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Hawkins award 2023: clinical outcome and tendon healing after arthroscopic repair of isolated supraspinatus tears: a retrospective comparative study in patients older than 70 years vs. patients younger than 50 years

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Background: The purpose of this study was to evaluate and compare the clinical and structural outcomes after arthroscopic repair of isolated supraspinatus tears in patients older than 70 years vs. patients younger than 50 years to determine whether age influences the treatment of these tears.

Methods: We conducted a retrospective, comparative study of 87 shoulders of 86 patients older than 70 years who underwent rotator cuff repair after isolated full-thickness supraspinatus tear between January 2010 and December 2020. A control group of 87 patients younger than 50 years was matched for sex, body mass index, smoking habits, tendon retraction according to Patte and fatty infiltration according to Goutallier. Clinical assessment used Constant-Murley Score (CMS), age- and sex-matched Constant Scores and Subjective Shoulder Value at 6 months. Cuff integrity was evaluated using ultrasonography based on the Sugaya criteria, types I-II-III being considered as healed.

Results: The CMS significantly improved by +17.91 points in elderly patients compared with +7.47 points in controls ($P < .1$) and activity ($P = .2$), mobility ($P < .1$), and strength ($P < .1$). The adjusted CMS significantly improved by +24.94 in elderly patients compared with +8.49 points in controls ($P < .1$). The Subjective Shoulder Value improved by +29.48 points in elderly patients compared with +23.47 points in controls. The improvement was similar in both groups. ($P < .10$). Satisfaction was similar in both groups ($P = .31$). Regarding structural outcomes, patients younger than 50 years presented better results in terms of healing than patients older than 70 years, as the healing rate was 73.7% in the elderly group and 88.5% in the control group ($P = .1$). The clinical outcomes were not significantly associated with the tendon healing ($P = .1$).

Conclusion: Functional gain for patients older than 70 years is better than their younger peers despite their low-grade healing. Arthroscopic repair after isolated supraspinatus tears should be considered as a valuable treatment regardless the age.

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The prevalence of rotator cuff (RC) tears increases with age, affecting up to 70% of people over 70 year old.⁴ For a long time, RC repair was reserved for patients under the age of 70. Tissue degeneration and comorbidities were considered as predictive factors for failure of tendon healing.³¹ Indeed, histological analysis

of RC tendons at different ages has shown that cellularity and vascularity are considerably reduced after the age of 70.⁴ The bone density of the tubercles is also reduced due to osteoporosis, which can compromise the quality of the bone fixation of the anchors.⁴⁴ In addition, elderly individuals frequently have comorbidities that can negatively influence tendon healing.³¹ These factors compromising the success of arthroscopic RC repair have widely spread the idea that results in young patients cannot be extrapolated to older people.

Historically, acromioplasty combined with tenotomy has been suggested as an alternative to repair in the elderly. However, there

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is evidence that these outcomes deteriorate over time⁵¹ and that repair offers superior long-term improvement in function and pain.⁹

With increasing life expectancy, a large part of the elderly population remains active longer and now has higher functional demands.^{18,53} Recent studies of RC repair in this demographic group have shown clinical satisfaction.^{10,24,42,47,49} It is therefore legitimate to question about the influence of age on the results of arthroscopic repair of RC.

The primary objective of this study was to compare the clinical outcomes and tendon healing after arthroscopic repair of an isolated supraspinatus tendon lesion in 2 groups of extreme range of age to determine whether age influences the management of these lesions: a group of patients aged 70 and over compared with a group of patients aged below 50.

The secondary objective was to study the correlation between tendon healing and clinical outcomes.

Materials and methods

Study design

This is a retrospective single-center study of patients who underwent arthroscopic RC repair between January 2010 and December 2020. All procedures were performed by the same surgeon. Inclusion criteria were patients under 50 and over 70 year old, who presented with a nontraumatic isolated full-thickness rupture of the supraspinatus tendon.

Exclusion criteria were a stiff shoulder or arthropathy, a history of ipsilateral surgery, shoulder instability, or lesion of an RC tendon other than the supraspinatus, nonrepairable RC rupture. The group, comprising subjects aged 70 years and above at the time of surgery, was matched to a control group with subjects aged below 50 years according to sex, body mass index (BMI), smoking habits, level of tendon retraction in the frontal plane according to Patte and fatty infiltration according to Goutallier. We obtained prior approval from the Local Health Research Ethics Committee.

Surgical technique

All repairs were performed under general anesthesia combined with an interscalene block. The procedures were performed under arthroscopy in the Beach Chair position.

First, an intra-articular assessment was performed to evaluate RC lesions (location, retraction), long biceps tendon lesions or cartilage lesions. Tenotomy of the long head of the biceps tendon was performed if the tendon was found to be delaminated. It was performed flush with the glenoid to perform a “self-locking tenotomy”.⁴⁶ The greater tuberosity was trimmed, and the supraspinatus was reinserted in 2 rows. Acromioplasty with a motorized burr and coplaning on the outer quarter of the clavicle were performed in all cases. Postoperatively, the shoulder was immobilized with a 20° abduction cushion for 6 weeks, and early passive rehabilitation according to the Liotard protocol²⁸ was allowed from the outset. Active movements and strengthening exercises were allowed after 6 weeks.

Clinical evaluation

Constant-Murley score (CMS)⁸ and Subjective Shoulder Value (SSV)¹⁴ scores were used to quantify objective and subjective levels of functional recovery. The age- and gender-adjusted CMS was also calculated.⁷ Patients were assessed preoperatively and at 6 months postoperatively by an independent observer.

| Patte Classification | |
|----------------------|--|
| Stade 1 | (a) proximal retracted stump near to the bony insertion |
| Stade 2 | (b) proximal retracted stump is at the level of the humeral head |
| Stade 3 | (c) the proximal retracted stump is at the level of glenoid or more proximal |

Figure 1 Tendon retraction in the frontal plane according to Patte.⁴¹

Postoperative satisfaction was assessed and then classified according to the following groups:

- patients who reported feeling “better” and had resumed all their previous activities, including sport, were considered “satisfied”.
- were considered “dissatisfied” patients who indicated feeling “the same” or “worse” than preoperative, or unable to return to previous activities, including sports.

Radiological assessment

Preoperatively, computed tomography arthrography or magnetic resonance imaging scans were used to evaluate the RC: tendon retraction in the frontal plane was assessed using Patte's classification (Fig. 1).⁴¹ Fatty infiltration of the muscles was assessed using Goutallier's classification (Fig. 2).^{12,15,17,21}

Postoperatively, we chose ultrasound to study the healing of the repaired tendon, as it provides similar results to magnetic resonance imaging in assessing postoperative healing.^{2,6,38} Tendon healing was assessed using Sugaya's ultrasound classification (Fig. 3).^{6,48} We considered as healed, a tendon presenting a Sugaya ultrasound classification ≤ 3 at 6 months.³⁵

Population

Eighty-seven shoulders from 86 patients aged 70 years or older who underwent arthroscopic repair of the RC met the inclusion and exclusion criteria. In the elderly cohort, the mean age of the population was 73.63 years (± 3.12 years) [70; 92]; 56 were women (64.37%) and 31 patients (35.63%) were men. The injured side was the right side in 95.4% of cases, and their dominant side in 77.01%. The mean BMI was 26.49 ± 3.21 kg/m². Forty-three patients (49.4%) had a normal BMI, 27 (31%) were overweight, and 17 (19.5%) were obese. Six patients (6.9%) were diabetic, 47 (54.0%) had hypertension, 30 (34.5%) had hypercholesterolemia, 17 patients (19.8%) were on antidepressants, and 20 patients (23.0%) were smokers. Twenty-seven patients (31.0%) were heavy workers. There were 32 patients with active hobbies (36.78%) and 55 with sedentary hobbies (63.22%). All of elderly patients had a tenotomy (Table 1).

In the control group, the mean age of the population was 45.7 years (± 3.18 years) [32; 50], 56 were women (64.37%), and 31 patients (35.63%) were men. The injured side was the right side in 93.1% of cases, and their dominant side in 78.18%. The mean BMI was 27.16 ± 3.4 kg/m². Forty-three patients (49.4%) had a normal BMI, 27 (31%) were overweight, and 17 (19.5%) were obese. Four patients (4.6%) were diabetic, 3 (3.4%) had hypertension, 11 (12.6%) had hypercholesterolemia, 17 patients (19.8%) were on antidepressants, and 20 patients (23.0%) were smokers. Twenty-seven patients (31.0%) were heavy workers. Seventy-four patients (85.06%) had a tenotomy, 13 patients (14.94%) had a tenodesis (Table 1). Preoperatively, we had according to Patte's classification, 24 shoulders (27.6%) classified as grade 1 and 63 (72.4%) as grade 2 (Table 1). Regarding fatty infiltration according to Goutallier, 16 shoulders (18.4%) were classified as grade 0 and 71 (81.6%) as grade 1 or 2 (Table 1).

| Goutallier Classification | |
|---------------------------|---|
| Grade 0 | (a) normal muscle without fat |
| Grade 1 | (b) fatty streaks within the muscle |
| Grade 2 | (c) less fat than muscle within the muscle |
| Grade 3 | (d) same amount of fat and muscle within the muscle |
| Grade 4 | (e) more fat than muscle within the muscle |

Figure 2 Fatty infiltration of supraspinatus tendon according to Goutallier.¹⁷

| Sugaya Classification | |
|-----------------------|--|
| I | Sufficient thickness, homogenous tendon (low signal on T2 images) |
| II | Sufficient thickness, partial high-intensity from within the tendon |
| III | Insufficient thickness without discontinuity |
| IV | minor discontinuity one more than one slice, suggesting a small tear |
| V | major discontinuity one, suggesting a moderate or large tear |

Figure 3 Ultrasound score for tendon healing according to Sugaya.⁴⁸

Table I Population.

| | ≤50 Y | ≥70 Y | P |
|------------------------|--------------|--------------|------|
| Total | 87 | 87 | |
| Characteristics | n (%) | n (%) | |
| Sex | | | |
| Male | 31 (35.63%) | 31 (35.63%) | 1 |
| Female | 56 (64.37%) | 56 (64.37%) | |
| Average age | 45.7 ± 3.18 | 76.63 ± 3.12 | <.01 |
| Dominance | | | .72 |
| Right-handed | 68 (78.2%) | 65 (74.7%) | |
| Left-handed | 19 (21.8%) | 22 (25.3%) | |
| Operated side | | | .75 |
| Right side | 81 (93.1%) | 83 (95.4%) | |
| Left side | 6 (6.9%) | 4 (4.6%) | |
| Dominant side involved | 68 (78.16%) | 67 (77.01%) | |
| Heavy worker | 27 (31.0%) | 27 (31.0%) | 1 |
| BMI | 27.16 ± 3.40 | 26.49 ± 3.21 | 1 |
| Normal <25 | 37 (42.5%) | 37 (42.5%) | |
| Overweight 25-30 | 33 (37.9%) | 33 (37.9%) | |
| Obese >30 | 17 (19.5%) | 17 (19.5%) | |
| Smoking habits | 20 (23.0%) | 20 (23.0%) | 1 |
| HTA | 3 (3.4%) | 47 (54.0%) | <.01 |
| Dyslipidemia | 11 (12.6%) | 30 (34.5%) | <.01 |
| Diabetes | 4 (4.6%) | 6 (6.9%) | .75 |
| Depression | 17 (19.8%) | 17 (19.8%) | 1 |
| Patte | | | 1 |
| 1 | 24 (27.6%) | 24 (27.6%) | |
| 2 | 63 (72.4%) | 63 (72.4%) | |
| Goutallier | | | 1 |
| 0 | 16 (18.4%) | 16 (18.4%) | |
| 1 or 2 | 71 (81.6%) | 71 (81.6%) | |
| Tenotomy | 74 (85.06%) | 87 (100%) | <.01 |
| Tenodesis | 13 (14.94%) | | |

BMI, body mass index; HTA, health technology assessment.

Initial clinical scores in the elderly population

In the cohort comprising subjects over 70 years of age, the preoperative total CMS averaged 56.24 ± 14.65 points (Table II). The preoperative CMS parameters were 7.55 ± 2.72 points in pain, 12.54 ± 2.96 points in activity, 6.09 ± 5.40 points in strength, and 29.12 ± 8.38 points in mobility. The adjusted CMS averaged

77.35 ± 19.11 points preoperatively (Table II). The mean SSV score was 49.25 ± 18.34 points preoperatively (Table II).

Initial clinical scores in the young population

In the cohort comprising subjects below 50 years of age, the total CMS was on average 63.76 ± 15.16 points preoperatively (Table II). The preoperative CMS parameters were 7.21 ± 3.28 points in pain, 12.62 ± 3.25 points in activity, 11.21 ± 8.07 points in strength, and 32.72 ± 6.85 points in mobility (Table II). The adjusted CMS averaged 74.59 ± 17.89 points preoperatively (Table II). The mean SSV score was 53.82 ± 19.57 points preoperatively (Table II).

Statistical analysis

Data are presented in tables, for each variable, the mean plus or minus the standard deviation (m±sd), or the number and its percentage n (%). Comparative analysis is based on a robust analysis of variance for means after verification of equality of variance using Levene’s test. In case of doubt about normality and/or failure to respect the hypothesis of equality of variances, the comparison was verified by the Mann–Whitney test. For percentages, the Chi-square test or Fisher’s exact test were performed. All analyses were carried out bilaterally with an α risk equal to 5% using IBM Corp. software. Released 2015. IBM SPSS Statistics for Windows, (version 23.0; IBM Corp., Armonk, NY, USA).

Results

Results in subjects over 70 years of age

Total CMS averaged 74.15 ± 11.64 points at 6 months (Table II). The mean improvement was +17.91 ± 18.08 points (Table III). Postoperative CMS parameters were all improved postoperatively (Table III), with a gain of +5.56 points in pain; +4.97 points in activity; +3.03 points in strength, and +5.29 points in mobility. The age- and sex-adjusted CMS averaged 102.29 ± 15.89 points at 6 months (Table II). The mean improvement was +24.94 ± 25.08 points (Table III). The mean SSV score was 78.74 ± 14.83 points at 6 months (Table II). The mean improvement was +29.48 ± 23.80 points (Table III). Eighty-one patients (93.1%) were satisfied with the surgery and 6 patients (6.9%) were not satisfied (Table IV). In the cohort of elderly subjects, we found 73.6% (64 patients) of supraspinatus tendons healed (Sugaya ≤3) at 6 months postoperatively and 26.4% (23 patients) unhealed (Table V).

Results in subjects under 50 years of age

The total CMS averaged 71.23 ± 15.71 points at 6 months (Table II). The mean improvement was +7.47 ± 18.34 points (Table III). Postoperative CMS parameters were improved by +4.47 in pain, +3.52 in activity, and +0.82 points in mobility. There was a loss of strength of –1.33 points at 6 months (P < .01) (Table III). The age- and sex-adjusted CMS averaged 83.08 ± 18.45 points at 6 months (Table II). The mean improvement was +8.49 ± 21.51 points (Table III). The mean SSV score was 77.01 ± 14.72 points at 6 months (Table II). The mean improvement was +23.47 ± 23.62 points (Table III). Seventy-seven patients (88.5%) were satisfied with surgery and 10 patients (11.5%) were not satisfied (Table IV). In the cohort of subjects aged under 50 years of age, we found 88.5% (77 patients) of supraspinatus tendons healed (Sugaya ≤3) at 6 months postoperatively and 11.5% (10 patients) unhealed (Table V).

Table II
Clinical scores for patients under 50 and over 70.

| | ≤50 Y | | ≥70 Y | |
|--------------------------|---------------|---------------|---------------|----------------|
| | Preoperative | Postoperative | Preoperative | Postoperative |
| | m ± sd | m ± sd | m ± sd | m ± sd |
| Constant-Murley Score | 63.76 ± 15.16 | 71.23 ± 15.71 | 56.24 ± 14.65 | 74.15 ± 11.64 |
| Pain | 7.21 ± 3.28 | 11.68 ± 3.03 | 7.55 ± 2.72 | 13.12 ± 2.27 |
| Activity | 12.62 ± 3.25 | 16.14 ± 3.59 | 12.54 ± 2.96 | 17.51 ± 2.57 |
| Strength | 11.21 ± 8.07 | 9.88 ± 6.33 | 6.09 ± 5.40 | 9.13 ± 6.38 |
| Mobility | 32.72 ± 6.85 | 33.54 ± 6.48 | 29.12 ± 8.38 | 34.40 ± 5.14 |
| Adjusted Constant-Murley | 74.59 ± 17.89 | 83.08 ± 18.45 | 77.35 ± 19.11 | 102.29 ± 15.89 |
| SSV | 53.82 ± 19.57 | 77.01 ± 14.72 | 49.25 ± 18.34 | 78.74 ± 14.83 |

SSV, subjective shoulder value.

Table III
Clinical improvement at 6 months according to age.

| | ≤50 Y | ≥70 Y | P |
|--------------------------|---------------|---------------|------|
| | m ± sd | m ± sd | |
| Constant-Murley Score | 7.47 ± 18.34 | 17.91 ± 18.08 | <.01 |
| Pain | 4.47 ± 3.99 | 5.56 ± 3.64 | .06 |
| Activity | 3.52 ± 4.33 | 4.97 ± 3.88 | .02 |
| Force | -1.33 ± 9.16 | 3.03 ± 7.34 | <.01 |
| Mobility | 0.82 ± 8.44 | 5.29 ± 9.63 | <.01 |
| Adjusted Constant-Murley | 8.49 ± 21.51 | 24.94 ± 25.08 | <.01 |
| SSV | 23.47 ± 23.62 | 29.48 ± 23.80 | .10 |

SSV, subjective shoulder value; P, p-value.
Bold values are statistically significant.

Table IV
Tendon healing and satisfaction as a function of age.

| | ≤ 50 Y | ≥ 70 Y | P-value |
|--------------|-----------|-----------|---------|
| | n (%) | n (%) | |
| Healing | | | |
| Yes | 77 (88.5) | 64 (73.6) | .01 |
| No | 10 (11.5) | 23 (26.4) | |
| Satisfaction | | | |
| Yes | 77 (88.5) | 81 (93.1) | .31 |
| No | 10 (11.5) | 6 (6.9) | |

Bold values are statistically significant.

Table V
Tendon healing at 6 months according to Sugaya classification.

| Sugaya | ≤50 Y | ≥70 Y |
|--------|-------------|-------------|
| | n (%) | n (%) |
| I | 13 (13.94%) | 11 (12.64%) |
| II | 60 (68.97%) | 45 (51.72%) |
| III | 4 (4.59%) | 8 (9.19%) |
| IV | 6 (6.89%) | 7 (8.05%) |
| V | 4 (4.59%) | 16 (18.39%) |

Comparison of results between the 2 cohorts

Improvement in the total CMS was significantly better in patients over 70 years of age ($P < .01$), as well as in the activity ($P = .02$), mobility ($P < .01$), and strength ($P < .01$) parameters. Improvement in the age- and sex-adjusted CMS was significantly greater in older subjects ($P < .01$) (Table III). There was no significant difference in the improvement of the SSV score ($P = .1$) (Fig. 4) (Table III).

There was no significant difference in satisfaction between the 2 groups ($P = .31$) (Table IV).

Older patients healed less well than younger subjects ($P = .01$) (Table IV). The overall complication rate did not differ between groups. Both groups had 0 infections and 0 stiffness.

Study of correlation between clinical results and healing

Improvement in functional scores was not significantly related to the quality of tendon healing (Table VI). The total CMS score improved by $+11.88 \pm 16.42$ points in healed patients and $+12.86 \pm 19.54$ points in unhealed patients ($P = .79$). There were no significant differences, including on the CMS parameters of pain, activity, strength, and mobility.

The age- and gender-adjusted CMS score improved by $+16.27 \pm 22.99$ points in healed patients and $+16.81 \pm 25.27$ points in unhealed patients ($P = .83$).

The SSV score was improved by $+22.19 \pm 24.43$ points in healed patients and $+27.45 \pm 23.75$ points in unhealed patients ($P = .26$) (Table VI).

Discussion

This study shows a greater improvement in functional scores in a population aged over 70 compared to a population aged below 50, despite poorer tendon healing at 6 months following arthroscopic repair of an isolated supraspinatus tendon rupture.

Comparison of functional and healing results with the literature

There are few studies comparing the clinical and tendon healing results of elderly patients with those of younger patients after arthroscopic repair of the RC (Table VII).

In our study, although there was a significant improvement in clinical scores in each group, elderly subjects had a greater gain in functional scores at 6 months: there was a significant difference compared to young subjects in total and age- and sex-adjusted CMSs, as well as in activity, mobility and strength. The improvement in SSV score at 6 months was similar. Satisfaction between the 2 cohorts was comparable.

Elderly patient healed less well than younger subjects, but the improvement in functional scores was not correlated with the quality of tendon healing. Thus, shoulder function was improved in all patients, regardless of age; the gain was greater in elderly subjects despite a lower healing rate. Moraiti et al³⁴ conducted a prospective, comparative, multicenter study in 40 patients over 70 and 40 below 50 years of age after arthroscopic repair of the supraspinatus and infraspinatus. The improvement in total CMS was $+25.8$ points in the elderly subjects vs. $+26.2$ points in the younger subjects, with similar gains between the 2 groups. Improvement in CMS adjusted for age and gender was significantly different in the 2 groups, in favor of the elderly group, with $+32.5$ points in patients over 70 years old vs. $+23.9$ points in patients below 50 years old. Healing was assessed by ultrasound. The healing rate was 82.5% in subjects over 70 vs. 95% in the below-50 group. Nevertheless, their study included a small number of

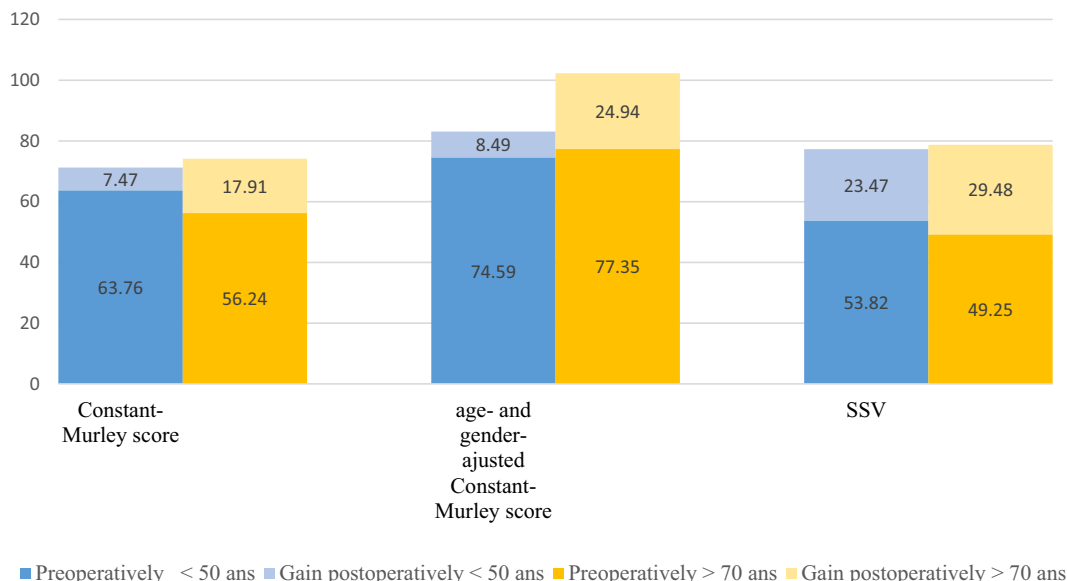


Figure 4 Histogram of clinical improvement at 6 months in both groups.

Table VI

Comparison of clinical improvement at 6 mo between patients with healed and nonhealed cuff.

| | Healed n (%) | Non healed n (%) | P |
|--------------------------|-----------------|---------------------|-----|
| Constant-Murley Score | 11.88 ± 16.42 | 12.86 ± 19.54 | .79 |
| Pain | 4.24 ± 3.78 | 5.21 ± 3.87 | .20 |
| Activity | 3.12 ± 3.89 | 4.49 ± 4.21 | .09 |
| Force | 0.69 ± 7.06 | 0.89 ± 8.92 | .91 |
| Mobility | 3.88 ± 8.19 | 2.84 ± 9.59 | .56 |
| Adjusted Constant-Murley | 16.27 ± 22.99 | 16.81 ± 25.27 | .83 |
| SSV | 22.19 ± 24.43 | 27.45 ± 23.75 | .26 |

SSV, subjective shoulder value; P, p-value.

patients, and there was no adjustment for degrees of tendon retraction and fatty infiltration, which were greater in the older group than in the younger group. Osti et al,⁴⁰ in a retrospective study, compared clinical outcomes after arthroscopic repair of the RC in 28 patients over 65 years of age with a control group of 28 patients under 65. In their study, clinical parameters such as anterior elevation, internal and external rotation, modified University of California, Los Angeles and short form 36 health survey questionnaire scores were comparable between the groups. These clinical results differ from our study. However, Osti et al considered people over the age of 65 to be “elderly”. Moreover, the short form 36 health survey questionnaire self-questionnaire reflects general health-related quality of life and is not specific to the shoulder. In their study, 96% of patients were satisfied in both the over-65 and below-65 age groups. Satisfaction results were similar to those found in our study. In their study, no imaging was performed postoperatively, which made it impossible to interpret the healing results. Rhee et al,⁴³ in a retrospective study, compared a group of 47 patients over 70 years of age who had undergone RC repair with a group of 191 patients considered young between 60 and 69 years of age. Both groups showed a significant improvement in clinical outcomes after RC repair; the Constant Score was significantly improved, with a gain of +17.6 points in the elderly group vs. +19.1 points in the younger subjects. The mean visual analog scale score was significantly improved, with a regression of 4.4 points in elderly patients vs. 4.6 points in those below 70 years

old. However, they found a healing rate of around 48.9% in elderly patients vs. 60.2% in younger patients, with no significant difference between the 2 groups. Healing was assessed by a follow-up magnetic resonance imaging 6 months after surgery according to Sugaya’s classification; tendons with a score ≤2 were considered healed. We included type 3 supraspinatus tendons among the healed, as their long-term clinical and healing evolution is different from that of type 4–5 tendons.³⁵ The Rhee et al⁴³ study also included open repairs, so these results were not specific to arthroscopic repair of the RC. Patients aged between 60 and 70 years were considered young, and no data were provided on comorbidities or preoperative analysis of tendon quality (retraction and fatty infiltration). Recently, Witney-Lagen et al,⁵² in a retrospective case–control study after arthroscopic RC repair, compared 60 shoulders of 59 patients aged over 75 years with 60 younger patients, adjusted for sex and lesion size. They found an improvement in the CMS of +25.1 point improvement in the elderly patients vs. +23.7 points in the controls, with no significant difference between the 2 groups. There was an improvement in the adjusted CMS of +36.2 points in elderly subjects vs. +30.4 in younger subjects, although this difference was not significant (P = .259). Pain improved by 7.5 out of 15 in elderly patients vs. 6.2 out of 15 in controls. The SSV was improved by +5.8 points out of 10 in elderly patients vs. +5.3 points out of 10 in controls, the difference between the 2 groups being nonsignificant (P = .165). In their study, 93% of elderly patients were satisfied vs. 86.7% of younger patients, with no significant difference. These results are similar to those found in our study. On the other hand, acromioplasty, tenotomy, or tenodesis were not reported; clearly, these types of cointervention can also influence results.²⁵ Furthermore, no information was provided on the preoperative quality of the RC tendon, yet atrophy of the infraspinatus tendon is a predictive factor of poor functional outcome^{23,26}; in our study, only the supraspinatus tendon was damaged. Finally, the state of tendon healing was not recorded, and failure was defined by dissatisfaction or revision by inverted total prosthesis. The functional failure rate was 11% in the elderly cohort and 7% in the younger control group. Gwark et al,¹⁹ in a retrospective study, compared the clinical and ultrasonographic results after arthroscopic repair of the RC in 53 patients over 70 years of age with a control group of 159 patients below 70 years, the 2

Table VII
Summary of principal findings in the literature.

| Study (author, y) - Clinical assessment | Type | Age (young/elderly) | N (young/elderly) | Elderly group | Young group | FU | P |
|---|---------------|---------------------|-------------------|---------------|-------------|-------|------|
| Our study | Retrospective | <50/>70 | 87/87 | | | 6M | |
| Gain total CMS | | | | +17.9 | +7.5 | | <.01 |
| Gain adjusted CMS | | | | +24.9 | +8.5 | | <.01 |
| Satisfaction | | | | 88.5% | 93.1 | | .31 |
| Gwark et al, 2018 ¹⁹ | Retrospective | <70/>70 | 159/53 | +33 | +34 | 12M | .62 |
| Gain adjusted CMS | | | | | | | |
| Moraiti et al, 2015 ³⁴ | Prospective | <50/>70 | 40/40 | | | 6M | |
| Gain total CMS | | | | +25.8 | +26.2 | | NS |
| Gain adjusted CMS | | | | +32.5 | +23.9 | | <.05 |
| Rhee et al, 2013 ⁴³ | Retrospective | 60-70/>70 | 191/47 | +17.6 | +19.1 | 14.6M | <.01 |
| Gain total CMS | | | | | | | |
| Witney-Lagen et al, 2016 ⁵² | Prospective | <60/>70 | 60/60 | | | 28M | |
| Gain total CMS | | | | +25.1 | +23.7 | | NS |
| Gain adjusted CMS | | | | +36.2 | +30.4 | | NS |
| Satisfaction | | | | 93% | 86.7% | | NS |
| Osti et al, 2009 ⁴⁰ | Prospective | <65/>65 | 28/28 | | | 24M | |
| UCLA | | | | +21 | +21 | | NS |
| Satisfaction | | | | 96% | 96% | | NS |

CMS, Constant-Murley Score; SSV, subjective shoulder value; NS, not significant; FU, follow-up; UCLA, University of California, Los Angeles.

groups being matched on sex and type of preoperative lesion. Improvements in adjusted CMSs, joint amplitudes, and pain were not significantly different between the 2 groups ($P = .37$). Healing rates did not differ between groups, with 66% of tendons healed in the elderly group vs. 68% in the control group ($P = .52$). These results differ from those found in our study, although Gwark et al¹⁹ defined “young” patients as those below 70 years of age. Although several studies have reported good clinical results after arthroscopic RC repair, it has been shown that the quality of tendon healing is negatively correlated with age.^{39,3} Our results are therefore in agreement with the literature. In our study, the healing rate in the cohort of subjects aged over 70 was 73.6%, compared with 88.5% of healed tendons in patients below 50 years old ($P = .01$). Boileau et al have shown that an isolated supraspinatus rupture has a healing rate of up to 95% after repair in patients below 55 years of age, whereas this percentage drops to 43% in patients over 65 years old.³ Godenèche et al,¹⁶ in a retrospective study, assessed 249 patients 10 years after arthroscopic repair of isolated supraspinatus tendon rupture associated with tenotomy or tenodesis. In their study, if biceps delamination was observed intraoperatively, patients with associated tenodesis had better results in function and strength than with tenotomy. In our study, the association of tenotomy of the long head of the long biceps was different between the 2 groups, which may introduce a bias.^{33,37,50}

Comparison of the influence of healing on clinical results with the literature

Few studies have reported a correlation between healing and functional outcome after RC repair.^{3,9,11} The study by Bagheri et al, on isolated supraspinatus tendon ruptures, found a significant improvement in the CMS whether the tendons were healed or not, but results were better in the case of healing.¹ For Djhangiri et al, isolated repairs of the supraspinatus tendon in patients over 65 years of age have a high healing potential and give good clinical results; these results were better if the tendons were healed.¹⁰ In contrast, the impact of tendon integrity on clinical and satisfaction scores is disputed.^{13,20,30,32,45} In our study, improvement in functional scores was not influenced by tendon healing. Our results are in agreement with the study by Lafosse et al²⁷ who, in a prospective series, found no correlation between these parameters. Liu and Baker also demonstrated that repair integrity did not influence functional outcome.²⁹ Collin et al,⁵ in a prospective study of 365 patients undergoing arthroscopic RC repair, found no link between

CMSs and healing after 6-month ultrasound follow-up. Recently, Nabergoj and al,³⁶ in a prospective multicenter study, followed 188 patients who had healed after arthroscopic repair of an isolated supraspinatus tendon rupture. As in our study, healing was defined by a Sugaya ultrasound score ≤ 3 at 6 months. No correlation was found on postoperative CMS regarding age, preoperative CMS, and fatty infiltration. The only factor negatively influencing final clinical outcome was female gender ($P = .001$). Our data are in line with previous studies and confirm that lack of healing does not necessarily lead to clinical failure.

Limitations

The main limitation of our study is the possibility that factors we did not investigate may affect the results. We attempted to minimize this risk by matching patients according to gender, BMI, smoking habits, tendon retraction in the frontal plane according to Patte and fatty infiltration according to Goutallier. The prevalence of comorbidities influencing tendon healing,³¹ such as diabetes, arterial hypertension, and dyslipidemia, is greater in the elderly population, which may have impact on group comparability. Healing was assessed by ultrasound, an operator-dependent examination, and not by the same radiologist; this can induce a bias in the interpretation of healing. Follow-up was limited to 6 months, which prevented us from predicting the future of these repairs and the durability of results; however, a minimum follow-up of 6 months has been shown to be appropriate to assess tendon healing.²²

Advantages

To our knowledge, this is the first retrospective study of arthroscopic supraspinatus repair to match preoperative tendon quality, directly comparing patients aged over 70 with a younger group. The strengths of this study lie in the fact that it was a retrospective study, involving a larger population than those found in the literature. The 2 populations were matched on musculo-tendinous status and comorbidities. All repairs were performed by a single operator, and the same rehabilitation program was applied to all patients.

Conclusion

Clinical and functional improvement after arthroscopic repair of an isolated supraspinatus lesion in patients over 70 years of age is

better than in patients under 50, despite poorer tendon healing. Satisfaction was comparable in both groups. These results allow us to validate the interest of this procedure after 70 years.

A larger population, longer-term follow-up and matching of associated procedures such as tenotomy will enable us to reinforce this indication by clarifying the clinical and anatomical evolution of these degenerative cuff repairs over time.

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References

1. Bagheri N, Bonnevalle N, Gallinet D, Barth J, Labattut L, Metais P, et al. Prospective study of tendon healing and functional gain after arthroscopic repair of isolated supraspinatus tear. *Orthop Traumatol Surg Res* 2020;106:S201-6. <https://doi.org/10.1016/j.otsr.2020.08.007>.
2. Barth J, Fotiadis E, Barthelemy R, Genna S, Saffarini M. Ultrasonic evaluation of the repair integrity can predict functional outcomes after arthroscopic double-row rotator cuff repair. *Knee Surg Sports Traumatol Arthrosc* 2015;23:376-85. <https://doi.org/10.1007/s00167-015-3505-z>.
3. Boileau P. Arthroscopic repair of full-thickness tears of the supraspinatus: does the tendon really heal? *J Bone Joint Surg Am* 2005;87:1229-40. <https://doi.org/10.2106/JBJS.D.02035>.
4. Brewer BJ. Aging of the rotator cuff. *Am J Sports Med* 1979;7:102-10.
5. Collin P, Abdullah A, Kherad O, Gain S, Denard PJ, Lädermann A. Prospective evaluation of clinical and radiologic factors predicting return to activity within 6 months after arthroscopic rotator cuff repair. *J Shoulder Elbow Surg* 2015;24:439-45. <https://doi.org/10.1016/j.jse.2014.08.014>.
6. Collin P, Yoshida M, Delarue A, Lucas C, Jossaume T, Lädermann A, et al. Evaluating postoperative rotator cuff healing: prospective comparison of MRI and ultrasound. *Orthop Traumatol Surg Res* 2015;101:S265-8. <https://doi.org/10.1016/j.otsr.2015.06.006>.
7. Constant CR, Gerber C, Emery RJH, Søjbjerg JO, Gohlke F, Boileau P. A review of the constant score: modifications and guidelines for its use. *J Shoulder Elbow Surg* 2008;17:355-61. <https://doi.org/10.1016/j.jse.2007.06.022>.
8. Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. *Clin Orthop Relat Res* 1987;160-4.
9. Dezaly C, Sirveaux F, Philippe R, Wein-Remy F, Sedaghatian J, Roche O, et al. Arthroscopic treatment of rotator cuff tear in the over-60s: repair is preferable to isolated acromioplasty-tenotomy in the short term. *Orthop Traumatol Surg Res* 2011;97:S125-30. <https://doi.org/10.1016/j.otsr.2011.06.006>.
10. Djanghiri A, Cozzolino A, Zanetti M, Helmy N, Rufibach K, Jost B, et al. Outcome of single-tendon rotator cuff repair in patients aged older than 65 years. *J Shoulder Elbow Surg* 2013;22:45-51. <https://doi.org/10.1016/j.jse.2012.03.012>.
11. Flurin PH, Hardy P, Abadie P, Boileau P, Collin P, Deranlot J, et al. Arthroscopic repair of the rotator cuff: prospective study of tendon healing after 70 years of age in 145 patients -. *Orthop Traumatol Surg Res* 2013;99:S379-84. <https://doi.org/10.1016/j.otsr.2013.10.007>.
12. Fuchs B, Weishaupt D, Zanetti M, Hodler J, Gerber C. Fatty degeneration of the muscles of the rotator cuff: assessment by computed tomography versus magnetic resonance imaging. *J Shoulder Elbow Surg* 1999;8:599-605.
13. Galanopoulos I, Ilias A, Karliafis K, Papadopoulos D, Ashwood N. The impact of Re-tear on the clinical outcome after rotator cuff repair using open or arthroscopic techniques - a systematic review. *Open Orthop J* 2017;11:95-107. <https://doi.org/10.2174/1874325001711010095>.
14. Gilbert MK, Gerber C. Comparison of the subjective shoulder value and the constant score. *J Shoulder Elbow Surg* 2007;16:717-21. <https://doi.org/10.1016/j.jse.2007.02.123>.
15. Godenèche A, Elia F, Kempf J-F, Nich C, Berhouet J, Saffarini M, et al. Fatty infiltration of stage 1 or higher significantly compromises long-term healing of supraspinatus repairs. *J Shoulder Elbow Surg* 2017;26:1818-25. <https://doi.org/10.1016/j.jse.2017.03.02>.
16. Godenèche A, Kempf JF, Nové-Josserand L, Michelet A, Saffarini M, Hannink G, et al. Tenodesis renders better results than tenotomy in repairs of isolated supraspinatus tears with pathologic biceps. *J Shoulder Elbow Surg* 2018;27:1939-45. <https://doi.org/10.1016/j.jse.2018.03.030>.
17. Goutallier D, Postel JM, Bernageau J, Lavau L, Voisin MC. Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan. *Clin Orthop Relat Res* 1994;78-83.
18. Grondel RJ, Savoie FH, Field LD. Rotator cuff repairs in patients 62 years of age or older. *J Shoulder Elbow Surg* 2001;10:97-9.
19. Gwark JY, Sung CM, Na JB, Park HB. Outcomes of arthroscopic rotator cuff repair in patients who are 70 years of age or older versus under 70 Years of age: a sex- and tear size-matched case-control study. *Arthroscopy* 2018;34:2045-53. <https://doi.org/10.1016/j.arthro.2018.02.047>.
20. Hanusch BC, Goodchild L, Finn P, Rangan A. Large and massive tears of the rotator cuff: functional outcome and integrity of the repair after a mini-open procedure. *J Bone Joint Surg Br* 2009;91:201-5. <https://doi.org/10.1302/0301-620X.91B2.21286>.
21. Horiuchi S, Nozaki T, Tasaki A, Yamakawa A, Kaneko Y, Hara T, et al. Reliability of MR quantification of rotator cuff muscle fatty degeneration using a 2-point Dixon technique in comparison with the goutallier classification: validation study by multiple readers. *Acad Radiol* 2017;24:1343-51. <https://doi.org/10.1016/j.acra.2017.03.026>.
22. Iannotti JP, Deutsch A, Green A, Rudicel S, Christensen J, Marraffino S, et al. Time to failure after rotator cuff repair: a prospective imaging study. *J Bone Joint Surg Am* 2013;95:965-71. <https://doi.org/10.2106/JBJS.L.00708>.
23. Jennesen KK, Lundgreen K, Madsen JE, Kvakestad R, Dimmen S. Prognostic factors for functional outcome after rotator cuff repair: a prospective cohort study with 2-year follow-up. *Am J Sports Med* 2018;46:3463-70. <https://doi.org/10.1177/0363546518803333>.
24. Jung HJ, Sim GB, Bae KH, Kekatpure AL, Chun JM, Jeon IH. Rotator cuff surgery in patients older than 75 years with large and massive tears. *J Shoulder Elbow Surg* 2017;26:265-72. <https://doi.org/10.1016/j.jse.2016.07.004>.
25. Kooistra BW, Hekman KMC, Van den Bekerom MPJ. Letter to the Editor: the debate of rotator cuff surgery in the elderly is going on! *J Shoulder Elbow Surg* 2019;28:e245-6. <https://doi.org/10.1016/j.jse.2019.03.023>.
26. Kwon J, Kim SH, Lee YH, Kim TI, Oh JH. The rotator cuff healing index: a new scoring system to predict rotator cuff healing after surgical repair -. *Am J Sports Med* 2019;47:173-80. <https://doi.org/10.1177/0363546518810763>.
27. Lafosse L, Jost B, Reiland Y, Audebert S, Toussaint B, Gobeze R. Structural integrity and clinical outcomes after arthroscopic repair of isolated subscapularis tears. *J Bone Joint Surg Am* 2007;89:1184-93. <https://doi.org/10.2106/JBJS.F.00007>.
28. Liotard J-P. Rééducation d'une épaule douloureuse : comment faire simple. *Revue du Rhumatisme Monographies* 2010;77:239-45. <https://doi.org/10.1016/j.monrhu.2010.04.007>.
29. Liu SH, Baker CL. Arthroscopically assisted rotator cuff repair: correlation of functional results with integrity of the cuff. *Arthroscopy* 1994;10:54-60.
30. Makhni EC, Steinhaus ME, Morrow ZS, Jobin CM, Verma NN, Cole BJ, et al. Outcomes assessment in rotator cuff pathology: what are we measuring? *J Shoulder Elbow Surg* 2015;24:2008-15. <https://doi.org/10.1016/j.jse.2015.08.007>.
31. Mall NA, Tanaka Miho J, Choi LS, Paletta George A Jr. Factors affecting rotator cuff healing. *J Bone Joint Surg Am* 2014;96:778-88. <https://doi.org/10.2106/JBJS.M.00583>.
32. Mellado JM, Calmet J, Olona M, Ballabriga J, Camins a, Pérez del Palomar L, et al. MR assessment of the repaired rotator cuff: prevalence, size, location, and clinical relevance of tendon re-rupture. *Eur Radiol* 2006;16:2186-96. <https://doi.org/10.1007/s00330-006-0147-z>.
33. Meraner D, Sternberg C, Vega J, Hahne J, Kleine M, Leuzinger J. Arthroscopic tenodesis versus tenotomy of the long head of biceps tendon in simultaneous rotator cuff repair. *Arch Orthop Trauma Surg* 2016;136:101-6. <https://doi.org/10.1007/s00402-015-2343-2>.
34. Moraiti C, Valle P, Maqdes A, Boughebi O, Dib C, Giakas G, et al. Comparison of functional gains after arthroscopic rotator cuff repair in patients over 70 years of age versus patients under 50 years of age: a prospective multicenter study. *Arthroscopy* 2015;31:184-90. <https://doi.org/10.1016/j.arthro.2014.08.020>.
35. Muniandy M, Niglis L, Claude Dosch J, Meyer N, Kempf JF, Collin P. Post-operative rotator cuff integrity: can we consider type 3 Sugaya classification as re-tear? *J Shoulder Elbow Surg* 2021;30:97-103. <https://doi.org/10.1016/j.jse.2020.05.002>.
36. Nabergoj M, Bagheri N, Bonnevalle N, Gallinet D, Barth J, Labattut L, et al. Arthroscopic rotator cuff repair: is healing enough? - PubMed. *Orthop Traumatol Surg Res* 2021;107:103100. <https://doi.org/10.1016/j.otsr.2021.103100>.
37. Nho SJ, Brown BS, Lyman S, Adler RS, Altchek DW, MacGillivray JF. Prospective analysis of arthroscopic rotator cuff repair: prognostic factors affecting clinical and ultrasound outcome. *J Shoulder Elbow Surg* 2009;18:13-20. <https://doi.org/10.1016/j.jse.2008.05.045>.
38. Niglis L, Collin P, Dosch JC, N M, Kempf JF. Intra- and inter-observer agreement in MRI assessment of rotator cuff healing using the Sugaya classification 10years after surgery. *Orthop Traumatol Surg Res* 2017;103:835-9. <https://doi.org/10.1016/j.otsr.2017.06.006>.
39. Oh HJ, Hoon Kim S, Kang JY, Hee Oh C, Gong HS. Effect of age on functional and structural outcome after rotator cuff repair. *Am J Sports Med* 2010;38:672-8. <https://doi.org/10.1177/0363546509352460>.
40. Osti L, Papalia R, Del Buono A, Denaro V, Maffulli N. Comparison of arthroscopic rotator cuff repair in healthy patients over and under 65 years of age. *Knee*

- Surg Sports Traumatol Arthrosc 2010;18:1700-6. <https://doi.org/10.1007/s00167-010-1081-9>.
41. Patte D. Classification of rotator cuff lesions. *Clin Orthop Relat Res* 1990; 81-6.
 42. Plachel F, Siegert P, Rüttershoff K, Akgün D, Thiele K, Moroder P, et al. Clinical midterm results of arthroscopic rotator cuff repair in patients older than 75 years. *J Shoulder Elbow Surg* 2020;29:1815-20. <https://doi.org/10.1016/j.jse.2020.01.093>.
 43. Rhee YG, Cho NS, Yoo JH. Clinical outcome and repair integrity after rotator cuff repair in patients older than 70 years versus patients younger than 70 years. *Arthroscopy* 2014;30:546-54. <https://doi.org/10.1016/j.arthro.2014.02.006>.
 44. Romeo AA, Hang DW, Bach BR Jr, Shott S. Repair of full thickness rotator cuff tears. Gender, age, and other factors affecting outcome. *Clin Orthop Relat Res* 1999;243-55.
 45. Russell RD, Knight JR, Mulligan E, Khazzam MS. Structural integrity after rotator cuff repair does not correlate with patient function and pain: a meta-analysis. *J Bone Joint Surg Am* 2014;96:265-71. <https://doi.org/10.2106/JBJS.M.00265>.
 46. Samargandi R, Abduh W, Favard L, Le Du C, Collin P, Berhouet J. "Tomydesis" might be a reliable technique for lesions of the long head of the biceps tendon associated with rotator cuff tears: a minimum 6-month prospective clinical follow-up study. *Eur J Orthop Surg Traumatol* 2020;30:83-7. <https://doi.org/10.1007/s00590-019-02525-0>.
 47. Stone MA, Ho JC, Kane L, Lazarus M, Namdari S. Midterm outcomes of arthroscopic rotator cuff repair in patients aged 75 years and older. *J Shoulder Elbow Surg* 2020;29:S17-22. <https://doi.org/10.1016/j.jse.2019.11.022>.
 48. Sugaya H, Maeda K, Matsuki K, Moriishi J. Functional and structural outcome after arthroscopic full-thickness rotator cuff repair: single-row versus dual-row fixation. *Arthroscopy* 2005;21:1307-16. <https://doi.org/10.1016/j.arthro.2005.08.011>.
 49. Verma NN, Bhatia S, Baker CL, Cole BJ, Boniquit N, Nicholson GP, et al. Outcomes of arthroscopic rotator cuff repair in patients aged 70 years or older. *Arthroscopy* 2010;26:1273-80. <https://doi.org/10.1016/j.arthro.2010.01.031>.
 50. Walch G, Edwards TB, Boulahia A, Nové-Josserand L, Neyton L, Szabo I. Arthroscopic tenotomy of the long head of the biceps in the treatment of rotator cuff tears: clinical and radiographic results of 307 cases. *J Shoulder Elbow Surg* 2005;14:238-46. <https://doi.org/10.1016/j.jse.2004.07.008>.
 51. Weber S. Arthroscopic debridement and acromioplasty versus mini-open repair in the treatment of significant partial-thickness rotator cuff tears. *Arthroscopy* 1999;15:79-82.
 52. Witney-Lagen C, Mazis G, Bruguera J, Atoun E, Sforza G, Levy O. Do elderly patients gain as much benefit from arthroscopic rotator cuff repair as their younger peers? *J Shoulder Elbow Surg* 2019;28:1056-65. <https://doi.org/10.1016/j.jse.2018.10.010>.
 53. Worland RL, Arredondo J, Angles F, Lopez-Jimenez F. Repair of massive rotator cuff tears in patients older than 70 years. *J Shoulder Elbow Surg* 1999;8:26-30.