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Two Plane Deformity Correction byIlizarov Ring Fixator- lessons learnt

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Abstract:*Malunion of long bone fractures and their associated deformities are rarely encountered now a days. We have performed deformity correction in a 32 years old female patient, who presented with malunitedfracture of shaft of both bones right leg, with gait abnormality and cosmetic concerns.The aim of our study was to find out the feasibility of using Ilizarov ring fixator for correction of long bone deformity. The deformity was analyzed and CORA was identified. The angular deformity was corrected with Ilizarov ring fixator using hinges. After consolidation of the regenerate, retrospectively we identified translation deformity in the anatomic coronal plane(which resulted in development of a-t CORA), which existed preoperatively and was aggravated post operatively. Correction of angulation deformity, immediately followed by correction of translation deformity (before consolidation of regenerate) would have prevented the residual translation deformity. Our case belonged to variant "3" in the classification system of DrorPaley. WhenIlizarov fixator is used,multiplanar deformity correction is feasible, but has to be done in stages.*

Keywords:*Biplanar,Deformity, Graph method, Ilizarov,Oblique plane,Tibia, Trigonometry,*

I. Introduction

Most of the deformities are encountered in a single plane, the correction of which can be done with various modalities.We are presenting a case of deformity in tibia which needed better planning.Deformities following malunionof tibial fracture is a rarity now a days. Deformity correction in such a sitting needs special expertise.The aim of our study is to find out the feasibility of using a ring fixator to correct complex deformity following malunion of fracture shaft of tibia.

II. Case Profile

This is a case report, where a 32 years old female patient came to our department in Sep 2014,withvarus and procurvatum deformity at the level of middle third and distal third junction ofright leg.Detailed history revealed that,she sustained fracture both bone due to road traffic accident 9 months back, for which she was treated with nativesplint for 3 months.After 9 months she came to us for treatment, since she had a deformity which created difficulty in walking with cosmetic disfigurement. On examination (Fig: 1) (Fig: 2) there was varusand procuvatum deformity in the middle third and distal third junction of right leg with shortening of 1.5cm of right leg. Also patient had difficulty in walking without support, because of deformity. No neurovascular deficit was encountered. There was no flexion deformity in knee but movement restriction at ankle joint was present. Radiological examination (Fig: 3), (Fig: 4) revealed malunion of fractured both bone at middle third and lower third junction in right leg with callus formation.

Fig-1: Varus deformity in Frontal plane

Fig-2: Procurvatum deformity in sagittal plane

Fig-3: AP view shows tibia and fibula malunion of tibia and fibula

Fig-4: Lateral views view shows malunion of

III. Management

Preoperative planningregarding following parameters was done.

- Preoperative Templating
- Frame design
- Position of hinges
- Level of Corticotomy
- Latent period – Distraction

Pre-operativetemplating was done to identify a) the mechanical axis deviation (MAD)(Fig: 5),(Fig: 6), b) Plane,magnitude, level of deformity c) anatomical and mechanical axis and CORA (Fig: 7).

Fig-5: Preoperative scanogram,
Fig-6: Templating shows medial deviation of mechanical axis MAD

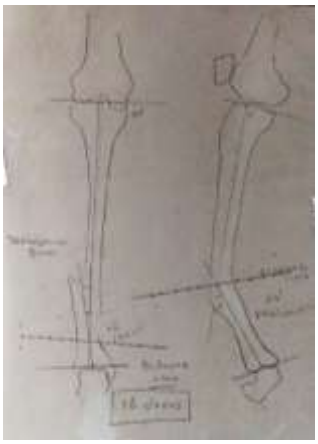


Fig-7: Varus deformity of 10 degree and procurvatum of 36 degree

The level of placement of hinges in the ring was identified using trigonometry and graph method,the hinge on the medial side was anteromedial and hinge on the lateral side poster lateral(Fig: 8).“Rule of Similar Triangle” was used to identify the rate of distraction in rod. The distraction rate at the level of distraction rod, (in order to achieve distraction of 1mm per day at the osteotomy site)was calculated to be 8mm per day (Fig: 9).

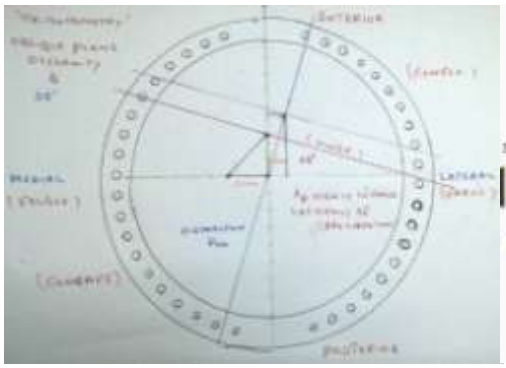


Fig-8: Graph method

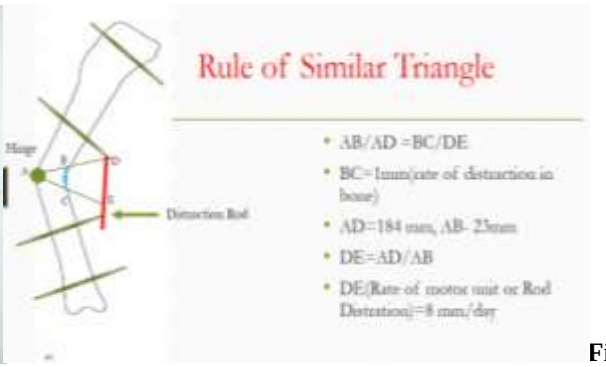


Fig- 9: Rule of similar Triangle

After templating the bone,construct was made with hinges anteromedially and posterolateraly and distraction rod posteromedially (Fig :10),After fixing the ring to the bone with wires,through lateral incision one inch of fibula was excised andthrough another anterior incision, corticotomy(open wedge) was performed at the level of CORA identified in lateral radiograph(which is just above the level of malunion site).Immediate post op radiograph(Fig: 11) shows hinges to be placed at the level of CORA in the lateral view.Distraction was initiated on 7th day. 8mm per day of distraction resulted in opening of osteotomised site at 1mm per day (Fig: 12). Full correction was achieved after 40 days (Fig: 13).After complete correction of deformity, hinges were replaced with rods, to allow full weight bearing.Consolidation achieved in 6 months,dynamisation was done at the end of 7 months. After one month of dynamisation, ring was removed (Fig: 14), advised protected weight bearing for short period with elbow crutch.The tracing of the x ray image and the relationship of the anatomical axis shows that there is good alignment in the lateral view ,but secondary translation in the AP view (Fig:15). The malalignment test (MAT) shows the mechanical axis to be deviated just lateral to the knee joint centre (Fig: 16).

Fig-10:construct with hinges

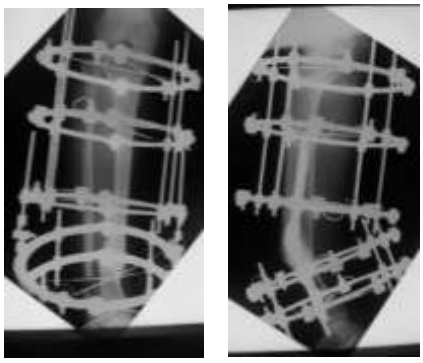


Fig-11: Immediate post op

Fig-12: Distraction on Progress**Fig-13:**After correction of deformity

Fig-14: After ring Removal



Fig-15: Secondary translation **Fig-16:** MAT shows MAD deviated laterally **Fig-17:**18 months aftercorrection

III. Follow-up

Follow-up was done once in two weeks during course of distraction, once a month after deformity correction Follow up after 18 months shows good consolidation of regenerate and correction of angular deformity(Fig: 17). Patient has good functional and cosmetic satisfaction. (Fig: 18), (Fig: 19).


Fig-18: Clinical correction of deformity


Fig-19: Normal function

IV. Discussion

Altered load transmission across jointscan lead to premature degenerative changes secondary to deformity [1], [2], [3]. Goals in deformity correction surgery are to relieve symptoms if present and to protect adjacent joints fromdevelopment of osteoarthrosis [3], [4]. Variousmodalities of treatment options are available ranging from splintage, corrective plaster cast, plating, IL IM nail, monolateral external fixator, Ilizarov ring fixator, six axis correction device (Ortho SUV, Taylor spatial frame)[5]. But we used Ilizarov ring fixator to correct the deformity. The technique involved frame design and application,sub periostealcorticotomy and pin and wire insertion [5]. Ilizarov frame provides a versatile fixation system that gives stability, soft tissuepreservation,adjustability, functionality. All factors are vital for bone to realize its full osteogenic potential [6]. Bone stability is essential for osteogenesis and depends on the stability of the external frame [6]. Frame stability is greatly impacted by the ring properties - rings of large diameter are less stable than smaller rings [7].

Oblique plane deformity:

Angular deformity may occur in any plane. The standard reference planes are the two anatomic planes coronal and sagittal. The standard reference radiograph that corresponds to the planes are the AP and lat radiograph,respectively. Uniapical angular deformities for which angulation is seen on both AP and lat radiograph are often incorrectly referred to as biplanar angular deformities. These biplanar angular deformities are actually uniplanar angular deformities in an oblique plane.Oblique plane deformity is not a biplanar deformity. Here the true plane of angulation lies between frontal and sagittal plane.In such cases Trigonometry is useful to find out the plane of deformity (while using regular AP and lat views)[8].

CORA: Centre of rotation of angulation

By definition CORA is the apex of the deformity,and is identified as the point of intersection of axis drawn

through the proximal and distal fragments (Fig: 20) [6], [9].

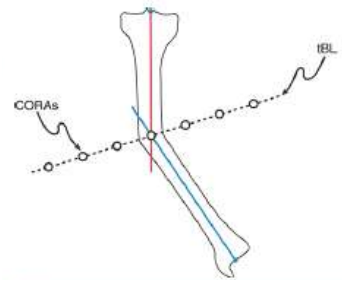


Fig-20: CORA

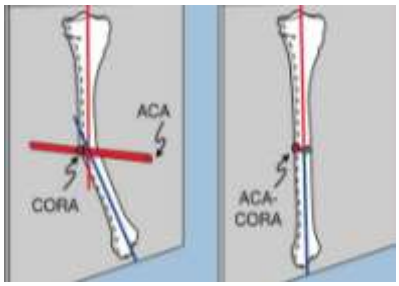
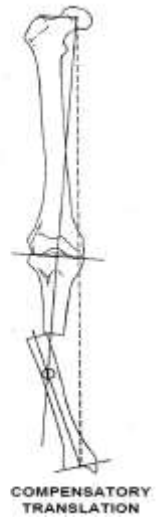


Fig-21: The red line around which the hinges are placed is called ACA

Angulation Correction Axis:
The axis around which the deformity has to be corrected (Fig: 21).

When the CORA falls below the level of apex of the deformity,Dror Paley[10] has named this translation as compensatory translation, and the CORA as a-t CORA (angulation –translation CORA) (Fig:22). In our case, the osteotomy and ACA were placed above the level of CORA in the AP view,and this has contributed to the secondary translation (i.e. osteotomy rule 3).



Order of Correction:
There is a slight difference between order of correction of deformities during fracture fixation and gradual deformity correction. In both, the angulation is corrected first and translation last.

Fracture Fixation (Lambotte's principle)[11], [12].	Deformity correction (Paley's Principle) [10].
Angulation,	Angulation,
Rotation,	Length,
Length,	Rotation,
Translation	Translation

Fig-22: CORA falls below the level of the deformity in AP plane

There are three osteotomy rules (Fig: 23) [13].
In our case rule 1 happened in procurvatum deformity and rule 3 happened in varus deformity,so there was a secondary translation seen in the AP view.

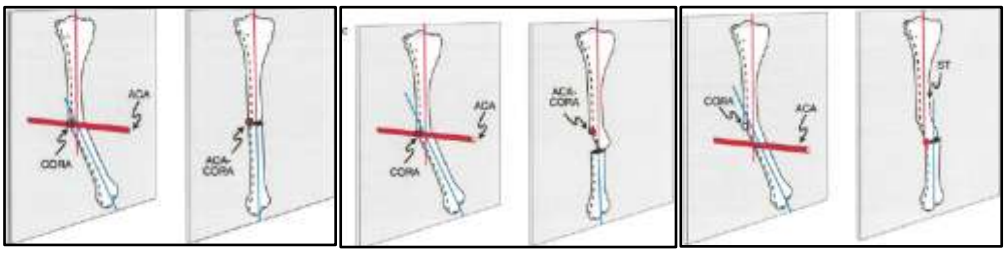


Fig 23: Osteotomy rules 1,2,3. Osteotomy rule 1:ACA &osteotomy are placed at the level of CORA.Rule: 2 ACA is placed at the level of CORA, osteotomy performed in different level.Rule 3: ACA and Osteotomy are placed above or below the level of CORA.

Retrospective analysis:

Now when we analyzed retrospectively we found that there are two CORA's , one in the lateral view which is at a higher level and other (a-t CORA) in the APview which is at a lower level.Moreover translation can be appreciated preoperatively in AP view alone. So the diagnosis was revised to " biplanar deformity with angulation in oblique plane and translation in anatomic coronal plane". A similar type has been described by Dror Paley and has been named as **"variant 3"**(one anatomic and one oblique plane deformity, with angulation and translation in different planes less than 90 degree apart;APradiograph shows angulation and translation, and lateral radiograph shows only angulation) [14].

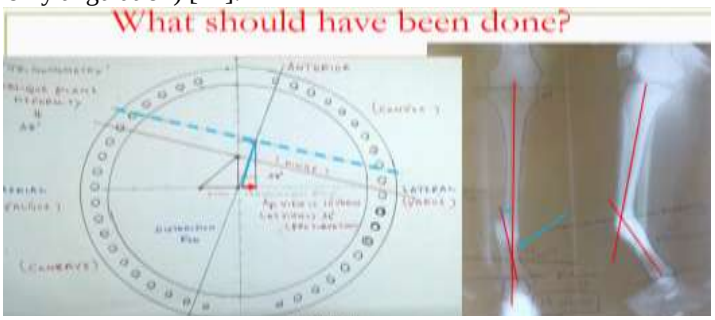


Fig 24: Amount of translation plotted in the graph retrospectively

What should have been done?

The amount of translation which should have been corrected with translation device has been plotted in the same trigonometry graph(Fig: 24).As a first stage, correction of angulation with osteotomy at the level of higher CORA, and, as a second stage, correction of translation throughsame osteotomy should have been done.The second stage correction of translation should have been done immediately following correction of angulation (before consolidation of regenerate). Alternatively an Ortho SUV which is a six axis correction device could have been used to correct all the deformities in a single stage.

V. Conclusion

Ilizarov ring fixator can be used to correct deformities in multiple planes [3], but the correction has to be done in multiple stages in the order mentioned previously. Alternatively six axis correction device like Ortho SUV can be used to correct all deformities in single stage.Although several options are available regarding deformity correction, the technique which should be instituted, depends up on deformity pattern,soft tissue status,and level of deformity. Proper planning is needed preoperatively, intraopertively and post operatively. Revision of planning to be done at any point of time during management.Proper counseling of the patient should be done to gain compliance, in case revision surgery is needed.

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