The epidemiology of proximal humeral fractures

Charles M Court-Brown, Ashima Garg and Margaret M McQueen

Royal Infirmary of Edinburgh NHS Trust, Lauriston Place, Edinburgh EH3 9YW, U.K. E-mail: mmcqueen@ed.ac.uk
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ABSTRACT – We present a 5-year prospective study of the epidemiology of 1,027 proximal humeral fractures. These fractures, which tend to occur in fit elderly persons, have a unipolar age distribution and the highest age-specific incidence occurs in women between 80 and 89 years of age. The commonest was the B1.1 impacted valgus fracture, found in one-fifth of the cases in this series, a type that is not included in the Neer classification.

We used both Neer and AO classifications. The AO classification proved to be more comprehensive because in the Neer classification, half of the fractures are minimally displaced and almost nine-tenths fall into only three categories. In the AO classification, the B1.1, A2.2, A3.2 and A1.2 sub-groups comprise over half of all proximal humeral fractures, while the AO type C fractures occur in only 6%. We suggest that the literature does not adequately reflect the spectrum of proximal humeral fractures.

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Proximal humeral fractures are relatively common, as they represent about 4% of all fractures seen in the average orthopaedic clinic (Horak and Nilsson 1975). Nevertheless, little is known about their epidemiology. This is probably because most of them occur in the elderly and are treated on an outpatient basis. Most major trauma centres and specialist shoulder surgeons tend to review complex proximal humeral fractures or the complications of managing them. Thus the literature has focussed on the management and outcome of a relatively small number of less common fractures and has largely ignored the considerable number of apparently straightforward proximal humeral fractures that are frequently seen by orthopaedic surgeons. We are unaware of a previous study that has examined the epidemiology of all proximal humeral fractures in a population.

Patients and methods

In the 5-year period between June 1992 and May 1996, 1,027 consecutive adult proximal humeral fractures were prospectively reviewed by the Orthopaedic Trauma Unit of the Royal Infirmary of Edinburgh, all in-patients and out-patients being included in the study. This is the only hospital treating musculo-skeletal trauma in a population of 700,000 patients. All those with this type of fracture were followed up by the two senior authors at a research clinic. Information about the cause of injury, the presence of associated injuries and the patients' prefracture functional status was determined by direct questioning within 2 weeks of injury by an independent research physiotherapist who was blinded to the type of fracture.

Each fracture was classified according to the Neer (1970) and AO (Müller et al. 1990) classifications by a single experienced orthopaedic trauma surgeon (CCB) to prevent inter-observer error. Intra-observer error was not tested. The Neer classification system is based on the location and displacement of the fractures, the number of fracture fragments and the presence or absence of a dislocation (Figure 1). There are 16 possible categories, although in this study, we found it difficult to separate adequately categories 15 and 16, these being head-splitting fractures with anterior or posterior displacement of the head fragments. Thus, all head-splitting fractures have been combined in category 15. The AO classification is more com-

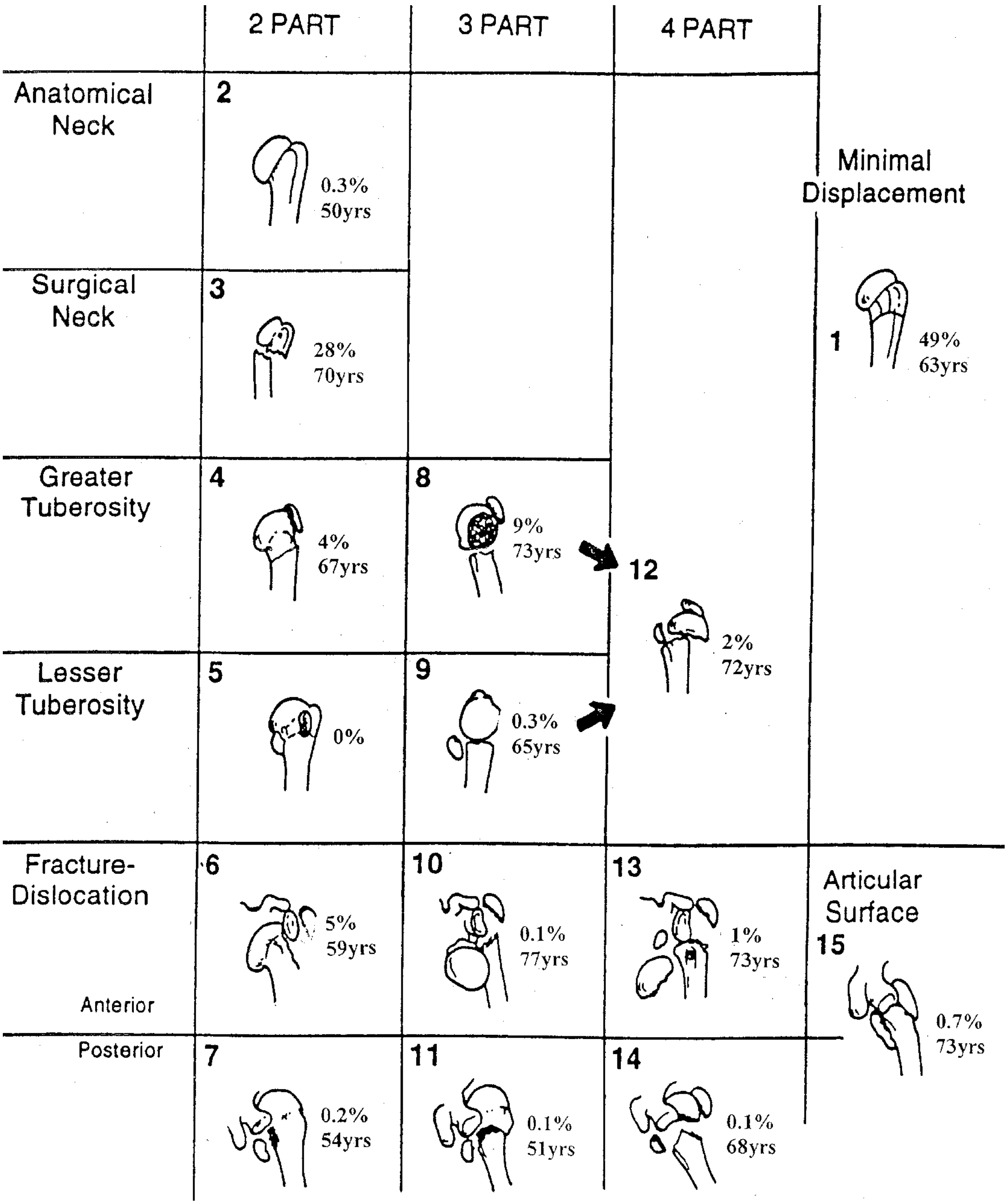

Figure 1. The Neer classification showing the incidence and average age in each category.

plex than the Neer classification and it is based on the location of the fractures, the presence of impaction, angulation, translation or comminution of the surgical neck and the presence or absence of a dislocation (Figure 2). Type A fractures are unifocal and involve the greater tuberosity or surgical neck. Type B fractures are bifocal, including some unusual fracture dislocations. Type C fractures contain all intra-articular anatomical neck fractures including dislocations and head-splitting fractures.

Radiographic assessment was undertaken at each examination, using antero-posterior and modified axial radiographs. The confidence intervals for the age- and sex-specific incidences were analysed,

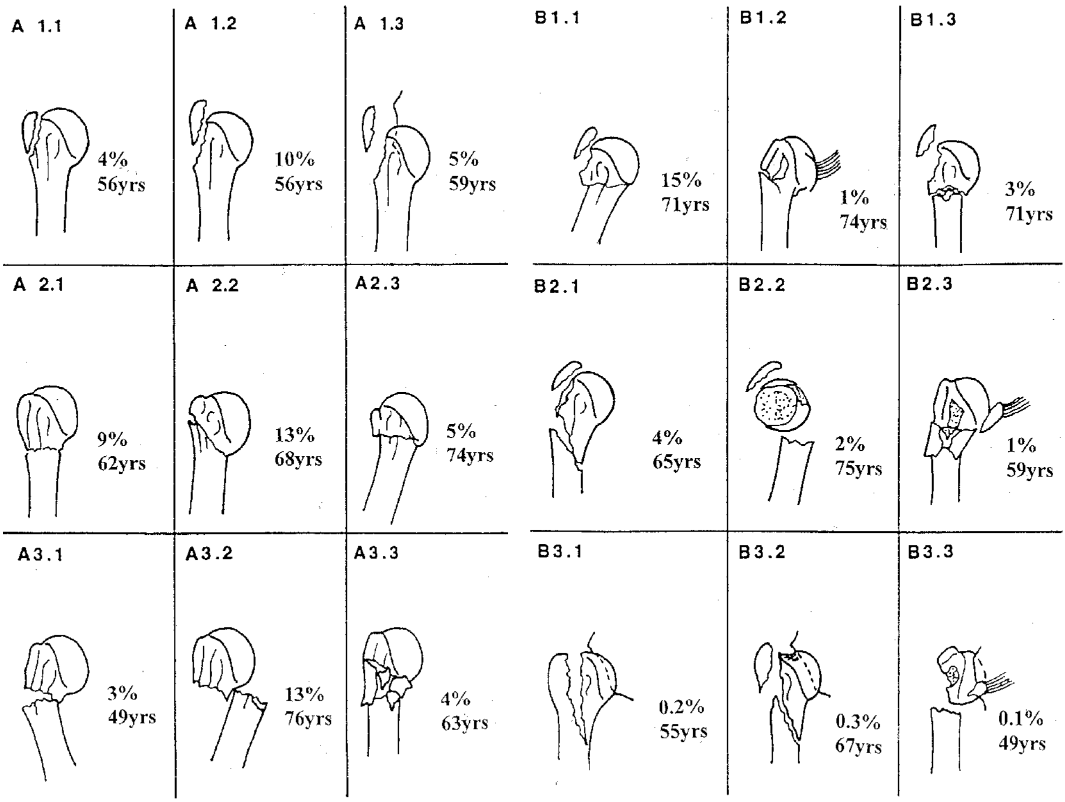

Figure 2.The AO classification of fractures showing the incidence and average age in each sub-group.

Table 1. The age-specific incidence of proximal humeral fractures in males and females per 100,000 of the population per year. The 95% confidence intervals are shown

Age	Male	Female
10–19	11 (6–16)	8 (4–13)
20–29	5 (2–8)	4 (2–6)
30–39	15 (9–18)	4 (2–7)
40–49	20 (14–27)	20 (14–27)
50–59	28 (20–37)	45 (35–56)
60–69	34 (24–45)	96 (80–112)
70–79	58 (43–76)	188 (164–211)
80–89	109 (75–152)	260 (116–355)
90–99	159 (43–406)	139 (81–223)

using Poisson distribution, and those for the relationship between age and fracture group, using binomial distribution.

Results

In the 5-year study period, 1,015 patients presented with proximal humeral fractures. 8 had bilateral fractures and a further 4 patients had two separate proximal humeral fractures during this period. Thus 1,027 fractures in 1,015 patients were included in the study. The average age was 66 (13–98) years. There were 278 males (27%) having an average age of 56 years and 737 females (73%) with an average age of 70 years. The age- and sex-specific incidence of proximal humeral fractures is shown in Table 1. Assessment of the prefracture functional status showed that the patients were generally fit and nine-tenths lived at home (Table 2).

We ascertained hand dominance in 1,005 patients. 939 (93%) were right-handed and 443 of these sustained a fracture in their dominant right arm. Of the left-handed patients, 37 had a fracture in their dominant left arm. We saw a tendency for the fractures to occur more commonly in the colder months. 97 patients had other musculo-skeletal injuries, but

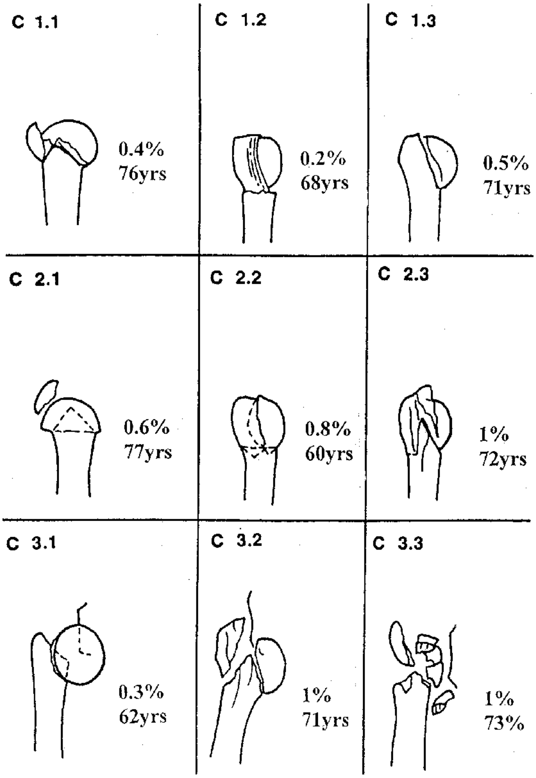

Figure 2.The AO classification continued from page 367.

only 3 patients had an Injury Severity Score of more than 15, having significant injuries to other body systems. The commonest associated injuries were fractures of the distal radius and proximal femur. 34 patients had distal radial fractures of which 13 were ipsilateral, 10 were contralateral and one was bilateral. 24 patients had proximal femoral fractures.

Data were available about the type of accident in 1,023 of the fractures. There were 5 principal causes of proximal humeral fractures: falls from a standing height (87%), other falls down stairs, slopes or from a height (4%), sports injuries (4%), road traffic accidents (4%) and direct blows or assaults (1%). The average age of patients injured in simple falls was 69 years compared to 54 years in those injured in falls down stairs or slopes and 46 years in patients injured in road traffic accidents. The average age of patients injured by a direct blow was 44 years, with 33 years being recorded for the sports injury group.

Table 2. The prefracture functional characteristics of 1,015 patients with proximal humeral fractures, percentages

Live at home	92
Live alone	38
Own shopping	89
Own dressing	93
Own personal hygiene	93
Own housework	81
Require home help	16

We analysed the effect of age on the epidemiology of proximal humeral fractures, using both the Neer and AO classifications. To facilitate analysis, the Neer classification was divided into 4 groups depending on the number of fracture parts as defined by the Neer criteria. Group 1 included all minimally-displaced fractures, group 2 contained the two-part fractures and fracture-dislocations (categories 2–7), group 3 consisted of the three-part fractures and fracture-dislocations (categories 8–11) and group 4 contained the four-part fractures, fracture-dislocations and head-splitting fractures (categories 12–15). We found an association between increasing age and the morphology of the proximal humeral fractures, as defined by the Neer classification (Table 3).

If the Neer classification is used, 49% of all proximal humeral fractures are in the minimally-displaced category. A further 28% are two-part surgical neck fractures and 9% are three-part greater tuberosity and surgical neck fractures. These 3 categories account for 86% of all proximal humeral fractures in the Neer classification with four-part fractures and fracture dislocations comprising only 3% (Figure 1). If the AO classification is used to describe proximal humeral fracture morphology, 66% of all fractures are type A unifocal fractures involving the greater tuberosity or surgical neck. 47% of all proximal humeral fractures involve the surgical neck (AO groups A2 and A3) and 19% are greater tuberosity fractures (group A1). 27% of all proximal humeral fractures are Type B bifocal fractures or fracture dislocations. Subdivision into the component groups reveals that 19% of proximal humeral fractures are B1 impacted bifocal fractures, 7% are B2 non-impacted bifocal fractures and the remaining 1% are B3 bifocal fracture dislocations. The type C intra-articular ana-

Table 3. Percentage of patients in each Neer group in each age decade. The 95% confidence intervals are also shown. An explanation concerning the groups is given in the text

Age	Groups			
	1	2	3	4
10–19	52 (33–70)	48 (30–67)	0 (0–11)	0 (0–11)
20–29	74 (52–90)	26 (10–48)	0 (0–15)	0 (0–15)
30–39	76 (61–87)	17 (8 –31)	4 (0.5–15)	2 (0.1–12)
40–49	59 (47–70)	36 (26–48)	4 (1–11)	1 (0.03–7)
50–59	54 (46–63)	38 (29–46)	6 (3–12)	2 (0.5–6)
60–69	55 (47–61)	31 (26–39)	10 (7–15)	4 (2–7
70–79	45 (40–51)	38 (32–43)	8 (8–16)	5 (3–9)
80–89	37 (31–44)	44 (38–51)	13 (10–19)	5 (3–9)
90–99	33 (15–57)	62 (38–82)	0 (0–16)	5 (0.1–24)

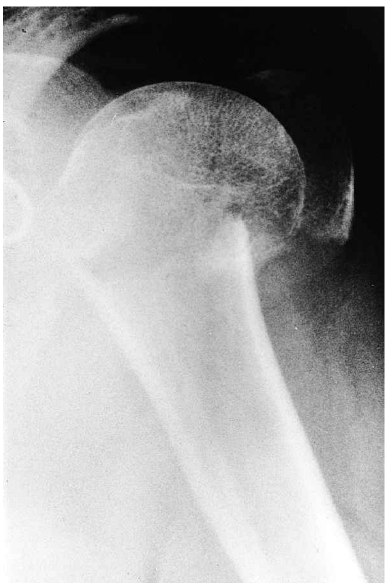

Figure 3. AO B1.1 bifocal impacted valgus fracture.

Figure 4. AO A2.2 unifocal impacted varus fracture.

tomical neck fractures account for 6% of all proximal humeral fractures. The C1 slightly displaced group comprises 1%, the C2 impacted markedly displaced group 3% and the C3 dislocation group 2% of proximal humeral fractures (Figure 2).

The commonest single fracture configuration seen during the study period was the AO B1.1 impacted valgus fracture (Figure 3). This accounted for 15% of all proximal humeral fractures. A further three fracture configurations (Figure 2) had an incidence of at least 10%, these being the A2.2 impacted varus surgical neck fracture (Figure 4), the A3.2 translated surgical neck fracture (Figure 5) and the A1.2 displaced surgical neck fracture (Figure 6). 10 of the 27 different sub-groups listed in the AO classification had an incidence of less than 1%.

Discussion

Not only are proximal humeral fractures relatively common, but the patients who sustain them tend to be fit, despite their advanced age. Fewer than 10% of patients in this series were institutionalised and about two-thirds of the group lived by themselves,

Figure 5. AO A3.2 unifocal translated surgical neck fracture.

Figure 6. AO A1.2 unifocal displaced greater tuberosity fracture.

with less than one-fifth requiring social support. It is obvious that patients who present with proximal humeral fractures are much fitter than those who present with proximal femoral fractures. However, evidence shows that patients with proximal humeral fractures are less fit than those having distal radial fractures (Kelsey et al. 1992) and it seems likely that patients with proximal humeral fractures are at an intermediate functional stage between those patients who present with distal radial fractures and those with proximal femoral fractures. Proximal humeral fractures often occur in the fit elderly independent patient who is still a net contributor to society but who might well be converted to a degree of social dependency by the fracture.

We found no previous study that has examined the epidemiology and morphology of a large number of proximal humeral fractures, using the two currently available classification systems. We have shown the data relating to incidence and average age in the diagrams introduced by Neer (1970) and the AO group (Müller et al. 1990) since these have become familiar to all orthopaedic surgeons.

There has been much debate about the reproducibility and prognostic value of proximal humeral classification systems. Recent publications examining both the Neer and AO proximal humeral fracture classifications have suggested that both classifications have a low consistency and that their inter-observer reliability is poor (Sidor et al. 1993, Siebenrock and Gerber 1993, Brien et al. 1995). However, classification systems enhance the understanding of the epidemiology and morphology of fractures. We have attempted to minimise the deficiencies of both classification systems by ensuring that all fracture classification was undertaken by one experienced orthopaedic surgeon who had used both of them for several years. We accept that there will still be problems with use of these systems, but believe that our method is appropriate, given the state of current classification systems.

We found the AO classification to be more comprehensive than the Neer classification. Not only are there many more fracture configurations in the AO classification, but the fact that about half of fractures in the Neer classification are combined in group 1, the minimally-displaced group, means that this classification cannot adequately describe the morphology of all proximal humeral fractures. We also believe that because nine-tenths of all fractures in the Neer classification are contained in three categories, the AO classification is more useful in describing the fracture morphology. Other aspects of the AO classification were also felt to be better than the Neer classification. The most important difference between the two classifications is that the AO system takes into account the fact that many proximal humeral fractures are impacted valgus fractures, but this type of fracture is not considered in the Neer classification. This is the reason for the apparent discrepancy between the AO B2.2 fracture and the Neer 8 three-part fracture (Figures 1 and 2). The Neer 8 fracture contains mainly three-part impacted valgus fractures since there is no other Neer category in which to place these fractures, but the AO B2.2 sub-group contains only the classic Neer three-part fractures associated with head rotation. 4 AO sub-groups, A2.3, B1.1, C1.1 and C1.2, contain variants of the impacted valgus fracture and one-fifth of all the proximal humeral fractures in this study were such fractures. It would seem reasonable that any classification of proximal humeral fractures should take this fact into account, particularly as there is evidence that the treatment of impacted valgus fractures may differ from that of non-impacted fractures of similar severity (Jakob et al. 1991).

It is interesting to note that over half of the fractures in this study consisted of only 4 AO fracture sub-groups, these being the B1.1, A2.2, A3.2 and A1.2 sub-groups. The B1.1 and A2.2 fractures have received very little attention in the literature since there are no studies of their management or outcome. By contrast, the fractures which have received most attention in the literature, the Neer three- and four-part fractures and fracture dislocations and the AO type C fractures occurred with an incidence of 13% and 6%, respectively, indicating that the literature does not adequately reflect the spectrum of proximal humeral fractures.

Age is unquestionably a major factor in the aetiology and epidemiology of proximal humeral fractures. We found that, like other fractures that occur in osteopenic bone, there is a unipolar distribution (Table 1), with the highest incidence occurring in women between 80 and 89 years of age (Court-Brown et al. 1998). Less than one-fifth of the fractures occurred in patients less than 50 years of age and only 11 were epiphyseal fractures in adolescents. It is interesting to observe that some of the proximal humeral fracture types occur in younger patients (Figure 2).

Not surprisingly, the mode of injury is influenced by the age of the patients. The few fractures that occurred in young patients were caused mainly by sport and road traffic accidents. Over the age of 30 years, the chief cause of proximal humeral fractures is a simple fall with over 90% of them in patients over 60 years being thus caused. Analysis of the relationship between age and type of fracture shows that the incidence of more complex fractures increases with age. Many surgeons believe that it is younger patients who have a more complex fracture morphology. We found that this was not the case; patients with osteoporotic proximal humeral fractures have more complex fractures.

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