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Original article

Correlation between obesity and severity of distal radius fractures

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ABSTRACT

Introduction: The incidence of obesity has increased significantly worldwide. Our hypothesis was that patients with obesity have a more severe distal radius fracture and we realized a study to evaluate this correlation between obesity and severity of distal radius fractures caused by low-energy injuries.
Materials and methods: A total of 114 patients with distal radius fracture were examined in a cross-sectional, observational study. Fractures were classified according to the international AO-Müller/Orthopedic Trauma Association (AO/OTA) classification in order to determine the severity. The patient's Body Mass Index (BMI) was calculated and a Pearson correlation was performed.
Results: The patients were predominantly female, and left side was more frequently affected. Most of the fractures were AO/OTA type A (71 patients). The majority of the involved patients in our study were overweighed or obese. We do not observe a direct correlation between grade of obesity and distal radius fracture severity.
Conclusions: Based on the results of this study obesity and severity of distal radius fractures do not correlate.
Level of evidence: Prognostic. Level IV. Case series.

1. Introduction

The incidence of obesity has increased worldwide by more than two-fold in the last 20 years [1]. More than 70% of adults in our region are overweight, and 32% are obese [2]. In France, around a third of the population (32.3%) have overweight, even up to a 15% of the population have obesity [3].

Obese patients have a 48% increased risk for trauma, including minor injuries and fractures. In addition, obesity is associated with an increase in injuries to the upper limbs resulting from falls from an individual's own height [4]. Reports have shown that up to 28% of women aged 75 years and under with fractures resulting from a low energy mechanism are obese [5]. Obesity was associated with an increase in the rate of falls from 24% to 92% [6].

In both, obese and non-obese patients, an increased incidence of fractures in relation to age [7], as well as a relationship between the incidence of fractures and a history of previous similar fractures, the use of glucocorticoids, and a history of maternal hip fractures, have been observed [8]. However, a higher frequency of fractures resulting from falls has been observed in obese than in non-obese women, as obese women use their upper extremities more extensively to facilitate standing from a seated position [9]. Obese patients have difficulty in deambulation, which can causes falls, and this low-energy trauma, can result in comminuted fractures with serious injuries to the skin and soft tissue, mainly in the distal ends of the long bones, and these low energy injuries, are more frequent in the upper extremity [3]. Additionally, these patients tend to have poor general health [9].

In men, the association between obesity and hip fractures has been shown to be partially dependent on physical constitution, suggesting that the risk of falls is greater for obese men [10]. Regarding the association between obesity and fractures in postmenopausal women, it has been found that the prevalence of fractures in obese and non-obese women is similar (17.3% vs. 16%); however, 41.4% of all fractures occurred in obese patients, suggesting that obesity is not a protective factor against fractures [11].

In contrast, some studies indicate that a low BMI is associated with an increased risk of fractures, mainly due to low bone mineral density, while a high BMI appears to have a protective effect [12]. The association between a low body mass index (BMI) and hip fractures is partly independent of bone mineral density, possibly as a result of increased fragility and risk of falling. However, the relationship between BMI and fracture risk is non-linear, and an increased risk gradient is observed in patients with BMI values

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lower than 20 kg/m^2 [12]. This observation is similar to another report in which the association between a change in BMI and risk of fractures in patients of both sexes was examined. The authors found that a reduction in BMI was associated with an increase of non-vertebral fractures in non-smoking patients; however, this association was not observed in patients who smoked [13].

In an evaluation of postmenopausal women who participated in the Study of Osteoporotic Fractures (SOF) and were followed for 11 years, the incidences of non-vertebral fractures were 37.5% and 44% in obese and non-obese women, respectively [8]. In addition, others have found a positive association between BMI and vertebral fractures [14,15]. We hypothesized that patients with obesity have a more severe distal radius fracture according to the AO/OTA classification system. We realize this study to evaluate the correlation between obesity and severity of distal radius fractures caused by low-energy injuries, using the AO/OTA classification system with sub-classifications.

2. Materials and methods

This was a cross-sectional observational study of consecutive patients who received outpatient consultations for follow-up of primary care in the Emergency Department, in a year time frame. The inclusion criteria consisted of skeletally mature patients with distal radius fractures caused by a low-energy mechanism (falls from standing or walking position exclusively), regardless of gender, initially evaluated by our service, with original radiographs of their injury to perform classification. Were excluded associated fractures that occurred in other locations of the body, amputations of any limb, patients in wheelchairs or who were bedridden, and pathological fractures, also excluded patients with associated diseases that were diagnosed and/or treated such as osteoporosis or osteopenia, rheumatoid arthritis, diabetes mellitus, and cancer in any region of the body.

During the consultation, patients were invited to participate in the study, and they were asked to read and sign an informed consent form approved by the Ethics Committee of the institution, which explained the purpose of the study. For the patients who agreed to participate, measurement of body mass was obtained using a floor scale, with light clothing and no shoes, and their height was measured. Subsequently, calculations were performed to obtain the BMI of each patient; these measurements were obtained during their first visit after treatment of the fracture. All emergency radiographic studies were evaluated by the same investigator and classified according to the international AO-Müller/Orthopedic Trauma Association (AO/OTA) classification with all types and subtypes included. The data collected from the patients included gender, age, dominant side, and side affected by the fracture. Besides divided BMI and the severity of distal radius fractures into two groups normal BMI/overweight and Classification A of AO/OTA (less severe) and Classification B and C from AO/OTA classification (more severe). With this variables a cross tabulation was made, searching for a risk estimate.

3. Statistical analysis

Variables such as gender, age, height, weight, BMI, dominate side, affected side and AO classification was evaluated. A Pearson causal correlation coefficient was calculated to assess the relationship between the degree of severity of the distal radius fracture according to the AO classification and the BMI (M: 29.79, SD: ±5.87) of the patients.

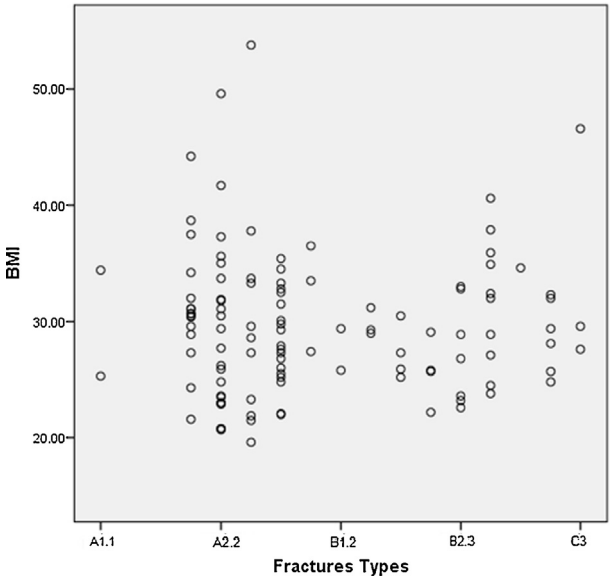

Fig. 1. The data did not show correlation between BMI of the patient and severity of fracture.

Table 1
Distribution of type of fracture and grade of obesity.

	Type A	Type B	Type C	Total
Normal weight	17 (73.9%)	4 (17.3%)	2 (8.7%)	23
Overweight	17 (45.9%)	15 (40.5%)	5 (13.5%)	37
Obesity	37 (68.5%)	12 (22.2%)	5 (9.2%)	54

4. Results

4.1. Demographic data

A total of 114 consecutive patients were included, all with a low energy fracture, of which was 30 male patients (26.3%), 84 female patients (73.6%), with a mean age of 52.9 years (range 18–84 years), and 49.1% of the patients were older than 65 years. The affected side was right in 48 patients (42.1%), and left side in 66 patients (57.8%). Eight patients declined participate.

4.2. BMI and severity of fractures

The average height of the included patients was 158 cm (range 139–178 cm), and the average weight was 74.7 kg (range 45–127.6 kg), corresponding to a BMI of 29.7 kg/m^2, which is in the overweight range. In total, 20.2% of our patients had a normal BMI (<25), 34.2% were overweight (BMI 25–30), and 45.6% were obese (BMI > 30).

Was observed no correlation between the AO/OTA types of fracture and the degree of obesity ($r = 0.001$, $n = 114$, $p = 0.994$). A scatter plot summarizes the result (Fig. 1).

Regarding the type of fracture in relation to the body weight of the patients, we found that in all patients, type A fractures were the most common, and the most severe fracture type, type C, was the least common type in all patients (normal weight, overweight, and obese) (Table 1).

The patients were divided into three groups according to his age, with average ages of 43 years, 53 years, and 65 years, and the frequency of distal radius fracture in these groups were 26.3%, 24.6%, and 49.1% of patients, respectively. When divided the patients into two groups (less severe and BMI; and more severe and BMI) we found, that there was an odds ratio of 1.296 for a severe radius

fracture in obese persons. And obese patients have a relative risk of 1.049 times as more likely to have a severe radius fracture.

5. Discussion

Obesity is increasing worldwide with various subsequent problems as diabetes mellitus, metabolic syndrome, myocardial infarction, and is not only reflected by metabolic diseases and their costs but also by orthopedic problems such as fractures [1,3]. There are several problems in obese patients with an orthopedic or trauma condition, this include difficult to carry out appropriate imaging studies, since in this patients it is usually necessary to increase the voltage of the X-ray, with the consequence of loss of contrast. Moreover, the skin folds and subcutaneous fat, often impede visualization of bony structures [3]. The infection rate in obese patients, is up to 10%, when it is associated with diabetes mellitus. Plus, obese patients presents a complications rate almost until seven times more [3].

There is a discrepancy in the literature regarding whether obesity reduces the severity of fractures or increases their frequency. Our results show that obese individuals are more susceptible to a distal radius fracture, which is supported by the literature [4], but there are no correlation between severity in AO/OTA type fracture and obesity. However our results shown that an obese person has a 56% probability to present a severe distal radius fracture. Recently in a retrospective study, a greater risk (62%) was identified, in obese patients to present a complex distal radius fracture, particularly in elderly patients. Besides they also identified that male gender, high BMI and elderly as risk factors to have a complex fracture [16]. In a retrospective analysis, it was found that obese patients did not show a more severe injury, after an accidental fall, however, the length of hospital stay was higher in obese patients; [17] lesions of obese patients have different characteristics than patients with normal weight, without presenting lesions more complex [18].

Distal radius fractures show a predilection for the female gender, [19] which is consistent with our results, as we found a female to male ratio of 2.5:1. Furthermore, we observed that most of our patients were right side dominant. However, the left side was most frequently affected (non-dominant side). This is consistent with results obtained by Sran et al. [20] who concluded that older women absorbed 45% less load in the dominant arm in falls from their own height.

One study was conducted to determine the value of overweight status/obesity as a risk factor for orthopedic conditions by comparing patients who visited the emergency room or received medical consultations with a reference population. The authors found that patients who visited the emergency room with a fractured ankle had a significantly higher BMI than the reference population. In addition, patients who received orthopedic consultations also had a higher BMI than the reference population, suggesting that obesity caused fractures or orthopedic conditions rather than acting as a protective factor [21].

Overweight status and obesity are considered protective factors for bone health. A positive association has been demonstrated between body weight and/or BMI and bone mineral density, resulting in a protective effect against osteoporosis and fractures. The main explanation is that greater weight produces greater mechanical load on the bones, resulting in subsequent bone remodeling to resist this load [22].

Two previous studies [23,24] examined the risk of non-vertebral fractures. One found that involuntary weight loss substantially increased the risk of fractures because of fragility (proximal femur, pelvis, and proximal humerus) in elderly women [23]. The other study did not find an increase in the non-vertebral fracture risk with weight loss [24]. Likewise, in our study, when examining the correlation between BMI and the degree of severity of the fracture, according to AO/OTA classification, we did not find any correlation between these parameters, i.e., obese patients did not experience more severe fractures than those with overweight status or normal weight. However, obese patients accounted for 45.6% of fractures in the studied cases and, together with overweight patients, accounted for 79.8% of fractures in our study.

Regarding the severity of fractures, Bostman et al. [25] examined the relationship between BMI and fractures in 4012 adults with elbow and ankle fractures and concluded that severe injuries that required surgical treatment were more common in obese patients. King et al. [26] found similar results while examining 280 ankle fractures using the Weber classification; Weber C fractures were 1.78 times more common in obese individuals than in non-obese individuals, but the severity of fractures in our patients was not associated with obesity.

Regardless of bone mineral density, a low BMI in men and women is associated with a significantly increased risk of age-specific fractures; while for patients with a high BMI, the risk of future fractures is decreased. They found that the risk ratio per unit increase in BMI was 0.98 (95% CI, 0.97–0.99) for any fracture, 0.97 (95% CI, 0.96–0.98) for osteoporotic fractures, and 0.93 (95% CI, 0.91–0.94) for hip fractures, and concluded that a low BMI confers a risk of importance for all fractures, independent of age and gender [12].

Based on the results of our study, obesity grade and severity of distal radius fracture do not correlate. Additionally, distal radius fractures were primarily observed on their non-dominant side, the majority of patients affected were older than 65 years.

6. Limitations

One of the weaknesses of our study was that we did not measure the bone mineral density of the patients and performs a more exhaustive analysis or test for a positive correlation. Besides we evaluated the distal radius fractures only with X-ray in two positions, we didn't study the patients with other additional image study like CT.

7. Future directions

Treat to determine the true relationship between bone mineral density and obesity, and fracture frequency.

Disclosure of interest

The authors declare that they have no competing interest.

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