Tips and Pearls
Minimizing Tourniquet Use in Knee Arthroplasty and Utilizing the Aquamantys® System

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Tips and Pearls to Minimize Tourniquet Use in Knee Arthroplasty

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INTRODUCTION

Tourniquets are traditionally used in knee arthroplasty to achieve a near-bloodless field and control intraoperative wound hemostasis. However, there are a number of disadvantages to tourniquet use that make minimizing its use potentially attractive. Minimizing the use of tourniquets when performing knee arthroplasty is shown to benefit patients by reducing postoperative thigh pain\(^\text{1-5}\) while accelerating early postoperative physical therapy, range of motion, and restoration of function.\(^\text{1,3-5}\) Using the combination of hypotensive anesthetic techniques with a spinal anesthetic can be quite effective at minimizing tourniquet time while also possibly reducing postoperative blood loss.\(^\text{6-8}\) The benefit of minimizing tourniquet time with assistance from the Aquamatys System (Medtronic, Inc., Portsmouth, NH, USA) is that the surgeon can find and coagulate bleeding areas during the surgery, thereby significantly reducing the occurrence of hidden blood loss that would otherwise occur after wound closure and tourniquet deflation.\(^\text{9}\)
PREOPERATIVE AND ANESTHETIC CONSIDERATIONS

Several considerations must be addressed preoperatively when planning to minimize tourniquet use during knee arthroplasty. However, rarely do such clinical issues preclude minimizing tourniquet use across all patient populations.

One of the keys to successfully minimizing tourniquet use during knee arthroplasty is the maintenance of “relative hypotension.” Maintaining a relative level of hypotension in the patient decreases bleeding during the procedure and can significantly affect the total amount of blood loss perioperatively. Therefore, a critical comorbidity that should be considered preoperatively is a history of moderate to severe hypertension. If the patient’s blood pressure is elevated during the procedure, increased bleeding from the intramedullary canals of the tibia and femur as well as from the soft tissues may result.10

Patients with moderate to severe high blood pressure may generate concerns regarding performance of hypotensive anesthesia during the procedure. Patients with hypertension frequently develop a degree of physiologic autoregulation whereby the heart, kidneys, and brain become acclimated to the baseline relative high blood pressure state.11,12 Maintaining low blood pressure during the surgical procedure can lead to an acute drop in organ perfusion pressure which could result in myocardial infarction (heart), stroke (brain), acute tubular necrosis and renal failure (kidneys).6,7,13,14 Preoperative consultation with anesthesia staff is paramount and beneficial in formulating a coordinated plan for relative hypotensive anesthesia use while minimizing tourniquet use. The use of a spinal or epidural anesthetic is effective for achieving this goal and patients functionally have a temporary sympathectomy of the relevant nerve branches.8 Supplementary administration of beta blockers (in accordance with current guidelines from The Centers for Medicare & Medicaid Services) and other anti-hypertensive medications may be necessary to help maintain lower blood pressure.15,16

Another critical preoperative consideration is identification of patients being treated with anticoagulants such as clopidogrel (Plavix®), enoxaparin (Lovenox®), warfarin (Coumadin®), aspirin (Bayer®, Anacin®, etc.), cilostazol (Pletal®), pentoxifylline (Trental®) and others. If possible, the surgeon should plan to have the patient discontinue the use of such anticoagulants as far in advance of the surgery as required to minimize their effects as such agents can significantly increase intraoperative bleeding.17 Specific consensus guidelines by The American Society of Regional Anesthesia and Pain Medicine (ASRA) indicate when to stop such anticoagulants prior to any surgery; these should be followed with strict guidance. Similar attention must be paid to “over the counter” supplements that may have significant anticoagulant activity. Such supplements include fish oil, vitamin E, garlic tablets, and many others. The surgeon should make note of such medicines preoperatively and encourage the patient to discontinue them well in advance of surgery.17 This practice should be observed independent of tourniquet strategy as the anesthesiologist cannot perform various neuroaxial or peripheral nerve blocks with anticoagulants on board.

Patients with a history of significant clotting disorders such as hemophilia, Von Willebrand’s disease, and other such blood dyscrasias that result in relatively poor coagulation should also undergo extensive preoperative workup with a hematologist and anesthesiologist prior to minimizing tourniquet use for knee procedures. Such patients may require preoperative transfusion with platelets, or fresh frozen plasma (FFP), to temporarily improve clotting during the surgical procedure. Again, in such patients, with appropriate preoperative workup, minimizing tourniquet use with meticulous intraoperative hemostasis can reduce intraoperative and postoperative bleeding.9

With regards to other medical comorbidities, it is important to consider minimizing tourniquet use in patients with significant vascular atherosclerotic disease. The proportion of patients with peripheral vascular disease increases in elderly patients.18 The risks of atherosclerotic embolic plaques rupturing and traveling distally in the lower extremity after tourniquet use have been well documented in the literature.19,20 Such embolic events can result in distal occlusion of the arterial supply to the lower extremity and put the patient at risk for ischemic injury to the distal lower extremity. Patients who have previously undergone lower extremity vascular grafting procedures are also well served by minimizing tourniquet use.20 In such patients, the high tourniquet pressures in the region of the thigh can increase the risk of graft thrombosis and occlusion, requiring revisions to the graft with associated complications.
Reduction in tourniquet use and total time can improve oxygen tension at the wound margins and improve wound healing in standard patients and patients who are already at higher risk of wound complications.\textsuperscript{21-23} Additionally, minimizing tourniquet use in patients with preoperative diabetic neuropathy can also reduce risks of neuropathic thigh pain and distal extremity pain.\textsuperscript{24} There is clear association between the duration of tourniquet usage and postoperative neurological deficits such as neuropathy.\textsuperscript{25}

AN OPERATIVE TECHNIQUE FOR MINIMIZING TOURNIQUET USE IN KNEE ARTHROPLASTY

Proposed here are technical considerations that were developed by the author of this piece to allow for the comfortable performance and successful minimization of tourniquet use in knee arthroplasty. These may facilitate the surgeon’s successful completion of the procedure and should also be considered.

Following standard surgical preparation and exsanguinations of the indicated leg, the tourniquet is then inflated to between 250-275 mm of mercury based on the patient’s systolic blood pressure. The skin incision is performed with the knee in flexion, which reduces the amount of initial bleeding that occurs whether a tourniquet is inflated or not.

The next step involves placing the knee into extension and completing the arthrotomy. The infrapatellar and suprapatellar fat pads are easily accessed and removed, and the Aquamantys device is used to coagulate bleeding tissue, particularly in the area of the subperiosteal tibia behind the fat pad, within the substance of the infrapatellar fat pad, and also in the suprapatellar fat pad. With the knee in extension, patellar resection is performed and a protective spiked metal button is placed on the prepared patellar surface to prevent intraoperative injury.

The remainder of the operation can be performed with the tourniquet deflated and the knee in relative flexion, which aids in the reduction of intraoperative bleeding. These first three steps can be easily completed within 3-4 minutes. Once these steps have been completed, we would propose flexion of the knee back up to between 70-90 degrees, based on surgeon preference, and followed by tourniquet deflation. We find that if this protocol is followed exactly, once the tourniquet is deflated, the bleeding will be minimal for the remainder of the case.

With the knee in flexion, a medial release can be performed as necessary for exposure, followed by removal of the medial and lateral meniscal tissues and standard bone cuts on the tibia and femur in the order preferred by the surgeon. With removal of the lateral meniscal tissues, the surgeon will have good visualization of the lateral genicular artery, which is a major source of bleeding postoperatively, and this can be coagulated easily and effectively with the Aquamantys device.

Once the tibial cuts have been made and the femoral preparation is complete, we have identified two techniques that are highly effective in reducing postoperative bleeding with regard to the knee capsule.

Technique 1: In this technique, the surgeon places the knee in full extension with a large bump underneath the calf muscle that is roughly made of 7 to 8 surgical towels wrapped with a device such as Coban\textsuperscript{TM} or an Ace\textsuperscript{TM} wrap. A lamina spreader is then placed into the medial or lateral compartment to distract the joint, along with a self-retaining Weilander retractor anteriorly to hold the patella out of the way. This positioning and retraction of the leg will allow excellent visualization and access to the posterior knee capsule. At this point, the Aquamantys device can be used to treat the entire posterior capsule and soft tissues both medially and laterally. Upon completion of one half of the knee (either medial or lateral), we move the lamina spreader to the opposite compartment and coagulate the remaining areas. We find that diligent use of this technique with the Aquamantys device as the tissue changes from red or pink to a tan color can significantly reduce bleeding prior to cementation.

Technique 2: In the second and equally effective technique, we place the knee in 90 degrees of flexion after completion of the tibial and femoral preparation and use a lamina spreader to distract the joint. A self-retaining retractor is used to hold the patella out of the way and the medial and lateral posterior capsular tissues are treated in a very similar manner to that described above. One advantage of this technique is that the positioning of the knee in 90 degrees of flexion allows excellent access to the posterior capsular tissues that are proximal to the posterior condyles and behind the posterior condyles. We find that diligent use of the Aquamantys device in the medial and lateral compartments, again using the change in tissue color as a guide, will be beneficial.
With both of these techniques, care must be taken to avoid overtreatment of the lateral tissues, including the popliteal area. Additionally, overtreatment in the anterolateral area can result in damage to the iliobial band. The Aquamantys device should not be used on intact tendons or ligaments, subcutaneous tissue, or bone that will be covered by the implant.*

Once we have achieved hemostasis in the posterior capsule, we place the knee back into extension, insert a laparotomy sponge into the back of the knee, and perform standard exsanguinations of the leg. The tourniquet is then reinflated to between 250-275 mm of mercury, based on the patient’s blood pressure, and component cementation can ensue. We would advocate maintaining tourniquet inflation for 7-8 minutes, until the cement has completely polymerized. Once the cement has polymerized, the tourniquet is deflated and any remaining bleeding areas are once more treated with the Aquamantys device.

By using this protocol, we have found that our total tourniquet time is usually limited to between 10 and 12 minutes and the use of suction drains postoperatively is unnecessary.

One additional technical point is the use of an injection cocktail in the back of the knee. We currently use a very simple cocktail consisting of 0.25% Marcaine® (up to 40 mls can be injected) with epinephrine in the back of the knee that is injected carefully when the knee is in extension with the lamina spreader in place. Again, this cocktail has been demonstrated in the literature to reduce postoperative bleeding even further in addition to reducing postoperative pain.26,27

With the use of these techniques, we have very effectively minimized tourniquet use in knee arthroplasty, achieving better patient outcomes with less pain, quicker recovery, and reduced length of stay at our facility.

This paper was prepared by a consultant paid by Medtronic at the time of the publishing.

* For a complete list of treatment guidelines, please refer to the product Instructions for Use.

REFERENCES


Marcaine is a registered trademark of AstraZeneca.

Plavix is a registered trademark of Bristol-Myers Squibb/Sanofi Pharmaceuticals Partnership.

Lovenox is a registered trademark of Sanofi-Aventis.

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Dr. Kusuma attended Vanderbilt University, where he was the recipient of the Harold Stirling Vanderbilt Scholarship. He graduated Summa Cum Laude with a BS degree in Chemistry and Economics. He stayed at Vanderbilt and earned a Master of Business Administration degree at Vanderbilt’s Owen Graduate School of Management, where he earned the prestigious Beta Gamma Sigma Award that is presented to the top five percent of MBA graduates nationally.

He also attended medical school at Vanderbilt University, followed by residency training at the University of Pennsylvania School of Medicine. During his residency, Dr. Kusuma earned many awards for his research accomplishments. Upon finishing his residency in 2007, he commenced fellowship training in total joint reconstruction at the world-renowned Rush University Medical Center in Chicago, Illinois. There, Dr. Kusuma trained with several true world pioneers in minimally invasive hip and knee surgery.