

Epidemiology of ankle fractures in Rochester, Minnesota

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The epidemiology of ankle fractures was examined among Rochester, Minnesota, residents during the 3-year period 1979–1981. Ankle fractures occurred with an overall age- and sex-adjusted incidence rate of 187 per 100,000 person-years; this is higher than in earlier population-based studies. The most frequent cause of ankle fractures was sports-related trauma. The incidence of fractures associated with moderate trauma, on the other hand, increased markedly in middle-aged women, but declined in elderly women. Diabetes mellitus and obesity were associated with fractures in middle-aged and older adults. Of accepted classifications, the Lauge-Hansen system provided the most clinically relevant information.

Previous population-based studies of ankle fractures have either been limited in some way to pediatric (Kärrholm et al. 1982, Landin & Danielsson 1983) or adult (Knowelden et al. 1964) cases or to those of a particular type (Cedell 1967) – or else have failed to define the clinical variety of ankle fractures (Buhr & Cooke 1959, Nilsson 1969, Garraway et al. 1979, Bengnér et al. 1986). Consequently, we determined the incidence of all ankle fractures and the frequency of each type according to several classifications by age, sex, and cause among Rochester, Minnesota, residents during the 3-year period 1979–1981. Additionally, we made an attempt to describe associations with possible risk factors for ankle fractures.

Patients and methods

Mayo Clinic provides the major share of orthopedic care to Rochester, Minnesota, residents and

maintains a master index to the diagnoses and surgical procedures recorded among its patients. The Rochester Epidemiology Project supports a similar index for the relatively small number of other providers of care to residents (Kurland & Molgaard 1981). This data system enabled us to identify all ankle fractures recorded among Rochester residents, whether the diagnosis was made as a result of autopsy, hospitalization in this or surrounding communities, emergency room treatment, nursing home care, or outpatient visits to office or clinic.

Each proband's complete outpatient and inpatient medical record was retrieved and reviewed. The cause, place of occurrence, and possible contributing factors were recorded for each fracture. Trauma was considered severe if it involved a traffic accident or fall from a height, or moderate if the fracture resulted from slipping or stumbling or from a fall on level ground. Sports-related trauma was classified separately. Osteoporosis was presumed to be present if there was a previous radiographic diagnosis of osteoporosis or if there was a history of antecedent fracture of the proximal femur, proximal humerus, distal forearm, or vertebral body subsequent to minimal or moderate trauma in someone 35 years old or over. Subjects whose weight was ≥ 120 per cent of that predicted for their height (Bray 1973) were considered obese. Diabetes mellitus was present if a

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patient met previously established diagnostic criteria (Melton et al. 1983). Prereduction radiographs were reviewed and each fracture was classified according to the following classifications: Lauge-Hansen (1950), Weber (1966), Burwell-Charnley (1965), or Salter-Harris (1963) if the patient had an open physis.

For the calculation of incidence rates, the entire population of Rochester was considered to be at risk, with denominator age- and sex-specific person-years (p-y) estimated from decennial census data (Schroeder & Offord 1982). Ninety-five per cent confidence intervals (95 per cent C.I.) around the incidence rates were estimated using the cumulative Poisson distribution. Incidence rates were directly age- and sex-adjusted, or age-adjusted for male:female comparisons, to the population structure of United States whites in 1980. The expected numbers of subjects with prior osteoporotic fractures or with a history of diabetes mellitus were estimated from the cumulative incidence of hip (Melton et al. 1982), pelvis (Melton et al. 1981), proximal humerus (Rose et al. 1982), and Colles' fractures (Owen et al. 1982), and the prevalence of vertebral fractures (L. J. Melton-unpublished data) or diabetes (Melton et al. 1983). The significance of relative prevalence rates was assessed using the cumulative Poisson distribution. Significance indicates $P < 0.05$ unless stated otherwise.

Results

During the studied period, 311 Rochester residents experienced 314 ankle fractures. The overall incidence of ankle fractures was 184 per 100,000 p-y (age- and sex-adjusted 187 per 100,000 p-y; 95 per cent C.I. 166–208). Most fractures (97 per cent) were among whites, reflecting in part the racial composition of the community. There were more ankle fractures among men than women, but age-adjusted incidence rates did not differ (201 per 100,000 p-y versus 172 per 100,000 p-y). Male predominance was most pronounced among young adults (Table 1). Although the incidence among males seemed again greater in 75–84 year-olds and those over 85 years, the latter rates were based on a relatively small number of patients and differences might have occurred by chance ($P > 0.05$).

Table 1. Incidence of ankle fractures among Rochester, Minnesota, residents by age and sex, 1979–81

Age-group	Men		Women		Both sexes	
	n	Rate ^a	n	Rate ^a	n	Rate ^a
0–4	1	15	1	16	2	16
5–	25	200	17	140	42	171
15–	51	354	27	139	78	230
25–	42	272	22	130	64	197
35–	17	175	18	175	35	175
45–	11	151	18	229	29	191
55–	3	51	22	314	25	193
65–	4	115	17	275	21	217
75–	4	210	8	176	12	186
85–	3	580	3	166	6	258
Total	161	207	153	165	314	184

^a per 100,000 person-years.

Fifteen per cent of these fractures were caused by severe trauma, whereas about a third were due to sports injuries (Table 2). Over 40 per cent were due to moderate trauma, with the remainder due to miscellaneous causes. The age- and sex-specific pattern of occurrence for these different cause-specific groups varied as well (Figure 1). Fractures due to severe trauma were more common among men, but revealed no marked variation with age. Sports-related injuries were also more frequent in men than women. There were no distinguishing characteristics for ankle fractures due to other miscellaneous causes, and rates were comparable for men and women.

Table 2. Direct causes of ankle fractures among Rochester, Minnesota, residents 1979–81

Cause	n	Per cent ^a
SEVERE TRAUMA	44	15
Motor vehicle accidents (25)		
Falls from heights (19)		
MODERATE TRAUMA	127	44
Stumbling down a step (48)		
Slipping or stumbling on level ground (79)		
SPORTS INJURIES	104	36
Softball (30)		
Volleyball (10)		
Football (9)		
Skating (9)		
Basketball (7)		
Soccer (6)		
Skateboarding (4)		
All others (22)		
BUMPED OR OTHER DIRECT VIOLENCE	13	4
Kicked in ankle (7)		
All others (6)		
MISCELLANEOUS	3	1
UNKNOWN OR NOT STATED	23	–
Total	314	100

^a Per cent of those with specified cause

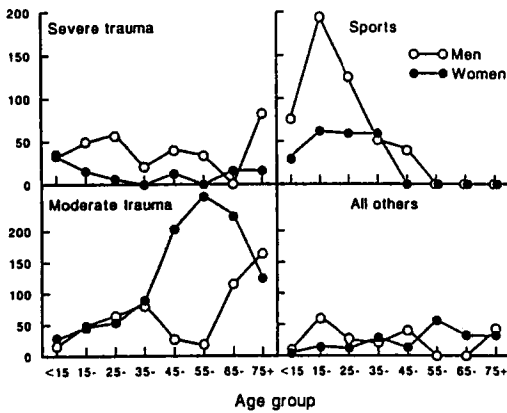


Figure 1. Age-specific incidence per 100,000 person-years for various causes of ankle fractures among Rochester, Minnesota, residents, 1979-1981.

Fractures due to moderate trauma, on the other hand, showed some of the epidemiologic features of osteoporosis-related fractures: namely, greater incidence rates among women and rising incidence rates after midlife. The decline in incidence among women ≥ 65 years of age is not characteristic of osteoporotic fractures, however. The moderate trauma probands had experienced 13 prior osteoporotic-type fractures (8 Colles', 2 proximal humerus, 1 proximal femur, 1 pelvis, and 1 vertebral fracture), but the expected number of such fractures was 11. Three individuals had previously been diagnosed with generalized osteoporosis, but no systematic evaluation was performed on most patients. Eight patients had diabetes mellitus; this was greater than the expected number of 3.8 ($P < 0.01$) and may have been related to the large proportion of obese patients (39 per cent of those with moderate trauma; 48 per cent of moderate trauma patients ≥ 35 years of age). None had recognized diabetic neuropathy.

The distribution of the 314 ankle fractures by type varied depending on the classification used. In the Lauge-Hansen classification, over 60 per cent were supination fractures (supination-adduction or supination-external rotation), whereas a fourth were pronation fractures (pronation-external rotation or pronation-abduction). About 15 per cent could not be classified in this system because they involved the physis and required utilization of the Salter-Harris system. In the Weber system, 27 per cent were below the

tibial plafond (Type A), whereas half were proximal (41 per cent Type B, 4 per cent Type C₁, and 5 per cent Type C₂). One fourth of the fractures could not be classified because they did not involve the lateral malleolus or were physal fractures. In the Burwell-Charnley system, 69 per cent of the fractures were unimalleolar, 19 per cent were bimalleolar, and only 12 per cent were trimalleolar. Of the 48 children's fractures, 19 per cent were Salter-Harris Type 1, 46 per cent Type 2, 23 per cent Type 3, and 12 per cent Type 4.

There was a relationship between the severity of trauma and the nature of the ankle fracture, because fractures of the supination-external rotation type were disproportionately associated with moderate trauma. This was reflected in the incidence by fracture type (Figure 2), where rates for supination-external rotation fractures most closely resembled those for moderate trauma fractures. Age- and sex-specific incidence rates for Weber Type B and Burwell-Charnley trimalleolar fractures also resembled the moderate trauma fracture incidence pattern.

The fractures occurred in the left and right ankle equally often. Thirty-five (11 per cent) were displaced. Open reduction was used in 27 per cent of patients, including 33 of the 35 displaced fractures, whereas closed reduction sufficed for the remainder. All the patients treated with open reduction were hospitalized, compared with only 11 per cent of those who underwent closed reduction. The average length of hospital stay for patients treated with closed reduction was 1 day and for those with open reduction 9 days.

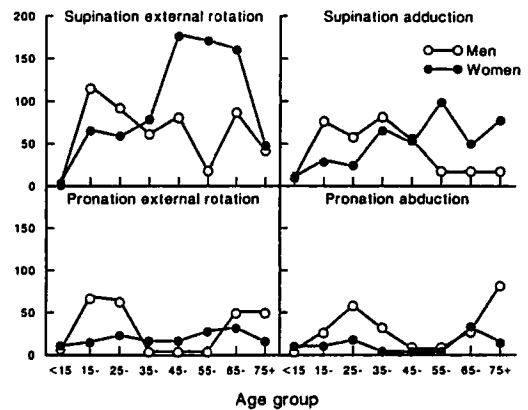


Figure 2. Age-specific incidence per 100,000 person-years for Lauge-Hansen (1950) classes of ankle fractures among Rochester, Minnesota, residents, 1979-1981.

Discussion

Incidence. A substantial proportion of current knowledge concerning the epidemiology of fractures derives from various Scandinavian settings and from Rochester, Minnesota. Thus, it is of interest to compare our findings on ankle fractures with those from northern Europe. In Rochester ankle fractures are common. The overall age- and sex-adjusted incidence rate of 187 per 100,000 person-years is over one and a half times the adjusted rate for proximal femur fractures (Melton et al. 1982), and nearly 60 per cent of that for distal forearm fractures (Garraway et al. 1979, Owen et al. 1982). Ankle fracture rates in Rochester are greater, however, than those from population-based studies in Great Britain and Sweden. The age- and sex-adjusted rate for Rochester residents ≥ 35 years old is 191 per 100,000 person-years, compared with 103 per 100,000 person-years for Oxford-Dundee in 1954–1958 (Knöwelden et al. 1964). Higher rates in Rochester compared with Oxford-Dundee have also been reported for hip (Gallagher et al. 1980), pelvis (Melton et al. 1981), proximal humerus (Rose et al. 1982), and Colles' fractures (Owen et al. 1982), and have been attributed to more complete case ascertainment (Garraway et al. 1979). However, incidence rates for hip fracture (Johnell et al. 1984, Zetterberg & Andersson 1982, Hedlund et al. in press, Falch et al. 1985, Zain Elabdien et al. 1984, Jensen 1980, Luthje 1983) and Colles' fracture (Bengnér & Johnell 1985, Falch 1983, Hansson et al. 1982, Solgaard & Petersen 1985) from Scandinavia are as high or higher than those for Rochester. Nonetheless, Rochester ankle fracture rates are greater than those for Malmö residents ≥ 35 years of age in 1950–1952, about 90 per 100,000 person-years (Bengnér et al. 1986); in the 1960's, 94 per 100,000 person-years (Nilsson 1969); or in 1980–1982, about 130 per 100,000 person-years (Bengnér et al. 1986). It has been suggested that the incidence of ankle fractures is rising (Landin & Danielsson 1983, Bengnér et al. 1986), as has been reported also for proximal femur (Melton 1987) and Colles' fractures (Bengnér & Johnell 1985), but the present study is

contemporaneous with the recent Malmö data. The ankle fracture rates reported here are higher than those from a study conducted 10 years earlier in the same community (Garraway et al. 1979), but overall rates of Colles' fracture (Owen et al. 1982) and hip fracture (Melton et al. 1982) have been relatively stable in Rochester for the past three decades.

Classification systems. Nearly all the fractures were classifiable in the Burwell-Charnley system, but fracture severity and the mechanism of injury could not be derived. The high percentage of unclassifiable fractures in the Weber system demonstrates an inability of this system to address fractures that do not involve the lateral malleolus. The Lauge-Hansen system, though cumbersome, provided the most thorough and clinically relevant information. Fractures that were unclassifiable with this system occurred almost exclusively in children.

The distribution of ankle fractures within various classification systems was generally similar to previous reports (Sarkisian & Cody 1976, Mast & Teipner 1980, Meyer & Kumler 1980, Wheelhouse & Rosenthal 1980, Zenker & Nerlich 1982) differing mainly with regard to our inclusion of small, lateral malleolar avulsion fractures. For example, when Mast & Teipner (1980) described the Lauge-Hansen distribution of their ankle fractures, 73 per cent were final stage fractures. Similarly, two thirds were classified as Weber Type B in previous reports (Beauchamp et al. 1983, Mast & Teipner 1980, Reuwer & Van Straaten 1984, Tunturi et al. 1983, Zenker & Nerlich 1982), whereas our results indicate fewer Type B fractures. Instead, we had more Type A fractures, representing the frequently seen and easily reduced lateral malleolar fractures mentioned above. These "chip" fractures account for the increased supination-adduction injuries and decreased supination-external rotation injuries evident in our data. Because of the inclusion of all the fractures, however, our results better illustrate the true clinical spectrum of the condition in the community.

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Acknowledgements

The authors wish to thank Ms. Kay L. Hurless for help with computer programming and Ms. Mary G. Ramaker for assistance in preparing the manuscript. This project was supported in part by research grants AM 30582, AM 26928 and AM 27065 from the National Institutes of Health.