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# Clinical Measurement of Longitudinal Femoral Overgrowth Following Fracture in Children

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## ABSTRACT

**We have studied residual limb length inequality following femoral shaft fractures in 62 children. From 61.2% of the children who had shortening of more than 1 cm at union, 34.21% still maintained the shortening at the completion of study. The longitudinal femoral overgrowth occurred significantly during the first 18 months of the fracture in 77.4% of the children, with an average of 1.17 cm. Children with proximal-third fractures and those who sustained the fractures before eight years of age have higher capability to correct the limb length disparity.**


**Keywords: Femoral fractures, Residual overgrowth, Clinical measurement**

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## INTRODUCTION

Femoral overgrowth is a universal phenomenon following femoral shaft fractures in children[1,6,10,13,14,15]. It is believed to be due to a physiological process associated with post-traumatic hyperaemia of the growth plate[1,3,4,6]. The literature has been contradictory regarding longitudinal overgrowth following fracture of the femur in children[1,6,10,13-15].

The average documented femoral overgrowth with radiographs after femoral shaft fractures treated conservatively ranged from 0.92 to 1.08 cm with a possible error of 1 mm[1,10,13-15]. Measurement of lower limbs length based on clinical methods has been accepted as a standard practice during follow-up with possible errors noted to be 5 mm[2,6,11].

The purpose of this study was to analyse the residual overgrowth with clinical measurement following fractures of the femoral shaft and the factors that influenced femoral overgrowth.

## MATERIALS AND METHODS

A retrospective study of the outcome of femoral shaft fractures treated conservatively with traction at a University Hospital was carried out. There were 140 children below 12 years of age treated during the period from January 1989 to December 1998. Sixty-two children were available for this study. Case notes of the children who sustained femoral shaft fracture treated with traction for six weeks were reviewed with particular reference to age at the time of injury, sex, fracture configuration and level and site of fracture. Fractures associated with head injury, ipsilateral or contralateral tibial fractures, and open fractures fixed with implants including bilateral femoral fracture were excluded from this study. Clinical assessment of limb length discrepancy with possible error of 5 mm was performed based on the measurement from the anterior superior iliac spine (ASIS) to the tip of the medial malleolus (MM). ASIS to medial knee joint line (MKJL) and MKJL to tip of MM lengths were measured using a measuring tape to exclude any shortening in the tibia. The patients were positioned supine with both lower limbs placed parallel and the pelvis squared to minimise measurement error. The difference between the limb measurements was taken as the length discrepancy. Measurements were made at the time of union and again at the last follow-up date.

## RESULTS

The average age of the patients was 6.2 years (range 1 to 10.4) and the average duration of follow-up was 40.5 months (range 6 to 143). There were 39 males and 23 females. Thirty-five patients sustained right femoral shaft fractures and 27 sustained left femoral shaft fractures. Twenty-seven (43.5%) of the fractures were in the proximal-third, 28 (45.2%) middle-third and seven (11.3%) in the distal-third.

All fractures united with shortening at the time of union ranging from 0.5 cm to 3 cm (mean 1.57 cm). Thirty-eight (61.2%) children had shortening of more than 1 cm and 24 (38.8%) had shortening of less than 1 cm. At the final follow-up, 13 (21.1%) children still maintained residual shortening of more than 1 cm, 39 children (62.9%) had shortening less than 1 cm and 10 acquired lengthening of more than 1 cm when compared to the opposite limb. The differences in limb length discrepancy at the time

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of union and time of follow-up were statistically significant ($p<0.05$).

Twenty-eight boys and 10 girls were noted to have shortening of the affected lower limb of more than 1 cm at the time of fracture union. However, at the time of follow-up, we observed 11 boys (39.2%) with only two girls (20%) still had more than 1 cm shortening. It appeared that sex of the child had no significant influence ($p>0.05$) on the overgrowth of lower limbs following femoral fracture.

Fourteen children aged below four years developed shortening at the time of fracture union, of whom seven (50%) had shortening more than 1 cm and another seven less than 1 cm. Thirty-four children aged between four and eight years old were found to have shortening at union with 21 (61.8%) having shortening of more than 1 cm and 13 (38.2%) less than 1 cm. With regards to children above eight years of age, 14 children were observed to have shortening at union, 10 (71.4%) of more than 1 cm and 4 (28.6%) less than 1 cm. Interestingly, we noted two children out of 7 (28.6%), aged below four years, whose femur united with shortening of more than 1 cm maintain the shortening at the time of review. Residual lower limb shortening of the same amount occurred in seven out of 21 (33.3%) and four out of 10 (40%) children aged between four and eight years and those above eight years old respectively. Children below eight years of age had more ability to correct shortening than those children above eight years old. The differences were statistically significant ($p<0.05$).

Twenty-seven children with proximal-third fractures united with shortening, 15 with more than 1 cm, and 12 with less than 1 cm. Two out of 15 children (13.3%) still maintained more than 1 cm limb shortening at the final review. Twenty-eight children suffered from middle-third fractures; 18 children (64.3%) had more than 1 cm shortening with 10 sustained less than 1 cm. At last follow-up, 10 (55.6%) children still had lower limb shortening of more than 1 cm. Seven children were hospitalised for lower-third fractures. 5 (71.4%) femoral fracture united with more than 1 cm shortening and only 2 (28.6%) less than 1 cm. At last review, only one case (20%) presented with more than 1 cm shortening. Based on this observation, the level of fracture did influence femoral overgrowth ($p<0.05$). Proximal third fractures had a higher potential to have overgrowth and to equalise limb length than middle and distal-third fractures.

Forty-three children were hospitalised for transverse fractures, of which 29 (67.4%) fractures united with more than 1 cm shortening. Eleven children (37.9%) were still noted to have lower limb shortening of the same length at the final visit. Sixteen children were admitted for oblique fractures, 8 (50%) of the fractures united with more than 1 cm shortening but only 1 (6.2%) still had residual shortening of the same amount at the time of last review. The differences in limb length discrepancy at the time of union and follow-up for oblique and transverse fractures were however statistically insignificant ($p>0.05$). It seemed that morphology of fractures had no significant effect on the residual limb length inequality.

There were 35 children (56.5 %) who sustained right femoral fractures, 21 (60.0%) of which had more than 1 cm shortening at union. At the time of last follow-up, 8 (38.1%) lower limbs were still shortened more than 1 cm. Twenty-seven were treated for fracture of the left femur, 17 (63.0%) united with more than 1 cm shortening. At the time of review, 5 (29.4%) still did not improved.

At the final follow-up, 10 children developed lower limb lengthening of more than 1 cm (femoral overgrowth) with the longest being 2.5 cm. Thirty-nine children still had disparity of their lower limbs less than 1 cm, and 13 lower limbs were still short by more than 1 cm. Femoral overgrowth occurred in 49 children with the mean overgrowth noted to be 1.17 cm (ranged 0.5 cm to 2.5 cm) with the longest being 2.5 cm in 2 children. The percentage of overgrowth noted before and after 18 months of follow-up was observed to be 77.3% and 77.5% respectively. It showed that overgrowth occurred significantly during the first 18 months of fracture.

## DISCUSSION

Fracture of the femoral shaft is a common injury in children. About half of the cases in this study involved children between four and eight years of age. This is in contrast to the report by Hedlund and Lindgren[9], which noted the maximum incidence in children to be between two and five years of age. The difference is probably due to the fact that in their study, falls were the most common cause of fractures, whereas in this study motor vehicle accidents were the major cause. Boys were involved more often than girls with a ratio of 2.4:1. Both sides were about equally affected. In 45% of the cases the fractures were in the middle-third, 43.5% in the proximal-third and 11.3% the distal-third. The distribution of fractures was almost identical to that of Shapiro[13] and Hougaard[10].

In this study, at the final follow-up, 21% of the children had residual lower limb length disparity of more than 1 cm, which is clinically significant; 62.9% with shortening of less than 1 cm, and 16.1% with lengthening. The average femoral overgrowth in this study was 1.17 cm. This figure is comparable with other studies[1,10,13,15].

We found that proximal third fractures showed a significant overgrowth compared to middle and lower third fractures. Our result supports the observation of Barfod et al and Staheli[2,4]. The majority of children who sustained femoral shaft fractures before eight years of age equalised their limb length at the final follow-up. Griffin et al and Staheli[7,4] reported similar findings.

Meals, Kohan and Cumming[11,12] found that femoral overgrowth tended to be greater when the non-dominant limbs were injured, but our study found that side of fracture did not influence the final longitudinal overgrowth. The correction of limb length disparity occurred regardless of sex, morphology of fracture, and side of limb involved. These findings were similar to those found in other studies[1-3,6,7,13-15].

Our study found that the overall femoral overgrowth occurred in 77.4% of the children. There was an almost equal percentage of children with femoral overgrowth in those reviewed before or after 18 months of post injury indicating that longitudinal femoral overgrowth occurred mainly during the first 18 months of the fracture. This finding was in agreement with Hedberg[8]. However, Vijlanto et al found correction going on for as long as five years following the fracture[15].

## CONCLUSION

Femoral overgrowth after femoral shaft fractures occurred in 77.4% of the children, with an average of 1.17 cm of overgrowth within the first 18 months of the fracture. Overgrowth was insignificant after 18 months. We would suggest that follow-up can be stopped 18 months after the injury. Proximal-third fractures showed a higher ability to correct the shortening and those fractures sustained before the age of eight years had a greater tendency to correct shortening. Sex and morphology and side of fracture did not seem to have any significant influence on the femoral overgrowth following femoral shaft fractures.

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