Minimally Invasive Hip and Total Knee Arthroplasty

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Description

Minimally invasive arthroplasty is a modification of conventional hip and total knee arthroplasty that utilizes specialized instruments. Along with a decrease in the size of surgical incision, a minimally invasive procedure may indicate reduced disruption of neurovascular tissues, muscle, tendons, and ligaments in comparison with conventional approaches.

The term minimally invasive surgery (MIS) refers to a variety of surgical approaches and procedures. MIS is commonly thought of as a very small incision, however, some “minimally invasive” procedures may describe incision lengths only slightly reduced from the conventional approach, with greater emphasis on approaches to reduce soft-tissue damage. Post-operative pain and rehabilitation protocols may also be changed to facilitate early recovery.

Hip Arthroplasty

Standard total hip arthroplasty (THA) is typically performed using a posterolateral or anterolateral approach, with an incision of 25–30 cm in length. This approach provides complete and continuous observation of the hip. Minimally invasive hip arthroplasty approaches include single-incision, measuring less than 10 cm in length, and 2-incisions, sometimes as small as 3 cm. The single-incision approach is a modification of the standard posterior, anterolateral, or anterior approaches that are commonly used for hip arthroplasty. However, the 2-incision approach constitutes a novel approach to hip arthroplasty that uses intermuscular planes to gain access to the hip joint. The anterior incision is used to expose and remove the femoral head, and prepare the acetabulum for placement of the acetabular component. A second lateral incision is used to prepare the femur and place the femoral component. Using either the single or 2-incision approach, the decrease in muscle and tendon trauma is achieved at the expense of complete and continuous observation of the hip.

Total Knee Arthroplasty

Standard total knee arthroplasty (TKA) is typically performed using a medial parapatellar arthrotomy with a 12- to 18-cm skin incision and eversion of the patella to allow direct visualization of the knee joint. There is no generally accepted definition of a minimally invasive approach in TKA. Minimally invasive approaches have been reported using the same medial approach, or less frequently with a lateral approach. In addition to the smaller incision, the patella may be subluxated instead of everted in order to reduce the tension on patellar
ligaments. In comparison with conventional TKA, there may be no dislocation of the tibio-
femoral joint.

Minimally invasive arthroplasty requires the use of specialized surgical instruments to facilitate exposure and guide placement of the prosthesis. In addition to the potential for greater force exerted on soft tissue when access to the joint is reduced by a smaller opening, a limited visual field has led to an increase in component misplacement and complications. In order to improve the accuracy of component placement under limited visualization, some surgeons may utilize fluoroscopy or computer-assisted navigation for alignment of prosthetic components.

Policy

Minimally invasive hip and total knee replacement may be considered medically necessary when performed in appropriately selected patients, by surgeons who are adequately trained and experienced in the specific techniques used, and in institutions that support a comprehensive post-operative rehabilitation program. Appropriately selected patients are those who would meet criteria for minimally invasive procedures (e.g., non-obese individuals who are motivated to participate in an accelerated rehabilitation program) as well as meeting established criteria for standard hip or total knee replacement.

Policy Guidelines

There are no specific CPT codes for minimally invasive hip or knee arthroplasty.

It is likely that the CPT code 27130 (arthroplasty, acetabular, and proximal femoral prosthetic replacement) or 27447 (arthroplasty, knee, condyle, and plateau; medial AND lateral compartments with or without patella resurfacing (total knee arthroplasty) would be used.

Physicians may elect to use a modifier -22 (unusual procedure or service) to reflect increased physician work. Alternatively, physicians may elect to use CPT code 27299 (unlisted procedure, pelvis or hip joint) or 27599 (unlisted procedure, femur or knee).

Rationale

The potential advantages of minimally invasive hip or total knee arthroplasty are expected primarily for short-term outcomes such as blood loss, length of hospital stay, and rehabilitation. These proposed advantages must be balanced against the possibility of increased operative difficulty, increased operating room time, reduced visibility, and the learning curve associated with any new technique, potentially resulting in an increase in misalignment and other complications such as failure of fixation, instability, dislocation, and infection. Therefore, any improvements in short-term outcomes need to be carefully weighed against the long-term outcomes of MIS, with a particular focus on complication and revision rates. In addition, outcomes should be compared with conventional hip or knee arthroplasty, which are generally associated with excellent outcomes of long-term improvement in pain and function and low long-term revision rates.

At the time this policy was created in 2004, the medical literature consisted primarily of case series or comparisons of short-term outcomes of MIS with concurrent or historical controls. In a 2003 symposium, 3 different surgeons reported their results of minimally invasive hip surgery.
(1) One published study reported results from 173 patients undergoing 189 arthroplasties—111 with a minimally invasive single-incision approach and 62 with a conventional incision. (2) Compared to the conventional incision group, the mini-incision group had significantly less mean operative time, blood loss, and intraoperative blood transfusion requirements. Good alignment, defined as an acetabular inclination of between 35–55 degrees, was reported for 94% of patients in the mini-incision group; alignment was not reported for the conventional incision group. Another study compared the results of minimally invasive hip arthroplasty in 85 patients with a concurrent group of 85 patients undergoing conventional arthroplasty. (3) The choice of approach was generally based on body habitus; i.e., the conventional surgery group had a higher weight and body mass index. Compared to the standard incision group, the mini-incision group had less operative blood loss. There was no significant difference in the incidence of complications between the 2 groups. No long-term data were available for these studies.

Sculco and colleagues compared the outcomes in a series of 42 patients who underwent a minimally invasive single-incision hip arthroplasty (8.8 cm in length) with a consecutive cohort of 42 patients who underwent hip arthroplasty using a conventional incision averaging 23 cm in length. (4) The operative time was slightly less in the minimal incision group, but there were no other differences in outcome, i.e., blood loss, length of stay, nerve palsy, infection, or component malposition. The authors then undertook a study in which patients were randomized to undergo hip arthroplasty using either an 8-cm incision (n =28) versus a 15-cm incision (n =32) and followed for up for 2 years. There were no significant differences in operative time, length of stay, wound drainage, component position, or complication rate. Fewer patients in the minimal incision group limped at 6 weeks and fewer required the use of a cane (p =0.04). There were no differences at 2 years. The authors concluded that a minimal incision was associated with an earlier return to a normal gait. Using an anterolateral approach, Howell reported on the outcomes of 50 minimally invasive hip arthroplasties in 46 patients, compared prospectively with a control group of 56 patients who underwent a conventional anterolateral incision. (5) The minimal incision group had a longer operative time, but less blood loss than the control group. The mean length of hospital stay for the minimal incision group was 4.4 days compared to 5.7 days in the control group.

Short-term results were also reported for 100 patients using a posterolateral minimal incision and for 100 consecutive cases with a 2-incision approach. (6, 7)

The published literature at this time reflected the intense interest, and also controversy, surrounding this procedure. (8, 9) In many instances, minimally invasive hip arthroplasty was instituted at the same time as postoperative pain management protocols, both designed to improve early mobilization and hospital discharge. The relative contribution of these 2 innovations to the early discharge could not be determined. The role of patient selection was another potential source of bias. For example, case series have generally excluded obese patients, and the considerable lay publicity regarding MIS may have led to self-selection of highly motivated patients. Controlled trials did not demonstrate any superiority of minimally invasive surgery for hip or total knee arthroplasty over conventional approaches.

Limited published data were available in 2004 regarding minimally invasive total knee arthroplasty. The bulk of the literature consisted of descriptions of surgical techniques or case series with either no controls or historical controls. (10-14) This evidence was considered inadequate to permit scientific conclusions.
2005 - 2009 Updates

Updated literature searches of the MEDLINE database were performed for the following periods: 2004 through June 2005; July 2005 through August 2006; September 2006 through October 2007; November 2007 through June 2008; July 2008 through May 2009. These literature searches focused on randomized controlled trials that compared minimally invasive procedures with conventional approaches.

Hip Arthroplasty

Three systematic reviews from 2007 - 2009 have reviewed minimally invasive hip arthroplasty. (15, 16, 17) Sharma and colleagues conducted a qualitative review of 16 level I or II studies pertaining to the various factors that influence rehabilitation after THA. (15) Five studies were identified that reported use of a minimally invasive surgical approach or smaller incision length (< 10 cm). Results of the studies indicated that minimally invasive surgical approaches, combined with aggressive pain control, speed recovery by improving patient compliance to accelerated rehabilitation. The faster recovery did not, however, affect the short-term or intermediate-term endpoint after THA as defined by use of walking aids, Harris hip score, Western Ontario and McMaster Universities Index of Osteoarthritis (WOMAC), Oxford hip score, SF-12 and SF-36 at six weeks from the surgery. Results from 5 studies that examined the effect of multimodal pain management indicated that aggressive postoperative pain control alone improves patient compliance in immediate postoperative rehabilitation, which leads to better pain control and hastens functional recovery. Another qualitative systematic review by Ulrich et al. found that most comparative studies show general equivalence between minimally invasive and standard approaches, but that more reports show disadvantages (increased complications) than advantages. (16) A quantitative systematic review compared outcomes from 5,285 minimally invasive hip arthroplasties with 1,341 conventional hip arthroplasties. (17) The analysis found a decrease in hospital stay (3.7 days vs. 5.0 days) with MIS, with no significant differences for operating time (80 vs. 87 minutes), blood loss (400 ml vs. 456 ml), Harris hip score (40 vs. 42) or measures of alignment. A number of randomized trials with 20 subjects or less per group have been published. Results of some of the larger randomized trials are described below.

One multicenter study randomized 60 patients to undergo either a conventional (15 cm incision length) or minimally invasive hip arthroplasty (8 cm incision length). (18) Operative time, transfusion requirements, narcotic usage, length of hospital stay, rehabilitation milestones, and complications were similar in both groups. The minimally invasive group had less blood loss at surgery and a lower incidence of a limp at 6-week follow-up. Another randomized study of 219 hips found no significant differences between patients who received an incision of 10 cm or less compared to a 16-cm incision in the conventional group, including operative time, blood loss, pain scores, analgesic use, or rehabilitation outcomes. (19)

Dorr et al. randomized 60 patients to computer-assisted total hip arthroplasty (THA) via a posterior mini (10 cm) or traditionally long (20 cm) incision. (20) Blinding of patients and evaluators was accomplished by lengthening the skin incision to 20 cm after completion of the mini-THA. There was a trend towards an increase in operating time (11 minutes), with no other differences in surgical or radiographic outcomes between groups. Twenty-nine of 30 patients (97%) in the mini-incision group were discharged by the second postoperative day in comparison with 67% of the long-incision group; the average hospital stay was 63 and 74 hours,
respectively. Pain scores were slightly lower at discharge (VAS of 2.2 vs. 3.1). By 6 weeks after surgery, there was no difference in clinical outcomes.

Using a 2-incision approach, Bal et al. found that 9 of 89 (10%) hip replacements required repeat surgery compared with 3 of 96 (3%) in a contemporaneous (non-randomized) control group who had single-incision minimally invasive hip arthroplasty. (21) Slower recovery for a 2-incision approach has also been reported in comparison with a mini-posterior-incision in a randomized trial involving 72 patients. (22) Some reports (case series) suggest that the posterior approach leads to more postoperative dislocations, but that this can be minimized by repair of the external rotators and capsule in all patients. (23)

Overall, these studies and other case series (24-26) suggest that MIS may be safe in experienced hands in the short-term, but do not demonstrate that minimally invasive hip arthroplasty is more beneficial than conventional approaches.

**Total Knee Arthroplasty**

Kolisek et al. found an increase in operating time (69 vs. 59 minutes), similar clinical benefit as measured by the SF-12, Knee Society Score, and Bartlett patella scores, and similar radiographic results with a 9 cm mid-vastus incision at 6 or 12 weeks follow-up. (27) There was no difference between groups in post-operative length of hospital stay, amount of analgesic use, return of knee function and total blood loss. Another multicenter study randomized 90 patients to mini mid-vastus, mini side-cutting, or standard TKA. (28) Operating times were longer with the minimally invasive approaches (112 vs. 92 minutes); all 3 groups remained in the hospital for 6 days. Radiographic outcomes were significantly poorer in the side-cut group, with significantly more outliers in overall limb alignment (43% vs 17%) and some measures of component positioning. Karachalios and colleagues reported that functional outcomes were improved in 50 patients who had a mini-midvastus approach in comparison with 50 patients who had conventional total knee arthroplasty when measured up to 9 months after surgery. (29) At 2-3 year follow-up, functional outcomes were similar between the two groups. Radiology identified technical errors in 6 patients (12%) in the minimally invasive group, prompting these surgeons to abandon routine use of minimally-invasive techniques. In addition, a retrospective comparative cohort study (100 mini-medial parapatellar vs. 50 standard TKA) with a single high-volume surgeon reported improved post-operative recovery (hospital stay, rehabilitation, narcotic usage, and need for assistive devices at 2 weeks post-operatively), but cautioned about the extensive learning curve (about 50 procedures) required to achieve these results. (30)

**Clinical Input Received through Physician Specialty Societies and Academic Medical Centers**

In response to requests, input was received through 4 Academic Medical Centers while this policy was under review. While the various Physician Specialty Societies and Academic Medical Centers may collaborate with and make recommendations during this process, through the provision of appropriate reviewers, input received does not represent an endorsement or position statement by the Physician Specialty Societies or Academic Medical Centers, unless otherwise noted. Clinical input agreed with the policy, as adopted in October 2009, that minimally invasive procedures may be considered acceptable alternatives to other standard approaches for hip and total knee replacement. Clinical input also agreed on the importance of surgeon training and continued high practice volume for good outcomes with minimally invasive approaches.

**Summary**
Randomized controlled trials suggest modest post-operative benefits in pain reduction and recovery and similar short to mid-term outcomes with minimally invasive techniques. It remains unclear whether the post-operative benefits are due to the smaller incisions, reduced soft-tissue trauma, or to the change in post-operative pain management protocols. In addition, several studies suggest that an increase in implant malalignment and other complications may increase when minimally invasive procedures are performed outside of high-volume centers with experienced surgeons. Therefore, minimally invasive procedures may be considered as an alternative to other approaches when performed at centers experienced in the procedure and by surgeons with appropriate training and practice volume.

References:


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