What's New in Total Hip Arthroplasty

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Total hip arthroplasty remains one of the most frequently performed reconstructive operations. Much work has again been done in this discipline over the past year with regard to scientific investigation, clinical outcome assessment, and the treatment of complications. In addition, controversies related to venous thromboembolism, medical-legal issues, and surgeon-industry relationships have been at the center of scrutiny and media coverage. We have elected to organize this update into six sections: (1) outcome of primary total hip arthroplasty, including bearing surface options; (2) outcome of revision total hip arthroplasty, including new methods of enhancement of bone growth and fixation; (3) hip resurfacing arthroplasty; (4) minimal incision surgery; (5) complications; and (6) practice management, including medical-legal issues, workforce issues, and industry-surgeon relationships.

**Outcome of Primary Total Hip Arthroplasty**

**Femoral Stem**

Many surgeons have reported excellent intermediate to long-term results in association with the use of tapered stems inserted without cement during primary total hip arthroplasty. Mallory reported on 2000 consecutive arthroplasties that were performed between 1984 and 2001. The mean duration of follow-up was 5.5 years. The rate of femoral stem survival was 98.6% at five years, 98.6% at ten years, and 96.6% at fifteen years. A separate analysis with use of aseptic loosening as the end point demonstrated a survival rate of 99.5% at five and ten years and of 99.1% at fifteen years. This success was attributed to the stem geometry and surface texture.

Adaptive bone changes after total hip arthroplasty vary according to biomaterials, design geometry, and surface texture. Proximal bone stress transfer has been thought to be less in association with proximally coated stems as compared with extensively coated stems. Capello et al. followed 144 hips that had been treated with a stem that was proximally coated with hydroxyapatite. All stems were well fixed. Thirty-seven percent of the femora demonstrated stress-transfer bone remodeling at fifteen years. There was no correlation with preoperative bone density, bone geometry, stem size, body weight, age, or diagnosis. These stress-transfer changes were more prevalent in women than in men (45% compared with 25%; \( p = 0.008 \)). Hips with stress-transfer bone remodeling in general had a smaller cortical ratio and a lower percentage of the canal filled by the stem distally. The clinical relevance of these changes is unclear.

Component malpositioning, particularly varus, has been associated with higher failure rates. Min et al. reviewed a consecutive series of ninety-eight arthroplasties that had been performed with a cementless tapered-wedge stem; the mean duration of follow-up was 7.7 years. The stem position was neutral in 63% of the hips, valgus in 21%, and varus in 16%. No revision was done. There was no difference among the three groups in terms of the Harris hip score or the prevalence of thigh pain. Similar bone remodeling changes were observed in all patients, regardless of stem position. The authors concluded that varus position did not adversely affect fixation durability or clinical outcome.

**Acetabular Component**

Bone remodeling around cementless cups has not been extensively studied. Meneghini et al. conducted a prospective randomized study to quantify periacetabular bone density after primary total hip arthroplasty; the mean duration of follow-up was 7.5 years. Sixteen patients were randomized into two groups of monobloc hemispherical cementless cups: nine patients received a porous tantalum cup, and seven received a cup with a titanium-alloy beaded surface. Bone mineral density was measured around the cup as well as in the contralateral acetabulum, which served as the control. There was a dramatic difference between the two types of cups. Bone density de-
Fracture of the ceramic bearing remains the most feared complication. Koo et al. followed 312 patients (367 hips) from four centers who had undergone total hip arthroplasty with use of identical implants with a ceramic-on-ceramic bearing. Five femoral head fractures occurred (prevalence, 1.4%). All of these fractures occurred during normal physical activities, and all occurred in hips with a short neck. The fractures involved a circular crack along the circumference of the thinnest portion of the head, extending radially along the longitudinal axis. This rate of component fracture may be specific to this particular design.

Highly Cross-Linked Polyethylene Bearings

Highly cross-linked polyethylene has evolved into the most frequently used bearing material for total hip arthroplasty. Many studies have documented clinically superior wear characteristics as compared with conventional polyethylene. Questions remain as to whether this bearing surface will be proven to be clinically more durable in patient populations that have been known to be especially at risk for wear. Stephani et al. reported less femoral head penetration in matched groups of obese patients when highly cross-linked polyethylene was compared with conventional polyethylene. The authors examined the results of forty-one hip arthroplasties after a mean duration of follow-up of 4.75 years. Highly cross-linked polyethylene was used in twenty-one hips (twelve in nonobese patients and nine in obese patients), and conventional polyethylene was used in twenty hips (sixteen in nonobese patients and four in obese patients). The linear penetration rate was significantly lower in the group with highly cross-linked polyethylene during both the bedding-in phase ($p = 0.036$) and the steady-state phase ($p = 0.009$).

The mechanical properties of polyethylene are altered during the cross-linking process. Reduction of material strength and toughness may result in fracture. Tower et al. reported the results of a detailed analysis of four retrieved fractured cup liners that had been made of highly cross-linked polyethylene by a single manufacturer. Cross-linking had been done by means of 10-Mrad electron-beam irradiation with subsequent above-melt-temperature annealing. All four liners had been inserted into an identical acetabular shell design. All liner fractures occurred at the superior aspect, along the groove in the polyethylene that engages the locking ring of the shell. There was no evidence of oxidation, and no other in vivo degradation was found. Surface wear was present and was classified as moderate in all four. When the liners were tested against never-implanted control liners made of the same material, there was no difference in terms of the mechanical properties. The authors postulated that the fractures were due to a combination of thin polyethylene in cups placed with a high abduction angle, resulting in excessive loading at the superior edge.

Cross-linking with a below-melt-temperature annealing process is believed to improve the mechanical properties.

Ceramic-on-Ceramic Bearings

Ceramic-on-ceramic bearings have been in clinical use for nearly forty years. Audible squeaking in a small number of patients with this bearing combination has received much attention recently. Walter et al. conducted a detailed radiographic analysis of component positioning in seventeen hips with squeaking. These hips represented 0.7% of the series of 2397 hip arthroplasties that were performed with use of a ceramic-on-ceramic bearing at their institution over an eight-year period. The mean time interval to the onset of squeaking symptoms was fourteen months following the index hip arthroplasty. There were a variety of implant designs, with the vast majority of the bearing surfaces being manufactured by a single company (CeramTec, Plochingen, Germany). The radiographs and computed tomography scans of these hips were compared with those for a group of nonsqueaking hips that were matched according to clinical profile and implant design. The cup position was found to be outside of the ideal range (anteversion in excess of 25° and abduction in excess of 45°) in 65% of the squeaking hips. In contrast, only 6% of the nonsqueaking hips had an “outlier” cup position. In the revised hips, the investigators consistently found evidence of articulation damage due to impingement or edge-loading as a result of suboptimal component positioning. Lusty et al. reviewed 301 consecutive primary total hip arthroplasties that had been performed with use of a third-generation ceramic-on-ceramic bearing coupling; the minimum duration of follow-up was five years (mean, 6.5 years). The rate of survival of both components with aseptic loosening as the end point was 99% at seven years. The most common complications were periprosthetic femoral fracture (prevalence, 1.7%) and psoas tendinitis (prevalence, 1.3%). The authors reported only one case of squeaking from the bearing (prevalence, 0.3%). The authors postulated that the fractures were due to a combination of thin polyethylene in cups placed with a high abduction angle, resulting in excessive loading at the superior edge.
Currier et al. examined eleven retrieved liners made of the same cross-linked polyethylene that was manufactured with use of below-melt-temperature annealing. The liners had been in service for 0.1 to 5.3 years. Oxidation of the material was present in all liners, with a visible white band being seen in seven of them. Six of these seven liners also exhibited clinical fatigue damage. Overall, eight of the eleven liners showed evidence of impingement or dislocation. The oxidation-related reduction of mechanical properties in the polyethylene was sufficient to allow the fatigue damage seen in these liners.

Additional improvements in highly cross-linked polyethylene have been made. Brunner et al. reported adding the antioxidant agent vitamin E to the manufacturing process. This process has been demonstrated to improve the wear characteristics and the material oxidation level.

Human articular cartilage is normally covered with a nanoscaled phospholipid layer that contributes to lubricity and biocompatibility. Moro et al. used an ultraviolet-ray-induced polymerization technique to coat the polyethylene liner surface with a biocompatible phospholipid polymer, 2-methacryloyloxyethyl phosphorylcholine. The important findings were that (1) wear particle production was reduced following hip simulator testing and (2) wears particles induced less bone resorption in an animal model.

Outcome of Revision Total Hip Arthroplasty

Cementless fixation has become the predominant preference for revision hip arthroplasty. Callaghan et al. presented the twenty-year follow-up results of eighty-three consecutive hip revisions that were performed with use of contemporary cementing techniques. The mean age at the time of revision was 62.4 years. For all patients, the failure rate (including both re-revision and loosening) was 39.1% for the cups and 13.8% for the stems. Among the living patients, 48% of the cups and 13% of the stems were re-revised. These results should provide a foundation for comparison with the results of newer technology and cementless fixation for revision hip arthroplasty.

Acetabular Revision

One of the most difficult clinical decisions is how to determine the optimal timing of surgical intervention for the treatment of periprosthetic osteolysis in an asymptomatic patient. Howie et al. reviewed sequential quantitative computed tomography scans of the pelvis in a study of thirty hips with a cementless modular cup; all of the cups were of an identical design. The initial scans were performed after a minimum of ten years of follow-up. The subsequent scans were performed at a median of fifteen months (range, twelve to twenty-seven months) after the index scan. Eighty-nine percent of the femoral heads were smaller than 28 mm. The mean outer diameter of the cup was 52 mm (range, 48 to 62 mm). Osteolysis progressed in sixteen (53%) of the thirty hips. Osteolytic lesions measuring >10 cm³ in volume on the index scan were 2.5 times more likely to progress. Patients with a greater linear wear rate, a higher activity level, Charnley class-A involvement, and a larger femoral head size had significantly larger lesions. Significant predictors for lesion progression were the initial size of the lesion, wear rate, and femoral head size. There was, however, considerable variation in the rates of progression of pelvic osteolysis in this cohort of patients with stable cementless cups.

Revision because of liner wear and osteolysis is common. Paprosky and Sporer reported on 127 acetabular revisions that were intended for liner exchange only. The authors found malpositioning in 19% of the hips, a cup design that was not suitable for liner exchange (because it was too small or had a different geometry) in 15%, and unstable fixation in 6.2%. Forty percent of the cups initially assessed to be without need for shell revision actually required full cup revision at the time of surgery. Hozack et al. reviewed the results of forty-three acetabular revisions. Twenty-nine hips had a liner exchange only, whereas fourteen hips had full cup revision. The mean age of the patients was sixty-three years. Six (21%) of the twenty-nine hips that had only liner exchange required re-revision because of shell loosening at a mean of twenty-two months (range, three to fifty-three months). Only one (7%) of the cups in the full revision group failed because of loosening at a comparable follow-up interval. The numbers were too small to conclude whether full cup revision should be considered when the preoperative planning is for only liner exchange for the treatment of polyethylene wear and osteolysis.

Large segmental or combined acetabular bone deficiency poses a substantial challenge. No single surgical technique has been proved to be the most efficacious and durable. Abeyta et al. reported the long-term results of fifteen revisions that had been performed with use of an oblong-shaped cup inserted without cement; the mean duration of follow-up was eleven years. Three hips required re-revision. The mean Harris hip score for the remaining twelve hips was 76.5 at the time of the latest follow-up. Palm et al. reported on the use of allograft impaction and cementless cups with a hydroxyapatite coating for acetabular revision in a study of eighty-seven patients with large bone defects. Contained defects were present in 45% of the patients, segmental defects were present in 49%, and combined or uncontained defects were present in 6%. The mean duration of follow-up was nine years. The rate of cup survival was 94% at nine years, with aseptic loosening as the end point. The hydroxyapatite coating along with supplemental screw fixation (both dome and peripheral) may have contributed to the success of these revisions even in the absence of sufficient contact with the host bone. Another surgical technique to address acetabular bone deficiency is the use of modular tantalum augment. Garbuz et al. followed thirty-four revisions performed with use of tantalum augments and tantalum cups for a mean of thirty-four months. Two cups failed and required re-revision, and short-term success was seen after 91% of the revisions.
Femoral Revision
An extensively coated stem has been successful for femoral revision surgery. Hamilton et al.13 reported on the use of such a stem design for the revision of a failed extensively coated stem. Sixteen failures were identified in a large database of 711 femoral revisions that had been performed with use of a single stem design with an extensive porous coating. All sixteen failed stems were re-revised with use of the same stem design. Three of the sixteen stems had insufficient follow-up. The mean duration of follow-up was 9.8 years for the remaining thirteen stems. None of those thirteen stems were re-revised. Bone integration was evident in twelve of the thirteen stems radiographically.

Technical challenges may be formidable in the presence of severe femoral bone deficiency. Parvizi et al.15 reported on the use of a modular proximal femoral replacement prosthesis for forty-eight complex femoral revisions. The indications for revision included periprosthetic fracture (twenty patients), reimplantation because of a deep infection (thirteen), a failed arthroplasty (thirteen), nonunion of an intertrochanteric fracture (one), and radiation-induced osteonecrosis (one). The mean duration of follow-up was three years. There was significant improvement in the mean Harris hip score, from 37 preoperatively to 65 postoperatively. However, only twenty-two of the hips were rated as good or excellent at the time of the latest follow-up. Ten patients required a total of eighteen reoperations. The survival rate with revision as the end point was 87% at one year and 73% at five years. While this may be an effective option for complex cases with severe bone deficiency, the functional outcome and the durability of the implant are less optimal than those associated with a typical revision.

Improvement in Implant Fixation and Bone Growth
Bone loss and suboptimal implant fixation to deficient bone remain the principal challenges to a successful clinical outcome. Several groups have reported using pharmacological agents to retain or to increase bone mass following total hip arthroplasty. Iwaki et al. reported an increase in bone mass following the administration of risendronate (a bisphosphonate) in a prospective randomized clinical trial with controls at the time of the two-year follow-up. Eberhardt et al. reported enhanced osseointegration of hydroxyapatite-coated implants in association with bisphosphonate administration in a rat model. Even more important, they found an equal amount of osseointegration in osteoporotic bone. Another group from Hanover, Germany, reported positive bone remodeling and retention of bone mass in association with local administration of magnesium hydroxide around the bone-implant interface in patients with osteoporosis.

Several types of titanium foam metal have been introduced into clinical application over the past two years. These materials generally have a larger pore structure that promotes greater bone ingrowth as compared with standard beaded or plasma-sprayed titanium surfaces. Garbuz et al.17 reported on cylindrical porous tantalum implants that were inserted into the distal part of the femur of eighteen rabbits. Three types of implants were inserted: (1) uncoated tantalum implants (control), (2) tantalum implants coated with calcium phosphate, and (3) tantalum implants coated with both calcium phosphate and alendronate. The authors reported significantly more total gap filling (143%), bone ingrowth (259%), and total bone formation (193%) in association with the cylinders that were coated with both calcium phosphate and alendronate in comparison with the uncoated implants. All of the values were also significantly greater when the implants coated with calcium phosphate plus additional alendronate were compared with those coated with calcium phosphate alone. If this type of coating enhancement can be proved to be effective and safe in the clinical setting, the outcome of complex revisions with bone deficiency may be improved. This type of material also may enhance soft-tissue attachment. Dickey et al. found that the most ideal material characteristics for the strongest soft-tissue ingrowth were (1) a pore size ranging from 500 to 600 μm and (2) 30% randomness. Further development of this type of material may aid in the reattachment of the hip abductors as well as the extensor mechanism around the knee joint.

Gene therapy has been applied to total hip arthroplasty. DePooer et al. reported on the use of gene therapy and the injection of additional cement into the bone-implant interface around loose femoral stems. The investigators used a viral vector, HAdV-5ntr, to eliminate the interface fibrous tissue. They then combined it with the prodrug CB1954 and injected a combination of the vector and the prodrug into the interface in twelve patients with a loose stem. The vector was injected into the hip joint directly, followed by prodrug injection in two days and by cement injection five to seven days later. The patients reported a reduction in pain and an improvement in overall function in the short term. Bone remodeling around the bone-implant interface and stem fixation stability remain to be further evaluated. Such an approach may become useful for elderly patients with substantial medical comorbidities who are not suitable candidates for major revision surgery.

Hip Resurfacing Arthroplasty
Hip resurfacing continued to receive much attention in the past year with the approval of a second implant system in the United States. Moreover, there has been intense media coverage as well as frequent postings on patient and industry websites. At the present time, it is estimated that hip resurfacing accounts for as many as 6% to 9% of all total hip arthroplasties in some countries, including Australia (7.9%), France (6%), Germany (9%), and the United Kingdom (7%). The current enthusiasm for hip resurfacing may have led to inaccurate and inappropriate patient expectations. Murphy et al. conducted a prospective study at a tertiary joint arthroplasty center. One hundred and thirty-nine consecutive patients were surveyed,
and 41% were aware of hip resurfacing. Among these, 46% learned of the procedure through the Internet and 42% learned of the procedure from family and friends. Only 19% reported having received information from an orthopaedic surgeon. Eighty-two percent believed that hip resurfacing was safer than a standard total hip arthroplasty, and 80% believed that hip resurfacing involved less soft-tissue damage and a faster return to function. When asked which type of hip arthroplasty would be preferable, 54% of the respondents preferred hip resurfacing, only 8% preferred a standard total hip arthroplasty, and 38% were unsure. There is clearly a discrepancy between patient perception and the scientific literature with regard to the clinical efficacy and safety of hip resurfacing arthroplasty.

Advocates for hip resurfacing have proposed that this procedure is associated with a superior functional outcome in comparison with standard total hip arthroplasty. Lavigne et al. conducted a randomized, prospective study in which hip resurfacing (107 patients) was compared with total hip arthroplasty (103 patients); both procedures were performed with use of identical surgical techniques. The duration of follow-up ranged from two to five years. Patients from both groups reported a high level of satisfaction, with no difference between the groups in terms of functional outcome measures or complications. The authors also reported higher activity levels in another cohort of patients who underwent hip resurfacing. Haddad et al. reported superior functional outcome in a matched-pair analysis of forty patients, each of whom had undergone hip resurfacing or total hip arthroplasty. Mont et al., in a matched-pair comparative analysis that included fifty-four patients in each group, reported higher postoperative activity levels among patients who had been managed with hip resurfacing. Naal et al. surveyed 112 patients at twenty-four months following hip resurfacing. Approximately 26% of the patients performed sports four times or more per week for longer than sixty minutes per session. One of the limitations of all of these studies was a higher preoperative activity level in the hip resurfacing cohort. This represented a selection bias that could have resulted in the higher activity level at the time of the latest follow-up. In summary, differences in patient selection make meaningful comparisons of postoperative activity quantification difficult between hip resurfacing and standard total hip arthroplasty.

Le Duff et al. specifically analyzed the activity levels of obese patients who had undergone hip resurfacing. In that study, 125 patients (144 hips) who had a body mass index of >30 kg/m² were compared with 531 patients (626 hips) who had a lower body mass index. The University of California at Los Angeles (UCLA) function and activity scores were lower in the obese group. The non-obese group had higher physical component scores on the Short Form-12 (SF-12) and higher Harris hip scores. The five-year implant survival rate was significantly higher in the obese group (98.6% compared with 93.6%), and the femoral component size was significantly larger in the obese group. The authors concluded that the better implant survival was attributed to lower activity level and larger implant size in the obese group.

Gait analysis has been performed to compare hip resurfacing and standard total hip arthroplasty. Shimmin et al. found no differences in the gait characteristics between the hip resurfacing group (fourteen hips) and the total hip arthroplasty group (twelve hips). Moreover, both of these groups were no different from a third (control) group made up of age-matched patients without any hip disease. Lavigne et al. reported gait data for three distinct groups of eight patients each; the first group was managed with hip resurfacing, the second group was managed with standard total hip arthroplasty, and the third group was managed with hip arthroplasty with use of a large-diameter femoral head. The investigators found better gait measurements in the hip resurfacing and large-diameter-head groups than in the standard total hip arthroplasty group. There was no difference between the hip resurfacing and the large-diameter-head groups.

There is controversy with regard to which surgical approach is best for hip resurfacing with regard to exposure, implant position, and preservation of femoral head vascularity. In the study by McBryde et al., 135 hip resurfacings that had been performed through the direct lateral approach were compared with another 774 hip resurfacings that had been performed through the posterolateral approach. After intermediate-term follow-up (range, two to ten years), there were no differences between the two approaches with regard to complications, the rate of reoperation, implant survival, or hip scores. The eight-year implant survival rate exceeded 97% for both approaches. Steffen et al. documented less reduction of femoral head blood flow in association with the anterior approach in contrast to the posterolateral approach. Kahn et al. also documented less reduction of blood flow in association with the anterolateral approach in contrast to the posterolateral approach. In summary, the posterolateral approach does lead to greater reduction of femoral head blood flow. However, there are no documented differences in terms of clinical outcome, the durability of fixation, or complications when these different surgical approaches are compared. Longer-term follow-up is necessary to determine if there is any difference in implant survival as a function of the surgical approach used for hip resurfacing arthroplasty.

More clinical outcome data from a large series of hip resurfacing procedures performed at different centers were reported at the 2008 Annual Meeting of the American Academy of Orthopaedic Surgeons. The second implant system that was approved by the United States Food and Drug Administration in 2007 was the Cormet design (Stryker, Mahwah, New Jersey). Three hundred and thirty-seven hips were included in a United States trial with a minimum duration of follow-up of two years. The Cormet system was associated with an overall revision rate of 4.7% (compared with 1.1% for standard total hip arthroplasty) and a femoral neck fracture rate of 3.3%. In another study reviewing the experience of a single surgeon...
with 2474 hip resurfacings, the overall failure rate was 3.8% after a mean duration of follow-up of seven years. The femoral neck fracture rate was only 0.6%. Of the forty-eight hips that were revised, twenty-nine had substantial femoral osteolysis. In the largest single-surgeon clinical series of >4000 hips, the nine-year rate of implant survival was 98%. Higher failure rates were observed in women, patients who had had previous surgery, and patients with osteonecrosis. Of the forty-one revisions, eighteen were performed because of a femoral neck fracture.

The Australian hip resurfacing registry includes >10,000 hips that have been treated since 1999. The five-year revision rate was 3.8% overall, compared with 2.8% for standard total hip arthroplasty. The revision rate was 1.9% for men under sixty-five years of age. This rate was similar to the revision rate for standard total hip arthroplasty in this specific patient group. A higher revision rate was found in women, patients with osteonecrosis, patients with inflammatory arthritis, and patients with developmental dysplasia of the hip. In contrast, Stulberg et al. reported no higher failure rate among patients with osteonecrosis when hip resurfacing was compared with standard total hip arthroplasty. Amstutz et al. described the largest single-surgeon hip resurfacing experience in the United States in a report on 1000 hips. There was a distinct difference between the initial 300 hips and the subsequent 300 hips as the clinical experience increased. The implant survival rate was 91.8% for the early group and 98.4% for the later group at the time of the five-year follow-up. The dislocation rate was 0.9%. These data underscore the importance of patient selection and surgical experience in optimizing the intermediate-term success of hip resurfacing arthroplasty.

Della Valle et al. reported on the collective experience of United States surgeons with hip resurfacing following its approval in 2006. Data were collected for the first 600 procedures. The duration of follow-up was short (three to six months). Adverse events were documented in forty-one cases (6.8%); these events included eleven reoperations (nine of which were performed for the treatment of a femoral neck fracture) and seven cases each of nerve palsy and dislocation. Longer follow-up is critical to determine if complications will increase or will become less frequent with more clinical experience.

**Navigation and Computer-Assisted Surgery in Hip Resurfacing**

Navigation has been used in an effort to increase the accuracy and consistency of hip arthroplasty component position. Most studies have demonstrated equal or superior accuracy in association with the use of navigation systems as compared with manual techniques. In one study, navigation was used to determine if the learning curve for hip resurfacing could be reduced. Twenty surgeons were randomized into three groups with different tasks for guidewire placement into the femoral head. The mean error from the ideal position was 23° in association with the manual technique and 7° in association with navigation. Schnurr et al. performed a study of thirty hip resurfacing procedures in which the manual technique was compared with the navigation-assisted technique. They found less varus positioning of the femoral component in association with the use of navigation. The learning curve associated with the use of navigation was long, but the set-up time was reduced to fifteen minutes with experience. In summary, these preliminary data are encouraging. It remains to be determined whether the advantage of an optimized femoral resurfacing component position would outweigh the extra costs, substantial learning curve, and additional operating time associated with the use of navigation.

**Complications of Hip Resurfacing Arthroplasty**

One of the most feared complications of hip resurfacing is femoral neck fracture. Marker et al. reviewed 550 hip resurfacing procedures that had been performed by a single surgeon. Twelve of the fourteen femoral neck fractures occurred in association with the first sixty-nine procedures. The fracture rate was 0.4% (two of 481 hips) after the initial learning curve. Women and obese patients were more likely to have a fracture. In another prospective multicenter study, Mont et al. compared an initial cohort of 292 patients with a second cohort of 724 patients. The difference was that refinement of the surgical technique and patient selection criteria were instituted in the second group. The overall complication rate decreased from 13.4% to 2.1%. More importantly, the femoral neck fracture rate decreased from 7.2% to 0.8%. Data from both studies emphasize the importance of proper patient selection and precise surgical technique when performing hip resurfacing arthroplasty.

Femoral neck notching has been cited as perhaps the most important factor leading to an increased risk of femoral neck fracture. Noisieux et al., in a cadaveric biomechanical study, created different situations with regard to femoral neck notching and varus component positioning. Varus positioning was found to be the most important factor leading to femoral neck fracture. In fact, femoral notch notching was not found to cause a reduction in the load needed to create a fracture. Most surgeons who are experienced in resurfacing arthroplasty strongly recommend the avoidance of both femoral neck notching and varus component positioning during hip resurfacing arthroplasty.

Concerns about metal ion levels have been raised not only for resurfacing but for any metal-on-metal coupling. Controversies exist with regard to the difference in accuracy when analyzing ion levels from the serum or the whole blood. Vendittoli et al. reported that serum ion levels were 1.39 and 1.37 times higher than whole blood levels for chromium and cobalt, respectively, in sixty-four patients. Age and activities did not affect ion levels. De Haan et al. measured ion levels in a competitive athlete who had undergone hip resurfacing. A marked elevation in ion levels returned to baseline after six days. Daniel et al. analyzed urine ion levels prospectively at standard intervals up to six years following hip resurfacing surgery. There was an increase of ion levels, reaching the
What’s New in Total Hip Arthroplasty

maximum at six months to one year after surgery, and then there was a steady decrease over the following five years. The whole blood chromium level was significantly lower at the six-year interval than at the one-year interval (p < 0.05). This reduction was a function of the patient’s ability to clear the ions provided there was no increase in ion production from the bearing surfaces. Finally, implant position has an influence on ion levels. Hart et al. reported higher ion levels in patients with a cup inclination of >56° as compared with patients with a cup inclination of <42°. In some patients, the ion levels were more than tenfold higher.

More studies have been reported with regard to lymphocyte aggregation, ALVAL (aseptic lymphocytic vasculitis-associated lesions), and metal hypersensitivity. Pandit et al. reported soft-tissue masses (pseudotumors) around hip resurfacing components in sixteen patients. All of the patients were women without a known history of metal allergy. The presenting symptoms included pain (twelve patients), a palpable lump (three), neurological symptoms (two), a sense of instability and subluxation (two), and spontaneous hip dislocation (one). White blood-cell counts were within normal limits in all cases, whereas inflammatory markers were elevated in 50%. Ultrasonography or magnetic resonance imaging demonstrated either a solid or a cystic mass arising from the hip joint. Histological analysis typically showed lymphocyte aggregates without polymorphonuclear leukocytes. The surgeons recommended revision to a conventional total hip replacement with a metal-on-polyethylene bearing. This problem may be related to metallurgy and the manufacturing process of the implants used in these patients. Campbell et al. also reported perivascular infiltrates of inflammatory cells in hip joint tissues retrieved from the sites of failed hip resurfacings, and they believed that a metal hypersensitivity reaction was a possible cause of failure.

Ball et al.20 observed scalloped bone remodeling in the posterior part of the femoral neck and around the acetabular component rim in fourteen hips. They hypothesized that these changes were due to neck-cup impingement. The changes were not, however, associated with implant loosening or femoral neck fracture. Hing et al.21 reported similar findings. They found femoral neck bone loss (>10% of the femoral neck diameter) in 28% of 163 hips following resurfacing. Interestingly, they found no additional reduction in the amount of femoral neck bone loss between the three-year and the five-year follow-up. They concluded that narrowing of the femoral neck was not associated with any adverse clinical or radiographic outcome up to a maximum of six years after the operation. Similar to the pseudotumors described above, longer-term follow-up is critical to further define the clinical relevance of these bone remodeling changes around hip resurfacing implants.

Conversion of a failed hip resurfacing to a standard total hip arthroplasty is theorized to be relatively simple. In the study by Ball et al.,20 the results of twenty-one conversions that had been performed following the failure of hip resurfacing were compared with those of sixty-four primary total hip arthroplasties that had been performed for the treatment of osteoarthritis. There were no differences between the groups with regard to operative time, intraoperative blood loss, or the complication rate, and the functional outcome was similar for the groups at a mean of four years of follow-up. Mont et al. reported similar outcome data when twenty-four conversions were compared with a matched cohort of primary total hip arthroplasties.

Minimal Incision Surgery

The initial enthusiasm brought about by the introduction of minimal incision hip arthroplasty appears to have gradually decreased over the past few years. Sustained superior functional outcome following minimal incision surgery has not been conclusively documented. Moreover, an increase in complications has been documented in many clinical series. Minimal incision surgery has contributed to the development of newer tissue-preserving surgical techniques, modifications of instruments and implants, the introduction of multimodal analgesia, the refinement of postoperative rehabilitation protocols, and, in some centers, accelerated patient discharge and return to function.

Dorr et al.22 conducted a prospective study of 231 patients in which the efficacy of minimal incision surgery was compared with that of standard-incision techniques involving the posterior approach. All procedures were performed by two experienced senior surgeons, each of whom had performed at least 100 minimal incision operations prior to the study. All patients were managed with identical anesthesia, multimodal analgesia, and rehabilitation protocols. The minimal incision was an average of 10 cm in length, whereas the standard incision was 20 cm in length. In all patients in the minimal incision group, the incision was extended to 20 cm at the completion of the operation in order to control for the length of the incision itself and potential patient perception bias. The mean duration of the hospital stay was shorter in the minimal incision group. Patients in the minimal incision group were more likely to be discharged in two days and to use only a single assistive device on discharge. They also reported less pain on each of the postoperative days until discharge. There was no difference between the groups at six weeks or three months after surgery with regard to gait and pain level. There were no differences between the two groups with regard to cup position, stem orientation, limb lengths, offset measurement, or complications.

Lin et al.23 evaluated hip muscle strength, walking speed, and functional scores in a study in which fifty-three patients who had undergone hip arthroplasty with use of a minimal anterolateral incision were compared with fifty-three patients who had undergone hip arthroplasty with use of a standard anterolateral incision. The major difference in the approaches was the amount of hip abductor released from the greater trochanter. During the first year after surgery, patients with the
minimal incision hip arthroplasty had significantly better muscle strength, walking speed, and functional scores. There was no difference between the groups after one year. Williams et al.24 prospectively followed sixty-seven hips that were treated with the two-incision approach and compared them with twenty-eight hips that were treated with use of a standard anterolateral approach. There was no difference between the groups in terms of implant position or clinical outcome. However, neither of those studies were randomized.

Patient satisfaction is often difficult to quantify. Dorr et al.25 performed psychological assessments and correlated the findings with patient satisfaction following minimal incision total hip arthroplasty. A questionnaire was administered to 165 patients before surgery and at various intervals after surgery. A minimal incision was used in 119 patients, and a standard incision was used in fifty-six. Incision length was found to be a factor that influenced patient satisfaction at six weeks. This difference was not observed beyond the short term because all of the patients were satisfied at the time of longer follow-up, regardless of the incision length. Forty percent of the patients with suboptimal satisfaction in the group with a standard incision were found to have other confounding reasons, independent of the incision length, that contributed to their dissatisfaction.

Minimal incision surgery is technically difficult. Berger et al. reported on the prospective clinical experience of four surgeons who began performing total hip arthroplasty with use of a minimal incision approach without formal training. Each surgeon performed 100 procedures. The collective complication rate associated with the first thirty-five operations was high (8%). The complication rate was reduced to 6%, 1%, and 0% for each subsequent 100 operations, respectively. This finding raises concerns with regard to the utility of minimal incision techniques in light of a high initial complication rate and no documented sustained superior clinical outcome beyond the short term.

The minimal incision approach has been extended to hip resurfacing arthroplasty. Chen et al. reported on 136 hip resurfacing procedures that were performed with use of a 7-cm gluteus maximus-splitting approach. They reported no more frequent complications as compared with their previous experience with use of a standard posterior approach. A satisfactory result was recorded for 97% of the patients at the time of the two-year follow-up. Piriou et al. reported on 100 hip resurfacing procedures that were performed with use of a modified minimal anterior incision. They reported no increase in operative time or in the rate of complications as compared with their previous experience with the posterior surgical approach. There was one femoral neck fracture.

**Complications**

**Venous Thromboembolism**

Venous thromboembolic disease is common following hip arthroplasty. Intense debate has focused on which prophylaxis methodology is most effective and safe. This topic was one of the most discussed clinical issues in the past year with the introduction of the Surgical Care Improvement Project mandated by the United States Centers for Medicare and Medicaid Services and other health-care purchasers in 2006. The American Academy of Orthopaedic Surgeons (AAOS) recently published clinical guidelines with regard to venous thromboembolic disease prophylaxis in orthopaedic patients. Differences between the AAOS guidelines and the American College of Chest Physicians (ACCP) guidelines have led to controversy not just among surgeons but also among medical disciplines and hospital administrators.

The orthopaedic community has long maintained that the clinical relevance of venous thromboembolic disease should not be based solely on the prevalence of asymptomatic lesions on venographic studies as reported in well-designed multicenter clinical trials. Dorr et al.26 retrospectively reviewed the results of 1179 total joint arthroplasties in 970 patients. The patients were stratified as being at low risk for venous thromboembolic disease (1046 operations) or at high risk for venous thromboembolic disease (133 operations). The low-risk group was managed with multimodal prophylaxis, including aspirin, dipyridamole, or clopidogrel bisulfate as well as intermittent calf pneumatic compression devices. The high-risk group was managed with adjusted-dose warfarin or low-molecular-weight heparin. All patients underwent a screening venous Doppler scan before hospital discharge. There were only three symptomatic pulmonary emboli, all in the low-risk group. There were five symptomatic deep-vein thrombi (prevalence, 0.4%) and sixty-one asymptomatic deep-vein thrombi (prevalence, 5.2%). A wound hematoma occurred in association with five (0.4%) of the operations; all were seen in patients who received either warfarin or low-molecular-weight heparin. The authors concluded that multimodal prophylaxis without following the ACCP recommendations was effective and safe for selected low-risk patients.

Effective pharmacological prophylaxis may result in greater complications in the orthopaedic patient population. Parvizi et al.27 reported a higher prevalence of periprosthetic infection in patients who received excessive pharmacological prophylaxis, which resulted in wound drainage and wound-healing problems. Sharrock et al.28 conducted a meta-analysis evaluating the efficacy and safety of multimodal prophylaxis (including regional anesthesia, pneumatic compression, and aspirin) in 7193 patients. Those patients were compared with patients who received either low-molecular-weight heparin (>15,000 patients) or warfarin (5000 patients). The authors reported a higher mortality rate due to all causes (0.41% compared with 0.19%) and a higher rate of nonfatal pulmonary emboli (0.60% compared with 0.35%) among patients receiving low-molecular-weight heparin as compared with those receiving the multimodal prophylaxis.

**Infection**

Reduction in the infection rate has been realized with timely administration of perioperative antibiotic prophylaxis, ad-
vances in surgical technique, and modifications of the surgical suite. Ritter et al. reviewed the results of 5980 total joint arthroplasties that had been performed by a single surgeon, at a single institution, in identical surgical suites, with use of the same surgical technique and perioperative management protocol, including antibiotics. The infection rate over this nineteen-year period (from 1986 to 2005) was 1.77% (1.03% for hip arthroplasty and 2.20% for knee arthroplasty). The infection rate was effectively reduced to 0.57% (a threefold reduction) when ultraviolet light was installed in the operating suites. Ultraviolet light did not substantially decrease the infection rate following hip arthroplasty (1.03% compared with 0.72%), but it did have an impact on the infection rate following knee arthroplasty (2.20% compared with 0.50%). Regression analysis demonstrated that revision surgery, previous infection, age, body mass index, cement fixation, and diagnosis had no effect on the rate of infection. These data are important as they reflect the infection rate associated with the use of contemporary surgical techniques and perioperative management protocols.

The clinical efficacy of appropriately timed antibiotic administration has been documented in many studies. Compliance, however, has been poor. Rosenberg et al. evaluated the utility of adding confirmation of antibiotic administration to the surgical timeout for wrong-site surgery in the operating room. The study included all patients who underwent spine surgery, total hip arthroplasty, and total knee arthroplasty. The mean time between antibiotic administration and skin incision was twenty-six minutes. This protocol resulted in a compliance rate of 99.1%. The authors also performed another retrospective analysis of forty patients who had undergone total joint arthroplasty during the three months prior to the institution of the protocol. The compliance rate was only 65% for that earlier patient subset. The compliance rate was maintained at 97% in the eighteen months following the termination of the study period, reflecting the effectiveness of changing a practice pattern at their institution.

A two-stage reimplantation protocol is the most commonly utilized method in the treatment of deep periprosthetic infection following total hip arthroplasty. Controversy remains with regard to which diagnostic criteria are best to exclude persistent infection. Bori et al. reviewed the results of frozen-section histological analysis for twenty-one patients who underwent reimplantation. Seven of the twenty-one patients had positive intraoperative cultures. The sensitivity, specificity, positive predictive value, and negative predictive value were 28.5%, 100%, 100%, and 73.6%, respectively, if the histological criterion was a minimum of five neutrophils seen in at least five high-power fields. Although the data documented a high probability of persistent infection if the results of frozen-section histological analysis demonstrated more than five neutrophils per high-power field, it was not possible to completely rule out infection if the neutrophil count was less than five. It is perhaps best to use a combination of clinical infection markers and frozen-section histological analysis to formulate a final decision regarding reimplantation.

Dislocation

Sah and Estok compared the rate of dislocation following conversion hip arthroplasty performed after the failure of a previous hemiarthroplasty with that following revision arthroplasty performed after the failure of a previous total hip arthroplasty. The hypothesis was that there might be a higher dislocation rate in the conversion group because of the need to downsize the femoral head diameter when the conversion arthroplasty was performed. There were eighty-nine hips in the conversion group and 115 hips in the revision group. The rate of dislocation was significantly higher in the conversion group than in the revision group (22% compared with 10%). There was no difference between hips with and without dislocation in terms of cup diameter or position. A smaller femoral head size contributed to a higher probability of dislocation. The authors recommended maximizing femoral head size and balancing soft-tissue tension when converting a previous hemiarthroplasty to a total hip arthroplasty.

Periprosthetic Femoral Fracture

Periprosthetic femoral fractures often occur in elderly patients with associated medical comorbidities. In the study by Bhattacharyya et al., a cohort of 106 patients with periprosthetic femoral fractures was compared with 309 patients with hip fractures and 311 patients who underwent primary total hip or total knee arthroplasty (controls). The comparator groups were matched for age and sex. The one-year mortality rate was 11% for the periprosthetic fracture group, compared with 2.9% for the primary total joint arthroplasty group. The mortality rate for the periprosthetic fracture group was similar to that for the hip fracture group (16.5% in both groups). Seventy-three of these periprosthetic fractures were Vancouver type-B fractures. Forty-nine of the seventy-three fractures were treated with revision hip arthroplasty, whereas twenty-four were treated with open reduction and internal fixation. The mortality rate was significantly lower in the revision group than in the open reduction and internal fixation group (12% compared with 33%; p < 0.03). However, the sample size was too small to determine if the preferred treatment method for Vancouver type-B fractures should be revision hip arthroplasty rather than open reduction and internal fixation.

Taunton et al. reviewed a large cohort of 3346 primary total hip arthroplasties that had been performed with use of a cementless proximally-coated femoral stem from 1987 to 2007 at two institutions. Forty-one hips (1.2%) had an acute postoperative periprosthetic femoral fracture. Twenty-eight of these fractures were displaced, unstable fractures. The fractures occurred an average of twenty-eight days (range, four to eighty-eight days) after surgery. Nineteen of these patients with a fracture were still using walking aids. There was a significant increase in the fracture rate during the last three years of the
study period. The authors attributed this increase to the contemporary practice pattern in the United States: smaller incisions, accelerated rehabilitation, and higher utilization of cementless stems.

**Practice Management**

**Specialty Hospitals**

The recent emergence of specialty hospitals focusing on procedural aspects of medicine has generated widespread controversy. Arguments have centered around (1) whether quality is improved and (2) whether specialty hospitals “preselect” patients with a low risk profile. Cram et al.34 conducted a retrospective cohort study of 51,788 Medicare beneficiaries who underwent total hip arthroplasty and 99,765 who underwent total knee arthroplasty in thirty-eight specialty orthopaedic hospitals and 517 general hospitals between 1999 and 2003. The demographic data and the ratio of primary to revision arthroplasties were similar. However, patients in specialty hospitals had fewer comorbidities and resided in more affluent zip codes. More procedures were performed in specialty hospitals for both hip and knee arthroplasties. The unadjusted rate of adverse outcomes was lower in specialty hospitals for total hip arthroplasty (3.0% compared with 6.9%) and for total knee arthroplasty (2.1% compared with 3.9%). The differences were even more pronounced after adjusting for patient profile and procedure volume. These data did substantiate better patient outcomes at specialty hospitals in the Medicare population.

Major differences exist between countries with regard to health-care delivery, clinical protocols, and patient outcomes. Peterson et al.35 reported data on the effectiveness of transferring a best-practice model from the United States to the United Kingdom with regard to reduction of the length of stay in the hospital following total hip arthroplasty. The reported mean length of stay in the United Kingdom was eleven days in 2000. In fact, <15% of the patients were discharged in less than eight days. The government elected to build a new specialty hospital near London for total hip arthroplasty. The benchmark process included partnering with a high-volume orthopaedic specialty hospital in the United States. A collaborative effort was undertaken to transfer the best-practice strategies and clinical protocols (surgical, anesthesia, rehabilitation) from the United States hospital to build and develop the new hospital in the United Kingdom. Data were collected for twelve months after the opening of the new hospital. The mean length of stay was 6.1 days for the 615 patients, representing a 45.5% reduction from historical data. Eighty-six percent of the patients were discharged in less than eight days. The infection rate was also reduced, from 1% to 0.16%. During the same twelve-month period, 1506 hip arthroplasties were performed in the United States hospital. The mean length of stay was four days. The only factor that was cited to account for the difference in the length of hospitalization was age of the patient, with younger patients in the United States hospital. This study suggests that the transfer of best-practice strategies can be effective in improving outcomes and achieving potential cost reduction.

**Regional Analgesia**

Regional blocks for analgesia have gained tremendous popularity in recent years. The use of regional anesthesia and analgesia techniques in patients receiving anticoagulants has been a subject of debate. There are well-established guidelines for using anticoagulants in patients receiving neuraxial blocks. There are no guidelines for the use of peripheral nerve blocks in patients receiving anticoagulants. Chelly and Schilling36 assessed the risk of hematoma formation related to the concomitant use of peripheral nerve blocks and pharmacological anticoagulation in patients undergoing total joint arthroplasty. Over a three-year period, 6935 blocks in 3588 patients were done at a single institution with use of standard protocols. The blocks were either single or continuous and included three sites: lumbar plexus, femoral, and sciatic. The perineural catheters were removed (in the continuous cases) on the second or third postoperative day. The anticoagulants included warfarin (50%), aspirin (23.8%), low-molecular-weight heparin (13.4%), and fondaparinux (12.8%). No hematomas were recorded. The study documented the safety of placing a peripheral nerve block before the administration of anticoagulation prophylaxis in patients undergoing total joint arthroplasty. Furthermore, the catheters can be safely removed while the patient is receiving pharmacological prophylaxis after surgery.

**Arthroplasty Surgeon Workforce Deficiency**

Demographic data indicate that there will be a dramatic increase in the demand for total joint arthroplasty in the United States in the years to come. Even more important, it has been estimated that there will be a 137% increase in the demand for revision hip arthroplasty and a 601% increase in the demand for revision knee arthroplasty by the year 2030. There is a concern that the discrepancy in the projected demand and the supply of arthroplasty specialists will widen. The 2005 AAOS membership survey reflected that only 7% of the respondents identified themselves as a specialist in adult hip and knee surgery. These specialists performed an average of 9.2 primary and 2.8 revision total hip arthroplasties per month. An additional 41% of the respondents identified themselves as having a clinical interest (not a focus) in adult hip and knee reconstructive surgery. These surgeons performed an average of 2.4 primary hip arthroplasties and 0.4 revision hip arthroplasties per month. The same survey also documented that fewer orthopaedic surgeons performed primary and revision total hip arthroplasty in 2004 as compared with the numbers generated from the 1990 AAOS membership survey. Iorio et al. conducted a survey of the AAOS membership and program directors for adult reconstructive surgery fellowships. Ninety percent of the 620 graduating orthopaedic residents in the United States selected a postgraduate fellowship in 2005, but only 6% chose adult reconstruction. There were 119 adult
reconstructive fellowship positions in sixty-two programs in 2006 to 2007, and 77.3% of the positions were filled at that time. In 2007 to 2008, only 61.7% of the positions were filled and 19.3% were filled by physicians who had been trained outside of the United States. The average age of a joint arthroplasty specialist in the United States is fifty-three years. The AAOS survey demonstrated that the average age of retirement for all orthopaedic surgeons was 63.3 years. As a consequence of these numbers, a critical shortage in the adult reconstructive surgeon workforce is predicted to occur over the next two decades.

Declining financial reimbursement for total hip arthroplasty continues to be a source of concern. Hariri et al.37 reported that payments from Medicare and Medicaid constituted an average of 33% of an orthopaedic surgeon’s practice revenue in 2006. This figure represented an increase from 26% in 1988. Medicare reimbursement for a primary total hip arthroplasty declined from $1718 in 1998 to $1361 in 2007, a 21% reduction. The reimbursement for revisions declined from $2416 to $1862, a 23% reduction during the same time interval. These were non-inflation-adjusted figures. The Centers for Medicare and Medicaid Services recently made a proposal to reduce the fees by an additional 21%. Additional fee reductions will undoubtedly affect the practice patterns of arthroplasty surgeons in the future.

Medical-Legal Issues
Arthroplasty surgery is especially susceptible to the risk of medical malpractice exposure. Upadhyay et al.38 surveyed 422 active members of the American Association of Hip and Knee Surgeons. Eighty-nine percent of the respondents had performed >100 hip and knee arthroplasty operations per year, and 78% had been named as defendant in at least one lawsuit alleging medical negligence. This figure is higher than the estimated incidence of thirteen per 1000 for non-federally employed practicing physicians reported by the Henry J. Kaiser Family Foundation in 2006. The adverse outcomes most commonly related to litigation following total hip arthroplasty were nerve injury, limb-length discrepancy, infection, vascular injury, and dislocation. These findings agree with those of previous reports identifying arthroplasty as among the most commonly litigated orthopaedic procedures.40 Suggested strategies for minimizing the risk of litigation include adherence to the prevailing defined standard of care and patient safety strategies, thorough patient communication, management of patient expectations, expert execution of the surgery, timely recognition and treatment of complications and adverse outcomes, and detailed medical record documentation.

Pay-for-Performance
Future government proposals to reform Medicare, such as the pay-for-performance (P4P) program will target quality rather than volume of services. The pay-for-performance program provides that surgeons participating in the Medicare and Medicaid programs in the United States can receive bonuses, subject to a cap, for reporting data on certain quality measures. Bozic et al.40 reported that evidence-based guidelines for pay-for-performance initiatives in arthroplasty surgery are yet to be fully developed. Preliminary peer-reviewed data have demonstrated a positive impact on the quality of health care from practice guidelines and the institution of quality-monitoring processes.

Direct-to-Consumer Advertising
Direct-to-consumer advertising (DTCA) for arthroplasty devices and surgical procedures is a common practice, and it remains controversial. Bozic et al.41 surveyed both surgeons and patients to examine the impact of direct-to-consumer advertising. Nearly all surgeons reported encountering questions from patients that were driven by direct-to-consumer advertising, most frequently regarding minimal incision surgery and specific implant designs. The majority of surgeons believed that direct-to-consumer advertising had a negative impact on the surgeon-patient interaction. Older surgeons (those with an age of more than fifty years) and more experienced surgeons (those in practice for more than twenty-five years) were more likely to view direct-to-consumer advertising as a positive factor in terms of patient education and improving physician-patient communication. Patients perceived direct-to-consumer advertising as positive with regard to gaining information on new technology, current implant designs, and surgical techniques. The authors concluded that the different perceptions between the surgeons and the patients underscore the importance for further improvement in surgeon-patient communication, which undoubtedly will improve patient outcomes and reduce litigation.

Industry-Surgeon Relationship
Industry-physician relationships are the subject of a national debate. In a survey of 3167 United States physicians from various specialties, 94% reported some relationship with industry, ranging from receiving gifts to receiving drug samples42. More than one-third received reimbursement for attending professional meetings or continuing medical education activities. More than one-quarter received payments for consulting, giving lectures, or enrolling patients in clinical trials. In 2007, the American Academy of Orthopaedic Surgeons implemented Standards of Professionalism (SOPs) related to Orthopaedist Industry Conflicts of Interest43. These standards serve as guidelines that enable surgeons to best serve the interests of patients while advancing the scientific and academic missions of the profession.

Evidence-Based Orthopaedics
The editorial staff of The Journal reviewed a large number of recently published research studies related to the musculoskeletal system that received a Level of Evidence grade of I. Over 100 medical journals were reviewed to identify these
articles, which all have high-quality study design. In addition to articles cited already in this Update, five level-I articles were identified that were relevant to total hip arthroplasty. A list of these titles is appended to this review after the standard bibliography. We have provided a brief commentary about each of the articles to help guide your further reading, in an evidence-based fashion, in this subspecialty area.

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References


Evidence-Based Articles

What’s New in Total Hip Arthroplasty


Related to Total Hip Arthroplasty


The risk of venous thromboembolism extends beyond the hospital stay after total hip arthroplasty. This study evaluated the cost-effectiveness of extended prophylaxis. The health benefits were measured as a reduction in the rates of symptomatic thromboembolism and death. The treatments that were analyzed included low-molecular-weight heparin, warfarin, and no prophylaxis. The authors analyzed studies with extended prophylaxis to twenty-eight days or more. They found a net gain in quality-adjusted life years in both cohorts receiving pharmacological extended prophylaxis relative to the cohort receiving none. Cost-effectiveness analysis demonstrated $106,454 per quality-adjusted life year gained for low-molecular-weight heparin and $13,115 for warfarin. The authors concluded that there was insufficient economic evidence to support extended prophylaxis with low-molecular-weight heparin following total hip arthroplasty. Additional studies are necessary to validate whether extended prophylaxis with use of warfarin is cost-effective.


This prospective randomized study was conducted to compare epidural analgesia with intra-articular infiltration and infusion of a multi-drug regimen (ropivacaine, ketorolac, and epinephrine) in eighty patients following total hip arthroplasty. Both protocols were continued to twenty-four hours after surgery. There was no difference between the groups with regard to the pain level during the first twenty-four hours. However, after cessation of treatment, there was significantly less pain in patients receiving the intra-articular infusion. Moreover, there was a significant reduction in narcotic use and the length of hospital stay in the infusion group. Innovative and effective postoperative analgesia can contribute to improved outcomes and cost-effectiveness in total hip arthroplasty.


Many previous studies have documented differences between these two most commonly utilized surgical approaches in performing total hip arthroplasty. This meta-analysis was conducted to determine if there are any differences in terms of the risks of dislocation, the prevalence of Trendelenburg gait, and sciatic nerve palsy. Only four studies met all of the inclusion criteria. These four studies included 241 patients. There was no significant difference between the approaches in terms of the rates of dislocation, Trendelenburg gait, or sciatic nerve palsy. However, there was a difference between the posterior approach and the direct lateral approach with regard to overall rate of nerve complications (2% compared with 20%). The differences reported in the past may be offset by modern prosthetic designs and surgical techniques.


Acetabular component size is dependent on femoral sizing during hip resurfacing arthroplasty. The surgeons randomly assigned 210 hips to either hip resurfacing or traditional total hip arthroplasty. There was no difference between the two groups with regard to the mean acetabular component size: 54.74 mm for total hip arthroplasty and 54.90 mm for hip resurfacing. The surgeons had to use a larger acetabular component in seven resurfacing procedures (6.8%) in order to match the femoral resurfacing size. There was no complication related to the acetabular component in either group. The authors concluded that acetabular bone removal was similar for the two groups given this particular implant design.


This prospective trial examined the utility of using sonication to remove material from retrieved implants for culture. The hypothesis was that higher yield and accuracy would be achieved with use of sonication. The study included 331 patients (207 knees and 124 hips). Aseptic failure had occurred in 252 patients, and septic failure had occurred in seventy-nine. With use of identical criteria to document infection, the sensitivity was greater with use of sonication (78.5% compared with 60.9%). There was no difference in terms of specificity (98.8% compared with 99.2%). Fourteen cases of infection were detected by means of sonicate-fluid culture but not by means of culture of the periprosthetic tissue alone. Importantly, for patients who had received antimicrobial therapy within fourteen days after surgery, the sensitivity was significantly better in association with the use of sonication (73% compared with 45%).