Fractures of the distal forearm in young adults

An epidemiologic description of 341 patients

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We describe the epidemiology of all distal radial fractures in young adults (men 20–59 years, women 20–49 years) in Lund (1992–95) and Malmö (1994–95), Sweden. During the study period, there were 341 patients with 346 fractures in the two cities, found through the Hospital Register of Diagnoses in Lund and the register of the Radiology Department in Malmö. More than half of the fractures were dislocated and 2/3 of the cases involved the radiocarpal or radioulnar joints, in contrast to the predominantly extra-articular fractures in the elderly. There was an even distribution between sexes and the fractures were mainly caused by a severe trauma, i.e., more than a simple fall, most often sports injuries in January, February and May. Our findings suggest that distal radial fractures in nonosteoporotic young adults should be regarded as a special entity, at least in epidemiological studies. Possibly they also require treatment differing from that for osteoporotic fractures.

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Although distal radial fractures account for about one sixth of all fractures seen in emergency rooms (Fernandez and Jupiter 1996), few studies have specifically dealt with this fracture in young adults (Knirk and Jupiter 1986, Kopylov et al. 1993) and no study has described the epidemiology in young adults. The epidemiological understanding of the distal radial fracture in general is based mainly on Scandinavian studies (Alffram and Bauer 1962, Frykman 1967, Falch 1983, Bengnér and Johnell 1985, Solgaard and Petersen1985, Schmalholz 1988, Robertsson et al. 1990, Hove et al. 1995), which have shown that the fractures are commoner in women, increase in incidence in both sexes with age, and are more often caused by falls on level ground than by high-energy trauma. All these criteria indicate that the distal radial fracture is most commonly an osteoporotic fracture in an elderly woman. In young adults, many chondral and ligamentous injuries associated with the fracture have been found by wrist arthroscopy, indicating a more complex injury pattern in these patients (Geissler et al. 1996, Lindau et al. 1997). We believe that the fracture in the young adult may be a different entity requiring special considerations regarding both diagnosis and treatment. We performed this study to describe fracture types, the severity of trauma, sex distribution, incidence, seasonal variations and methods of treatment in young adults.

Patients and methods

The inclusion criteria were distal radial fractures in men (20–59 years) and women (20–49 years) living in the city of Lund between 1992 and 1995 (population 95,000) or the city of Malmö between 1994–1995 (population 244,000). The different age-limits between sexes were due to commonly accepted age-limits for clinical osteoporosis, and the various study periods were chosen to obtain large enough groups to be representative of both cities.

Patients with a permanent address elsewhere were not included. Both cities have only one emergency hospital each for the catchment area. Complete data on the population could therefore be collected from the Hospital Register of Diagnoses in Lund and from the register of the Radiology Department in Malmö. All private units were contacted and they confirmed that fewer than 5 patients were treated in all these units together. The population figures for various age groups in the two cities were obtained from Statistics Sweden (Box 4413, SE-203 15 Malmö, Sweden) (Table 1). Medical records and radiographs of all patients were examined. In one case, the radiographs were missing, and consequently the fracture type could not be determined.

A distal radial fracture was defined as a fracture within 3 cm from the radiocarpal joint (Mallmin and

Table 1. The number of distal radial fractures in relation to age and sex in Lund (mean population 95,000) between 1992–1995 and in Malmö (mean population 244,000) between 1994–1995. The age-specific annual incidence per 10,000 inhabitants (95% confidence interval) has been calculated in various age groups

	Lund			Malmö		
Age	P	F	I	P	F	I
Men						
20–29	41	19	4.6 (3.0–6.0)	36	28	7.8 (6.1–8.9)
30–39	28	15	5.4 (3.4–7.1)	36	37	10 (7–12)
40–49	27	15	5.5 (3.5–7.3)	31	42	13 (10–15)
50–59	18	12	6.6 (4.1–8.5)	26	30	12 (8–14)
Women						
20–29	38	20	5.2 (3.6–6.8)	38	16	4.2 (2.6–5.7)
30–39	26	11	4.1 (2.3–5.9)	33	28	8.3 (6.6–9.3)
40–49	28	31	11 (8–13)	31	42	14 (10–16)

P population at risk in thousands during the study period.
F number of fractures during the study period.
I annual age-specific incidence per 10,000 inhabitants with 95% confidence interval in parentheses.

Ljunghall 1992). The trauma was defined as moderate (a fall from a standing position) or severe (Alffram and Bauer 1962, Mallmin and Ljunghall 1992). The radiographic analysis included the classifications of Frykman (1967) and AO (Müller et al. 1990). In the primary radiographs, we measured the dorsal and/or palmar angulation of the joint perpendicular to the axis of the proximal radius (Solgaard 1984, 1992) together with the radial length (Solgaard 1984, 1992) and the ulnar variance (Palmer et al. 1982, Schuind et al. 1992). The normal angle for palmar tilt is from 0° to palmar 22° (Friberg and Lundström 1976, Altissimi et al. 1986, Solgaard 1984, 1992, Mann et al. 1993, Metz and Gilula 1993) and therefore palmar angulation was defined as a palmar tilt that increased beyond palmar 22° or dorsal angulation if the joint surface was tilted dorsally over the zero level of the radius. Radial length less than 8 mm was considered pathological (normal radial length is 8–17 mm, Solgaard 1984, 1992). The ulnar variance was considered to be pathological if it was more than 2 mm (normal minus 4 mm to plus 2 mm, Palmer et al. 1982, Schuind et al. 1992).

Results

We found 346 distal radial fractures in 341 patients. 4 patients sustained bilateral fractures at the same time, and 1 patient sustained 2 fractures during the study period. In 36/341 patients (11%), the fracture was sustained in another city or country. The left hand was involved in 55% of the cases. The male/female ratio was 1.3/1 (Malmö 1.6/1; Lund 1/1, not significant). The median age of both men and women was 39 (the 90th percentile; men 24–55, women 24–49) years. The incidence for the entire study group was 7/10,000 (Table 1). Most fractures were sustained in January, February, May and June (Table 2). The mechanism of injury was a severe trauma (most often sports injuries) in 75% of the fractures (Table 3). 94% of the fractures in young men were caused by severe trauma, which was different from both older men ($p = 0.0001$) and women ($p = 0.0001$), (Table 4). Otherwise there was no difference in severity of trauma. Other concomitant injuries were found in 17% of the cases (in 5% as part of a multi-trauma), and these occurred 6 times oftener in men.

Initial dislocation was found in half of the fractures with a dorsal angulation of the radius in all cases but 6 (4 with radial dislocation only and 2 with a palmar angulation). According to Frykman's (1967) classifi-

Table 2. Seasonal variations in relation to severity of trauma

Month	Total n	Severe trauma n
January	36	32
February	41	39
March	23	20
April	22	17
May	38	30
June	35	21
July	27	21
August	25	18
September	26	11
October	19	15
November	29	18
December	26	20

Table 3. Type of trauma in relation to sex distribution

Type of trauma	Fractures	M/W ratio[a]
Fall from a height	57	2.8 (1.2–6.4)
Traffic accidents	48	1.7 (0.7–3.8)
Sports	127	1.5 (0.9–2.5)
Miscellaneous	7	1.3 (0.2–11.1)
Fall on stairs	23	1.1 (0.3–3.5)
Fall on level ground	84	0.7 (0.4–1.3)

[a] men / women ratio and 95% confidence interval

Table 4. Frequency of severe trauma in comparison with moderate trauma in relation to age and sex

Age	Men	Women
< 40	94%	69%
> 40	71%	61%

Table 5. Fracture distribution, according to Frykman's classification, in relation to sex and severity of trauma

Type	n	M/W ratio[a]	S/M ratio[b]
I	76	1.0 (0.5–1.9)	2.2 (1.1–4.4)
II	37	1.1 (0.4–2.6)	3.1 (1.1–9.0)
III	78	1.8 (0.9–3.4)	3.6 (1.7–7.7)
IV	34	2.8 (0.9–8.2)	7.5 (1.7–33)
V	34	0.4 (0.1–1.2)	1.8 (0.7–5.0)
VI	19	0.9 (0.2–3.2)	1.7 (0.5–6.4)
VII	17	1.8 (0.4–7.5)	7.0 (0.9–57)
VIII	50	2.6 (1.1–6.2)	4.0 (1.5-11)

I–VIII fracture types according to Frykman's classification.
n number of the specific fracture-type.
[a] Men / women ratio and 95% confidence interval
[b] Severe / moderate ratio and 95% confidence interval.

Table 6. Fracture distribution according to the AO classification in relation to sex and severity of trauma

Type	n	M/W ratio[a]	S/M ratio[b]
A2	118	0.9 (0.5–1.5)	2.2 (1.2–3.7)
A3	48	0.8 (0.3–1.7)	2.1 (0.9–5.1)
B1	54	3.1 (1.3–7.6)	3.9 (1.5–10)
B2	13	1.2 (0.2–5.4)	12 (0.7–215)
B3	11	2.7 (0.4–17)	10 (0.5–183)
C1	36	2.0 (0.7–5.3)	3.5 (1.1–11)
C2	34	1.0 (0.4–2.6)	5.6 (1.5–22)
C3	31	3.4 (1.0–11)	4.2 (1.2–15)

A2–C3 fracture types, according to the AO classification.
[a] and [b], see Table 5.

cation, the fracture involved the radiocarpal or distal radioulnar joints in two thirds of the cases (Table 5). The intra-articular fracture types III, IV and VIII were most often caused by a severe trauma, with a male predominance in the most severe type (Frykman VIII; Table 5). The AO classification (Müller et al. 1990) showed radiocarpal joint involvement (B1-C3) in half of the cases (Table 6). Chauffeur's type of fracture (B1) had a male predominance. Types B1 and C2 fractures were mostly caused by a severe trauma. The fractures were comminuted in the metaphyses in 72% of the cases. The ulnar styloid was fractured in 44% of the cases. In the initial radiographs, the median (90th percentile) dorsal angulation was 2° (palmar 12°–dorsal 32°), the radial length was 10 (6–13) mm and the ulnar variance was 0 (minus 2–plus 4) mm.

The primary treatment was a plaster cast in 89% (53% without reduction, 36% following closed reduction) and surgery 11% (7% open reduction and internal fixation and 4% with closed reduction and external fixation). Re-reduction was performed in 13% in the plaster-treated group; in half of these patients, external fixation was used as the new treatment. The median (90th percentile) duration of immobilization was 4 (3–6) weeks.

Discussion

We found that distal radial fractures in young adults were intra-articular in more than 2/3 of the cases, were dislocated in 50%, were mostly caused by a severe trauma (mainly sports injuries) and were evenly distributed between the sexes.

We find it remarkable that so many fractures in young adults involved the radiocarpal or the radioulnar joints. This contrasts with the fracture distribution in the elderly. Schmalholz (1988) described 33% intra-articular fractures in 1,536 patients of whom 83%

Table 7. Comparison between distal radial fractures in young adults in the present study and the epidemiologic study from Stockholm (1988) where 85% were elderly patients. Distribution according to Frykman's classification in percentages

Fracture type	Present study	Stockholm
I–II	31	67
III–IV	33	23
V–VI	16	5
VII–VIII	20	5

were elderly (Table 7). The predominance of extra-articular fractures in the elderly may be due to the fact that osteoporosis mostly affects cancellous bone, so that the metaphysis is weakened more and earlier than the subcartilagineous or cortical bone. Conversely, the better quality of metaphyseal bone in young patients increases the risk that subcartilagineous bone will yield to fracture. Intra-articular fractures may also have associated chondral or ligamentous injuries (Lindau et al. 1997). Another common fracture type at younger ages was Chauffeur's fracture of the radial styloid (type B1 in the AO classification) (Table 6), which is due to trauma to a radially deviated wrist. This was associated with severe trauma and occurred mainly in men and might therefore be analogous to a scaphoid fracture (Green 1993).

Most fractures were the result of a severe trauma, i.e., more than a simple fall on level ground, in contrast to the minor trauma that causes a fracture in the elderly (Alffram and Bauer 1962, Bengnér and Johnell 1985, Mallmin and Ljunghall 1992). Men of all ages often had a severe trauma as the cause of their fracture, especially those under 40 years of age (Table 4). These findings were not seen in the Malmö series reported by Bengnér and Johnell (1985), but they are in agreement with earlier observations in Malmö reported by Alffram and Bauer (1962). However, our

finding that severe trauma was also the main cause of fracture in younger women (Table 4) is contrary to findings in both Malmö reports (Alffram and Bauer 1962, Bengnér and Johnell 1985), whereas in women over 40 years, a somewhat lower percentage had had a severe trauma, which might reflect proximity to the menopause and beginning osteoporosis.

We found an equal sex distribution, unlike the female predominance in the osteoporotic age group (Schmalholz 1988) (Table 7). In the studies by Alffram and Bauer (1962) and Falch (1983), equal sex distribution was also found in the younger age groups. We found a male predominance in more severe trauma, which was most obvious in the lower age groups (Table 4), especially with falls from heights (Table 3) and with concomitant injuries, including multi-trauma. There was also a male predominance of Frykman type VIII fractures (Table 5) and Chauffeur's fractures. Thus, young men more often sustained a complicated intra-articular fracture.

The age-specific incidence in our study was much lower than that in osteoporotic women, which is reported to be 120 per 10,000 between 60 and 79 years of age (Bengnér and Johnell 1985). The Malmö study from 1953–57 (Alffram and Bauer 1962) showed a lower incidence in the younger age groups, compared to our study and the study from 1980–81 (Bengnér and Johnell 1985), and we therefore agree with Bengnér and Johnell (1985) that there appears to be an increase in the age-specific incidence in all age groups. The overall fracture incidence was higher in Malmö, which might reflect social differences between the large postindustrial city of Malmö and the academic town of Lund.

The high incidence in January and February corresponds to the seasonal distribution in the elderly (Schmalholz 1988), but the causes were different. In young adults, the fractures were often due to winter sport activities, while the elderly broke their wrists in falls on snow and ice (Falch 1983, Schmalholz 1988, Robertsson et al 1990, Mallmin and Ljunghall 1992, Hove et al. 1995).

In our patients, almost half of the fractures required primary reduction, and of these almost 1/4 were operated on. The reduction rate was like that in the osteoporotic group described by Schmalholz (1988), where half were treated with primary reduction. Although no information about the need for surgical procedures was given in his material, some of these patients were probably treated with—e.g., external fixation. It is therefore interesting to note that the treatment tradition seems to be independent of patient age. The treatment options ought to be quite different, since a normal bone stock allows most osteosynthesis materials to fixate the fracture fragments, whereas in osteoporotic bone, even the fixation pins for an external fixator may lose their grip. The incapacity of osteoporotic bone was reflected by the greater need for re-reduction seen in Schmalholz's (1988) material, as compared to ours (Table 7), which probably was due to osteoporotic comminution in the metaphysis of the radius.

The quality of an epidemiological study depends on the completeness and amount of collected data. By extending the study period in Lund, we increased the amount of data and acquired enough material to compare the cities. According to interviews with the private units, hardly any fractures may be missing, and we therefore doubt that this could affect our conclusions.

Bengnér and Johnell (1985) stated that "the challenge in fracture treatment during the 1980s and probably the 1990s will continue to be elderly women". We agree regarding quantity. However, we have shown that the distal radial fracture in young adults is usually an intra-articular fracture, caused by a severe trauma. In many cases, it is complicated by associated chondral and ligamentous injuries (Geissler et al. 1996, Lindau et al. 1997). Because of longer life expectancy, younger patients are more likely to develop and suffer from secondary arthrosis caused by an inadequately treated intra-articular fracture (Knirk and Jupiter 1986). They also make higher demands on wrist function in work and leisure activities. Hence, we suggest that distal radial fractures in young adults constitute a different entity from the osteoporotic fracture, with different demands regarding diagnosis and treatment.

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Alffram P-A, Bauer G C H. Epidemiology of fractures of the forearm. A biomechanical investigation of bone strength. J Bone Joint Surg (Am) 1962; 44 (1): 105-14.

Altissimi M, Antenucci R, Fiacca C, Mancini G B. Long-term results of conservative treatment of fractures of the distal radius. Clin Orthop 1986; 206: 202-10.

Bengnér U, Johnell O. Increasing incidence of forearm fractures. A comparison of epidemiologic patterns 25 years apart. Acta Orthop Scand 1985; 56 (2): 158-60.

Falch J A. Epidemiology of fractures of the distal forearm in Oslo, Norway. Acta Orthop Scand 1983; 54 (2): 291-5.

Fernandez D L, Jupiter J B. Epidemiology. In: Fractures of the distal radius. A practical approach to management. Springer-Verlag, New York Inc. 1996: 24-5.

Friberg S, Lundström B. Radiographic measurements of the radio-carpal joint in normal adults. Acta Radiol Diag 1976; 17: 249-56.

Frykman G. Fracture of the distal radius including sequelae, shoulder-hand- finger syndrome, disturbance in the distal radio-ulnar joint and impairment of nerve function. Acta Orthop Scand (Suppl 108) 1967: 38.

Geissler W B, Freeland A E, Savoie F H, McIntyre L W, Whipple T L. Intracarpal soft tissue lesions associated with an intra-articular fracture of the distal end of the radius. J Bone Joint Surg (Am) 1996; 78, 357-65.

Green D P. Operative hand surgery. Third edition. Churchill Livingstone 1993: 800.

Hove L M, Fjeldsgaard K, Reitan R, Skjeie R, Sörensen F K. Fractures of the distal radius in a Norwegian city. Scand J Plast Reconstr Hand Surg 1995; 29: 263-7.

Knirk J L, Jupiter J B. Intra-articular fractures of the distal end of the radius in young adults. J Bone Joint Surg (Am) 1986; 68: 647-59.

Kopylov P, Johnell O, Redlundh-Johnell, Bengnér U. Fractures of the distal end of the radius in young adults: a 30-year follow-up. J Hand Surg 1993; 18B: 45-9.

Lindau T R, Arner M, Hagberg L. Intra-articular lesions in distal radius fractures in young adults: A descriptive, arthroscopic study in 50 patients. J Hand Surg (Br) 1997; 22 (5): 638-43.

Mallmin H, Ljunghall S. Incidence of Colles' fracture in Uppsala. A prospective study of a quarter-million population. Acta Orthop Scand 1992; 63 (2): 213-5.

Mann F A, Raissdema S S, Wilson A J, Gilula L A. The influence of age and gender on radial height. J Hand Surg (Am) 1993; 1: 711-3.

Metz V M, Gilula L A. Imaging techniques for distal radius fractures and related injuries. Orthop Clin North Am 1993; 24: 217-28.

Müller M E, Nazarian S, Koch P and Schatzker J. The comprehensive classification of fractures of long bones. Springer Verlag, New York 1990: 106-15.

Palmer A K, Glisson R R, Werner F W. Ulnar variance determination. J Hand Surg 1982; 7 (4): 376-9.

Robertsson G O, Jonsson G T, Sigurdson K. Epidemiology of distal radius fractures in Iceland in 1985. Acta Orthop Scand 1990; 61: 457-9.

Schmalholz A. Epidemiology of distal radius fracture in Stockholm 1981-82. Acta Orthop Scand 1988; 59 (6): 701-3.

Schuind F A, Linscheid R L, An K N, Chao E Y S. A normal data base of posteroanterior roentgenographic measurements of the wrist. J Bone Joint Surg (Am) 1992; 74: 1418-29.

Solgaard S. Angle of inclination of the articular surface of the distal radius. Radiologe 1984; 24: 346-8.

Solgaard S. Distal radius fractures. Classification, function and recommendations to treatment. Thesis, Copenhagen University, Denmark 1992.

Solgaard S, Petersen V. Epidemiology of distal radius fractures. Acta Orthop Scand 1985; 56: 391-3.