

SURGICAL TREATMENT OF FEMORAL FRACTURES IN OBESE CHILDREN: DOES EXCESSIVE BODY WEIGHT INCREASE THE RATE OF COMPLICATIONS?

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Background: In light of the increasing rate of obesity among children in the United States, this study examines whether obese children have an increased rate of complications following surgical treatment of femoral shaft fractures.

Methods: A retrospective review of the charts of children between six and fourteen years of age who were treated operatively for a femoral shaft fracture was performed, and complications were identified.

Results: One hundred and three children (104 fractures), with a mean age at the time of injury of 9.3 years, were identified. Fifty-nine fractures were treated with external fixation, and forty-five were treated with an intramedullary rod. Six children (6%) were considered obese, with a weight for age at the 95th percentile or higher. An additional four children were extremely heavy at the 90th to the 94th percentile of weight for age. Three complications occurred in the six obese children, and one complication occurred in the four extremely heavy children. Eleven (12%) of the remaining ninety-three children had a complication. When examined according to treatment groups, the complication rate for heavier children was higher for both the group managed with an intramedullary rod and the group that had external fixation ($p = 0.004$).

Conclusions: Obese children have an increased rate of postoperative complications compared with children who are not obese. Therefore, parents of obese children should be warned that such children may have a potentially increased risk of complications associated with surgical management of a femoral fracture.

Level of Evidence: Prognostic Level II. See Instructions to Authors for a complete description of levels of evidence.

Epidemiologic data suggest that children living in the United States are becoming obese at an increasing rate¹⁻⁴. Data from 1990 to 2000 showed a dramatic increase in the number of obese children, with the most recent estimates showing that 15% of children from six through eleven years old and 16% of children from twelve through nineteen years old were considered to be obese on the basis of body mass index^{2,3}. The rate of increase has been highest among Mexican Americans and non-Hispanic blacks³.

Obesity in children is associated with hypertension, non-insulin-dependent diabetes, and high cholesterol, all of which are risk factors for cardiovascular disease in adulthood. Orthopaedic problems occurring more frequently in obese children include slipped capital femoral epiphysis and tibia vara¹.

As the prevalence of childhood obesity increases, the expectation that there will be more children with femoral fractures who are substantially overweight also increases. In adults, obesity is associated with surgical complications, such as thromboembolic disease, wound dehiscence, and infection, as well as an increase in anesthetic risks^{5,6}. With this background, the aim of this study was to determine whether obesity in children was an identifiable factor associated with an increased rate of complications after surgical intervention. Also, we hoped to determine whether the excessive soft tissues surrounding the femur in obese children made surgery more difficult, resulting in operative times that were longer than otherwise anticipated.

Materials and Methods

An internal-review-board-approved, retrospective chart review spanning the previous seven years was conducted with use of the codes for femoral shaft fractures in the *International Classification of Diseases, Ninth Revision* as well as the



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TABLE I Comparison of Obese and Nonobese Patients

	Subgroups			Total
	Obese	Extremely Heavy	Nonobese	
No. of children	6	4	94	104
Age* (mo)	106 (74-171)	100 (75-117)	113 (72-168)	112 (72-168)
Weight* (kg)	45.9 (24-68)	34.8 (27-40)	32.2 (18-60)	33.1 (18-68)
Side of fracture (R:L)	4:1	2:2	47:48	53:51
Fracture type (open:closed)	1:5	0:4	15:79	16:88
Gender (M:F)	4:2	4:0	63:30	71:32
Fracture location				
Mid-part of shaft	4	2	75	81
Proximal aspect	1	0	10	11
Distal aspect	1	2	9	12
Fracture pattern				
Oblique	2	0	10	12
Spiral	1	0	14	15
Transverse	2	4	37	43
Comminuted	1	0	33	34
Mean operative time (min)	108	80	126	124

*The values are given as the mean with the range in parentheses.

codes for the treatment of femoral shaft fractures in *Current Procedural Terminology*^{7,8}. Only children between six and fourteen years of age were included in the study, as we treat younger children with spica casts and those who are more than fourteen years old with locked intramedullary fixation.

Charts were reviewed for pertinent history, details of treatment, and clinical follow-up of the fracture until healing and resumption of normal weight-bearing. The anesthetic record was used to determine patient weights because, at our institution, the weight of children undergoing surgery is usually obtained as an estimate from the parents. Weights were charted on standard pediatric weight-for-age charts distributed by the Centers for Disease Control and Prevention. In most cases, the height of the patient at the time of injury was not recorded. The anesthetic record also provided the length of the operation. The operative report provided details about the device used for fracture fixation. Particular attention was paid to whether the patient had a complication of treatment.

According to the criteria of the Centers for Disease Control and Prevention⁹, a child was considered obese if he or she was in the 95th percentile or greater for weight for age based on normative data for the entire pediatric population. Children with a weight of greater than the 90th percentile for weight for age were two standard deviations above the mean, which we defined as extremely heavy. These children may be either obese or extremely tall. Patients who were obese or extremely heavy were compared with the remaining patients in the study population. T tests were used and were considered significant for a p value of <0.05.

In addition, the patients with complications were compared with those without complications. Complications were considered to have occurred if the patient had an adverse event that was important enough to have required hospital admission (for example, intravenous antibiotics for a wound infection) or an additional surgical intervention (a wound dehiscence). Thus, minor problems, such as a draining pin requiring only oral antibiotic treatment, were not considered to be a complication for the purposes of our analysis.

Results

The charts of 103 patients between the ages of six and fourteen years were available for review. Fifty patients had a femoral fracture on the left side, fifty-two had one on the right side, and one had a fracture bilaterally; therefore, the total number of fractures was 104 (Table I). Sixteen fractures were open, and eighty-eight were closed. Thirty-two fractures occurred in girls, and seventy-one occurred in boys. The mean age at the time of fracture was 9.3 years (range, six to 14.3 years). Seventy-seven fractures were isolated, and twenty-seven were in patients with polytrauma. The mean duration of follow-up was 6.3 months (range, two to twenty-two months).

Eighty-one fractures were located in the mid-part of the shaft; twelve fractures, in the distal one-third; and eleven fractures, in the proximal one-third of the femur. Fractures were described as transverse (forty-three), comminuted (thirty-four), oblique (twelve), or spiral (fifteen). Five pediatric orthopaedic surgeons treated these fractures according to surgeon preference. External fixation was used in fifty-nine fractures, and in-

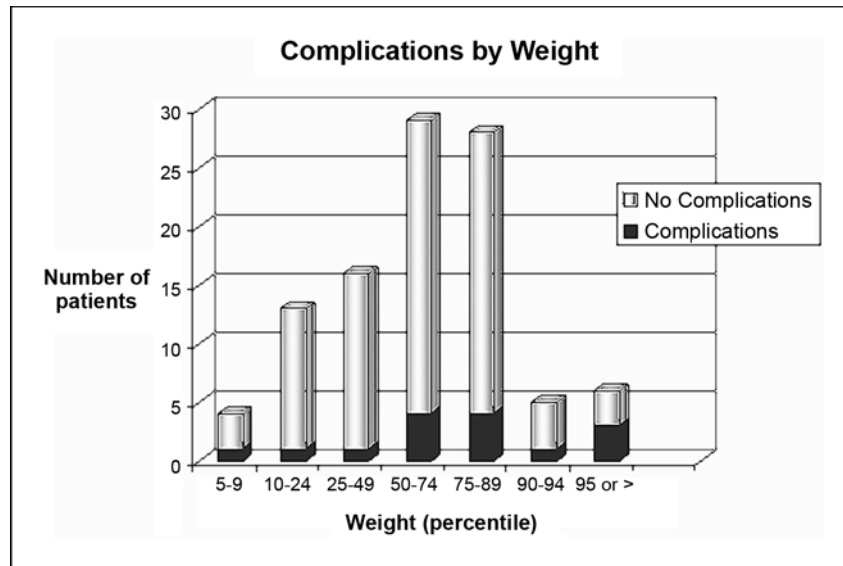


Fig. 1

The number of complications by weight. Many more complications are seen in the higher weight groups when adjusted for the smaller number of children in the highest weight groups.

tramedullary fixation was performed in forty-five.

Six (6%) of the 103 children were obese. Four of the six children were boys, and two were girls. Five of them had a closed fracture, and one had an open fracture. Three fractures had been treated with an external fixator, and three had been managed with an intramedullary rod. Only one patient, who was skeletally mature and had had intramedullary fixation with a locking nail and a piriformis starting point, had an indication in the chart that the fixation selected was chosen in consideration of the excessive body weight of the child. Three of the six children had postoperative complications, which included one refracture and two wound problems (a wound dehiscence and a wound infection). As half of the obese children had a complication, the rate of complications for those chil-

dren was significantly higher ($p = 0.004$) than that for the nonobese children (eleven [12%] of ninety-three children) (Table II, Fig. 1).

Four children were between the 90th and 94th percentile of weight for age and could be characterized as very heavy. One complication occurred in this small group. A child who had been managed with an external fixator had a pin-track infection that required operative débridement of bone and removal of the pin.

In order to analyze a slightly larger group of children in the upper echelons of weight for age, we compared the ten children who were in the 90th percentile or above by weight. Four complications occurred in this group. Two patients had been treated with external fixation, and two had been man-

TABLE II Complications for All Patients

Type of Complication	Obese	Extremely Heavy	Nonobese	Total
Refracture through the old fracture site	1		2	3
Pin-track infection requiring operative débridement		1	1	2
Loss of alignment in the frame			2	2
Wound infection	1		1	2
Malunion			1	1
Osteomyelitis			1	1
Wound dehiscence	1			1
Compartment syndrome			1	1
Broken rod			1	1
Broken pin			1	1
Total	3	1	11	15

TABLE III Comparison of Treatment with Intramedullary Rod and External Fixation

	External Fixation	Intramedullary Rod	P Value
No. of fractures	59	45	
Mean age (<i>mo</i>)	104	124	0.001
Mean weight (<i>percentile</i>)	54	56	0.4
Mean duration of surgery (<i>min</i>)	114	140	0.01
Rate of open fractures (%)	14	16	0.4
Rate of complications (%)	15	13	0.3

aged with an intramedullary rod. The complications in the latter two children included a wound dehiscence and a deep wound infection. The postoperative complications in the two children who underwent treatment with an external fixator device were a refracture and a pin-track infection requiring operative débridement.

For the heavy and obese children, the mean operative time was ninety-one minutes (range, forty-five to 155 minutes), which was shorter than that for the nonobese children (126 minutes; range, twenty to 300 minutes). The difference was not significant. A post hoc power calculation of the differences in the operative time demonstrated sufficient power (>80%) to detect a clinically meaningful difference of approximately sixty minutes between the obese and nonobese children.

Since the expected complications would be different depending on the treatment selected, the entire study group was divided and then reanalyzed according to treatment (external fixation or intramedullary rod). The groups were similar in terms of the number of complications, the proportion of open fractures, and patient weight. The children managed with an intramedullary rod were, on the average, slightly older and had a longer duration in the operating room than did those who had external fixation devices (Table III).

In the fifty-nine patients managed with external fixation, the four children who had a weight for age that was two standard deviations above normal had a significantly higher complication rate (two of four children) than the remaining children in the group (seven [13%] of fifty-five children) ($p = 0.02$).

In the forty-five children managed with an intramedullary rod, the four who had a weight for age that was two standard deviations above normal had a significantly higher complication rate (two of four children) than the children who had a weight for age that was under the 90th percentile (four [10%] of forty-one children) ($p = 0.02$). In both fixation groups, no increase in complications was seen, with the numbers available, when fixation designed for the pediatric population was used in children who had a weight for age that was two standard deviations above the mean.

Discussion

Similar to obese adults, obese children have an increased rate of complications after orthopaedic procedures compared with those who are not obese. The complications primarily involve the wound or a failure at the fracture site. In

order to improve the outcome for obese children, it may be necessary to pay more meticulous attention to wounds in such patients or to leave external fixation in place until abundant callus formation is evident. The children with excessive body weight in this study did not have increased operating-room times, which may mean that the procedures are not technically harder to perform.

This study has some limitations. The optimum technique for defining obesity is to use the body mass index⁴. However, to calculate body mass, it is necessary to know the height of the child. In this retrospective review, we found that few children had been measured for height; therefore, we defined obesity, in accordance with the weight-for-age charts of the Centers for Disease Control and Prevention⁹, solely on the basis of a weight for age. It is possible that not all children with a weight for age at or above two standard deviations of the mean are obese, although it is likely that they are overweight. However, there are still concerns about the ability to use pediatric devices and treatment techniques on children who are heavy, regardless of whether they fit the strict definition of obesity.

In addition, weight was derived from a review of the anesthetic record. According to the practices of our institution in the management of polytrauma or femoral fractures, most weights were estimates reported by the parents. Thus, some of the weights may have been overreported or underreported.

Finally, the subpopulation of obese children in our study was 6% (six of 103 patients), which does not compare with the data on the national rate of obesity in children, which was estimated to be closer to 15% of the general population in the year 2000³. The discrepancy between our observed rate of obesity (6%) in children with femoral fractures and the expected rate of 15% may be attributable to many factors. These include the difference in measuring body weight for age rather than measuring the body mass index, a sampling error due to the smaller population of children in our study compared with the thousands of children examined in the larger studies of obesity, a regional difference relating to better dietary and exercise habits in our geographic catchment area, or perhaps the fact that fewer femoral fractures actually occur in obese children either because the excessive soft tissues protect the femur or a more sedentary lifestyle predisposes both to obesity and a decrease in trauma.

Because the complication rate after surgery is greater for obese children, parents should be warned before surgery

about the increased risks associated with the treatment of a femoral fracture in an obese child. ■

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