The Diagnostic Utility of Midcarpal Anesthetic Injection in the Evaluation of Chronic Wrist Pain

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Abstract The evaluation of chronic wrist pain can be a diagnostic dilemma. Lidocaine injections combined with corticosteroids are often used for both diagnosis and therapy. The purpose of this study was to determine if a midcarpal injection of lidocaine could serve as a diagnostic tool in patients with chronic wrist pain. Specifically, the relationship of pain relief from the injection and improvement of grip strength were compared to the presence of intracarpal pathology as confirmed by wrist arthroscopy. Forty-five patients with chronic wrist pain underwent a

midcarpal injection of lidocaine with or without corticosteroids. Forty of the 45 underwent concomitant steroid injections; a majority of the 40 patients reported relief of pain for two or more weeks. Improvement of pain and improvement of grip strength were determined. Each of these patients subsequently underwent a radiocarpal and midcarpal arthroscopy, and the pathologic findings of arthroscopy were compared to the improvement of pain and grip strength. These data were compared to a cohort of six volunteers without history of wrist pain or trauma that underwent midcarpal injection of lidocaine. Statistical analysis was performed using Receiver-Operator-Characteristic analysis. The average age of patients with chronic pain was 30.3 years, with an average of 9.8 months of wrist pain. The ultimate diagnoses included 35 patients with carpal instability dissociative, two with nondissociative instability, seven with complex instability of the carpus, three with extensor carpi ulnaris tendonitis and one with deQuervain's tenosynovitis. After lidocaine injection, the normal cohort had a mean loss of 2 kg (−5.3%) ($p=0.02$) in grip strength, whereas the experimental cohort had a mean improvement in grip strength of 5.73 kg (34.4%). Improvement of pain after injection did not correlate with pathologic arthroscopic findings ($p=0.92$). Improvement in grip strength after midcarpal lidocaine injection of 6 kg or 28% had a 73% sensitivity and a 70% specificity ($p=0.02$) of having intracarpal pathology at the time of arthroscopy. Of the chronic wrist pain patients, only four had a normal arthroscopy, and the remainder had at least one area of significant pathology attributing to their pain. We conclude that a midcarpal injection of lidocaine can serve as an effective diagnostic tool in the evaluation of the patient with chronic wrist pain. Improvement of grip of 28% with or without relief of pain is highly correlated with intracarpal pathology.

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Introduction

The evaluation and treatment of chronic wrist pain can often be challenging. The etiology of chronic wrist pain is broad and includes intracarpal pathology (dissociative, nondissociative, complex carpal instability and chondral lesions), degenerative arthritis, tendonopathy, occult fractures, psychiatric manifestations and nonbiologic etiologies. Although radiographic advances have been made with wrist arthrography or high resolution 3 Telsa magnetic resonance imaging with coils specific to the wrist, these technologies are expensive and are not a cost-effective means to evaluate this genre of patients. The use of an anesthetic injection with or without corticosteroid preparations into joints, bursas and tendon sheaths has been well described in the literature [1, 2, 10, 11]. In the evaluation of painful hip after total hip arthroplasty, the workup can be enhanced by injection to demonstrate an intra-articular cause [1]. In difficult cases of hip pain, pain relief with intra-articular injection of anesthetic can help to clarify the cause of the pain and predict post-operative pain relief after successful total hip arthroplasty [2]. Selective anesthetic injection in the foot and ankle can also identify specific areas of pain assisting in operative planning for arthrodesis [10]. Shoulder injections in the subacromial space have long been utilized to assist in diagnostic work up of impingement syndrome [11]. Despite the prolific use of these injections, their use has not been fully evaluated as a diagnostic tool for chronic wrist pain, although it has been described in the literature [14]. The purpose of this study is to evaluate the diagnostic utility of an injection of lidocaine into the midcarpal space in patients with chronic wrist pain who ultimately underwent wrist arthroscopy as part of their treatment for the condition. The goal of this study was to determine the sensitivity and specificity of the midcarpal injection in determining significant wrist pathology, as diagnosed with wrist arthroscopy compared with the improvement of pain and grip strength obtained from the midcarpal injection.

Materials and Methods

Between January 1998 and July 2002, 322 patients were enrolled in a prospectively accrued database of patients with chronic wrist pain that was approved by the Investigational Review Board and the Committee for Protection of Human Subjects. From this database, patients with chronic wrist pain (defined as >6 months of pain), who had undergone a midcarpal injection of lidocaine with or without corticoste-

roid, had their changes in grip strength and pain relief recorded on 100 point scale (0 = no pain relief, 100 = all pain relieved) and had undergone wrist arthroscopy as part of their treatment, were included in this investigation. Patients were excluded from the study if they had not undergone a midcarpal injection, completed data had not been recorded or arthroscopy had not been performed. During the evaluation of the wrist pain, each patient underwent examination by the senior author (A.Y.S.) and had three trials of grip strengths measured (third ring, Jamar Model 1 Hand Dynamometer Clifton, NJ) before and after injection of the midcarpal space with lidocaine with or without corticosteroid. The midcarpal injection was performed after the wrist underwent a five-minute chlorhexidine or betadine scrub, followed by skin preparation with betadine solution or alcohol in patients allergic to iodine. Either a 1% lidocaine without epinephrine or a 3:1 solution of lidocaine and celestone (Schering, Canada, Inc.) was introduced into the midcarpal space at four-corner region with a 25-gauge needle under fluoroscopic guidance (Figures 1 and 2). Injection into the midcarpal space allows the anesthetic to bathe the articular surfaces of the midcarpal joint as well as the SL and LT articulations. It has been the senior author's anecdotal experience that the midcarpal injections result in pain relief, whereas in this patient population, the radiocarpal injection does not.

Fifteen minutes after injection, patients were asked to rate on a 100 point scale (0 = no relief, 100 = all pain relieved), the amount of pain relief they received after injection. Three post-injection grip strength measurements using the same grip strength device were then taken. After failure of conservative management, patients underwent wrist arthroscopy of the radiocarpal and midcarpal joints as part of their treatment. Wrist arthroscopy was performed under regional or general anesthesia using the Concept wrist tower (Linvatec, Largo, FL) on a custom-made base

Figure 1 Preparation and injection of the midcarpal joint of the wrist. The area between the capitate, hamate, triquetrum and lunate is the target. Fluoroscopy can be used to verify the site of injection.

Figure 2 A 25 g needle is introduced into this space under fluoroscopic control under sterile conditions.

plate (Mayo Foundation, Rochester, MN). The index and middle fingers were placed into finger traps, and 15 lb of longitudinal traction was applied. The extremity was exsanguinated, and a brachial tourniquet was used. The radiocarpal joint was evaluated via the 3–4, 4–5 and 6U portals, with gravity inflow and outflow. The midcarpal joint was evaluated via the midcarpal ulnar and radial portals, with outflow established via an 18-gauge needle. A systematic evaluation of the radiocarpal joint was performed, evaluating the extrinsic ligaments (radioscaphocapitate, long radiolunate, short radiolunate, ulnar arcuate ligaments), the triangular fibrocartilage complex, the articular surfaces and the intrinsic ligaments (membranous portion). Similarly, the midcarpal joint was inspected, paying particular attention to the scapholunate, lunotriquetral and capitolunate articulations and the condition of the articular surfaces. Instability was evaluated using the Geissler grading scale [5] (Table 1), and chondromalacia was graded using a modification of the Outerbridge classification (Table 2) [5, 13, 12]. Significant carpal instability was defined as Geissler grade III or greater, and

significant chondromalacia was defined as Outerbridge III or higher.

In order to compare this cohort to a group of normals, six volunteers without a history of wrist pain or trauma underwent a midcarpal injection of lidocaine after baseline grip strength was obtained and after the senior author (AYS) examined and confirmed that there were no abnormal clinical exam findings. Similar to the chronic wrist pain group, 15 min later, grip strengths were recorded. For statistical analysis purposes, the assumption was made that this group had normal arthroscopic findings and no pathologic findings.

Statistical analysis was performed using a computer and SAS software. The outcome of primary interest was the presence of significant pathology based on the results of wrist arthroscopy. Perceived pain relief and change in grip strength following a midcarpal injection during the outpatient office visit were examined to determine their association with the primary outcome. This relationship was evaluated using Receiver-Operator-Characteristic (ROC) analysis. Sensitivity and specificity were calculated for each level of pain and grip strength change. The area under the ROC curve was computed and tested for significance set at an $\alpha \leq 0.5$. ROC analysis has been used frequently to assess the accuracy of diagnostic tests. The two indicators of the accuracy of a test are its sensitivity and specificity. Sensitivity and specificity are threshold-dependant measures and vary depending on which test score is chosen as a cut off. Changing the threshold alters the proportion of true-positive and true-negative respondents that are classified correctly by a test such that an increase in sensitivity is generally associated with a decrease in specificity. While a decision threshold must be chosen for a test to be used in patient care, there is not a need to choose a threshold when assessing a test's accuracy. ROC analysis provides a comprehensive picture of the ability of a test to make a distinction being examined over all decision thresholds. A ROC plot is obtained by graphing sensitivity values versus their equivalent 1-specificity values for all observed thresholds. The area under a ROC curve is indicative of the overall accuracy of a test.

Table 1 Geissler classification of carpal instability at arthroscopy.

Grade	Classification
1	Attenuation or hemorrhage of interosseous ligament as seen from the radiocarpal space. No incongruity of carpal alignment in midcarpal space.
2	Attenuation or hemorrhage of interosseous ligament as seen from the radiocarpal space. Incongruity or step-off of carpal space. There may be slight gap (less than width of probe) between carpal bones.
3	Incongruity or step-off of carpal alignment as seen from both the radiocarpal and midcarpal space. Probe may be passed through gap between carpal bones.
4	Incongruity or step-off of carpal alignment as seen from both the radiocarpal and midcarpal space. There is gross instability with manipulation. A 2.7 mm arthroscope may be passed through the gap between carpal bones.

From Geissler et al. [5]

Table 2 Modified outerbridge classification for chondromalacia.

Grade	Classification
0	Normal articular cartilage
1	Swelling and softening of articular cartilage
2	Fissuring of articular cartilage which does not reach bone
3	Fissuring of articular cartilage down to bone which is not exposed
4	Exposed subchondral bone

From Outerbridge [12, 13]

Results

Of the 322 patients enrolled into the chronic wrist pain database, 45 met the inclusion criteria. Among the 45 identified, 27 were male, and 18 were female; 38 were right-hand dominant, while seven were left-hand dominant. The average age was 30.28 years (standard deviation of 8.72 years). Seventeen of the 45 patients relayed a non-traumatic history of wrist pain, whereas 28 had a traumatic history. Thirty-eight patients were active duty military, where as seven were not. All patients related chronic wrist pain symptoms greater than 6 months in duration (average duration of wrist pain 9.8 months). Six volunteers (average age 33.1 years; standard deviation 2.2 years), who had no history of wrist pain or trauma, served as control subjects. All of the volunteers were right handed and had a normal clinical exam of the wrist. The assumption was made that these six volunteers had normal arthroscopic findings of their wrists.

The ultimate diagnoses of the patients excluding the controls (i.e., 45 patients) included 35 with carpal instability dissociative, two with non-dissociative instability, seven with complex instability of the carpus, three with extensor carpi ulnaris tendonitis and one with deQuervain's tenosynovitis. Some patients had more than one finding. Radiographic findings were normal in 44 patients; one had an ulnar positive variant. There were no complications associated with the injections that were noted by the investigators.

Four patients (10%) with chronic wrist pain had completely normal arthroscopic findings, while 41 patients had significant arthroscopic findings ranging from arthrosis, isolated dynamic or static scapholunate or lunotriquetral instability, to perilunar instability findings, to complex instability of the carpus. The 41 patients who had pathologic findings on their arthroscopy were offered treatment ranging from AIN/PIN neurectomies, capsulodesis, intercarpal arthrodesis, total wrist fusions depending on their diagnosis. The overall average for relief of pain (in the 45 experimental patients) on a 100-point scale after lidocaine midcarpal injection was $76.67 \pm 30.43\%$. The average improvement of grip strength after injection of lidocaine in the midcarpal joint in this group was 5.7 ± 9.5 kg or $34.4 \pm 52.9\%$. The

differences in pain relief and grip strength from pre- to post-injection were statistically significant ($p=0.01$ and $p=0.02$, respectively).

In comparing the normal cohort to the experiment cohort, there was a statistically significant difference in pre- to post-injection grip strengths. The experimental cohort had a mean improvement of 5.73 kg (34.4% improvement), where as the normal cohort had a mean loss of 2 kg (−5.3% loss) of grip strength ($p=0.02$, or $p=0.04$ for percent differences).

With respect to relief of pain compared to arthroscopic findings (i.e., significant findings vs. normal findings), no statistical difference was observed ($p=0.92$). In other words, improvement of pain relief was a poor predictor of arthroscopic pathologic findings. However, if the patient had an improvement of grip strength of 6 kg (or 28% improvement of grip), then there was a statistical significance of having intracarpal pathology ($p=0.02$ and $p=0.04$, respectively).

Using improvement of grip strength after midcarpal lidocaine injection had a 73% sensitivity and a 70% specificity ($p=0.02$) (Figures 3, and 4). However, pain relief, although highly sensitive, had at best a 50% specificity ($p=0.46$) (Figures 5, and 6).

Discussion

Evaluation in chronic wrist pain can be challenging and difficult. Multiple etiologies for chronic wrist pain include arthritis, tendonopathy, intra-carpal pathology (including

Figure 3 Receiver Operator Characteristic analysis curve comparing percent increase grip strength compared to arthroscopic findings.

Figure 4 Sensitivity vs Specificity curve for percent increase grip strength compared to arthroscopic findings. There was a 73% sensitivity and 70% specificity ($p=0.02$) of finding pathology on arthroscopic evaluation of the wrist if there was an improvement of 28% grip following a midcarpal injection of anesthetic.

carpal instability and chondral lesions), psychologic and non-organic causes. Numerous diagnostic tools are available with varying degrees of invasiveness, cost and clinical utility. The diagnostic tools include history, physical examination, conventional radiography, dynamic fluorography, arthrography, MRI and arthroscopy. A simple inexpensive test, which could be done in the office to assist in the diagnosis and treatment, would be helpful in delineating the etiology of chronic wrist pain.

Diagnostic injections have been utilized in many joints to aid in diagnosis and predict surgical success [1, 2, 10]. In the treatment of hip pain in patients being evaluated for total hip arthroplasty (THA) intra-articular injection of local anesthetic has a 96% sensitivity in predicting pain relief after successful THA [2]. In the evaluation of painful total hip arthroplasty in which diagnostic workup was otherwise negative, 13 of 14 patients with relief from intra-articular injections of local anesthetic had loose components [1]. Intra-articular injections have been used in the foot and ankle to guide surgical decisions for selective fusion. Seventeen of 20 patients evaluated with selective injection followed by fusion had significant pain relief [10]. Intra-articular injections of many joints guide treatment decisions in orthopedic surgery. Despite this, few if any reports specifically address the utility of injections in the wrist for the diagnosis and treatment of chronic wrist pain.

Advanced diagnostic modalities available in the evaluation of chronic wrist pain include MRI, triple-injection arthrography and arthroscopy. Although promise has been shown in magnetic resonance, it is expensive and has limited utility in the diagnosis of many causes of chronic wrist pain

[9, 8]. Triple-injection arthrography, although useful is not as sensitive as arthroscopy for defining intra-carpal pathology [3]. Arthrography is 56% sensitive, 83% specific and 60% accurate in the diagnosis of intra-carpal ligament tears when compared with arthroscopy [8]. Radiocarpal and midcarpal arthroscopy is the gold standard for evaluation of intra-carpal pathology as it allows direct visualization and potential for

ROC Results with % of Pain Relief as the Marker
Marker = relperc

Figure 5 Receiver Operator Characteristic analysis curve comparing percent relief of pain compared to arthroscopic findings.

Figure 6 Sensitivity vs Specificity curve for percent relief of pain compared to arthroscopic findings. There was a high sensitivity and at best 50% specificity ($p=0.46$) of finding pathology on arthroscopic evaluation of the wrist if there was an improvement of pain following a midcarpal injection of anesthetic.

surgical correction at the same setting [6, 4, 7]. Despite its utility, arthroscopy is expensive and invasive with all of the risks associated with surgery [16].

The midcarpal joint is comprised of seven bones. The chondral regions of the distal aspect of the proximal row and the proximal chondral portion of the distal row can be visualized at arthroscopy of the midcarpal region [15]. As well, the scapholunate (SL), lunotriquetral (LT) and capitolunate (CH) intracarpal intervals and the midcarpal extrinsic ligaments, triquetrohamate, radioscapulohamate and triquetrocapsular can be visualized and evaluated via midcarpal arthroscopy. With anesthetic injection into the midcarpal space, the chondral areas, intrinsic and extrinsic ligaments of the midcarpus are bathed in anesthetic. Injection of anesthetic, resulting in relief of pain allowing for increased grip strength suggests pathology in one or more of these structures.

Injection of the midcarpal space with lidocaine is a minimally invasive test that can assist in the diagnosis of intra-carpal pathology. In our study, an increase of 28%, or 6 kg, had a 73% sensitivity and 70% specificity for intra-carpal pathology. This injection provided a simple and effective test to localize the etiology of pain in this challenging group of patients.

This study was limited by a small number of normal patients and patients with chronic wrist pain with normal

arthroscopic findings. The low number of patients with chronic wrist pain with normal arthroscopic findings may be attributable to a selection bias: patients that ultimately underwent to surgery endured lengthy workups for chronic wrist pain, and as such, a majority of patients with nonbiologic factors were not taken to surgery. Another weakness of this study may be that the radiocarpal joint may be the source of pathology, i.e., a triangular fibrocartilage complex injury or radiocarpal arthrosis. In patients without perforations in the membranous portions of the intrinsic ligaments, relief of pain may not occur if anesthetic could not find its way to the radiocarpal joint.

Despite these limitations, our study provides a simple, minimally invasive and effective test in the diagnosis of chronic wrist pain. At our institution, patients with wrist pain currently undergo local midcarpal injections of anesthetic and steroid. This injection is an inexpensive test with low morbidity and can assist in diagnosis and guide therapy. The technique has been effectively utilized in many other joints including the shoulder, hip and foot and ankle. Midcarpal injection of lidocaine with a 28% improvement of grip strength has a statistically significant association with the intracarpal pathology diagnosed by wrist arthroscopy, and can be utilized as an effective tool in the evaluation of the patient with chronic wrist pain.

References

1. Crawford RW, Ellis AM, Gie GA, Ling RSM. Intra-articular local anaesthesia for pain after hip arthroplasty. *J Bone Jt Surg [Br]* 1997;79-B:796–800.
2. Crawford RW, Gie GA, Ling RSM, Murray DW. Diagnostic value of intra-articular anaesthetic in primary osteoarthritis of the hip. *J Bone Jt Surg [Am]* 1998;80B:279–81.
3. Cooney WP. Evaluation of chronic wrist pain by arthrography, arthroscopy and arthrotomy. *J Hand Surg* 1993;18A:815–22.
4. Garcia-Elias M. The treatment of wrist instability. *J Bone Jt Surg [Br]* 1997;79B:684–90.
5. Geissler WB, Freeland AE, Savioe FH, McIntyre LW, Whipple TL. Intracarpal soft-tissue lesions associated with an intra-articular fracture of the distal end of the radius. *J Bone Jt Surg* 1996;78A:357–65.
6. Geissler WB, Freeland AE, Weiss A-PC, Chow JYC. Techniques of wrist arthroscopy. *J Bone Jt Surg* 1999;81A:1184–97.
7. Hofmeister EP, Dao KD, Glowacki KA, Shin AY. The role of midcarpal arthroscopy in the diagnosis of disorders of the wrist. *J Hand Surg* 2001;26A:408–14.
8. Johnstone DJ, Thorogood S, Smith WH, Scott TD. A comparison of magnetic resonance imaging and arthroscopy in the investigation of chronic wrist pain. *J Hand Surg* 1997;22B:714–8.
9. Kato H, Nakamura R, Shionoya K, Makino N, Imaeda T. Does high-resolution MR imaging have better accuracy than standard MR imaging for evaluation of the triangular fibrocartilage complex? *J Hand Surg* 2000;25B:487–91.
10. Khoury NJ, El-Khoury GY, Saltzman CL, Branser EA. Intraarticular foot and ankle injections to identify source of pain before arthrodesis. *AJR* 1996;167:669–73.
11. Neer CS II, Welsh RP. The shoulder in sports. *Orthop Clin North Am* 1977;8:583–91.
12. Outerbridge RE. The etiology of chondromalacia patellae. *J Bone Jt Surg* 1961;43B:752–7.
13. Outerbridge RE. Further studies on the etiology of chondromalacia patella. *J Bone Jt Surg* 1964;46B:179–90.
14. Shin AY, Glowacki KA, Bishop AT. Dynamic axial carpal instability: a case report. *J Hand Surg* 1999;24A:781–5.
15. Viegas SF. Midcarpal arthroscopy: anatomy and technique. *Arthroscopy* 1992;8:385–90.
16. Weiss AP, Akelman E, Lambiase R. Comparison of the findings of triple-injection cinearthrography of the wrist with those of arthroscopy. *J Bone Jt Surg [Am]* 1996;78A:348–56.