

## Obesity and fracture healing

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**Abstract:** *Background:* Obesity is an independent risk factor in trauma related morbidity. This study described the prevalence of obesity/overweight in children and adolescents reporting a recent fracture in relation to fracture healing and associated complications. *Methods:* In this prospective randomized controlled study. 52 cases were enrolled with various fractures, who underwent definitive treatment either conservative / operative. All patients were classified in various categories depending upon their BMI, after calculating their height and weight according to WHO standards. All patients were followed up for at least 4 months with monitoring clinically and radiologically at 6th, 12th weeks and there after once a month for evaluation of status of bone healing and complications. *Results:* Average healing time was 8.4 weeks. In case of pre obese it was 7.07 weeks with  $P < 0.09$ . In class I Obese, it was 8.8 weeks with  $P < 0.001$ . In class II Obese, it was 7.6 weeks with  $P < 0.005$  and in class III, it was 9.5 weeks with  $P < 0.005$ . After applying t value and P value we found that there is significant delay in healing time, in patients belonging to higher obese class accompanied by complications. *Conclusion:* We found significant increase in fracture healing time with higher BMI and also associated complications.

**Keywords:** Obesity, Fracture, BMI, Fracture Healing, Complications.

### Introduction

Obesity was traditionally thought to be beneficial to bone and thus to protect against osteoporosis [1-3]. According to the centres for disease control and prevention 1999-2002 statistics. Almost 16% of children and adolescents have a BMI (kg/m<sup>2</sup>)  $\geq$  95th percentile for age and gender and are classified as overweight [4]. The prevalence of overweight has more than tripled in the past three decades [5]. Concomitantly, the prevalence has increased for many obesity related co-morbid conditions [6]. Orthopaedic complications of excess weight in adults include progression of degenerative osteoarthritis and articular cartilage breakdown [7-8], a decline in physical functioning [9] and poorer outcomes after orthopaedic surgery for obesity related disorders [10-11].

Some orthopaedic conditions/disorders that are unique to childhood also have been suggested to be weight related. For example, retrospective analysis of children and adolescents with slipped capital femoral epiphysis and adolescent tibia-vara (Blount's disease) reveal representation of overweight individuals [12-14]. Mechanical loading due to over-weight stimulates bone formation by decreasing apoptosis and increasing

proliferation and differentiation of osteoblasts and osteocyte through the Wnt/bcatenin signaling pathway [15-17]. Therefore, mechanical loading conferred by body weight is part of the assumption that has led to widespread belief that obesity may prevent bone loss and osteoporosis [18-22]. However recent reports have shown that excessive fat mass may not protect humans from osteoporosis and in fact increased fat mass which is associated with low total bone mineral density and total bone mineral content [23-24].

Various studies reported that weight above 95<sup>th</sup> percentile had an increased risk of complications following titanium elastic nailing for femur fractures. The smaller cross-sectional area confers a biomechanical disadvantage that, coupled with the greater body weight, increases the vulnerability to fracture after a fall, entered anthropometric and DEXA bone density data from 50 boys, into a computer simulation to estimate the mean impact force on bone. They predicted that obese patients had a higher likelihood of fracture at low fall heights compared with non-obese patients.

In our study we found that patients were more likely to sustain complex variety of fracture with delay in healing time, making them vulnerable to complications (i.e malunion, nonunion, post-operative infection etc), which made us to evaluate.

**Material and Methods**

A total number of 52 cases with various fractures were enrolled and treated conservatively / operatively at Al-Ameen Medical College and Hospital, Vijayapur, Karnataka between June 2014 to June 2015.

*Inclusion criteria:* Patients regardless of age with high BMI or Obese.

*Exclusion criteria:*

1. Patients with normal weight or BMI.
2. Osteogenesis imperfecta, Chronic Kidney diseases and patients on long term corticosteroid.

BMI was obtained by measuring weight in kilograms and height in meters, and calculated according to standard given by WHO formula as below.

$$BMI = \text{Weight (in kg)} / \text{Height (in meters)}^2$$

Patients were divided into four BMI classes

Under weight	<18.5
Normal range	18.5- 24.9
Over weight	>=25.0
Pre-obese	25.0-29.9
<b>Obese</b>	<b>&gt;=30.0</b>
Obese class I	30.0-34.9
Obese class II	35.0-39.9
Obese class III	>= 40.0

Demographic data including name, age, sex, diagnosis, weight, height, BMI, postoperative complications, length of follow up’s healing time were recorded. Complications like nerve injuries/palsies were diagnosed on motor examination. A sample size calculation was performed to determine minimum number of patients required to detect 20% difference in complexity between BMI classes. Statistical significance was assigned at P <0.05, All results are expressed as mean SD. The data were analyzed using the student’s t- test for paired samples, analyses of variance (ANOVA) and linear regression analysis. A significant level of P - 0.05 was used for all comparisons. All tests were two sided and values of P - 0.05 indicated statistical significance for a power of 80%.

**Results**

Out of 52 cases enrolled for study, 7 cases were excluded, 1 with chronic kidney disease, 2 with a long term steroid therapy, 4 failed to follow up. So total of 45 patients were taken into consideration with a systematic BMI calculation, 45 cases were sorted out in 4 classes. Such that Preobese (25-29.9 BMI) were 15 in number, class I obese (30-34.9 BMI) were 16 in number, class II obese (35-39.9 BMI) were 10 in number and class III obese (40 + BMI) were 4 in numbers.

All these patients who were treated conservatively or operatively were strictly followed up for at least four months, monitoring clinically and radiologically at every 6<sup>th</sup> week, 12<sup>th</sup> week and there after once a month for evaluation of status of bone healing and complications.

BMI range	Healing time of cases in weeks		Normal healing time in weeks		t - value	P - value	Conclusion
	Mean	STDV	Mean	STDV			
25-29.9	7.07	2.71	5.7	1.26	1.72	>0.09	Not significant
30-34.9	8.8	1.73	6.4	0.81	4.32	<0.001	Significant
35-39.9	7.6	1.7	6.2	0.6	2.43	<0.005	Significant
40+	9.5	1.3	6.75	1.5	2.77	<0.005	Significant

The average healing time was 8.4 weeks. While in cases of Pre-obese it was of mean 7.07 weeks with  $P > 0.09$ , In class I obese it was of mean 8.8 weeks with  $P < 0.001$ , In class II of 7.6 weeks with  $P < 0.005$  and in class III it was 9.5 weeks with  $P < 0.005$  [Table No 2]. These differences were highly suggestive of delay in healing process, which was more significant in class two and class three. These results were systematically plotted on a bar diagram showing significant delay in healing time which is more evident in class two and class three obese. The complications include infection, nerve injury, delayed union, malunion, nonunion and implant failure were observed. Occurrence of these complications in various classes of obese patients which is statistically presented in terms of percentage, showed that patients with BMI below 25 showed 16.66% of complication, Preobese individuals showed 73.33%, 68.75% in class I, 80% in class II and 75% in class III, showing average percentage of 97.87%. Comparing the percentage of good results in patients with BMI below 25 to obese classes it was 8.34 to 2.13 [Table No 3].

**Table-3: Data Analysis on number of Complications and Good Results**

BMI Range	Percentage of complications	Percentage of good results	
Below 25	16.66%	8.34%	
25-29.9	75%		
30-34.9	80%	97.87%	2.13%
35-39.9	90%		
40+	75%		

Those patients with complications like wound infection were treated with antibiotics accordingly, who responded well. Whereas patients with non-union, malunion and implant failure underwent repeat surgical procedure.

### Discussion

In this study, we found that obese and overweight patients were more likely to have increased bone healing time and complications. Based on the available literature, obesity appears to affect bone metabolism through several mechanisms. Obesity may decrease bone formation because adipocytes and osteoblasts are derived from common

multipotent mesenchymal stem cells. Bone continuously undergoes a process called modeling/remodeling by bone resorption and bone formation by osteoclast and osteoblast respectively. Bone metabolism is regulated by adipocytes, osteoblasts and osteoclasts. Fat accumulation in bone is closely related to bone formation and resorption. Adipocytes secrete several cytokines such as TNF alpha, IL1, IL6 adiponectin and leptin which are capable of modulating osteoclastogenesis through RANKL (receptor activator of nuclear factor kappa-b) pathway causing bone resorption. According to Framingham study, Felson et al. [18] Increased body weight or BMI is positively correlated with bone mineral density or bone mass. Obesity is associated with low grade chronic inflammation.

In obesity, adipose tissue is infiltrated with an increased amount of macrophages activity and increased bone resorption, which is positively correlated with the upregulation of RANKL. Pro-inflammatory cytokines including TNF- $\alpha$ , IL1 and IL6 are key mediators in the process of osteoclast differentiation and bone resorption. It has also been established that upregulated pro-inflammatory cytokines are primary mediators of osteopenia or osteoporosis. These pro-inflammatory cytokines are capable of stimulating osteoclast activity through the regulation of the RANKL/RANK/OPG pathway. The significant increase in the development of osteoarthritis in obese human subjects is another evidence that chronic inflammation influences bone metabolism.

Comparing the treatment of all fractures between groups, obese patients were more likely to receive operative intervention for their fractures. This is consistent with a study who reviewed 1341 paediatric patients and found that obese patients had higher incidence of orthopaedic surgical intervention. Obese children have more subcutaneous fat around their thighs, making it more difficult to achieve proper cast moulding and fracture stabilization, supporting that conservative line of management will have higher chance of failure leading to complications. Based on the above evidence we found similar findings in

obese patients who were treated conservatively and were found with complications like malunion and nonunion. Fat mass in body may limit the response of total body and regional bone mass to the mechanical force induced by muscle, resulting in reduced skeletal mass relative to body size. In some obese children, this may result in osteoporosis at an age when fracture incidence is highest. Achieving an optimal peak bone mass during adolescence is crucial. The possible detrimental effect of fat on the bone accrual in the face of an increasing incidence of obesity has significant implications for future skeletal health.

### Conclusion

Obesity is associated with delay in bone healing time, thereby increasing associated complications like infection, malunion, nonunion, refracture and implant failure. Our results support the suggestion that fracture risk, musculoskeletal discomfort and impairments in mobility may be health hazards of significant overweight in children and

adolescents. Efforts should be made to encourage health care provider's recognition of the orthopaedic complications of excess weight so that interventions can be initiated. Future studies should investigate the biomechanical principles that underlie the increased prevalence of orthopaedic problems in obesity. Finally, significant overweight children and adolescents should be encouraged to engage in alternative modes of physical activity, such as bicycle riding or swimming, that potentially could alleviate the severity of lower extremity joint loading and discomfort.

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