



Epidemiology of scapular fractures

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The aim of the study has been to acquire basic epidemiological data based on a representative group of patients with scapular fractures treated in one centre.

The study analyses group of 250 patients. Diagnostics was based on CT examinations, in 227 cases with 3D reconstructions, in 97 cases compared with operative findings. Fractures were classified according to the modified anatomical classification of Tscherné and Christ. The analysed groups of patients include only the fracture lines whose existence has been verified by 3D CT reconstructions and intraoperative findings.

The most common fracture in the group was that of the scapular body (52%), followed by fractures of the glenoid fossa (29%), fractures of the processes (11%) and fractures of the scapular neck (8%). The most frequent associated injuries to the ipsilateral shoulder girdle were clavicular fractures (19%).

Scapular fractures occur primarily in men, predominantly in 4th – 6th decades (66 % patients). The group of women was significantly older as compared to men ($p = 0.017$). The group of patients with scapular neck fractures was significantly younger as compared to the age of patients with glenoid fracture ($p = 0.021$) and scapular body fracture ($p = 0.035$).

Keywords : scapular fractures ; CT diagnostics ; epidemiology.

INTRODUCTION

Epidemiological studies of fractures of individual bones, or their segments, have become an integral part of the orthopaedic literature. With regard to the shoulder girdle, these studies deal primarily with fractures of the proximal humerus and clavicle (5,12,13,15,20).

However, no detailed epidemiological study has yet been carried out dealing in detail with scapular fractures, despite the increasing attention being paid to these fractures in recent years (6). The sources of most statistical, or epidemiological,

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data come, with one exception (26), from studies that were published several decades ago, or from small unicentric, or multicentric, analyses (1,3,4,15-17,19,22,24,27). Incomplete data in individual studies and absence of analysis by fracture patterns did not allow a comprehensive comparison of individual groups of patients (2,3,15,17,23,26).

The aim of the present study has been to acquire basic epidemiological data based on a representative group of patients treated in one centre.

MATERIAL AND METHOD

Group of patients: The analysed consecutive group comprised 250 patients with acute scapular fractures admitted to the authors' Level I Trauma Centre during the six-year period between January 2008 and January 2014.

Evaluation: Patients were categorised in terms of age, gender, the injured side, type of fracture, associated injuries to the shoulder girdle and the method of treatment.

The whole group was further subdivided in terms of age into two groups, i.e. patients of 60 years of age or younger, and those over 60 years of age, in which the same data were analysed. The dividing age limit of 60 years was set on the basis of previous experience showing that it represents the general era of the initial manifestations of osteoporosis (9).

The examination procedure varied according to the patient's general condition. In 174 non-polytraumatized patients who were capable of being examined in the standing position, a complete series of radiographs was taken initially, i.e. AP view of the shoulder girdle, Neer I and Neer II views. In 76 high-energy injuries, the fracture was diagnosed on the basis of CT scans. CT examination was performed in all 250 patients, in combination with 3D CT reconstruction of the shoulder girdle in 227 cases: where indicated, subsequent subtraction of the humeral head, ribs and clavicle was undertaken (10). In 19 cases the fracture was classified using CT scans, including 2D reconstructions and intraoperative findings. In 4 patients, only radiographs and CT scans were available.

Fractures were classified according to a modified anatomical classification (9), which is based on classification of Tscherne and Christ (25). Our basic group of patients includes only the fracture lines whose existence has been verified by 3D CT reconstructions and intraoperative findings.

Scapular fractures were classified as fractures of the scapular body (Fig. 1), glenoid fossa (Fig. 2), processes (isolated fractures of coracoid process, acromion process, spine of scapula, superior border, superior angle) (Fig. 3) and scapular neck (Fig. 4) (8,9). Combined fractures were included in the groups of scapular body, glenoid or neck fractures according to the course of the main fracture line. Associated injuries to the shoulder girdle included fractures of the clavicle, acromioclavicular (AC) dislocation, glenohumeral (GH) dislocation and proximal humerus (PH) fractures.

Statistics: Statistical software SPSS Statistics 17.0 (Command Syntax Reference, Chicago, IL, USA) was used for data analysis. The Chi-square test of homogeneity, One-way ANOVA (Age, Decade),



Fig. 1. — Fracture of the scapular body, 3D CT reconstruction, posterior view

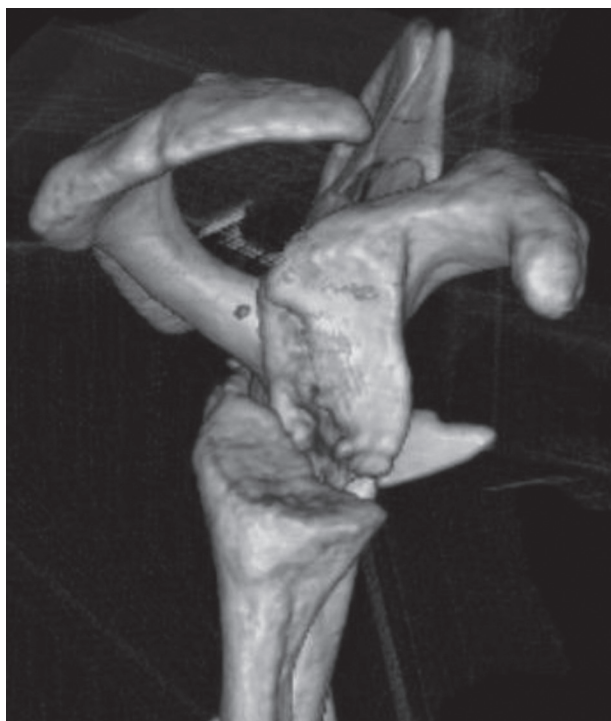


Fig. 2. — Fracture of the glenoid fossa - distal part, 3D CT reconstruction, lateral view

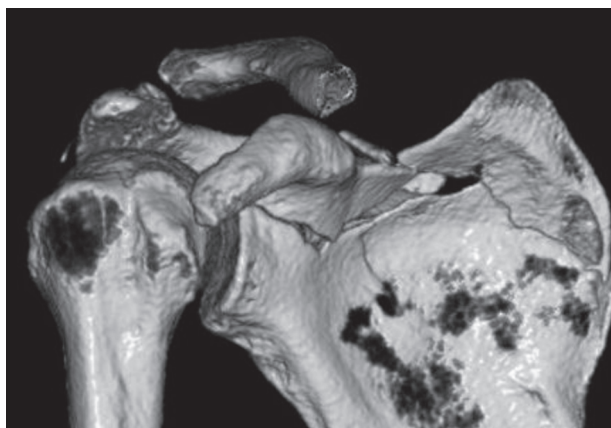


Fig. 3. — Fracture of the scapular processes (coracoid process, acromion process and superior angle), 3D CT reconstruction, anterior view

T-test and Kruskal-Wallis test were used to compare the proportions, means and medians between the groups. All reported p-values are two-side and $p < 0.05$ was considered as statistically significant. Throughout the text, data are expressed as mean (\pm standard deviation), or as median (range).

RESULTS

Age and gender: The study group comprised 199 men and 51 women. Their mean age was 45.3 years (range, 15-92); in men 43.5 years (range, 16-83), in women 52.4 years (range, 15-92). The group of women was significantly older compared to men ($p = 0.017$). The patients up to the age of 60 years totalled 204, while the total number of those older than 60 years was 46 (Table I). The injury involved the right side in 119 patients and the left side in 131 patients.

The male/female (M/F) ratio was 3.9/1 in the whole group. In the group up to the age of 60 years, the predominance of men was more significant, i.e. 5.2/1, compared to 1.6/1 in the group over the age of 60 years.

The biggest difference in the male/female ratio in the whole group was found in scapular body fractures, i.e. 5.2/1, and the smallest in the group of scapular neck fractures, i.e. 1.4/1, although the difference in gender was generally statistically insignificant ($p > 0.2$).

Age decades: The majority of patients in the whole group (66%) were in 4th, 5th and 6th decades. The same applies to men, while most women were in 6th or 7th decades (Fig. 5).

Fracture patterns: The fracture pattern was determined in 227 patients on the basis of 3D CT reconstructions and in 19 patients according to CT scans and intraoperative findings. The intraoperative findings in 61 patients corresponded exactly to preoperative 3D CT reconstructions. In 19 patients with CT scans without 3D CT reconstruction, the intraoperative findings corresponded in 12 cases exactly with preoperative classification, whereas in 7 patients the fracture anatomy slightly differed from the preoperative assessment.

The most common fracture in the group was that of the scapular body, namely in 131 cases (52%), followed by 73 fractures of the glenoid fossa (29%), 27 fractures of the processes (11%); the least frequent were fractures of the scapular neck, with only 19 cases (8%), (Table II).

Comparisons of the distribution of individual fracture patterns in the whole group and in the groups under and over the age of 60 were statistically insignificant, $p = 0.132$.

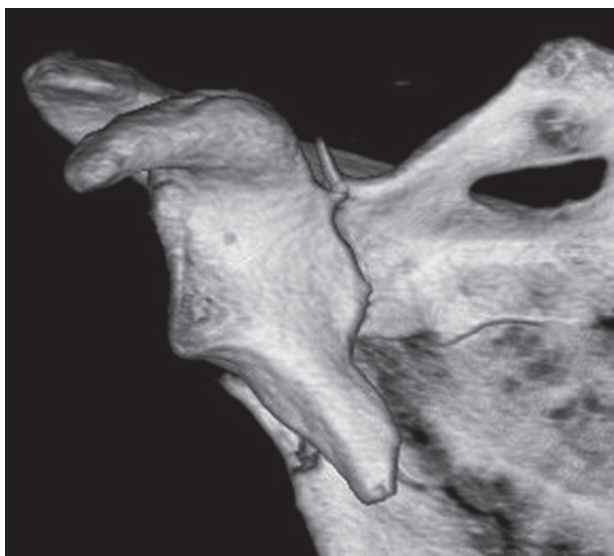


Fig. 4. — Fracture of the scapular (surgical) neck (fissure of the scapular body also visible), 3D CT reconstruction, anterior view

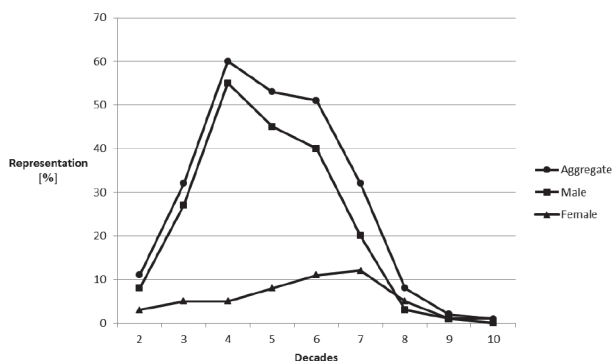


Fig. 5. — Analysis of the authors' groups of patients - gender and decades

The highest mean age of 46.7 years was recorded in fractures of the glenoid fossa, followed by 45.9 years in fractures of processes and 45.6 years in fractures of scapular body. The lowest mean age, i.e. 37.7 years, was found in fractures of the scapular neck. The group of patients with scapular neck fractures was significantly younger as compared to the age of patients with glenoid fracture ($p = 0.021$) and scapular body fracture ($p = 0.035$).

Associated injuries to the shoulder girdle: The most frequent associated injuries to the ipsilateral shoulder girdle were clavicular fractures, which were diagnosed in 47 (19%) of 250 patients. They occurred most often in combination with fractures

of the scapular body and neck, equally in 21% of cases (Table III).

Dislocation of the GH joint occurred in 9 cases (4%), fractures of the PH and AC dislocation in 8 cases (3%) each.

The mean age of 47 patients with an associated clavicular fracture was 41.1 years (range, 19-83). Of these 47 patients, 43 (91%) were in the group up to the age of 60 years and only 4 (9%) patients were older than 60 years. Clavicular fractures accounted for 23% (43 of 250) in the group up to the age of 60 years and only for 9% (4 of 46) in the group over the age of 60.

The mean age of 8 patients with an associated fracture of the PH was 56.4 years (range, 35-79). In the group up to the age of 60 years, a fracture of the PH was sustained by 4 (2%) out of 204 patients, in the group over the age of 60 years also by 4 patients (9%) out of 46 (Table III).

DISCUSSION

Analysis of literature has shown that there are not many recent studies dealing with epidemiology of scapular fractures. In addition, most of them evaluate only a small cohort and do not include all important data (9,11,14,17).

The advantage of our group is a sufficient number of patients, exact diagnosis of the fractures based on 3D CT reconstructions and intraoperative findings, including subdivision of the whole cohort into groups of patients under and over the age of 60.

Comparison of our group with the groups of other authors (1,3,4,15,16,19,22,14,26) has shown the following:

Number of patients and type of fractures analysed: Few groups comprised more than 100 patients (1,15,19,22) (Table IV). Some groups were selected on the basis of the type of fracture (15), or the method of treatment (3).

Diagnosis and classification: Almost all authors diagnosed the type of fracture on the basis of radiographs, with the exception of the group of Armitage et al. (3) in which 3D CT reconstruction was performed in all 90 patients, and the group of Tadros (22) in which it was performed in 99 of 107 fractures. Determination of individual types of fractures was questionable, as without 3D CT

Table I. — Group age and ratio M/F in authors' group of patients. (Pts-patients, M-male, F-female, y - years)

| Fracture types | Age all pts (y) | Age male (y) | Age female (y) | M/F all pts | M/F to 60 y | M/F over 60 y |
|----------------|-----------------|--------------|----------------|-------------|-------------|---------------|
| All types | 45.3 (15-92) | 43.5 (16-83) | 52.4 (15-92) | 3.9 / 1 | 5.2 / 1 | 1.6 / 1 |
| Body | 45.6 (15-75) | 44.6 (16-75) | 50.7 (15-73) | 5.2 / 1 | 6.1 / 1 | 3.0 / 1 |
| Glenoid fossa | 46.7 (18-92) | 44.7 (19-83) | 54.1 (18-92) | 3.3 / 1 | 4.8 / 1 | 1.1 / 1 |
| Processes | 45.9 (17-83) | 39.7 (17-65) | 60.5 (25-83) | 2.4 / 1 | 5.7 / 1 | 1 / 2.5 |
| Neck | 37.7 (19-56) | 34.6 (19-55) | 43.2 (26-56) | 1.4 / 1 | 1.4 / 1 | ... |

Table II. — Types of fractures in the authors' group of patients (Pts-patients, N-number, y – years)

| Fracture types | All pts N / % | Pts to 60 y N / % | Pts over 60 y N / % |
|----------------|------------------|----------------------|------------------------|
| All types | 250 / 100 % | 204 / 100 % | 46 / 100 % |
| Body | 131 / 52 % | 107 / 52 % | 24 / 52 % |
| Glenoid fossa | 73 / 29 % | 58 / 28 % | 15 / 33 % |
| Processes | 27 / 11 % | 20 / 10 % | 7 / 15 % |
| Neck | 19 / 8 % | 19 / 10 % | 0 / 0 % |

Table III. — Associated injuries of ipsilateral shoulder girdle in individual types of scapular fractures in authors' group of patients. (AC-acromioclavicular, GH-glenohumeral, PH-proximal humerus, fxs-fractures, N-number)

| Fracture types | Number of fxs | Clavicle fxs N / % | AC dislocation N / % | GH dislocation N / % | PH fxs N / % |
|----------------|---------------|-----------------------|-------------------------|-------------------------|-----------------|
| All types | 250 | 47 / 19 % | 7 / 3 % | 9 / 4 % | 8 / 3 % |
| Body | 131 | 28 / 21 % | 1 / 1 % | 3 / 2 % | 2 / 2 % |
| Glenoid fossa | 73 | 12 / 16 % | 4 / 5 % | 5 / 7 % | 3 / 4 % |
| Processes | 27 | 3 / 11 % | 2 / 7 % | 1 / 4 % | 3 / 11 % |
| Neck | 19 | 4 / 2 % | 0 / 0 % | 0 / 0 % | 0 / 0 % |

reconstructions it is in most cases impossible to define the exact fracture anatomy (10,18,23). In addition, certain types of fractures included in some classifications used by other authors, did not correspond to the reality. Therefore, we assessed in the analysis primarily the extra-/ intraarticular fracture ratio (Table IV).

None of the above-mentioned studies dealt primarily with the epidemiology of scapular fractures. The data from these studies, that we used, served only to characterise the group of patients. The only exception is the epidemiologic study published by Zhang (26), comprising 585 patients with 595 fractures. Unfortunately, this study stratifies patients only by age decades (men, women and the whole group), without specifying their mean age.

Male/ female ratio: Dominating the analysed groups were men, in a ratio ranging from 1.6/1 (15), or 2/1 (19), up to 15.6/1 (22). Most authors reported a ratio of 4/1 (1,3,16,17,24,26). In our group, the male/ female ratio was 3.9/1.

Mean age and age decades: The mean age in previously reported series ranged between 25.9 and 42.5 years (Table IV) (1,3,4,15,16,19,22,24,26). The mean age in our group was slightly higher, i.e. 45.3 years.

In the group of patients reported by Ideberg (15), the mean age of men was 15 years less than of women, while in our group the difference was only 9 years. In the Zhang's study, the share of men and women was almost the same in individual decades.

Division of patients by decades was published only by Zhang (26), who recorded the highest

Table IV. — Analysis of groups of patients from literature. * 100 glenoid fractures presented in text, ** including acromioclavicular dislocations. (Fxs-fractures, Pts-patients, Ass-associated, G-glenoid, B-body, N-neck, P-Processes)

| Author | N of fxs | Typ of group of pts | Radiodiagnostics | Average age (y) | Ass. clavicle fxs | Fracture types |
|----------------|------------|--|---------------------|-----------------|-------------------|--|
| Imanati 1975 | 52 | nonselected | Rtg | 27 | 23 % | G-4 %, B-19 %, N-66 %, P-4 %, Comb-7 % |
| McGahan 1980 | 121 | nonselected | Rtg | 35 | 26 % | G+P-31 %, B- 43 %, N-26 %, P-18 % |
| Armstrong 1984 | 62 | nonselected | Rtg | 43 | 39 % | G-9 %, B-55 %, N-18 %, P-18 % |
| Thompson 1985 | 56 | nonselected | Rtg | 33 | 27 % | G+N-34 %, B-54 %, P-12 % |
| Ada 1991 | 113 | nonselected 9 operated on pts | Rtg | 26 | 25 % | G-10 %, B-35 %, N-27 %, P-28 % |
| Ideberg 1995 | 338 / 100* | 338 fx s- nonselected 100 fxs-glenoid | Rtg | 56 | 43 %** | G-30%, Extraarticular fxs-70% |
| Tadros 2007 | 107 | nonselected | 99 3D CT, 8 Rtg | 35 | 21 % | non mentioned |
| Armitage 2009 | 90 | only operated on pts | 90 3D CT | 40 | - | G-17 %, B-61 %, N-22 % |
| Zhang 2012 | 595 | nonselected | Rtg | - | - | G-18 %, B-46 %, N-29 %, P-7 % |
| Authors 2014 | 250 | nonselected 39 % of operated on pts | 227 3D CT, 23 CT | 45 | 19 % | G-29 %, B-52 %, N-8 %, P-11 % |

numbers of patients, both men and women, in 4th decade. In our group, most men were also in 4th decade, but most women were in 6th and 7th decades (Fig. 6).

The male/ female ratio, mean age and distribution into decades might be influenced by a number of factors, such as selection of patients (fracture pattern, method of treatment), geographical factors, etc. Our group suggests that the higher share of women older than 60 years may be caused by osteoporosis. The same opinion is shared by Ideberg (15).

Share of individual types of fractures: As mentioned above, the exact determination of the type of fracture depends on 3D CT reconstructions, in addition to intraoperative findings, as well as on the classification scheme used (2,8,9,11,13,25,27). In the most frequently cited statistics (13,19,26), fractures of the scapular body accounted for 45%, of the scapular neck for 25%, of processes for 20% and of the glenoid for 10% of the total number of scapular fractures, which significantly differs from our data analysis. This may be explained by a lower number of patients (121) included in their

studies, together with diagnosis based merely on radiographs.

Therefore, in most of the groups based on radiographic examination alone, it was more beneficial to assess the extra-/ intraarticular fracture ratio. This ratio varies widely (1,4,16,19,24,26). In our group, the biggest share, i.e. 30%, was that of glenoid fractures. This may be explained by the fact that the patients referred to our department for specialised consultation most often had intraarticular, i.e. more severe, fractures. The same number of intraarticular fractures, i.e. 30%, was, however, recorded by Ideberg (15), who does not specify the type of treatment. Schandelmaier et al. (21) identified, in a total of 438 scapular fractures, 101 (23%) glenoid fractures, Armitage (3) reported, in a group of 90 surgically-treated patients, only 15 (17%) and Mc Gahan in 121 patients only 10% of intraarticular fractures (19).

Associated injuries to the shoulder girdle: Predominating in all studies were associated fractures of the clavicle (1,4,16,17,22). Their share ranged between 12-39%, when our 19% corresponded roughly to the average. Unlike our study, the other studies do not specify in detail the

incidence of fractures of the clavicle in individual types of scapular fractures (Table IV).

Frequency of AC dislocation was mentioned only by Armstrong (4), namely 6%, and Ada (1) 4%. In our group, AC dislocation occurred in 3% of patients.

Fractures anywhere in the humerus were reported by Armstrong (4) with the frequency of 11% and Tadros (22) 12%. We focused only on fractures of the PH which were diagnosed 3% of cases.

It is also interesting to assess the incidence of fractures of the clavicle and PH in patients under and over the age of 60 years. Our data indicate that the fractures of clavicle are typical of patients up to the age of 60 years, while PH fractures are more common in patients over the age of 60 years and are of osteoporotic nature (Table II). The incidence of fractures of the clavicle and of the PH may be influenced also by the mechanism of injury, which was not the subject matter of our detailed analysis.

GH dislocations and subluxations are not mentioned in the literature. We diagnosed them in association with all types of scapular fractures, except for scapular neck fractures. Most frequently, in 7%, they accompanied glenoid fractures. The correct number of dislocations and subluxations might not be diagnosed at the time of injury, due to subsequent spontaneous relocation.

CONCLUSION

Scapular fractures occur primarily in men, predominantly in 4th – 6th decades. After 60 years

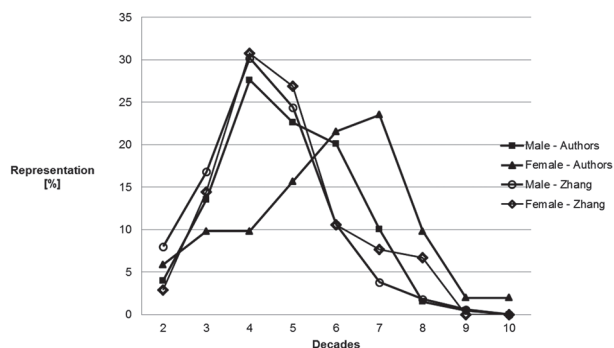


Fig. 6. — Comparison of gender in the authors' and Zhang's groups of patients

of age, there is an apparent increase in the share of women. The most common are fractures of the scapular body (52%), followed by glenoid fractures (29%). The least frequent are fractures of the scapular neck (8%), which are typical of patients up to the age of 60.

Acknowledgements

The study was prepared under the grant the IGA Ministry of Health, Czech Republic NT/14092: Diagnostics and operative treatment of displaced intraarticular fractures of the scapula.

The authors wish to thank Chris Colton, M.D., and Ludmila Běbarová for their assistance in the preparation of the manuscript.

Informed consent: Informed consent was obtained from all individual participants included in the study.

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