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Limb length discrepancy (LLD) after lower limb long bone fractures in pediatric age group

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Abstract

Background: It has been mentioned that Limb length discrepancy may vary with the age of child, position of fracture and the type of treatment done (ORIF- open reduction and internal fixation/CRIF- closed reduction and internal fixation/Conservative). This treatment methods influence the amount of overriding after reduction of fracture.

Aims and Objectives: To determine the Limb Length Discrepancy (LLD) developing after lower limb long bone fractures in age group 2 years to 16 years.

Methodology: They were 20 patients, with history of lower limb long bone fracture with minimal duration post fracture of 6 months. Subject particulars were recorded as per methodology protocol by two different observers.

Results: The study group ranged from 3 years to 16 years with mean age of 8.5 years. There were eleven males and nine females. Seven out of twenty patients managed conservatively with plaster application and Open reduction and plating done for 8 patients. Remaining five patients were treated with closed reduction and fixation with either Titanium Elastic nails or external fixator. Post op X ray showed no overriding in eight patients and all were from the group managed by open reduction and plate fixation. Fractures managed by closed reduction found to have over riding which was less than 1 cm in four subjects and 1cm to 2cms in remaining five cases. LLD when measured, it ranged between -1cms to +3cms (mean +1 cm). Three post fracture limb has no Limb Length Discrepancy (LLD) at all. There was lengthening seen in rest of patients it was up to 1 cm in 10 and more than 1cm in five cases. 2 patients out of 20 patients developed significant lengthening and presented with limp, so they underwent epiphysiodesis near skeletal maturity.

Conclusion: There is need to educate parents and budding orthopedic surgeons regarding the importance of conservative management and acceptance of some degree of allowable mal-alignment. The fractures in pediatric age groups need to be followed till skeletal maturity as there is associated risk of developing LLD during the course of fracture union. This LLD sometime needs intervention in the form of timely epiphysiodesis at the time of near skeletal maturity.

Keywords: LLD, tibia, femur, epiphysiodesis

Introduction

It's being published in literature that the human body is not always symmetrical. Minimal asymmetry without any symptoms is physiological. This asymmetrical variation called as fluctuating asymmetry (FA) and can be measured by Mean FA^[1, 2].

Mean FA = mean absolute value of left side - mean absolute value of right side.

The closure the value to zero, least is the FA (Fluctuating asymmetry)

Considering above, minor Limb Length Discrepancies due to asymmetry between right and left limbs are common. In upper limb this is not clinically significant unless it's very severe. In lower limb LLD up to 2 cm have been observed commonly in children. This shortening is compensated for by pelvic tilt and is not clinically significant^[3]. If it is more than 2cms may present as limp and symptomatic which needs intervention.

The causes of this LLD as far as lower limbs are concerned, includes congenital, developmental, traumatic, infective and various vascular lesions. There are various factors

responsible for LLD after fractures which include age at the time of fracture, level of fracture, type of fracture, fractures management (open or closed reduction) and type of surgery performed (plate application or Titanium elastic nails insertion).very rarely they present as shortening after the fractures. The causes may be the angulation and excessive overriding.

Most of the studies in literature deal with LLD following the congenital defects and there is limited literature regarding LLD following fractures, separately. Present study was planned to estimate the LLD after fractures managed with various methods at different ages in the institute.

The important is timely identification of this LLD as there is minimally invasive treatment available till physeal plate exists, that is epiphyseodesis. This is not possible once the skeletal maturity has attained. Importance of periodic monitoring after fracture at least till the time of fracture remodeling, has been attended in this study

Literature review

“The children are not miniature adults” [4], this statement has been coded in many articles published in literature and holds good for skeletal system. It was found that pediatric population has more number of bones, 270 at birth which peaks to about 300 as baby grows and decreases finally to 206 at skeletal maturity [5].

Pediatric skeleton has one extra structure called epiphyseal (growth) plate [6]; this has major contribution to the bone growth. There exists thick periosteum with lot of osteogenic cells having bone forming potential in the diaphysis also [8]. The growth by the epiphyseal plate is in longitudinal manner and called as interstitial growth of bone. The periosteal cells are responsible to increase the girth of bone by laying new layers; this is called as appositional growth [8].

The factors which increases the periosteal and the epiphyseal vascularity, increases the growth locally. These factors results in relative lengthening of the bone. These factors include trauma, infection, AV malformation and hemangioma [9].

Fractures comprise 10% to 25% of all types of pediatric injuries [10]. Among them the involvement of femur, tibia and fibula either isolated or combined is 6 percent to 8 percent [11]. These fractures can be managed either conservatively or surgically depending on the age, biology of fracture and surgeon's ease.

The conservative management includes application of plaster cast, Thomas splint or traction device. Surgical management includes application of plate (surface implant), elastic nails (intramedullary implants) and external fixation [12].

There is periosteal elevation at the fracture site after trauma and the process of inflammation starts. This resembles the procedure called girdling or debarking done in horticulture to increase the fruits production [13].

This increases the vascularity locally to the fractured bone. This stimulates the epiphyseal plate and the periosteum resulting in the relative increase in bone growth. This process lasts till bone gets remodeled and quiescent. As it remodels very quick in very young children of age less than 2 years, there is no marked impact of increase vascularity to bone, on the lengthening [14].

Considering the mechanism of increased growth there is expected over growth of 1 to 2 cms after long bone fractures. The minimal amount of overriding of about 1cm to 2cms is acceptable as it gains length once the fracture heals [15].

The LLD of 2cms or less will be compensated by pelvic tilt

without noticeable change in the gait pattern and more than 2 cms will presents as limp clinically. If LLD is less than 2 cms, it doesn't need intervention most of the time, LLD between 2 cms to 5 cms need temporary or permanent blockage of the lengthened limb to compensate. If LLD found to be more than 5 cms, it needs lengthening of the shortened limb [16].

Plate application most of the time is by open reduction and needs lot of periosteum elevation which stimulates bone growth further and there is a need of second surgery after the union process completes for the plate removal, this stimulate it again resulting in further lengthening [17]. Considering this plate application should be limited to very complicated fractures which cannot be managed by other means.

Elastic nails have advantage of minimal periosteal irritation and negligible stimulus to the fractured bone. Also have advantage of biological fixation with very minimal complications. The choice of maintaining fracture reduction should always be kept open whenever possible [18].

There are various method of measuring LLD, standard method of true length measurement of the lower limb by tape is ideal for screening. If there is doubt and the further intervention needed for LLD, before any intervention CT scan stands gold standard [19].

Present study is the LLD developed after the fracture managed by different means.

Aims and Objectives

- To determine the Limb Length Discrepancy after lower limb long bone fractures in age group 2 years to 16 years.
- To determine the effect of LLD over the activities of the patient.

Material and Methods

It was done after clearance from Institutional Review Board (IRB) and informed written consent from the parents.

Study design: Retrospective observational study.

Study place: Department of Orthopedics

Participants: 20 patients with history of lower limb long bones fracture with minimal duration post fracture of 6 months.

Inclusion criteria

- all diaphyseal and metaphyseal fractures (Femur and tibia +/- fibula)
- Operated at our hospital or other hospital, visiting our hospital for implant removal or other orthopedics condition.
- Managed by any means ORIF/CRIF/Conservative.

Exclusion Criteria

- Pathological fractures
- Infection after the surgery
- Compound fracture
- Fracture with bone loss.

Methodology

After selecting patient the following record collected from them

- Pre-Operative X-Rays.
- Immediate post-operative X-Rays with alignment measurement.
- Follow-up X-Rays till remodeling occurs.

Manual measurement of both lower limbs with two observers

performed (After squaring of pelvis, the length measured from ASIS to medial malleolus with medial knee joint line as the center). CT scannogram if limb length discrepancy is more than 2 cms.

Results

There were 20 patients enrolled in the study during three months period of study. The age of patients enrolled in study ranged from 3 years to 16 years with mean age of 8.5 years. Considering the weight according to age, there was Positive deviation among 9 patients and 7 patients had negative deviation and 4 patients had ideal weight for age.

BMI when measured ranged between 9 to 20 Kg/mtr² with mean value of 13.684 kg/mtr². There were eleven males and nine females (fig. 1). Six patient seeked orthopedics opinions after 1 week of injury and rest fourteen patients reported immediately after the injury. Bone involved was isolated tibia in five, combined tibia and fibula in three and femur bone involvement in twelve patients (Table 1) (Fig. 3).

Eleven patients had fracture on the right side and remaining nine had left side involvement. There was metaphyseal fracture in 7 and diaphyseal fracture in 13(Fig. 2).

Seven out of twenty patients managed conservatively with plaster application and Open reduction and plating done for 8 patients (Fig. 4). Remaining five patients were treated with closed reduction and fixation with either Titanium Elastic nails or external fixator (table 2) (fig 5).

Post op X ray showed no overriding in eight patients and all were from the group managed by open reduction and plate fixation. Fractures managed by closed reduction found to have over riding which was less than 1 cm in four subjects and 1cm to 2cms in remaining five cases.

LLD when measured, it ranged between -1cms to +3cms (mean +1 cm). There was shortening in 2 cases. Three post fracture limb has no Limb Length Discrepancy (LLD) at all. There was lengthening seen in rest of patients it was up to 1 cm in 10 and more than 1cm in five cases.

Only 2 patients among all Lengthening has limp as symptoms and LLD was confirmed on Ct scannogram. These patients underwent epiphyseodesis near skeletal maturity.

Discussion

The standard mean BMI in pediatrics is 21.75 ranging between 18.5 to 25, in our study there was negative deflection with BMI ranging between 9 to 20 Kg/mtr² with mean value of 13.684^[20]. This shows existence of malnourishment in the community.

The prevalence of lower limb fracture is slightly more in females than males with 1: 0.85 ratios^[21]. There are more of males (1.2:1) in our study and this likely is due to small sample size. It was found in the literature that there exist delay in seeking the medical attention after fracture, but the reason found is due to non accidental injuries (batter baby syndrome), where the history is hidden^[22]. The scenario is different in our locality, there was delay in considerable delay in six patients and the reason was the bone setter and quacks.

There is equal prevalence of thigh fracture and leg bones in literature with almost 1:1 ratio^[23]. There is slightly more involvement of the femur (60 percent) when compare to the tibia and fibula (40 percent), this doesn't have any impact on management.

Issin *et. al.* in their study regarding epidemiology has shown predominance of diaphyseal fracture when compare to metaphyseal fractures with ratio of 1.4:1^[24]. There was similar trend in our study with 1.8:1 ratio with diaphyseal

fracture more than metaphyseal fracture. This may be less elasticity of diaphysis than metaphysic which gives way early with similar amount of deforming forces.

Regarding the acceptance of overriding, at the time of reduction and post fracture limb lengthening, various studies being published. Studies by H Nevil *et. al.* and Daniel H., there is always associated increased growth after fracture and it is due to hyper vascularity during union process. They accepted 1 to 2 cms shortening in the fracture at the time of initial reduction and LLD for them ranged between 0.4 to 2.7 cms with mean growth of 0.92 cms. Ours findings are closed to them with mean over growth of 1 cm (range -1cm to +3 cms). The residual over riding in their study was more when fractures were managed with implants. Our findings also agree with this, the reason might be the perfect reduction with no overriding at the time of fracture fixation which results in lack of margin or room to accommodate further lengthening in due course of fracture union.

They do proposed timely intervention for lengthened limb in form of epiphyseodesis which we did for 2 patients near skeletal maturity. Both of them were treated surgically for the fractures.

Conclusion

There are various options available for the fractures involving the long bones of lower limb and decision most of the time made by surgeon depending of ease of procedure and parent concern regarding the post Op reduction x- ray (which though looks little mal- aligned but falls in acceptable range). There is need to educate parents and budding orthopedic surgeons regarding the importance of conservative management and acceptance of some degree of allowable mal-alignment. This not only prevent the child from two surgeries) putting the implant and taking it out after union), but also it prevent from any intervention if at all LLD develops.

The fractures in pediatric age groups need to be followed till skeletal maturity as there is associated risk of developing LLD during the course of fracture union. This LLD some time needs intervention in the form of timely epiphyseodesis at the time of near skeletal maturity.

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