Rotator Cuff Impingement: Correlation Between Findings on MRI and Outcome After Fluoroscopically Guided Subacromial Bursography and Steroid Injection

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OBJECTIVE. The purpose of this study was to describe the use of fluoroscopically guided subacromial bursography in the management of rotator cuff impingement and to correlate clinical outcome with preprocedural MRI findings.

MATERIALS AND METHODS. Sixty-nine patients with clinically and MRI proven subacromial impingement referred for fluoroscopic subacromial bursography and steroid injection between January 2004 and January 2006 were included in the study. After contrast-enhanced bursography, each patient received an injection of 80 mg of methylprednisolone and 1–2 mL of 0.25% bupivacaine into the bursa. Outcome was determined retrospectively and classified as complete resolution of symptoms, partial resolution of symptoms, or no change. MRI findings of impingement were graded according to severity. Outcome was evaluated as complete resolution and as complete or partial resolution in relation to MRI findings, duration of symptoms, age, and sex.

RESULTS. Complete resolution of symptoms was recorded in 40 (58%) of the patients. Fifty-seven (83%) of the patients reported some relief of symptoms after a mean follow-up period of 6 months. Shorter duration of symptoms and minor-grade MRI findings were associated with complete resolution. Younger age and minor-grade MRI findings were associated with complete or partial resolution.

CONCLUSION. Imaging-guided subacromial steroid injection may be of benefit in the short-term management of clinically and MRI-proven subacromial impingement, with 83% of 69 patients reporting symptom relief at 6-month follow-up evaluation. Patients with shorter duration of symptoms and minor-grade MRI findings have improved outcome.

Shoulder pain is a significant cause of morbidity worldwide with an incidence of 11.2–19 cases per 1,000 patients per year. The prevalence of shoulder pain among persons 50–70 years old is 6.7%. The prevalence increases with age, shoulder pain affecting 21% of persons 70 years and older. In 70% of these cases, pain relates to derangement of the rotator cuff. The true prevalence of rotator cuff disease is even higher among persons without symptoms. The overall prevalence of tears of the rotator cuff on MRI is 34% among symptom-free patients of all age groups, being 15% for full-thickness tears and 20% for partial-thickness tears [1–4]. Men and women are equally affected.

The pathophysiologic mechanism of rotator cuff degeneration remains controversial. There are two main theories: extrinsic compression of the cuff and intrinsic tendon degeneration. Neer [5] proposed that rotator cuff impingement by the subacromial arch was the principal cause of shoulder pain. He and his associates [5, 6] proposed that impingement generates bursitis and subacromial inflammation and that secondary rotator cuff tendon attrition, intrasubstance microtears, and tendinosis progress to tendon stretching and tear. Successful management of subacromial bursitis may limit progression of this sequence and ultimately protect the rotator cuff. Proponents of the intrinsic theory [7–9], however, state that rotator cuff tears result from progressive age-related degeneration and that most tears occur in a relatively hypovascular zone (critical zone). Results of more recent studies [10, 11], however, suggest that the critical zone is of normal vascularity or hypervascular and that the pathogenesis of rotator cuff disease is a subject of much debate. It is likely that tendon degeneration results from a combination of extrinsic, intrinsic, and biomechanical factors, including rotator cuff impingement and intrinsic degeneration.
Approaches to the management of impingement and subacromial bursitis are varied, and outcomes among patients are unpredictable. Nonoperative management includes the use of antiinflammatory drugs in conjunction with rest. In refractory cases and in the treatment of patients with persistent shoulder pain despite such intervention, subacromial steroid injections often are used and are frequently followed by muscle-strengthening programs. Operative treatment, including acromioplasty with decompression and rotator cuff repair, may be considered in the treatment of patients whose condition does not improve after 6 months of conservative therapy or of patients younger than 60 years with debilitating symptoms that impair function. The results of conservative treatment vary, ongoing or worsening symptoms being reported by 30–40% patients at follow-up [12–14]. Patients with more severe symptoms, longer duration of symptoms, and a hook-shaped acromion tend to have worse results than do other patients [14, 15].

Results of studies of outcome after steroid injection also vary. A randomized controlled trial [16] of treatment with a single subacromial injection of methylprednisolone administered without imaging guidance to patients with posttraumatic impingement showed no beneficial effect on pain reduction or duration of immobility. Blair et al. [17], however, concluded that subacromial injection of corticosteroids is effective short-term management of symptomatic subacromial impingement syndromes. That the diagnosis of subacromial impingement syndrome was made on clinical grounds without imaging correlation, specifically without MRI confirmation of the diagnosis, is a major limitation of most studies. Also in most studies, reported subacromial injections have been administered without imaging guidance and, hence, whether the injection was delivered to the bursa or to the adjacent soft tissue is speculative. Studies have shown that in many procedures performed without imaging guidance, the needle is not sited in the subacromial bursa, hence steroid is delivered to the peribursal soft tissues at best. In one study [18], only 29% of blind subacromial injections were accurately placed, and the outcome was better when the injection was accurately placed. A study by Naredo et al. [19] showed that patients undergoing sonographically guided subacromial injection had significantly better results than those undergoing blind injection.

Rotator cuff impingement syndromes are largely a clinical diagnosis based on a characteristic history and signs found at physical examination, such as the Neer impingement sign, the Hawkins-Kennedy impingement sign, and the painful arc sign [20]. Imaging is a useful adjunct for confirming the anomaly, describing its extension, and visualizing associated findings. MRI is the most useful technique for evaluation of shoulder pain due to subacromial impingement and rotator cuff disease and can be used to diagnose bursal inflammatory change, structural causes of impingement and secondary tendinopathy, and partial-and full-thickness rotator cuff tears [21–25]. The aim of this study was to record the clinical effect of imaging-guided subacromial steroid injection on the treatment of patients with clinically and MRI proven subacromial impingement syndrome and to correlate outcome with patient age, duration of symptoms before injection, and preprocedural findings on MRI.

Materials and Methods

All patients with clinically and MRI proven subacromial impingement who underwent fluoroscopically guided subacromial injection in a tertiary referral orthopedic unit between January 2004 and January 2006 were included in the study. Clinical diagnosis was based on the combination of a classic history suggestive of impingement and the finding at a complete physical examination of signs of impingement, such as the Neer impingement sign and the Hawkins-Kennedy impingement sign. Patients were referred for shoulder MRI by their primary care physician (rheumatologists, sports physicians, and orthopedic surgeons).

Shoulder MRI was undertaken in each case with a 1.5-T MRI system (Avanto, Siemens Medical Solutions, or Intera, Philips Medical Systems) with a dedicated shoulder coil. In each case, coronal oblique T2-weighted, coronal oblique STIR, and axial gradient-echo images were acquired at similar repetition and echo times. Acquired images were reviewed by two radiologists, and discrepancies were resolved by consensus. The MRI findings of impingement were described and reported and then graded according to severity. Grade 1 consisted of isolated subacromial bursitis. Grade 2 consisted of grade 1 with the addition of coracoacromial arch anomaly producing impingement. This lesion included hypertrophic change in the acromioclavicular joint with an inferiorly oriented osteophyte, thickening of the coracoacromial ligament, and a hook-shaped acromion (Figs. 1A and 1B). Grade 3 consisted of grade 2 with
MRI of Rotator Cuff Impingement

Fig. 2—30-year-old man with grade 1 findings of isolated subacromial bursitis and symptom duration of 1 month who reported complete resolution of symptoms after fluoroscopically guided subacromial steroid injection. A, Subacromial bursogram shows isolated subacromial bursitis. B, Coronal oblique STIR MR image (TR/TE, 2,000/20; inversion time, 160 milliseconds; echo-train length, 8) shows isolated subacromial bursitis (arrow).

Fig. 3—46-year-old woman with inflammatory changes in acromioclavicular joint with osteophyte formation, secondary impingement, and bursitis (grade 2). Symptom duration was 4 months, and patient reported complete resolution of symptoms after 6 months of follow-up. A, Subacromial bursogram shows inflammatory changes in acromioclavicular joint. B, Coronal oblique STIR MR image (TR/TE, 2,000/20; inversion time, 160 milliseconds; echo-train length, 8) shows changes in acromioclavicular joint (open arrow) with osteophyte formation (closed arrow).

In each case, after clinical consultation with the primary care physician, fluoroscopically guided subacromial bursography was performed by a musculoskeletal radiologist. With aseptic technique and use of local anesthetic, a 22-gauge needle was inserted under fluoroscopic guidance into the subacromial space through the anterior approach. Needle position was confirmed by injection of 1–2 mL of nonionic contrast medium (iohexol, Omnipaque 300, GE Healthcare) into the bursa. An injection of 80 mg of methylprednisolone and 1–2 mL of 0.25% bupivacaine then was administered.

There was no cutoff for symptom duration or symptom severity. All patients with clinical symptoms and signs suggestive of impingement and characteristic MRI findings were referred for treatment. Standard conservative treatment, including the use of nonsteroidal antiinflammatory drugs, was continued for 2 weeks after the injection and then discontinued. Outcome in each case was subjectively determined by the patient after a mean follow-up period of 6 months and was classified as one of the following: exacerbation of symptoms after injection, no change in symptoms after injection, partial improvement (defined as reduction in subjective pain but not complete resolution or improvement in activities of daily living), or complete resolution of symptoms after injection. Patient characteristics, including age, sex, duration of symptoms before injection, history of previous injections, and history of previous surgery were noted.

Correlation was made between ultimate patient outcome and preprocedural MRI findings, duration of symptoms, and patient age. Statistical software (SAS version 8, SAS Institute) was used for data analysis. Chi-square tests for comparison of proportions, chi-square tests for trend, and Student’s t tests to compare means in independent groups were used at a 5% two-sided level of significance. The variables of age, male sex, duration, and grade (entered as a continuous variable) were included in a multivariate logistic regression model with backward selection to estimate the independent predictors of resolution. The analysis was conducted with outcome as complete resolution and was repeated with outcome as partial or complete resolution. Institutional ethics approval was sought and granted for the retrospective review.

Results

Figures 2–5 illustrate examples of subacromial bursography with corresponding MRI images. Over the study period, 69 patients with clinical and MRI evidence of subacromial impingement were referred for fluoroscopically guided subacromial bursography with targeted steroid bupivacaine injection into the bursa. The group consisted of 31 men and 38 women with a mean age of 48.6 ± 15.3 (SD) years (range, 24–88 years). The duration of symptoms was 0.3–120 weeks with a mean duration of 13.6 ± 21.6 weeks. Table 1 shows the MRI grades.

No patients reported exacerbation of symptoms. Twelve (17%) of the patients reported no change in symptoms. Four of the 12 reported initial resolution of symptoms lasting 10 days, 4 weeks, 5 weeks, and 8 weeks. At 6-month follow-up evaluation, however, the symptoms were back to baseline. One of these patients believed the return of symptoms was the result of returning to training too soon. The others did not recall any factors that triggered the return of symptoms. One of the patients who reported no change also underwent MRI of the cervical additional supraspinatus tendinopathy. This lesion was classified as tendon swelling with increased signal intensity on T2-weighted and STIR sequences. Grade 4 consisted of grade 3 with additional partial-thickness supraspinatus tendon tear, including acromial, bursal, and intratendinous tears. This finding was classified as an area of focal hyperintensity contacting only one surface of the supraspinatus tendon or involving only the intratendinous substance of the tendon. Grade 5 consisted of grade 4 with additional complete supraspinatus tendon tear (Fig. 1C).
spine showing disk protrusion at C6–C7 with nerve root impingement, which likely contributed to the symptoms.

Seventeen (25%) of the patients reported partial relief of symptoms with a reduction in pain or improvement in activities of daily living. Seven of the 17 reported initial complete resolution lasting 2 weeks, 4 weeks (three patients), 6 weeks (two patients), and 8 weeks (five patients) followed by gradual return of symptoms. Forty (58%) of the patients reported complete resolution of symptoms after 6 months of follow-up. No significant complications were reported. Ten (14%) of the 69 patients reported initial exacerbation of symptoms lasting up to 24 hours after steroid injection, but the symptoms subsequently resolved.

Patients of all ages benefited from treatment. Fifteen (65%) of 23 patients younger than 40 years reported complete resolution of symptoms, and only one (4%) of the 23 reported no change. By comparison, 17 (57%) of 30 patients 40–60 years old and eight (50%) of 16 patients older than 60 years reported complete resolution. Table 2 shows patient outcome by age group.

Table 3 shows patient outcome by MRI grade. Most of the patients with lower-grade lesions had complete resolution, and the proportion of patients with complete resolution of higher-grade lesions was small. Nineteen (83%) of the patients with grade 1 MRI findings (isolated bursitis) reported complete resolution of symptoms. Only two (33%) of the patients with grade 4 findings (partial-thickness tears) and none of those with grade 5 findings (full-thickness tears) reported complete resolution.

Table 4 shows patient outcome by symptom duration before treatment. Thirty-five
(73%) of the patients with symptom duration of less than 1 year reported complete resolution of symptoms, compared with five (24%) of the 21 patients with symptom duration of more than 1 year and two (17%) of those with symptom duration of more than 2 years. Sixteen (40%) of the 40 patients reporting complete resolution of symptoms had a duration of symptoms of less than 3 months; only two (5%) of the 40 had had a symptom duration of more than 2 years. Similarly, seven (58%) of the 12 patients with no change had a symptom duration of more than 2 years.

In the comparison of complete resolution (n = 40) with partial resolution or no change (n = 29), as MRI grade increased, the proportion of patients with complete resolution decreased with a significant linear trend (p = 0.0008). Although patients with complete resolution were younger than those with other outcomes, the difference in age was not significant (46 vs 52.2 years; p > 0.05). The mean duration of symptoms was significantly shorter among patients with complete resolution than those without (mean duration, 7.8 vs 21.8 weeks; p = 0.02). There was no significant difference in proportions of men and women with complete resolution. Stepwise logistic regression showed MRI grade was the single independent factor associated with complete resolution.

In the comparison of patients with relief of symptoms (complete or partial resolution, n = 57), as MRI grade increased, the proportion of patients with complete or partial resolution also decreased with a significant linear trend (p = 0.0007). Those with complete or partial resolution were significantly younger (mean age, 46.6 vs 58 years; p = 0.02) than the others. Again, proportions were similar among men and women. The mean duration of symptoms was shorter in patients with some resolution of symptoms, but the difference was not significant (9.3 vs 34.2 weeks; p = 0.06). Stepwise regression showed the single independent predictor of resolution was duration of symptoms, which was negatively associated with resolution (odds ratio, 0.95; 95% CI, 0.91–0.99).

**TABLE 4: Patient Outcome by Symptom Duration Before Treatment**

<table>
<thead>
<tr>
<th>Duration of Symptoms (mo)</th>
<th>Complete Resolution (%)</th>
<th>Partial Resolution (%)</th>
<th>No Change (%)</th>
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<tbody>
<tr>
<td>&lt; 3</td>
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<td>84</td>
<td>16</td>
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<td>3–5.9</td>
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<td>69</td>
<td>19</td>
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<td>9</td>
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<td>&gt; 24</td>
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**Discussion**

The results of this study suggest that fluoroscopically guided subacromial injection of steroid may be of benefit in the evaluation and short-term management of clinically and MRI proven subacromial bursitis. Eighty-three percent of patients reported relief of symptoms a mean of 6 months after treatment (58% complete and 25% partial responses). These results are better than those of physical therapy and analgesia alone. In a study by Chard et al. [12] only 39.4% of 137 patients treated conservatively reported relief of symptoms at follow-up, compared with 83% of the patients in our study.

Previous studies of subacromial injection in the management of rotator cuff tendinitis have shown varying results. A randomized controlled study by McInerney et al. [16] into the use of subacromial injection of methylprednisolone in the treatment of patients with posttraumatic impingement of the shoulder showed no beneficial effect of the treatment. In that study, however, all of the patients had a history of trauma, which may have biased the results. In addition, the diagnosis was based on findings at clinical examination, and intervention was without imaging guidance and therefore random. In a randomized controlled study with 55 patients with rotator cuff tendinitis of less than 12 weeks’ duration, the investigators [24] compared injection of methylprednisolone and lignocaine with use of lignocaine alone and found no statistically significant difference in symptoms at 3-month follow-up evaluation. Although the result was disappointing, injections were random and without imaging guidance and hence in many cases were likely delivered to peribursal soft tissue.

Alvarez et al. [25], who compared steroid injection combined with an anesthetic with administration of anesthetic alone in the management of chronic rotator cuff tendinitis, concluded that steroid is not more effective than lignocaine alone in improving quality of life and range of motion or in relieving impingement symptoms. Blair et al. [17], who compared the use of subacromial injection of lignocaine alone with use of triamcinolone acetonide with lignocaine, concluded that injection of steroid is effective short-term therapy for impingement syndromes. The follow-up period in that study ranged from 28 to 33 weeks. Of 19 patients who received steroid injections, 16% reported moderate to severe pain at follow-up evaluations, compared with 71% of 21 patients who received local anesthetic alone. Many studies of the use of steroid injection in the management of shoulder pain have had conflicting results. Winters et al. [26] attempted to categorize patients with shoulder pain on clinical grounds into a shoulder girdle group and a synovial group. They concluded that for shoulder girdle disorders, manipulation is the best treatment, whereas synovial disorders are best managed by corticosteroid injection.

A critical limitation of all of the aforementioned studies is that the diagnosis was made on clinical grounds alone. It is quite possible that in many cases poor outcome reflected the fact that shoulder pain was caused by a problem other than subacromial impingement. Winters et al. [26] indicated that patients with shoulder girdle symptoms did not benefit from subacromial injection. This limitation was overcome in our study because only patients with both clinical impingement syndromes and MRI correlation were evaluated and referred for subacromial injection. This difference may explain in part why our patients reported better outcome than did patients in whom the diagnosis was based on clinical grounds alone.

The finding of fluid in the subacromial bursa is nonspecific and may be a coincidental finding in a patient with shoulder pain. In a patient with a clinical history suggestive of subacromial impingement and with signs of impingement, however, this finding is more likely to be significant. In our study these patients were most likely to benefit from steroid injection. Eighty-three percent of patients with isolated bursitis on MRI and with clinical impingement syndromes reported complete resolution of symptoms. Lack of response to treatment should therefore prompt a search for an alternative cause of symptoms. At least one of the 12 patients in this study who did not respond to steroid injection went on to undergo cervical MRI that revealed nerve root impingement at C6–C7, which possibly contributed to the symptoms.
A possibly critical limitation of the studies was that subacromial injection was performed blindly. It is likely that many of the injections were not into the subacromial bursa and that a number of neighboring structures were infiltrated, which increases the risk of side effects. One study [18] showed that only 29% of blindly administered subacromial injections were accurately placed. Our finding that the outcome of imaging-guided injection and targeted bursography is better than that of blind injection is in concordance with the results reported by Naredo et al. [19]. Those investigators compared blind injection with sonographically guided local injection of corticosteroids and found that after a follow-up period of 6 weeks the imaging-guided group had significantly more improvement.

In our study, better outcome was associated with shorter duration of symptoms, minor-grade (grades 1 and 2) MRI findings, and younger patient age. This outcome correlates with shorter duration of symptoms, minor-grade MRI findings, and with persistent post-traumatic impingement of the shoulder. Emerg Med J 2003; 20:218–221


Singson RD, Hoang T, Dan S, Friedman M. MR evaluation of rotator cuff pathology using T2-weighted fast spin-echo technique with and without fat suppression. AJR 1996; 166:1061–1065


patients with longer symptom duration and more severe MRI findings. In effect, MRI of the shoulder may be of benefit to patients with clinically suspected impingement because it allows confirmation of the diagnosis and allows the operator to predict which patients are more likely to respond to fluoroscopically guided bursography with targeted steroid and bupivacaine injection.

References


