SUMMERY AND CONCLUSION

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Outcomes after total hip arthroplasty have continually improved due to advances in surgical technique, prosthetic design and postoperative rehabilitation. Surgical technique, in particular, has undergone numerous modifications and improvements since the introduction of the traditional postero-lateral and anterolateral approaches ***(Wenz et al., 2002)-(Berger, 2003).***

Excellent outcomes have also been achieved with other conventional surgical approaches to THA, such as the anterior (i.e., Smith-Peterson), direct lateral or trans-gluteal (i.e., Hardinge), and lateral trans-trochanteric (i.e., Charnley) approaches ***(Kelmanovich et al., 2003).***

Conventional THA involves incision lengths from 25-40 cm, which allow for complete and continuous observation of the entire hip joint and surrounding structures. The disadvantages of such large incisions are that they often result in significant soft tissue disruption, pain and lengthy rehabilitation periods. ***(Wenz et al., 2002)-(Berger, 2003).***

Consequently, interest is growing in the development of minimally invasive approaches, which involve the use of smaller incisions. An incision length of $\leq$ 10 cm has generally been defined as a "mini-incision." The primary difference between minimally invasive and conventional approaches is the means by which the surgeon exposes and gains access to the hip joint. Minimally invasive surgery may also involve the use of specialized instrumentation specifically designed to facilitate mini-incision THAs. Such specialized instrumentation, including illuminated retractors, smaller handles

on bone-shaping tools, and implant insertion instruments, has the potential to reduce the complexity of minimally invasive THAs by optimizing exposure and access to the hip, as well as ensuring accurate component placement. Specialized instrumentation also has the potential to protect the soft tissue structures by avoiding transection of muscles and tendons, but these benefits have not been conclusively demonstrated in well-designed studies. The use of more sophisticated and specialized surgical navigation and computer-assisted tools may also permit accurate orientation and fixation of the implant without complete visualization of the bony landmarks. For each minimally invasive surgical approach, evidence obtained from the scientific literature suggests that use of x-ray, fluoroscopy, or other novel image-guided technology during the procedure is optional and up to the discretion of the surgeon. ***(Waldman, 2003)- (Irving, 2004).***

Currently, there are no specific guidelines to determine when minimally invasive THA should be performed with surgical navigation systems or image-guided technology. The goals of both minimally invasive and traditional THAs are the same, namely; *the anatomical reconstruction of the hip joint*, resulting in favorable prosthetic joint load and function. Mechanically, the goals are to create a stable articulation with an optimal range of motion, restore biomechanics for muscular efficiency, and equalize limb lengths ***(Irving, 2004).***

Additionally, both approaches currently employ standard prosthetic elements of known durability. Several variations of minimally invasive THA, including a two-incision approach, an anterolateral approach, an anterior approach, and a single-incision approach, have been reported. The two-incision approach was developed primarily to avoid transection of muscles, ligaments and tendons ***(Berger, 2003).***

The anterolateral approach uses either the interval between the anterior one-third and posterior two-thirds of the abductors or the interval between the medius and tensor fascia lata ***(Waldman, 2003).***

The anterior approach employs a curved, transverse or short, straight incision to allow exposure of the underlying tensor fasciae lata muscle. There may also be a small, proximal incision to allow for passage of femoral reamers and prosthetic components, and occasionally an additional small, distal incision for the passage of acetabular instruments ***(Kennon et al., 2003).***

The single-incision approach is similar to the standard posterior approach. Stretching during the procedure brings the final size of the incision to approximately 3.5 inches. At six weeks post surgery, the wound naturally contracts to approximately three inches ***(Waldman, 2003).***

The medical literatures include a number of studies of minimally invasive total hip arthroplasty. Patients enrolled in these studies had a variety of indications for hip replacement, including Osteonecrosis and congenital dysplasia, with primary osteoarthritis being the most common. Follow-up periods generally ranged from two months to two years, although one study provided five-year follow-up ***(Wright et al., 2004).***

None of these studies randomized patients to type of procedure, therefore allowing the potential for selection bias that could hamper evaluation of the relative efficacy and safety of these procedures. There were also several studies that evaluated the feasibility of minimally invasive THA. Major limitations of these studies include variation in a number of important elements, such as minimally invasive surgical techniques, implant design, type

of fixation, patient demographics, type of disease, and outcome measures. Additionally, most studies had relatively short follow-up duration. These variations render it difficult to compare findings among studies with regard to overall efficacy of minimally invasive THA.

Non-randomized studies compared minimal incision THA to conventional incision THA ***(Higuchi et al., 2003)*** (n=212) reported statistically significant reductions in procedure duration and intraoperative blood loss in patients who underwent mini-incision THA compared to patients who underwent the procedure using a conventional incision. In another study of similar size ***(Wenz et al., 2002)***, patients who underwent minimal-incision THA required significantly fewer blood transfusions and walked significantly sooner postoperatively than did conventionally treated patients, though their length of hospital stay was the same. One comparative study (n=84) that provided five-year follow-up data reported that operative and short- and long-term clinical outcomes were equivalent for both minimal-incision and conventional THA. Patient satisfaction with the appearance of the scar, however, was much greater in the minimal-incision group than in the group that underwent conventional THA ***(Wright et al., 2001; Wright et al., 2004).***

(DiGioia et al., 2003) compared minimal incision THA using an image-guided navigation system to conventional THA. Patients in the minimal-incision group required significantly fewer blood transfusions than did patients in the traditional incision group. At six months' follow-up, patients who had undergone the minimal-incision procedure had better results than their comparator group in terms of limp, stair climbing, and distance walked. At one year, however, there were no significant differences between the groups. In the fourth prospective, controlled study of 84 patients ***(Wright et al., 2001)***, investigators reported that primary THA can be safely and

effectively performed through an abridged mini-incision approach; however, there was no significant benefit other than improved cosmesis.

In a prospective, uncontrolled study (n=100), ***(Berger, 2003)*** used a minimally invasive, fluoroscopy-assisted, two-incision technique for THA. The ***complication rate*** was 1%. After the first 12 cases, investigators initiated an outpatient protocol. Of the subsequent 88 patients, 75 (85%) returned home on the day of surgery, and 13 (15%) returned home one day post surgery. ***Radiographic outcomes*** in the first 30 patients revealed that 95% of femoral stems were in neutral alignment, and abduction angles for acetabular components averaged 45°. Cup abduction angles between 45° and 55°, when combined with appropriate acetabular and femoral anteversion, result in maximum overall range of motion and stability. No component migrated or failed to show ingrowth.

A retrospective study conducted by ***(Goldstein et al., 2003)*** reported significantly less preoperative blood loss for patients with minimal incision THAs than for those with standard incision THAs, although operative time was approximately the same for both groups. From the patient data reviewed for this study, the investigators concluded that the minimal-incision technique should not be considered a minimally invasive operation. Under the skin, the operation is equivalent to a THA performed through a longer, curved incision. A second retrospective study comparing minimal-incision to standard-incision THA failed to find any significant operative differences between the two procedures but did report a higher complication rate and greater incidence of suboptimal radiographic assessments in patients who underwent minimal-incision THA ***(Woolson et al., 2004)***.

This study did not provide any follow-up after discharge and, therefore, yielded no data regarding the functional or long-term clinical outcomes for minimal-incision THA.

One small case series of 14 patients ***(Sherry et al., 2003)*** reported on a minimally invasive technique; Postoperative **Harris Hip Scores (HHS)** were significantly better than preoperative scores in these patients. Another case series involving 98 patients ***(Hartzband, 2004)*** using a minimally invasive posterolateral total hip arthroplasty reported multiple advantages of the procedure. The advantages include rapid rehabilitation with quick return to activities of daily living, less postoperative pain, shorter hospital length of stay, reduced blood loss and improved cosmesis. The author does recognize that adequate training is essential and advocates the use of specialized instrumentation. Concerns are noted regarding proper positioning of the implant and proximal skin abrasion.

(Chimento et al., 2005) reported on a prospective, randomized study comparing a standard posterolateral approach with a modified minimally invasive approach. Group A (n=28) received an implant via an 8 cm incision and group B (n=32) via a 15 cm incision. Outcome criteria included operative time, blood loss, hospital length of stay, peri-and postoperative complications, blinded radiographic evaluation, pre- and postoperative interleukin levels, narcotic usage and functional outcomes including Harris hip score. To ensure uniformity, the same surgeon, anesthesiologist and physical therapist treated all patients. The authors realize that the small sample size limits the assessment of complications such as nerve palsy, dislocation, cement technique and position of components. They also note that a criticism of the study might be that Group B should have had a longer incision to be representative of the standard length incision. With the exception of less blood

loss and less limp in six weeks by Group A, outcome differences were not statistically significant. At one-year follow-up there was no difference between the groups and after two years the mean Harris Hip Score was 94.5 for both groups ***(Chimento et al., 2005).***

In a cohort study ***(de Beer et al., 2004)*** compared outcomes of a minimal, single-incision (n=30), direct lateral approach to a standard approach (n=30). Minimal incision was defined as ≤10 cm in length. Outcomes included opioid consumption, clinical radiography, Harris hip score, Oxford hip score, blood loss, intraoperative complications, and length of hospital stay. Outcome measures revealed no statistical differences between the groups. Concerns voiced by the surgeons were that the minimal incision provided only a "partial snapshot" of the procedure, required two surgical assistants and great care needed to be taken to avoid excessive trauma to the tissue. The authors concluded that the length of the skin incision for the direct lateral approach is "clinically and functionally irrelevant" ***(de Beer et al., 2004).***

Another study ***(Howell et al., 2004)*** described the minimal anterolateral approach (n=50) in comparison to the standard approach (n=57). This prospective study reported a prolonged operative time for the study group which was attributed to the inexperience of the surgeon. Blood loss in the study group was significantly less than the control group, but hemoglobin and transfusion requirements were not significantly different between the two groups. Hospital length of stay was shorter for the study group. The body mass index (BMI) of the study group was significantly lower than control group which may have introduced bias and affected the hospital length of stay. This author concludes that the minimal incision anterolateral approach is safe and is coupled with a possibly shorter hospital length of stay ***(Howell et al., 2004).***

(Ogonda et al., 2005) conducted a prospective, randomized blinded trial in which the same surgeon performed all procedures using a single-incision posterior approach for a minimally invasive group (n=104) and a conventional group (n=105). Outcome measures included hemoglobin levels, postoperative utilization of pain medication, postoperative mobilization, radiographic analysis, and hospital length of stay. Radiologist, therapist, nursing staff, and patients were all blinded to the type of incision that was used for each patient. Standardization of anesthesia, pain management and rehabilitation protocol provided consistency in outcomes. Blood loss was significantly more in the standard incision group with no differences in transfusion rates and levels of hemoglobin and hematocrit. The duration of the surgical time was greater according to body mass as opposed to incision type. No significant differences were seen between the groups as it relates to C-reactive protein, postoperative pain, postoperative mobilization, hospital length of stay, and radiographic studies. The patients' progress at the six-week follow-up visit was measured by the Harris hip score, Oxford hip score, McMaster University Osteoarthritis Index (WOMAC) and the Short Form-12 (SF-12). No significant differences were seen between the study group and the control group. The authors concluded that single-incision minimally invasive THA is a safe procedure but offers no significant benefit over the standard incision (16 cm) ***(Ogonda et al., 2005).***

The American Academy of Orthopaedic Surgeons (**AAOS**) clinical guidelines state that the Academy believes that minimally invasive surgery for total joint replacement "is a promising, but evolving surgical technique that requires additional scientific evidence to validate its short and long-term safety and effectiveness, in comparison to conventional joint replacement methods" ***(AAOS, 2005).***

The American Association of Hip and Knee Surgeons **(AAHKS)** statement on minimally invasive surgery advises surgeons to critically evaluate these emerging techniques. The AAHKS stated that additional scientific evidence and evaluation is needed before minimally invasive techniques are widely used in clinical practice. ***(AAHKS, 2004).***

In February 2005, the National Institute for Health and Clinical Excellence **(NICE)** published interventional procedure guidance on "Minimally invasive two-incision surgery for total hip replacement." The guidance states that the current evidence "does not appear adequate for this procedure to be used without special arrangements for consent and for audit or research" ***(NICE, 2005).***

CONCLUSION

MIS THA via the 2-incision approach has the potential to provide a number of benefits, including decreased preoperative blood loss and pain, more rapid recovery of hip function and return to normal activity, reduced length of hospital stay, and cosmetically appealing small scars. However, this procedure is technically challenging, and the introduction of a new surgical technique always has the potential for disadvantages as well as advantages. The surgeon must undertake special training to become familiar with the unique surgical approach and specialized instruments employed during the 2-incision procedure. As a result, there is a significant learning curve. Before 2-incision MIS THA can be introduced into widespread practice, properly designed prospective trials will be needed to compare this technique with more standard approaches and determine its safety, efficacy, and long-term durability ***(Victor T et al. 2004).***

Evidence from some clinical trials suggest that minimally invasive primary total hip arthroplasty (THA) may reduce soft tissue trauma, operative blood loss and postoperative pain, as well as shortening recovery time relative to traditional-incision THA. However, not all studies reported a significant difference in outcomes, and one study described an increased complication rate and higher incidence of suboptimal radiographic outcomes associated with minimally invasive techniques, even when performed by highly trained orthopedic surgeons In addition, only one of the published studies provided long-term follow-up; therefore, the data are insufficient to evaluate long-term outcomes for minimally invasive THA. A full assessment of the different types of surgical instruments, navigation tools, and methods and approaches for implantation is also hampered by insufficient data ***(Woolson, et al., 2004).***

The minimal incision technique is not a minimally invasive operation. Under the skin, the operation is exactly the same as a THA performed through a standard incision ***(Goldstein et al., 2003).***

Further analysis of this new technique is needed before it can be recommended for general use ***(Woolson et al., 2004).***

Visualization during either technique is paramount. If the surgeon is unable to visualize adequately, the surgical incision may be lengthened during the surgical procedure. Minimally invasive THA surgery must be subjected to properly designed and rigorously controlled studies to test its safety, efficacy, and durability. Before the minimally invasive technique can be adopted as a standard of care, statistical data from multiple centers must be collected, analyzed, and subjected to peer review ***(Ranawat & Ranawat, 2003).***