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Original Research

Association of Body Mass Index With the Pattern of Surgically Treated Ankle Fractures Using Two Different Classification Systems

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ABSTRACT

The present retrospective cohort study assessed the association of body mass index (BMI) with the pattern of ankle fractures using 2 classifications systems. Of the 1011 consecutive patients who underwent surgery for ankle fractures in 2 hospitals from January 2009 to December 2011, 837 had a classifiable fracture according to 1 of 2 classification systems and complete information available for covariates. The association of BMI, adjusted for age, sex, corticosteroid use, diabetes, and smoking status with having a more proximal fibula fracture (Weber class A to C) and an increasing number of malleoli involved (uni-, bi-, or trimalleolar) was assessed using multivariable ordered logistic regression analysis. The mean age of the patients was 50.9 ± 16.9 years, and 461 (55%) were female. On multivariable analysis, BMI and male sex were associated with having a more proximal fibula fracture using the Weber classification, with an odds ratio (OR) of 1.07 (95% confidence interval [CI] 1.04 to 1.11; $p < .001$) per 1 kg/m^2 increase and OR of 2.96 (95% CI 2.13 to 4.11; $p < .001$) compared with female sex, respectively. Age was not associated with this fracture classification. In an analysis of uni-, bi-, and trimalleolar fractures, age per 10 years showed higher odds (OR 1.24, 95% CI 1.14 to 1.36; $p < .001$) and male sex lower odds compared with female sex (OR 0.36, 95% CI 0.27 to 0.48; $p < .001$) of having trimalleolar fractures than uni- or bimalleolar fractures. An increasing BMI did not seem to be a risk factor, although an inverse U-shaped relationship was seen between quintiles of BMI and the OR of having trimalleolar versus uni- or bimalleolar fractures. Corticosteroid use, diabetes, and smoking status were not significantly associated with the pattern of the ankle fractures using either classification system. In conclusion, an increasing BMI and male sex were risk factors for proximal fibula fractures, and female sex and age were risk factors for bi- and trimalleolar fractures.

Ankle fractures are one of the most common injuries seen by orthopedic surgeons, with an incidence of 101 to 187 per 100,000 inhabitants annually (1–3). With the current epidemic of obesity in Western societies, considerable interest exists regarding the association of increases in body mass index (BMI) and the incidence of fractures (4–6). In population studies, a low BMI and current smoking status were associated with an increased risk of any fracture (7,8). In contrast, a high BMI was associated with an increased incidence of ankle fractures (9–12) and with postoperative complications after surgery for ankle fractures in concert with other risk factors such as age, diabetes, American Society of Anesthesiologists score (13), and functional status (14).

However, few studies have reported on the association of BMI and other risk factors with the pattern of ankle fractures (15–17). The proportions of overweight and obese patients were larger among 24 patients with displaced fractures than among 24 patients with undisplaced fractures (15), and obese patients had more Orthopaedic Trauma Association (OTA) (18) type B and C fracture types than did nonobese patients (19). A recent retrospective study of 280 patients assessed the risk factors for the severity of ankle fractures according to the Weber classification (20) and reported that patients with a

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BMI ≥30 kg/m^2, male sex, and age ≤25 years had greater odds of having a more proximal fracture (16).

A number of classification systems are available for ankle fractures, including those of Lauge Hansen and Müller/AO/OTA (18,21). The complex nomenclature of the various subgroups has, however, precluded them from widespread use (22). In clinical practice, simpler classification systems are often used, such as the Weber classification (20) or a division into unimalleolar, bimalleolar, and trimalleolar fractures, modified after the major categories of the Broos and Bisschop system (23). The uni-, bi-, trimalleolar classification can also be considered a stability-based classification that can guide treatment and has prognostic value (24,25).

The objective of the present study was to assess the association of BMI with the pattern of ankle fractures using 2 classifications system, the Weber classification and the number of malleoli involved (uni-, bi- or trimalleolar), after adjustment for age, sex, and other possible confounding variables.

Patients and Methods

Subjects and Study Design

The present study was a retrospective cohort study of patients who had received surgical treatment (open reduction and internal fixation) for unstable and closed ankle fractures at 2 Norwegian hospitals (Akershus University Hospital and Østfold Hospital). These 2 hospitals have a combined geographic catchment area of about 730,000 inhabitants. All patients aged ≥18 years, who were living in the catchment area and were treated for unstable and closed ankle fractures by open reduction and internal fixation from January 1, 2009 to December 31, 2011 were eligible for inclusion in the present study.

Patients were selected from the information systems of the hospitals using the discharge diagnoses (10th revision of the International Classification of Diseases codes S82.3 to S82.9, S93.2, and S93.4) (26) combined with the surgical procedure codes (Nordic Medico-Statistical Committee Classification of Surgical Procedures codes NHJ00 to NHJ98 and NHE 99) (27). A total of 1149 patients were eligible for medical record review. We excluded 138 patients, including those living outside the hospitals' catchment areas, those with misclassified fractures types or year of fracture, those who had experienced polytrauma or high-energy trauma (motor vehicle or motorcycle accidents, bicycle accidents, skiing accidents, pedestrians injured by any of these, and falls from a height of ≥3 m), those conservatively treated, and patients with cognitive problems or apoplexy who were unable to respond to the questionnaires.

Of the remaining 1011 patients, 837 had information available for BMI and current smoking status, had classifiable fractures according to 1 of the 2 classification systems, and were available for analysis. Details of the exclusions are shown in the Fig..

The study was approved by the Norwegian Social Science Data Services (approval no. 28813/5) and the Regional Committees for Medical and Health Research Ethics, Health Region South East (approval no. 2012/384).

Medical Record Review and Variables

All electronic medical records and radiographs were reviewed by 1 of us (M.G.N. or U.S.) to verify the recorded diagnosis and procedures and to collect information on the demographics (age at trauma and sex), BMI, physical status before surgery (American Society of Anesthesiologists classes I to III: I, completely healthy fit; II, mild systemic disease; and III, severe systemic disease) (13), diabetes (yes or no), corticosteroid use (yes or no), current smoking status (yes, no, or unknown), fracture site (left or right), fracture classification (see the next section), and treating hospital.

Fracture Classification

The radiographs of the patients were classified for descriptive purposes using the Weber classification and as uni-, bi-, and trimalleolar fractures (23). The fracture

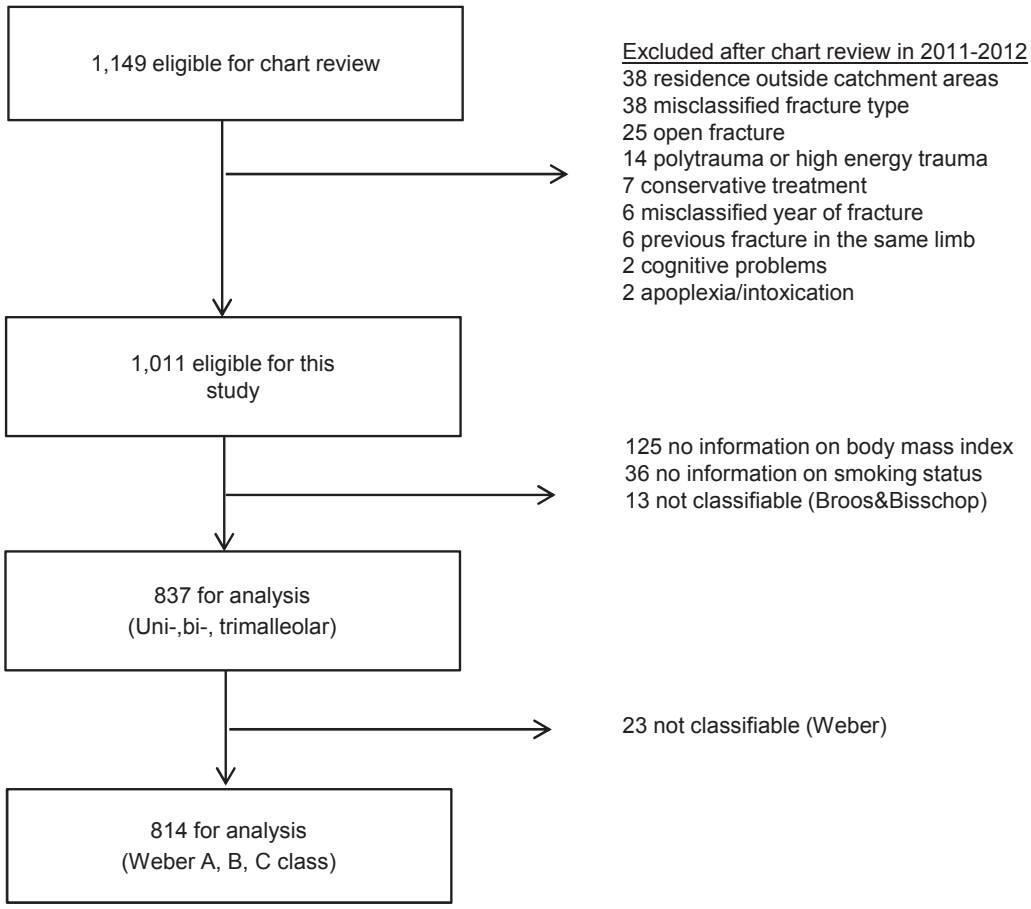

Fig. Flow chart of the study.