Journal of
Kerman University of Medical Sciences
https://jkmu.kmu.ac.ir
10.34172/jkmu.2023.37
Vol. 30, No. 4, 2023, 224-228

Original Article

Open Access
Publish Free

Comparison of Lower Extremity Long Bone Fracture Surgery Results between Obese and Non-obese Patients

Nasrollah Jamshidi Gohari[1], **Mahmood Karimi Mobarake**[1], **Amirreza Sadeghifar**[1*]

[1]Department of Orthopedics, School of Medicine, Kerman University of Medical Sciences, Kerman, Iran

Abstract

Background: Obesity is a growing epidemic in developed countries which leads to an increase in the percentage of obese people in the orthopedic trauma population and affects patients' postoperative period. Lower extremity long bone fractures are among the most common fractures and lead to significant complications, prolonged hospitalization, and heavy financial burden on the community health networks.

Methods: In this cohort study, all patients with lower extremity long bone fractures (tibia or femur) treated in Bahonar hospital in Kerman were included using the simple sampling method. Then, they were divided into two groups based on BMI (patients with BMI greater than or equal to 30 were considered obese, and with BMI less than 30 were considered non-obese) and followed up for one year after treatment.

Results: Our study was conducted on two groups, each including 65 people, of obese and non-obese people with lower extremity fractures. In statistical studies, no significant difference was found between the obese and non-obese groups in terms of underlying disease ($P=0.1$), fracture site ($P=0.130$), open or closed fracture ($P=0.283$), type of surgery ($P=0.217$), and fracture complications ($P=0.699$).

Conclusion: According to this study, there is no significant relationship between the complications of lower extremity long bone fractures in obese and non-obese people; it seems that after the incidence of fracture, mostly systemic complications should be considered in obese people. Finally, considering the differences between the results of this study and similar studies and genetic and ethnic differences in other parts of Iran, conducting further studies in this field with larger sample sizes in different geographical locations is recommended.

Keywords: Fractures of long bones, Lower limb bones, BMI

Citation: Jamshidi Gohari N, Karimi Mobarake M, Sadeghifar A. Comparison of lower extremity long bone fracture surgery results between obese and non-obese patients . *Journal of Kerman University of Medical Sciences*. 2023;30(4):224–228. doi:10.34172/jkmu.2023.37

Received: October 3, 2022, **Accepted**: March 7, 2023, **ePublished**: August 20, 2023

Introduction

Obesity is a growing epidemic in developed countries (1). The Centers for Disease Control and Prevention (CDC) estimates that 36.5% of adults in the US during 2011-1014 were obese (BMI > 30 kg/m^2), accounting for 66 million adults (2). Obesity decreases the quality of life and increases related diseases (e.g., diabetes, hypertension) and taxes on people (3,4). The increasing prevalence of obesity will likely lead to an increase in the percentage of obese people in the orthopedic population. The difference between non-obese and obese orthopedic patients is important for their postoperative period. After surgery, obese people are at higher risk for postoperative complications and poor long-term outcomes (5). Once considered a problem in high-income countries, obesity is now rising in low-income countries, particularly in urban settings (3). Lower extremity fracture is a term that includes many fractures. Generally, lower extremity fractures are more common in the elderly, are associated with significant complications, and lead to extended hospitalization. These costly fractures are often caused by trauma and place a heavy financial burden on community health networks (6). Being overweight may protect the individual against bone loss by increasing estrogen, converting androstenedione to fat cells, and decreasing the concentration of sex hormone-binding globulins. In addition, the effect of body weight and fat mass can be another factor stimulating bone formation. Moreover, adipose tissue acts as a storage source for steroid hormones. Studies confirm that estrogen has inductive effects on the expression of osteoblast genes (6). Reports indicate that estrogen promotes DNA replication, increases bone matrix protein production, and acts as a mitogen for osteoblasts. This hormone increases the expression of alkaline phosphatase and collagen type 1, while its absence increases osteocalcin expression and collagen. In addition, estrogen stimulates growth hormone-expressing receptors and progesterone, and it also increases growth factors and decreases bone resorption and the effect of proteolytic enzymes by regulating the parathyroid

*Corresponding Author: Amirreza Sadeghifar, Email: sadeghifar@kmu.ac.ir

hormone in osteoblasts (7). In a study done in England to compare the lower extremity fractures in obese and non-obese children aged 2 to 14 years from 2004 to 2010, there were 78 obese children and 278 non-obese children. Pelvis, bilateral tibia, and femoral fractures, intensive care unit (ICU) stay, and mortality were more common in obese patients (8,9,10). Considering the prevalence and cost of these fractures, high complications, and mortality and due to the difference in the prevalence of fractures from one country to another based on age, sex, race, and the limited research on the impact of obesity on surgical outcomes, this study aimed to investigate the relationship between lower extremity fracture surgery results in obese and non-obese patients.

Material and Methods

This cohort study was conducted on 130 patients (selected by simple sampling method) with lower extremity long bone fractures (tibia or femur) treated in Bahonar hospital in Kerman. Patients entered the study after the study objectives were explained to them and informed consent was obtained. The exclusion criteria were previous fractures in the same limb, other concomitant fractures in the upper limbs, and BMI below 20. The patient information form inquiring about age, gender, underlying disease, type of surgery, fracture site, and whether the fracture was open or closed was completed. Patients were divided into two groups based on BMI i.e., weight (kg) per square of height (m). According to the definition, people with a BMI greater than or equal to 30 were considered obese, and less than 30 were non-obese. The weight and height of all patients were measured at the time of admission with a special bed (Figure 1). This bed was made by Pand Co. exclusively for this study, had four weight sensors in the legs and a digital display, and was able to measure the weight of patients in each part of the bed at a gram level. It also had length markings to measure height. Fasting glucose between 100 and 125 was considered pre-diabetic and above 125 diabetic. Patients then underwent follow-up two weeks, one month, three months, six months, and one year after surgery and were studied for complications including infection, non-union or late-healing fracture, re-fracture, need for re-surgery for any reason, thromboembolism, and restriction of movement. The extracted data were statistically analyzed using SPSS software.

Results

Our study was performed on 130 patients with lower extremity fractures, with 65 subjects in the non-obese group and 65 subjects in the obese group, according to BMI. Of these, 38 were women (29.3%), and 92 (70.7%) were men. The mean age of the participants was 33.12 ± 0.17 years, with the lowest and the highest at 16 and 72 years old, respectively.

One hundred-one subjects (77.6%) had no specific underlying disease. Concerning underlying diseases, seven subjects (4.9%) were diagnosed with diabetes, seven (4.9%) with high blood pressure, and nine (7.6%) with cardiovascular diseases. There was no significant relationship between the type of underlying disease in obese and non-obese people ($P=0.1$). Table 1 shows the frequency of other underlying diseases.

The fracture site in 41 patients was the femur and in 43 patients was the tibia, and 13 patients had hip and femoral fractures simultaneously. Table 2 shows the frequency of other fracture sites separately . Statistical studies did not find any significant differences in terms of the fracture site between obese and non-obese people ($P=0.130$).

The type of fracture was open in 18 (27.6%) and 23 (35.3%) patients in non-obese and obese groups, respectively. Statistical studies did not find any differences in fracture type between obese and non-obese people ($P=0.283$).

Figure 1. Bed for measuring patients' weight and height

In terms of surgery performed on studied subjects, three (4.6%) obese and two (3%) non-obese patients were treated non-surgically. Table 3 shows the type of implant. Statistical studies did not find any significant differences in the type of surgery between obese and non-obese people ($P=0.217$).

The frequency of postoperative complications is reported in Table 4, and no significant difference was found between obese and non-obese groups in terms of complications ($P=0.699$). Also, in terms of re-surgery, 11 cases from the obese group and 10 cases from the non-obese group had undergone re-surgery; the difference was not statistically significant ($P=0.0$) despite the higher number of obese individuals. Also, no significant differences were found between complications and the fracture site ($P=0.267$), type of fracture (open or closed) ($P=0.512$), and type of treatment ($P=0.699$).

Discussion

This study investigated the relationship between lower extremity fracture surgery results and obesity in patients. The study results generally showed that there was no significant difference concerning underlying disease, complications, fracture site, type of fracture, and type of surgery between the obese and non-obese groups. Also, no significant relationship was found between complications and type of surgery, fracture site, and fracture type.

Our study also showed that the obese patient group had a higher frequency of underlying diseases; however, there was no significant difference between the two groups. A study by Nguyen et al examined obesity and diabetes in US adults. This study showed that the prevalence of diabetes increased with increasing weight classes (11). In a study by Yang (12), a significant relationship was reported between obesity and blood pressure. The incidence of hypertension increased with an increase in obesity, suggesting that the risk of cardiovascular disease in obese people should be considered more carefully.

A study by Ahmad and and Jones compared the results of acute Achilles rupture surgery in obese and non-obese patients; although in the obese group, there were more wound complications and less healing, in the end, no significant difference was reported between the results in the two groups (5), which is consistent with the results of our study. In contrast, a study by Chen et al compared the surgical outcomes in hallux valgus patients and obese and non-obese patients, and it reported that obese patients were significantly at higher risk of re-surgery and consequently these patients should not undergo hallux valgus surgery (9). However, despite the discrepancy between the results of this study and ours, we should bear in mind that hallux valgus surgery has an inherently high risk for re-surgery and recurrence. Several studies (13-15) also showed that obesity alone is a risk factor for general surgical complications such as surgical infection, more bleeding during surgery, and increased surgery time.

A prospective multinational study by Compston et al compared the fractures in obese and non-obese postmenopausal women in 17 locations in 10 countries. A total of 60,393 women over the age of 55 were diagnosed with fractures, with leg fractures and ankle traumas being more common in obese patients. Obese patients experienced more leg fractures and ankle traumas (10).

Table 1. Evaluation of the frequency of underlying diseases in obese and non-obese patients

Underlying disease	Obese		Non-obese	
	No.	%	N	%
Diabetes	4	6.1	3	4.6
Blood pressure	4	6.1	3	4.6
Diabetes+blood pressure	3	4.6	2	3
Thalassemia	0	0	1	1.5
Cardiovascular diseases	5	7.6	4	6.1
Non-underlying diseases	49	75.3	52	80

Table 2. Evaluation of the frequency of fracture sites in obese and non-obese patients

Fracture site	Obese		Non-obese	
	No.	%	N	%
Femur	21	32	20	30
Tibia	19	29.2	24	36.9
Pre-trochanteric	7	10.7	4	6.1
Distal femur	5	7.6	7	10.7
Pilon	4	6.1	6	9.2
Tibia and femur	9	13.8	4	6.1

Pilon fracture: distal tibia fracture involving ankle joint surface.

Table 3. Evaluation of the frequency of surgery type in obese and non-obese patients

Type of surgery	Obese		Non-obese	
	No.	%	N	%
Nail	24	36.9	22	33.8
PFN	2	3	1	4.6
DHS	2	3	2	3
Ext fixator	7	10.7	9	13.8
Plate	27	41.5	29	44.6

PFN, proximal femur nail; DHS, dynamic hip screw.

Table 4. Evaluation of the frequency of postoperative complications in obese and non-obese patients

Fracture complications	Obese		Non-obese	
	No.	%	N	%
Infection	4	6.1	4	6.1
Non-union	8	12.3	6	9.2
Compartment syndrome	3	4.6	1	1.5
DVT	1	1.5	2	3
Death	1	1.5	0	0

DVT: deep vein thrombosis

However, the study found no significant relationship between fracture sites and obesity.

A study conducted by the University of Tehran (2014) investigating the relationship between bone density and waist size (abdominal obesity), BMI, and history of fracture in the Iranian population showed that in people with a history of fracture, abdominal obesity was significantly higher than in other people, while BMI was not significantly different between the two groups as in our study (16). In a study by Nguyen et al, the results showed that women with hip fractures had significantly lower weight, lower bone density, and lower abdominal fat (11). However, since both studies were retrospective and the fractures had happened in the past (in some of them many years ago) and were not simultaneous with obesity, the results should be interpreted with more caution.

A study by Yang et al (12) in Australia investigated the number of non-pathological fractures caused by minor trauma. Their findings showed that 19 men and 107 women suffered from fractures. Also, the elevation of abdominal fat was significantly associated with an increased risk of fractures, especially in women. The interpretation of study findings reveals that women with abdominal obesity are at higher risk for bone fractures, while such a result was not found in men; this is different from our study where no significant association was found between fractures in men and women.

Also, a study by Prieto-Alhambra et al (13) on menopausal women found that the frequency of fractures was inversely related to the patient's weight. There was also a statistically significant relationship between obesity and fracture in postmenopausal women in terms of the fracture site. Obesity could have prevented hip and pelvic fractures but was associated with an approximately 30% increased risk of developing humerus fractures. The researchers attributed the difference to the type of fall and the protective role of adipose tissue accumulated in certain body parts.

In a study by Weinlein et al, in the United States to assess obesity and its complications in people with femoral shaft fractures, as in our study, there was no significant relationship found between complications after femoral shaft fracture surgery in obese and non-obese people, but mortality rate and systemic complications such as respiratory problems were higher in obese individuals (17).

In another study conducted in the United States from 2005 to 2012 on 14 638 patients with tibia fractures (18), it was found that among patients who underwent surgery, obese people experienced significantly more complications, including infection, non-union, and thromboembolism, which was contrary to the results of our study. However, only tibial fractures were examined in this study, and the type of surgery and complications were not examined.

In a study by Gil et al (19), which examined the effect of obesity on postoperative complications, treatment costs, and length of hospitalization in patients with open ankle fractures, it was found that obesity increased the complications, cost, and duration of hospitalization. In this study, only 10% of patients were in the obese group, and also this study was performed only on open fractures, making it different from our study.

A cohort study by Benedick et al (20), examining the effects of obesity on ankle trauma, also showed that obese people had more ankle dislocations and more wound healing complications, but the need for surgery was the same in both groups; given the fact that there are more diabetics and more drug users in the obese group, these results were expected. A study done by Thorud et al in the United States investigated the effect of obesity on the healing of ankle fractures (21); in line with our study, this study showed no significant relationship between non-union and obesity. However, alcohol-consuming patients in the study showed significantly more non-union. Although underlying diseases were investigated in our study, drug and alcohol consumption was not considered.

Finally, according to a study by Proietto (22) in 2020, there is a relationship between obesity and bones, and there are multiple factors that influence the risk of fracture, including the quality of the bone, the risk of falls, and the padding around the bone. These multiple factors partly explain the finding that obesity protects against fractures in some sites while increasing the risk in other parts of the body. While it is well known that increased weight builds bone, several mechanisms related to obesity make the bone more fragile. These include:

- The increased production of bone marrow fat cells at the expense of bone-forming osteoblasts
- An increase in inflammatory cytokines leading to the activation of bone-resorbing osteoclasts
- Mutations in the FTO gene, and increased osteoblast senescence

However, the relationship between bone and obesity is not unidirectional. There is now evidence suggesting that osteocytes can regulate body weight by acting as weighing machines.

It seems that according to the results of our study and similar studies, obesity cannot be considered a risk factor for complications after fracture treatment, and weight gain mostly causes systemic complications in the body, leading to disability and other problems. Our study has not thoroughly examined systemic complications.

Conclusion

According to this study, there is no significant relationship between the complications of lower extremity long bone fractures of obese and non-obese people, and it seems that systemic complications in obese people should be monitored after fractures. Finally, considering the differences between the results of this study and similar studies and genetic and ethnic differences in other parts of Iran, further studies in this field with larger sample sizes in different geographical locations are recommended.

Authors' Contribution

Conceptualization: Amirreza Sadeghifar.
Data curation: Nasrollah Jamshidi Gohari.
Formal analysis: Nasrollah Jamshidi Gohari.
Funding acquisition: Amirreza Sadeghifar.
Investigation: Amirreza Sadeghifar.
Methodology: Mahmood Karimi Mobarake.
Project administration: Amirreza Sadeghifar.
Resources: Nasrollah Jamshidi Gohari.
Supervision: Amirreza Sadeghifar.
Validation: Mahmood Karimi Mobarake.
Visualization: Amirreza Sadeghifar.
Writing–original draft: Nasrollah Jamshidi Gohari.
Writing–review & editing: Amirreza Sadeghifar.

Competing Interests

The authors declared that there is no conflict of interest.

Ethical Approval

This study was approved by the ethical committee of Kerman University of Medical Sciences(No. IR.KMU.AH.REC.1397.086).

References

1. Sabharwal S, Root MZ. Impact of obesity on orthopaedics. J Bone Joint Surg Am. 2012;94(11):1045-52. doi: 10.2106/jbjs.k.00330.
2. Ogden CL, Carroll MD, Fryar CD, Flegal KM. Prevalence of obesity among adults and youth: United States, 2011-2014. NCHS Data Brief. 2015(219):1-8.
3. Li Z, Bowerman S, Heber D. Health ramifications of the obesity epidemic. Surg Clin North Am. 2005;85(4):681-701. doi: 10.1016/j.suc.2005.04.006 .
4. Yach D, Stuckler D, Brownell KD. Epidemiologic and economic consequences of the global epidemics of obesity and diabetes. Nat Med. 2006;12(1):62-6. doi: 10.1038/nm0106-62.
5. Ahmad J, Jones K. The effect of obesity on surgical treatment of Achilles tendon ruptures. J Am Acad Orthop Surg. 2017;25(11):773-9. doi: 10.5435/jaaos-d-16-00306 .
6. Theill LE, Boyle WJ, Penninger JM. RANK-L and RANK: T cells, bone loss, and mammalian evolution. Annu Rev Immunol. 2002;20:795-823. doi: 10.1146/annurev.immunol.20.100301.064753.
7. Nakashima T, Hayashi M, Fukunaga T, Kurata K, Oh-Hora M, Feng JQ, et al. Evidence for osteocyte regulation of bone homeostasis through RANKL expression. Nat Med. 2011;17(10):1231-4. doi: 10.1038/nm.2452.
8. Backstrom IC, MacLennan PA, Sawyer JR, Creek AT, Rue LW 3rd, Gilbert SR. Pediatric obesity and traumatic lower-extremity long-bone fracture outcomes. J Trauma Acute Care Surg. 2012;73(4):966-71. doi: 10.1097/TA.0b013e31825a78fa.
9. Chen JY, Lee MJ, Rikhraj K, Parmar S, Chong HC, Yew AK, et al. Effect of obesity on outcome of hallux valgus surgery. Foot Ankle Int. 2015;36(9):1078-83. doi: 10.1177/1071100715581449.
10. Compston JE, Watts NB, Chapurlat R, Cooper C, Boonen S, Greenspan S, et al. Obesity is not protective against fracture in postmenopausal women: GLOW. Am J Med. 2011;124(11):1043-50. doi: 10.1016/j.amjmed.2011.06.013.
11. Nguyen ND, Pongchaiyakul C, Center JR, Eisman JA, Nguyen TV. Abdominal fat and hip fracture risk in the elderly: the Dubbo Osteoporosis Epidemiology Study. BMC Musculoskelet Disord. 2005;6:11. doi: 10.1186/1471-2474-6-11.
12. Yang S, Nguyen ND, Center JR, Eisman JA, Nguyen TV. Association between abdominal obesity and fracture risk: a prospective study. J Clin Endocrinol Metab. 2013;98(6):2478-83. doi: 10.1210/jc.2012-2958.
13. Prieto-Alhambra D, Premaor MO, Fina Avilés F, Hermosilla E, Martinez-Laguna D, Carbonell-Abella C, et al. The association between fracture and obesity is site-dependent: a population-based study in postmenopausal women. J Bone Miner Res. 2012;27(2):294-300. doi: 10.1002/jbmr.1466.
14. Re RN. Obesity-related hypertension. Ochsner J. 2009;9(3):133-6.
15. Tjeertes EK, Hoeks SE, Beks SB, Valentijn TM, Hoofwijk AG, Stolker RJ. Obesity--a risk factor for postoperative complications in general surgery? BMC Anesthesiol. 2015;15:112. doi: 10.1186/s12871-015-0096-7.
16. Ahanjideh F, Keshtkar AA, Payab M, Qorbani M, Shaygan N, Ramim T, et al. Relationship between abdominal obesity, body mass index, and history of fractures with bone density in the Iranian population: a national comprehensive plan for the prevention, diagnosis and treatment of osteoporosis. Iran J Diabetes Metab. 2015;14(3):217-24. [Persian].
17. Weinlein JC, Deaderick S, Murphy RF. Morbid obesity increases the risk for systemic complications in patients with femoral shaft fractures. J Orthop Trauma. 2015;29(3):e91-5. doi: 10.1097/bot.0000000000000167.
18. Burrus MT, Werner BC, Yarboro SR. Obesity is associated with increased postoperative complications after operative management of tibial shaft fractures. Injury. 2016;47(2):465-70. doi: 10.1016/j.injury.2015.10.026.
19. Gil JA, Durand W, Johnson JP, Goodman AD, Daniels AH. Effect of obesity on perioperative complications, hospital costs, and length of stay in patients with open ankle fractures. J Am Acad Orthop Surg. 2019;27(11):e529-e34. doi: 10.5435/jaaos-d-17-00860.
20. Benedick A, Audet MA, Vallier HA. The effect of obesity on post-operative complications and functional outcomes after surgical treatment of torsional ankle fracture: a matched cohort study. Injury. 2020;51(8):1893-8. doi: 10.1016/j.injury.2020.05.006.
21. Thorud JC, Mortensen S, Thorud JL, Shibuya N, Maldonado YM, Jupiter DC. Effect of obesity on bone healing after foot and ankle long bone fractures. J Foot Ankle Surg. 2017;56(2):258-62. doi: 10.1053/j.jfas.2016.11.010.
22. Proietto J. Obesity and bone. F1000Res. 2020;9:F1000 Faculty Rev-1111. doi: 10.12688/f1000research.20875.1.