Efficacy of a Single Image-Guided Corticosteroid Injection for Glenohumeral Arthritis

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Abstract

Background: There is limited data available on the efficacy of cortisone injection for glenohumeral osteoarthritis (GHOA). The amount and longevity of pain relief provided by a single cortisone injection is unclear. Additionally, it remains uncertain how the severity of radiographic GHOA and patient reported function and pain levels impact the efficacy of injection. Therefore, we sought to describe relief provided by a single, image guided glenohumeral injection for patients with GHOA. Additionally, we hypothesized that patients with more severe radiographic GHOA and poorer baseline shoulder function would require earlier secondary intervention.

Methods: Patients with symptomatic GHOA who elected to receive a corticosteroid injection for pain relief were prospectively enrolled. A phone interview was conducted to record baseline OSS and VAS scores prior to the injection, as well as at months 1, 2, 3, 4, 6, 9, and 12. Endpoints were designated when patients required a second injection, progressed to surgery, or reached month 12. Patients were grouped by their respective baseline OSS (mild, moderate/severe) and Samilson-Prieto radiographic classification (mild, moderate, severe) for analysis.

Results: Thirty shoulders (29 patients) were analyzed. 52% of patients were male. The average age of 66.1 years. No significant difference was seen in overall survival (defined as no additional intervention) between groups based on either OSS or Samilson-Prieto grades. Additionally, OSS and VAS scores at each follow-up were compared to baseline. For the entire cohort, a clinically significant difference was seen between baseline and months 1-4 for OSS and between baseline and months 1-4, 6,9, and 12 for VAS.

Discussion: This study aimed to determine the efficacy of corticosteroid injections for GHOA. There were no differences in the need for secondary interventions in this population based on

severity of either the OSS or the Samilson-Prieto radiographic classification. However, patients with more severe shoulder dysfunction based on OSS did experience a statistically significant greater symptomatic relief compared with patients with milder dysfunction. Additionally, following a single injection, patients in this cohort experienced statistically and clinically relevant improvements in shoulder function and pain up to 4 months post-injection.

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Corticosteroid Injections, Image-Guided, Glenohumeral Osteoarthritis, Samilson-Prieto classification, Oxford Shoulder Score, Visual Analog Scale

Level 1 and 2 studies on the use of corticosteroid injections in the non-operative management of glenohumeral osteoarthritis (GHOA) are lacking.[7] Because of this, the American Academy of Orthopaedic Surgeons (AAOS) has been unable to make recommendations for or against the use of corticosteroid injections for GHOA in their published clinical practice guidelines.[15] Previous studies have shown intra-articular injections to be safe for the treatment of osteoarthritis in other large joints.[10] However, these studies have not been performed exclusively on the shoulder, nor have they given us data on the success of corticosteroid injections on delaying the need for secondary intervention, either repeat corticosteroid injections or total shoulder arthroplasty. Additionally, it is unknown if the severity of radiographic GHOA or the patient's subjective shoulder pain and function, as documented by VAS pain score and patient reported outcomes (PROS), affect the efficacy and longevity of a glenohumeral corticosteroid

injection for arthritis. These gaps in our understanding limit our ability to provide adequate counseling to patients regarding the usefulness of corticosteroid injections as a non-operative treatment for GHOA.

Previous studies have attempted to evaluate the benefit of corticosteroid injections on shoulder pain.[3,16,17] However, the usefulness of these studies is limited by their heterogeneity, including varying sources of shoulder pain (AC joint arthritis vs adhesive capsulitis), differing methods of corticosteroid injections, retrospective nature, and their small sample sizes. The lack of image-guided injections in many of these studies is of particular concern, as previous studies have concluded that image-guided corticosteroid injections are more accurate than blind injections, and they may provide longer symptomatic relief in patients with shoulder pathology.[1,11] Moreover, the available data does little to help us predict which patients will have limited, short lived improvement in their symptoms, and which patients, if any, will enjoy a robust, long lasting response.

We hoped to bridge some of the gaps in our knowledge surrounding conservative management of GHOA with corticosteroid injections by establishing a protocol that allows for accurate, image-guided glenohumeral corticosteroid injection and monthly patient follow-up using validated questionnaires for pain and shoulder function. We believe that our study will provide data on the amount and duration of pain relief to expect from a single corticosteroid injection for GHOA.

A second aim of this study is to evaluate the reliability of radiographic GHOA severity and validated shoulder function questionnaires in predicting the amount and duration of pain relief patients may expect from a single injection. We hypothesized that those patients with (1) more severe radiographic osteoarthritis based on the Samilson-Prieto classification and (2) poor

baseline Oxford Shoulder Scores (OSS) would require earlier secondary intervention with either repeat injections or surgical intervention.

Materials and Methods

Twenty-nine patients (30 shoulders) were prospectively enrolled in an observational study following institutional review board approval and patient informed consent. We included shoulders that met these inclusion criteria: adults (>18 years old) with radiographically documented, symptomatic GHOA, who were indicated for a corticosteroid injection as initial treatment of GHOA. Additionally, only patients who could cognitively consent to participate in the study and continue monthly communication through phone interviews were included. Patients <18 years old, and those with inflammatory arthritis, rotator cuff tear arthropathy, significant cervical spine abnormalities, and those with shoulder pain but without GHOA were excluded.

Patients were classified using two methods: Oxford Shoulder Score (OSS) questionnaire to classify subjective shoulder function and the Samilson-Prieto classification system to classify radiographic severity of osteoarthritis. The Samilson-Prieto classification system grades arthritis as follows: Grade 0 (normal), Grade I (humeral neck osteophytes <3mm, mild), Grade II (osteophytes 3mm-7mm, moderate), and Grade III (osteophytes >7mm, severe). The radiographs of each shoulder were independently graded by a board-certified orthopedic surgeon sub-specializing in surgery of the upper extremity and an orthopedic surgery resident. When there was disagreement between independent observers, we used the grade given by the attending surgeon.

The OSS questionnaire consists of a series of twelve questions. A score of 0-4 was given for each patient response, and a cumulative score between 0-48 was calculated; the higher the score, the better the shoulder function. Mild, moderate, and severe shoulder dysfunction was determined by an initial OSS between 30-48, 20-29, and 0-19, respectively.[5, 6] Patients with moderate and severe shoulder dysfunction were combined in the study to improve sample size for comparison.

Patients were identified in clinic by obtaining standard shoulder radiographs. Those who agreed to participate in the study were scheduled for image-guided glenohumeral corticosteroid injections. Prior to the injection, patients were contacted over the phone in order to obtain a baseline OSS (0-48) and Likert (VAS) pain score (0-10). The anticipated injection date for each patient was then recorded. Subsequent phone interviews were conducted in a similar manner, and OSS and VAS scores were recorded at the following intervals: Month 1 (within 2 weeks of the image-guided injection), 2, 3, 4, 6, 9, and 12. The endpoint of the study occurred when patients required subsequent intervention with another corticosteroid injection, shoulder arthroplasty, or after 12 months from the initial injection. For patients who underwent a second intervention (cortisone injection or shoulder arthroplasty), we used the last recorded VAS and OSS score prior to the intervention for the remainder of the time points. This methodology was chosen to avoid artificially improving or worsening the PROS by the results of the second intervention.

Statistical analysis

The collected data was imported into SYSTAT 13 and SPSS statistical analysis software and Kaplan-Meier survival plots were created. Based on the OSS, we compared the percentage of patients with mild shoulder dysfunction versus percentage of patients with moderate/severe dysfunction that did not require secondary intervention at twelve months post-injection. This was

repeated, comparing patients with mild, moderate, and severe osteoarthritis based on the Samilson-Prieto classification system. Additionally, Mann-Whitney U tests were performed to compare VAS scores between patients with mild or moderate/severe shoulder dysfunction based on the OSS at various time points, including baseline, months 1, 2, 3, 4, 6, 9, and 12. The Mann-Whitney U test was repeated to determine if the VAS scores varied significantly at all time points based on the Samilson-Prieto classification. A student T-test was performed to compare the change in OSS scores from baseline to month 1 between patients with mild or moderate/severe shoulder dysfunction. The T-test was repeated to compare the change in VAS scores from baseline to Month 1 between the two groups. Lastly, a student T-test was performed to compare the change in OSS and VAS scores from baseline at each time point in the study for the entire cohort.

Results

Twenty-nine shoulders were available for analysis with one shoulder being lost to follow-up at month 12. 52% of the patients were men. The average age of this cohort was 66.1 years (range= 43-86 years). Of the twenty-nine shoulders, eight shoulders were classified as having mild osteoarthritis based on the Samilson-Prieto classification, thirteen as moderate, and eight as severe**.** The inter-observer agreement was 93.3% for Samilson-Prieto grades between the two observers. Seventeen patients had mild shoulder dysfunction based on OSS, (Average score 35.5) while twelve patients had either moderate or severe dysfunction (average score 21.8) **(Figure 1).** Additional demographic data are summarized in **Table I.**

The average baseline VAS score for the entire cohort was 5.8. The average VAS scores for patients with mild, moderate, and severe radiographic osteoarthritis based on the Samilson-

Prieto classification were 4.9, 6.5, and 5.7, respectively. The average baseline VAS scores based on our OSS subgrouping for mild and moderate/severe shoulder dysfunction were 5.12 and 7, respectively (**Figure 2).** A Mann-Whitney U test was performed for VAS scores between the two groups. The VAS scores were not significantly different at any time points between the groups.

Twelve patients in the study required secondary intervention with either arthroplasty or a repeat injection prior to the end of the twelve-month study period. According to the Kaplan-Meier survival analysis, 58.6% of patients for the entire cohort made it to twelve months without requiring secondary intervention overall. When analyzing our subgroups based on OSS, 64.7% of the mild group (Std. Error 11.6%, CI 95% [0.38-0.82]), and 50% of the moderate/severe group (Std. Error 14.4%, CI 95% [0.21-0.74]) made it to twelve months without requiring secondary intervention. At 6 months post injection, 82.4% of patients with mild shoulder dysfunction did not require secondary intervention (Std. Error 9.2%, CI 95% [0.55-0.94]), and 83.3% of patients in the moderate/severe group did not require secondary intervention (Std. Error 10.8% CI 95% [0.48-0.96])**.** To further compare the survival distributions, we utilized a Log Rank analysis (a nonparametric hypothesis test to compare the survival distributions of two samples) and failed to show a difference in overall survival curves between the two groups ($p=0.446$).

A Kaplan-Meijer survival analysis was also performed for patients with mild, moderate, and severe osteoarthritis based on the Samilson-Prieto classification. Patients with mild radiographic osteoarthritis had an 87.5% chance of not requiring a second intervention at twelve months (Std. Error 11.7%, CI 95% [0.39-0.98]). Patients with moderate radiographic osteoarthritis had a 46.2% chance of not requiring a secondary intervention at twelve months (Std. Error 13.8%, CI 95% [0.19-0.70]). Patients with severe radiographic osteoarthritis had a 62.5% chance of not requiring secondary intervention at twelve months (Std. Error 17.1%, CI

95% [0.23-0.86]). A Log rank analysis failed to show a difference in the survival curves between groups (p=0.08).

The student T-test was performed to compare the change in OSS scores from baseline to month 1 after the injection. The mean increase in OSS in the mild group following the injection was 6.2. The mean increase in OSS in the moderate/severe group following the injection was 12.8. The increase from baseline to month 1 was found to be significantly higher in the moderate/severe group when compared to the mild group (p=0.03, CI 95% [1.37-11.9]). A T-test was repeated, comparing the change in VAS scores from baseline to month 1 after the injection. The average improvement in VAS in the moderate/severe group was 3.4, whereas the average improvement in VAS in the mild group was 2.4. This was not found to be significant (p=0.32, CI 95% [-1.21-2.99]).

The change in OSS scores from baseline was calculated for the entire cohort at each time point. A student T-test was then used to compare the change in OSS scores from baseline, which did show a significant difference in the mean at month 1, 2, 3, and 4. The difference was not significant at months 6, 9, and 12**.** This was compared against the Mean Clinically Important Difference for the OSS of 3.3, as defined by Xu et. al.[14] This data showed an improvement in the OSS above the MCID during months 1-4 with the change in OSS falling below the MCID during months 6, 9, and 12 **(Figure 3)**.

The change in VAS scores from baseline was calculated at each time point. A student T-test was used to compare the change in VAS scores to baseline. This showed a statistically significant change in the mean at months 1, 2, 3, 4, 6, 9, and 12**.** The change in VAS was compared against the MCID for VAS of 1.4, which has been defined in previous studies.[12, 13]

This demonstrated improvements in VAS above the MCID for the entirety of the study **(Figure 4).**

Discussion

The goal of this study was to determine the efficacy of a single, image-guided corticosteroid injection in the conservative management of GHOA and determine the magnitude of symptom relief as well longevity. We also wanted to determine whether subjective shoulder dysfunction and or radiographic severity of GHOA impacted the amount and duration of symptom relief.

To accomplish this, we developed a protocol to provide standardized, image-guided glenohumeral injections. We felt this was important for several reasons. Soh et al found that patients who underwent image-guided injections had statistically significant improvements in their shoulder pain at 6 weeks compared with patients who had blind injections.[11] Additionally, image-guided glenohumeral injections have been found to be better at achieving intra-articular needle placement. Aly et al performed a systematic review which compared the accuracy of image-guided versus blind injections surrounding the shoulder girdle. They found that image-guided injections into the glenohumeral joint were 92.5% accurate, whereas blind injections were only 72.5% accurate.[1]

In this study, there was no significant difference in the number of patients who underwent secondary intervention with a steroid injection vs total shoulder arthroplasty in the mild or moderate/severe groups based on the OSS. Additionally, radiographic severity of the GHOA based on the Samilson-Prieto classification did not impact the duration of pain relief to expect from a single injection. However, the value of “survival” to evaluate the efficacy of an injection

may be limited, due to the multiple factors involved when indicating a patient for total shoulder arthroplasty, including both patient and surgeon factors. Of note, no formal guidelines were provided to participating surgeons regarding timing of TSA following injection. There is some concern that cortisone injection increases the risk of infection following TSA. It is our general practice to avoid TSA within 3 months of an injection; this also has impacts on usefulness of "survival".[18]

The OSS is a validated questionnaire that gives shoulder surgeons an indication how patients are doing functionally.[5] Additionally, VAS is a validated score that has been used to monitor changes in patient's pain with rotator cuff disease as well as patients following shoulder arthroplasty.[12, 13] We used both OSS and VAS in this study to get an overall appreciation of how patients were doing both functionally and symptomatically following the injection. Recently, Xu et. al. sought to determine the MCID for the OSS. In their paper, they published the results on over 300 patients following arthroscopic rotator cuff repair and followed them for 24 months post operatively. They were able to determine that the MCID for the OSS was 3.3 (95% CI [2.1-4.6]) at 12 months post operatively.[14] Given these results, we were able to extrapolate the MCID to be 3.3 for our study cohort.

Importantly, we were able to illustrate that a single image-guided corticosteroid injection can improve the average OSS from baseline to above a MCID for 4 months **(Figure 3)**. This suggests that the image guided corticosteroid injection did provide clinically significant improvements in shoulder function up to 4 months post-injection. Additionally, we were able to show that patients with worse baseline OSS scores may expect more functional improvements than patients with milder disease from a single corticosteroid injection. However, some of this could be a result of the ceiling effect of the OSS questionnaire.[2] Regardless, these findings can

prove useful when counseling patients on what to expect from a single injection and help manage patient expectations.

A prior study by Tashjian et al, determined the MCID for the VAS score for patients with rotator cuff disease and for patients who underwent shoulder arthroplasty to be 1.4.[12, 13] We extrapolated this MCID to our cohort. Based on our results, the average VAS score did remain below baseline for the entirety of the study, and, somewhat surprisingly, that improvement was greater than the MCID throughout 12 months, suggesting that this difference was clinically significant **(Figure 4).**

One interesting finding was that patients with severe radiographic GHOA, on average, had lower baseline VAS scores and had a trend towards a higher survival based on our Kaplan-Meier survival analysis when compared with moderate radiographic GHOA. This could be coincidental given the relatively small sample size, or it could represent lower functionality, older age, or more comorbidities in this population; this again points to the limitations of using "survival" while evaluating the results of a cortisone injection. Nevertheless, radiographic severity of disease did not predict the duration of pain relief to expect from an image-guided corticosteroid injection in this study. There may be some concern that patients presenting with severe GH OA and glenoid bone loss will sustain progression of bone loss during non-operative management. No specific guidance was provided to study surgeons regarding this; rather, each surgeon could use her or his own judgement when counseling patients regarding injection.

One of the strengths of this study is its prospective, cohort design, which can provide strong evidence in the absence of a randomized controlled trial.[19] Additionally, follow-up in this cohort was excellent. We were able to maintain contact with 28/29 patients (29 shoulders) for 12 months following the injection. Another strength is the standardization of our injection protocol.

By only using image-guided injections and limiting our study to only patients with GH OA, potentially confounding factors were eliminated. Finally, our study includes not only radiographic measures, but also patient reported outcomes of function and pain.

There were several limitations of to this study. First, our sample size is small. Increasing the sample size may have improved the chances at finding a statistically significant difference in survival curves between study groups and decreased the chances at a possible type II error. Additionally, there was no evaluation of other modalities patients were concurrently using to treat their arthritis, such as physical therapy or NSAIDs. Also, we did not examine possible confounders, most notably the presence of a concomitant rotator cuff tear. However, it has been suggested that the likelihood of a rotator cuff tear in the setting of primary GHOA is low.[4, 8] No patients had rotator cuff arthropathy. Additional comorbidities such as diabetes, hypothyroidism, fibromyalgia, etc. could have a potential impact on subjective pain and function.

Conclusion

In conclusion, this study sought to prospectively determine the efficacy of a single, image-guided corticosteroid injection. To accomplish this, we used a validated shoulder survey and VAS scores obtained prospectively at routine intervals after injection in patient with radiographically confirmed GH OA. Patients in this cohort experienced statistically and clinically significant improvements in their shoulder function (OSS) for 4 months post injection, with dwindling effects thereafter. Additionally, these patients reported statistically and clinically significant improvements in their pain (VAS) for up to a year, most pronounced over the first 4 months. However, either baseline OSS severity, or radiographic severity of GHOA predicted the amount of pain relief patients can expect from a single, image-guided glenohumeral injection.

These results may help shoulder surgeons counsel their patients on the duration and amount of pain relief to expect from a single, image-guided steroid injection. Additional larger, prospective studies, potentially performed in a randomized fashion with a control group, will be helpful to draw more definite conclusions on the efficacy of cortisone for GH OA.

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Figure and Table Legends:

Figure 1: Average OSS for patients with mild and moderate/severe shoulder dysfunction

Figure 2: Average VAS for patients with mild and moderate/severe shoulder dysfunction

Figure 3: Kaplan-Meier survival curve comparing the 12-month survival from secondary intervention for patients with mild and moderate/severe shoulder dysfunction based on the Oxford Shoulder Score

Figure 4: Kaplan-Meijer survival curve comparing the 12-month survival from secondary intervention for patient with mild, moderate, and severe radiographic shoulder arthritis based on the Samilson-Prieto Classification

Figure 5: Monthly change in the OSS from baseline vs MCID

Figure 6: Monthly change in VAS from baseline vs MCID

Figure 7: Average OSS change from baseline through months 12 for the entire cohort

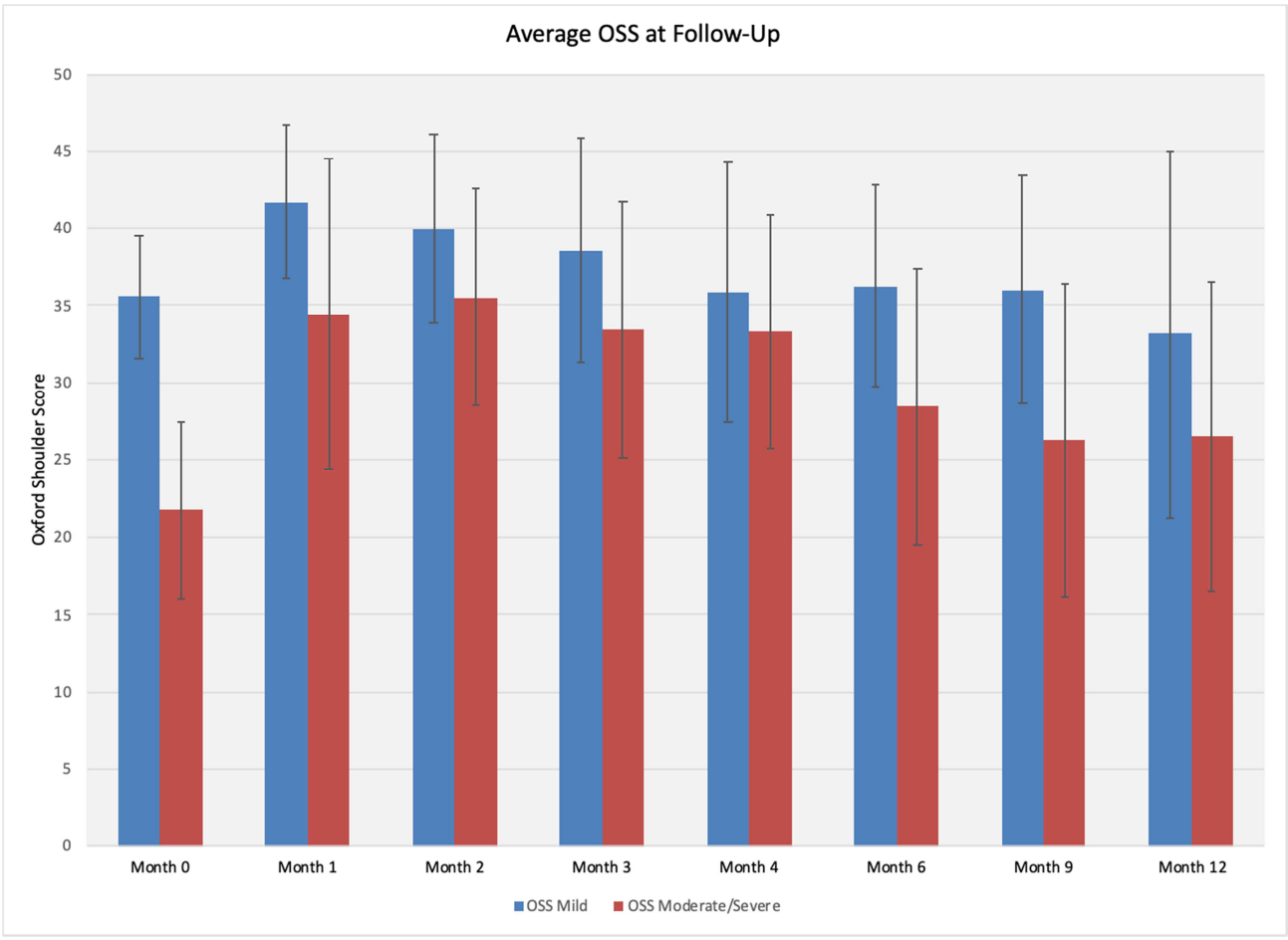
Figure 8: Average VAS change from baseline through month 12 for the entire cohort

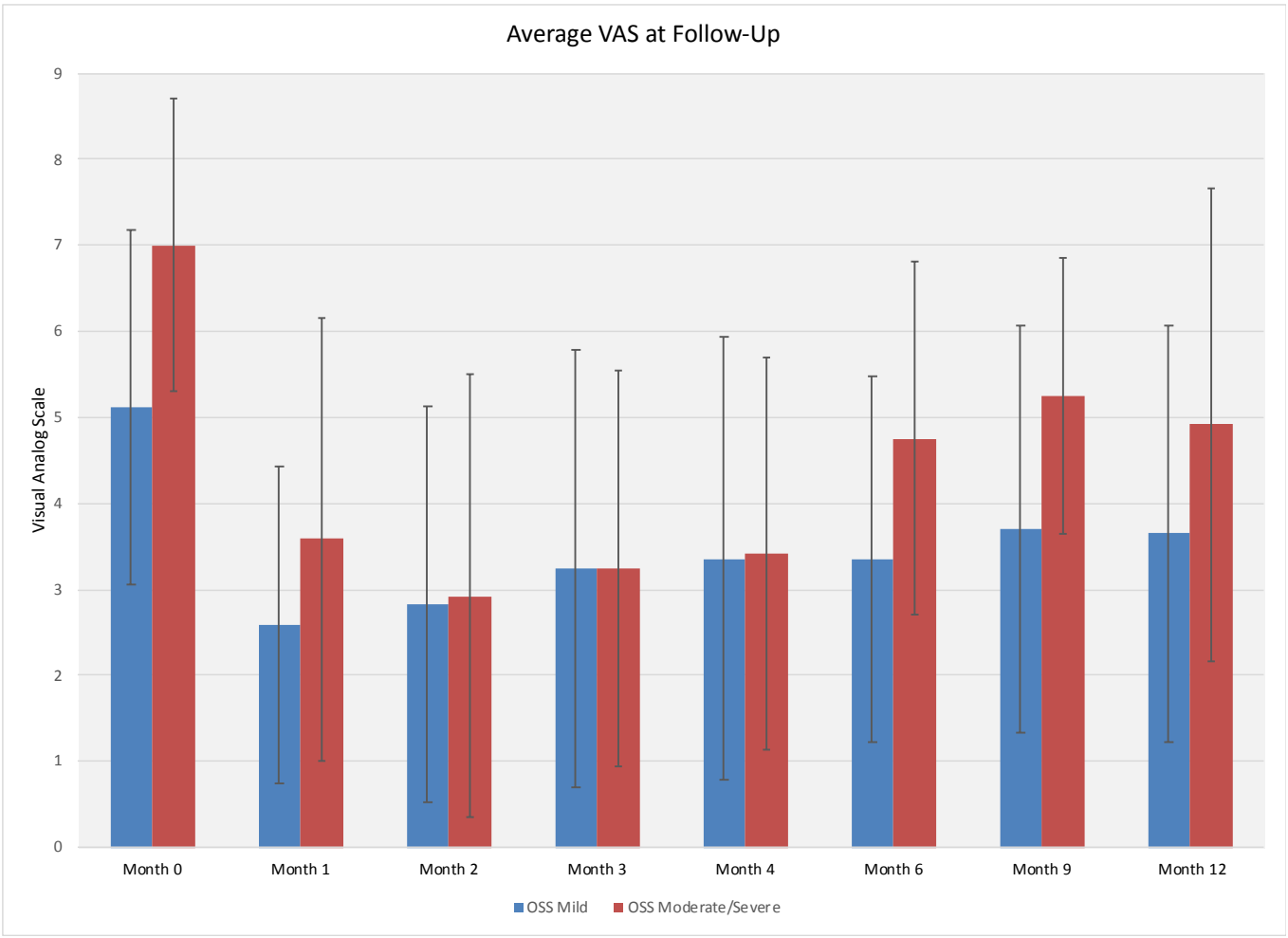
Table I: Patient demographics, including the following: Age, Sex, Laterality, Samilson-Prieto classification, Oxford Shoulder Score Group, Mild or Moderate/severe

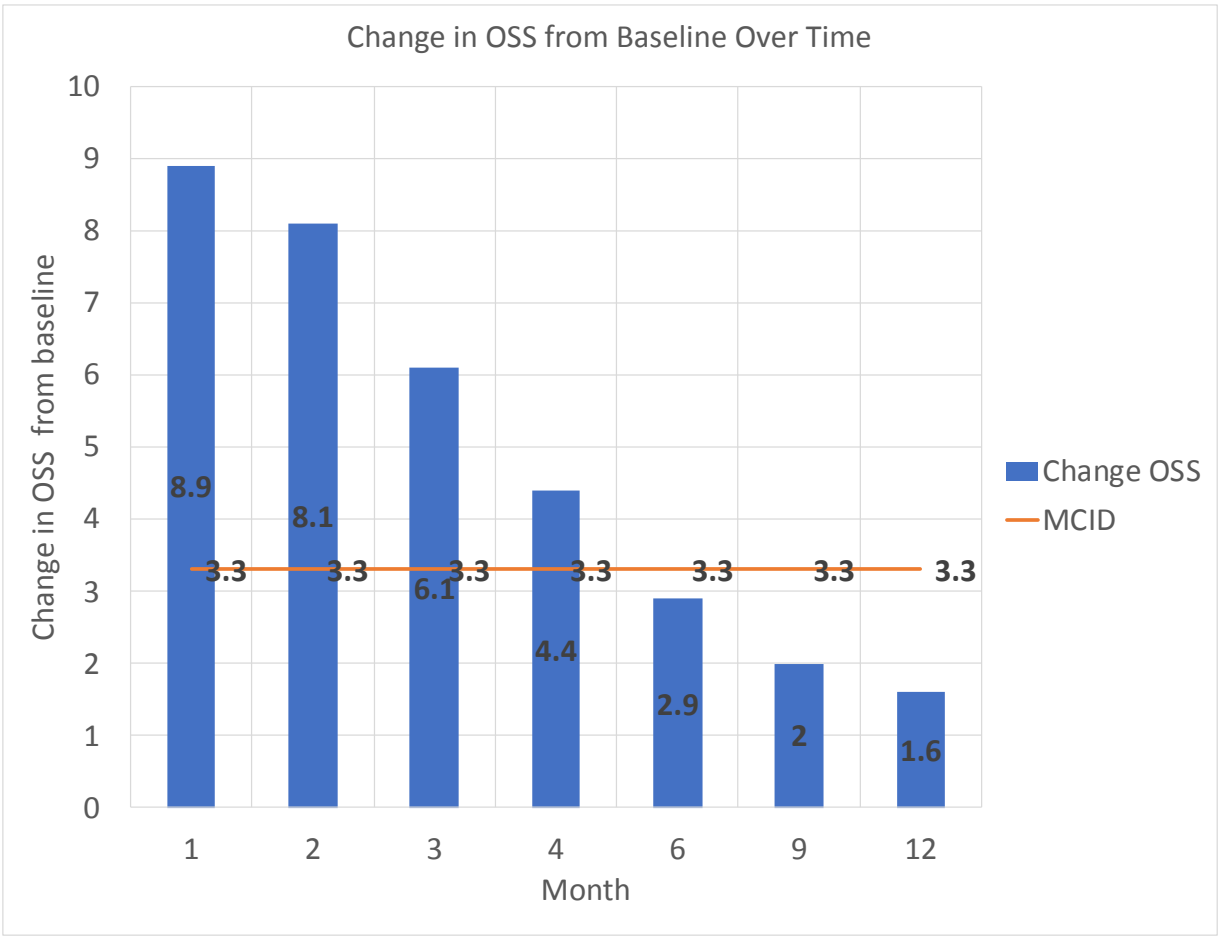
Table II: Average change in the OSS from baseline for months 1, 2, 3, 4, 6, 9, 12. This change was above the MCID for months 1-4, falling below the MCID during months 6, 9, and 12.

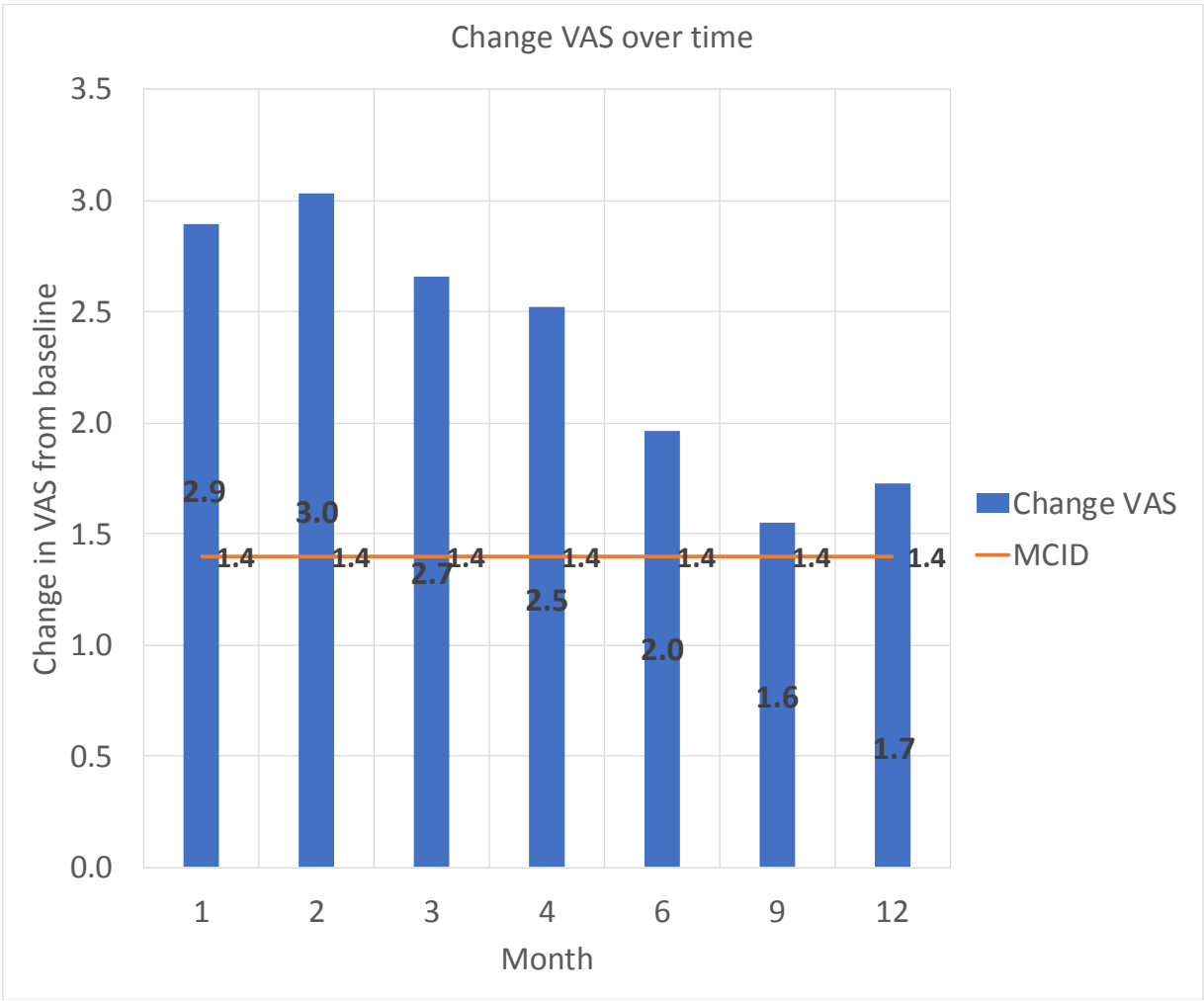
Table III: Average change in VAS from baseline for months 1, 2, 3, 4, 6, 9, and 12. This change was above the MCID for all time points in the study.

29 shoulders / 28 patients	Average
Age	66.1 y/o (range= 43-86 years)
Sex	52% Male
Laterality	59% Right-Sided
Samilson-Prieto Classification	
Class I	8/29 (27.5%)
Class II	13/29 (45.0%)
Class III	8/29 (27.5%)
Oxford Shoulder Score Classification	
Mild	17/29 (58.6%)
Moderate/Severe	12/29 (41.4%)


Average OSS at Follow-Up
Oxford Shoulder Score
50
45
40
35
30
25
20
15
10
5
0
Month 0
Month 1
Month 2
Month 3
Month 4
Month 6
Month 9
Month 12
OSS Mild
OSS Moderate/Severe


Average VAS at Follow-Up
Visual Analog Scale
0
1
2
3
4
5
6
7
8
9
Month 0
Month 1
Month 2
Month 3
Month 4
Month 6
Month 9
Month 12
OSS Mild
OSS Moderate/Severe


Change in OSS from Baseline Over Time
Change in OSS from baseline
10
9
8
7
6
5
4
3
2
1
0
8.9
8.1
6.1
4.4
2.9
2
1.6
3.3
3.3
3.3
3.3
3.3
3.3
3.3
1
2
3
4
6
9
12
Month
Change OSS
MCID


Change VAS over time
Change in VAS from baseline
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2.9
3.0
2.7
2.5
2.0
1.6
1.7
1.4
1.4
1.4
1.4
1.4
1.4
1.4
1
2
3
4
6
9
12
Month
Change VAS
MCID