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CLINICAL RESEARCH

Does a Positive Neer Impingement Sign Reflect Rotator Cuff Contact with the Acromion?

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Abstract

Background One possible cause of shoulder pain is rotator cuff contact with the superior glenoid (cuff-glenoid contact) with the arm in flexion, as occurs during a Neer impingement sign. It has been assumed that the pain with a Neer impingement sign on physical examination of the shoulder was secondary to the rotator cuff making contact with the anterior and lateral acromion.

Questions/purposes We determined if the arm position where pain occurs with a Neer impingement sign would correlate with the position where the rotator cuff made contact with the superior glenoid, as determined by arthroscopic evaluation.

Patients and Methods We prospectively studied 398 consecutive patients with a positive Neer impingement sign during office examination and used a handheld goniometer to measure (in degrees of flexion) the arm position in which impingement pain occurred. During subsequent arthroscopy, the arm was moved into a similar position, and we measured the arm's position in flexion at the point the rotator cuff made contact with the superior glenoid using a handheld goniometer. We compared the degrees of flexion at which pain occurred preoperatively and at which there was cuff-glenoid contact.

Results Among the 398 patients, 302 (76%) had arthroscopically documented cuff-glenoid contact, whereas 96 did not. For the 302 patients with a positive Neer sign preoperatively and with arthroscopically documented cuff-glenoid contact, the average preoperative impingement pain position was 120.1° ± 26.7°, similar to that of the average intraoperative cuff-glenoid contact position of 120.6° ± 14.7°.

Conclusions Our data suggest pain associated with a positive Neer sign more often relates to contact of the rotator cuff with the superior glenoid than to contact between the rotator cuff and acromion.

Level of Evidence Level II, prognostic study. See Guidelines for Authors for a complete description of levels of evidence.

Each author certifies that he has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.
Each author certifies that his or her institution has approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.

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Introduction

Impingement syndrome was described by Dr. Charles Neer II in 1972 [27] as a spectrum of disease of the rotator cuff resulting from rotator cuff degeneration and impingement of the rotator cuff on the acromion and coracoacromial arch. Clinically, this syndrome was characterized by pain in the shoulder and proximal arm anteriorly and laterally with elevation of the arm. Neer [27, 28] described a diagnostic sign for impingement performed by passively flexing the patient's arm until pain is felt in the anterior or anterolateral proximal arm. According to Bigliani and Levine [3], a positive impingement sign

typically occurs with the arm between 70° and 120° flexion. This 'Neer sign' has been considered an important diagnostic indicator for rotator cuff impingement [22, 28].

It has been suggested impingement pain may occur as a result of contact between the rotator cuff and the superior glenoid (hereinafter termed "cuff-glenoid contact") [37]. Cuff-glenoid contact has been observed with the arm in abduction and external rotation (called "internal impingement") and with the arm in forward flexion (called "flexion contact") [7, 18, 38]. Cuff-glenoid contact with the arm in abduction and external rotation or with the arm in flexion has been documented in cadaver [36], MRI [16], and clinical studies involving arthroscopy [18, 30, 35].

One arthroscopic study suggested rotator cuff contact with the superior glenoid when the arm was in flexion (as with a Neer impingement sign) was common, regardless of the shoulder diagnosis [18]. In that study, patients with such contact were compared with a control group without such contact. The factors associated with cuff-glenoid contact with the arm in flexion were the presence of Type II superior labrum anterior and posterior lesions and of osteoarthritis of the humeral head. Although cuff-glenoid contact was common, that study did not determine the relationship of cuff-glenoid contact to the position of the arm at which pain occurred. However, cuff-glenoid contact seemed to occur at a degree of arm elevation similar to that described by Neer for a positive sign.

Therefore, we asked whether in patients with a positive Neer impingement sign observed during office examination, the degree of flexion at which the sign became positive in the clinic would be similar to the arm position in which the rotator cuff was arthroscopically seen to make contact with the superior glenoid.

Patients and Methods

From August 1992 through November 2007, any patient undergoing shoulder surgery for any reason at our institution was prospectively entered into a database. We retrospectively reviewed that database and found, of the total of 1854 patients it had recorded, 1331 had undergone diagnostic arthroscopy with or without a subsequent open procedure; 681 of the 1331 patients had a positive Neer sign preoperatively. Of the 681 patients, we excluded 283: 263 because, during arthroscopy, observation of the cuff-glenoid contact was obscured by synovitis or was absent secondary to a large massive rotator cuff tear; and 20 with a diagnosis of frozen shoulders because the contact under anesthesia was evaluated after the manipulation. The remaining 398 patients (191 males, 207 females) had an average age of 44.2 years (range, 13–86 years). This study was approved by our Institutional Review Board.

All 398 patients underwent a thorough preoperative history, completed subjective questionnaires within 4 weeks before surgery, and had a comprehensive physical examination performed by the senior author (EGM) or under his supervision. This examination included 646 data points for motion, strength testing, and provocative maneuvers, as previously reported [6, 12–14, 19–21, 25, 26, 31, 32].

The Neer sign was performed in the office with the patient standing. Using the technique described by Neer [28], the examiner stabilized the affected arm by placing one hand on the shoulder to limit scapular rotation and used the second hand to elevate the patient's arm passively in flexion with the arm in internal rotation until the patient felt pain in the anterior or lateral deltoid only. If the patient had pain elsewhere, it was not considered a positive Neer sign. For the sign to be positive, the pain had to be in the anterior or lateral portion of the shoulder near the acromion or in the deltoid region. The sign was considered negative if there was pain in the acromioclavicular joint, trapezius muscle, posterior shoulder joint line, or shoulder blade region. Once pain in the anterior or lateral deltoid was reported, the examiner stabilized the patient's arm in that position, and a handheld goniometer then was used to determine the degree of arm flexion (Fig. 1).

All patients subsequently underwent arthroscopy of the shoulder under general anesthesia with or without a scalene block. After the induction of anesthesia, the patient was

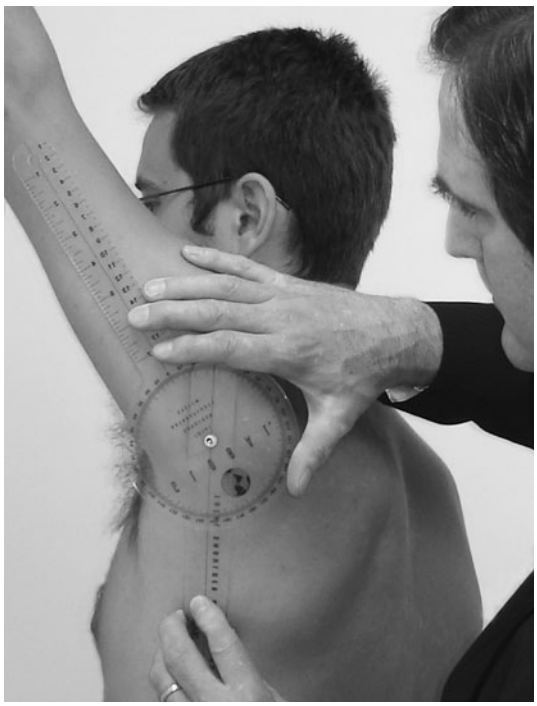

Fig. 1 A goniometer is held by the examiner to determine the degrees of arm flexion where pain occurred.

placed in a lateral decubitus position with a bean bag and was secured with towels and tape to prevent thorax motion. The arm was held in a commercially available arm holder with 10 pounds of traction. The arthroscope was placed in a standard posterior portal, and the joint was insufflated with saline via a pressurized pump set at 80 mm Hg. The senior author performed a thorough diagnostic evaluation of the glenohumeral joint, including inspection for rotator cuff and labrum abnormalities. Rotator cuff tears of the supraspinatus were stratified by severity by noting whether they were partial or full thickness [8]. The rotator cuff tears were not débrided until the site had been inspected for cuff-glenoid contact.

The patient's arm then was removed from the arm holder, and an operative assistant on the opposite side of the surgeon moved the arm into flexion as for a Neer sign [24]. An assistant held the scapula with one hand, a technique similar to that used in the office examination and as described by Neer [28]. With the arthroscope held at the posterior joint line as described previously [18], the arm was gradually flexed until cuff-glenoid contact (between the rotator cuff and the superior labrum anterior to the biceps attachment) was noted. With the arm held in this position, the degree of elevation of the shoulder was measured with a handheld goniometer. This position was measured to the nearest 5° and represented the degrees at which the rotator cuff tendon first made contact with the superior glenoid. Next, maximum arm flexion was measured with the goniometer as the assistant fully elevated the arm in flexion [18].

The final diagnosis for all patients was determined by history, physical examination, and arthroscopic findings. Radiographic studies were not used as the source of the final diagnosis in this study because all patients had undergone diagnostic arthroscopy.

We used a paired-samples Student's t test to compare the degrees of flexion noted during the preoperative positive Neer sign with those obtained during shoulder arthroscopy. A two-tailed Pearson correlation was used to test correlation between the degrees of flexion noted during the preoperative positive Neer sign and those obtained during shoulder arthroscopy. We used a standard statistical program (SPSS® 16.0; SPSS, Inc, Chicago, IL, USA) for our analyses.

Results

Of the 398 patients who had pain with a Neer sign during office examination, 302 (76%) had arthroscopically documented cuff-glenoid contact. In the 302 patients, the preoperative measurement of flexion at which the patient reported pain was similar ($p = 0.780$) to the intraoperative measurement of flexion at the point of contact with the rotator cuff: 120.1° ± 26.7° (95% confidence interval, 117.1°–123.3°) versus 120.6° ± 14.7° (95% confidence interval, 118.9°–122.3°); we observed a correlation ($r = 0.850$; $p = 0.011$) between the two measures. For the 302 patients, there were no differences in degrees of flexion at the point of contact according to diagnosis, except for patients with a diagnosis of isolated acromioclavicular arthritis (Table 1).

Of the 302 patients, 164 (76%) had rotator cuff disease (Table 1). For the 164, there was no difference between the average preoperative and intraoperative degrees of flexion (121.4° ± 25.5° and 118.8° ± 14.9°, respectively). When rotator cuff disease was stratified by severity, only the patients with partial tears ($n = 67$) had a difference between the preoperative and intraoperative degrees of flexion ($p = 0.008$) (Table 2).

Discussion

This study sought to determine if there was a relationship between the degrees of flexion where a Neer impingement

Table 1. Degrees of preoperative and intraoperative flexion in 302 patients

Primary diagnosis	Number of patients with contact	Preoperative flexion (°)*	Intraoperative flexion (°)*	p Value	Difference between intraoperative and preoperative angles (°)*	p Value of difference between angles
Rotator cuff disease†	164/216 (75.9%)	121.2 ± 25.5	119.0 ± 14.9	0.360	−2.2 ± 0.3	0.360
Biceps and superior labrum anterior posterior lesion	15/18 (83.3%)	121.7 ± 28.1	117.7 ± 17.0	0.673	−4.0 ± 0.4	0.673
Instability	66/93 (71.0%)	124.9 ± 20.0	123.5 ± 14.1	0.650	−1.4 ± 0.2	0.650
Acromioclavicular disease	52/62 (83.9%)	110.4 ± 34.2	122.3 ± 13.5	0.025	11.9 ± 0.4	0.025
Other‡	5/11 (45.5%)	119.0 ± 32.5	124.0 ± 19.5	0.763	5.0 ± 0.3	0.763
Total	302/398 (75.9%)	120.1 ± 26.7	120.6 ± 14.7	0.780	0.5 ± 0.3	0.780

* Values are expressed as mean ± SD; †includes impingement syndrome, partial tears, and full tears; ‡other diagnoses include osteoarthritis, osteonecrosis, and soft tissue tumor.

Table 2. Degrees of preoperative and intraoperative flexion in 164 patients

Rotator cuff abnormality	Number of patients with contact	Preoperative flexion (°)*	Intraoperative flexion (°)*	p Value
Tendinitis	54/70 (77.1%)	119.5 ± 24.7	121.2 ± 15.1	0.442
Partial tear	51/67 (76.1%)	124.8 ± 23.5	114.7 ± 12.2	0.008
Full tear	59/79 (74.7%)	119.8 ± 27.9	120.3 ± 16.2	0.873
Total	164/216 (75.9%)	121.4 ± 25.5	118.8 ± 14.9	0.360

* Values are expressed as mean ± SD.

sign caused pain during clinic examination and the degrees of flexion found during arthroscopy of the shoulder where the rotator cuff contacts the superior glenoid when the arm is placed in flexion. We found that these two values were not statistically different and that they were highly correlated. This finding suggests that the pain of a Neer impingement sign as performed in the office may reflect contact of the rotator cuff to the superior glenoid and not to the acromion as previously suggested by Neer [27].

There are several limitations of this study which should be considered when evaluating the results. First, we used a fluid pump at the time of arthroscopy that might have distorted the degrees at which the tendon contacted the bone. The insufflations of the joint may have made the rotator cuff contact the superior glenoid at a higher angle than would occur physiologically when there is little fluid in the joint. However, a fluid pump has been used at the time of arthroscopy by others evaluating contact of the rotator cuff with the superior glenoid [7, 15, 17, 18, 24, 35, 37]. Second, it is possible making the measurements with the patients standing when awake and in the lateral position under anesthesia could have affected the results. However, in the office and the operating room, the Neer sign was performed in exactly the same manner and as described by Neer [28]. In both situations, the arm was raised in forward elevation in the sagittal plane of the shoulder with the hand face down, as described by Neer [28]. Third, the limitations of goniometric measurements using handheld goniometers are well documented [4, 5, 11, 23, 34, 39]. Interexaminer reliability is lower than intraexaminer reliability in most studies in awake subjects [4, 10, 11, 23, 34]. Although in our study, the only examiner making the measures in the operating room was the senior author, we did not perform intraobserver reliability studies to measure arm flexion in the office or in the operating room. Similarly, it is possible that more sophisticated techniques for measuring shoulder motion, such as triplanar radiography or electromagnetic sensors, might provide more accurate data, but none of these techniques is suited for use in the operating room. Fourth, we excluded from analysis patients with large to massive rotator cuff tears because those patients had no rotator cuff tendons available to make contact with the superior glenoid and because we consistently observed no contact of the greater tuberosity with the superior glenoid. As stated previously, it was not the goal of our study to determine why patients with massive rotator cuff tears did or did not have pain. Fifth, we did not attempt to answer the enigma of why some patients with rotator cuff disease have or do not have pain with a Neer impingement sign (the exact cause of rotator cuff irritation has not been fully elucidated) or to explain why some patients with other disease entities around the shoulder may experience a positive Neer impingement sign. Although this study was designed to correlate arm position with cuff-glenoid contact, it does not suggest this contact is the only source of pain with a Neer impingement sign. We did not study the subacromial space as part of this study because some of the patients did not warrant subacromial inspection; all of the patients with rotator cuff disease as a primary diagnosis did have the subacromial space examined openly or arthroscopically. Despite the anecdotal suggestion of some surgeons, we have found it is technically impossible to view the acromion and coracoacromial ligament arthroscopically with the arthroscope in the subacromial space while moving the arm in flexion. As a result, we did not explore the possibility that the rotator cuff tendons on the bursal surface might be contacting other structures. Finally, we did not perform differential injections in this protean group of patients to determine other potential sites of pain in the shoulder.

Our data suggest that the degree of flexion at which there is pain with the Neer impingement sign on office examination correlates well with the degrees of flexion where the rotator cuff makes contact with the superior glenoid arthroscopically. These findings suggest, but do not prove, this contact between the rotator cuff and the superior glenoid may be a pain generator when the arm is flexed in a manner similar to that of a Neer impingement sign. Cadaveric studies support our observation that, with arm flexion greater than 90°, the rotator cuff makes contact with the superior glenoid and not the acromion [36]. Graichen et al. [9], using MRI of the glenohumeral joint in different degrees of elevation, measured the closest distance between the acromion and the greater tuberosity in the

shoulder of 12 healthy volunteers. They found, at 90° of arm elevation, the closest distance was lateral to the supraspinatus tendon in 50% of the subjects, and with the arm abducted 120°, the minimal distance was lateral to the supraspinatus insertion on the greater tuberosity in all cases.

The exact cause of pain with rotator cuff abnormalities continues to be unknown, but it has been postulated to be intrinsic tendon disease [29], tension overload [1, 2], vascular insufficiency [33], and impingement of the rotator cuff to the acromion, the coracoacromial ligament, the coracoid, or the posterior-superior glenoid. We did not confirm nor refute any of these mechanisms as the cause of pain in our patients, but we did establish by arthroscopic visual examination with the arm in flexion (as for a Neer impingement sign), the rotator cuff was in contact with the superior glenoid at the same angle that the Neer impingement sign produces symptoms during examination in the office. This finding suggests, in some patients, the pain produced with a positive Neer impingement sign may not be generated from contact between the rotator cuff and the acromion, as originally suggested by Neer [28]. It is possible the pain pattern attributed to rotator cuff disease is multifactorial or the result of causes other than contact between the rotator cuff and the anterolateral acromion. Additional study is needed to delineate the role of cuff-glenoid contact in patients with symptomatic rotator cuff disease and to determine why not all patients have pain.

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