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Study of Bone Allograft in Correction of Juxta Articular Angular Deformities by Open Wedge Osteotomies

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A B S T R A C T

Juxta articular angular deformities are commonly seen both in young as well as adults. They are seen to be having high prevalence especially in children. In vast majority these are physiological and resolve on their own. Asymmetric growth disturbances are commonly caused by rickets, infections, trauma, arthritis of knee. Treatment options vary from epiphysiodesis if physis is not fused to osteotomies vis a vis open as well as close wedge osteotomies. Both having their respective advantages as well as disadvantages. We evaluated the corrections achieved by combining open wedge osteotomies with allograft and the subsequent maintenance of the corrections. Implications of osteointegration and incorporation of graft, infection rate and related complications was documented in a series of 20 cases and followed for a period of 6 months asymmetric growth disturbances and it was found that desired corrections with osteointegration achieved in all patients.

Keywords: Bone allograft, juxta articular deformity, deformity correction, open wedge Osteotomy

INTRODUCTION

Angular deformities such as genu valgum deformity have shown to have high prevalence in the Indian population with prevalence being as high as 9.2 percent in school going children [1]. Other commonly seen juxta articular angular deformities include genu varum, cubitusvarus and valgus and coxavara. Juxta articular angular deformities of long bones are common and if not treated lead to early joint degeneration and osteoarthritis [2]. These angular deformities are managed by conservative methods if physiological. Such deformities is young patient may be treated by growth modulation in open physis [3]. However large deformities in skeletally mature case need corrective osteotomy or external fixation and distraction. Use of external fixators such as Ilizarov fixator is cumbersome and has increased risk of pin tract infectionsosteotomy correction can be done by open wedge or closed wedge methods. Open wedge osteotomies do not compromise length and stability when compared to close wedge osteotomies [4]. Open wedge osteotomies lead to better survivability and less complications when compared to closing wedge osteotomy done for the same. Allogenic bone grafts are widely used in corrective osteotomies, non-union, delayed union of fractures and in various replacement and tumour resection surgeries.Use of allogenic bone graft with proper surgical technique, need no additional procedure and avoid potential complications associated with harvesting procedure when compared to autograft and better osteointegration when compared to synthetic substitutes [5]. Since osteotomy and allograft wedge are done in metaphyseal area which is rich in bone /progenitor cells increase the osteogenic potential of allograft help in early osteointegration. In our institutional bone bank processed deep feezed gamma sterilized allogenic bone graft of femoral head and Total knee arthroplasty cuts were readily available were used allograft bone wedge to fill the open wedge.

Through our prospective clinical study, we studied the use of allogenic bone graft in open wedge osteotomies in treatment of angular deformities and compared the desired correction achieved clinically and radiologically and maintenance of deformity correction.

MATERIALS & METHODOLOGY

20 cases were selected after they met the inclusion criteria of the study and corrective osteotomy were done by using institutionally procured allograft and fixation device such as k wires and fixed plating and the patients were followed for a period of 6 months.

Inclusion Criteria: Patients with fused epiphysis with juxta articular angular deformities of long bones of upper and lower limbs requiring correction by open wedge osteotomies.

Exclusion Criteria: Patients with non-fusion of epiphysis and any active pathology of bone, irradiated bone.

METHOD

All patients were evaluated with radiographs, including anteroposterior, lateral, and 45-degree patellar axial, long double-leg standing anteroposterior alignment radiograph. Wrist and fore arm AP and lateral radiograph in case of malunited distal end radius fracture were taken to measure deformity.

To calculate the desired angle of correction, a line was drawn from the center of the femoral head through the apex of the medial tibial eminence. Next, a line was drawn from the center of the talar dome through the same point on the tibia. The angle formed by the intersection of these 2 lines provides the necessary osteotomy correction angle. The wedge was then calculated using tracing paper and preoperative wedge size calculated.

Out of 20 cases there were 6 cases of varus deformity of knee and 13 cases of valgus deformit, 1 was of post traumatic deformity of wrist. Out of 6 cases, 3 cases underwent High tibial osteotomy whereas 3 underwent medial open wedge distal osteotomy.

The 13 cases of valgus deformity underwent lateral open wedge distal femur osteotomy with allograft and fixation with either k wire or plating. The age range of the patients was between 14 to 45 years.

The case of malunited distal radius fracture underwent open wedge distal radius osteotomy with plate fixation with allograft. A minimum follow up of 6 months was present.

HIGH TIIBIAL OSTEOTOMY TECHNIQUE

A 6-cm vertical incision was made over the centre of the knee between the medial aspect of the tibial tuberosity and the posteromedial aspect of the tibia, below the joint line. Following which from medial border of the patellar tendon, subperiosteal dissection was done towards the posteromedial aspect of the tibia, while protecting distal insertion of the superficial medial collateral ligament. Two guide wires were inserted in the standard fashion at a point 3-4 cm below the medial joint line and passed obliquely 1 cm below the lateral articular margin of the tibia towards the tip of the fibular head. Under fluoroscopic guidance, a tibial osteotomy was done immediately below the guide wires using an osteotome. The osteotomy site was checked with a valgus force and then the osteotomy was opened according to the preoperative planning.Thereafter, the desired wedge was inserted until the osteotomy was opened to the desired extent. After degree of correction had been achieved, internal fixation was done using a T-plate with three proximal and two distal holes. The proximal screws were applied under fluoroscopic guidance and the defect was always grafted with allograft. Before final plate fixation, limb alignment was checked fluoroscopically.

ALLOGENIC GRAFT PROCUREMENT

The Institutional bone bank had grafts procured from consenting patients having undergone total hip and knee arthroplasty at the institute and stored them at -76 degree Celsius for a minimum of three months before use. The gamma radiation was done at an accredited center.

The graft was morselized into fragment and wedge were carved and washed in saline and impregnated with vancomycin.Sample for cultures were taken to ascertain sterility of allograft was all negative.

FOLLOW - UP

Patients were evaluated immediately postoperative, suture removal day (14^{th} day), at 1 month, 3 month and Six months and subsequent radiographs were taken and corrected angles determined radiologically and clinically. In follow up of 6 months assessment of osteointegration, deformity correction, maintenance and any complication and infection was done. Osteointegration was evaluated by Sloof*et al.*, [6] criteria and surgical site infection identified using American College of Surgeons and Surgical Infection Society [7].

Sloof criteria for osteointegration of allogenic bone graft

1. Prescence or absence of pre-existing lucent lines between pre-existing bone and graft
2. Absent graft resorption
3. Radiographic homogeneity of graft

INFECTION

Infection was seen to be present in 1 out of the 20 cases and hence a 5 percent infection rate was seen. The cases showing superficial infection in pseudomonas aeruginosa organism was cultured. Patient was treated by 3rd generation cephalosporin. On subsequent follow up wound was healed at two weeks. In study conducted by Anagnostakos, K., Mosser*et al*., [8] level 4 studies were done to see infection post high tibial osteotomy. One study had a level of evidence II, five level of evidence III and 20 level of evidence IV. Superficial infections were seen in 1–9% and deep infections in 0.5–4.7% of the cases. One study reported on a secondary bacterial arthritis in 4.5 % of the cases.

Hence rate of infection rate of 5 percent was seen to be comparable. In study we used vancomycin impregnation in allogenic bone graft as suggested by study of Lakhwani*et al*., [9] in which use of vancomycin impregnation of allogenic bone graft was shown to prevent graft related and surgical site infections. Ketonis*et al*., [10] reported that vancomycin impregnated allograft bone was able to resist colonization by organisms while retaining the ability to allow adhesion of osteoblastic cells. Low infection rate in our study can be hence attributed to Vancomycin impregnated allograft use, gamma sterilization of allogenic bone graft and good record keeping and SOP being followed in our institutional bone bank.

Table 1: Infection Seen in Our Study

	Frequency	**Percent**
Infection present	1	5
Infection not present	19	95
Total	20	100

Surgical site infections were assessed according to American College of Surgeons and Surgical Infection Society

Only in 1 case infection was seen at 5th day in form of serous discharge due to pseudomonas aeruginosa and which was treated with third generation cephalosporins and sterile culture report was obtained at suture removal day wound healed subsequently.

OSTEONTEGRATION

Osteointegration of allogenic bone graft was assessed using signs delineated by Sloof et al which included attainment of graft homogeneity and absence of graft resorption. The success rate in terms of adequate osteointegration in our study was 90 percent-18 out of 20 cases. Sloof*et al*., [6] reported healing rate of 80 percent at 4 months for allogenic bone graft used in total hip replacement for acetabularprotusion.

Mean period of healing was seen at 20 weeks in 18 out of the 20 cases. This is in line with study published by Wouter Van Genechten, Maxim Van den Bempt 1 [11] Maximum healing rate of over 90 percent was seen at 3 months and it was found even though there is earlier healing reported in osteotomies like high tibial osteotomies with autograft no functional outcome differences are present at 3 months when compared with allogenic graft. Hence good osseointegration in osteotomy site lead to good functional outcome and early weight bearing in our prospective study. Hence along with the good osteointegration, it is highlighted that allogenic bone graft used as wedges when used after vancomycin impregnation, with good planning and maintaining sterility in bonbank leads to good stability and outcomes in open wedge osteotomies.

Table 2: Osteointegration Seen in Our Study

	Follow-up 6 months	**9 months**	**12 months**
Osteointegration seen	18 cases	1 case	1 case
Osteointegration not seen	2	1	-
Total	90%	95%	100%

Osteointegration was assessed using Sloofs criteria and adequate osteointegration was seen in 18 out of the 20 cases at six months of follow up. Among Rest of two cases one allograft was osteointegrated at 9 months of follow up and remaining one at one year.

CORRECTION AND MAINTENANCE OF CORRECTIONRADIOLOGICALLY AND CLINICALLY

Maximum correction required was 16 degree and Minimum correction was of 6 degrees. The maximum wedge required was of 15 mm and minimum wedge used was of 4mm with mean wedge size of 8.4 mm. Pre- and post-operative

correction were assessed radiographically and clinically and wedge correction was calculated using radiographs and on table after osteotomy and correcting deformity. study conducted by Justin J. Mitchell *et al*., [12] excellent results were noted of distal femur osteotomy in 83 percent patients over 2 years and valgus deformity were corrected using allograft and distal femur osteotomy and similarly in our study mean correction of 80 percent was noted both radiologically and clinically with adequate wedge being maintained and no complete failure in correction was noted radiographically. In study conducted by James Besley*et al*., [13] in Medial opening wedge high tibial osteotomy with allograft augmentation was found to be a more stable construct than without a graft. This finding may be of significant importance in patients requiring a large correction such as correction about 8-10 degree as noted in our study. Valgus malrotation of the tibial head is reduced when an allograft is inserted into the osteotomy gap, which may help to protect the lateral cortex post-operatively.

Table 3: Average Percentage Correction Clinically

Postop -Correction angle clinically	89.46
Suture removal-Correction angle clinically	89.46
One Month-Correction angle clinically	82.90
Three Months-Correction angle clinically	81.92
Six Months-Correction angle clinically	80.10

Table 4: Showing Average correction Radiologically

Average Percentage correction Radiographically	
Postop - Correction angle radiograph	89.46
Suture removal-Correction angle radiograph	89.46
One Month-Correction angle radiograph	82.17
Three Months-Correction angle radiograph	81.92
Six Months-Correction angle radiograph	80.10

Average Corrections were seen clinically and radiologically was seen to be 89percent immediatelty post operatively and subsequently 82 percent of desired correction at 1 month, 81.92 percent at three months and at 80 percent at 6 months.

Case Presntation 1

Image 1: Scanogram Showing Correction Angle and Osteotomy Site

Image 2: X-Ray of B/L Knee of Genu Varum

Image 3: Osteotomy cut in High Tibial Osteotomy

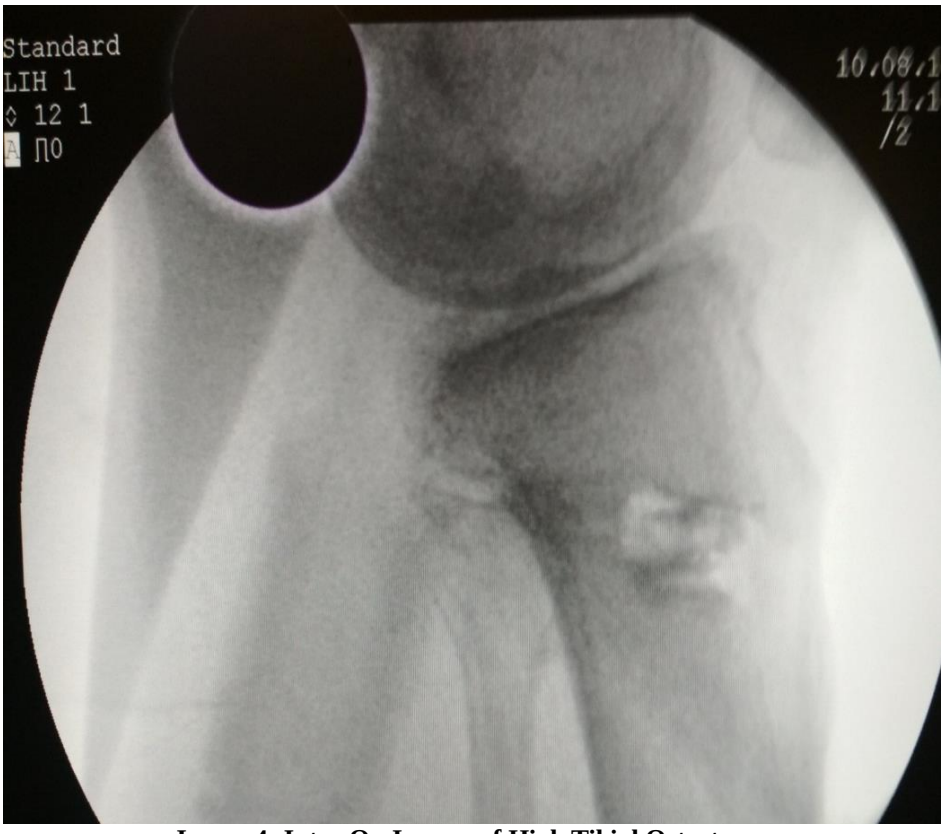

Image 4: Intra Op Images of High Tibial Osteotomy

Image 5: Post Op Xray of High Tiibial Osteotomy with Allograft

Case Presentation 2

Image 6: ScanogramB/l Genu Valgum

Image 7: Showing Lateral Open Distal Demur Osteotomy for Genu Valgum

Image 8: Post Op X-ray Open Distal Femur Osteotomy with Allograft & k wire fixation

Case Presntation 3

Image 9: Scanogram B/L Genu Varum with Osteotomy site at Tibia

Image 10: Stapler removal after Hemiphysiodesis

Image 11: Intra op Images of medial open wedge Tibial osteotomy

Image 12: Medial Open Wedge Tibial Osteotomy

Image 13: Post op Xray of Tibial osteotomy with plating with Allograft

Case Presntation 4

Image 14: Post traumatic right genu varum

Image 15: Preop Scanogram of Right Genu Varum

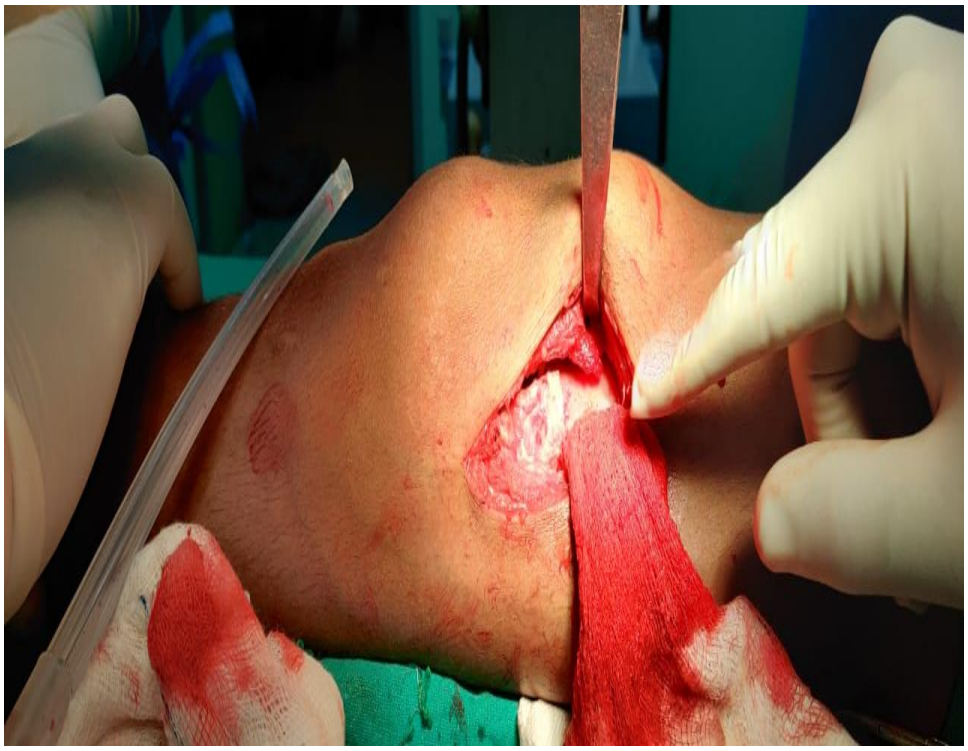

Image 16: Open Distal Femur Osteotomy

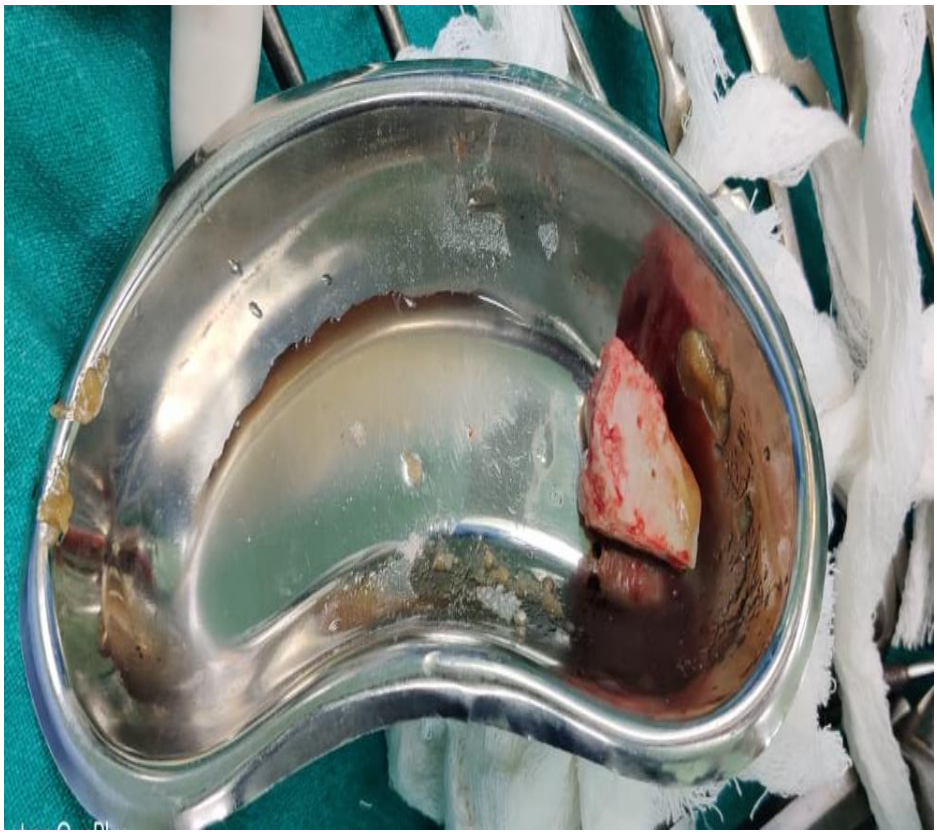

Image 17: Wedge To Be Placed Obtained From Femoral Head

Image 18: Post op x-ray of Medial Open Distal femur osteotomy with Plating with allograft

DISCUSSION

In our study 20 patients who gave written and informed consent and required open wedge osteotomy with allogenic bone graft were assessed for various etiologies such as idiopathic, post traumatic, developmental and other deformities. Among 20 cases 4 were bilateral, 13 were of genu valgum deformity and 6 were of genu varum deformity and one post traumatic wrist deformity following malunited distal radius fracture. Medial open wedge osteotomy, High tibial osteotomy, Lateral open wedge osteotomy combined with fixation with plates wires and Open wedge dorsal distal radius osteotomy with plate fixation and allogenic bone graft impregnated with vancomycin was used.

CONCLUSION

We conducted the study in 20 cases in our institution comprising of 13 genu valgum and 6 genu varum cases, 1 case of Malunited distal radius fracture and performed open osteotomy with allograft use and fixation via k wires in 7 cases and Plate fixation in 13 cases and the patients were followed up for a period of 6 months.

The maximum wedge used was of 15mm in a case of post traumatic genu varum and minimum wedge used was in a case of malunited distal end radius of size4mm.Average wedge correction done was 8.4 mm.

Radiological and clinical correction was followed up following surgery for a period of 6 months and 80 percent of desired correction was achieved, discrepancy was present due to manual tracing methods applied, oversimplified correction of 1 mm for 1-degree correction and variability while measuring correction angle.

Majority of patients i.e. 18 out of 20 patients achieved graft osteointegration and there was no failure of graft uptake or graft resorption and allograft helped achieved construct stability and desired correction in open wedge osteotomies.

Infection rate of only 5 percent was seen and only case was in form of superficial infection and was managed with third generation cephalosporin and wound healed subsequently.

Hence it was concluded that use of allograft in correction of juxta articular angular deformities by open wedge osteotomies leads to desired correction and allograft osteointegration is seen without any donor site complications of autograft and synthetic substitutes.

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