COA Paper Session 6: Hip Reconstruction 1 ●
Moderators Douglas Naudie, ON, and Dick van der Jagt, President of the South African Orthopaedic Association

47 –
Prospective Randomized Trial Comparing Alumina Ceramic-On-ceramic with Ceramic-On-conventional Polyethylene Bearings in Total Hip Arthroplasty: Up to 10 Years Follow-up in Patients Under Age 60
Peter Lewis, St Michael's Hospital, Toronto; Ali Al-Belooshi, St Michael's Hospital, Toronto; Michael Olsen, St Michael's Hospital, Toronto; Emil H. Schemitsch, St Michael's Hospital, Toronto; James P. Waddell, St Michael's Hospital, Toronto

Purpose: The use of UHMW polyethylene acetabular liners is known to cause polyethylene wear related osteolysis, the major limiting factor in its use in the younger active patient. Modern alumina ceramic articulations have been developed in order to reduce wear and avoid polyethylene debris. This prospective randomized long-term study aims to compare the outcome between an alumina ceramic-on-ceramic (CC) articulation with a ceramic on UHMW polyethylene articulation (CP). **Method:** Fixty-six hips in 55 patients with mean age 42.2 (range 19-56) each received uncemented components (Wright Medical) and a 28mm alumina head with acetabular liner selected via sealed envelope randomization following anesthetic induction. Subsequent regular clinical and radiologic follow up measured patient outcome scores and noted any radiological changes. **Results:** Twenty-six CP hips and 30 CC hips were evaluated. One failure required revision in each group. Mean St Michael's outcome score for each group with up to 10 years follow-up (median 8 years, range 1-10) was 22.8 and 22.9 respectively ($p=0.057$). Radiographs with a minimum 5 years post-operative follow-up were analyzed in 42 hips (23 CC and 19 CP). The mean time of wear measurement for the CC group was 8.3 years (SD 1.3, Range 4.8-10.1 years) and for the CP group was 8.1 years (SD 0.9, Range 6.1-9.2 years)($p=0.471$). Wear was identified in all but one CP hip but in only 12 of 23 CC replacements. Mean wear in the CP group was 0.11mm per year and 0.02mm per year in the CC group ($p<0.001$). **Conclusion:** To our knowledge this is the first long term randomized trial comparing in-vivo ceramic-on-ceramic with ceramic-on-polyethylene hip articulations. Other than significantly greater wear in the polyethylene group there was no significant difference in long-term outcome scores between the two groups with up to 10 years of follow-up. The use of a ceramic-on-ceramic bearing is a safe and durable option in the young patient avoiding the concerns of active metal ions and osteolytic polyethylene debris.

48 –
Randomised Double-blinded Study Comparing Clinical Outcome and Gait Characteristics After Large Diameter Head Total Hip Arthroplasty (LDH-THA) and Hip Resurfacing (HR)
Martin Lavigne, Université de Montreal; Julie Nantel, Université de Montreal; Alain G. Roy, Université de Montreal; Francois Prince, Université

de Montreal; Pascal-André Vendittoli, Université de Montreal; Marc Therrien, Université de Montreal

Purpose: Better clinical outcome is generally reported after hip resurfacing when compared to conventional 28mmTHA. This may simply be the consequences of biased patient selection, patient perception or the advantageous use of larger diameter femoral heads in HR. The true clinical benefits of HR can only be assessed by comparison with LDH-THA in a blinded randomized study to eliminate/reduce those biases. This was the aim of the study. **Method:** Charnley class A patients were randomized between HR or LDH-THA and kept blinded for one year. Clinical data, gait analysis, postural balance evaluations and functional tests were performed preoperatively at 3, 6, 12 and 24 months postoperatively. Fourteen normal patients served as controls. **Results:** Twenty-four patients were assigned to each group. There was no significant difference in WOMAC, SF-36, activity scores, and patient satisfaction. A slight advantage was observed for HR during the functional reach test (postural balance) and for LDH-THA during the step test (speed, strength and balance), all other tests showing no differences. Both groups quickly reached controls value for all tests by 3 months. **Conclusion:** We have failed to demonstrate a clear difference in outcome between HR and LDH-THA. Both groups fully recovered quickly. The postulated clinical advantages of HR over 28mmTHA most likely result from using a larger head in highly motivated patients. The only clear advantage of HR over LDH-THA remains proximal femoral bone conservation, although with the excellent durability of currently used femoral stems, HR has to demonstrate comparable survivorship before bone conservation is considered a true benefit.

49 –

Biomechanical Reconstruction of the Hip: 28mm THA versus Large Diameter Head THA versus Hip Resurfacing

Martin Lavigne, Université de Montreal; Payam Farhadnia, Université de Montreal; Pascal-André Vendittoli, Université de Montreal

Purpose: Clinical studies still show significant variability in offset and leg length reconstruction after 28mmTHA. Precise restoration of hip biomechanics is important since it reduces wear and improves stability, abductor function and patient satisfaction. There is a tendency to increase offset and leg length to ensure stability of 28mmTHA. This may not be needed with the more stable LDHTHA and hip resurfacing implants, therefore potentially improving the precision of the hip reconstruction. The aim of this study was to verify this assumption. **Method:** Leg length and femoral offset were measured on standardized digital radiographs with a computer software in 254 patients (49 HR, 74 LDHTHA, 132 28mmTHA) with unilateral hip involvement and compared to the normal contralateral side. **Results:** Femoral offset was increased in 72% of 28mmTHA (mean +3.3mm), 56% of LDHTHA (mean +1.0mm) and 8% of HR (mean -3.2mm) (intergroup differences $p<0.05$). The mean LLI was greater after 28mmTHA (+2,29mm) vs. (-0.45mm for LDHTHA and -1.8mm for HR). The percentage

of patients with increased leg length >4mm was greater for 28mmTHA (11%) compared to LDHTHA (2.7%) and HR (2%). **Conclusion:** The stability afforded by the larger head of LDHTHA reduces the surgeon's tendency to increased leg length and femoral offset to avoid instability as during 28mmTHA. In addition, compared to HR, LDHTHA allows more precise restoration of equal leg length and femoral offset in patient with greater pre operative deformities (low femoral offset and LLI > 1cm). LDHTHA may represent the most precise method of hip joint reconstruction.

50 –

Proximal versus Fully Porous Coated Femoral Stems: A Multicenter Randomised Trial

Steven J.M. MacDonald, University Hospital, University of Western Ontario; Robert L. Barrack, Washington University Department of Orthopaedic Surgery; Seth Rosenzweig, Tulane University Department of Orthopeadic Surgery; Jeffrey F. Guerin, University Hospital, University of Western Ontario; Richard W. McCalden, University Hospital, University of Western Ontario; Eric Bohm, University of Manitoba Joint Replacement Group; Robert B. Bourne, University Hospital, University of Western Ontario; Cecil H. Rorabeck, University Hospital, University of Western Ontario

Purpose: There are two broad-based categories of cementless femoral components performed during total hip arthroplasty: proximally coated versus fully porous coated. While both have enjoyed widespread clinical applications, there remains debate regarding differences in clinical outcome scores, relative incidence of thigh pain and the development of stress shielding. The purpose of this study was to investigate these variables in a multi-center prospective randomized blinded clinical trial. **Method:** Between three centers 388 patients were enrolled in this clinical trial. 198 patients received a proximally coated tapered cementless femoral component (Synergy, Smith and Nephew, Memphis) and 190 patients received a fully porous coated cementless femoral component (Prodigy, Depuy, Warsaw). Patients were evaluated pre-operatively, at 3, 6, 12 months and annually thereafter, with multiple validated outcome measures including WOMAC, SF12, HSS, UCLA activity and thigh pain scores. A cohort of 72 patients underwent preoperative and postoperative DEXA scanning. **Results:** 367 patients had a minimum of 2 years follow-up (average 6.4 years). There were no differences in age at surgery, BMI, or pre-operative clinical outcome scores (WOMAC, SF12, HSS, UCLA activity, thigh pain) between groups. There were no differences in any post-operative clinical outcome scores at any interval of follow-up. There were no differences in incidence of thigh pain between groups at any time. The only measurable difference between study groups was in bone mineral density evaluation. Bone density change in Gruen zone 7 was 23.7% with the Prodigy stem and 15.3% with the Synergy stem (p=0.011). **Conclusion:** Both fully porous coated and proximally porous coated cementless stems performed well, with no clinical differences at a minimum of 2 years follow-up. Only bone mineral density evaluations could detect any differences between these femoral components designs.

51 –

Cemented and Cementless Total Hip Arthroplasty: Results of a Randomised Controlled Trial at 17 to 21 Years Follow-up

Keegan Au, London Health Sciences Centre; **Kristoff Corten**, University Hospital, University of Western Ontario; Robert B. Bourne, University Hospital, University of Western Ontario; Cecil H. Rorabeck, University Hospital, University of Western Ontario; Andreas Laupacis, Li Ka Shing, Knowledge Institute of St. Michael's Hospital

Purpose: A randomised controlled trial comparing fixation of a Mallory-Head prosthesis for total hip arthroplasty (THA) with and without cement was performed with average 19 years (range 17-21 years) of continuous follow-up. **Method:** Two hundred and fifty patients were randomised to undergo THA using either a Mallory-Head THA prosthesis designed to be inserted with cement or one designed for cementless insertion. Both patients and those involved in outcome assessment were blinded to the type of implantation. Patients were followed yearly after the first post-operative year for outcomes including mortality, revision arthroplasty, and health-related quality of life assessment scores. **Results:** Primary THA was performed with cement in 124 patients and without cement in 126 patients. Mean age at the time of surgery was 64 years, and 48% were female. During the period of review, there were 78 (31%) deaths in the cohort, and 75 (30%) patients underwent revision surgery. Kaplan-Meier survivorship analysis revealed significantly increased revision rates in cemented compared with cementless THA using failure of either component ($p=0.01$) or femoral component ($p<0.001$) as endpoints. Although acetabular failure accounted for most revisions overall, no significant difference between groups was noted ($p=0.075$). With the exception of cost to quality adjusted life years, all quality of life outcome measures improved post-operatively and, although reducing modestly through the period of review, demonstrated no difference between groups at final follow-up. **Conclusion:** This study has demonstrated a concerning high revision rate with both cemented and cementless THA in patients with a mean age of 64 years at the time of surgery, which significantly affected cost effectiveness. With the implants studied, cementless femoral fixation was superior to cemented, with no cementless femoral component failures through the duration of this study. This study demonstrates the importance of post-market surveillance and evidence-based improvements in THA design (i.e., bearing couples and fixation).

52 –

Total Hip Replacement Surgery Utilizing the Echelon Primary Femoral Stem

Peter Lewis, St. Michael's Hospital, Toronto; Michael Olsen, St. Michael's Hospital, Toronto; Emil H. Schemitsch, St. Michael's Hospital, Toronto; James P. Waddell, St. Michael's Hospital, Toronto

Purpose: While the durability of most uncemented femoral stems remains unknown, it is the aim of this study to demonstrate Echelon Primary femoral stem performance with regard patient outcome and overall implant survival.

Method: Between February 1998 and March 2007, 428 patients received the Echelon Primary stem. The mean age of each patient was 58.1 (SD 11.1, Range 20-87). Body mass index averaged 30.5 kg/m2 (SD 5.8, Range 17.7-58.2). The majority of patients received a Reflection uncemented acetabular component (91%) and an ultra high molecular weight polyethylene liner (76.5%), although the highly cross linked polyethylene is now used with increased frequency, used in 31% of hips since 2005. The majority of femoral heads were cobalt chrome (79.3%). **Results:** Kaplan Meier survivorship for the Echelon Femoral stem with revision for aseptic loosening as end point at 100 months is 99.3% (95% CI 97.1-99.8). Taking revision for any reason as the end point the Kaplan Meier survivorship is 98.3% at 100 months (95% CI 95.9-99.3). A pre-operative WOMAC score was available for 345 of the 392 patients with mean score of 43.5 (95% CI 41.6-45.4). At the three-month post-operative review the mean WOMAC score was significantly increased to 74.54 (95% CI 72.7-76.3)($p<0.001$) and by 1 year 84.3 (95% CI 80.5-88.1). At subsequent years, the modified WOMAC score remained at a plateau of around 80. General health assessment using the SF-36 shows an improvement in the physical component score from 33.1 (95% CI 32.3-33.9) preoperatively to 42.6 (95% CI 41.7-43.6)($p<0.001$) at three months and 48.19 (95% CI 44.2-52.2) at latest follow up. The mental component scores increased from 48.7 (95% CI 47.6-49.9) to 51.4 (95% CI 50.3-52.4)($p<0.001$) and 53.5 (95% CI 50.3-56.6) respectively. **Conclusion:** This large prospective review of the Echelon Primary femoral stems reveals an excellent survivorship of the stem with a 99.3% survival at 8 years with regard aseptic loosening and 98.3% survival including revision for any reason. Patient outcome scores are significantly improved and subsequently maintained. There have been no changes with regard to manufacture or design of the stem within the period of review.

53 –

Radiographic Review of Limb Length Discrepancy in Total Hip Arthroplasty

Mitchell J. Winemaker, Hamilton Arthroplasty Group, Hamilton Health Sciences Henderson Hospital; Anthony Staibano, McMaster University; Danielle Petruccelli, Hamilton Arthroplasty Group, Hamilton Health Sciences Henderson Hospital; Justin de Beer, Hamilton Arthroplasty Group, Hamilton Health Sciences Henderson Hospital; **Carlos Lopez,** McMaster University Faculty of Health Sciences

Purpose: We retrospectively reviewed the pre- and post-operative radiographs of 116 patients receiving primary THA in a high volume arthroplasty centre to evaluate technical causes for limb length discrepancy. We hypothesized that limb lengthening most commonly occurs as a result of low placement of the acetabular implant. **Method:** A sample of 116 primary THA's performed between 2005 and 2007 with complete one-year postoperative clinical outcomes scores and appropriate radiographs available on PACS were identified from a prospective arthroplasty database. Pre- and one-year postoperative AP bilateral hip radiographs were reviewed, and pre- and post-operative leg length discrepancy as well as the respective

acetabular and femoral contribution to any postoperative leg length discrepancy (if present) were measured. **Results:** We found that 19 THA's out of 116 (16.4%) were lengthened greater than 8 mm. Mean difference from preoperative to postoperative leg length was 13.3 mm (SD 7.6 mm). A mean of 6.3 mm (SD 6.2 mm) in lengthening was contributed by the femoral stem, and 5.3 mm (SD 6.3 mm) of lengthening was contributed by placement of the acetabular implant (p=0.738). There was a significant correlation between lengthening of the limb and femoral placement of the stem (r=0.5, p<0.0001). Likewise, there was a strong correlation between limb lengthening and low placement of the cup (r=0.6, p<0.0001). Of those limbs that were lengthened greater than 8 mm, Oxford Hip Score at one-year post-operative was not correlated with over-lengthening (r=0.06, p=0.551). **Conclusion:** These results support our hypothesis that limb lengthening is indeed due to low placement of the acetabular implant, and equally this was attributable to error in placement of the femoral stem. We conclude that with careful preoperative planning and intraoperative identification of the tear drop, a significant reduction in clinically relevant limb lengthening can be achieved.

54 –

Determination of Novel Anatomical Landmarks for Use in Navigated Hip Replacement in the Lateral Position

Andrew Warner, Robarts Research Institute; **Douglas Naudie**, London Health Sciences Center, University Hospital; Xunhua Yuan, Robarts Research Institute; Robert B. Bourne, London Health Sciences Center, University Hospital; Cecil H. Rorabeck, London Health Sciences Center, University Hospital; David Holdsworth, Robarts Research Institute

Purpose: Accurate acetabular cup positioning is essential to successful total hip arthroplasty (THA). Intra-operative navigation of the acetabular component can optimize positioning, but often necessitates registration of the pelvis in the supine position. The majority of surgeons use the lateral position, however, which hides commonly employed registration landmarks. The purpose of this study was to identify novel anatomical landmarks for use in navigated THA from the lateral approach. **Method:** We identified 156 patients that underwent pelvic CT scans for non-orthopaedic reasons from which 60 patients (mean age 62 years; 30 males, 30 females) were included in the study. CT scans were analyzed with sophisticated software (region grow, isosurface creation, and geometry overlay features). Saved coordinates from each scan were inputted into the program MATLAB (Mathworks, Natick, MA), v7.0, on a Macintosh-based workstation. A code was created to be able to calculate the normal vector for both planes and then calculate the angle formed between the normal vectors. The anterior plane (pubic tubercle (PT) and anterior superior iliac spine (ASIS)) was defined in addition to a series of lateral planes by retaining the ipsilateral PT and ASIS from the anterior plane, plus a variable third landmark. Angles obtained were those between the anterior and lateral planes. Angle conversions between the planes were analyzed using a paired t-test with a p-value of <0.05 accepted as significant. **Results:** The list of landmarks

acquired included those used for supine registration (PT and ASIS) in addition to: posterior superior iliac spine (PSIS); posterior inferior iliac spine, (PIIS); ischial tuberosity (IT); tuberculum of the iliac crest (TIC); and a line drawn along the outer lip of the iliac crest. The angle between the anterior plane and the novel lateral planes did not show a significant level of variance for two of the proposed lateral planes ($P<0.05$). **Conclusion:** An imageless navigation system in THA that can be accurately employed in the lateral position will benefit many surgeons. The invariance in angle calculations for the lateral planes calculated using the PSIS and the TIC suggest that they could be novel pelvic landmarks for lateral plane registration.

55 –

Early Experience of Hueter-anterior Approach for Hip Resurfacing

Paul-Edgar Beaulé, University of Ottawa; Benoit Benoit, University of Ottawa

Purpose: The short-term results of metal-on-metal hip resurfacing (HR) have been excellent. However, extensile approaches such as the posterior and trochanteric slide have been used to ensure proper component placement. The minimally invasive (MI) anterior Hueter approach is both muscle and vascular sparing to the femoral head. The purpose of this study is to evaluate the learning curve of this approach in performing hip resurfacing. **Method:** The first 50 MI HR done by a single high volume arthroplasty surgeon were compared with his previous fifty procedures performed through a trochanteric slide osteotomy, with respect to (BMI, sex, etiology and age) were comparable ($p= .372$, .122, .143 and .353, respectively). **Results:** Overall, the traditional transtrochanteric lateral approach took significantly longer to perform compared to MI RAH (97 versus 109 minutes, $p=0.014$). If we exclude the first 25 MI RAH cases (mean, 106 minutes), the difference is greater (89 versus 109 minutes, $p=0.002$). The mean femoral component stem to femoral shaft angle (SSA) was not significantly different between the two groups (MI RAH=142.7, lateral approach=140.0, $p=0.053$). The cup abduction angle (CA) was slightly different between the two groups (MI RAH 42.5°, lateral approach=39.2°, $p=0.03$). More patients had cup abduction angles in the 45°-55° range ($p=0.009$) in the MI HR group but none had a cup angle over 55° of abduction in either group. On the femur side, component positioning was comparable. **Conclusion:** Based on our early results, the anterior-Hueter approach is a reasonable alternative to more extensile surgical approaches. Like any MI approach to hip surgery, great care has to be taken not to put the cups too vertical. Further long-term studies as well as comparisons to other approaches such as the posterior approach will determine if the anterior approach can be recommended for hip resurfacing.

56 –

Computer Navigated Hip Resurfacing: An Evaluation of Accuracy and Learning Curve

Michael Olsen, St. Michael's Hospital; Edward T. Davis, Royal Orthopaedic Hospital, Birmingham, U.K.; James P. Waddell, St. Michael's Hospital; Emil H. Schemitsch, St. Michael's Hospital

Purpose: Hip resurfacing is a technically demanding alternative to total hip arthroplasty. Placement of the initial femoral guidewire utilizing traditional mechanical jigs may lead to preparatory errors and a high degree of variability in final implant stem-shaft angle (SSA). Intra-operative computer navigation has the potential to decrease preparatory errors and provide a reliable method of femoral component placement. The current study evaluated the accuracy and learning curve of 140 consecutive navigated hip resurfacing arthroplasties. **Method:** Between October 2005 and May 2007, 140 consecutive Birmingham Hip Resurfacings were performed on 132 patients (107 male, 25 female). The mean age of the cohort was 51.2 years (range 25-82). Indications for surgery included osteoarthritis (n=136) and avascular necrosis (n=4). Pre-operative templating was performed using digital AP unilateral hip radiographs. Neck-shaft angles (NSA) were digitally measured and relative implant stem-shaft angles planned. The central guidewire was drilled and verified intra-operatively using an imageless navigation system. Implant stem-shaft angles were assessed using 3 month post-operative radiographs. **Results:** Pre-operative templating determined a mean NSA of 132.2 degrees (SD 5.3 degrees, range 115-160). The planned SSA was a relative valgus alignment of 9.5 degrees (SD 2.6 degrees). The post-operative SSA differed from the planned SSA by 2.5 degrees (SD 1.9 degrees, range 0-8). The final SSA measured within ±5 degrees of the planned SSA in 89% of cases. Of the remaining 11% of cases, all measurements erred in valgus. No cases of neck notching or varus implant alignment occurred in the series. The mean navigation time for the entire series was 18 minutes (SD 6.6 minutes, range 10-50). A learning curve was observed with respect to navigation time, with a significant decrease in navigation time between the first 20 cases and the remainder of the series. There was no evidence of a learning curve for implant placement accuracy. **Conclusion:** Imageless computer navigation shows promise in optimizing preparation of the femoral head and reducing the introduction of mechanical preparatory factors that predispose to femoral neck fracture. Navigation may afford the surgeon an accurate and reliable method of femoral component placement with negligible learning curve.