Subacromial Corticosteroid Injection: Efficacy and Accuracy of the Three Main Approaches

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The aim of this study was to review the literature available regarding the various sites and techniques for corticosteroid injection of the subacromial space of the shoulder. Efficacy of corticosteroid injection in this area and accuracy of injection in three different sites were used as determinants. Data was collected using PubMed, ScienceDirect, JSTOR Online, MedLine, WebScience, AccessMedicine, eMedicine, DynaMed, and Natural Medicine databases. Articles regarding injection site, technique, efficacy of subacromial corticosteroid injection, and measurement of injection accuracy were reviewed, as were articles clearly defining a preference for one site or method of injection over another. Twenty articles were reviewed and the three major techniques of subacromial injection are the anterolateral approach, the lateral approach, and the posterolateral approach. The exact point of injection may differ slightly based on physician preference, however the methods used to identify key anatomical landmarks for each injection site remain similar throughout the literature. Corticosteroid injection of all three sites either reduced patient pain levels, increased range of motion, or both. Up to 91% of test subjects have experienced improvement in one or both of these areas following corticosteroid injection (Yu et al 2006). Though there was no consensus over which approach is the most accurate, the evidence suggested that physician confidence of accurate injection and actual measured accuracy differ by as much as 20% (Blair et al. 1996). There was no preference, as defined by the literature, between general practitioners and surgeons in regard to site or technique.

INTRODUCTION
Shoulder pathologies according to Mitchell et al. (2005) are estimated to be the third leading cause of primary care musculoskeletal consultation. According to previous results among primary care practices, shoulder pain has been found prevalent in 11.7-15 percent of the patient population (Arrol and Goodyear-Smith 2005). Many current forms of treatment include physical therapy, therapeutic modalities, surgery, and corticosteroid injection. Subacromial corticosteroid injection remains one of the most common treatments for shoulder pain among physicians of all specialties (Gruson et al. 2008). Corticosteroid, a steroid hormone, is chosen for its ability to be injected directly into anatomical structures to decrease pain and swelling. The main approaches to subacromial injection are the anterolateral, posterolateral, and lateral sites (Sardelli and Burks 2008). The efficacy of corticosteroid injection into the subacromial space is well documented in both surgical journals and general medicine journals alike. The accuracy of each approach has been documented in literature using ultrasound and other diagnostic imaging techniques.

The Anterolateral Approach
Many physicians use the anterolateral approach to inject the subacromial space (Park et al. 2010). However, there are several published descriptions of this approach. Park et al. (2010) perform the anterolateral approach using a 21-guage needle inserted 1 cm inferior to the anterolateral corner of the acromion process. When the needle comes into contact with the greater tuberosity, it is partially withdrawn from the space and redirected in a more horizontal plane while downward traction of the humerus increases the subacromial space (Park et al. 2010). Successful injection is assumed in the presence of the “ballooning sign”, or a feeling of “fullness” palpable anterior to the acromion (Park et al. 2010). According to another study, a 21- or 22-gauge needle is inserted 2 cm distal to the lateral edge of the acromion instead of 1 cm (Gruson et al. 2008). Still another study instructs physicians to perform an anterior injection more medially, “…in the soft spot medial of the humeral head, lateral of the coracoid, and 1 cm inferior to the clavicle, and [direct the needle] to the posterolateral corner of the acromion” (Henkus et al. 2008). The subacromial space is found when resistance to injection is no longer felt; no traction is used (Henkus et al. 2008). The average distance from the skin to the subacromial bursa via the anterolateral approach has been measured arthroscopically with needle placement at 2.9 cm +/- 0.6 cm, easily reachable with a 22- or 25-gauge needle (Sardelli and Burks 2008). Other findings show the average distance measured from the skin to the closest bursal border using an anterolateral approach is 2.1 cm with the use of radiographic contrast and fluoroscopy (Mathews and Glousman 2005).

The Posterolateral Approach
Chae and Jedlicka (2009) identify the posterolateral aspect of the acromion by palpation. The needle is inserted immediately below the angle of the acromion angled approximately 30° anterior to the coronal plane and slightly superior to the transverse plane to the depth of approximately 1.5 to 2 cm (Chae and Jedlicka 2009). This study describes a method similar to the anterolateral approach, however the needle is inserted from the back of the shoulder. A common posterolateral injection site is 2 cm distal and 1 cm medial to the posterolateral tip of the acromion, with the needle angled 45 degrees to follow along the posterior acromion (Gruson et al. 2008). Another posterolateral injection

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site is 1 cm distal to the posterolateral corner of the acromion, angling the needle anteromedially (Sardelli and Burks 2008) or anterolaterally (Henkus et al. 2008). The mean distance to the subacromial space via the posterior approach measured arthroscopically is 5.2 cm +/- 1.1 cm, nearly twice the depth required by the anterolateral approach (Sardelli and Burks 2008). Via radiographic contrast and fluoroscopy, the mean distance to the closest bursal boundary when entering posteriorly was measured at 2.4 cm (Mathews and Glousman 2005).

The Lateral Approach
The lateral approach to the subacromial space is found to be the least commonly used method in subacromial corticosteroid injection. Yamakado (2002) prefers to inject laterally, 1 cm anteroinferior to the posterolateral angle of the acromion process. A 32-mm long 22-gauge needle is used to perform this technique (Yamakado 2002). The needle is angled 45 degrees upward and inward, in a direction lateral to the anterior edge of the acromioclavicular joint (Yamakado 2002). According to Eustace et al. (1997) the lateral approach passes the needle through the deltoid muscle medially and slightly anteriorly. Sardelli and Burks (2008) measure the distance from the skin to the subacromial space laterally as 2.9 cm +/- 0.7 cm. Measurement was taken 1 cm distal to the acromion process, in line with the clavicle (Sardelli and Burks 2008). The average distance to the subacromial space using the lateral approach is similar in distance to the anterolateral approach. However, the anatomy of the shoulder poses a mechanical block: the head of the humerus sits in the way of a large portion of the subacromial space from the side.

Efficacy of the three approaches
Anterolateral Approach
Subacromial corticosteroid injection efficacy of the anterolateral approach has been measured using reduction in pain, increase in joint range of motion, and strength improvement as determinants. Yu et al. 2006 measured 91% of patients experienced improvement of pain and range of motion in 238 shoulders (n=209) after anterolateral injection of the corticosteroid betamethasone. Eighteen of the subjects who did not see improvement were later diagnosed with a rotator cuff tear, an injury requiring surgery (Yu et al. 2006). Neer impingement sign, Hawkins impingement sign, painful tendon sign, and joint range of motion were used to evaluate the subjects and determine corticosteroid efficacy (Yu et al. 2006). In a separate study, Blair et al. (1996) performed a blind study between corticosteroid injections and placebo injections. In the corticosteroid group 15 out of 40 had a negative impingement sign 33 weeks after injection, while only four patients out of the 40 in the placebo group exhibited the same improvement (p < 0.005) (Blair et al. 1996). The active range of forward elevation had also improved by an average of 24 degrees in the corticosteroid group, while the placebo group improved an average of 10 degrees (p < 0.005) (Blair et al. 1996).

Lateral Approach
Lateral injection of the subacromial space shows a drop in pain experienced during the Neer impingement test from 1.9 +/- 1.0 on a 0-3-pain scale before the injection to 0.36 +/- 0.78 after injection (p = 0.75) (Yamakado 2002). Pain during the Hawkins impingement test has drops from 2.3 +/- 0.96 pre-injection to 0.64 +/- 0.93 post-injection, rated on a one to ten pain scale (p = 0.99) (Yamakado 2002).

Posterolateral Approach
Chae and Jedlicka (2009) recorded 9 of 10 patients with impingement, supraspinatus tendonitis, and/or subacromial bursitis as experiencing immediate relief of pain post-injection through the posterolateral method. The largest therapeutic gain is seen in the second week post injection, with consistent loss of effect thereafter (Chae and Jedlicka 2009). Furthermore, Arroll and Goodyear-Smith (2005) concluded that corticosteroid injection is effective for significant reduction of symptoms of rotator cuff tendonitis for up to 9 months. Sardelli and Burks (2008) measure the distance from the skin to the subacromial space at an average of 5.2 cm from the posterolateral injection site, compared to the 2.9 cm average for the anterolateral and lateral approaches. Because the needle must pass through more tissue, immediate tolerance of the injection by the patient may differ across all three approaches (Sardelli and Burks 2008).

Though proven effective, Hiemstra et al. (2003) accounts for three cases of septic infection of the subacromial space post corticosteroid injection. It was concluded that 1 in 162,000 patients will experience sepsis after a corticosteroid injection via any approach (Hiemstra et al. 2003). Of the three cases studied, two of the patients were unable to work because of permanent disability, and the third had a “poorly functioning shoulder” (Hiemstra et al. 2003). Average time from initial injection to incision and drainage was 14.7 days over the three patients, though the average for the general population is 7-30 days (Hiemstra et al. 2003). However, the septic state of the three patients was not conclusively proven to be a result of the injection (Hiemstra et al. 2003).

Accuracy of three approaches
The literature shows that physician confidence of accuracy is higher than the measured accuracy (Henkus et al, 2009; Partington and Broome 1998). As previously postulated, “ballooning sign” (a “…palpable fullness that can be palpated distal to the anterior acromion”) was not an indicator of accurate anterolateral injection (Park et al. 2010). Within their findings, 10 out of 136 anterolateral injections that “ballooned” reached the subacromial space alone, while 67 of 136 reached the subacromial space with hindrance (Park et al. 2010). One study showed 15 out of 17 posterior injections to be considered “accurate” by the injecting physician, while a Magnetic Resonance Image (MRI) of the patients showed that only 13 out of 17 injections landed in the subacromial space (Henkus et al. 2008). The same study reported physician confidence in 15 of 16 anteromedial injections while MRI imaging revealed only 10 of those 16 were in the subacromial space (Henkus et al. 2008).
Structures that are hit by the needle or the corticosteroid injection include the subacromial bursa, acromioclavicular joint, glenohumeral joint, subcutaneous tissue, and the deltoid muscle group (Henkus et al 2008). Injection infiltrating the subacromial bursa alone had a significant decrease in pain and increase in function regardless of the approach used (p = 0.004) (Henkus et al. 2008). From a total of 33 injections made in the study, 13 of these infiltrated the rotator cuff, leading to an increase in pain and decrease in function (Henkus et al. 2008).

When testing accuracy using imaging techniques, fluoroscopy and radiographic materials were not as accurate as dissection. In 20 cadaver shoulders, fluoroscopy and a radiographic injection showed 90% (18/20) accuracy from the anterolateral approach (Mathews and Glousman 2005). However, upon random dissection, 60% (6/10) were found to be in the subacromial space or bursa (Mathews and Glousman 2005). The same study recorded 80% (16/20) accuracy from the postero-lateral approach using fluoroscopy, while random dissection proved that 80% (8/10) were accurate (Matthews and Glousman 2005). Though the lateral approach is not mentioned as often as the anterolateral or posterior approaches, Yamakado (2002) records 70% (39/56) of lateral injections were accurate, visualized with radiographs of the shoulder. However, 12% of the injections were found to have hit the deltoid muscle group, 5% were injected into the glenohumeral joint, and 4% remained in the subcutaneous layer (Yamakado 2002). Another study shows the lateral approach to be relatively inaccurate, using radiographic findings to show 29% (4/14) of lateral injections did not reach the target subacromial space (Eustace et al. 1997). The evidence suggests that using imaging techniques such as radiographic materials and fluoroscopy were fairly accurate.

**Ultra-sound guided injection vs. Blind injection**

The literature discusses the use of ultrasound-guided injection over blind injection. This was done with the patient in the crass position by:

Placing the transducer along the longitudinal axis of the supraspinatus tendon. The transducer may be moved to the insertion of this tendon along the greater tuberosity. With the transducer placed between the acromion and greater tuberosity, it is rotated 90 degrees perpendicular to the tendon to see a cross-sectional view of the deltoid muscle and the deeper supraspinatus tendon.

To optimize visualization of this tendon, tilting the transducer medially may be necessary (Cheng et al. 2009). Chen et al. (2006) uses abduction range of motion to determine efficacy of corticosteroid injection using a “horizontal approach”. Upon blind injection (without ultrasound guidance) shoulder abduction improved from 71.03 +/- 12.38 degrees prior to injection to 100 +/- 18.18 degrees post injection, a statistically insignificant improvement (p > 0.05) (Chen et al. 2006). Ultrasound-guided injection, however, shows statistically significant improvement (p < 0.05), from 69.05 +/- 14.72 degrees to 139.29 +/- 20.14 degrees of abduction (Chen et al. 2006). Another study used a gadolinium ion injection and MRI imaging to measure accuracy of blind versus ultrasound-guided injection technique (Rutten et al. 2007). Using the posterolateral approach with a 21-gauge needle, a study of 20 injections showed no difference in accuracy between blind and ultrasound-guided injections (Rutten et al. 2007). In fact, 100% (10/10) of injections in both the guided and unguided group hit the subacromial bursa as intended (Rutten et al. 2007). An experienced orthopedic surgeon performed the blind injections while an experienced musculoskeletal radiologist performed the ultrasound-guided injections (Rutten et al. 2007).

Accuracy issues with subacromial space injections may be due to complications caused by shoulder impingement, a condition in which the subacromial space is diminished. Tillander and Norlin (2002) measured the subacromial space arthroscopically at an average of 8 mm +/- 4 mm in 30 impingement patients, while a control group had an average subacromial space of 16 mm +/- 2 mm. Thus, it was concluded that impingement patients have 50% less subacromial space than unaffected patients (Tillander and Norlin 2002). The measuring device used was found reliable within 1 mm (Tillander and Norlin 2002). This decrease in subacromial space may explain the inconsistent findings regarding injection accuracy.

**Primary Care vs. Surgical Technique**

Most of the studies available are published in surgical journals, due to the orthopedic nature of the topic. Of the studies used in this review, three were published by general practitioners or in general/family practice journals. Many general practitioners have published reviews of the literature or studies in regard to efficacy and functional outcome of corticosteroid injection, but none on accuracy (Hiemstra et al. 2003; Green et al. 1998; Mitchell et al. 2005). The literature suggested that general practitioners prefer the use of non-steroidal anti-inflammatory drugs or physical therapy before corticosteroid injection (Green et al. 1998; Mitchell et al. 2005). A case study by a general practitioner referenced the use of Anakinra, a form of human IL-1 receptor antagonist, injected subcutaneously (Omoigui and Irene 2004). The patient recorded a drop in shoulder pain from 9/10 to 3/10 within 5 minutes of the injection, and improved from 40 degrees of abduction to full range of motion after 6 injections over 5 months (Omoigui and Irene 2004). It is possible that family practitioners generally choose to inject the subacromial space less often than orthopedic surgeons due to limited experience performing the procedure.

**Conclusion**

While the specific point of entry for the three sites of subacromial space injection may vary slightly according to physician preference, the evidence for efficacy of corticosteroid injection for shoulder pain is consistent throughout the literature. Through findings in the literature, the anterolateral approach is the most preferred subacromial injection technique while the lateral approach is the least preferred. Accuracy, measured by fluoroscopy, MRI, radiograph, and dissection, shows no outstanding results for any of the three main approaches. With...
small sample sizes and lack of detail in regard to the exact point of injection, more evidence is needed to support the use of one approach over another.

The same holds true to ultrasound-guided injection against blind injection. Although there may be advantages of an ultra-sound guided injection due to the availability of real images (Chen et al. 2006) the literature does not support a consistent improvement of accuracy over blind injections. There are opposing studies showing accuracy of ultrasound-guided injection against blind injection, suggesting more research is needed to determine if ultrasound-guided injection truly is more consistently accurate.

No conclusions can be drawn on the preference of injection site or technique between surgical journals and general practice journals. It can be seen that general practitioners are more concerned with the efficacy of corticosteroid injection, thus prefer to try alternative treatments first. However, orthopedic surgeons prefer the use of corticosteroids and continue to research the accuracy of subacromial injections.

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