Meniscus-Targeted Injections for Chronic Knee Pain Due to Meniscal Tears or Degenerative Fraying

A Retrospective Study

Igor Wilderman, MD, CCFP, DAAPM, Rachel Berkovich, BSc, Christopher Meaney, MSc, Omer Kleiner, BSc, Vsevolod Perelman, MD, MSc, CCFP(EM), FCFP, CEUS, CHSE-A

Objectives—Meniscal tears caused by acute trauma or degenerative fraying affect a wide array of individuals. An effective, long-lasting treatment has widely been sought after. Intra-articular corticosteroid injections have been among the methods of controlling pain for more than 60 years. However, such injections tend to produce short-lasting results, with profound effects lasting an average of up to 4 weeks. The purpose of this study was to determine the average duration and magnitude of pain relief after meniscal-targeted injections.

Methods—The electronic medical records of 135 patients were accessed for this retrospective chart review. Patients who had meniscal tears or degenerative fraying and were treated with meniscal-targeted injections were selected. Patients' visual analog scale (VAS) pain scores (before and after treatment) were recorded, along with the percentage of pain relief and duration of pain relief.

Results—Ultrasound-guided meniscus-targeted corticosteroid injections for meniscal tears or degenerative fraying produced 5.68 (SD, 5.28) weeks of pain relief on average, with a decrease in pain from initial to follow-up visits of 2.14 ($P < .0001$) as per the visual analog scale score, and an Integral of Pain Relief score of 3.98.

Conclusions—Our findings indicate a substantial benefit from 20- or 40-mg meniscus-targeted triamcinolone injections, granted the limitations of chart review research and no control group comparison. Results highlight the need for future prospective research comparing meniscus-targeted injections with intra-articular injections to identify a better modality for treating patients with chronic knee pain caused by meniscal tears or degenerative fraying.

Key Words—degenerative fraying; meniscal-targeted injections; meniscal tears; musculoskeletal; pain relief; sports medicine/orthopedics

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Address correspondence to Igor Wilderman, MD, CCFP, DAAPM, Wilderman Medical Clinic, 8054 Yonge St, Thornhill, ON L4J 1W3, Canada.

E-mail: iw@drwilderman.com

Abbreviations

CI, confidence interval; EMR, electronic medical record; IPR, Integral of Pain Relief; OA, osteoarthritis; PRP, platelet-rich plasma; RCT, randomized controlled trial; US, ultrasound; VAS, visual analog scale

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The knee meniscus consists of 2 half-moon–shaped structures that are mainly composed of water, collagen, and proteoglycans. The function of the meniscus is to stabilize the knee through load transmission, shock absorption, and lubrication of the knee joint.[1] The menisci are able to distribute loads and thus reduce tibial stress, protecting knee cartilage and aiding in the prevention of osteoarthritis (OA).[2] The most common cause of meniscal tears in younger patients relates to acute trauma to the joint, whereas in older patients, degenerative alterations are more frequently the cause of meniscal deterioration (Figure 1).[2]

Intra-articular corticosteroid injections have been practiced for almost 60 years in the management of knee pain. They have been found to be effective in alleviating local signs and symptoms in patients with meniscal damage and are found to be compatible to arthroscopic debridement.[3] Several factors were implicated in causing a variation in the duration of the response to intra-articular corticosteroid injections, including the dose, the underlying cause of joint pain, the accuracy of the injection, and the duration and severity of disease before injection.[4] Despite such variations, the average beneficial effects of intra-articular corticosteroid injections for meniscal damage have been observed to last for up to 4 weeks.[5]

Many practitioners limit the doses of corticosteroid injections to minimize systemic effects.[5] However, one of the major obstacles with intra-articular treatments stems from our bodies' natural filtration system: the injected medication, even in a slow-release form, is rapidly absorbed from the joint space via synovial capillaries and lymphatic drainage.[6] Since soluble agents, such as corticosteroids, are rapidly cleared from joints, regardless of the size or dosage of the drug, this translates into a major barrier to successful treatment.[7] The half-life of soluble steroids in the knee joint is between 1 and 4 hours.[7] The use of suspensions containing polyethylene glycol, dextran, or polysorbate possibly extends the intra-articular half-life up to 12 hours.[8]

Intra-articular injections are typically administered into the knee joint via the suprapatellar or infrapatellar bursa (or recess), via a medial or lateral approach. However, at the Wilderman Medical Clinic, it has been empirically observed that such injections do not appropriately alleviate pain in patients with a diagnosis of meniscal tears or degenerative fraying. This is speculated to be related to the considerable distance between the suprapatellar bursa (recess) and the menisci and the rapid absorption and clearance of corticosteroids locally without them reaching the target area. The hypothesis for this study was that an injection performed with spread into the parameniscal area, also referred to as the perimeniscal area in the literature but is synonymous, will allow for greater bioavailability of cortisone at the affected site, thus providing a better clinical result. To achieve maximum accuracy, the clinicians are using an ultrasound (US)-guided technique to target the injection directly into the intended area. Using US guidance, the needle is advanced to the meniscus, and then withdrawn 1 mm off the surface. Thus, the injection is performed with spread into the parameniscal area (Figure 2). As a MEDLINE literature search on meniscal-targeted injections yielded minimal results, the purpose of this study was to determine the average duration and magnitude of pain relief after US-guided parameniscal corticosteroid injections on patients with chronic knee pain associated with either

Figure 1. Ultrasound image of a meniscus with degenerative fraying, taken from a medial viewpoint.

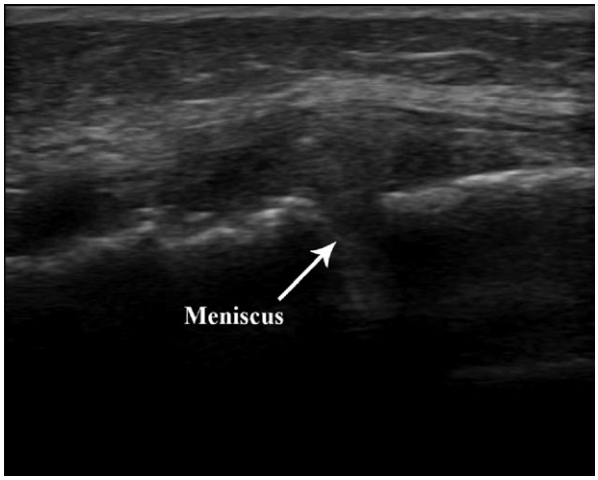
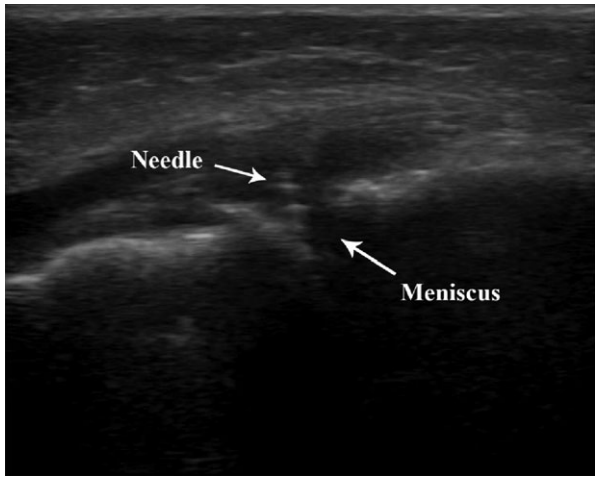


Figure 2. Ultrasound image of a needle being inserted directly into the parameniscal area, captured from a medial viewpoint.



meniscal tears or degenerative meniscal fraying and manifested by joint line tenderness on palpation.

Materials and Methods

Participants

This study received ethics approval by the University of Toronto Health Sciences Research Ethics Board. The electronic medical records (EMRs) of 135 patients were used for this retrospective chart study. No recruitment was required because of the nature of retrospective studies, as all information was obtained from the EMRs of eligible patients. Inclusion criteria were as follows: (1) diagnosis of meniscal tearing or degenerative fraying based on a physical examination and diagnostic imaging; (2) history of receiving 1 or more injections of extended-release 20- or 40-mg triamcinolone; and (3) having at least a 1 or higher rating of pain before the intervention and 1 after the intervention at follow-up.

Materials

The password-protected EMRs of the selected patients were accessed by a nonblinded reviewer. The duration of pain relief was measured in weeks; a visual analog scale (VAS) was used to determine the extent of pain relief seen in patients; and the percentage of pain relief was used to determine the magnitude of pain relief.

Procedure

Written informed consent was obtained by staff at the Wilderman Medical Clinic from each patient in the study at the time of initial enrollment in the clinic. It was explained to patients that they could withdraw their consent at any time. After consent, a query was built in the EMR database to identify patients who had undergone meniscal knee injections. The EMRs were then searched to identify patients with Ontario Health Insurance Plan diagnostic codes 844 (sprains, strains, or other knee and leg trauma), 848 (other sprains or strains), 715 (OA), and 739 (other diseases of the musculoskeletal system and connective tissue). Charts were then individually reviewed to confirm the presence of the signed consent form and verify that the patients indeed had all of the following elements present: (1) diagnosis of knee OA, meniscal disease, and chronic knee pain; (2) diagnostic imaging confirming the diagnosis; (3) history of steroid injections; (4) reported VAS scores at baseline (before intervention) and at a follow-up visit; (5) reported duration of pain relief after the intervention; and (6) reported percentage of pain relief.

Statistical Analysis

The data obtained were statistically analyzed by SAS version 9.4 software (SAS Institute Inc, Cary, NC). Demographic and patient information are reported as counts and percentages for categorical variables and means and percentages for continuous variables. The primary outcomes were as follows: (1) duration of pain relief (weeks); (2) whether injection led to at least a 25% reduction in pain as per the VAS; and (3) percentage of pain relief. The Integral of Pain Relief (IPR) was also computed. The IPR was derived from the application of a multiplication operator (duration of relief × percentage of relief). A paired t test was used to compare continuous measures between initial and follow-up appointments (change in VAS). $P < .05$ was considered statistically significant.

Results

Originally, 2 separate statistical analyses were run for both diagnoses investigated: meniscal tears and degenerative fraying. However, there was no significant difference between both diagnoses and the efficacy of treatment; thus, the data were pooled together. Data were available for 135 patients. Patients had a mean age of 70.1 (SD, 12.3) years. The youngest patient was 31 years, and the oldest patient was 89 years. A total of 113 patients had a diagnosis of degenerative fraying, and 22 had a diagnosis of meniscal tearing due to acute trauma. Twenty-seven patients had their lateral meniscus affected; 37 patients had both lateral and medial sides affected; and 71 patients had their medial meniscus affected. Most patients were female (n = 92 [68.2%]); 65% of patients received some form of pain medication (opioid and nonopioid; n = 88 [65.2%]); and 107 (79.3%) patients were given a 40-mg injection of triamcinolone, whereas the remaining 28 (20.7%) were given a 20-mg injection.

The mean VAS pain score at the initial visit was 7.91 (95% confidence interval [CI], 7.65, 8.17). The mean VAS pain score at the follow-up appointment

was 5.77 (95% CI, 5.33, 6.19). It was found that there was a significant 2.14 VAS decrease (95% CI, −2.52, −1.77) in pain scores from the time of a patient's initial visit to the subsequent follow-up appointment (paired t test, $t = -11.38$; $df = 134$; $P < .0001$). Patients were asked to rate (in a percentage) how much pain relief they had after injection. The mean pain relief percentage after injection was discovered to be 70.19% (SD, 33.66%; 95% CI, 64.46%, 75.91%). Each patient had provided the duration of pain relief after 20- or 40-mg triamcinolone steroid injections, measured in weeks. The mean duration of relief was computed, and the results depicted 5.68 (SD, 5.28) weeks of relief (95% CI, 4.78, 6.58 weeks) on average for the population of patients in this study. Thus, after multiplying the pain relief percentage by the duration of pain relief, the mean IPR value was found to be 3.98.

There was no association between either age or sex and differences in pain scores. There was no association between the administration of non-narcotic or narcotic pain medication and a difference in pain scores. There was no significant difference in pain scores between 20- or 40-mg triamcinolone injections. There was no association between age or sex and the duration of pain relief. There was no association between a comorbid diagnosis in patients with either diabetes or fibromyalgia and the duration of pain relief. However, patients with only diabetes had a lower average duration of pain relief than those who were not diabetic. Patients who did not use narcotic pain medication had less of a reduction in pain and a shorter duration of pain relief than those receiving narcotics.

Discussion

The results demonstrated that US-guided, meniscal-targeted injections produced a 2.14 decrease in VAS pain scores, which patients perceived as a 70.19% decrease in pain severity (mean pain relief percentage), for an average duration of 5.68 weeks after initial injection, with an IPR value of 3.98. These results demonstrate the efficacy of US-guided meniscal injections of corticosteroids in alleviating chronic knee pain associated with OA, meniscal tears, and meniscal degeneration. However, with the nature of chart reviews and a lack of control group, this cannot be said with certainty until a prospective study is conducted. Before forgoing in prospective investigations in this area, an inquiry into alternative location- and substance-based approaches must be done to understand alternative approaches to treating meniscal tears and degeneration using a parameniscal approach.

Preexisting literature has examined the efficacy of location-based approaches to corticosteroid administration; however, most tended to only investigate various locations in the intra-articular space or knee joint. A randomized controlled trial (RCT) evaluated the efficacy of intra-articular corticosteroid injections to the knee and compared accuracy rates between the anterolateral joint line and suprapatellar lateral injection sites.[9] Results found that, irrespective of the injection site in the intra-articular space, most patients had a clinically significant improvement in VAS scores compared to initial measures.[9] Contrary to the aforementioned RCT, a systematic review examined the accuracy of intra-articular knee injections depending on the different anatomic locations within the joint.[10] With a number of possible anatomic injection sites, this review examined the efficacy of 8 different locations in the intra-articular space: anteromedial joint line, medial midpatellar, superomedial patellar, anterolateral joint line, lateral midpatellar, superolateral patellar, lateral suprapatellar bursa, and infrapatellar site.[10] Pooled data found the 4 lateral sites, particularly the superolateral patellar site, had the greatest accuracy for injection efficacy.[10] Another RCT tested the efficacy of periarticular soft tissue injections compared to intra-articular corticosteroid injections in the treatment of painful knee OA.[11] Sixty-three patients with knee OA were randomized to receive either periarticular or intra-articular injections of corticosteroids.[11] Results showed that periarticular infiltration proved as efficacious as the alternative intra-articular injections and could be a safer location method for the administration of corticosteroids for symptomatic knee OA.[11]

This study is not the first to demonstrate the effectiveness of parameniscal injections under US guidance for chronic knee pain due to OA; however, to our knowledge, it is the first to present the effectiveness of meniscal-targeted injections for the reduction of chronic knee pain in patients with meniscal tears and degenerative fraying. Most relevant to this research, a 2017 case series aimed to evaluate the effectiveness of US-guided perimeniscal corticosteroid injections in patients with symptomatic knee OA.[12]

Pain relief and functional improvement were the targeted outcome measures investigated. A 22-gauge needle was advanced into the anteromedial meniscus wall, after being retracted by 1 mm, and an injection of a corticosteroid was administered into the perimeniscal tissue.[12] According to VAS scores, all study participants showed a significant reduction in pain over time $(F = 38.33;\ P < .001)$.[12] This reduction was shown at 1- and 4-week follow-ups. Although the case series had a few limitations, including a small number of patients, lack of long-term follow-up, and the absence of a placebo group, the main results mirror our research, as they are in agreement with the clinical evidence that suggests the short-lived efficacy of intra-articular corticosteroid injections in comparison to perimeniscal US-guided injections.

The results of our research seem to provide a much longer, nearly 6-week, duration of symptom reduction compared to previously published studies of intra-articular corticosteroid injections for chronic knee pain, which showed a mean pain relief duration of 3 weeks. This can be explained by the better local bioavailability of cortisone in the area of main inflammatory processes. We did not observe a difference in outcomes between 20- and 40-mg triamcinolone injections. We hypothesize that this finding indicates the need for future studies investigating the dose-dependent response to intra-articular steroid injections, as well as for evidence-based research focusing on the injection of substances other than corticosteroids for OA treatment.

Most research has focused on corticosteroid administration for the treatment of painful knee OA and tendinopathy. However, there have been investigations examining alternative substances to treat OA that subsequently focused on a location-based approach. These corticosteroid alternatives include platelet-rich plasma (PRP) and dextrose prolotherapy. This type of evidence opens up new doors beyond the present research and allows for US-guided parameniscal injections to be practiced with varying treatments as alternatives to corticosteroids.

A 2017 systematic review examined the role PRP plays in regenerative cartilage healing in various musculoskeletal disorders, particularly in knee OA, as it is becoming an accepted, effective alternative to steroid injections.[13] With PRP's demonstrated regenerative and anti-inflammatory effects, a systematic review including 10 RCTs investigated the efficacy of PRP injections into the intra-articular space for knee OA.[13] Results showed significantly better pain relief with PRP injected into the intra-articular space compared to saline injections at 6- and 12-month follow-ups.[13] To our knowledge, there are no published studies yet investigating the efficacy of PRP injections targeting the meniscus. An additional RCT investigated the efficacy of dextrose prolotherapy injected into the periarticular space compared to the intra-articular space in decreasing pain and increasing function for individuals with symptomatic knee OA.[14] The evidence base for prolotherapy is growing, with reparative benefits and functional restoration widely seen in patients with OA. The evidence in the literature concurs with the notion that intra-articular corticosteroid injections raise controversy over side effects and a minimal pain relief duration.[14] Thus, recent reports have shown the healing benefits of injecting prolotherapy into the periarticular space as an alternative. Results of the 2017 RCT showed reduced pain at a 5-month follow-up for both periarticular and intra-articular prolotherapy injections.[14] However, periarticular prolotherapy injections showed superior effects in lessening the degree of disability over time, and individuals had significantly lower pain scores at 1-, 2-, 3-, 4-, and 5-month follow-up visits.[14]

There is an abundance of research on various intra-articular knee joint injection locations, comparing their efficacy, as well as on corticosteroid-alternative substances such as PRP and prolotherapy. Due to the nature of this chart review, results cannot be deemed causal. Thus, the options for prospective research are vast and can be quite expansive, with a focus on parameniscal injections of varying substances, at varying doses, in hopes of discovering the optimal treatment efficacy for a variety of degenerative conditions, such as OA.

Integral of Pain Relief

The VAS score is a commonly used and well-validated way to measure pain. However, the VAS score is a subjective measure. Thus, when used in rating anything but the present level of pain, it is subject to a recall bias and a ceiling effect.[15] With the VAS score being such a common measure of pain relief in the literature, this may be a reason why many pain studies have failed to show significant results. There

is a dire need for the selection of proper validated assessment tools or measures to scientifically evaluate the efficacy of the investigative treatment.[16] There is currently no documented valid and effective method for objectively measuring a patient's pain; therefore, physicians rely on self-report measures, such as the VAS and numeric rating scale scores.[17]

The current literature concludes that the percentage difference in pain intensity is more suitable than pain scores for measuring the pain relief magnitude.[17] A more suitable measure for pain relief can be implemented in future pain relief research. At the Wilderman Medical Clinic, the IPR has been generated and used. The IPR measures the extent of pain relief by asking the patients the percentage of relief they had after injection, multiplying that by the duration of relief, to obtain a single value.[18] This value not only examines the amount of relief they had but also considers how long they had it, creating a multidimensional measure. Future research using the IPR can look into 2 things. The first would be an investigation of optimal IPR values for various interventional methods such as physiotherapy and cortisone injections to determine the efficacy of different treatment modalities. Second, the IPR assumes that both variables are equal, which is shown through the multiplication of both variables to achieve a sole IPR value.[18] This presents a limitation. Prospective research can work toward assigning weighted values to both variables of the IPR (percentage of pain relief × duration of relief), as for some patients either variable would be of greater importance, depending on the severity and type of pain they have.

Conclusions

Ultrasound-guided targeted injections of corticosteroids performed with spread into the parameniscal area produced substantial pain relief in patients with both posttraumatic and degenerative meniscal disorders. However, because of the nature of retrospective reviews and a complete lack of a control group, there is a need for prospective randomized evaluations of different interventional modalities, for dose-response research, and for investigations of parameniscal injections using alternatives to corticosteroids, such as PRP. If similar results were to be produced as established in this research, it could be said with confidence that meniscal-targeted injections are indeed superior to intra-articular injections for said population, and this could be groundbreaking in targeting and treating chronic knee pain caused by meniscal tears and degenerative fraying.

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