Patients’ Assessments of Pain Prior to and After Ultrasound-Guided Knee Arthrocentesis and Intra-articular Steroid Injection in a Rheumatology Practice

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**Abstract**

**Purpose:** Due to the paucity of studies addressing patient outcomes, the purpose of this study was to measure patients’ assessments of pain prior to and after ultrasound-guided knee arthrocentesis and intra-articular steroid injection in a rheumatology practice.

**Data Sources:** A quantitative pre-test, post-test design was used for this study. A convenience sample of 23 patients with knee effusions and pain were asked to rate their pain using the numerical rating scale (NRS) prior to and two weeks after receiving an ultrasound-guided knee arthrocentesis and intra-articular steroid injection. Demographic data (gender, ethnicity, age, and diagnosis) were obtained from each participant and electronic medical record.

**Conclusions:** Results from this study demonstrated a statistically significant (***P*** = .000) decrease in the participants’ mean pain scores resulting in a positive patient outcome.

**Implications for Practice:** Future application of portable ultrasound should be considered in other clinical settings such as remote primary care with challenging patients requiring knee arthrocentesis and intra-articular steroid injection when referral is not an option. The many advantages of ultrasound offer the clinician a more sensitive and reliable imaging tool. Ultrasound complements the physical exam when assessing, detecting, and treating a knee effusion.

**Introduction**

Knee pain from effusion is a common patient complaint in a rheumatology practice with osteoarthritis as the main cause (Esen, Akanrmak, Aydin, & Unalan, 2013). This is particularly true in the elderly population and can result in disabling knee pain, morbidity, and decreased quality of life (Blagojevic, Jinks, Jeffery, and Jordan, 2010). Identification of knee effusions by the provider can be difficult due to obesity, thickened synovium, challenging anatomy, small effusions, and pain limiting a thorough exam (Wiler, Costantino, Filippone, & Satz, 2010). The standard landmark palpation-guided technique for knee arthrocentesis and intra-articular steroid injection has traditionally been used by providers to treat this musculoskeletal disorder. However, studies have demonstrated this technique does not always result in complete decompression of the knee and has caused more procedural pain; is less accurate, safe, and efficacious; and may result in a shorter duration of treatment outcome when compared to the ultrasound-guided procedure (Curtiss et al., 2011; McAlindon, et al., 2012; Park, Lee, Nam, Lee, & Nam, 2011; Sibbitt, et al., 2009; Philipose, Baker, O’Rourke, & Deodhar, 2011; Cunningham et al., 2010; Sibbitt et al., 2012; Hurdle, Wisniewski, & Pingree, 2012; Sibbitt et al., 2011; Hurdle, 2011).

While studies have demonstrated the advantages of ultrasound-guided knee arthrocentesis and intra-articular steroid injections over standard landmark-guidance, few studies have demonstrated the effect on patient outcomes. Due to the paucity of studies addressing patient outcomes from ultrasound-guided knee arthrocentesis and intra-articular steroid injection, the purpose of this study was to measure patients’ assessments of pain prior to and 2 weeks after ultrasound-guided knee arthrocentesis and intra-articular injection in a rheumatology practice. It is anticipated the results from this study will assist in closing the gap in this area of research.

**Literature Review**

**Knee Pain**

Knee pain is a common patient complaint in a rheumatology practice. Approximately 30% of adults older than 65 years of age have complained of knee pain or stiffness in the past 20 days (Cheng, Kim, Ottestad, & Narouze, 2009). While there are multiple causes for knee pain in a rheumatology practice (rheumatoid arthritis, psoriatic arthritis, osteoarthritis, gout, knee injury, pseudogout, and reactive arthritis), osteoarthritis remains the most common with a prevalence rate between 10-20% in the general population (Esen et al., 2013). According to the World Health Organization (WHO), osteoarthritis is the fourth common cause of years lost to disability (Hirsch, Kitas, & Klocke (2013). The knee is the most common joint affected by osteoarthritis (Esen et al., 2013)). Self-reported knee pain and radiographs of knee osteoarthritis are common in the older population; half of the people 50 years of age and older reported having knee pain over the last year and one quarter experienced severe disabling knee pain and decreased quality of life (Blagojevic et al., 2010).

**Knee Effusion**

Knee effusion (fluid in and around the knee joint) is a common complication of osteoarthritis and the presence and amount of the effusion are associated with synovitis, exacerbation of osteoarthritis, and pain (Hong, et al., 2011). In Esen et al., (2013) study using ultrasound to compare painful knees with osteoarthritis to painless knees, suprapatellar effusions were detected in 55% of the painful knees compared to 22% of the painless knees. The results of this same study revealed a significant relationship between the Kellgren-Lawrence grading scale for osteoarthritis and the frequency of suprapatellar effusion on ultrasound exam (p = 0.026). In addition to pain, knee effusions can cause altered gait in those patients with osteoarthritis. Rutherford, Hubley-Kozey, and Stanish (2012) compared patients with (n= 17) to those without (n=18) knee effusions, finding knee effusions affected knee mechanics and muscle activity during gait in those participants with osteoarthritis. Those patients with effusions demonstrated increased knee flexion angles and decrease knee extension resulting in altered muscle activation.

Knee effusions can be difficult to identify on physical exam due to obesity, synovial hypertrophy, challenging anatomy, small effusions, and pain restricting a thorough exam (Wiler et al., 2010). Synovial hypertrophy, a swelling of the synovial lining, can be difficult to differentiate from synovial effusion on physical exam (Wakefield & D’Agostino, 2010). According to the Outcomes Measures Rheumatoid Arthritis Clinical Trials (OMERACT 7) group, who proposed the first consensus ultrasound definitions for musculoskeletal pathologies, a synovial effusion is an abnormal hypoechoic or anechoic (relative to subdermal fat) intra-articular material that is displaceable and compressible without a Doppler signal (Wakefield et al., 2005). Ultrasound is more sensitive than clinical exam when detecting and localizing a knee effusion (McAlindon et al., 2012)). Physical exam, when compared to ultrasound of the knee, had only 59% sensitivity and 65% specificity for detecting knee effusions and could be related to the minimum amount of fluid (7-10 milliliters) required to detect a knee effusion using ultrasound (Royall, Farrin, Bahner, & Stawicki, 2011). Clinicians have traditionally managed knee pain from effusion by performing an arthrocentesis, where fluid is aspirated from a synovial joint space for diagnostic or therapeutic indications using the standard landmark palpated-guided aspiration followed by intra-articular steroid injection (Royall et al., 2011). While this technique has been typically successful, studies have reported this approach to cause more procedural pain; compromise accuracy, efficacy, and safety; and result in shorter duration of treatment outcome than ultrasound-guided knee arthrocentesis and intra-articular steroid injection (Curtiss et al., 2011; McAlindon, et al., 2012; Park et al., 2011; Sibbitt et al., 2009; Philipose et al., 2011; Cunningham et al., 2010; Sibbitt et al., 2012; Hurdle et al., 2012; Sibbitt et al., 2011; Hurdle, 2011).

**Musculoskeletal Ultrasound**

Musculoskeletal ultrasound is recognized as a powerful tool complementing the physical exam when assessing, diagnosing, and managing musculoskeletal disorders (Kang, Lanni, Nam, Emery, & Wakefield, 2012). In spite of its unique application in the clinical setting, the use of musculoskeletal ultrasound by rheumatologists in the United States still lags behind that of Europe (American College of Rheumatology Musculoskeletal Ultrasound Task Force, 2010). While global surveys indicate that 75-80% of rheumatologists believe ultrasound should be used routinely in their practice, studies in the U.S. indicate that only 20% of rheumatologists perform ultrasound in their practices (Joshua, 2012).

Ultrasound offers many advantages over other imaging modalities. Musculoskeletal ultrasound in the clinical setting is superior to magnetic resonance imaging (MRI), computerized tomography (CT) scan, and fluoroscopy because it is practical, non-invasive, rapid, safe, provides real-time images, accurate, reproducible, portable, lacks ionizing radiation, low cost, and can be used in an outpatient clinical setting (Berkoff, Miller, & Block, 2012; De Zordo et al., 2009; Hong et al., 2011; Im, Lee, Park, Cho, & Kim, 2009; De Zordo & Romagnoli, 2012; Guerini et al., 2012; Lento & Strakowski, 2010; Joshua, 2012). Ultrasound is a patient friendly imaging procedure, utilized in the exam room with the patient in a static position or mobile, capable of demonstrating the relationship of structures during movement, examining multiple joints in one visit, and is readily repeatable (American College of Rheumatology (ACR) Musculoskeletal Ultrasound Task Force, 2010). The information gleaned from ultrasound provides the clinician with much needed information to assess, diagnose, and treat the underlying problem. However, lack of training programs and standardization in the use of ultrasound along with the limited practical experience needed to refine the skill creates an operator-dependent technique among individual providers (Kang et al., 2012; ACR Musculoskeletal Ultrasound Task Force, 2010). The need for competency assessment demonstrating practical skills, knowledge, and personal qualities has also increased (Kang et al., 2012).

Cost of equipment is another concern as is the reimbursement rate for use in private practice. According to the Centers for Medicare and Medicaid Services (CMS), the 2014 Physician Fee Schedule CPT Code 20610 (aspiration and /or injection of major joint such as knee) reimbursement is $65.80 and CPT Code 76942(ultrasound guidance for needle placement, imaging supervision, and interpretation) reimbursement is $164.00 (<http://www.cms.gov>). There are conflicting arguments regarding the cost of performing ultrasound-guided intra-articular injections. Chavez-Chiang et al., (2012) reported recent data suggesting ultrasound needle guidance in intra-articular injections may potentially increase cost 150%-200% ($180-$210/procedure) in the United States. A study conducted by Sibbitt et al.,(2011) examining the cost effectiveness of using ultrasound compared to landmark-guided intra-articular steroid injection of arthritic joints using standard reimbursement schedules, reported an 8% reduction in cost/patient/year and a 33% ($64) reduction in cost/patient/year for hospital outpatients (p< 0.001).

**Ultrasound-Guided Knee Arthrocentesis and Intra-articular Steroid Injection**

Two of the most common diagnostic and therapeutic procedures performed in a rheumatology practice are arthrocentesis and joint injections (D’Agostino & Schimidt, 2013). For patients suffering with pain due to knee effusion, arthrocentesis is the procedure performed to relieve pain due to pressure and obtain fluid for analysis to differentiate various pathologies including infection, immune-mediated inflammation, crystal-induced inflammation, trauma, and neoplasm (Philipose et al., 2011). Historically, clinicians have performed knee arthrocentesis using the standard landmark-guided approach which has proven to be an effective method (Sibbitt et al., 2009; Wiler et al., 2010). However, when arthrocentesis is performed using the standard landmark-guided approach several potential problems can and do occur including increased procedural pain due to contact with nerves and other joint structures, incomplete decompression of the knee, and inaccurate placement of the intra-articular steroid injection after arthrocentesis which may lead to post-injection pain, crystal synovitis, hemarthrosis, joint sepsis, and steroid articular cartilage atrophy (Cheng et al., 2009; D’Agostino & Schmidt, 2013; Im et al., 2009; Berkoff et al., 2012). The addition of musculoskeletal ultrasound has provided yet another method of performing this procedure but in a safer and more efficient manner. Ultrasound is used to (1) detect whether or not a knee effusion exists (2) detect the exact location of the fluid (3) guide the needle to the fluid to aspirate, and (4) confirm correct placement of the intra-articular steroid injection ( Sibbitt et al., 2012; Royall et al., 2011).

**Synthesis of Literature**

In reviewing the literature, several studies demonstrated the benefits of ultrasound-guided knee arthrocentesis when compared to standard landmark palpated-guided approach, however, few studies addressed patient outcomes. A randomized controlled trial of 148 painful joints comparing ultrasound-guided to conventional palpated-guided intra-articular triamcinolone acetonide injection found that ultrasound needle guidance (1) increased the detection of effusion by 200% and the volume of aspirated fluid by 337% (2) resulted in a 43% reduction in procedural pain (p < 0.001) (3) a 58% reduction in absolute pain scores at 2 week outcome (p < 0.001) using the visual analog scale (VAS) (4) a 75% reduction in significant pain (VAS pain score >5 cm (p <0.001) (5) resulted in 25.6% increase in responder (asymptomatic knee with VAS < 2 cm at 2 weeks) rate or a reduction in VAS score > 50% from baseline (p < 0.01), and (6) resulted in a 62% reduction in the non-responder ( symptomatic joint with VAS > 2 cm at 2 weeks) rate or a reduction in VAS score < 50% from baseline (p < 0.01) (Sibbitt, et al., 2009). In a later randomized controlled trial sixty–four knee effusions were randomized to either the palpation–guided or ultrasound-guided group (Sibbitt et al., 2012). One of the outcome measures was synovial fluid volume yield. The ultrasound-guided group produced 183% more aspirated synovial fluid volume when compared to palpation-guided (P < 0.0001). Additional studies (Sibbitt et al., 2011; Cunningham et al., 2010; Curtiss et al., 2011) agreed that ultrasound-guided intra-articular steroid injections are more accurate than standard landmark-guided injections.

While Sibbitt’s (2012) study results demonstrated increased accuracy and greater removal of synovial fluid volume; other studies have demonstrated just the opposite. A prospective, randomized, controlled study of sixty-six patients presenting to the emergency room with knee effusions, compared ultrasound-guided to standard landmark-palpation-guided knee arthrocentesis, and found no difference in the amount of fluid obtained between techniques (p = 0.17) but did report less procedural pain with the ultrasound-guided procedure (Wiler et al., 2010). A study by Chavez-Chiang et al., (2012) investigated the outcomes (pain at 2 weeks and 6 months using VAS) and cost-effectiveness of arthrocentesis and injection of 80 mg of triamcinolone in 96 symptomatic rheumatoid knees using two different syringes and palpated landmark-guided technique. They reported a significant reduction in pain at 2 weeks and 6 months from baseline using VAS (p < 0.001) and a 23% ($35 US) reduction in cost/patient/year for a patient treated in a physician’s office (p < 0.001).

A systematic review by Gilliland, Salazar, and Borchers (2011) explored whether ultrasound-guided injection improved outcomes when compared to anatomic-guidance. The authors found variability in the studies reviewed. Ultrasound-guided intra-articular injections were more accurate and led to quicker pain reduction and improvement in function; however long-term outcomes (6 weeks to 6 months) were not significantly different from palpated landmark-guided injections.

**Methods**

This quantitative pre-test, post-test study assessed patients’ pain intensity prior to and two weeks after ultrasound-guided knee arthrocentesis and intra-articular steroid injection. Approval by the Institutional Review Board of The University of Alabama was obtained and permission to conduct the study was also obtained from the administration of the rheumatology practice at the study location. A convenience sample of patients presenting to the rheumatology clinic with knee pain and effusion were screened and entered into the study. No participants refused to enter the study. The inclusion criteria included anyone 19 years or older and able to read and understand English. Prospective participants who were excluded from the study included those participants who: (1) presented with signs of infection (redness, warmth, and pain) of the knee joint (2) had blood inside the knee joint identified by ultrasound (3) were on anticoagulants such as warfarin or dabigitran (4) had obvious tendon-ligamentous instability (knee clinically unstable) (5) had previously experienced a total knee replacement (6) had prior knee surgery within a month, and (7) could not read or understand English.

**Procedure**

Each patient who presented to the rheumatology practice with a potential knee effusion and pain was clinically evaluated by the investigator (nurse practitioner). The investigator examined the involved knee for a “bulge sign” indicating knee effusion. The investigator screened the patient for inclusion and exclusion criteria accessing the patient’s medical record for needed information. An ultrasound was then performed on the involved knee. If the ultrasound confirmed a knee effusion, the investigator was informed. Privately, the investigator informed the patient about the study, offered entry into the study, and if agreeable, informed consent was obtained. Demographic data were also collected. Each patient rated knee pain using the Numerical Rating Scale (NRS). The patient was given a NRS to take home and informed that in 2 weeks the investigator would call and request another pain rating using the same scale. All study forms contained code numbers only to protect patient confidentiality. All patients were called 2 weeks after ultrasound-guided knee arthrocentesis and intra-articular steroid injection and asked to rate their pain using the NRS.

**Instrument**

The NRS is a unidimensional measure of pain intensity made up of a single 11-point numerical scale used to measure pain in the adult patient (Hawker, Mian, Kendzerska, & French, 2011). This is a self-completed pain scale where the participant rates pain by circling the number that best represents the pain. Zero was defined as ‘no pain’ and ten was defined as ‘the worst pain ever’. The NRS is easy to comprehend, complete, and score. Another advantage is it can be administered over the phone. The NRS has a high test-retest reliability in both literate and illiterate patients (r = 0.96 and .95, respectively). Construct validity of the NRS was shown to correlate highly with the Visual Analog Scale (VAS) with the correlation ranging from 0.86 to 0.95 (Hawker et al., 2011).

**Ultrasound-Guided Knee Arthrocentesis and Intra-articular Steroid Injection**

The ultrasound-guided knee arthrocentesis and intra-articular steroid injection was performed on each participant as treatment for the knee effusion and pain. This is a routine procedure performed in this rheumatology practice for a patient with knee effusion with pain and was not part of this study. The ultrasound was performed according to the American Institute of Ultrasound in Medicine (AIUM) (2012) guidelines and the knee arthrocentesis and steroid injection were performed by a nurse practitioner or an American Registry for Diagnostic Medical Sonography-Registered Musculoskeletal (ARMS-RMSK) certified physician and sonologist. With the patient in the supine position with the involved knee flexed 30 degrees, the knee was cleaned according to protocol, a standard knee ultrasound was performed to locate the fluid, guide the needle to the knee fluid, aspirate the fluid, and provide an intra-articular injection which consisted of Methylprednisolone acetate 40 mg and 5 milliliters of 1% Lidocaine.

**Data Analysis**

Descriptive statistics were used to describe the demographics of the sample (age, gender, ethnicity, and diagnosis) and the pre and post-procedural pain scores. A paired sample t-test was used to describe the mean and standard deviation of the pre and post pain scores, compare the difference in the mean pre and post-test scores, and determine level of significance. Data analyses were conducted using the Software Package for the Social Sciences (SPSS) version 21.

**Results**

**Descriptive Analysis: Characteristics of the sample**

The study sample consisted of 23 participants after four participants were dropped from the study due to problems encountered with three of the participants during the ultrasound-guided arthrocentesis and one participant with a hemarthrosis of the knee. The mean age of the participants was 60.26 with a range from 40-82. The majority of the participants were Caucasian (65.2%) followed by African American (34.8%). Females (n = 17) comprised 73.9% of the study compared to males (n = 6) at 26.1%. The most common rheumatic diagnosis was osteoarthritis (69%) followed by psoriatic arthritis (13%), rheumatoid arthritis (8.7%), and gout (8.7%).

**Paired T-test Analysis**

The mean pre-procedural pain score of the 23 participants was 7.57 with a standard deviation of 1.674. The most frequent pre-procedural pain score was 7.0 at 26.1%. The mean post-procedural pain score was 3.0 with a standard deviation of 2.431. The most frequent post-procedural pain score was 0.0 at 21.7%. The difference in the mean pre and post-procedural pain scores was 4.565 with a standard deviation of 2.694. The t-test found this difference to be statistically significant (***t =*** 8.127; ***p*** = .000). The mean difference in the pre and post-procedural pain scores of those participants with osteoarthritis was 4.625 with a standard deviation of 2.89 with the t-test finding statistical significance ( ***t*** = 6.94; ***p*** = .000). The mean difference in the pre and post-procedural pain scores of those participants with gout, rheumatoid arthritis, and psoriatic arthritis combined was 4.429 with a standard deviation of 2.507. The t-test found statistical significance (***t*** = 4.673; ***p*** = .003). When comparing group means by gender, the mean change in pain between males (mean = -3.17) and females (mean = -5.06), the t-test found no significant difference (***t*** = 1.523; ***p*** = .639) indicating both males and females experienced the same change in pain. When comparing group means by ethnicity, the mean change in pain between Caucasians (mean = - 5.00) and African Americans (mean = -3.75), the t-test found no significant difference (***t =*** 1.063; ***p =*** .644) indicating both Caucasians and African Americans experienced the same change in pain.

**Discussion**

Few studies have investigated the effect ultrasound-guided knee arthrocentesis and intra-articular steroid injection has on patient outcomes. This lack of outcome data has caused some doubt and resistance to fully integrate ultrasound-guided procedures into orthopedic and rheumatology practices (Sibbitt et al., 2009). In this study the objective of the author was to measure patients’ assessments of their pain before and 2 weeks after an ultrasound-guided knee arthrocentesis and intra-articular steroid injection and subsequent result on patient outcomes. Results from this study demonstrated a statistically significant (***p*** = .000) decrease in participants’ mean pain scores resulting in positive patient outcomes. Previous studies have demonstrated conflicting results. A study by (Sibbitt et al., 2012) demonstrated similar findings when 64 effusive knees were randomized to either a palpated-guided or ultrasound-guided group. Ultrasound-guidance proved to be superior to palpated-guidance resulting in significantly less procedural pain, greater fluid yield, and statistically significant (***p*** = 0.034) decrease in patient’s pain at 2 weeks resulting in improved clinical outcomes. In this same study forty-three patients had rheumatoid arthritis and twenty-one had osteoarthritis and were evenly randomized to each group compared to the present study where the majority of participants had osteoarthritis. A study by (Cunningham et al., 2010) demonstrated different results when 184 patients with inflammatory arthritis and an inflamed joint were randomized to receive ultrasound-guidance versus palpated-guidance corticosteroid injections. The ultrasound-guided corticosteroid injections were significantly more accurate when compared to palpated-guided injections. However, there was no statistically significant difference between ultrasound-guidance and palpated-guidance injections for the major outcome variables (pain, stiffness, & function) when measured at 2 weeks or 6 weeks. The results of this study were similar to those found in the systematic review by (Gilliland et al., 2011) where ultrasound-guidance showed a quicker reduction in short-term pain (2-weeks). Generating future ultrasound-guidance studies with a more narrow focus may produce more consistent positive patient outcomes. Studies concentrating on the established advantages of ultrasound-guidance such as more complete decompression of a joint effusion and accuracy of needle placement and their relationship to patient outcomes would yield more definitive results.

There were two distinct advantages to ultrasound-guidance versus palpated-guidance the author found when performing the procedure. When aspirating the knee fluid, 1) the author could visualize any obstruction at the tip of the needle such as fronds (echogenic foci representing synovium that has undergone metaplasia into cartilage) (Roberts, Miller, & Erlanger, 2004), reposition the needle, and continue withdrawing fluid and 2) the author could visualize the needle tip against thickened synovium, withdraw the needle back from the synovium, and continue withdrawing fluid. If these two circumstances had occurred using palpated-guidance, the provider would have believed all the fluid had been withdrawn and extracted the needle resulting in incomplete decompression of the joint.

**Limitations**

Because this study required patients who had a knee effusion with pain and the unpredictability of accessing these type patients in a rheumatology clinic, a convenience sampling was used in recruiting participants limiting the generalizability of the results. The addition of a control group (landmark palpation-guided knee arthrocentesis and intra-articular steroid injection) and randomization would have produced a more rigorous study. The addition of a qualitative component to the study may have captured each participant’s pain experience contributing to the study results in more detail. Future studies should extend the patients’ post-procedure pain assessments out to 6 months.

**Implications for Practice**

The findings of this study have implications for clinical practice and patient outcomes. Future application of portable ultrasound should be considered in other clinical settings such as in remote areas of primary care with challenging patients requiring knee arthrocentesis and intra-articular steroid injection when referral is not an option. The many advantages of ultrasound discussed earlier will offer the clinician a more sensitive and reliable imaging tool. Ultrasound complements the physical exam when assessing, detecting, and treating a knee effusion. More and more basic and advanced musculoskeletal courses are being offered across the U.S. for nurse practitioners and physicians who have decided to offer this imaging procedure in their respective practices.

**Summary**

Musculoskeletal ultrasound is a reliable, efficient, and safe imaging tool. It provides many advantages when compared to conventional knee arthrocentesis and intra-articular steroid injection. For the providers, ultrasound offers an opportunity to provide the best clinical outcomes for their patients while potentially minimizing the pain associated with the procedure.

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