MIS Hip and Knee Replacement Anesthesia Protocol: Epidural Technique for the MIS THA

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Introduction

With the oldest members of the "Baby Boom" generation currently in their sixth decade of life, the number of patients undergoing total hip arthroplasty (THA) can be expected to increase significantly over the next few decades. Patients today are more informed about their health care options and are demanding newer, better techniques to accommodate active lifestyles. Once thought of as primarily an option for the elderly, it has become clear that the range of patients who are candidates for THA is expanding to include the younger, employed, and active populations.

Better prostheses and improved surgical and anesthetic techniques have allowed dramatic changes in the perioperative experience for patients. Standard THA involves an incision length of 25-30cm and an inpatient stay of 3.5-4 days, with many patients transferring to a rehabilitation facility due to an inability to perform activities of daily living on an independent basis. For those patients still in the workforce, a 6-8 week period of physical therapy and recuperation was necessary prior to resuming most job duties. Currently, the average age for THA is 68 while the average age for minimally invasive THA is significantly lower at 57 in our institution. It is natural that younger patients needing THA gravitate toward those facilities offering progressive surgical, anesthetic and pain management options.

In addition, these minimally invasive techniques can be of enormous benefit to the traditional, older arthroplasty patient by allowing them to retain muscle strength and mobility compared to more invasive methods. At centers frequently performing the procedures, minimally invasive THA patients have lower blood loss, earlier ambulation and better functional recovery (Wenz et al. 2002).

The development of minimally invasive techniques in arthroplastic surgery has necessitated changes in the standard anesthetic and postoperative pain management of total hip arthroplasty (THA). Surgical options include the Zimmer *MIS™ 2- Incision®* THA and the "mini" single-incision THA. The *MIS 2-Incision* hip is essentially a muscle sparing procedure while the "mini" does require transmuscular incisions, but to a far lesser extent than traditional THR. Both procedures utilize specialized instruments, lighted retractors, and a meticulous surgical technique. Physical therapy milestones are not compromised and patients must demonstrate the same ability to walk, climb stairs, and perform ADLs prior to discharge as traditional surgical patients. They are weight-bearing within several hours of surgery. Patients undergoing the *MIS 2-Incision* procedure may be discharged the same day of surgery while those undergoing the Mini-Incision approach typically stay 2-3 days.

Standard anesthetic techniques for traditional THA involved a spinal, epidural, combined spinal-epidural catheter, or general anesthetic. Often an arterial line would be placed due to the hypotensive anesthetic technique used to reduce blood loss while cutting through the large gluteal muscles. Postoperative management included either an epidural infusion of an analgesic for 48 to 72 hours after THA, a PCA intravenous morphine, or an injection of intrathecal morphine at the time of spinal anesthesia. Removal of central neuraxial catheters was problematic due to anticoagulation used for DVT prophylaxis. Postoperative stays of 3 to 5 days in the hospital were followed in many cases by admission to a rehabilitation facility.

While these methods of anesthetic management were adequate for patients staying 3-5 days as an inpatient, the accelerated postoperative course of minimally invasive THA patients has necessitated concomitant changes in the perioperative anesthetic management. No longer having the luxury from either an economic or patient preference point of view for an extended inpatient stay, surgeons and anesthesiologists have sought better ways of preoperative, intraoperative and postoperative management. It is most beneficial when these are considered as a global approach to management of the patient rather than as distinct events.

Multimodal pain management in orthopaedic surgery has been shown to reduce opioid use, improve pain scores, and decrease the incidence of nausea. (Skinner et al. 2004, Buvanendran et al. 2003). Although the specific definitions of "multimodal" vary among centers, the concept at its core involves the use of opioids, COX-2 inhibitors, NSAIDS, acetaminophen, steroids, both peripheral and central neuraxial blockade as well as local infiltration of the surgical field with local anesthetics. (Skinner 2004). By employing medications and block techniques that address the pain generator

This anesthesia protocol is based on the experience of the authors. All patient care decisions remain the responsibility of the treating physicians. It is recommended that this protocol be reviewed within the treating institution to assess compatibility with the institution's practices, procedures, and treatment philosophy. The information and recommendations in this protocol have been reviewed by the authors and reflect their current practice as of the date this protocol is published.

mechanisms at multiple levels, it is possible to improve overall pain scores and diminish side effects seen with the traditional all-opioid technique.

In order to achieve these aggressive goals, emphasis has been placed on several key aspects of the anesthetic plan:

- Preoperative COX-2 inhibitor
- Preoperative extended release opioid
- Adequate surgical block
- Proper sedation
- Maintenance of body temperature
- Adequate hydration
- Nausea prophylaxis
- Smooth transition from intraoperative to postoperative pain control

Preoperatively

Ideally, perioperative management of the THA patient begins in the orthopedic surgeon's office. A doctor-patient relationship has been established and education about the procedure has occurred from both surgical and pain management perspectives. In these minimally invasive procedures, the goals of the surgeon and the anesthesiologist are coexistent and patient education begins at the initial point of contact, regardless of traditional roles. Patients are given a prescription for oxycontin and celecoxib to be filled prior to admission unless contraindicated. Known contraindications include aspirin or NSAID allergy as well as sulfonamide allergy.

For those patients scheduled as ambulatory or same-day discharge, they are instructed to take celecoxib 400mg po and oxycontin 10mg po the morning of surgery with a small sip of water. Patients may also take their usual medications in concordance with preoperative anesthetic policy.

Although the tissue trauma is considerably less when using either the *MIS 2-Incision* or Mini-Incision surgical technique, it is still important to use a multi-modal approach to pain management.

An IV is placed in the holding area and midazolam is titrated to achieve anxiolysis. No additional opioid is typically given in an effort to avoid nausea. The delivery kinetics of controlled release oxycodone are such that approximately one-third of the total dose is delivered in the first 60 minutes (Mandema et al. 1996).

Epidural Technique

Either in the preop holding area, regional block room, or the operating room, an epidural catheter is placed at the L1-L4 level, slightly higher than the traditional approach. The diameter of the higher lumbar roots is less than those of the lower lumbar and sacral roots which has been hypothesized to facilitate blockade with local anesthetics (Hogan 1996). Additionally, there is a lesser degree of degenerative change seen in the higher lumbar region when compared to the lower segments, which may also aid in achieving an adequate surgical block. A combined spinal-epidural and "single-shot" spinal anesthetic techniques are generally not advised due to excessive duration of the block and inability to confirm a working epidural prior to surgical incision. Additionally, the transition from spinal anesthetic to adequate oral pain medication may be difficult.

Although most anesthesiologists are familiar with epidural technique, the following will review some of the key points that lead to a high degree of success. With the patient in a seated position, knees flexed and chin to chest, the arms are positioned in a relaxed posture in front. While there are commercially available positioning devices that greatly facilitate optimal posture, a non-swivel stool and a cooperative assistant supporting the patient is adequate as well. The iliac crests are palpated and the approximate L4 level is identified. The lumbar region is prepped and draped in a sterile fashion. Spinous processes are identified if body habitus allows. At a point low in the interspinous space, lidocaine 1% is infiltrated with a 1.25-inch 25g needle. Identify the spinous process of the lower vertebra and infiltrate generously above the spinous process. An important concept while infiltrating local anesthetic is that of "mapping" the area with the smaller 25g needle. By creating a mental 3-D image of the interspace while infiltrating, the placement of the epidural needle is facilitated. A single pass technique of placing local anesthetic does not provide much useful information.

The epidural needle of choice is placed initially in the lower third of the interspace. Contacting the lower spinous process ensures midline placement. By walking cephalad, but not necessarily angling the needle cephalad, if one encounters bone, the best redirection of the needle is cephalad again. If one chooses to take a more random, rather than systematic approach to identifying the epidural space, contacting bone upon advancement leads to 360° of possible redirection. By contacting the lower spinous process with the epidural needle prior to advancement, as well as starting lower in the interspace, if bone is then encountered, the best redirection is cephalad, rather than a random redirection.

The presence of a clinically significant dorsal epidural band has generated much discussion (Seeling 1990, Morisot 1992). Regardless of the final conclusion, even a brief clinical practice will demonstrate the occurrence of a unilateral block. It is advantageous to direct the epidural needle 0° to 10° from midline toward the operative side.

Loss of resistance technique is used to identify the epidural space. It can be helpful to minimize the air injected, as it tends to settle near the takeoff of the nerve root and may lead to an incomplete or "patchy" block. Confirmation with a small amount of saline/air is a reconfirmation of successful entry into the epidural space. The catheter is threaded into the space 3-5cm. Lim et al. demonstrated that coiling of the epidural catheter is often seen after 3cm insertion. If mild, transient paresthesia occurs on the contralateral side, reentry into the epidural space may be considered with a slight redirection of the needle to the operative side. Meticulous technique and full consideration of the nuances of epidural anesthetic techniques cannot be overemphasized. By relying on a pure epidural approach to anesthetic management, rather than a spinal with the hope of a functioning postoperative epidural, fewer failures of analgesia are seen in the recovery room.

Intraoperatively

A test dose of 3mL of 1.5% lidocaine is given. If negative for intravascular or intrathecal injection, approximately 5-6mL of 2% lidocaine with epi is given. This is followed by 4-6mL of 0.5% bupivacaine. The lidocaine provides rapid onset of the block and the bupivacaine provides a denser block to facilitate muscle relaxation. Using the two local anesthetics in combination gives benefits of each. Lidocaine alone may not provide a dense enough block. In contrast, using 0.5% bupivacaine as a sole agent may lead to prolonged block and delay in discharge from the recovery room. Once an adequate block is achieved, a propofol infusion is started to provide deep sedation. It is important to note that a lower total volume of local anesthetic is used during this technique due to the higher placement of the catheter. It is a tendency of anesthesiologists to achieve level of block more cephalad than required for THA.

Hypothermia

Prevention of hypothermia is essential to each step of the perioperative process. Schmied et al. showed that intraoperative blood loss was significantly increased with mild to moderate hypothermia. As the patient moves to the recovery room, hypothermia may delay discharge to the floor. A fluid warmer is used as soon as possible to avoid administration of a large amount of unwarmed IV solution. In the initial phases of the procedure, 1.5-2L of intravenous lactated Ringer's is given to counteract the sympathectomy of the epidural anesthetic. Overall fluid management during the surgical procedure is aggressive due to regional anesthetic, continued blood loss in the postoperative period, and the need for ambulation several hours after completion of surgery. A total volume of 3000-3500mL is administered.

Patients receive two units of autologous blood that have been donated preoperatively. Urine output is monitored to assure proper hydration with placement of a foley catheter prior to surgical prep.

Nausea Prevention

Postoperative nausea continues to plague many otherwise technically perfect anesthetics. Predictors of postoperative nausea and vomiting include female gender, history of motion sickness or PONV, smoking, and postoperative opioid use (Apfel 1999). None of these predictors, however, proved absolute, and the repercussions of PONV are so detrimental to the fast track approach used in minimally invasive THA that 5HT3 blockers are given to all patients. Ondansetron 4mg IV during the procedure may be used alone or in combination with dexamethasone 4-8mg IV.

Postoperatively

Patients are started on an infusion of 0.1% bupivacaine with 5mcg of fentanyl per mL at a rate of 5-6mL/hour with a PCEA mode of 1mL q 15 minutes. Epidural infusion continues throughout the postoperative period until approximately 2 pm the day of surgery. A second dose of oxycodone 10-20mg is given 1 hour prior to discontinuation of the epidural infusion to avoid a "gap" in analgesia. The Foley catheter is discontinued early in the afternoon. Postoperatively, they may continue on oxycodone po bid-tid as well as celecoxib 200mg q day.

Patients must undergo physical therapy within 2-4 hours after discharge from the recovery room. Hypotension, despite the aggressive measures employed, is still an issue. The patients are transitioned from a reclining position to several episodes of sitting, standing with assistance, walking with two crutches, climbing stairs, and getting dressed. Patients often exceed our goals and walk with one crutch, a cane or unassisted by the afternoon of surgery.

Comments

This protocol provides the basic framework for an appropriate minimally invasive THA or minimally invasive TKA anesthetic. Although personal experiences with techniques used for other orthopaedic procedures vary widely, we have found that this technique works well in our clinical setting. Other institutions have found success with peripheral nerve catheter techniques combined with spinal or general anesthesia. The epidural technique provides a means of anesthesia as well as postoperative analgesia. Reliance on a "single-shot" spinal with morphine or a morphine sulphate injection postoperatively has proven to be problematic due to sedation, nausea, and other side effect issues, while peripheral nerve catheters offer an interesting option for those anesthesiologists equipped for those procedures.

The epidural technique provides good surgical relaxation of the muscles; however it is not to the degree seen with general anesthetics and intravenous muscle relaxants. An understanding of the difficulties encountered by both the surgeons and the anesthesiologists helps the entire team adapt these innovative procedures that represent truly revolutionary changes in joint replacement surgery.

While we discharge our *MIS 2-Incision* THA patients the day of surgery, that may or may not be practical in other settings. What ensures the success of the protocol is the fastidious attention to detail in this anesthetic plan. It requires a commitment to the overall goals of the OR team, the recovery room nurses, floor nurses, pain management staff, and physical therapists. In addition, the preoperative education of a motivated patient is essential. Knowing that these outcomes can and have been achieved in a variety of practice settings gives patients, surgeons, anesthesiologists, and associated team members exciting options in the future of joint replacements.

References

Apfel CC. A simplified risk score for predicting postoperative nausea and vomiting: conclusions from cross-validations between two centers. *Anesthesiology*. 1999 Sep;91(3):693-700.

Berger RA. The technique of minimally invasive total hip arthroplasty using the two-incision approach. *Instr Course Lect*. 2004;53:149-55.

Borghi B, Laici C, Iuorio S, Casati A, Fanelli G, Celleno D, Michael M, Serafini PL, Pusceddu A. [Epidural vs general anaesthesia] *Minerva Anestesiol*. 2002 Apr;68(4):171-7. Italian.

Broadbent CR, Maxwell WB, Ferrie R, Wilson DJ, Gawne-Cain M, Russell R. Ability of anaesthetists to identify a marked lumbar interspace. *Anaesthesia*. 2000 Nov;55(11):1122-6.

Buvanendran A, Kroin JS, Tuman KJ, Lubenow TR, Elmofty D, Moric M, Rosenberg AG. Effects of perioperative administration of a selective cyclooxygenase 2 inhibitor on pain management and recovery of function after knee replacement: a randomized controlled trial. *JAMA*. 2003 Nov 12;290(18):2411-8.

Chelly JE, Gebhard R, Coupe K, Greger J, Khan A. Local anesthetic PCA via femoral catheter for the postoperative pain control of an ACL performed as an outpatient procedure. *Am J Anesthesiol*. 2001;28:192-4.

Choi PT, Bhandari M, Scott J, Douketis J. Epidural analgesia for pain relief following hip or knee replacement. Cochrane Database Syst Rev. 2003(3):CD003071. Review.

Hirabayashi Y, Saitoh K, Fukuda H, Igarashi T, Shimizu R, Seo N. Magnetic resonance imaging of the extradural space of the thoracic spine. *Br J Anaesth*. 1997 Nov;79(5):563-6..

Hogan Q. Size of human lower thoracic and lumbosacral nerve roots. *Anesthesiology*. 1996 Jul;85(1):37-42.

Igarashi T, Hirabayashi Y, Shimizu R, Saitoh K, Fukuda H, Mitsuhata H. The lumbar extradural structure changes with increasing age. *Br J Anaesth*. 1997 Feb;78(2):149-52.

Lim YJ, Bahk JH, Ahn WS, Lee SC. Coiling of lumbar epidural catheters. *Acta Anaesthesiol Scand*. 2002 May;46(5):603-6.

Mandema JW, Kaiko RF, Oshlack B, Reder RF, Stanski DR. Characterization and validation of a pharmacokinetic model for controlled-release oxycodone. *Br J Clin Pharmacol*. 1996 Dec;42(6):747-56.

Morisot P. [Is posterior lumbar epidural space partitioned?] *Ann Fr Anesth Reanim*. 1992;11(1):72-81. Review. French.

Schmied H, Kurz A, Sessler DI, Kozek S, Reiter A. Mild hypothermia increases blood loss and transfusion requirements during total hip arthroplasty. *Lancet*. 1996 Feb 3;347(8997):289-92.

Sculco TP. Minimally invasive total hip arthroplasty: in the affirmative. *J Arthroplasty*. 2004 Jun;19(4 Suppl 1):78-80. Review.

Seeling W, Rockemann M. [Unilateral epidural anesthesia] *Reg Anaesth*. 1990 Mar;13(2):23-8. German.

Sheehan E, Neligan M, Murray P. Hip arthroplasty, changing trends in a national tertiary referral centre. Ir J Med Sci. 2002 Jan-Mar;171(1):13-5.

Siguier T, Siguier M, Brumpt B. Mini-incision anterior approach does not increase dislocation rate: a study of 1037 total hip replacements. *Clin Orthop*. 2004 Sep(426):164-73.

Skinner HB. Multimodal acute pain management. *Am J Orthop*. 2004 May;33(5 Suppl):5-9. Review.

Skinner HB, Shintani EY. Results of a multimodal analgesic trial involving patients with total hip or total knee arthroplasty. *Am J Orthop*. 2004 Feb;33(2):85-92; discussion 92.

Tang Z. Minimally invasive total hip replacement. *Issues Emerg Health Technol*. 2004 Aug(60):1-4.

Wenz JF. Mini-incision total hip arthroplasty: a comparative assessment of perioperative outcomes. *Orthopedics*. 2002 Oct;25(10):1031-43.

Woolson ST, Mow CS, Syquia JF, Lannin JV, Schurman DJ. Comparison of primary total hip replacements performed with a standard incision or a mini-incision. *J Bone Joint Surg Am*. 2004 Jul;86-A(7):1353-8.