

Adult ankle fractures—an increasing problem?

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The epidemiology of ankle fractures is changing. Increasing longevity has resulted in the highest age-specific incidence of ankle fractures being in women between 75 and 84 years of age. The introduction of the AO classification has facilitated analysis of the commonest fracture types. This survey of 1,500 ankle fractures, seen in a 3-year period in the

Edinburgh Orthopaedic Trauma Unit, shows that the commonest ankle fractures are the B1.1 and A1.2 lateral malleolar fractures. Isolated malleolar fractures accounted for two thirds of the series, with bimalleolar fractures occurring in one fourth of the patients and trimalleolar fractures in the remaining 7%. Open fractures occurred in 2%.

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The recent introduction of the complete AO ankle classification (Müller et al. 1990) has provided a classification of ankle fractures which is relatively easy to understand and to apply. However, despite widespread acceptance of the AO classification there has, as yet, been no detailed analysis of the epidemiology of ankle fractures utilizing it. We present a study of the epidemiology of 1,500 consecutive adult ankle fractures presenting to the Edinburgh Orthopaedic Trauma Unit over a 3-year period.

Patients

An epidemiological analysis of adult ankle fractures was undertaken by examining the database of the Edinburgh Orthopaedic Trauma Unit which has kept full inpatient and outpatient records since January 1988. The 3-year period between January 1988 and December 1990 was selected for analysis, as this period coincided with the last census of the Edinburgh population, this being published in 1991. During the 3 years of the study, adult ankle fractures were admitted to 2 hospitals in Edinburgh but examination of the Edinburgh census indicated that the catchment population of the Royal Infirmary of Edinburgh was 410,000. This figure has been used in the calculation of epidemiological data.

All relevant data, except the AO classification, were recorded prospectively. The AO classification was documented retrospectively by examination of the initial radiographs. These were all evaluated by the senior author (CCB). The open fractures were further classified using the Gustilo classification (Gusti-

lo and Anderson 1976, Gustilo et al. 1984). The causes of fracture were divided into 7 basic categories these being twisting injuries (including inversion and eversion injuries), simple falls, falls down stairs, steps, slopes or embankments, falls from any height, sporting injuries, direct blows or assaults and traffic accidents.

Results

In the 3-year study period, 1,500 ankle fractures were treated in the Edinburgh Orthopaedic Trauma Unit. 779 (52%) occurred in men. The average age of the adult ankle fracture population was 45 (15–98) years. Overall there were 132 fractures per 100,000 men a year and 112 fractures per 100,000 women a year. The highest age-specific incidence in men was seen between the ages of 15 and 24 (223 fractures per 100,000 persons per year). In women, the highest age-specific incidence was 248 fractures per 100,000 persons a year, this occurring in the decade between 75 and 84 years of age (Table 1).

38% were type A infra-syndesmotric fractures, 52% were trans-syndesmotric type B fractures and the remaining 10% were supra-syndesmotric type C fractures (Table 2). 58% of all ankle fractures are caused either by a twisting injury or a simple fall. These mechanisms of injury together with falls downstairs tend to occur in older patients. The third commonest cause of ankle fractures is sports injuries. 75% of sports-related ankle fractures followed soccer injuries and 11% were caused by rugby. The remaining fractures were caused by 17 different sports, with skiing

Table 1. The age-specific incidences of ankle fractures. These are expressed as the number of fractures per 100,000 persons of that decade

Decade	Men	Women
15-24	223	105
25-34	125	53
35-44	111	64
45-54	93	93
55-64	117	176
65-74	90	169
75-84	145	248
85-94	107	84

Table 3. The causes of fracture for the different AO fracture types in percentages. The average age for each cause is given

	Twist	Fall	Stairs	Height	Sport	Blow	RTA ^a
Type A	32	23	6.8	7.4	22	5.8	12
Type B	27	37	8.9	4.4	13	5.3	3.8
Type C	3.7	28	6.8	11	21	9.3	19
Total	26	31	7.9	6.2	17	5.9	8.5
Average age	47	53	49	35	25	36	42

^a Road traffic accidents

Table 2. The incidence (%) of fracture in the different AO subgroups

Type A	Type B	Type C
A1.1	-- ^a	
A1.2	15.1	
A1.3	9.7	
A2.1	9.6	
A2.2	1.0	
A2.3	1.5	
A3.1	0.8	
A3.2	<0.1	
A3.3	0.3	
Overall	38	
	B1.1	21
	B1.2	0.4
	B1.3	5.9
	B2.1	7.1
	B2.2	7.0
	B2.3	1.1
	B3.1	3.1
	B3.2	0.3
	B3.3	6.4
	Overall	52
	C1.1	2.8
	C1.2	2.0
	C1.3	0.6
	C2.1	1.0
	C2.2	1.5
	C2.3	1.0
	C3.1	0.3
	C3.2	0.4
	C3.3	<0.1
	Overall	9.6

^a A1.1 represents a lateral ligamentous sprain and has been excluded

and running accounting together for 5%. The least common causes of ankle fractures are falls down-stairs or slopes, falls from a height and direct blows or assaults. The latter two causes, together with sporting fractures, tend to occur in younger patients (Tables 3 and 4).

The causes of the different AO fracture types were similar in type A and type B fractures, with twisting and simple falls causing most of these injuries. However, type C fractures were different. A few supra-syndesmotomic fractures were due to twisting injuries, although a considerable number were caused by simple falls. However, type C fractures often were high-velocity injuries in traffic accidents, falls from a height and some sporting activities.

Table 4. Average age and cause of fracture for each AO subgroup

Type	Average age (yr)	Twist (%)	Fall (%)	Stairs (%)	Height (%)	Sport (%)	Blow (%)	Rta (%)
A1.2	44	43	22	7.1	2.9	18	4.6	3.3
A1.3	43	41	20	7.3	4.9	9.8	2.4	7.3
A2.1	33	7.6	13	2.8	13	29	9	25
A2.2	42	6.6	33	0	20	6.6	13	20
A2.3	56	0	41	18	0	9.1	27	4.5
A3.1	35	0	46	0	0	46	0	7.8
A3.2	69	0	100	0	0	0	0	0
A3.3	29	0	0	0	7.5	0	0	25
B1.1	46	20	27	6	2.5	18	5.3	0.6
B1.2	35	44	22	11	0	0	11	0
B1.3	52	55	29	2.6	1.3	2.6	2.6	2.6
B2.1	41	9.7	38	11	8.5	11	8.5	3.6
B2.2	56	6.9	53	18	4.9	7.8	1	8.8
B2.3	47	0	41	24	5.9	5.9	0	24
B3.1	44	21	45	7.1	7.1	12	4.7	2.4
B3.2	56	25	50	25	0	0	0	0
B3.3	53	3.2	57	19	6.4	3.2	4.2	6.4
C1.1	40	15	44	7.4	7.4	22	0	3.7
C1.2	43	0	24	16	12	20	12	16
C1.3	41	0	33	11	44	11	0	0
C2.1	39	0	40	0	0	50	0	10
C2.2	44	0	33	6.6	13	6.6	0	40
C2.3	47	0	33	25	25	0	0	17
C3.1	58	50	50	0	0	0	0	0
C3.2	38	0	40	0	20	20	0	20
C3.3	34	0	0	0	0	100	0	0

Unimalleolar fractures

70% of all ankle fractures were isolated malleolar fractures. According to the AO classification, there are 7 basic types of isolated malleolar fractures. 6 of these, the A1.2, A1.3, B1.1, B1.2, B1.3 and B2.1, affect the lateral malleolus, while the A2.1 fracture is an isolated medial malleolar fracture.

The 3 commonest lateral malleolar fractures, the A1.2, A1.3 and B1.1 fractures, were broadly similar in terms of the average age of the patient and the causes of fracture. The B1.3 comminuted trans-syndesmotomic fracture also tends to be caused by twisting and simple falls, but occurs in older patients, presumably because of the osteoporotic nature of the bone. The uncommon B1.2 fracture tends to occur in younger patients and, again, is mainly caused by twisting and falls (Table 4). It is interesting that the B2.1 trans-syndesmotomic fracture, associated with rupture of the deltoid ligament, does not usually occur with twisting, but does occur following simple falls downstairs, with sports and direct blows.

The A2.1 medial malleolar fracture had epidemiological characteristics different from the lateral malleolar fractures. These fractures tended to occur in younger patients and rarely follow twisting or simple falls. The commonest cause of the A2.1 fracture was sport, followed by traffic accidents and falls from a height. The only other fracture that might be classified as an isolated medial malleolar fracture is the A3.1 infra-syndesmotomic lesion associated with a postero-medial fracture. This uncommon fracture occurred in less than 1% (12 patients). Like the A2.1 fracture, it tended to occur in younger patients, the average age of this particular subgroup being 35 years. Virtually all of the A3.1 fractures were caused by sport or simple falls.

Bimalleolar fractures

The classical bimalleolar fracture involves the medial and lateral malleoli. There are 4 subgroups in the AO classification dealing with this type of bimalleolar fractures, these being the A2.2, A2.3, B2.2 and B2.3 fractures. As with the isolated malleolar fractures there are other subgroups which are technically bimalleolar but include either a postero-medial fragment (A3.2 and A3.3) or a posterior malleolar fracture (B3.1).

Bimalleolar fractures affecting the medial and lateral malleoli accounted for 11% of the series. By far the commonest is the B2.2 fracture. It is often difficult to separate the B2.2 and B2.3 fractures, but the B2.2 noncomminuted fracture appears to be commoner than the comminuted B2.3 variant and, interestingly,

it tended to occur in an older group of patients (Table 4). Most bimalleolar fractures occurred following simple falls, falls downstairs or slopes and in road traffic accidents. It is interesting that direct blows or assaults caused a relatively large number of A2.3 fractures.

Other variants of the bimalleolar fracture were uncommon. Only the B3.1 fracture affecting the lateral and posterior malleoli was encountered with any frequency. It is usually caused by twisting or, more commonly, by a simple fall. The A3.2 postero-medial fracture associated with avulsion of the lateral malleolus was seen in only 1 case, this being a 69-year-old woman, who had a simple fall. There were 4 A3.3 fractures with a postero-medial fracture and a transverse lateral malleolar fracture. These were all high-energy injuries in younger patients.

Trimalleolar fractures

The AO classification has 2 related trimalleolar subgroups, the B3.2 and B3.3 fractures. It is sometimes difficult to distinguish between these 2 subgroups and the comminuted B3.3 fracture was encountered more frequently than its noncomminuted B3.2 equivalent. Both trimalleolar fractures occurred in slightly older patients and both were essentially low-velocity injuries which follow twisting, simple falls or falls downstairs. Overall, the trimalleolar fractures comprised 7% of the whole series (Table 4).

Supra-syndesmotomic fractures

The AO classification devotes a whole fracture type to supra-syndesmotomic fractures. 10% of all fractures were type C supra-syndesmotomic fractures, but only 5 of these subgroups occurred with any significant frequency. These are the C1.1, C1.2, C2.1, C2.2 and C2.3 subgroups. The remaining fractures are very uncommon (Table 1). All of the patients with these 5 commoner type C fracture subgroups had a similar average age. Only 15% of the C1.1 fracture subgroup occurred following a twisting injury and, in general, type C fractures tended to occur because of a simple fall or a high-velocity injury, such as a fall from a height or a traffic accident. Very few type C fractures occurred as a result of a direct blow or assault (Table 4).

Open fractures

Only 26 (2%) open fractures occurred. The average age was 44 years. There were 9 type A fractures, 15 type B fractures and 2 type C fractures. 7 of the fractures were Gustilo type I in severity with 10 being type II and the remaining 9 being type III. All but one of the type III fractures were IIIA, the remaining frac-

ture being IIIB in severity. None of the open fractures followed a twisting injury, although 5 followed a simple fall. 2 occurred following a fall downstairs and 3 were associated with a fall from a height. There were no open fractures associated with sports injuries and only 1 occurred as a result of a direct blow. The remaining 15 followed traffic accidents. 11 of the 26 open fractures were B2 fractures. The B2 subgroups were evenly spread, with four B2.1 fractures, 3 B2.2 fractures and 4 B2.3 fractures.

Discussion

Considering the frequency of ankle fractures, it is surprising that so little has been written about their epidemiology in recent years. Bengnér et al. (1986) documented the increasing incidence of ankle fractures in Sweden between the early 1950s and the early 1980s and Kannus et al. showed a similar increase in Finland between 1970 and 1994. Daly et al. (1987) examined the epidemiology of ankle fractures in Minnesota, USA. This group had difficulty in applying the early AO classification. We found no particular problems in using the AO classification, although it was sometimes difficult to distinguish between B1.1 and B1.2 fractures. The only difference between these fractures is damage to the anterior syndesmosis, which is frequently difficult to detect clinically in an acute fracture. There was also occasionally some difficulty in distinguishing between B2.2 and B2.3 fractures, where the degree of comminution is the only difference and a similar problem sometimes arose with B3.2 and B3.3 fractures. Notwithstanding these minor problems, we found the AO classification useful and easy to apply.

Begnér et al. (1986) noted that the incidence of ankle fractures in Sweden had increased from 65 per 100,000 persons a year in 1950/52 to 107 per 100,000 persons a year in 1980/82. A decade later, we found that the incidence of ankle fractures in Edinburgh was 122 per 100,000 persons a year. Given the inevitable increase in the incidence of all fractures in the intervening decade, we believe that the Swedish results compare well with ours. A similar incidence was noted by Lindsjö (1981), who calculated a figure of 114 per 100,000 persons a year in the early 1970s in Sweden. Kannus et al. (1996) determined the incidence of osteoporotic ankle fractures and noted that there were 168 ankle fractures per 100,000 persons in women aged between 70 and 79 years in 1994 in Finland, compared to 63 per 100,000 persons in 1970. Daly et al. (1987) documented an incidence of 184 fractures per 100,000 a year in Minnesota, USA. The overall

trend is clear. The incidence of ankle fractures is rising, but there are discrepancies between the various figures quoted in the literature. The most likely reason for this is that a number of researchers have examined only inpatient data and consequently their age-specific incidences are lower than they should be. We believe our data to be accurate, since both inpatients and outpatients have been included.

All series agree that the overall incidence of ankle fractures in men is higher than in women, but that in recent years the section of the population showing the most dramatic increase in the incidence of ankle fractures is elderly women. This is particularly shown by Bengnér et al. (1986) who demonstrated that the number of women in Lund, Sweden, over the age of 65 years who presented with ankle fractures increased by 173% in a 30-year period. Kannus et al. (1996) also found a 145% increase in osteoporotic ankle fractures in Finnish women between 1970 and 1994, with an equivalent increase of 116% in Finnish men. This undoubtedly accounts for the fact that the highest age-related incidence of ankle fractures in our series was seen in women between 75 and 84 years of age. It is also interesting that Buhr and Cooke (1959), in analyzing the incidence of ankle fractures in England between 1953 and 1957, showed that the commonest age for ankle fractures in women was between 50 and 59 years. Bengnér et al. (1986), examining the 3-year period between 1980 and 1982, found that the highest age-related incidence was seen in women between 60 and 70 years of age and in our study, carried out between 1988 and 1990, the highest incidence was between 75 and 84 years of age. These figures confirm that the average age of patients is increasing.

Most ankle fractures in men were seen between the ages of 15 and 24, when there was an incidence of 223 fractures per 100,000 patients a year. Not surprisingly, one third of this group were sports-related injuries. The fact that the highest incidences of fractures in men and women are separated by 50 years accounts for the bimodal distribution of ankle fractures.

Despite the use of different classification systems, we believe that most surgeons still find it useful to classify ankle fractures according to the number of involved malleoli and whether or not there is a supra-syndesmotric fibular fracture. Our relative incidences of unimalleolar, bimalleolar and trimalleolar fractures are not dissimilar from other series. We found that two thirds were unimalleolar fractures. This is similar to that documented by Bengnér et al. (1986). If one includes the bimalleolar fracture variants (A3.2, A3.3 and B3.1), we found that 13% of fractures were bimalleolar, 7% were trimalleolar and 10% were supra-syndesmotric.

All authors agree that AO type B trans-syndesmoti-
c fractures are commoner than type A infra-syndesmoti-
c or type C supra-syndesmoti-
c fractures. We had a
higher incidence of type A fractures than Lindsjö
(1981) or Bengnér et al. (1986) and a considerably
lower incidence of type B fractures than documented
by Bengnér et al. (1986). However, there seems to be
broad agreement that supra-syndesmoti-
c type C fractures comprise about one tenth of all adult ankle frac-
tures.

No previous study has classified a large series of
ankle fractures into its constituent AO subgroups. In
our series, only 2 fracture types (B1.1 and A1.2) oc-
curred with an incidence of more than 10%. A further
6 fractures occurred with an incidence of more than
5% and 9 fracture types had an incidence of less than
1%. Many of the different types of ankle fractures
will be seen only infrequently by surgeons.

Most fractures were caused by low-velocity inju-
ries, such as twisting, simple falls or falls down-stairs.
This is particularly true of type A and type B frac-
tures. However, there were exceptions. The A2.1 iso-
lated medial malleolar fracture was particularly asso-
ciated with high-velocity injuries in traffic accidents,
falls from a height and sporting injuries. This was also
true of the less common A2.2 and A3.3 fractures.
Type C fractures also were rarely caused by twisting,
but usually by high-velocity impacts in traffic acci-
dents or falls from a height.

Previous reports concerning open fractures of the
ankle have suggested that their incidence is about 5%
(Olerud et al. 1978). We believe that this figure is too
high and has probably been calculated solely by ana-
lyzing inpatient fractures. The high incidence of iso-
lated fractures of the fibula indicates that in many
centers a large number of ankle fractures will be man-
aged nonoperatively on an outpatient basis. Despite

their relative scarcity, open ankle fractures are very
important. A recent review by Court-Brown and Qua-
ba (1996) showed that half of the open ankle fractures
required plastic surgery in the form of split skin graft-
ing or flap cover to achieve soft-tissue closure.

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