

THE INCIDENCE OF ROTATOR CUFF RUPTURE AN ANATOMIC STUDY

by J. JEROSCH, T. MÜLLER and W. H. M. CASTRO

To evaluate the incidence of rotator cuff ruptures, we examined 122 autopsy specimens of the shoulder and compared our results with those reported in the literature. The incidence of partial tears in our study was 28.7% ; the incidence of complete rupture was 30.3%. The frequency increased with age. We found no cuff rupture without supraspinatus tendon involvement. Very often, the cuff tear was bilateral. We do not share the opinion that the rupture of the rotator cuff is primarily an injury of men. We found a higher incidence in female than in male shoulders.

Keywords : shoulder joint ; rotator cuff rupture ; anatomic study.

Mots-clés : épaule ; rupture de la coiffe des rotateurs ; étude anatomique.

SAMENVATTING

*J. JEROSCH, T. MÜLLER en W. H. M. CASTRO.
De incidentie van de rotatorenmanchetruptuur. Een anatomische studie.*

Om de incidentie van rotatorenmanchetrupturen te bepalen, werden 122 schouderpreparaten onderzocht en de resultaten vergeleken met de resultaten uit de literatuur.

De incidentie van de partiële rupturen bedroeg in onze studie 28,7% ; de incidentie van de totaalrupturen 30,3%. De frequentie nam toe met de leeftijd. Een rotatorenmanchetruptuur zonder supraspinatuspeesafwijking werd niet gezien. Vaak was de ruptuur bilateraal. De mening, dat de ruptuur van de rotatorenmanchet primair een letsel bij mannen is, kunnen wij niet delen. Integendeel, de incidentie was hoger bij vrouwen dan bij mannen.

RÉSUMÉ

*J. JEROSCH, T. MÜLLER et W. H. M. CASTRO.
Incidence des ruptures de la coiffe des rotateurs.
Étude anatomique.*

Cent vingt-deux préparations anatomiques d'épaules furent examinées en vue de déterminer l'incidence des ruptures de la coiffe des rotateurs. Les données recueillies furent comparées aux données de la littérature.

Dans notre étude, l'incidence des ruptures partielles était de 28,7% ; l'incidence des ruptures complètes de 30,3%. La fréquence augmente avec l'âge. On n'observa pas de ruptures de la coiffe des rotateurs sans atteinte du tendon du sus-épineux. La rupture était souvent bilatérale. L'opinion que la rupture de la coiffe s'observe surtout chez l'homme ne fut pas confortée par cette étude. Bien au contraire, l'incidence des ruptures était plus élevée dans le sexe féminin.

INTRODUCTION

Many opinions about the pathogenesis, diagnosis and therapy of cuff ruptures have been expressed in the literature (1-10, 12-14, 15-20, 22-27). By contrast, only a few authors have reported on

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autopsies to confirm the frequency of this pathology (3, 5, 13, 20, 21, 24, 25). The results differed widely from one study to another, perhaps because they were obtained from dissimilar populations that varied in age distribution. Comparing studies was difficult because some authors did not include basic data, such as age. Regarding these discrepancies, it is not surprising that according to the literature, the frequency of rotator cuff ruptures in elderly people varies from 11% to 100%. The only correlation among the studies is that cuff ruptures are found more frequently in older than in younger people.

However, accurate knowledge of the frequency of this defect is indispensable for a discussion of its therapy. We therefore performed an anatomical study and compared our results with those we found in the literature.

MATERIAL AND METHODS

One hundred twenty-two shoulder joints of 62 cadavers, 21 men and 41 women, were dissected. The average age was 79 ± 7 years (mean \pm SD), ranging from 58 to 95 years (fig. 1). They came from the Department of Anatomy, Heinrich-Heine University of Düsseldorf. No information on lifestyle of the subjects, on the professional activities, on the history of shoulder complaints, or on the hand dominance of the studied subjects was available. We first separated the deltoid muscle from its origin. The subdeltoid bursa was then excised to obtain a free view of the rotator cuff. All dissections were performed exclusively by the authors with special care not to injure the rotator cuff artificially. The specimens were dissected after injection of fixation liquid ; therefore we were not able to identify associated bursitis. Ruptures were classified according to McLaughlin into five categories :

- A. Superficial rupture (no communication between joint and bursa)
- B. Pure transverse rupture
- C. Pure longitudinal splits
- D. Tears with retraction
- E. Massive avulsions of the cuff.

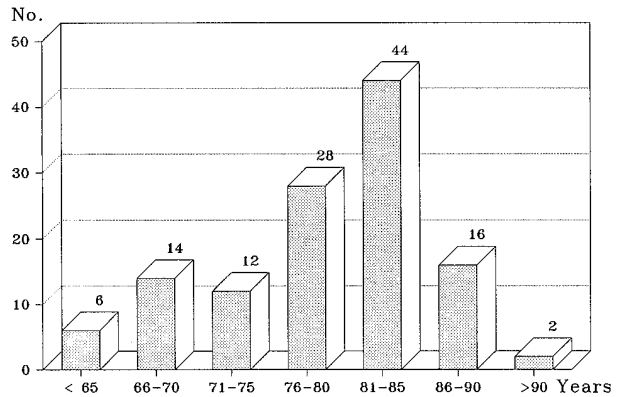


Fig. 1. — Age distribution of 122 shoulder specimens, which we dissected with special attention to the rotator cuff tendons.

Each specimen was photographed. The results were then evaluated statistically and the level of significance was determined by the chi-square test.

RESULTS

Ruptures of the rotator cuff were found in 72 of 122 rotator cuffs (59%). In 13 people, the ruptures were in the right shoulder, and in 11 the ruptures were on the left. In 24 people, rotator cuff ruptures were found in both shoulders (fig. 2). This difference in side distribution was not statistically significant.

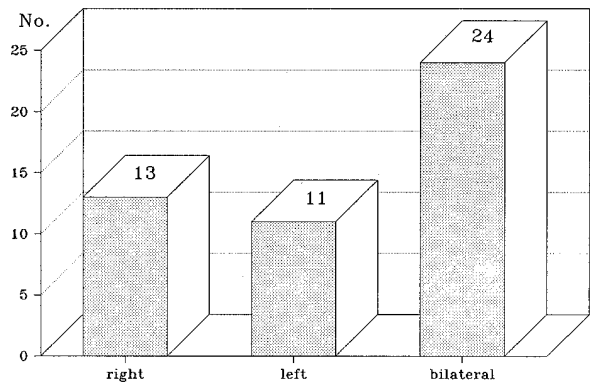


Fig. 2. — In an anatomic study of 122 shoulder specimens we found 72 rotator cuff ruptures. In 13 people, the ruptures were in the right shoulder, and in 11 the ruptures were on the left. In 24 people, rotator cuff ruptures were found in both shoulders. The difference in side distribution was not statistically significant.

Superficial rupture we found to be the most frequent type occurring in 35 joints (28.7%). The other 37 ruptures (30.3%) belonged in the four categories of complete tears, B-E. Among them were three pure transverse ruptures, 13 pure longitudinal splits, and 12 tears with retraction. Nine joints presented massive avulsions of the cuff. In these cases only remnants of the tendon fibers were found (fig. 3).

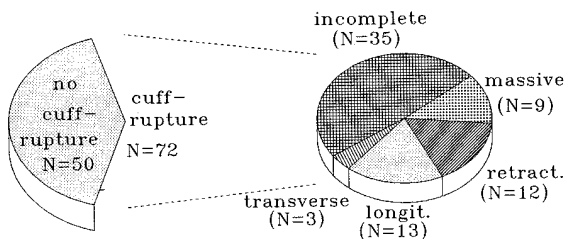


Fig. 3. — In an anatomic study of 122 shoulder specimens we found 72 rotator cuff ruptures. The most frequent type was a superficial rupture, which occurred in 35 joints. Among the complete ruptures there were 3 pure transverse ruptures, 12 tears with retraction, 13 longitudinal splits, and nine massive cuff tears.

In our series 18 of the 42 male joints (43.9%) were ruptured and 54 of the 82 female joints (66.7%) were ruptured. This difference was significant ($p < 0.05$, chi-square test).

All ruptures extended to some degree into the supraspinatus area. In 56 joints, only the tendon was affected. Two tears appeared in both the supraspinatus and infraspinatus tendons, five in the supraspinatus and subscapularis tendons. In nine cases with massive avulsions of the cuff, all three tendons were affected. The rupture rate increased with age. In 6 out of 30 specimens younger than 70 years we found a cuff rupture (30%). A rotator cuff rupture was found in 23 out of 40 specimens aged between 71 and 80 years (57.5%), and in 43 out of 62 among those specimens older than 80 years (69.4%). The difference between the specimens younger than 70 years and those older than 71 years is significant ($p < 0.05$ chi-square test). However, we found no significant difference between the specimens older than 80 years and those between 71 and 80 years (fig. 4).

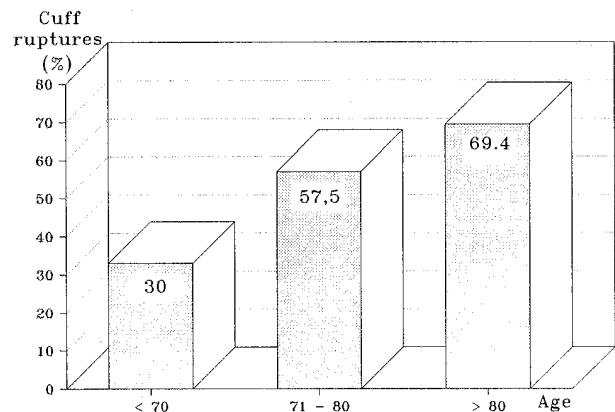


Fig. 4. — The incidence of rotator cuff rupture in 122 shoulder specimens increased with age. The incidence was 30% (6/20) in people younger than 70 years, 57% (23/40) in people between 71 and 80 years, and 69.4% (43/62) among those older than 80 years. The difference between the first two age groups is significant ($p < 0.05$, chi-square test), and not significant between groups two and three.

DISCUSSION

The results of this study correspond to the opinion expressed in the literature that the incidence of rotator cuff ruptures increases with age. In the population we studied we found ruptures in 30% (6/20) of people younger than 70, and in those between 71 and 80 years we found ruptures in 57.5% (23/40). This difference was significant. Among those over 80 years, we found ruptures in 69.4% (43/62). This latter increase was not significant. We believe that another significant increase is hardly possible; certainly the increase necessary to raise the incidence to 100%, as reported by Gschwend, is not possible.

We also found in this study that cuff ruptures occur with nearly equal frequency on either side. Therefore, this work did not support the opinion expressed in the literature that rotator cuff ruptures of the dominant extremity are more common (11, 17). Half of the rotator cuff ruptures we observed were in the left shoulder, while it is highly unlikely that half of the population we examined was left handed. Furthermore, 30% of the cuff ruptures we found were bilateral, indicating a predisposition to lesions in this region.

We found the incidence of cuff ruptures to be higher in woman than in men, a difference that was significant. Refior showed similar results (24), whereas Ludolph indicated that rotator cuff tears affect primarily men (11).

In the majority of cases, the cuff rupture was localized in the supraspinatus tendon, affecting this tendon alone in 78% of the cases. In the nine shoulders with massive avulsions of the rotator cuff, the subscapularis and the infraspinatus tendon were involved too. There were no cuff ruptures that did not involve a defect within the supraspinatus tendon.

Several causes for this dominance of the supraspinatus area were found. Rathburn and Macnab described an avascular zone in this tendon near its insertion (22). Neer found the subacromial impingement to be causative (18). One should not forget, however, that during abduction the supraspinatus tendon slides below the acromial arch and, more importantly, the acromioclavicular joint. At this point it can be irritated mechanically (20). We did not study the morphology of the acromion and can therefore not correlate different acromion morphology with the incidence of rotator cuff ruptures.

We now want to compare our results with those we found in the literature. Petersson reports on two different studies (20, 21), one comprising 99 shoulder joints with a mean age of 74 years (21). The frequency of incomplete ruptures was 18%, which is less than the 28.7% found in our study. In his second study of 170 shoulder joints with a mean age of 69 years, he found incomplete ruptures of the rotator cuff in 19% (20). The higher average age of our population was probably not the only factor that caused the difference in the incidence of ruptures. One should also be aware of the difficulty in defining an incomplete rupture in an anatomical specimen and in distinguishing it from an undamaged rotator cuff. This problem can certainly rather be solved in a slightly different manner.

Petersson reported frequencies of complete ruptures of 14% (1984) and 13% (1983), as compared to 30.3% in our study. The most likely explanation for this difference is the higher age of our population. Petersson also found that rotator cuff

ruptures only occur with involvement of the supraspinatus tendon and that the tears are often bilateral.

Refior performed autopsies of 195 shoulder joints from cadavers aged 2 to 85 years (24). He did not specify the mean age. He found ruptures in 11%. It is astonishing, however, that he only found one incomplete rupture. His material was very extensive and about two-third of the shoulders he examined were from cadavers older than 50 years. This surprising number points to the difficulty mentioned above in distinguishing between partly ruptured and still intact rotator cuffs in the pathology laboratory.

Refior also reported that the supraspinatus tendon is always involved and that the number of cuff tears increases with age. In about one-quarter of all cases with complete ruptures, Petersson observed massive avulsions of the cuff from its insertion at the humerus. In only a few shoulders the direction of the tear was purely transverse to the tendon fibers. These results also run parallel to those of our own study.

DePalma examined 96 cadaver shoulders aged 18 to 74 years, without mentioning the average age (3). He observed a gradual progression in the severity of the tears in each successive decade. The incidence of incomplete ruptures was 58.1%, which is much more than that in our study and the above mentioned studies revealed. He probably set the borderline very low between "physiologic" and "pathologic". The supraspinatus tendon was the area of the cuff in which he found the most ruptures, with the tears sometimes extending to the infraspinatus area. DePalma was the only examiner who found isolated ruptures of the subscapularis tendon in 20.8%. One must keep in mind that it is not easy to define exactly the different parts of the rotator cuff in elderly people, because there is a fusion of the tendon fibers. Therefore the exact extension of the tears must sometimes be defined at the examiner's discretion. DePalma saw complete perforations in 9.3% of his joints. This is less than in all mentioned studies. In this context it might be of interest to know the mean age of his material as a very young mean age could explain this low incidence of cuff ruptures.

In a study of a small number of shoulder joints Rothmann found rotator cuff tears in 60% (26). In the seventh decade, the incidence even reached 100%. As he did not differentiate between superficial and complete tears, comparing his results with ours is difficult. Another drawback of his study was the small sample size he examined (only 60 specimens).

Grammont performed examinations on an unknown number of shoulder joints (5), in which the incidence of cuff ruptures was about 33%. He did not differentiate between complete and partial tears, so it is almost impossible to compare these results with those of the other studies.

McLaughlin made a rather nonspecific statement concerning rotator cuff tears (13). In the joints he examined he reported finding degenerated or ruptured cuffs 25% of the time, but he did not describe them or give an age distribution. Therefore, it is impossible to compare these numbers with our results.

CONCLUSIONS

- The incidence of rotator cuff tears increases with age, while the incidence of complete cuff ruptures in elderly people is reported in the literature between 10 and 30%. We found complete tears in 30% of our population.
- The incidence of incomplete rotator cuff tears is reported in literature between 20 and 60%, compared to 28.7% in our study. The main problem is distinguishing between partially ruptured and intact tendons in autopsy specimens.
- The supraspinatus tendon is normally involved in the cuff rupture, and we did not see any ruptures of the rotator cuff without injury to the supraspinatus portion.
- There is no statistical evidence that rotator cuff tears occur more commonly in the right or left shoulder.
- Cuff ruptures are bilateral in many cases. A predisposition, either due to genetic or to damage cause in this region is possible.
- We found a higher incidence of cuff ruptures in woman than in men.

REFERENCES

1. BRUNNER U., HABERMEYER P., KRUEGER P., SACHS G., SCHWEIBERER L. Klinik und Klassifizierung der periartikulären Erkrankungen des Glenohumeralgelenkes. *Unfallchirurg.*, 1985, 88, 495-499.
2. COFIELD R. H. Current concepts review : rotator cuff disease of the shoulder. *J. Bone Joint Surg.*, 1985, 67-A, 974-979.
3. DEPALMA A. F. *Surgery of the shoulder*. J. B. Lippincott, Philadelphia, 1983, pp. 211-231.
4. ELLMANN H., HANKER G., BAYER M. Repair of the rotator cuff. *J. Bone Joint Surg.*, 1986, 68-A, 1136-1144.
5. GRAMMONT P. M., LELAURIN G. Die Scapula-Osteotomie und Acropole-Prothese. *Orthopäde*, 1981, 10, 219-229.
6. GRETENKORD K., MANN M. Rotatorenmanschettenrupturen — operative Behandlung und Ergebnisse. *Z. Orthop.*, 1984, 122, 213-216.
7. GSCHWEND N., ZIPPEL J., LIECHTI R., GRASS S. Die Therapie der Rotatorenmanschettenruptur an der Schulter. *Arch. Orthop. Unfall-Chir.*, 1975, 83, 129-143.
8. KESSEL L., WATSON W. The painful arc syndrome. *J. Bone Joint Surg.*, 1977, 59-B, 166-172.
9. KUJAT R. Das Impingementssyndrom der Schulter. *Unfallchirurg.*, 1986, 89, 409-417.
10. KUJAT R., WIPPERMANN B. W., GEBEL M. Scultersonographie bei Rotatorendefekten. *Unfallchirurg.*, 1986, 89, 398-401.
11. LUDOLPH E., ROESGEN M., WINTER H. Die Begutachtung der Rotatorenmanschettenruptur. *Akt. Traumatol.*, 1985, 15, 175-179.
12. MACNAB I. Die pathologische Grundlage der sogenannten Rotatorenmanschetten-Tendinitis. *Orthopäde*, 1981, 10, 191-195.
13. MCLAUGHLIN H. L. Rupture of the rotator cuff. *J. Bone Joint Surg.*, 1962, 44-A, 979-983.
14. MCLAUGHLIN H. L. Lesions of the musculotendinous cuff of the shoulder. *J. Bone Joint Surg.*, 1944, 26, 31-51.
15. MELZER C., KRÖDEL K., REFIOUR H. J. Der Wert der Arthrographie in der Diagnostik traumatischer und degenerativer Veränderungen der periartikulären Strukturen des Schultergelenkes. *Unfallchirurg.*, 1986, 89, 243-247.
16. MUDGE K., WOOD V. E., FRYKMAN G. K. Rotator cuff tear associated with os acromiale. *J. Bone Joint Surg.*, 1984, 66-A, 427-429.
17. MUNZINGER U., GSCHWEND N., SCHERER M., MEYER R. P. Unsere Erfahrungen mit der operativen Behandlung der Rotatorenmanschettenruptur. *Orthopäde*, 1981, 10, 230-237.
18. NEER C. S. Anterior acromioplasty for the chronic impingement of the shoulder. *J. Bone Joint Surg.*, 1972, 54-A, 41-50.

19. NEVIASER T. J., NEVIASER R. J., NEVIASER J. S., NEVIASER J. S. The four-in-one arthroplasty for the painful arc syndrome. *Clin. Orthop.*, 1982, 163, 107-112.
20. PETERSSON C. J., GENTZ C. F. Ruptures of the supraspinatus tendon. The significance of distally pointing acromioclavicular osteophytes. *Clin. Orthop.*, 1983, 174, 143-148.
21. PETERSSON C. J. Ruptures of the supraspinatus tendon. Cadaver dissection. *Acta Orthop. Scand.*, 1984, 55, 52-56.
22. RATHBURN J. B., MACNAB I. The microvascular pattern of the rotator cuff. *J. Bone Joint Surg.*, 1970, 52-B, 540-55.
23. REFIOR H. J., STÜRZ H. Rekonstruktive Techniken der Rotatorenmanschettenruptur. *Z. Orthop.*, 1984, 122, 27-30.
24. REFIOR H. J., KRÖDEL A., MELZER C. Examinations of the pathology of the rotator cuff. *Arch. Orthop. Trauma Surg.*, 1987, 106, 301-308.
25. REICHELT A. Die Rotatorenmanschettenruptur. *Z. Orthop.*, 1985, 123, 38-43.
26. ROTHMANN R. H., PARKE W. W. The vascular anatomy of the rotator cuff. *Clin. Orthop.*, 1956, 41, 176.
27. WEBER M., ROMPE G. Die Entstehung und Beurteilung der sogenannten Rotatorenmanschettenrupturen. *Z. Orthop.*, 1987, 125, 108-119.

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