LIMB LENGTH DISCREPANCY FOLLOWING CONSERVATIVE MANAGEMENT OF FEMORAL SHAFT FRACTURES IN CHILDREN, CLINICAL REVIEW AND RECOMMENDATIONS

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ABSTRACT

BACKGROUND

Shaft of femur is third most common location of fractures among children. In children there is strong potential for early union and remodeling even with conservative treatment. Conservative treatment is an accepted and good option while treating fracture shaft of femur in children under 10 years of age. Main complication of femoral shaft fracture is a possible leg length discrepancy and angulation resulting from initial overriding of bone fragments and from the overgrowth phenomenon in the fractured limb.

MATERIALS AND METHODS

In the present study 50 children were treated conservatively for fracture of shaft of femur between May 1993 to December 1993 (one year) at Department of Orthopaedics, Government Medical College, Jammu. All children were treated conservatively by skin traction for a mean period of 14 days followed by hip spica cast for further 28 days, there-after mobilization in functional brace. The mean follow-up was 5 years. At last follow up, mean age was 10 years and 7 patients attained skeletal maturity (7%).

RESULTS

Results were accessed after reviewing records of 50 children under study. At the last follow-up, the fractured limb was shorter than the normal limb, 1.5 mm on average, based on measurements of the femoro-tibial Skelton and 3.5 mm on average, based on, level of the femoral heads, while radiograph taken with patient in the standing position. The major part of this shortening was due to fractured femur (2.1 mm on average). The mean femoral overgrowth was 9.6 mm and then mean tibial outgrowth was 0.6 mm.

CONCLUSION

All children were respectively reviewed clinico-radiologically and results were analysed. In this study, a positive correlation was found between amount of initial fragment overlap and the overgrowth phenomenon. While comparing final limb length discrepancy with initial overlap, 9.3 mm overlap was found to be tolerated to avoid significant limb length discrepancy.

KEYWORDS

Fracture; complication; discrepancy; overlap; skeletal maturity.

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BACKGROUND

After fractures of upper limbs, femur is the third most common bone fractured among the children. Mode of injury remains similar for many authors like road traffic accident, fall from bicycle and fall from swings. All fractures in children less than 10 years have excellent potential for union and remodeling. Overgrowth is seen in fractures managed by conservative treatment because of increased vascularity during various stages of fracture healing. Very little overgrowth is seen in patients managed operatively where fracture ends are aligned anatomically and fixed rigidly. Mean overgrowth of fractured limb has been shown to be 7 to 8 mm by Reynolds et al,[1] 8.1 mm by Clement and Colton,[2] 9.2 mm by Shapiro,[3] 10 mm by Edvardsen and Syversen,[4] 10.8 mm by Hougaard[5] and 11.7 mm, BT Nordin et al.[6] Most of the overgrowth (78%) has been shown to occur within the first 18 months following the fracture.[6] To avoid any limb length discrepancy due to this subsequent overgrowth, it could be appropriate to tolerate an over-riding of the bone fragments before union so that the consecutive overgrowth could compensate for initial shortening. Stephens et al[7] recommended less than 10 mm, Shapiro et al[3] 15 mm, Edvarsen and Syveresen[4] 15 to 20 mm, and Barfod and Christensen[8] 20 mm overlap subsequently. This wide range is because of difference of time and method of measurement of discrepancy. Standard methods remain same for all the authors regarding overriding and angulation.

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Aims and Objectives

The aim of this study was to access the final limb length discrepancy and guidelines to prevention overgrowth.

MATERIALS AND METHODS

The clinical data of 50 children under this study of isolated fracture shaft of femur is summarized in table-1. Only isolated shaft of femur was included in the said study where all other fractures with articular involvement, ipsilateral limb fracture, compound fracture, re-fracture and fracture of congenitally abnormal limb were excluded from the study.

Sex Ratio (M/F)	27/10 = 2.7
Mean age	4.0 (0.8 to 10.0) yrs.
Fractured Side (Right/Left)	28/22
Fracture Level: -proximal third -mid shaft -distal third	 16.8% 75.2% 8.0%
Fracture type -transverse -oblique -Spiral	 24.2% 13.4% 62.4%
Treatment -mean time in traction (days) -mean time in spica (days)	 14 (0 to 28) 28 (0 to 58)

Table 1. Clinical Data of 50 Patients

Radiographic Evaluation

Standard anteroposterior and lateral radiographs at the time of injury were evaluated to determine side (left, right), level of injury (proximal, middle or distal third) type of fracture (transverse, oblique, spiral etc.). Check radiographs were performed at the time of spica application and at 6 weeks respectively and analysed for overlap and angulations in both anteroposterior and lateral projections whichever is clearly measurable. A negative value in discrepancy indicates a shortening, a negative angle in coronal plane indicates a valgus deformity and a valgus deformity in sagittal plane a recurvatum. Standard radiographic evaluation was done at final assessment time by making patient stand 1.5 meters distance from X-ray tube and using long film. Tibial measurement was also done to note down compensatory overgrowth. Femoral length was measured from top of femoral head to distal end of medial femoral condyle. Tibial length was measured bottom of the medial condyle to centre of distal tibial epiphyses. Angles were measured by accessing intersection of longitudinal axis in both anterior and lateral planes.

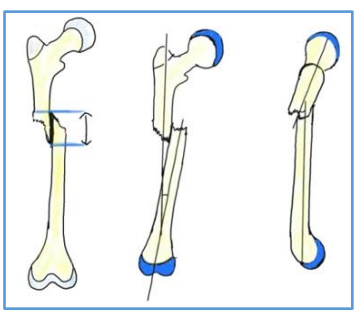

Figure 1

Methodology followed for measuring overlap and angulations.

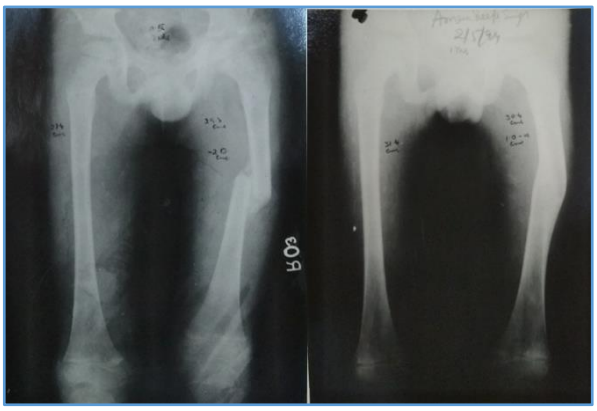

Figure 2

X-Ray of patient at 6 weeks and one year, showing 20 mm of shortening of fractured femur.

Figure 3

X-Ray of femur at 3 weeks and one year showing 7mm of shortening.

Radiographic Measurement of Limb Length Discrepancy

For measurement of limb length discrepancy standard full limb radiograph in standing position of both lower limbs obtained with X-ray beam centered at knees facing interiorly, at maximum distance of 1.5 meters. Pelvis was levelled by placing inserts under heel of short limb where required. Femoral length was measured from top of the femoral head to the distal end of medial femoral condyle. Tibial length was measured from the bottom of the medial tibial Condyle to the centre of the distal tibial epiphysis. The femora-tibial length was measured from the top of the femoral head to the centre of the distal tibial epiphysis. The femoral overgrowth was measured as initial overlap value minus the final femoral length discrepancy.

RESULTS

Radiological findings and measurements of 50 patients are summarized in table II. At the last follow-up, the fractured limb was shorter than the other limb; 1.5 mm on average

based on measurements of the femorotibial Skelton and 3.5 mm on average based on the level of the femoral heads on the patient in the standing position. The major part of this shortening was due to the fractured femur (2.1 mm shortening on average). The ipsilateral tibia showed a slight compensation, as it was 0.6 mm longer on average. The mean femoral overgrowth was 9.6 mm and the mean tibia overgrowth was 0.6 mm. None of patient showed muscular atrophy, Cutaneous necrosis following hop spica. Five patients had plaster sore which healed subsequently following removal of plaster. Foreign objects in plaster which is very much common with children were found in three hip-spica plaster.

	Mean (mm)	Minimum (mm)	Maximum (mm)	Standard Deviation
Follow-up (years)	5.0	0.5	17.7	4.6
Age at last follow-up	9.0	2.2	22.8	5.4
Measurements at 6 weeks				
Overlap (mm)	-11.8	-39	1	9.6
Coronal angulation (degree)	6.1	-10	29	1.0
Sagittal angulation (degree)	5.6	-3	36	8.1
Measurements at last follow-up				
Femoral length discrepancy (mm)	-2.1	-17	21	9.1
Tibial length discrepancy (mm)	0.6	-7	8	2.8
Femora-tibial length discrepancy (mm)	-1.5	-22	22	10.5
Limb length discrepancy measured at femoral heads (mm)	-3.5	-18	14	6.7
Overgrowth	9.7	8	30	8.3

Table 2. Radiological findings of the 50 Patients. Negative value indicates a shortening of limb

DISCUSSION

Fracture femur is the third common fracture in children. Femur being single bone in thigh surrounded by musculature and after fracture there is huge hematoma, it is difficult to be palpated. These are the reasons why immediate plaster spica is not applied infect on resorption of hematoma soft callus appears within 14 to 21 days depending upon age of the patient and final spica can be applied without further angulation and displacement.[8-10] Limb length discrepancy is the most common complication reported after femoral fracture in childhood. Most authors agree that significant overgrowth occurs during eighteen months to first two years after injury which will not be corrected further.[11-18] Although our series is small as compared to other larger series.[19,20] Male children were predominant. The two sides were nearly equally affected despite a slight right (56%) predominance. The middle third of the femur was the most affected (60-78%) followed by the proximal third and the distal third respectively. Many patients showed limping during follow-up because of overgrowth of more than 5 mm. Mode of injury remains almost same for most of authors is fall from bi cycle, road traffic accidents and fall from swings, etc.

Overgrowth and Factors Influencing Overgrowth

We observed the femoral overgrowth of 9.6 mm in our study which is comparable with other studies.[2,3,4,6,7,9] We observed overgrowth in 86% of the children whereas Shapiro[3] reported 100% overgrowth in his series. Overgrowth of femur was highly influenced by the initial overlap (p =0.02). More important the overlap, the significant overgrowth was observed. This effect of overgrowth has already been shown by Edvardsen and Syversen,[4] and by Reynolds.[1] On the contrary, other factors such as age (p=0.239), sex (p=0.189), fracture level (p=0.893) and Fracture type (p=0.938) did not statistically influence overgrowth. These results are in agreement with the findings of the other authors,[3-9] except for Caelment and Colton[2] who found an influence of gender on overgrowth, for Barford and Cristensen[8] who reported an influence of the fracture level and for Ehrensperger, J[9] who found an influence of fracture type. The angulations in the frontal and sagittal planes did not influence the overgrowth. Sharpiro noted a 2.9 mm overgrowth of the ipsilateral tibia in 82% of patients[9] while we found 0.6 mm tibial overgrowth.

Factors Influencing Final Limb Length Discrepancy

The final limb length discrepancy was significantly influenced by the initial overlap (p=0003). The equation for regression analysis was final limb length discrepancy = 5.8 mm (0.62 x initial overlap). According to this equation 9.35 mm would be the optimal overlap that would lead to a minimal limb length discrepancy. On the contrary, the final limb length discrepancy was not influenced by overgrowth (p=0.244), by sex (p=0.093), by age at the time of trauma (p=0.071) and by fracture type (p=0.132). Frontal angulation (p=0.227) or sagittal angulation (p=0.227) did not influence the final limb length discrepancy. Our results did not agree with Holschneider, A.M.,[10] and Stephens et al[7] who found a relationship between initial angulation and final limb length discrepancy.[4]

Considering the fact that most of the overgrowth (78%) occurs in the first 18 months to 24 months after fracture,[6,7,9] that the overgrowth phenomenon stops after 3 years and 6 months[9] in the vast majority of patients (85%), and the limb length discrepancy remains unchanged until the end of growth, we can conclude that limb length discrepancy measured on an average 4.9 years after fracture is a good

representation of the final limb length discrepancy at skeletal maturity.

Factors Influencing Overlap

During conservative treatment no correlation was found between overlap at the time of union and the duration of skin traction (p=0.624).

CONCLUSION

In our study, it can be concluded that 9.3 mm of initial overlap or overriding in the femoral fracture in children while treating conservatively, below the age of 10 years is well compensated by overgrowth and avoiding significant limb length discrepancy, once skeletal maturity is attained and conservative treatment still a accepted option while treating fracture shaft of femur in children avoiding risks associated with surgery of scarring, infection, re-surgery for implant removal etc.

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