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Impact of metabolic syndrome on patient outcomes of supination-external rotation ankle fracture

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ABSTRACT

Metabolic syndrome has been known as a risk factor for morbidity following orthopedic procedures, yet its impact on surgical treatment of ankle fractures remains unclear. The aim of this study was to compare the patient outcomes of surgical treatment of supination-external rotation ankle fractures in patients with and without metabolic syndrome. This study was designed as a retrospective matched case-control study. Forty-nine patients with supination-external rotation ankle fracture and metabolic syndrome were age-, sex-, and fracture type-matched with 49 controls without metabolic syndrome. Olerud-Molander Ankle Score (OMAS), Visual Analog Scale (VAS), Kellgren and Lawrence (K&L) scale, and complications were assessed at final follow-up. The mean postoperative follow-up was 19.5 months (range, 13–44). The OMAS measurements in the metabolic syndrome group were lower than those in the control group ($p = 0.006$) and the VAS for pain measurements in the metabolic syndrome group were greater than those in the control group ($p < 0.001$). The K&L scale and complications did not differ significantly between the two groups. Patients with metabolic syndrome are at risk for higher pain scores and lower functional outcomes after surgical treatment for supination-external rotation ankle fracture. These results suggest that metabolic syndrome should be treated together with ankle fractures.

Introduction

Ankle fractures are one of the most common injuries encountered by orthopedic surgeons. They have increased in frequency due to growth in the number of people involved in athletics and the size of the elderly population [1–3]. The outcomes of these ankle fractures are known to be affected by associated medical comorbidities, such as diabetes or severe osteoporosis [4–6]. However, while surgical procedures for treating ankle fractures are well established, identification and prevention of poor outcomes in patients with medical comorbidities, which have recently increased, are still insufficient.

Metabolic syndrome is a constellation of medical conditions arising from abdominal obesity, hypertension, insulin resistance, and dyslipidemia [7]. The prevalence of metabolic syndrome has increased to 25% of the adult population due to aging and the obesity epidemic in industrialized countries; the result is that this condition poses a major public health challenge [8,9]. Regarding the association between metabolic syndrome and incidence of fracture, many studies have reported various results, but meta-analyses have found that metabolic syndrome has no explicit effect on the incidence of bone fractures, or have even shown a lower fracture risk [10,11].

Unlike studies on the incidence of fractures, few studies have explored the impact of metabolic syndrome on the surgical outcomes of ankle fractures. Sadighi et al. [12] reported a higher rate of nonunion in patients with metabolic syndrome than in those without it, and Menendez at al [13]. reported increased risk for in-hospital complications and a less rapid return of independent functional mobility in patients with metabolic syndrome who sustained an isolated ankle fracture. However, none of these studies investigated the clinical and radiological outcomes of ankle fractures in patients with metabolic syndrome. If metabolic syndrome affects the surgical outcome of patients with ankle fractures, it is clinically important because these patients need more aggressive post-operative management than those without metabolic syndrome.

The aim of this study was to compare the clinical and radiographic outcomes of surgical treatment of ankle fractures in patients with and without metabolic syndrome. The authors hypothesized that patients with metabolic syndrome would show worse surgical outcomes for supination-external rotation ankle fractures than would patients without metabolic syndrome.

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Methods

After local ethics committee approval, we conducted a retrospective review of the medical records of patients who had undergone surgical treatment for supination-external rotation ankle fracture between January 2013 and December 2016. All surgeries were performed by a single senior orthopedic surgeon. Patients with less than 1 year of follow-up, concomitant tibia shaft fracture, open fracture, history of previous fracture, or other notable ankle injury, or who were younger than 18 years (skeletally immature), were excluded from the study. Patients with marked comminution or displacement of articular surfaces considered for primary external fixation were also excluded.

According to the National Cholesterol Education Program (NCEP) Adult Treatment Panel (ATP) III definition [7], metabolic syndrome is defined as the presence of at least three of the following five criteria: (1) a clinical diagnosis of diabetes treated with oral hypoglycemic medication or insulin, or a fasting serum glucose level of 110 mg/dL or higher, (2) arterial blood pressure of 130/85 mm Hg or higher, or current use of antihypertensive medication, (3) a plasma triglyceride level of 150 mg/dL or higher, (4) a high-density lipoprotein cholesterol level of less than 50 mg/dL for females or less than 40 mg/dL for males, and (5) a waist size greater than 88 cm for females or 102 cm for males. The modified NCEP ATP III criteria suggest that the cut-off points for waist circumference should be specific according to ethnicity. In individuals of Asian origin, a cut-off of 90 cm in men and 80 cm in women is used [14]. After reviewing the medical records based on these criteria, patients were grouped by the presence of metabolic syndrome.

Clinical outcome

As a primary outcome measure, we used the Olerud-Molander Ankle Score (OMAS) [15], which is a validated patient-reported outcome measure for ankle fractures. The Visual Analog Scale (VAS) [16] for pain was used as a secondary outcome measure. The OMAS and VAS for pain were evaluated on all follow-ups, but the analysis used the scores from patients' final follow-ups.

Radiographic outcome

To evaluate radiographic changes after ankle fracture, the Kellgren and Lawrence (K&L) scale was used [17]. The K&L scale was developed to evaluate osteoarthritis in several joints and is validated by radiographic assessment of ankle posttraumatic osteoarthritis [18]. Two orthopedic surgeons independently analyzed the K&L scale while blinded to the presence of metabolic syndrome. In cases of disagreement, the final scale was decided by consensus.

Complications

Postoperative complications were investigated through the review of medical records by two of the authors, and were classified into categories such as implant failure, superficial infection, deep infection, wound dehiscence, and so on. For simplicity of analysis, complications were dichotomized according to their presence or absence.

Sample size calculation and sampling

In a pilot study of 20 patients from each group, OMAS was 74.2 (standard deviation [SD], 14.2) in patients with metabolic syndrome and 82.5 (SD, 14.8) in patients without metabolic syndrome. Based on this data, 98 patients, with an allocation ratio of 49:49, were sufficient to provide 80% power with a 2-side level of 0.05, showing a statistically significant difference between the two groups. We performed random sample selecting for metabolic syndrome, as well as case-control matching based on gender, age, and fracture type for non-metabolic syndrome, using SPSS v20.0 (SPSS, Inc., an IBM Company, Chicago, IL, USA).

Statistical analysis

The Kolmogorov-Smirnov test was used to identify the normal distribution of the variables. The demographics, clinical outcomes, and radiographic outcomes of the two groups were compared using independent *t*-tests for continuous variables, and Chi-squared or Fisher's exact tests for categorical variables. Statistical significance was accepted when $p < 0.05$. The statistical analyses were performed with SPSS v20.0.

Results

The age and sex of the metabolic syndrome group were similar to those of the control group. In addition, there were no significant differences in the follow-up period, nor other variables that may have affected the outcomes differently between the two groups. However, the body mass index (BMI) of the patients in the metabolic syndrome group was significantly greater than that of the control group (Table 1).

Table 1
Patient characteristics.

Variables	Metabolic syndrome (n = 49)	Non-metabolic syndrome (n = 49)	p-value
Mean age, y (range)	59.8 (44–76)	58.6 (49–75)	0.510
Gender, n			
Female	26	26	1.000
Male	23	23	
BMI (kg/m^2)	30.8 (25.2–36.6)	25.1 (18.5–31.1)	< 0.001
Fracture type, n			0.834
SER II	4	5	
SER III	2	3	
SER IV	43	41	
Occupation[a], n			0.681
White collar worker	14	13	
Blue collar worker	14	18	
Service worker	21	18	
Follow-up, mo (range)	20.2 (15–44)	18.7 (13–34)	0.106

[a] White collar workers were defined as salaried professionals or educated workers; blue collar workers were defined as those performing manual labor; service workers were defined as those working in a service industry.

Analysis of OMAS showed a significant difference between the groups, in that OMAS measurements in the metabolic syndrome group were lower than those of the control group ($p = 0.006$) (Fig. 1). Similarly, VAS for pain measurements were significantly greater in the metabolic syndrome group than in the control group ($p < 0.001$) (Fig. 2), which indicates a poorer clinical outcome.

On the K&L scale for evaluating radiological changes after ankle fracture, the progression of posttraumatic arthritis was observed in some patients, but no difference was found between the two groups (Table 2).

The overall rate of complications was 10.2% in the metabolic syndrome group and 6.1% in the control group, but no statistically significant difference was found between the two groups (Table 3). With the exception of deep infections, all complications were resolved with non-surgical treatment in the outpatient clinic. There was one readmission for a deep infection requiring debridement in the control group. After repeated debridement and intravenous antibiotic treatment, the patient made a full recovery without implant removal.

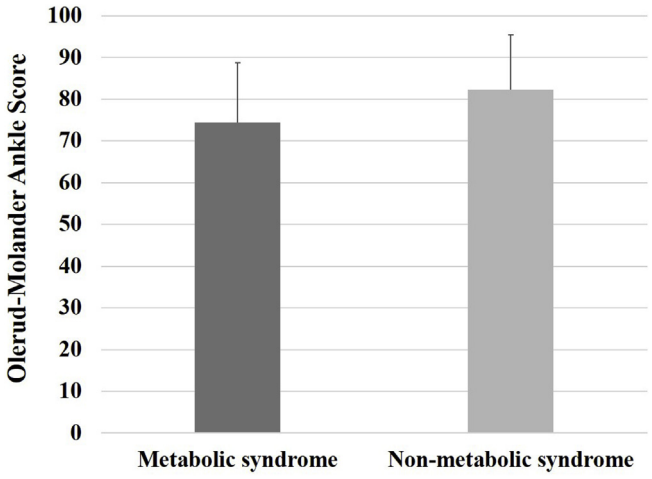

Fig. 1. Olerud-Molander Ankle Score (OMAS). OMAS measurements in the metabolic syndrome group were significantly lower than those of the non-metabolic syndrome group.

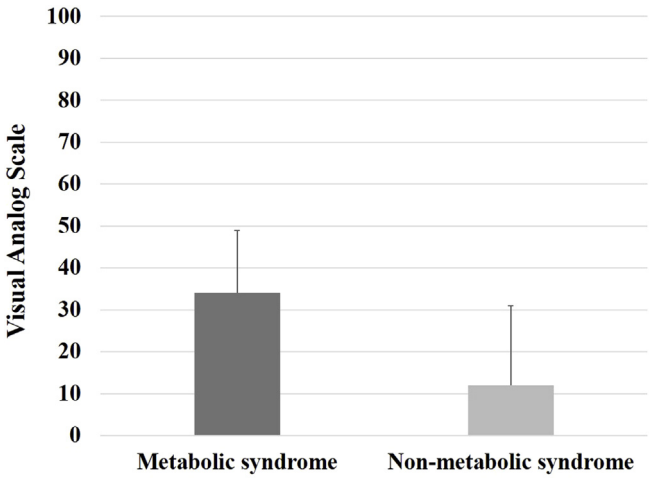

Fig. 2. Visual Analog Scale (VAS) for pain. VAS for pain measurements in the metabolic syndrome group were significantly higher than those of the non-metabolic syndrome group.

Table 2
Posttraumatic osteoarthritis.

Variables	Metabolic syndrome (n = 49)	Non-metabolic syndrome (n = 49)	p-value
K&L scale			0.764
0	37	34	
1	10	12	
2	2	3	
3	0	1	
4	0	0	

K&L, Kellgren and Lawrence.

Table 3
Postoperative complications.

Variables	Metabolic syndrome (n = 49)	Non-metabolic syndrome (n = 49)	p-value
Complication			0.786
Implant failure	0	0	
Superficial infection	2	1	
Deep infection	0	1	
Wound dehiscence	2	0	
Others	1	1	

Discussion

The primary finding of this study is that the surgical treatment for supination-external rotation ankle fracture in patients with metabolic syndrome showed worse clinical outcomes in terms of the OMAS, and VAS for pain than did patients without metabolic syndrome. On the other hand, there were no significant differences in the rate of complications or the K&L scale between the two groups. These findings indicate that when patients with metabolic syndrome sustain ankle fractures, they should be informed that their clinical outcomes may be worse, and the ankle fracture treatment should be managed together with treatment for metabolic syndrome.

Metabolic syndrome includes diabetes, which is a well-known risk factor for less favorable outcomes after surgical treatment of ankle fractures [4,6,19]. Several studies have demonstrated that patients with diabetes have a higher rate of complications and more severe complications than do other patients, which cause unfavorable clinical outcomes. Obesity is also a component of metabolic syndrome. Some authors have reported that obesity is a factor contributing to negative postoperative outcomes in ankle fracture surgeries [20,21]. However, there is also evidence that obesity does not affect the clinical outcomes of ankle fractures [22], so the role of obesity in ankle fracture outcomes remains controversial.

Beyond the negative impacts of each individual component of metabolic syndrome, metabolic syndrome as a whole can create a vicious circle of sedentary behavior and low physical activity [23,24]. In addition, some studies have found that metabolic syndrome has been linked with psychological depression [25–27]. Considering these factors and their negative effects on postoperative rehabilitation in other fractures [28,29], we hypothesized that the physical and psychological issues accompanying metabolic syndrome would cause poorer clinical outcomes in patients with metabolic syndrome in this study.

In contrast to the clinical outcomes that showed differences between the two groups, the difference in the rates of complications between the two groups was not identified as statistically significant. However, because the rate of complications after ankle fractures is not high, a post hoc power analysis indicated that the

power for rate of complications in this study is 0.015, which is not sufficient to verify a difference between the two groups. Unlike the previous nationwide database studies showing a higher rate of complications in the metabolic syndrome group [6,13], this study investigated a database from an individual institution. For this reason, the authors deduce that it is likely that a statistically significant difference does exist between the two groups, despite the fact that a statistically significant difference was not found in this study (Type 2 error).

This study has two limitations. First, among the types of fractures within the Lauge-Hansen classification system [30], the authors included only the supination-external rotation type of ankle fracture. The type of ankle fracture is determined depending on the severity of the fracture and is associated with different clinical outcomes. Because obesity as a component of metabolic syndrome affects fracture severity [31], the authors decided to include only supination-external rotation fractures, which are the most common type, to minimize the bias from a variety of fracture types affecting clinical outcome differences between the two groups. Although it may be a drawback that the results of this study cannot be applied to all ankle fractures, this allows a more accurate assessment of the impact of metabolic syndrome on the outcome of ankle fractures in general, and supination-external rotation fractures in particular. Second, the authors reviewed radiographs to evaluate posttraumatic arthritis changes after ankle fracture. However, when considering the point that posttraumatic osteoarthritis can initially occur a long period of time after the fracture [18,32], the follow-up period of this study is not sufficient to make a definite conclusion. Therefore, additional long-term follow-up is required.

Conclusion

The results of this study indicate that patients with metabolic syndrome are at risk for higher pain scores and lower functional outcomes after surgical treatment for supination-external rotation ankle fracture. Therefore, the authors suggest that these patients should manage metabolic syndrome together with ankle fracture treatment in consideration of worsening clinical outcomes associated with metabolic syndrome.

Author contributions

Young Hwan Park: Lead investigator and first author.
Woon Kim: Data analysis and manuscript review.
Ji Hyun Park. Choi: Data analysis and manuscript review.
Hak Jun Kim: Corresponding author, primary surgeon.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the contents of this study.

Conflict of interest statement

None of the author of this paper has a financial or personal relationship with other people or organization that could inappropriately influence or bias the content of the paper.

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