

Approach to Knee Injections: A Review of the Literature.

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KEYWORDS:

Arthrocentesis

Knee joint

Ultrasound guided
injection

Many factors should be considered when managing a joint injection for an osteoarthritic knee. Along with the type of needle, medication to be injected, and how often the injections need to be done, the actual step-by-step procedure should be carefully considered. Studies have shown variability between medial vs. lateral approaches, and guidance by ultrasound or anatomical landmarks. The lateral midpatellar site was found to have a 93% accuracy compared to the anteromedial and anterolateral with only 75% and 71% accuracy, respectively (Strength-of-recommendation - SOR B)8. Ultrasound has been shown to increase accuracy rates as well, providing 95.8% injection accuracy for the knee joint compared to only 77.8% without using any imaging ($p < 0.001$)(SOR C)8. Cost effectiveness is another issue and revolves around whether the increased benefits outweigh the cost of ultrasound in knee injections. Studies show they do in the hospital setting, with spending at 58% less on overall procedures (\$224) compared to conventional (anatomically guided) methods ($p < 0.0001$)(SOR B)10. The aim of this literature review is to discuss the most up-to-date material on knee injections and the approaches which: 1) have the most efficacy, 2) produce the least side effects, 3) have the easiest inter-physician reliability, and 4) are most cost effective.

Osteoarthritis (OA) is a chronic, degenerative, and debilitating disease commonly found in old age. OA affects 13.9% of adults aged 25 and older and 33.6% of those greater than 65 years old in the US population. From 1990-2005, OA prevalence increased by almost 6 million people and will continue to increase given the aging U.S. population.¹ OA is characterized by deteriorated articular cartilage and osteophyte bone formation, commonly referred to as bone spurs, within the joint. In patient's refractory to pain medication, osteopathic manipulation, and other conservative measures, physicians may offer injectable corticosteroids, analgesics, or hyaluronic acid preparations to help alleviate the pain. Physicians doing knee injections have varied accuracy and several techniques and methods have been experimented with in order to find the most precise and accurate technique for injection of the knee joint. This review will provide an up to date summary of the most recent research regarding knee injections, focusing on those with the greatest success in areas of pain reduction, duration of alleviation, cost, and accuracy of procedure.

MATERIALS AND METHODS

Search Strategies and Selection Criteria:

Literature was searched using 2 databases up to February 2013 in the English language including PubMed, Medline,

and other journal search engines. The keywords used in the searches were knee injections, ultrasound-guided, knee injection techniques, and knee osteoarthritis. The initial search of 'knee injections' yielded 3,381 publications. After screening and determining article relevance and timeliness, 25 publications were considered, and 15 were included in this review. The Centers for Medicare & Medicaid Services website was used for reimbursement costs.

RESULTS AND DISCUSSION

The knee consists of two distinct joints, the tibiofemoral and patellofemoral joint. Within the tibiofemoral joint is a pair of fibrocartilaginous menisci which mainly functions to evenly disperse the weight and pressure placed on the joint. A second function is to provide protection from friction of the femur and tibia. When either of these two key functions becomes ineffective, pathology may occur. Osteoarthritis is a degenerative disease in which the cartilage degrades due to reduced water content. This is a result of the decreased amount of proteoglycan content in the cartilage. The cartilage normally contains 85% water in young healthy individuals, yet decreases to roughly 70% in older individuals as a result of the reduced proteoglycan content.² A negative outcome of the decreased proteoglycan and water content of the cartilage is a decrease in the ability to withstand stress and a greater likelihood to tear. Small tears in the cartilage can cause a local reaction where the cells lining the joint attempt to remove the tissue, producing an inflammatory reaction.

Chronic, every day "wear and tear" of the joint can exacerbate symptoms such as swelling, pain, and erythema. Patients may

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attempt several methods of relieving symptoms like physical therapy, non-steroidal anti-inflammatory drugs, icing, and rest. However, chronic stress on the joint may not respond to such treatment and primary care physicians may offer two other options: arthrocentesis, or removing synovial fluid from the joint, and injection of corticosteroids or other medications into the joint.

INDICATIONS

Indications for arthrocentesis other than osteoarthritis include: diagnostically such as for an acute mono/polyarthritis or hemarthroses; therapeutically to drain large effusions or hemarthroses. Injection of corticosteroids or hyaluronic based products may be used therapeutically for pain reduction.^{3,4} Arthrocentesis can also be used for detection of hemarthroses or fat globules to aid diagnosis of knee pain.

CONTRAINDICATIONS

Absolute contraindications to placing a needle in the knee joint include: cellulitis, bacteremia, joint prosthesis, severe overlying dermatitis, or any infection of the soft tissues. Relative contraindications include: suspected bacteremia, septic arthritis, hyperglycemia, diabetics, and anyone with an inherited or acquired coagulopathy.^{3,4}

TYPES

Commonly used since introduced in the 1950's, corticosteroid injections are still the most popular form of injectable medicine for those suffering from OA, RA, and other causes of pain of the knee. Cortisone is the most well-known corticosteroid for this treatment, though, there are others commonly used by primary care physicians. Cortisone is usually accompanied by some type of analgesic such as lidocaine for immediate relief of symptoms. Newer formulations, such as hyaluronic acid, are being used to replenish the joint with lubricant. Hyaluronic acid can best be understood as a naturally occurring "motor oil" for our joints, providing lubrication that decreased friction and potentially the inflammatory processes that follow. The FDA approved the first hyaluronic acid injection in 2003 for the knee. Since then, several new forms have been marketed, such as Hylan G-F 20 (Synvisc®), Sodium Hyaluronate (Hyalgan®) (Supartz®), Orthovisc®, and Euflexxa®. The most popular are Synvisc® and Hyalgan®, both very high molecular weight preparations given as a weekly injection over a period of 3 and 5 weeks, respectively. The cost of 3 vials of Synvisc® is roughly \$620, while the cost of five vials of Hyalgan® is roughly \$661.⁵ A study of 32 patients with primary knee arthritis were randomly given either Synvisc® or Hyalgan® and evaluated both before the injection and up to 26 weeks after the injections. Results of 15 patients from each group showed no difference between the two joint

supplements at 26 weeks follow up, while both significantly improved symptoms.⁶

TECHNIQUES FOR INJECTION

Opinions have been varied on determining the most efficient method of injecting the knee. With proper training, approaching from either the medial or lateral side of the knee may be used; however, recent studies have shown that the lateral side provides greater accuracy for needle placement, heightened by the use of ultrasound. A summary of 14 different studies yielded positive results for increased accuracy using imaging. A study of 621 needle injections within the knee and shoulder for various reasons produced 603 accurate placements, a 97.1% percent placement accuracy using imaging. In conjunction, the same 14 studies recorded a total of 665 patients without any type of imaging to help guide the procedure and only 471 of the patients were accurately injected with the needle, a 70.8% accuracy rate. Within this study, ultrasound guided knee injections had an accuracy rate of 95.8% compared to 77.8% without any imagining of the knee ($p < 0.001$).⁷

Ultrasound has been shown to increase the accuracy of properly inserting the needle in the joint. The utilization of ultrasound in everyday procedures in the primary care office is increasing. A recent 2011 study of inflammatory and osteoarthritic patients has shown that mean fluid depth of effusions of patient's knees showed significant difference between the lateral (9.2 mm), medial (6.5 mm), and midline (5.9 mm) ($p < 0.0001$) ($p < 0.001$ for lateral vs. medial and lateral vs. midline).⁹ If effusions are indeed accumulating in the lateral pouches of the knee, it would be reasonable to attempt arthrocentesis from this side as well. A further study, aimed at the relationship of the effusion volume to the accuracy of the anatomical approach could be beneficial.

To further increase accuracy, physicians must ensure that they are entering the knee through the easiest and most effective approach. A 2002 study has showed one physician performing 240 knee injections, divided equally between anteromedial, anterolateral, and lateral midpatellar sites, was able to successfully place the needle into the intra-articular space 71% of the time for anterolateral approach, 75% for anteromedial approach, and 93% for the lateral midpatellar approach (Figure 1).⁸ The physician used only anatomical landmarks to guide the approach and a Fluorocan unit was used to confirm placement using a contrast material. Compared to an expected accuracy of 100%, both anterior approaches (medial and lateral) were significantly lower than the expected rate ($p < 0.0001$). The lateral midpatellar approach was not significantly different than the expected accuracy of 100% ($p > 0.05$).⁸ The data provided in this study suggests

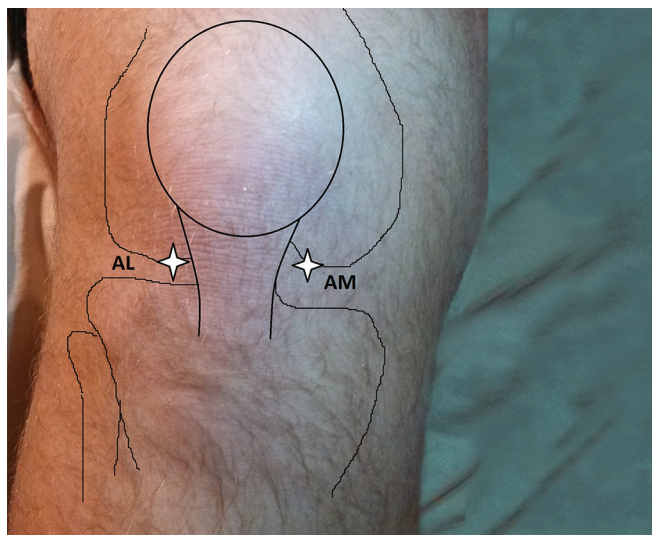


Figure 1: Schematic representation Anterolateral (AL) and Anteromedial (AM) approaches.

the lateral midpatellar approach to be a far more superior approach to knee injections when compared to anteromedial and anterolateral approaches.

A 2006 study showed slightly different results. Using 156 knees of 78 fresh cadavers, four injection sites were split up equally to assess accuracy rates of intra-articular injection: Anteromedial (AM), Anterolateral (AL), Lateral Midpatellar (LMP), and Medial Midpatellar (MMP). AM and AL approaches were performed with the knee bent approximately 90° off the edge of the table while the LMP and MMP approaches were performed with the knee in extension. All injections were performed by the same orthopedic surgeon. Accuracy rates in descending order were: AL (85%), LMP (76%), AM (73%), and MMP (56%). There was statistical significance between the MMP approach versus the AM ($p < 0.05$), AL ($p < 0.0001$), and LMP ($p < 0.05$) approaches. However, there was no significant difference between the AL, AM, and LMP approaches ($p > 0.05$).¹³ The data shows that any one of 3 approaches could be used if preferred by the Primary Care Physician. However, both studies show that in general, the lateral side of the knee is consistently more accurate than the medial side of the knee and may provide more benefit if the physician is comfortable with procedure.

COMPLICATIONS

Arthrocentesis has relatively few complications that should be monitored for and they include: dry tap (most common and is failure to aspirate any synovial fluid), localized trauma, pain, recurrence of effusion, and iatrogenic infection.^{3,4} Infection is considered a rare complication. There is limited recent evidence as to the rate of infection post-arthrocentesis, however septic arthritis occurrences have been reported

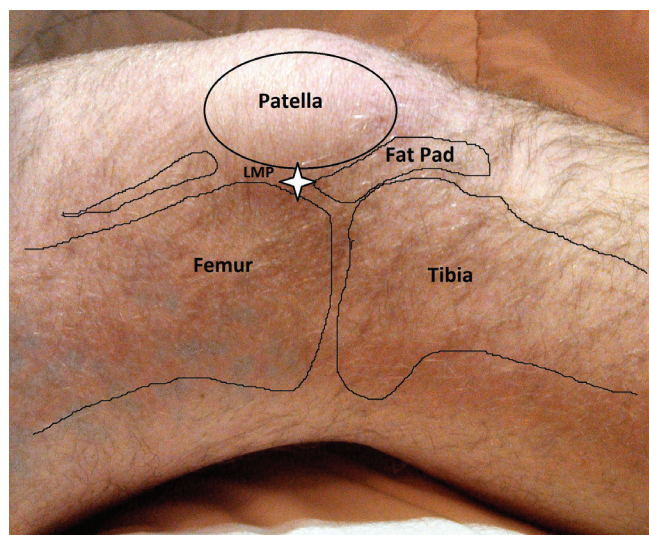


Figure 2: Schematic representation Lateral midpatellar (LMP) approach.

in literature ranging from 1:3000 – 1:50000, with the dates of these studies occurring between 1954 – 1981.^{14, 15} The University of Miami School of Medicine reported only two cases in 100,000 intra-articular injections while only one case was reported over 46,000 intra- and peri-articular injections in Massachusetts.¹⁴ Both studies used only thorough alcohol swabbing to cleanse the area prior to the procedure without sterile gloves. Using stringent aseptic techniques (sterile gloves, antiseptic swabbing), zero cases were reported at the Mayo Clinic where 3,000 peri-articular and intra-articular injections are performed annually.¹⁶

DURATION OF EFFECT AND COST-EFFECTIVENESS

In a randomized study of 244 inflammatory arthritis patients receiving joint injections including small, intermediate, and large joints, 120 were injected using a palpation technique while the other 124 were injected using an ultrasound-guided technique. The pain scale used was based on the 10 cm VAS, whereas 0 cm = no pain and 10 cm = unbearable pain. Significant pain was graded as a VAS of ≥ 5 cm. Introductory pain referred to insertion of the needle while injection pain referred to injection of the treatment drug. The study found that ultrasound-guided techniques caused much less introductory pain (33% less) and significant procedural pain (40% less) as well as less injection pain (81% less) and significant injection pain (87% less) (all $p < 0.01$) than palpation methods. With ultrasound-guided techniques, the duration of therapeutic effect was increased by 32% (1.2 months, $p < 0.0001$) and the need for a second injection was prolonged by 12% (0.9 months, $p = 0.034$).¹⁰ Reduced procedural pain combined with longer effect provides further evidence that ultrasound-guided techniques are a valuable tool when treating inflammatory arthritis of the knee.

Using data from a third party payer (Medicare, 2010 and 2013 data, Table 1), costs were concluded for each of the patients. Ultrasound-guided techniques decreased the costs per patient per year by 8% (\$7) but significantly decreased the costs per third party payer per year by 33% (\$64, $p < 0.0001$). Note that this study was done in an outpatient hospital setting and not a physician's office. The same study used this data to report what the costs would have been in a physician's office and although the study showed decreased pain and longer therapeutic effects, there was actually an increase in both patient per year and third party payer per year costs (\$246 and \$336, respectively). This data is unreliable as it is invalid to make any assumptions or conclusions from speculation.¹⁰

Table 1: 2010 and 2013 (South Carolina locality) Medicare Reimbursements¹²

Procedure	CPT Code	Cost Reimbursed by Medicare/Procedure	
		2010	2013
Large Joint Arthrocentesis	20610	\$73.01	\$55.91
Intermediate Joint Arthrocentesis	20605	\$55.68	\$61.13
Small Joint Arthrocentesis	20600	\$51.25	\$44.11
2 ml triamcinolone acetonide	J3301	\$14.94	\$14.94
Ultrasound Guided Injection	76942	\$185.47	\$159.76

A second study done on osteoarthritic knee joints alone using ultrasound-guidance, showed a significant reduction in pain associated with the injection procedure as well as post procedure. The 92 subjects were randomized and directly compared for pain before the procedure, pain during the insertion of the needle, pain during injection of the treatment drug, pain 2 weeks after the procedure, and pain 6 months after the procedure. Ultrasound image-guided intra-articular injections of the knee were found to be 48% less painful during the introduction of the needle, 58% less individuals reported significant procedural pain, 91% less pain and 100% less significant pain during injection of the drug compared to conventional methods (all $p < 0.01$).¹¹

Short (2 weeks) and long (6 months) term data also found better results with ultrasound use. Patient's pain at 2 weeks was 42% less ($p < 0.03$) and duration of the therapeutic effect at 6 months was increased by 36% (1.1 month) ($p < 0.01$) along with an increase in the time to next procedure by 18% (1.1 month) ($p = 0.08$).¹¹

Along with reduction in pain, patients spent 13% less (\$17) per year compared to conventional methods, although not statistically significant ($p < 0.13$). The most significant data

was that third party payers such as US Medicare in the hospital setting spent 58% less on these procedures (\$224) compared to conventional methods ($p < 0.0001$).¹¹ With cost-effective treatments becoming increasingly more important in healthcare, we believe ultrasound-guided injections of the knee offer a benefit to patients, providers, and the healthcare system. This study was done in a hospital setting and the economic benefits in a private setting haven't been studied.

Bias in this study could be considered in that all ultrasound guided procedures were performed by fellows-in-training while all conventional procedures (anatomically landmarks) were performed by an experienced proceduralist. The study would benefit from one group of physicians or fellows completing all of the injections.

CONCLUSION

Corticosteroid, analgesic, and hyaluronic acid preparations continue to be a pivotal step in the treatment of a growing population of OA, RA, and inflammatory arthritis (IA) patients. "Primum non nocere," do no harm, reminds physicians that they must provide the optimal care of treatment that produces the least amount of pain. Therefore, it is the responsibility of the physician to uphold and give the patient the most up-to-date treatment using the experimentally proven techniques and procedures. Although to this day, methods for knee injections remain a debated subject and may forever be that way based on a physician's own skill set, current literature reports greatest success with a lateral, ultrasound-guided technique as the best overall approach to knee injections.

Future studies should be directed towards following patients after injection to gain a better understanding of acute relief vs. long term relief from knee injections. Many studies had conflicting instructions for patients post injection and it may be of interest to focus on the outcomes of patients told to rest the knee joint for 3 days versus those told to immediately mobilize the joint.

The knee is a commonly encountered source of complaint in the primary care office. Injecting the knee may never produce a perfect outcome. With the life-long duty of bearing our truncal load, an increasingly obese society, along with some anatomical flaws, the knee is physiologically inefficient and destined for failure. When conservative measures fail, use of a lateral approach with ultrasound-guidance is a cost-effective and minimally pain inducing procedure that reduces overall pain and enhances duration of relief and would be a sound approach for the primary care physician.

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