ROTATOR-CUFF CHANGES IN ASYMPTOMATIC ADULTS
THE EFFECT OF AGE, HAND DOMINANCE AND GENDER

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We studied the integrity of the rotator cuff in both
dominant and non-dominant shoulders of 90
asymptomatic adults between the ages of 30 and 99
years using ultrasound. The criteria for diagnosis had
been validated on unembalmed cadaver specimens.

We found no statistically significant difference in the
incidence of impingement findings between dominant
and non-dominant arms or between genders. The
prevalence of partial- or full-thickness tears increased
markedly after 50 years of age: these were present in
over 50% of dominant shoulders in the seventh decade
and in 80% of subjects over 80 years of age. Our results
indicate that rotator-cuff lesions are a natural correlate
of ageing, and are often present with no clinical
symptoms. Treatment should be based on clinical
findings and not on the results of imaging.

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Traumatic rupture of the rotator cuff was first described by
Smith (1834), and in 1924 Meyer published an attrition
theory of its aetiology. Neer (1983) emphasised the impor-
tance of impingement as a cause of rotator-cuff tears and
repetitive activity has been implicated as a cause in sports
medicine (Richardson, Jobe and Collins 1980) and in
industrial medicine (McDermott 1986).

Little is known about the epidemiology of rotator-cuff
problems, since conclusions based only on patients with
shoulder problems (DePalma, Gallery and Bennett 1949)
may be misleading. Cadaver dissections (Yamanaka et al
1983) may also represent a biased population and lack data
about history, hand dominance, and level of activity.

Ultrasound imaging of the rotator cuff has been used
since the mid-1980s (Crass et al 1984; Middleton et al
1986; Mack et al 1988). We have developed criteria for
ultrasound diagnosis based on studies using unembalmed
cadavers, and have subsequently studied a population who
had never been to a physician for shoulder complaints to
assess the incidence of rotator-cuff pathology.

MATERIALS AND METHODS
Ultrasound technique. Fourteen unembalmed human
shoulder specimens from subjects more than 50 years old
were examined by ultrasound using a Hitachi EUB 405 w/
L33s 7.5 to 5.0 MHz linear dual-frequency probe (American
Medical Systems, Livonia, Michigan). Anterior, lateral
and posterior views were studied in the neutral position
and an anterior view with the arm in internal rotation. The
specimens were mounted on a specially devised holder with
two Kirschner wires transfixing the spinous process of the
scapula to facilitate the ultrasound evaluation. The results
were recorded and the films used for documentation. A
lesion was then made arthroscopically in the rotator cuff,
using a meniscal knife, and the specimens re-examined. The
details of the lesion were not known to the radiologist
who determined the site and size of the arthroscopic lesion
from films taken for documentation. The shoulder specimen
was then dissected. The findings including bursal thickening,
bicipital tendonitis, rotator-cuff lesions (both arthro-
scopically induced and pre-existing), and changes in the
acromioclavicular and glenohumeral joints were noted.

On the basis of the findings we developed criteria for the
grading of impingement changes from ultrasound images.
These were:
Stage 1. Bursal thickness from 1.5 to 2.0 mm.
Stage 2. Bursal thickness over 2.0 mm.
Stage 3. Partial- or full-thickness tear of the rotator cuff.

Inhomogeneity of the ultrasound image of the rotator
cuff was not a reliable sign of tendon degeneration, but
partial-thickness tears as small as 4 mm could be visualised.

Subjects. We recruited volunteer subjects from the employ-
ees of the Henry Ford Hospital, patients referred to the
hospital for non-shoulder complaints, and subjects from a
senior citizens’ residence. Participants were chosen for inclusion in the study by an orthopaedic surgeon on the basis of age between 30 and 99 years, completely asymptomatic shoulders and no history of shoulder problems in the past severe enough to have required medical attention. All subjects gave informed consent.

For epidemiological purposes we took this sample to represent the general adult population who had never received medical attention for a shoulder problem. We recorded the age, gender and dominant hand for each subject as well as the current level of exertional activity with their arms. Both shoulders were examined by ultrasound in anterior, lateral and posterior views in the neutral arm position and in an anterior view with the arm in internal rotation. The results were recorded on a previously prepared computerised form and films were taken for documentation.

Statistical analysis. For statistical analysis we considered dominant and non-dominant arms separately. Chi-squared tests were used to assess the significance of associations between the presence of cuff disease in the dominant arm or non-dominant arm and gender, exertional activities, and age grouped into the fourth decade (30 to 39), the fifth decade (40 to 49) and the sixth decade or over (50 to 99). The association between the presence of cuff disease in the dominant and non-dominant arm was evaluated by McNe- mar’s test.

RESULTS

Of the 90 subjects, 47 were women and 43 were men; 77% were caucasian, 13% black, 9% asian and 1% hispanic. There were 18 subjects in each of the fourth, fifth and sixth decades of life, 13 in each of the seventh and eighth decades, and 10 between the ages of 80 and 99 years. The proportion of women to men was nearly equal for each decade.

We found no statistically significant difference between the prevalence of rotator-cuff lesions in each gender for either the dominant or non-dominant arm. The prevalence of stage-3 impingement according to dominant and non-dominant arm and decade of life is shown in Figure 1: there was a linear increase in prevalence after the fifth decade of life for both dominant and non-dominant arms. This difference was statistically very significant between the third and fourth decades and the fifth decade and above (dominant arm \( p = 0.00001 \); non-dominant arm \( p = 0.00001 \)). There was no statistically significant difference between the prevalence of stage-3 impingement in the dominant and non-dominant arms.

The prevalence of stages 1, 2 and 3 for each decade for the dominant arm is shown in Figure 2. Most of the lesions in the fourth and fifth decades were stage 1 or stage 2. All stage-3 lesions in the fourth and fifth decades were partial tears. In the sixth to tenth decades, 55% of stage-3 lesions were full-thickness tears, but there was no age-related increase during this time interval. We found no statistically significant differences in the incidence of rotator-cuff lesions related to gender or the reported level of exertional activities.

DISCUSSION

The modern imaging technique of ultrasound, which has no biological hazards, has facilitated epidemiological studies of soft-tissue lesions such as disc and meniscal disease. Real-time ultrasound provides a well-tolerated, convenient and cost-effective method of studying rotator-cuff disorders in the general population (Seltzer et al 1979; Crass et al 1984; Middleton et al 1986; Mack et al 1988).

Mack et al (1988) compared ultrasound evaluation with surgical and arthrographic findings, and found 95% accuracy when ultrasound was compared with surgical observation of full-thickness tears and a 91% correlation when it
was compared with arthrography. They also performed sonography on two cadavers and concluded that this technique failed to detect partial-thickness defects of any size and full-thickness defects of less than 1 cm. Since then the sensitivity of real-time ultrasound has improved and specific techniques have been developed. We established ultrasound criteria for staging rotator-cuff disorders according to the Neer classification of impingement syndromes, using 14 unembalmed cadaver shoulder specimens. We found that partial-thickness tears greater than 4 mm could reliably be detected, but that inhomogeneity of the rotator cuff was not a reliable indicator of degenerative changes.

Our subject population, between the ages of 30 and 99 years, had never sought medical advice for a shoulder problem and all were asymptomatic at the time of the ultrasound evaluation. Even so, subjects in the fourth and fifth decades of life showed a 5% to 11% prevalence of stage-3 impingement lesions, with a marked increase after this age, reaching 50% in the seventh decade and 80% prevalence in the ninth and tenth decades. All the stage-3 impingement lesions in the earlier decades were partial tears, but after the fifth decade 55% were full-thickness; the ratio of full- to partial-thickness rotator-cuff repairs was uniform for this interval.

Previous estimates of the prevalence of rotator-cuff lesions have been based on post-mortem and cadaver dissections, and none of these was related to the decade of life. Keyes (1933) examined 73 unselected dissecting-room cadavers and found full-thickness tears of the supraspinatus tendon in 13.4% of shoulders. No full-thickness tears were present below the age of 50 years; the incidence over 50 years was 31%. Keyes did not record partial-thickness tears. Wilson and Duff (1943) examined an unselected series of 74 bodies at post-mortem and 34 dissecting-room cadavers over the age of 30 years. They found full-thickness tears of the supraspinatus in 11% and partial-thickness tears in 10% of the shoulders. Fukuda, Mikasa and Yamanaka (1987) reported a 7% prevalence of complete tears and a 13% prevalence of incomplete tears in cadavers, but gave no age details. Our finding for the prevalence of full-thickness tears approximates to that reported by Keyes (1933).

We found no statistically significant relationship between either hand dominance or exertional shoulder activities and the incidence of impingement lesions. This is an important finding in relation to occupational rotator-cuff problems which have been attributed to repetitive motion injuries (McDermott 1986), but cannot be extrapolated to competitive athletes since there was none in the study population. We also found no gender difference in the prevalence of impingement lesions.

Our results indicate that rotator-cuff lesions may be regarded as a natural correlate of ageing, with a statistically significant linear increase after the fifth decade of life. All the lesions which we found were present without clinical symptoms. The high incidence of rotator-cuff lesions in the older asymptomatic population, means that in this age group the initial treatment of suspected rotator-cuff lesions should be based on clinical judgement; reliance should not be placed on MR, sonographic or arthrographic imaging of the rotator cuff.

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REFERENCES


