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Safety and Efficacy of Minimally Invasive Total Hip Arthroplasty

A Henderson, J Grahame

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Abstract

For many years, total hip arthroplasty (THA) has been a consistently effective surgical treatment for patients suffering degenerative hip diseases. The advent of minimally invasive THA has raised questions about the effectiveness, risks, and benefits of these approaches compared to the conventional techniques. This article evaluates the most recent (2004-2008) published literature on minimally invasive THA. A number of studies revealed moderate short-term postoperative benefits with minimally invasive THA, including decreased pain and earlier ambulation. There were no long-term benefits for minimally invasive procedures other than a shorter incision scar. When compared to the standard technique, both demonstrate high long-term success rates. Complications from minimally invasive THA were seen in several studies and were most often attributed to limited operative field visibility and/or surgeon inexperience with the technique. In conclusion, minimally invasive THA, while providing some postoperative benefit to patients, is not more effective than standard THA and is a more complicated and challenging surgery to perform. Minimally invasive THA should only be performed by surgeons who have had extensive training in the technique and should be reserved for patients who meet selection criteria with regards to body habitus, to minimize complications.

INTRODUCTION

Osteoarthritis (OA) is the most common cause of joint disease in the United States. Most people will have arthritic changes in their joints during their lifetime and many will go on to develop pain and disability related to osteoarthritis. The chronic pain and decreased mobility caused by hip arthritis can profoundly impact a person's functional ability and quality of life.

Dr. Phillip Wiles performed the first total hip replacement in 1938. By the 1960s, total hip arthroplasty (THA) had become the mainstay of definitive treatment for hip OA, with consistent long-term results.[1] The past few decades have brought numerous surgical advancements, both in THA and minimally invasive surgical procedures. With the common use of other minimally invasive procedures, ranging from laparoscopic cholecystectomy to knee arthroscopy, there has been increased focus on developing less invasive techniques for THA.

While there are many variations of THA approach and technique, there are several key components to all THA procedures. The femoral head is replaced with a prosthetic femoral head attached to a stem, which is affixed into the femur. The acetabulum is resurfaced and a prosthetic acetabular cup is fitted. Both the acetabular and femoral prosthesis can be either press-fit or cemented into place. During the procedure, leg length and range of motion are measured to ensure proper placement and functioning of the components. In standard single incision THA, the surgery is performed through an incision approximately 20cm in length along the lateral aspect of the thigh. With minimally invasive THA the incision is about 10cm in length.[2] Because minimally invasive THA significantly reduces the size and, subsequently, access to the surgical site, special retractors and surgical instruments have been developed to aid in visualization and component placement.

The intuitive assumption with regards to minimally invasive THA is that minimal incision means minimal soft tissue trauma and thus decreased blood loss, reduced postoperative pain, and more rapid recovery. With the media's interest in medical advancements and the availability of information via the internet, it is common for patients to investigate and pursue medical treatments that they have read about online or seen on television. In the face of patient enthusiasm for minimally invasive options, it is important for practitioners to objectively consider the data on this relatively new

technique. This review examines recent published literature to determine the risks, benefits, and efficacy of minimally invasive THA when compared to standard THA.

METHODS

A review of the literature was conducted using PubMed, Medline, and Google Scholar and utilized the following search terms: total hip arthroplasty, minimally invasive, minimal incision, and posterior. The search was limited to articles printed in English. Literature that addressed knee arthroplasty, bilateral hip arthroplasty, or any approaches other than posterior were not included. The final articles chosen were limited to those published during or after 2004.

LITERATURE REVIEW

There have been few randomized control trials (RCT) examining the benefits and risks of minimally invasive THA in comparison to conventional THA procedures. In 2005, Chimento et al. completed an RCT comparing operative time, hospital time, intraoperative blood loss (IBL), total blood loss (TBL) intra- and postoperative complications, interleukin-6 (IL-6) levels, radiographic appearance, and functional outcome. The minimally invasive THA patients experienced significantly less IBL and TBL. Additionally, at a six-week follow-up, patients who had undergone conventional THA were twice as likely to exhibit a limp. All patients, regardless of operative technique, achieved similar functional ability at the one-year evaluation. Although the absence of a limp in the minimally invasive group demonstrated a more normal gait and indicated quicker return of function, there were no differences in other measures of functional goals. Patients from both groups were able to independently transfer, ambulate, and traverse stairs within a similar timeframe. Complication rates were low in both groups and there was no statistical evidence that minimally invasive THA was more or less prone to complications.[3]

Ogonda et al. also reported minimal differences in outcomes between minimal-incision THA and standard THA procedures. In this prospective RCT, 219 patients were randomly assigned to undergo minimal-incision or standard THA performed by a single surgeon with extensive experience in both procedures. Postoperative outcome assessment included hematocrit, blood loss, pain score, and amount of analgesic administered. The only significant difference between the groups was IBL. Minimal-incision patients had less IBL, however there was no difference in TBL, transfusion rates, or postoperative hematocrit. The authors note that IBL is difficult to accurately assess because blood loss can be hidden within the soft tissue of the surgical site. In addition, it is impossible to blind the operating room staff, whom are apt to anticipate more blood loss in the conventional procedure, biasing the estimate between the groups. The authors suggest that the importance of the IBL difference is minimized in light of the similar hematocrits and transfusion rates between the experimental and control group.[4] This reasoning could also be applied to the Chimento et al. study, which noted no significant difference in units transfused within the two groups.[3] Ogonda et al. only evaluated early post-operative outcomes and walking ability up to six weeks after surgery. C-reactive protein levels were measured in both groups to evaluate soft-tissue trauma. There were no differences in C-reactive protein on the second postoperative day. The authors suggest that this indicates that the mini-incision technique did not significantly reduce soft tissue damage during the THA.[4]

Dorr, Maheshware, Long, Wan, & Sirianni conducted a prospective, blinded RCT to examine the effect of minimally invasive techniques on pain relief and functional recovery. After completing the minimally invasive procedure, surgeons extended the skin incision to maintain blinding for the duration of the study. Patients in the experimental group spent less time in the hospital, many being discharged by postoperative day two. Minimally invasive surgical patients were more likely to use a single device for walking assistance, such as a cane, than their control group counterparts, who needed the assistance of a walker or crutches. Minimal-incision patients experienced less pain throughout their hospital course. There was no difference in surgical time, IBL, TBL, hemoglobin, or hematocrit. Radiolographic analysis of component alignment and cement grade was performed by a blinded investigator to determine accuracy of prosthesis placement. There was no significant discrepancy between the two groups. Three weeks after surgery, all patients, regardless of procedure, had equivalent gait, Harris hip scores (HHS- a scoring system used to rate functional ability), and muscle strength. At six months, patient satisfaction with the outcome of the procedure was comparably high between the two groups.[5]

Woolson, Mow, Syquia, Lannin, and Schurman conducted a retrospective study comparing consecutive unilateral THA procedures. Three surgeons performed fifty mini-incision and eighty-five standard THA. The fifty patients in the experimental group represented the first cases for which the surgeons had employed the mini-incision technique. Which

surgery type was used depended on several factors, including body mass index (BMI), American Society of Anesthesiologists (ASA) rating, and comorbid conditions. As a result, patients in the mini-incision group had considerably lower BMI and ASA ratings and were, in general, healthier individuals when compared to the control group patients. Despite the health status of the mini-incision patients, the study indicated that they were significantly more likely to experience wound complications and prosthetic component malpositioning. The authors note that even as the surgeons gained experience with the procedure, over half of the surgery-related complications of the mini-incision group occurred in the second half of the patient group. There were no indications that mini-incision procedures had any intraoperative or postoperative benefits. The authors consider the results to show no clear benefit to mini-incision surgery and recommend that more research needs to be conducted before mini-incision THA becomes routine. The favorable health status of the mini-incision patients suggests that they were at an advantage with regards surgery outcome. However this was not reflected in the results, giving more strength to the authors' conclusion.[6]

In the only long-term evaluation of mini-incision THA reviewed, Wright et al. conducted a prospective controlled study comparing single-incision posterior mini-incision THA to standard posterior THA with follow-up through five years. Forty-two primary mini-incision procedures were compared to forty-two patients who received a standard THA.[7] Similar to Woolson et al., there was a selection bias with regard to the weight and BMI of patients selected for mini-incision THA.[6] The authors evaluated postoperative HHS, TBL, length of hospital stay, and postoperative component placement. Five years after surgery, HHS and component alignment were reevaluated and patients were asked to complete a questionnaire regarding their satisfaction with the appearance of the incision scar. The primary difference between the experimental and control group was evident in the patient evaluation of the appearance of the surgical site. A significant number of patients (31) who had a mini-incision procedure reported that they were enthusiastic or satisfied with the incision appearance, compared to 20 patients in the standard incision group. No mini-incision patients reported being disappointed with the incision, while five of the control group patients were dissatisfied with the appearance. The results also indicated that patients who underwent mini-incision surgery had shorter operative time and slightly higher postoperative HHS. The authors attribute the shorter operative time to the decreased time needed to close a shorter incision. At five years post-op, radiographic evaluation of the implant alignment revealed no malpositioning in either group. Although patients were happier with the cosmetic results of the mini-incision, Wright et al. did not indicate that there were any long-term differences in function between mini-incision and standard THA.[7]

Several of the above studies have emphasized the technical difficulty of minimally invasive THA.[456] The surgical field is constrained, making visualization of anatomical landmarks and alignment of the acetabular and femoral components more challenging.[4] Pagnano, Leone, Lewallen, and Hanssen published a retrospective study in which eighty consecutive patients who underwent the minimally invasive THA were compared to 120 consecutive conventional THA patients. They reported that patients who underwent posterior mini-incision THA had longer and more variable operative times and more postoperative complications. Mini-incision patients were almost three times as likely to require reoperation when compared to the control group. There was not sufficient data from the control group to evaluate functional milestones. However, the authors maintained that the minimally invasive group displayed, "modest" functional outcomes when compared to a younger population that had undergone minimally invasive THA. The authors concluded that mini-incision THA posed "a substantial prevalence of complications, and unpredictable technical challenges."[8]

Some suggest that successful minimally invasive THA requires specialized equipment and substantial training.[9] In response to the increased use of minimally invasive THA, specialized instruments, designed specifically for the procedure, have been developed. Inaba, Dorr, Wan, Sirianni, and Boutary published a case series examining the outcomes of 100 consecutive mini-incision THA patients who underwent surgery in 2002 to 100 consecutive mini-incision patients who had surgery during 2004, all preformed by the same surgeon. The patients who underwent THA in the later group exhibited shorter hospital stays, less postoperative pain, and quicker functional recovery.[10] The results support the intuitive concept that increased experience and the availability of more specialized equipment can improve the short-term outcomes of this technically difficult procedure.

DISCUSSION

The reviewed literature indicates several areas where minimally invasive THA is beneficial compared to standard incision THA. The most significant and commonly observed

benefit of minimally invasive THA was earlier return of function, including early postoperative ambulation.[35] Minimally invasive THA patients also displayed decreased postoperative pain and shorter hospitals stays.[5] Minimally invasive THA procedures resulted in decreased IBL; however, there was no significant difference in transfusion requirements between the control and experimental groups in any study, indicating that the decrease in IBL, while statistically significant, is not clinically significant.[34] An additional benefit was decreased surgical scar length. While it is not considered an important functional or medical benefit, minimal scaring can influence overall patient satisfaction.[7]

The primary drawback of minimally invasive THA is limited visualization of the surgical field because of the abbreviated incision length. The smaller surgical window requires extensive surgeon training and experience, as well as specialty instrumentation to ensure appropriate femoral and acetabular component positioning.[10] Although a smaller incision increases the technical difficulty of the THA procedure, when performed by a surgeon experienced in the minimally invasive technique, the outcomes are equivalent to standard incision procedures.[3457]

The majority of the reviewed studies concluded that minimal incision THA procedures have similar complication rates to standard THA when performed by an appropriately trained surgeon. However, some maintained that minimal incision THA procedures have more complications, including component misalignment, than standard THA. There are several factors that explain this discrepancy.[68] The Woolson et al. study examined the first fifty minimally invasive procedures performed by the respective surgeons, which had more complications when compared to the surgeons' standard THA patient cases. The complications rates were consistent throughout the course of the study. This accentuates the need for extensive training in the minimally invasive procedure and suggests that it takes many more than fifty cases to become proficient in the technique.[6] Pagnano et al. also found an increase in complications with the minimally invasive technique. However, the study employed a two-incision posterior approach, while all other literature reviewed in this paper utilized a single-incision technique.[8] There are potential differences in efficacy between single-incision and two-incision minimally invasive THA, which is an area that requires more research and is beyond the scope of this review.

It is difficult to establish the difference between minimally invasive THA and minimal-incision THA. The terms are used interchangeably in much of the literature. Both Chimento et al. and Ogando et al. used a posterolateral approach for the experimental and control groups, which involves the release of several muscle insertions regardless of incision length.[34] Therefore "the only difference in surgical technique between the two groups was the length of the skin incision and the shorter incision in the fascia lata in the mini-incision group."[4] Dorr et al. described a minimally invasive technique that involved less muscle and soft tissue disruption compared to the conventional THA. This mini-incision surgery did not require a cut into the tensor fascia lata, the femoral attachment of the gluteus maximus and quadratus femoris remain intact, and there were minimized incisions into the capsule and decreased splitting of the gluteus maximus muscle fibers.[5] The discrepancy in terminology and the existence of several different techniques, all termed "minimally invasive" or "minimal incision" highlights the need for more clarification and research to determine if minimized muscle release is beneficial for recovery and function.

Minimally invasive THA, when performed by an experienced surgeon using specialty equipment, can have results equivalent to conventional THA. However there is no evidence that suggests the minimally invasive procedure provides superior outcomes. There were statistically significant, short-term benefits with minimally invasive THA, but do these results equate to a clinically significant benefit for patients? Is IBL important to patients if it does not cause complications? One study found that mini-incision patients had shorter hospital stays than their standard incision counterparts. The average difference in hospital stay length between the two groups was ten hours.[4] Is ten hours a significant benefit in the patient's view?

Although the literature does not support replacing conventional THA procedures with the minimally invasive approach, it will continue to be an option for surgeons and patients. Two main factors should guide the use of this procedure. Minimally invasive THA requires a skilled surgeon who has had extensive training in the procedure. It is suggested that greater than fifty minimally invasive procedure need to be performed per year to maintain adequate proficiency.[2] In addition, careful patient selection is vital. Due to the limited visualization of the surgical field, minimally invasive THA is ill advised in patients who are overweight (BMI >28) or excessively muscular or for

patients undergoing revision of a previous THA.[2] When performed by an experienced surgeon on the right patient, minimally invasive THA is a reasonable option.

Conventional THA has been a consistently effective treatment for degenerative diseases of the hip. The minimally invasive technique does not decrease the risks associated with THA, provides mild short-term benefits, and is a more difficult procedure to perform. While the literature demonstrates that minimally invasive THA can be safe and effective, the evidence does not support making it the standard of care.

References

1. Learmonth, I.D., Young, C., & Rorabeck, C. (2007). The operation of the century: total hip replacement. Lancet, 370, 1508-1519.
2. Sculco, T.P. (2004). Minimally invasive total hip arthroplasty: In the affirmative. The Journal of Arthroplasty, 19, 78-80.
3. Chimento, G.F., Pavone, V., Sharrock, N., Kahn, B., Cahill, J., & Sculco, T.P. (2005). Minimally invasive total hip arthroplasty: a prospective randomized study. The Journal of Arthroplasty, 20, 139-144.
4. Ogonda, L., Wilson, R., Archbold, P., Lawlor, M., Humphreys, P., O'Brien, S., et al. (2005). A minimal-incision technique in total hip arthroplasty does not improve early postoperative outcomes: A prospective, randomized, controlled trial. The Journal of Bone and Joint Surgery, 87, 701-710.
5. Dorr, L.D., Maheshwari, A.V., Long, W.T., Wan, Z., & Sirianni, L.E. (2007). Early pain relief and function after posterior minimally invasive and conventional total hip arthroplasty: A prospective, randomized, blinded study. The Journal of Bone and Joint Surgery, 89, 1153-1160.
6. Woolson, S.T., Mow, C.S., Syquia, J.F., Lannin, J.V., & Schurman, D.J. (2004). Comparison of primary total hip replacements performed with a standard incision or a mini-incision. The Journal of Bone and Joint Surgery, 86, 1353-1358.
7. Wright, J.M., Crockett, H.C., Delgado, S., Lyman, S., Madsen, M., & Sculco, T.P. (2004). Mini-incision for total hip arthroplasty: A prospective, controlled investigation with 5-year follow-up evaluation. The Journal of Arthroplasty, 19, 538-545.
8. Pagnano, M.W., Leone, J., Lewallen, D.G., & Hanssen, A.D. (2005). Two-incision THA had modest outcomes and some substantial complications. Clinical Orthopaedics and Related Research, 441, 86-90.
9. Bostrom, M.P., Demetrakopoulos, D., Reinhart, J., & Sculco, T.P. (2005). Minimally invasive posterior approach to total hip replacement. Current Opinion in Orthopaedics, 16, 2-4.
10. Inaba, Y., Dorr, L.D., Wan, Z., Sirianni, L.E., & Boutary, M. (2005). Operative and patient care techniques for posterior mini-incision total hip arthroplasty. Clinical Orthopaedics and Related Research, 441, 104-114.
11. Harris, W.H. (1969). Traumatic arthritis of the hip after dislocation and acetabular fractures: Treatment by mold arthroplasty: an end-result study using a new method of result evaluation. The Journal of Bone and Joint Surgery, 51, 737-755.
12. Hellmann, D.B. & Stone, J.H. (2007) Arthritis and musculoskeletal disorders. In S. McPhee, M. Papadakis, & L. Tierney (46), Current Medical Diagnosis & Treatment (pp. 827-886). New York: McGraw-Hill.
13. Hungerford, D.S. (2004). Minimally invasive total hip arthroplasty: in opposition. The Journal of Arthroplasty, 19, 81-82.

Author Information

Ann B. Henderson, PA-S
Master of Physician Assistant Program, Eastern Virginia Medical School

Jason A. Grahame, MPA, PA-C
Assistant Professor, Master of Physician Assistant Program, Eastern Virginia Medical School