.7%) in the non-cemented group reported thigh pain. There was one complication (1.75%), late periprosthetic infection, in the cemented group which was treated with two-stage reimplantation, and subsequent resolution of infection.

Discussion

Cemented femoral fixation for THA has a long history of success. It has been the treatment of choice for older patients. Non-cemented femoral fixation became popularized in the 1980's, and is widely used in younger patients and the revision surgery. However, its application in older individuals is increasing. Proponents of cemented fixation advocate long safety record, reproducibility and predictability of outcomes. They also point out the limitations of non-cemented fixation, such as intra-operative fractures, unpredictability of fixation and thigh pain. On the other hand, decreased operative time, lower rates of fat embolism and decreased familiarity with cementing technique has been proposed as advantages of non-cemented fixation.

Based on the results of this study, both cemented and non-cemented techniques are very effective in this age group. In patients with significant cardio-pulmonary compromise (ASA III and IV), non-cemented fixation appears safer with slight increase in thigh pain.

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Femoral and Acetabular Component Utilization in the United States

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The purpose of this presentation is to review the current state of total hip arthroplasty (THA) implant usage in the United States. According to data from the Millennium Research Group¹, the number of hip arthroplasty procedures in the US grew 2.0% in 2009 to 444,600 procedures. 60% of these procedures were primary THA's, 24% were partial hip replacements, 4% were hip resurfacings, and 13% were revision THA's.

According to research from UBS², U.S. sales of THA implants increased 4.7% in 2009 to \$2.54 billion. DePuy/Johnson & Johnson had the largest market share, controlling 31% of the THA implant market. Stryker had the second largest market share at 22%, followed by Zimmer with 21%, Smith & Nephew with 12%, Biomet with 12%, and Wright Medical with 3%. According to data from the Orthopedic Research Network³, which included 129 nationally dispersed hospitals and approximately 18,000 THA procedures in 2009, 86% of primary THA's used in 2009 were cementless (both stem and cup), 10% were hybrid (cemented stem and cementless cup), <1% were reverse hybrid (cementless stem and cemented cup) or cemented (both stem and cup), and 3% were resurfacing procedures.

With respect to bearing surface, 49% of the primary THA bearings used in 2009 were metal-on-highly cross-linked polyethylene, 3% were metal-on-conventional polyethylene, and 21% were metal-on-metal (down from 34% in 2007). 9% of metal-on-metal bearings had 1-piece (non-modular) cups, while 12% used modular cups. 19% of the primary THA bearings used in 2009 were ceramic-on-highly cross-linked polyethylene (up from 8% in 2007), 1% were ceramic-on-conventional polyethylene, and 4% were ceramic-on-ceramic or metal-on-ceramic (down from 7% in 2007).

With respect to acetabular components, 86% of cups sold in 2009 were modular two-piece acetabular cups, and 14% were one piece (non-modular) cups. From 2000-2007, there was an increase in cases with one-piece cups, from 3% in 2000 to 23% in 2007. More recently, however, this trend has been reversed, with 19% one-piece cups being sold in 2008, and 14% in 2009.

With respect to femoral heads, metal heads accounted for 81% of femoral heads used in 2009, while the use of ceramic heads increased from 12% in 2007 to 19% in 2009 (despite a decrease in ceramic liner use from 5% in 2007 to 1% in 2009). The trend toward larger diameter femoral heads also continued. In 2001, <1% of the femoral heads were larger than 32mm in diameter; by 2007, the majority (52%) of femoral heads sold were over 32mm. In 2009, 23% of femoral heads were more than 36mm, 35% were 36mm, 22% were 32mm, and the remaining 22% were less than 32mm.

The largest category of hip stems used in primary THA in 2009 were cementless stems which accounted for 81% of primary THA's (up from 40% in 2000), followed by cemented stems at 13% (down from 55% in 2000), resurfacing at 3%, and revision stems used in primary THA's at 2% (up from 1% in 2007).

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SYMPOSIUM II: NEW SURFACES FOR BONE INGROWTH

9:15-9:23 am

The Science and Metallurgy of New Ingrowth Surfaces

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Brett Levine, MD, MS

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The development of porous metals and coatings is a historic achievement that has led to major advances in the field of orthopaedic surgery. In the past, the majority of implants have been fabricated utilizing traditional metals (cobalt-chromium, titanium and stainless steel alloys) and coatings (fiber metal, sintered beads, plasma spray and cancellous structured titanium). Despite excellent clinical results utilizing these materials, there remain some inherent biomechanical and structural limitations to these traditional metals/coatings. In light of these relative shortcomings, a new generation of porous metals/coatings has been introduced to improve upon clinical results and expand operative indications for use of these new materials.

The microscopic appearance of these new porous metals attempts to mimic cancellous bone and contain complex nanostructures. The relative open-cell structure of these new materials affords several intriguing properties, including; high volumetric porosity (60-80%), low moduli of elasticity and high-friction surface characteristics.

This new generation of porous metals/coatings is derived mainly from titanium and tantalum both of which are relatively inert transition metals. Each maintains a high level of biocompatibility in vivo and have a well-documented bioactive nature, forming a bone-like apatite coating in vivo. This high affinity for bone and fibrous tissue ingrowth has extended the limits of these new porous constructs for use in megaprotheses, patellectomy and patella salvage. Although these new porous metallic options are in their early stages of evolution, the initial clinical data and basic science studies support their use as an alternative to traditional implant materials.¹

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Biological Response to New Porous Metals

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After over two decades of clinical success with first generation porous coatings, a new generation of porous metals designed for biologic fixation has recently evolved. The new porous structures are generally similar and incorporate, to somewhat varying degrees, increased friction coefficient against bone, increased volume porosity (with resulting lower stiffness) and distinctly microtextured surfaces. These features have raised the level of opportunity for and reliability of implant fixation by improving initial stability and the rate/extent of bone ingrowth.

There are at least six new generation porous metals, one made of tantalum, the rest of titanium. Two are modified porous coatings while the rest are manufactured either as a coating or in bulk form for monoblock implants. Providing there is ample mechanical strength, appropriate quality control over manufacturing tolerances and proper dimensional registry with instrumentation, biologic fixation should be obtained with the new materials. Bone ingrowth is almost certain to occur given a biocompatible material, appropriate pore size and adequate initial implant stability.

Animal implant studies have demonstrated ample evidence of bone ingrowth with all the new materials and rapid development of mechanical fixation strength. There is no absolute value of interface strength that determines success or failure of implant fixation - it is not possible to describe a threshold of fixation below which is inadequate or above which is sufficient for adequate clinical function. This is because bone strength varies considerably with density, mechanical demands vary considerably with patient weight and activity level, and biologic fixation is affected by the viability of host bone, the extent of initial fixation, and the early postoperative load bearing regimen, all of which are patient specific. It is therefore difficult to interpret cited values of interface strength derived from animal implant models (e.g., transcortical implants) that are not very relevant to hip arthroplasty. Of note is that only bone growth into the superficial 100 μm to 200 μm of a porous structure contributes to mechanical fixation of the implant as a whole. Bone growth deep inside the pores does not increase interface strength and thus the bulk porosity of monoblock implants does not provide additional opportunity for attachment strength, only opportunity for better load sharing with host bone by virtue of lower stiffness.

Clinical documentation of the biological response to the new porous metals is scant. Retrieval studies of porous tantalum devices, the ones with the longest clinical history, have verified bone ingrowth, although not always to the same extent as might be expected from basic science information. Lower stiffness porous tantalum monoblock cups have shown greater peri-implant bone retention than stiffer metal-backed cups, important evidence of decreased stress shielding. The new generation porous metals will potentially increase the reliability of biologic fixation in hip replacement surgery while also providing new tools to address complex reconstructions, especially in revision procedures.

Clinical Indications for and Complications of New Ingrowth Surfaces

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Several highly porous metal materials have become available over the past several years for use in hip arthroplasty. With the initial material consisting of a highly porous version of tantalum with interconnected porosity exceeding 80%. Over the past decade accepted indications for use of these materials have included primary and revision acetabular components and primary femoral components. The greatest attention has been focused on revision acetabular usage particularly for major bone defects where contact on host bone is limited or where bone quality is impaired as in patients with previous radiation. Use of this material has occurred in conjunction with strategies for improved mechanical fixation and increased contact and support to host bone using multiple screws, acetabular augments to fill bone voids, and cup cage constructs for more massive defects. This combination of improved materials, implant designs, and methods have allowed successful treatment of massive bone deficiencies not previously reconstructible using standard implants and techniques.

Those complications generally associated with hip arthroplasty have occurred with highly porous metal implants and the question becomes whether these problems have occurred in similar, greater or lesser frequency than has been seen with previous materials and designs. To date, no unique or special complications have been reported specific to the use of highly porous metals. Component loosening has been observed with highly porous metal implants in instances where initial mechanical fixation was insufficient, particularly in the face of pelvic dissociation or major defects with minimal screw fixation of the socket used at the time of the original arthroplasty. Loosening has also been observed in cases where implants have been placed against entirely dead bone as in the instance of prior massive acetabular allograft. Periprosthetic infection has also been seen, though the question exists whether the incidence has been improved by the use of implants with antibiotic containing cement used for assembly of the polyethylene insert to the cup as elution of antibiotic in the early post operative timeframe could theoretically have a beneficial effect on subsequent infection rate, though no data to date has proven this effect. Stress shielding previously recognized around extensively coated femoral components also has been shown to occur behind rigid solid titanium acetabular components with prevention of this same stress shielding when less rigid highly porous metal implants are used without a rigid metal shell as a substrate. Whether this reduced stress shielding will have benefits long term to young patients undergoing these procedures where maintenance of quality periacetabular bone may be of importance in subsequent decade's remains to be established. Wear on associated osteolysis have plagued hip arthroplasties over the past decades is unclear given the introduction of alternative bearings and the wide spread use of cross linked polyethylene. Whether the use of less rigid highly porous acetabular components and the ability to eliminate traditional modular connections by direct compression molding of polyethylene into the porous metals or cementation of liners to highly porous shells will provide incremental benefit by reducing backside wear, backside motion and the stresses in the polyethylene especially as seen in locking mechanisms of traditional modular connections is unclear. Longer term data is still needed to document whether the introduction of highly porous metal hip implants and the potential benefits these may have on aseptic loosening, stress shielding, implant mechanical integrity, and infection risk are actually realized and translated into improved clinical performance and better implant durability.

SYMPOSIUM III: UPDATE ON BEARING SURFACES

10:15-10:23 am

Ten Year Follow-Up of Highly Cross-linked Polyethylene Liners in Total Hip Arthroplasty

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Introduction

Highly cross-linked polyethylene is one of the most widely utilized bearing surfaces for total hip arthroplasty (THA). The product has been introduced to decrease osteolysis secondary to polyethylene wear debris, thereby anticipating increasing long-term survivorship of the THA. The electron-beam irradiated cross-linked and melted polyethylene was one of the first of the contemporary formulations to be introduced for clinical use at the end of 1999 and had been extensively evaluated *in vitro*¹. There have been limited clinical reports of other formulations of the product to date. One randomized study, by Martell et al., reported a decrease in femoral head penetration at 2 years compared to conventional polyethylene². Early clinical studies have provided insight into the magnitude of the early bedding in and have shown to be small and clinically irrelevant²⁻⁴. The formulation of the product evaluated in this current study has shown low wear rates at 3-year and 6-year follow-up intervals^{3,4}. The purpose of this study is to report on the 10 year clinical and radiographic outcomes of patients with the product liners. This will be the longest term report of clinical and radiographic results of THAs with this formulation of the product liners.

Methods

Three hundred and eighty-five primary THA's (355 patients) in which the product liners with either 22mm, 26mm, 28mm or 32mm femoral heads were implanted between January 1, 1999 and December 31, 2002. The clinical measures used to evaluate these patients are the Harris hip, EQ-5D, and UCLA activity scores. In addition to conventional plain radiograph assessment, Martell Hip Analysis Suite (Chicago University, Chicago, IL) was used to measure head penetration over time. A matched set of 186 THA's (129 patients) with 26mm and 28mm head sizes coupled with conventional gamma sterilized in air polyethylene with a minimum of 7 years follow-up was identified as a wear measurement control group.

Results

No components show radiographic loosening, failure or fracture. There are no osteolytic lesions around the cup or stem. No revisions have been performed for polyethylene wear or liner fracture. The average scores (\pm StDev) for the Harris hip, EQ-5D, and UCLA activity surveys were 87.28 ± 15.54 , 80.79 ± 16.84 , 6.09 ± 2.04 respectively. Based on the longest follow-up film of individuals with a minimum 7 year follow-up, the average head penetration rates were $8.6 \pm 77.4 \mu\text{m}/\text{year}$ and $3.5 \pm 86.6 \mu\text{m}/\text{yr}$ for 28mm and 32mm heads respectively. There was no significant difference in the head penetration rates between the 28mm and 32mm heads. The wear rate of a match set of conventional PE was $96.7 \pm 139.0 \mu\text{m}/\text{year}$.

This average wear rate of conventional PE is significantly different than the wear rates shown with the product ($p < 0.0001$). For individuals with the product liners with a minimum 10 year follow-up, the average head penetration rates were $11.5 \pm 46.3 \mu\text{m}/\text{year}$ and $24.1 \pm 80.4 \mu\text{m}/\text{yr}$ for 28mm and 32mm heads, respectively, with no significant difference in penetration rates between the two head sizes.

Discussion

Patients with implanted conventional gamma polyethylene show significant wear of the material with both 26mm and 28mm femoral heads. Conversely, patients with highly cross-linked polyethylene display no measurable wear in this minimum 10 year follow-up study. The radiographic results are excellent with no signs of periprosthetic osteolysis. This is in contrast to the high incidence of periprosthetic osteolysis at 10 years seen with conventional polyethylene. The wear results continue to indicate very low wear in vivo with no signs of changes over time. This long-term clinical and radiographic follow-up study of patients receiving primary THA using the product liners represents the largest series and longest follow-up period for this bearing material.

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Ceramic-Ceramic Articulation at 10 years: Is it Past its Prime?

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Introduction

Alumina ceramic bearings are scratch resistant, and have superior lubrication and wear resistance compared to other bearings. They were reintroduced in the US in 1996 as a part of an IDE multicenter clinical study.

Methods

Five surgeons from five centers implanted 380 ceramic/ceramic bearings in 359 patients and compared them to a control population of 95 metal on polyethylene controls in 93 patients. In 1996 three patients cohorts were initially randomized: group I (99 hips) had ceramic bearings with a porous titanium cup; group II (95 hips) had ceramic/ceramic with a roughened HA Arc deposited Ti cup; group III (95hips) served as the control with a metal-on-polyethylene bearing and a porous titanium cup. In 1998 the second phase added a Titanium clad ceramic acetabular implant (186 hips) with a ceramic head and an HA ARC Titanium cup. There was no difference in the demographics between the patients who received alumina ceramic bearings and those who received the metal-on polyethylene controls. 67% were male patients with an average age of 53.5 years and follow-up is 9.5 to 12 years. All patients received the same cementless double tapered Ti femoral stem. The study group was analyzed for Kaplan-Meyer survivorship revision for any reason, radiographic findings, complications, squeaking, and functional parameters.

Results

There is no significant difference in clinical performance (Harris Hip Scores) between the four patient cohorts. Survivorship revision for any reason is 96.8% for all ceramic on ceramic cases compared to 91.3% for the control metal-on-polyethylene cases ($p=0.0046$). There are no pending revisions and no revisions have occurred for aseptic loosening. The only ceramic bearing surface failures (0.5%) include a liner fracture at 6 years post-op and a peripheral ceramic chip that occurred at 9 years and required revision. 3% of the control cases were revised for wear and osteolysis. Osteolysis was found in 17.6% of the control group and in 0.5% of those patients receiving the ceramic bearing. Occasional squeaking has occurred in three ceramic patients (0.8%) without clinical significance.

Conclusions

Alumina ceramic bearings for THA in a relatively young and active patient population have performed well out to 12yrs with high survivorship and a low rate of complications.

Acknowledgements

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Metal-Metal Articulation: Is it Worth the Risk?

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There is more than 20 years of clinical experience with second generation metal-metal bearings in hip arthroplasty. Over that time, the benefits and risks have been identified, revised, weighed, and compared to the alternatives. The two greatest practical benefits of metal-metal bearings are 1) the lower dislocation risk of larger diameter bearings in total hip replacement and 2) the relatively thin monoblock sockets that allow hip resurfacing with comparable acetabular bone removal. The major risk of metal-metal bearings is the variably increased exposure to metal particles and ions and the associated biological reactions.

Over the past decade, the aggregate experience with crosslinked polyethylene demonstrates dramatically reduced wear, reduced osteolysis, and a reduction in wear-related revisions. The industry has moved cautiously toward larger diameter bearings with crosslinked polyethylene, and 36mm (and larger) bearings are now available for modular acetabular components (as small as 50mm). These larger diameter crosslinked polyethylene bearings address the practical motivation for using metal-metal bearings: higher stability. Concurrently, there are increased concerns regarding the variably elevated levels of cobalt and chromium ions associated with metal-metal bearings. At this time, the benefits of metal-metal bearings in total hip replacement do not outweigh the risks for most patients.

There is more than 14 years clinical experience with metal-metal resurfacing. In the target demographic (larger stature (males), younger, OA), the survivorship is equal to or better than that of concurrent total hip replacement. The functional results and patient satisfaction, in addition to the survivorship data, support continued utilization of hip resurfacing in appropriate patients. Currently, there is no alternative bearing for hip resurfacing. The risks related to ion exposure can be minimized through patient selection, proper component positioning, and monitoring of blood / serum ion levels. At this time, the benefits of metal-metal resurfacing in selected patients outweigh the risks.

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The Next Generation of Bearing Surfaces

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In North America, we now have widespread experience with the so-called alternate bearings. These include highly cross-linked polyethylene, metal on metal and ceramic on ceramic articulations. Although each of these options is an improvement over conventional polyethylene, limitations remain. There is increasing concern with adverse tissue reactions with metal on metal articulations. Ceramic articulations remain low wear options but squeaking and fracture remain a concern. With both hard bearing options, implant position is critical. Highly cross-polyethylene has performed well, but liner fractures have been reported. Thus, there remains room for improvement.

Improvements going forward will likely come from two directions. The first and most common direction will be improvements in existing materials. This includes improving the strength of both the highly cross-linked polyethylene and ceramics. The second includes new materials that are biocompatible, have sufficient strength and allow for thinner acetabular components. Thinner acetabular components are necessary to maximize femoral head size and optimize resurfacing options. Included in this group are potential biologic solutions for early articular cartilage loss.

In summary, most advances will be through modifications of existing well performing bearings. New technologies that currently being evaluated in laboratory studies or early clinical studies will be discussed. These may provide large head advantage without metal ion exposure. All new bearing surfaces require careful clinical study.

SYMPOSIUM IV: UPDATE ON INFECTIONS

11:00-11:08 am

Diagnosis of Prosthetic Hip Infections: Guidelines and New Techniques

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Diagnosis of PJI can be challenging. Although clinical history and radiographs may at times provide valuable information, diagnosis of PJI often requires a step-wise approach and implementation of tests that may reach the diagnosis.

- 1) ESR and CRP are the best screening tests for PJI. The likelihood of PJI in patients with normal ESR and CRP is less than 4%. So ESR and CRP should be done in all patients with painful joints
- 2) The best next test for diagnosis of PJI is aspiration of the joint, especially for the knee.
- 3) Aspirate of the joint should be sent for neutrophil count, neutrophil percentage and culture. Using ROC, we have determined the threshold for neutrophil count and neutrophil percentage for both chronic and acute infection. Using joint aspirate cell count we have developed a new diagnostic criteria for PJI

Diagnostic Criteria for PJI (Rothman Criteria)

A joint is infected if one of the following criteria are met:

*Positive culture

*Intraoperative purulence

*Draining sinus tract

* Or three of the following four are abnormal:

- ESR > 30 mm/hr

- CRP > 10 mg/L

- WBC > 1760 cells/ μ L for chronic cases or 10,700 cells/ μ L in acute postop

- PMN% > 73% for chronic or 89% acute postop

The AAOS recently convened a group of experts to develop guidelines for diagnosis of PJI. In order to provide the clinical practice guidelines the workgroup first formulated a set of preliminary recommendations that specified what should be done in whom, when, where and how often or how long. These were intended to function as the questions for systematic review by AAOS research team. Once the entire relevant published articles are assembled and graded (Level I to IV) the workgroup then provided a final recommendation that is graded as **strong** (good quality evidence), **moderate** (fair quality evidence), **weak** (poor quality evidence) **inconclusive** (insufficient or conflicting evidence) or **consensus** (in the absence of reliable evidence the workgroup makes a recommendation based on clinical opinion). Below is a brief description of the AAOS guidelines that were developed recently. The complete guidelines can be found at www.aaos.org

Novel/Molecular Modalities for Diagnosis of PJI

In recent years numerous investigators have invested efforts for diagnosis of PJI using molecular techniques.

RT- PCR: Rocky Tuan and his group have reported the use of reverse transcription-quantitative polymerase chain reaction (RT-qPCR) using universal primers for detection of periprosthetic joint infection. Serial dilutions of simulated synovial fluid infections were analyzed with rRNA RT-qPCR. The rRNA RT-qPCR assay was able to detect as few as 590 colony forming units/mL of *Staphylococcus aureus* and 2900 colony forming units/mL of *Escherichia coli*. The rRNA RT-qPCR signal closely followed cell death, pointing to its potential use as a viability marker. rRNA-based RT-qPCR demonstrated 100% specificity and positive predictive value with a sensitivity equivalent to that of intraoperative culture. The RT-qPCR signal followed bacterial culture trends but exhibited detectable level for seven days after sterilization, allowing for the detection of infection after the antibiotic administration. These findings indicate that rRNA RT-qPCR is a sensitive and reliable test that retains the universal detection and speciation of DNA-based methods while functioning as a viability indicator.

Multiplex ELISA - Since 2005, we have been investigating the role of ELISA for diagnosis of PJI. Last year Carl Deirmengian also published a study in which he had described the role a few inflammatory markers in diagnosis of PJI. In his study IL-6, IL-8, and IL-1B appeared to hold promise in diagnosis of PJI. We have also been investigating the role of ELISA for diagnosis of PJI since 2005. We have found that macroglobulin-a2, VEGF, IL6, IL8, and C-reactive protein in the joint aspirate may be very valuable for diagnosis of PJI.

Leukocyte Dip stick—another interesting finding at our center has been that LE dip stick, that is usually utilized for diagnosis of UTI and other infections, may also have a great role in diagnosis of PJI. After completing a study on over 300 patients, this test was found to have a sensitivity of near 100% and specificity of 87%.

IBIS-5000 (Multiplex PCR): A very unique and interesting molecular modality to diagnosis of PJI is IBIS-5000. This is a multiplex PCR machine that uses pan-genomic primer to amplify DNA of organisms in the retrieved infected tissues. Following amplification mass spectrometry is performed followed by sequencing that helps identify the nature of infecting organism. We utilize this technology for identification of organisms in challenging infection cases in general and culture negative cases in particular.

Recommended Readings

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What is the Effect of Resistant Bacteria and New Antibiotics in Prosthetic Joint Infection?

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Prosthetic joint infection is a major complication associated with total hip arthroplasty. It is also one of the most common complications of a growing number of total hip arthroplasties.

The treatment of prosthetic joint infection has been made even more difficult because of the presence of resistant bacteria causing the infection and the limited number of antibiotics that are effective in the treatment of the bacteria. The exact number of resistant bacteria in total joint arthroplasty is unknown but the percentage may be reflected in the data from the Centers for Disease Control and Prevention's National Nosocomial Infections Surveillance System. The percentage of methicillin-resistant *Staphylococcus aureus* (MRSA) increased from 2% in 1974 to 22% in 1995 and 63% in 2003 (12% community associated). Recent data supports a significant decrease in the number of healthcare-associated MRSA infections. The incidence rate of hospital onset invasive MRSA infections was 1.02 per 10,000 population in 2005 and decreased 9.4% per year through 2008. The findings are corroborated by a second study on MRSA central line-associated bloodstream infections that reported data from hundreds of different intensive care units with a 50-70% decrease between 2001 and 2007. The reasons for the decrease in MRSA infections were not clear but believed to be multifactorial. First is the implementation of MRSA prevention practices and following the recommendations for the prevention of healthcare-associated infections. Another controversial reason is the decolonization of patients before surgical treatment. This surveillance program may be cost effective in high risk settings (> 25% risk for infection) where patients who are likely to be colonized with MRSA. It is also critical that active surveillance should not be implemented without a comprehensive review of infection control practices. The final factor that may have played a role in decreasing MRSA infections was shorter length of hospital stays.

If a prosthetic joint infection does occur, the choice of antibiotics for resistant pathogens is limited. The Infectious Disease Society of America proposed solutions to this lack of antibiotics in a 2004 policy report, "Bad Bugs, No Drugs..." It is hoped that new antibiotics will be developed in the near future. Until then, telavancin (lipoglycopeptide) and ceftaroline (cephalosporin) are both relatively new and effective against methicillin-resistant *Staphylococci*. Accumulating data suggests that rifampin, an antibiotic that targets RNA polymerase, is highly effective against biofilm mediated infections. Further work should be performed to discover other novel molecules that inhibit RNA metabolism to determine their efficacy against biofilm mediated infections.

While the challenges of prosthetic joint infections due to resistant bacteria are great, the decrease in MRSA prevalence coupled with the introduction of new antibiotics may help us in the treatment of this devastating complication.

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Choices and Techniques for Antibiotic Spacers

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Deep periprosthetic infection is a serious complication of total hip arthroplasty. Goals of treatment of this complication are eradication of infection, restoration of patient function and long term fixation of implants. In North America 2 stage reimplantation is the treatment of choice for chronic deep seated infection around a total hip arthroplasty. Choice of treatment at the first stage is either a SPACER (static or dynamic) or resection arthroplasty plus/minus antibiotic bead insertion. At second stage revision choice of components will vary by surgeon, but most revision surgeons currently would favor uncemented technology on the femoral and acetabular side.

Most studies to date have focused on eradication of infection as the primary outcome. In these studies success in the short term has been achieved in 85-90% of cases with 2 stage exchange. In 2 recent studies mid to long term results of 2 stage reimplantation have been addressed. In one study from the Mayo clinic (Sanchez-Sotelo et al CORR 2009) patients were followed between 2-16 years post two stage exchange (mean 7 years). Eradication of infection was very successful with reinfection rate of 7.3%. The main issue in this study was a 14% mechanical failure rate. The authors attribute this to 2 factors; 1. In many cases cement was used for fixation at the second stage. This was due to the fact that eradication of infection was believed to be more successful with this approach. 2. In cases where uncemented components were use on the femoral side only proximal fixation was used. Two studies have specifically looked at the use of uncemented components at the second stage (Masri et al J Arthroplasty, Kray et al CORR 2005). In the report from Kray et al reinfection rate was 7%. In a paper from our institution (Vancouver General / UBC) reinfection rate was 10.3%. In this series the PROSTALAC articulated spacer was used at the first stage with modern uncemented revision components at the second stage. In this series at a mean of 4 year follow-up there were no mechanical failures.

In another study from our center the long term success with the PROSTALAC articulated spacer was looked at (Biring et al JBJS). In this series infection was eradicated in over 90% of cases. Function was also assessed and was seen to be as good as non infected revisions.

What is the PROSTALAC? Prosthesis of Antibiotic Loaded Acrylic Cement. It has been used at our center in complex cases since 1986 and in routine cases since 1991. Besides the 2 studies already mentioned above numerous studies from our center have been published and are listed below. To summarize the results of these studies the PROSTAC system is generally successful in eradicating infection in 90% of cases, stable implant fixation in 85-90% of cases and satisfactory outcomes in 80-85%.

The treatment of deep periprosthetic hip infection has come a long way. Initial treatments focused solely on infection eradication. Today most modern treatments while infection eradication is primary goal , secondary goals of long term fixation and improvement in patient function are gaining more importance. While most research on treatment of infection has shown positive gains the treatment of MRSA/MRSE is a problem without a good solution currently. In a study at our center on 50 patients with these resistant infections eradication with a 2 stage exchange with a PROSTALAC spacer used at the first stage occurred in 78%.

This was significantly lower than in our series of non resistant cases. Given the increasing number of cases with resistant organisms we feel this is an area requiring future research to increase our eradication rates.

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Recent Results with Debridement & Suppression and Two-Stage Reimplantation: Are we getting better?

Daniel J. Berry, MD

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Prosthetic infection following total hip arthroplasty (THA) remains one of the most serious and challenging operative complications. Unlike most other complications of THA, the rate of prosthetic infection has not declined notably in recent years. While prevention remains the preferred goal, once infection has occurred effective management is essential.

Debridement and prosthetic retention followed by antibiotic treatment/suppression historically has been used to treat selected early postoperative infection and some acute hematogenous infections. This talk will examine the results of this form of treatment as applied in recent years with modern surgical indications and methods and modern antibiotics.

Two-stage reimplantation is the most commonly used form of treatment in North America for chronic antibiotic sensitivity. With evolving surgical indications and techniques, use of antibiotic impregnated spacers, have the results of this method of treatment changed over time? This talk will examine the results of two-stage reimplantation using modern indications, techniques, and antibiotics.

PRESIDENTIAL GUEST ADDRESS

11:43 am-12:00 pm

Current Status of Hip Arthroscopy: The British Experience

Mr. Richard N. Villar, MB, BS, BSc(Hons) MA, MS, FRCS

Cambridge Lea Hospital, Cambridge, United Kingdom

Hip arthroscopy has demonstrated a somewhat unpredictable evolution. Once thought to be impossible it has now reached a point where it is advancing forward at a rapid pace. Now, in Europe, the United Kingdom in particular, the frequency of hip arthroscopic procedures is 4.8 procedures per 100,000 population per year. In the United States this figure is 11 procedures per 100,000 population per year. This huge surge in interest for hip arthroscopic surgery has most likely been brought about by the recognition that femoroacetabular impingement (FAI) can be treated arthroscopically. There is, however, a long learning curve for the procedure and it is clear that specialist training is required in order to be able to undertake hip arthroscopy safely. The skills required for open surgery do not always translate themselves well to arthroscopic surgery, and vice versa. It should also be recognized that FAI represents but one reason for undertaking hip arthroscopic surgery. If FAI disappeared tomorrow there would still be plenty of work for the hip arthroscopic surgeon to handle.

The development of hip arthroscopic surgery can be conveniently divided into a number of phases. Before 1990 may be regarded as the "Introductory" phase of hip arthroscopy. Numbers were small, indications diverse, and only a few, largely self-selected centers were performing the procedure worldwide. From 1990-2000 hip arthroscopy entered its "Consolidation" phase when surgeons recognized that the procedure could be undertaken in different ways, while both supine and lateral approaches gained popularity. Numbers expanded, research started to gather momentum and complications were quantified. From 2000-2010 hip arthroscopy then entered its "Expansion" period. Some centers began to undertake many, many hip arthroscopic procedures, numbering well into the thousands. It became recognized that both central and peripheral compartments of the hip existed and together should form part of a routine hip arthroscopy. Studies began to report results rather than technique, training courses developed throughout the world and surgery for FAI began to dominate.

Now, in the decade 2010-2020, hip arthroscopy may perhaps be regarded as being in its "Diversification" phase. The procedure is as applicable to the international athlete as it is to the more sedentary worker. Meanwhile the indications for hip arthroscopic surgery are developing rapidly. In some countries hip arthroscopy rests in the domain of the arthroscopic surgeon, while in others it is part of the overall practice of a hip surgeon who will also undertake hip arthroplasty.

Hip arthroscopic surgery's future is bright; the techniques so far described representing but a tiny part of the likely repertoire of a hip arthroscopic surgeon in ten years' time. Peri-articular hip surgery is developing rapidly; the importance of hip stability is becoming a greater issue, while the arthroscopic inspection and, sometimes, management of the painful hip arthroplasty has gained a foothold. Ligamentum teres reconstruction has been undertaken, as has the arthroscopic management of dysplasia, sciatic neurolysis, fracture fixation and a variety of biological techniques for articular cartilage defects. The International Society for Hip Arthroscopy (ISHA) has been formed, bringing together hip arthroscopic surgeons from around the world in a common forum. There is a true brotherhood of hip arthroscopists now in existence and, through this friendly co-operation; it is clear that the procedure is destined for even bigger and greater things. Hip arthroscopy is here to stay.

The John Charnley Award

1:00-1:10 pm

An Accurate and Extremely Sensitive Method to Separate, Display and Characterize Wear Debris: Polyethylene, Metal and Ceramic Particles

Fabrizio Billi, PhD

Paul D. Benya, PhD

Aaron Kavanaugh, BS

Edward Ebramzadeh, PhD

John S. Adams, MD

Harry A. McKellop, PhD

Orthopaedic Hospital, Los Angeles, CA

The analysis of wear particles produced in joint simulator wear tests of prosthetic joints is a key tool in identifying the wear mechanisms that produced the particles, and in predicting and evaluating their effects on the periprosthetic tissues. In Part 1, an efficient and accurate method was developed for extracting polyethylene (PE) wear particles from the bovine serum typically used in wear tests, and for thoroughly characterizing their size distribution and morphology. The serum proteins were completely digested, preventing loss of the smallest, sub-micron particles and minimizing particle clumping. The PE particles then were purified by ultracentrifugation in density gradients that contained multiple layers of reagents designed to remove contaminants and recover the particles without filtration, another step that can induce clumping. The particles were deposited directly onto a featureless silicon wafer coated with an organic glue, providing excellent dispersion and high background contrast to facilitate accurate, automated, morphometric analysis. The accuracy and precision of the new protocol were assessed by recovering and characterizing particles from wear tests of PE acetabular cups with zero, 5 or 7.5 Mrads of gamma irradiation crosslinking. The new method introduced in this study demonstrated important differences in the particle size distributions and morphological parameters among the three types of polyethylene that could not be detected using prior isolation methods.

In Part 2, this approach was adapted for metal and ceramic particles. The particles were centrifuged through multiple layers of denaturants, and a metal-selective high density layer, and deposited directly onto a featureless silicon wafer for SEM analysis, or onto a TEM grid, enabling accurate chemical and morphological analysis of individual particles. By eliminating the need to collect the particles in a pellet, the protocol avoided irreversible aggregation, providing well-dispersed particles for highly accurate chemical and morphological analysis. The efficacy and accuracy of the new protocol were evaluated by recovering standardized 50 nm gold beads, as well as metal and ceramic particles generated in joint simulator wear tests. The new protocols overcome a number of limitations of prior methods, and can be used simultaneously to recover PE, metal and ceramic particles in sizes ranging from nanometers to micrometers, from synovial fluid and periprosthetic tissue.

The Frank Stinchfield Award

1:10-1:20 pm

Dislocation in Revision THA: Randomized Clinical Trial of 36/40mm vs 32mm Head

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Bassam A. Masri, MD

Clive P. Duncan, MD, MSc

Nelson V. Greidanus, MD, MPH

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Background

Dislocation after revision total hip is a common complication.

Questions/Purposes

The primary purpose was to assess whether a large femoral head (36/40mm) would result in a decreased dislocation rate compared to a standard head (32mm). A secondary purpose was to confirm that the use of large cobalt-chrome heads did not result in increased linear polyethylene wear in revision THA.

Patients and Methods

A randomized clinical trial was undertaken to assess the effect of large femoral heads on dislocation after revision total hip. Patients undergoing revision hip arthroplasty at seven centers were randomized to 32mm head or 36/40mm head. Patients were stratified according to surgeon. Primary endpoint was dislocation. Polyethylene wear was measured using radiostereometric analysis (RSA). Quality-of-life measures were: WOMAC, SF-36 and satisfaction. One hundred eighty four patients were randomized: 92 in the 32mm head group and 92 in the large head group. Baseline demographics were similar in the two groups. Patients were followed from two to five years postoperatively.

Results

In the large head group dislocation rate was 1.1% (1/92) versus 8.7% (8/92) for the 32mm head ($p=0.035$). There was no difference in polyethylene wear between the two groups, nor in quality-of-life outcomes.

Conclusions

This randomized clinical trial demonstrates that a large femoral head (36/40mm) can significantly reduce dislocation rate in patients undergoing revision total hip, without increasing linear polyethylene wear. As a result of this study the authors now routinely use large heads with a highly cross-linked polyethylene acetabular liner in all revision hip arthroplasty.

Level of Evidence

Therapeutic study, Level I (randomized clinical trial). See the Guidelines for Authors for a complete description of levels of evidence.

The Otto Aufranc Award

1:20-1:30 pm

Demineralized Bone Matrix around Porous Implants Promotes Rapid Gap Healing and Bone Ingrowth

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Background

Noncemented revision arthroplasty is often complicated by the presence of bone-implant gaps that reduce initial stability and biological fixation. The potential for demineralized bone matrix to enhance gap healing and porous implant fixation has not been clearly studied or demonstrated.

Purpose

We sought to demonstrate the osteoinductive properties of demineralized bone matrix and ascertain by what time and to what extent it promoted gap healing around and bone ingrowth within porous implants.

Methods

Porous titanium implants were inserted into the proximal metaphyses of canine femora and humeri with an initial 3mm gap between host cancellous bone and the implant. Gaps were left empty (control), or filled with either demineralized bone matrix or devitalized demineralized bone matrix (negative control), and left in situ for 4 weeks and 12 weeks. A total of 6 gaps of each type were studied at each time period. Volume healing of the gap with new bone was quantified with 3D microCT scanning while bone apposition and ingrowth were quantified using backscattered scanning electron microscopy.

Results

The density of bone inside gaps filled with demineralized bone matrix reached 64% and 93% of surrounding bone density by 4 weeks and 12 weeks, respectively. Compared with controls and negative controls, gap healing using demineralized bone matrix was twice to three times greater at 4 weeks and 12 weeks ($p < 0.01$) and bone apposition and ingrowth were twice to six times greater ($p < 0.03$).

Conclusions

Demineralized bone matrix has proven osteoinductive capacity in orthotopic bone sites.

Clinical Relevance

Demineralized bone matrix has potential for enhancing implant fixation in revision arthroplasty.

SYMPOSIUM V: CONTROVERSIAL TOPICS IN HIP SURGERY 2011

1:30-1:38 pm

Update on VTE Guidelines: ACCP, SCIP, AAOS

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The ACCP is currently working on the ninth edition of Evidence-Based Antithrombotic and Thrombolytic Therapy Guidelines to be released this year. The "Prophylaxis in Orthopaedic Surgery Patients" chapter has significant orthopaedic input but the result of the final voting is uncertain at this time. However, there are many changes that have been made in the structure and process of this edition that appear to address the criticisms from the orthopaedic community. Five major points of disagreement between the ACCP and the AAOS are as follows:

- 1) The significance of asymptomatic DVT and the appropriateness of combining the rates of symptomatic and asymptomatic VTE to determine superiority of prophylactic regimens
- 2) The necessity of promoting individualized patient risk stratification
- 3) The value of evidence other than randomized drug trials in supporting the strongest recommendation
- 4) The frequency and importance of post-operative bleeding complications caused by aggressive pharmacologic prophylaxis
- 5) Conflict of interest with the pharmaceutical industry

The process is not yet complete, but there will very likely be major change in several of these areas. The following are some examples:

- 1) In this edition the rates of asymptomatic DVT will only be utilized to calculate relative risk for any given comparison of agents. The relative risks will be used to calculate the absolute event rates versus a much lower (and realistic) baseline risk of symptomatic DVT/PE. The effect will be that the absolute increase or decrease of symptomatic events per thousand will be compared with a similar calculated risk of adverse events such as bleeding. Therefore, it appears likely that many of the strong (1A) recommendations will be weakened by this methodology, whereas modalities that can be clearly demonstrated to have fewer adverse events may be strengthened.
- 2) There will be many "close call" situations which will require the surgeon's judgment as to the relative risks of VTE and bleeding. This supports the concept of individualized (AAOS) rather than group (ACCP) risk stratification.
- 3) Patient preference will be factored into the decision-making process. For example, it has been shown a patient regards a non-fatal PE with about the same "disutility" as a major bleed. Therefore the recommendation for a drug that produces a lower VTE rate, but an equal increase in bleeding will, not necessarily be more strongly recommended than an agent with more VTE but less bleeding. Estimation of bleeding rates, however, is problematic because of significant heterogeneity in the literature.
- 4) The ACCP has instituted a strict conflict of interest policy which excludes individuals with financial ties to industry from participating in voting on the final recommendations.

New Pharmacologics and Mechanical Devices for VTE Prophylaxis

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Professor and Chairman, Department of Orthopaedic Surgery
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The ideal agent for prophylaxis after total hip arthroplasty would be both effective and safe and it would be an oral agent that requires no monitoring. The agents that have been most commonly used for DVT prophylaxis for THA in the past include: Warfarin, low molecular weight heparin, fondaparinux and aspirin. In general mechanical devices have been used as an adjunctive agent. All of these agents have limitations. Recently 3 new oral agents have demonstrated efficacy in randomized trials in limiting venous thromboembolic disease after total hip arthroplasty.

These 3 agents include: dabigatran (direct thrombin inhibitor), rivaroxaban (factor Xa inhibitor) and apixaban (factor Xa inhibitor). These 3 drugs are oral agents that require no monitoring. These agents have been evaluated in randomized trials compared to enoxaparin. These studies have been powered to assess overall DVT rates rather than symptomatic PE and DVT. In a series of randomized trials all 3 agents have been shown to have been more effective than and as safe as enoxaparin in preventing overall DVT formation after THA (symptomatic and asymptomatic events). Dabigatran and Rivaroxaban have been approved for use in Europe but not the United States.

Recently, a portable mechanical compression device (MCD) has been evaluated in a randomized trial. This device allows the patients to use the mechanical compression after discharge from the hospital. In a randomized trial comparing MCD versus enoxaparin low PE rates were noted in both groups (1% in each group respectively). Unfortunately, the study was not powered for symptomatic DVT but it was powered for complications. There was a significantly higher bleeding rate in enoxaparin patients (6% vs 0% respectively). This form of portable prophylaxis does show potential and we are looking forward to future studies.

There is great interest in the clinical application of these new oral agents that require no monitoring. Although these agents do show potential in randomized trials it is critical to determine not only their efficacy but their safety when used as prophylactic agents after total hip arthroplasty in the community.

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Pseudotumors: Rare or Common?

Mr. David W. Murray, MD, FRCS

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There is growing concern about the use of metal-on-metal bearings for hip replacement, based primarily on reports of pseudotumour and other adverse reactions to metal debris with resurfacing arthroplasty (HRA). Until recently, there were few concerns with metal-on-metal total hip replacements, whether they were large femoral head (LFH, articulating against a resurfacing cup) or standard devices (THR, articulating on a standard cup). In order to examine this issue information was gathered from multiple surgeons who had had problems with metal-on-metal bearings and were part of the Metal Hip Research Group.

Data about adverse reactions resulting in revision surgery was analysed. The reactions were associated with formation of solid or cystic soft tissue masses (pseudotumours) with or without metallosis or osteolysis. In the majority of cases in which retrieved samples were studied there was evidence of release of appreciable amounts of metal debris. In HRA this was predominantly due to edge loading in the articulation. For the other subgroups debris was also released due to wear at the head neck junction and corrosion. The highest incidence of reactions occurred in the LFH group. Within each subgroup (HRA, LFH, THR) reactions were associated with multiple different designs of implant from multiple manufacturers. There was marked variation of incidence with different designs, ranging from <1% to 20%. Patient and surgeon factors also influenced the incidence.

The results of this survey suggest that pseudotumour and other adverse reactions to metal debris are common with certain designs of implant and patient subgroups. MOM implant designs without good supporting clinical data should be used with caution

Osteonecrosis: Does Anything Other than Arthroplasty Really Work?

Michael A. Mont, MD

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Osteonecrosis is a devastating disease that often leads to collapse of the femoral head. It generally affects patients under 40 years. Patients present with groin pain and associated risk factors such as corticosteroid, alcohol, and tobacco use. It is important to know the risk factors because early diagnosis is the key to saving these joints. Patients with advanced arthritis have few alternatives except for hip arthroplasty procedures. This presentation will deal with various head sparing treatments, which are best for patients who have pre- or early post-collapse disease, before late degenerative changes have occurred.

Numerous attempts have been made at non-operative treatments. Pharmacologic options such as the use of statins [1, 15], anticoagulants [13], and bisphosphonates [8, 14] have been used with limited success. Others have used non-invasive techniques including hyperbaric oxygen [2], or ultrasound [18] to prevent femoral head collapse in early stage disease. However, all of these non-operative treatments should be considered still experimental.

Standard core decompression has had variable success rates ranging from 39 to 86% often depending on disease stage [3, 5, 6]. Poor results are typically associated with poor technique and more advanced disease. It involves removing an 8 to 10 millimeter core of bone from the femoral head. Indications are early pre-collapse disease, with small- and medium-sized lesions. Recently, percutaneous pinning has been utilized in a number of reports as an alternative. It is performed in a similar manner and has comparable results to conventional core decompression, but is performed with smaller drills [12].

There are numerous bone grafting procedures that can be performed on hips diagnosed with osteonecrosis. Indications can be extended to early post-collapse disease. Grafting procedures can be either vascularized or non-vascularized. Vascularized grafts are technically difficult procedures, which require two operative teams and a surgeon who is comfortable performing micro-vascular anastomoses. There are several options for non-vascularized grafts, including the "light bulb" [10, 11, 16, 17] and "trapdoor" procedures [4, 7, 9] that have success rates from 70 to 90 percent.

In a recent meta-analysis prior to 1990, the mean survivorship of THA in patients who had osteonecrosis was 83%, while after 1990 it was 97%. Advances have included second generation cementing techniques and proximally coated femoral. Given the mixed results seen with head-sparing procedures in late-stage disease, the risk-benefit ratio has to be weighed in light of the improved results of THA.

In summary, pharmacological treatments are currently being investigated but are still experimental, and other surgical head preserving procedures can be used successfully in patients diagnosed early with small- or medium-sized lesions that have pre- or early post-collapse disease. For patients with large lesions and who have already experienced collapse, recent reports indicate that patients have successful results with total hip arthroplasty.

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SYMPOSIUM VI: NON-ARTHROPLASTY TREATMENT OF EARLY ARTHRITIS

2:25-2:33 pm

Surgical Dislocation for Impingement

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Open surgical treatment for hip impingement has evolved significantly over the past several years and is one of the standard surgical techniques to treat hip impingement disease.¹ The advantages of this technique include a wide, open exposure and visualization of the entire acetabular rim, the entire femoral head, femoral head-neck junction and proximal femur. The results of the surgical technique in the treatment of hip impingement have been published by several groups. The early to mid-term results are good to excellent in the majority (68 – 96%) of patients.²⁻⁶ In addition to the treatment of common forms of femoroacetabular impingement, the surgical dislocation approach provides the opportunity for comprehensive correction of severe impingement deformities. These include severe combined cam and pincer morphologies, chronic deformities secondary to slipped capital femoral epiphysis, residual Perthes-like hip deformities and post-traumatic deformities. The clinical results of hip impingement surgery for these less common disorders are not yet established. Nevertheless, early results in small patient cohorts are encouraging. In more complex hip deformities, the surgical hip dislocation approach can be combined with femoral neck and intertrochanteric osteotomies, relative neck lengthening, and trochanteric advancement. Labral and articular cartilage disease can be addressed with repair, grafting and/or microfracture. Open surgical treatment of more complex hip disorders provides comprehensive correction beyond the current capabilities of hip arthroscopy. Therefore, surgical dislocation for the treatment of various hip impingement deformities has an important and unique role in the field of hip preservation surgery.

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Periacetabular Osteotomy: Which Patient Benefits?

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I. RESULTS OF PELVIC OSTEOTOMIES

Good results have been published with multiple types of pelvic osteotomies (double, triple, and various periacetabular osteotomies). In general, if the osteotomy is performed well in the properly selected patient, pain relief, function, hip mechanics, and coverage of the femoral head will all be improved.

A. Ganz Periacetabular Osteotomy - Results

1. Initial Report

a. Ganz (1988)

- i. Wiberg angle improved
- ii. Lesquesne angle improved
- iii. Marked ↓ in pain
- iv. Complications (in 1st 75 cases)
 - a. Intra-articular osteotomies in 2
 - b. Resubluxation in 2
 - c. Overcorrection in 2
 - d. Nonunion of pubis in 1
 - e. HO in 4

b. Multiple authors (Siebenrock, Matta, Davey, Murphy, Crockarell, Trumble, Hussell, Kralj, Clohisy, Peters, Dagher, Pogliacomi) report favorable clinical results with acceptable complication rates. Learning curve can be long.

2. Patients with osteoarthritis

a. Trousdale (1995)

- i. Wiberg angle improved on avg. 27°
- ii. Lesquesne angle improved on avg. 25°
- iii. Harris Hip Score ↑ from 61 to 86 postoperatively
- iv. Patients with ↑ severe DJD had ↓ results
- v. Complications
 - a. HO in 14
 - b. Reoperations in 9 (THA or further osteotomy). 5 of 9 had grade III DJD prior to osteotomy.

3. Long term results – Steppacher et al, 2008, CORR) – At 20.4 years 60% of hips preserved.

II. Factors Predicting Poor Outcome (conversion to THA)

A. Increasing age at surgery

B. Lower Merle d'Aubigne and Postel score

- C. Positive preoperative anterior impingement test
- D. Preoperative limp
- E. More severe preop DJD
- F. Postop extrusion index greater than 20%

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Arthroscopic Treatment of the Early Arthritic Hip: Does it help?

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Simple debridement procedures can hope to only have a palliative effect but will not alter the natural progression of the disease. Selective removal of damaged tissue is not likely to accelerate the process, although open studies have shown that complete removal of the labrum results in more rapid progression of arthritis.¹ In our experience, arthroscopic debridement among well selected cases results in noticeable improvement among 50% of patients at two years and 36% at five-year follow-up.² By 10 years, virtually all patients have been converted to total hip arthroplasty with only a handful that simply live with their disease.

Current focus has been on the management of femoroacetabular impingement, a recognized etiology of early age onset osteoarthritis.^{3,4} This is especially encountered among young adult athletes who push their bodies beyond the diminished physiologic limits imposed by the altered morphology of their hip joints.⁵ Ninety percent had Grade III or Grade IV articular damage at the time of arthroscopic intervention.^{6,7} This indicates that the secondary damage is advanced by the time it becomes clinically evident. The results of arthroscopic surgery to address the secondary damage and correct the underlying impingement are still quite favorable, although the observations suggest that earlier recognition and treatment would still be preferable. Twenty-five percent undergo microfracture with results comparable to the non-microfracture group.

By the time a diagnosis of “early arthritis” is made, it is likely that the damage in the joint (especially chondromalacia) is more advanced than suggested by imaging studies including radiographs and MRI. This secondary damage cannot be completely reversed. Often, arthroscopic treatment can diminish the accompanying symptoms and it seems logical that addressing the underlying etiology may improve the future outlook. However, the science would not support a statement that we are truly altering the natural history of the disease.

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SYMPOSIUM VII: COMPLICATIONS AFTER TOTAL HIP ARTHROPLASTY

3:15-3:23 pm

MRI (and CT) in the Evaluation of Complications following THA

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Magnetic Susceptibility: Quantitative measure of material's tendency to become magnetized by B₀: proportional to strength of B₀ and susceptibility constant (1.5T only!)

- ◆ When exposed to B₀, materials become magnetized to different extents
- ◆ Adjacent tissues with different susceptibilities distort field ; results in mis-mapping of spins

Reduction of Susceptibility: Current Capabilities

- Frequency shift misregistration causes signal hyperintensity and void
- Distortion in slice and readout $\propto 1/\text{strength of } G_z \text{ and } G_x$ so $\uparrow G_x$ strength, \downarrow misregistration
 - Wide receiver bandwidth (GE 100-125kHz;; Philips/Siemens 350-500Hz/pixel)
 - High resolution frequency direction: \downarrow voxel size, \uparrow spatial resolution and definition of metal-induced distortion
- Signal loss secondary to diffusion on SE; partially corrected by FSE: \uparrow NEX, \uparrow SNR
- Avoid frequency-selective fat suppression and GRE techniques
- View Angle Tilt (Kim Butts, PhD): re-apply slice-select gradient during the read out period
- SEMAC (slice encoding for metal artifact correction; Lu et al MRM 2009): additional phase encoding in the slice direction
- MAVRIC (multi-acquisition variable-resonance image combination; Koch et al MRM 2009)
 - 3D sequence that samples off the resonant frequency with multiple “bins”

Imaging of Osteolysis

- Conventional radiographs underestimate the extent: Inaccurate; poor reliability
 - Oblique views impart greater sensitivity, especially at the posterior column/wall (*Southwell et al; JBJS 1999;81B;289-295*)
- Multidetector helical CT allows for higher mAs technique and facilitates reformations
 - Increase effective energy: HSS THA: 140 kVp, 300 mAs
 - Uses ionizing radiation; radiation burden for serial examinations; Inferior soft tissue contrast
- MRI more sensitive than x-ray (*JBJS 2004: 86A:1947-1954*)
 - Superior soft tissue contrast (process starts at a synovial/soft tissue level)
 - Direct multiplanar capabilities: No ionizing radiation

Accuracy of MRI in detecting periacetabular osteolysis (Walde et al; CORR 2005; 437: 138-144)

- MRI Sensitivity = 95%; Radiographs (with oblique views) = 52%; CT (optimized) = 75%
 - For radiographs and CT, lesion detection was dependent on lesion location
- MRI Specificity = 98%; X-Ray 96%; CT 100%

Prospective MRI Assessment of Wear-induced Synovitis

- MRI can distinguish between polymer +/- metal containing tissue and normal tissue without debris
- Pathology confirmed the absence of infection in all cases
- While sensitive for polymer debris, smaller amounts of metallic debris may go undetected by MRI
- ALVAL/ALTR appears to elicit a specific synovial pattern on MRI

MRI of MOM Surface Replacement: Prospective Evaluation

- Osteolysis present in 5/31 symptomatic hips (16%); All patients were symptomatic
- Synovial expansion present in 28/43 hips (65%); both symptomatic and asymptomatic
- In symptomatic pts, synovitis did correlate to blood Co ($r=0.6$, $p=0.03$) but not blood Ch

(MR) Imaging of Arthroplasty

- MOST ACCURATE TEST TO DETECT WEAR INDUCED SYNOVITIS AND BONE LOSS
 - Serial evaluation of painful AND asymptomatic arthroplasty
 - MRI allows for detection of joint lining at the origin of adverse biologic reaction
 - Quantitative assessment of intracapsular synovial load and osteolysis
 - Qualitative assessment of patterns of bone loss
 - Detect compression of adjacent nerves and vessels
- Synovial expansion (“pseudotumors”) occur with BOTH MOM and MOP constructs
- Not all soft tissue masses surrounding arthroplasties are wear-related
- Caution to implicate wear-induced disease with no expansion of the pseudocapsule
- MRI Protocols available through **potterh@hss.edu**

Iliopsoas Impingement and Tendinitis after Hip Arthroplasty

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Iliopsoas impingement and tendinitis is a poorly understood and likely under-recognized cause of groin pain and disability after total hip arthroplasty. Groin pain has been reported as frequently as 18% after metal-metal resurfacings, 15% of metal-metal total hip arthroplasties, and 4.3 to 7% of conventional total hip arthroplasties. The patient with this complication frequently has symptoms of groin pain with flexion-extension activities, such as climbing stairs, rising from a chair, or getting in or out of an automobile. The findings on physical examination are usually subtle, with mild groin tenderness and pain exacerbation by resisted seated hip flexion. After exclusion of component loosening, occult fracture, and infection, the diagnosis may be confirmed by imaging: cross-table lateral radiograph, computed tomography, magnetic resonance imaging, or ultrasonography. The diagnosis is confirmed by an image guided injection of the iliopsoas tendon sheath with local anesthetic and steroid.

Non-surgical treatment with medication, physical therapy and one or two injections into the tendon sheath has had limited success. In a literature review of 38 patients, non-surgical treatment was successful in only 39%. In the largest single center series, injection therapy was successful in 68% (13 of 19 patients) at short-term follow-up. It is unlikely to be successful when there is a prominent metal shell anterior to the bony acetabular rim or other metal impingement against the tendon. Surgical treatment consists of release or resection of the iliopsoas tendon alone or in combination with acetabular revision for an anterior overhanging component. In a literature review of 71 reported hips, surgical treatment was successful in 91% of hips at a mean follow-up of two years. The author recommends iliopsoas tenotomy or resection when the lateral radiograph or CT scan shows full anterior bone coverage of the metal shell. When imaging studies show anterior acetabular component overhang, the author recommends acetabular revision (if possible), combined with iliopsoas resection in the presence of visible inflammation or damage of the tendon.

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Treatment of Periprosthetic Osteolysis without Loosening

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I. Introduction

- Modular acetabular components in THA have been the component of choice for more than three decades in North America
- While achieving solid bone ingrowth of these components has proved reproducible with excellent long-term clinical track records, the polyethylene has been the weak link in the system
- Polyethylene wear and osteolysis are seen frequently with long-term follow-up
- The current generation of highly cross-linked polyethylenes will hopefully reduce the incidence of these complications, but millions of modular components with non highly cross-linked polyethylenes were performed globally, and the issues related to their failure modes, and indications for revision will be important clinical issues for decades to come
- While there are occasional exceptions, in general once osteolysis begins to develop it will be progressive and can lead to massive bone loss and acetabular component loosening
- Strategies to minimize the complications of massive osteolysis include routine radiographic review of THA patients (q1-2 years), more frequent reviews once the presence of osteolysis is established, and earlier rather than later surgical intervention once progression is seen

II. Assessment of Osteolysis

- In general, plain radiographs tend to underestimate the amount of true bone loss that is present
- Routine imaging may include:
 - i) AP Pelvis and AP and lateral hip views
 - ii) Judet views
 - iii) CT scan

III. Fundamental Questions to Answer

- I) *When should I operate?*
 - i) symptomatic patient (however <50% of patients with osteolysis will have symptoms)
 - ii) asymptomatic patient with large lesion potentially compromising component fixation
 - iii) asymptomatic patient with documented progression of osteolysis on serial radiographs
- II) *Why has the component failed?*
 - i) specific polyethylene issues
 - ii) cup design issues
 - iii) technical issues
 - iv) related to time in vivo

- v) r/o infection (especially if see early osteolysis)
- III) *Is the acetabular component solid or loose?*
 - i) often difficult to assess preoperatively
 - if 50% of shell circumference has osteolysis on AP or lateral x-ray, have a suspicion for possible fixation compromise
 - ii) may be an intraoperative decision – judiciously check acetabular component fixation intraoperatively

IV) *If the acetabular component is solid, can I retain it and either do a liner exchange or cement in a new polyethylene?*

A) Conditions necessary for a liner exchange:

- i) Satisfactory component position
- ii) Intact locking mechanism
- iii) Undamaged acetabular component
- iv) Liner of adequate thickness
- v) Acceptable track records of components
- vi) Ability to achieve intraoperative hip stability
- vii) Availability of polyethylene of appropriate shelf life and sterilization technique

B) Conditions necessary for cementing a liner

- i) Satisfactory component position
- ii) Adequate acetabular component internal diameter for cement mantle and polyethylene thickness
- iii) match age/demands of patient

IV. **Technical Considerations**

A) Liner Exchange

- Remove liner
- Assess component stability
- Assess locking mechanism
- Graft osteolytic lesions either directly, or via a trapdoor technique in the ilium (note – contraindicated if this compromises the lateral buttress of the pelvis)
- Always be prepared for a full revision with extraction devices and revision acetabular components and inserts and bone graft

B) Cementing a liner

- The acetabular component needs to be textured by design or by technique
- The polyethylene component needs to be textured by design or by technique
- The cement mantle should be 2-4 mm thick
- Avoid over-sized and uncontained polyethylene
- Performed correctly, cemented liners are equal to modular liners for push out strength

C) Bone grafting

- No data to suggest what technique or material is superior
- Cancellous chips probably most frequently used
- BMPs have been tried by this author as they are osteoinductive, but there is a significant cost associated with them

V. **Results and Complications**

- at this point there are only short-term reports in the literature
- the largest series is from the Norwegian Arthroplasty Register which demonstrated that isolated liner revisions (318 cases) had a higher re-revision rate than those cases that underwent revision of their ingrown sockets (398 cases)

- most frequent complication has been postoperative dislocation
- instability complication may be less with direct lateral approach

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Treatment of Dislocation with Big Heads and New Constrained Liners

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Dislocation after total hip arthroplasty is a potentially devastating complication that can be difficult to manage. Many patient and mechanical factors have been associated with an increased risk of dislocation. Surgical options include the use of larger femoral heads, unconstrained tripolar femoral heads, dual mobility designs and newer constrained devices. Advances in bearings have expanded prosthetic head options from traditional sizes to diameters as large as 60 mm. Large heads enhance stability secondary to increased range of motion before impingement and increased jump distance prior to subluxation.^{3,5}

Risk factors for dislocation can be categorized as impingement-independent and impingement-related. Impingement-independent factors involve compromise of soft tissue tension and maybe related to insufficient offset, improper position of the hip center, insufficient tissue balance, trochanteric avulsion, compromised abductor muscle or inadequate soft tissue closure. Patient specific factors include neurologic disorders, advanced age, gender, diagnoses such as developmental dysplasia and rheumatoid arthritis, number of previous surgeries, non-compliant patient behavior and substance abuse. While the posterior approach has been associated with a higher rate of dislocation versus the direct lateral approach, the incidence has markedly decreased with current emphasis on repair of the posterior capsular structures. The direct lateral approach (presenter's preference) has the advantage of improved visualization of the acetabulum and femur without the compromising the posterior capsular structures which are integral to the stability of the hip.^{3,4,6} Impingement-related risk factors for dislocation can be subdivided into several groups. While larger heads have been shown to decrease incidence of dislocation, head-to-neck ratio may be more important. Inadequate head-to-neck ratio produces impingement. Considering a standard neck length in a 7° included angle taper, range of motion prior to impingement increases from 127.4° for a 28mm head to 138.62° for a 36mm head. Additionally, the taper geometry has an effect on range of motion. A 36mm head with a 7° included angle taper will allow 138.6° range of motion prior to impingement while the same head size with 12/14 allows 132.09°. A neck design with flat sides or trapezoidal shape enhances range of motion prior to impingement. A long versus short neck is advantageous for minimizing bony impingement. Acetabular liners without high walls or labrums decrease impingement. Optimization of femoral and acetabular component position can decrease impingement. Finally, restoration of proper offset and removal of osteophytes can prevent bone and soft tissue impingement.

A thorough evaluation of the soft tissues is warranted because a tenuous or stretched abductor mechanism increases the risk of dislocation. Prosthetic stability can be enhanced by positioning the acetabular component in a reduced, more horizontal angle of inclination. A constrained acetabular component or a snap-fit cup with an extended labrum can also be helpful when dislocation potential is increased. The effectiveness of such intraoperative technical modifications can be enhanced by modifying the postoperative rehabilitation program to include the use of an abduction orthosis.

At the time of component reduction the surgeon must make final determinations with respect to stability and leg length. Optimally, the acetabulum should be reconstructed to

maintain the anatomic hip center and the femur should be reconstructed to restore its anatomic length. When dealing with the issue of hip stability versus leg length, one should always opt for stability. If a trochanteric osteotomy has been performed, stability may be enhanced by advancement of the trochanteric fragment. If a posterolateral approach has been performed, attempts should be made to repair the short external rotators. If the direct lateral approach has been used, meticulous approximation of the myofascial sleeve should be performed.

Postoperative management is dictated by the extent of surgical reconstruction performed. Stability as assessed at reduction is critical in determining need for a hip abduction orthosis during initial physical therapy and rehabilitation. The physical therapist should be apprised of concerns regarding stability and instruct the patient with respect to hip precautions such as prolonged sitting in a chair, techniques for rising from a toilet, climbing stairs and riding in a car. If a trochanteric osteotomy was performed, there should be appropriate delay in commencing hip abduction exercises.

With respect to dislocation, prevention is the best treatment and paramount to avoiding this complication. The soft tissue envelope about the hip must be respected in every primary and revision arthroplasty. Component position and orientation must be optimized. Restoration of offset and leg length helps to restore soft tissue balance and tension. The use of large femoral heads with reduced tapered geometries enhances the range of motion prior to impingement and therefore, diminishes the incidence of dislocation. Constrained liners may be indicated but represent a necessary evil and should be used with caution.² Our disappointing experience with the S-ROM Poly-Dial constrained liner has led us to explore newer designs.^{1,2} Several newer designs are approved for use in the U.S. One particular design used in our practice allows constraint of a 36mm head.¹ Therefore, the range of motion prior to impingement varies from 109 to 114°, a significant enhancement over previous designs. Results have improved with the introduction of these newer designs.¹

Suggested Reading

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Total Hip Arthroplasty following Failed Osteosynthesis

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Introduction

Patient survival is increasing following treatment of both pelvic and proximal femur fractures. Many patients go on to develop post-traumatic arthritis and may benefit from conversion THR. Goal of this talk:

1. Identify issues related to uniqueness of these cases.
2. Suggest treatment strategies to improve outcome

General Features

1. Regardless of whether discussing prior ORIF of pelvis or femur, must recognize:
 - a. Location of prior incision: compatible with your plan ?
 - b. Location and presence of prior hardware: need to remove or not ?
 - c. Always think about infection ! (data from Parvizi et al)
 - d. THE BONES:
 - i. United ? yes or no
 - ii. Continuous ? yes or no
 - iii. Deformed ? yes or no

Prior Pelvic ORIF

1. Hardware removal
 - a. If not in the way, leave it or remove with limited technique including from inside.
2. H.O. presence: removal and prophylaxis
3. Socket technique:
 - a. Fixation: usually hemisphere will work
 - i. Think of this as a revision: USE SCREWS !
 - b. Orientation:
 - i. Traditional landmarks may be altered
 - ii. Consider femur first technique if version is unclear

Prior ORIF Femur

1. Hardware removal
 - a. Get the right tools
 - b. Know the type of screw, plate, or nail
 - c. Modern nails may have distal screw interlock !!!
2. Subcapital fractures:
 - a. Fixation options either cement or cementless
 - b. Cementing:
 - i. May plug fixation holes with bone
 - c. Most standard stems work:
 - i. Length and offset not an issue
3. Intertrochanteric fractures:
 - a. A little more complicated:
 - i. Loss of height may necessitate calcar enhancing stem

- ii. Fixation: cemented but extrusion can be a problem. If cementless, consider longer stems if transfixation screws need to be bypassed
- iii. Malunion: modular stems can be an asset !
- iv. Nonunion: many of these patients have non-unions of part if not all of the fracture.

Option: excise nonunion fragments and replace with calcar type stem. Trochanteric fixation may require cable/plate.

- b. The emerging problem of intramedullary hip screws:
 - i. Union rates high (although cutout still occurs)
 - ii. The problem is the trochanter:
 - 1. Trochanteric non-union / fracture
 - 2. Huge hole through the abductors ! May affect abductor strength
 - iii. Sclerotic endosteum may influence stem orientation.

Results

Most studies demonstrate reasonable success with conversion but attention to detail is crucial.

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New Techniques for Treatment of Type B2 Periprosthetic Fractures

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The Vancouver Classification of femoral periprosthetic fractures is now widely used to define this injury, guide treatment and measure outcomes.

Vancouver B2 fractures involve a fracture around a loose femoral component with the remaining bone stock of good quality without excessive comminution. One recent fracture pattern is that of a fracture involving the calcar region medially and extending well below the lesser trochanter, particularly when a wedge-shaped tapered stem is used.

These fractures are best treated with a revision total hip arthroplasty, with the fracture being fixed with a long-stem revision implant. Different techniques have been used over the years.

Long-stem cemented fixation allows immediate weight bearing and is ideal for elderly patients with a limited life expectancy. However, this technique is not as durable as cementless fixation, and ultimate re-revision is difficult because of the length of the cement column. For this reason, this technique is not suitable for younger patients or patients with a life expectancy over 10 years.

Cementless fixation with fully porous-coated stems is a very effective and durable technique with excellent long-term results, notwithstanding the potential for stress shielding. Using this technique, the femur is reamed distally, and the remaining proximal femur is contoured to fit the implant. The fracture is reduced around a trial implant, and held provisionally with reduction clamps. The stem is then inserted distally. On occasion, a cortical only cortical strut is needed to control the fracture. A recent modification of this technique is the use of an additional extended trochanteric osteotomy to help with cement removal, and to further expose the femur for accurate distal reaming.

More lately, however, modular fluted titanium stems have been seeing an increasing popularity in North America. These stems not only allow excellent distal fixation with less proximal stress-shielding than long fully porous-coated stems, but also fine tuning of leg lengths by using different proximal bodies after the stem has been fixed distally. Because this technique depends on distal fixation, and the distal and proximal portions of the stem are independent of each other, this technique has greatly simplified the management of periprosthetic fractures. Using this so-called 'distally fixed scaffold approach', the distal femur is prepared to accept the distal portion of the stem. The stem is then inserted, and different proximal bodies are trialed to achieve the desired leg lengths and soft tissue tension. Once the length of the proximal body is determined, it can be attached to the distal stem, and the proximal bone is then reassembled around the stem. With this technique, particularly with B2 fractures, there is no need for cortical on lay strut allografts.

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SYMPOSIUM VIII: CURRENT TOPICS IN REVISION TOTAL HIP ARTHROPLASTY

4:17-4:25 pm

Modular Revision Stems - Pros and Cons

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Philosophy of modularity for revision THA

The philosophy of femoral stem modularity is twofold. First it allows the surgeon to separate the difficult task of achieving secure fixation for the stem from the equally difficult tasks of restoring hip stability, leg length and hip biomechanics. Second, it makes easier at least one part of a difficult operation.

Types of modular stems

The prototype of the modular revision stem is the product stem. The product stem is a modular cementless hip implant that has a modular proximal sleeve that mate with a fluted smooth stem, which is not designed for bone integration. The reliance of this stem on proximal bone integrity for ingrowth naturally limit its application to many of the more substantial bone defects commonly seen in revision surgery.

Modern modular revision stems employ tapered conical distal stems designed for immediate axial and rotational stability with subsequent osseointegration of the stem. Modular proximal segments now allow the surgeon to achieve bone contact proximally as well as distally with eventual ingrowth in either or both locations. Modularity of the revision stem builds on the advantages of the Wagner stem design with the ultimate goal of improving survivorship and reducing the incidence of stem subsidence and instability. The independent sizing of the proximal body and distal stem allows for each portion to obtain intimate bony contact and gives the surgeon the ability precisely control the femoral head center of rotation, offset, version, leg length, and overall stability. The key contrast between the modern tapered revision stems and the product is the distal fixation that is achieved with modern stems which allows for use in a more heterogeneous population of patients with distinct amounts of proximal femoral bone loss.

Advantages

Modern modular tapered revision femoral stems have numerous potential advantages. Of critical importance is the ability to manage an array of situations with significant femoral bone loss. This versatility allows the Arthroplasty surgeon to quickly gain familiarity with the techniques and instruments for preparation and implantation and subsequently master the use for a variety of situations. The versatility also allows the operating room staff to become quickly comfortable with the instrumentation and components. Additionally, the ability to use the stem in a variety of bone loss situations allows for less intraoperative shuffle, as bone loss can be significantly over and underestimated preoperatively. Furthermore, in almost all situations distal fixation can be obtained rather simply, and reliably.

Likely the most overt advantage to the modular revision stems is the ability to separate completely the task of fixation from other tasks such as restoring offset, leg length, and obtaining stability. The ability to do this potentially allows the surgeon to minimize patient restrictions postoperatively. The modular stems also enable the surgeon to quickly increase the length of the proximal body, change the neck-shaft angle, and change the femoral version. These allow for optimization of the component fit for each patient situation to maximize anatomic reconstruction of hip

mechanics, particularly offset. Additionally, the surgeon can control the diameter of the proximal body to ensure proper bony apposition if an extended trochanteric osteotomy was made to obtain femoral exposure.

Most modern modular systems employ straightforward instrumentation that aids in making the operation easier for the staff and the surgeon, while enhancing the operating room efficiency and reducing cost. Also, although the implant itself may result in more cost, most modular systems allow for a decrease in inventory requirements, which could potentially make up the cost differential.

Disadvantages

Although there are clear advantages to the modularity in the revision stem, there exists potential disadvantages that must be understood and addressed. Fracture of a femoral component is a relatively rare complication of THA, however, modularity increases the number of mechanical interfaces that can potentially lead to fretting, corrosion, and ultimately fracture. Several prior studies have demonstrated failure at the neck of modular femoral implants with design weaknesses. Also, fatigue fracture of the product B stem was recently reported in the literature, potentially related to the lack of proximal femoral bone support. In most femoral revision situations there is some bony support at the proximal junction, which could limit this risk. Additionally, as designs improve upon weaknesses of the previous generation of implants, and manufacturing and machining of arthroplasty implants improves the potential for fractures and complications at the modular junctions is reduced.

In the era of healthcare reform with the spotlight on reducing costs, it must be mentioned that at the current time there may be increased implant costs associated with modular revision components, as compared to the non-modular components. This, of course, may depend on the individual hospital contracts with the implant manufacturers, but a cost advantage may come in the form of decreased operating room time and improved operating room efficiency with the use of a single system for most revision femoral work, as well as the ability to decrease inventory with a modular system.

Clinical results

We prospectively followed 118 patients who underwent 122 revision hip surgeries (four bilateral) using a modern cementless modular revision femoral component between 2003 and 2007, and obtained a minimum two-year follow-up. Eighty percent of revisions were for pain with radiographic evidence of femoral loosening, while the other twenty percent were for a variety of reasons including periprosthetic fracture, periprosthetic infection, conversion total hip arthroplasty, and instability.

The product outcome values improved from a preoperative mean of 68 to a postoperative mean of 82, while Harris Hip Scores improved from a preoperative mean of 62 to 77. Subsidence of the femoral stem was less than 5mm in 98% of hips, with one stem demonstrating 5mm of subsidence, and another stem showing 7mm of subsidence. There was radiographic evidence of osseointegration in 100% of revisions. Femoral offset (as compared to the contralateral side) was restored in 66% of hips, while in 19% the offset was increased between 3 to 5mm, and in 16% the offset was decreased between 3 to 6mm.

Leg length was corrected to within 5mm of the contralateral leg in 78% of hips. When the preoperative leg length discrepancy was less than 2cm the leg length was corrected to within 5mm in 93% of cases. Reoperations were performed in 10 cases (8%) – including two for instability (treated with constrained liners), one for a Vancouver Type B1 periprosthetic fracture (treated with product C), and two for treatment of hematoma, and two for treatment of deep infection.

Our results indicate that the modern modular femoral revision stem allows for the ability to secure adequate initial fixation of the femoral component with minimal subsidence, obtain excellent osseointegration (100% in this series), offer a low dislocation rate (3%), and restore leg lengths and femoral offset (although there is no comparison in the recently published literature).

The Use of Porous Metal Augments in Revision Hips with Severe Peri-Acetabular Defects: A 6 year Follow-up.

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Background

Hemispherical acetabular components can be used in the majority of acetabular revisions. However, severe periacetabular bone loss or an associated pelvic discontinuity can result in compromised initial fixation and result in subsequent early loosening. Porous metal acetabular augmentation is one method to improve initial stability and promote bone ingrowth. The purpose of this study was to evaluate the midterm results of porous acetabular augmentation in Paprosky Type IIIA defects without a pelvic discontinuity and in Paprosky Type IIIB defects with an associated pelvic discontinuity.

Methods

40 patients with a Type IIIA acetabular defect and 28 patients with a Type IIIB acetabular defect underwent an acetabular revision using a porous tantalum elliptical acetabular component along with one or more porous acetabular augments between 2002 and 2008. Patients were followed semi annually with clinical and radiographic evaluation.

Results

40 patients (40 hips) treated for a Type IIIA acetabular defect were identified at an average follow-up of 5.0 years. 4 patients were unable to be located while 2 additional patients had died a minimum of 2 years after surgery and were included. One of the remaining 36 patients required re-revision for aseptic loosening while all remaining acetabular components were considered radiographically stable. The average modified Merle d'Aubigne pain and ambulation score improved from 3.5 to 9.7.

28 patients (28 hips) treated for a Type IIIB acetabular defect were identified at an average follow-up of 4.5 years. 5 patients were unable to be located while 3 additional patients had died a minimum of 2 years after surgery and were included. One of the remaining 23 patients required re-revision for aseptic loosening while 4 additional patients had early migration of their acetabular component and were considered radiographically loose despite remaining asymptomatic and demonstrating no further component migration. The remaining 18 hips remain radiographically stable with an average improved modified Merle d'Aubigne pain and ambulation score from 3.3 to 9.6.

Conclusions

The use of a porous acetabular augment in Paprosky Type IIIA defects without a pelvic discontinuity and in Paprosky Type IIIB defects with an associated pelvic discontinuity demonstrate favorable midterm clinical and radiographic outcomes. Porous acetabular components with an associated acetabular augment provide a biological alternative for acetabular reconstruction in patients with severe periacetabular bone loss with or without an associated pelvic discontinuity.

Revision of Failed Ceramic-Ceramic and Metal-Metal Hip Arthroplasties

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Hard-on-hard bearings (metal-metal and ceramic-ceramic) became popular in the past decade in an attempt to improve the results of THA. The proposed advantages were two-fold: To lower the wear rate and debris generation from the articulating surface and to increase stability through the use of larger heads (particularly in the case of metal-metal). Both of these bearing options were developed and gained popularity before the clinical track record of highly cross-linked polyethylene was as well established as it is today. Current evidence indicates that the wear rate of HCLPE is 50-90% lower than conventional PE even for thinner liners which allows for use of larger heads, neutralizing to a substantial degree the purported advantages of the hard bearings. This data emerged over time, however, as hard bearings became available in the market place and grew rapidly and peaked in the 40% range by around 2006. Since that time, hard bearing use has steadily declined due to unique complications reported with varying frequency. For ceramics, the major unique complications are breakage and noise generation (squeaking); for metals the major issue is adverse tissue reactions of various descriptions and to a lesser degree failure of ingrowth or early loosening of components. To determine the spectrum, incidence, and severity of complications and revisions encountered with the use of hard bearings, the clinical results at two major centers with extensive experience with each of the bearings was reviewed.

At the Rothman Institute/Thomas Jefferson University, 1,756 ceramic-ceramic components were implanted and followed clinically. The average age was 49.7 years and 60.2% were male. The overall revision rate was 2.2% (38/1756) with the most common etiology being aseptic loosening of the cup (8), stem (10), or both (3) for and overall failure of fixation rate of 1.2% or 55% of the revisions (21/38). Five cases (0.2% overall; 13% of revisions) were definitely related to the bearing surface (squeaking 4, fracture 1) and ten cases were potentially attributable to the bearing surface (impingement, subluxation, wear; 0.6% overall, 26% of revisions). The revision procedures were straight forward, not associated with extensive tissue damage, and demonstrated a good to excellent result at follow-up averaging 54 months. Average time to revision was 25.7 months.

Between 1996-2006 1,542 metal-metal primary THAs were performed by Joint Implant Surgeons of Columbus, Ohio of which minimum two year follow-up was available on 1,215 (76%). Three systems were utilized, a modular titanium shell with a Co-Cr insert with a 28mm or 32mm inner diameter insert, a Co-Cr monoblock shell of increasing thickness mated with a 38mm Co-Cr head, and a Co-Cr monoblock thin (3mm) shell with anatomic heads of increasing diameter (40-60mm). The average age was 57 and follow-up average 60.2 months. The overall revision rate was 5.3% (64/1215) of which 16 were adverse tissue reactions definitely related to the metal-metal implant (1.3% of cases overall 16/1215; 25% of revisions, 16/64). The most common cause of revision was failure of fixation which occurred in 33 cases (2.7% overall; 51% of revisions, 33/64). The incidence of revision was higher in women and higher for some components than others. In addition the results of revision was associated with substantial tissue damage in many cases, a compromised clinical result following revision, and a higher than expected re-revision rate.

Revision of Hip Resurfacing: As Good as a Primary Total Hip?

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Background

In three prospective randomized trials[1-3], metal on metal (MOM) hip resurfacing (HR) has been shown to be comparable in clinical outcome to total hip replacement (THR) with significantly lower metal ion release than large head MOM THR[1,4]. However, the outcomes of revision HR, are a topic of debate with some studies showing it comparable to primary THR[5] and others showing that the reason for revision (i.e. pseudotumor) being associated with a poorer outcome[6,7]. The purpose of this study is to compare outcomes of patients undergoing revision of HR to those undergoing primary THA at our center.

Methods

Twenty-six patients (19M, 7F, mean age = 51.4±6.6 years) undergoing revision of HR to a THA from 2004-2009 (Group A) were retrospectively reviewed and compared to 26 patients undergoing THA for primary osteoarthritis with no prior hip surgery (Group B) (20M, 6F, mean age = 52.0±5.5 years). HR revisions were required due to excessive pain (n=10), fracture (n=7), cup loosening (n=6), femoral loosening (n=2), and pseudotumor (n=1). Four of the 26 failed resurfacings had isolated revision of the acetabular component. Average time to revision was 20.2±16.3 mos.

Results

Mean length of hospital stay was 3.3±1.0, and 3.6±0.9 days for groups A, and B, respectively (p=0.27), while blood loss was 532.5±174.0, versus 410.9±111.8 cc. (p=0.007) with no patients requiring transfusion. Functional outcome were comparable in both groups. One patient in the HR group required re-revision due to cup loosening secondary to metal hypersensitivity. One patient in the primary THA group required revision secondary to aseptic loosening of acetabular component.

Conclusions

Our results indicate that revision of HR has comparable functional outcomes to primary THA with no difference in complication rates. Further longitudinal studies are necessary to determine the long term survivorship of the primary total hip after failed HR.

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CME Accreditation Statement

This activity has been planned and implemented in accordance with the Essential Areas and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint sponsorship of the American Academy of Orthopaedic Surgeons and The Hip Society.

The American Academy of Orthopaedic Surgeons is accredited by the ACCME to sponsor continuing medical education for physicians.

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The American Academy of Orthopaedic Surgeons designates this continuing educational activity for a maximum of 7.75 *AMA PRA Category 1 Credits™*. Physicians should only claim credit commensurate with the extent of their participation in the activity.

Goals and Objectives

The objectives of the Open Meeting of The Hip Society are to provide up-to-date information on the treatment of hip problems including arthroplasty and non-arthroplasty options and surgical techniques. Interactive symposia will be utilized.

Upon completion of this program, participants should be able to:

- Update clinical skills and basic knowledge through research findings and biomechanical studies.
- Discuss the various surgical and non-surgical treatments and management of conditions related to the hip joint.
- Determine indications and complications in total hip arthroplasty.
- Critique presentations of surgical techniques and demonstrations of treatment options.
- Evaluate the efficacy of new treatment options through evidence-based data.

FDA Statement

Some pharmaceuticals and/or medical devices at the Specialty Day Meeting have not been cleared by the U.S. Food and Drug Administration (FDA) or have been cleared by the FDA for specific purposes only. The FDA has stated that it is the responsibility of the physician to determine the FDA status of each pharmaceuticals and/or medical devices he or she wishes to use in clinical practice.

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Each participant in The Hip Society/AAHKS Meeting has been asked to disclose if he or she has received something of value from a commercial company, which relates directly or indirectly to the subject of their presentation. The Hip Society has identified the options to disclose as follows:

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Lawrence D Dorr, MD (Los Angeles, CA): 1 (Zimmer);3C (Mako Surgical Corp.);4 (Mako Surgical Corp. Total Joint Orthopedics);8 (Journal of Bone and Joint Surgery - American; Clinical Orthopaedics and Related Research; Journal of Arthroplasty); Submitted on: 09/30/2010. *

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Peter F Sharkey, MD (Media, PA): 1 (Physician Recommended Nutraceuticals, Inc.);2 (Stryker Stelkast, Inc.);3B (Stryker Stelkast, Inc.);4 (Physician Recommended Nutraceuticals.);7 (Journal of Arthroplasty American Journal of Orthopedics Clinical Orthopaedics & Related Research American Journal of Orthopaedics);8 (Journal of Arthroplasty);9 (American Association of Hip & Knee Surgeons); Submitted on: 09/30/2010 and last confirmed as accurate on 10/04/2010. *

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