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A COMPARATIVE ANALYSIS OF ELEVATION OF DEPRESSED TIBIAL CONDYLE FRACTURE BY AUTOGENOUS BONE GRAFT AND HYDROXY APATITE CRYSTALS

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ABSTRACT

BACKGROUND: Proximal tibial plateau fractures are serious and complex injuries that pose difficulty in management. Their management is challenging because of the severe displacement of the bony fragments, the concomitant depression and impaction of the cancellous subchondral bone, and the complications like Compartment syndrome, cartilage destruction, soft-tissue envelope damage, infection, knee instability, stiffness and arthritis.

OBJECTIVES: A comparative analysis of elevation of depressed tibial condyle fracture by autogenous bone graft and hydroxyl apatite crystals.

METHODS: A prospective study of 30 patients with Schatzker type II, III, V, and VI with depressed tibial plateau fractures were identified and divided into 2 groups, all the patients were treated by elevation of depressed tibial condyle fracture, patients in group A have been operated by using bone graft and in group B have been operated by using hydroxy apatite as void filler, 15 in each group.. The preoperative and intra operative and post operative data was noted and final evaluation was done using knee society score.

RESULTS: The patients were followed up at 1,3 and 6months, Fair results were seen in 53.30% of patients treated with bone graft and 80% of patients treated with hydroxyapatite crystals at one month, where as 46.70% of patients treated with bone graft and 20% of patients treated with hydroxy apatite crystals showed poor result at end of one month.93.3% of patients treated with bone graft and 86.7% patients treated with hydroxyapatite crystals showed excellent results, and 6.7% of patients treated with bone graft and 13.3% of patients treated with hydroxyapatite crystals have shown good results at 3 and 6 months.

CONCLUSION: We conclude that there was no much significant difference between functional outcome between both the groups but the complication of late collapse is higher in patients treated with bone graft when compared to those treated with hydroxyapatite crystals.

KEYWORDS: Tibial Plateau fractures, Schatzker, knee society score.

INTRODUCTION

The knee joint is complex joint and is the commonly injured joint now a days because of increased vehicular trauma and sports related injuries.

Being superficial joint and more exposed to external forces, this joint easily gets injured.

The first account of internal fixation was by a brass wire by A.M. Cart in 1770 since then fracture treatment has never looked back.

Fractures of the proximal tibia, particularly those that extend into the knee joint are termed as tibial plateau or tibial condylar fractures. These fractures constitute about 1% of all fractures and 8% of the fractures in elderly. The lateral condyle is more frequently involved than the medial condyle[1]. Whereas the involvement of bicondylar lesions is found in 10 to 30% of the reported series[2]. The indications for non-operative versus operative treatment of tibial plateau fractures vary widely in literature. Different surgeons have advocated different treatment protocols, some in support of conservative and some against.

The objectives of treatment of tibial plateau fracture, is precise reconstruction of the articular surfaces stable fragment fixation allowing early mobilization and repair of all concomitant ligamentous and other soft tissue lesions[3].

High velocity injury sustained in automobile disasters and increase in road traffic accidents as a whole is creating an ever-growing problem. Since man has taken to travelling at high speeds in the sitting position with the loading edge composed of flexed hind limbs, when the machine in which the subject is travelling stops suddenly, most of the impact is taken at first upon the patella, then the tibia and femur in varying proportions and at various positions. The stationary lower limb may be struck by a moving object; this is the common pedestrian injury, the so called "**Bumper Fracture**", since the bumper of most vehicles being placed roughly at knee height. In the past two decades, with improvements in surgical techniques and implants, there has been a trend towards surgical management of these injuries. *Thus we have advanced from conservative approach to internal fixation mode of treatment.*

Nevertheless, tibial plateau fractures remain challenging because of their number, variety and complexity. Despite a plethora of articles, written in the past 50 years, that have addressed the problems of classification and results of various treatments the optimal method of management remains controversial[4] particularly *for high energy tibial plateau fracture (type IV. V, &VI.)*

WHAT CONSTITUES A COMPLEX TIBIAL PLATEAU FRACTURE?

There are four factors which determine the prognosis of tibial plateau fracture[5]

l. Degree of articular depression
2. The extent of separation of condylar fracture lines
3. Diaphyseal-metaphyseal comminution and dissociation
4. Integrity of soft tissue envelope.

In high energy fracture these above factor are severe in nature, combine to make the definition of complex high energy tibial plateau fracture. It is this type of fracture we are concerned with.

AIMS AND OBJECTIVES

To study the biomechanics and tibial plateau fracture pathology.

The aim of the study is to evaluate the usage of hydroxyl apatite crystals (G-Bone) in depressed tibial condyle fractures and to compare and analyse the functional outcome with that of autologous bonegrafting.

To restore the anatomical congruity of the articular surfaces.
Early mobilization of patient.

MATERIALS AND METHODS

Source of data :

Subjects who have sustained depressed tibial condyle fractures and are admitted to Raja Rajeswari Medical College and Hospital , Bangalore, Satisfying the inclusion criteria are taken for this study

Study Design – A Prospective Analytical study

Study Period – Cases satisfying the inclusion criteria admitted in RRMCH, Bangalore during the study period of October 2019 to May 2021 will be included.

Sample Size Estimation -. The Sample Size is **30** in each groupand is calculated based on approximate availability of number of cases in the above mentioned duration satisfying inclusion and exclusion criteriaandwere divided into 2 groups , all the patients were treated by elevation of depressed tibial condyle fracture, patients in group A have been operated by using bone graft as void filler and patients in group B have been operated by using hydroxy apatite as void filler, 15 in each group. These patients were evaluated in the final analysis. The preoperative and intraoperative data was noted from the indoor files. The final evaluation was done using KNEE society score.

Methods of collection of data (including sampling procedures if any)

All cases meeting the inclusion criteria of both genders presenting with depressed condylar fracture tibia centered in Hospital attached to Rajarajeshwari Medical College And Hospital , Bengaluru.

Inclusion Criteria:

a) adults between 20 and 60 years
b)Schatzker's type II, III,V and VI tibial condyle fractures with fracture depression more than 10mm were included.
C) Subjects who gave consent.

Exclusion Criteria:

a) Open fractures (more than Grade II – Gustilo's), fracture depression
less than 10mm and young patient less than 20 years were excluded.
b) Subjects who were non ambulatory, prior to the fracture.
c)Subjects who have sustained polytrauma.
d)subjects who have features suggestive of arthritis prior to fracture.

CLASSIFICATION SYSTEM

The SCHATZKERS CLASSIFICATION was used to classify these fractures. The patients were followed up for a minimum period of 6 months.

MANAGEMENT:

The patients were first seen in the casualty. The history was taken followed by general and local examination of the patient. Concerned specialists undertook appropriate management of the associated injuries. Intensive care was given to those patients who presented with shock and immediate resuscitative measures were taken. Once the patient's general condition was fit, relevant x-Rays were taken. CT was done for depressed fractures and for type 5 & 6 in selected cases.

Surgery was performed at the earliest possible time depending on their medical condition, skin condition and the amount of swelling. Surgery was delayed if Compartment Syndrome

or increasing swelling was noticed, patient were then placed in skeletal traction with limb elevation.

All surgeries were done under C-arm image intensifier control. Depressed fractures were augmented either with bone graft or calicium hydroxyapatite crystals. The fixation devices used for support consisted of T Buttress plate, L Buttress plates, spoon plates 4.5mm cortical screws and 6.5mm and 7.0mm cannulated and non-cannulated cancellous screws. The source of bone graft used was either from iliac crest or local graft.

IMPLANTS USED FOR INTERNAL FIXATION OF TIBIAL CONDYLAR FRACTURE:

Hydroxy apatite:

It is also called as hydroxyl apatite. Hydroxy apatite is a naturally occurring mineral form of calcium apatite with the formula Ca5 (Po4)3 (OH), but is usually written Ca10 (Po4)6 (OH)2 to denote that the crystal unit cell comprises two entities.It crystallizes in the hexagonal crystal system. It has a specific gravity of 3.08 and is 5 on the mohs hardness scale. Pure hydroxyl apatite powder is white. Naturally occurring apatite's can however also have brown, yellow, or green colorations.This modified hydroxyl apatite granules and block are made of calcium hydroxyl apatite in highly crystalline form. The body absorbs it slowly. It is derived from bovine bone which has been sintered at a very high temperature of +500°C. This leaves only pure inorganic structure. It does not carry any risk of transmission of any disease because no organic matter survives such high temperature.

It is available in

1)granules

2)blocks.

The bone filler acts as a scaffold and encourage the rapid filling of the void by naturally forming bone provides an alternative to bone grafts. It will also become part of the bone structure and will reduce the healing time thus compared to situation, if no bone filler was used. Generally speaking dense hydroxyl apatite does not have the much strength to enable it to succeed in long term load. It should be supported by plating.

Bone graft: Autogenous tricortical bone graft taken from ipsilateral iliac crest and local graft is used as void filler in one group of patients to elevate the depressed tibial plateau fractures.

BUTRESSS PLATE:

The widening ends of long bone consist of large amount of cancellous bone. Such bone is comparatively weaker and has tendency of axial deviation or bending under the effect of compressive or shearing force. A lag screw cannot prevent the deformity and in order to supplement the fixation a buttress plate is essential to prevent collapse.

Types: T plate
L plate
Hockey stick plate

ANATOMICAL LOCKING COMPRESSION PLATE

Anatomical Locking compression plates are indicated for certain high energy bicondylar fractures, those with severe comminution and in osteoporotic fractures. Laterally based locking plate offers an alternative to an additional medial plate or external fixator for support of the medial column in bicondylar fractures.

Interfragmentary compression cannot be achieved by locked plates; supplementary use of Interfragmentary screws may be required to prevent loss of reduction and to ensure adequate compression of the fragment.

SCREWS
Cortical screws - 4.5 mm diameter of various lengths
Cancellous screws: - 16mm, 32mm partially threaded and fully threaded
Locking screws

OPERATIVE PROTOCOLS:
BICONDYLAR FRACTURE:
A mid line or two incision technique is used for reduction of both the condyles. Arthrotomy is done for inspection of ligament injury or meniscal injury. Meniscectomy done if indicated. Depending upon comminution and depression, fixation is done by L, T or hockey stick plate or locked plates and cancellous screws along with bone graft/hydroxyapatite crystals. Dual plating can be done if other side is unstable where collapse may occur.
Postoperatively patients were immobilized with an above knee posterior slab or a compression bandage. The sutures were removed on the 12th postoperative day. I.V antibiotics was given for 3 days post-operatively followed by oral antibiotics for another 7 days. The patients were advised quadriceps exercises, non-weight bearing crutch walking, on discharge. An immediate postoperative X-ray was also done.

TOTAL CONDYLAR DEPRESSION:
Fracture of medial or lateral condyle needs appropriate reduction as malunion may develop with varus or valgus misalignment. The depressed plateau is elevated, articular surface reconstructed and fixed with buttress plate.

SPLIT AND DEPRESSED FRACTURE:
Surgical intervention is necessary in a fracture more than 3-4 mm spilt and depressed. The depressed fragment is elevated and autogenous bone grafts/hydroxy apatite crystals are put and split is reduced and reduction is held with Kirschner wires. The fragments are then fixed with suitable plates and cancellous and cortical screws.

CENTRAL DEPRESSION FRACTURE:
A window is made in the metaphyseal area below the depressed fragment, the depressed fragment elevated and autogenous corticocancellous bone graft/hydroxy apatite packed beneath. Autogenous bone graft was harvested from the anterior aspect of the iliac crest/local graft. Fragment and graft were stabilized with cancellous screws or plate fixation.

FOLLOW UP
The first follow up was done at 6 weeks during which an X-ray was taken to look for signs of fracture union and loss of reduction if any; Knee hinged brace advised if necessary. Union was defined as evidence of bone healing by direct or indirect means in at least two radiographic planes and a full painless weight bearing joint.
The Second follow up was done at 3 months during which one more X-ray was done and a clinical evaluation of union done. Based on the clinical and radiological signs of union patients were allowed partial weight bearing and gradually progressed to full weight bearing. The patients were then followed up at 3months, 6 months and 1 year respectively during which time the anatomic and functional evaluation was done using the Knee society Score.
Within 3 months:Date of knee mobilization started, Duration of knee brace given, Date of weight bearing allowed, Clinical union time, Radiological union time, Loss of reduction, non-union, Infection, Implant loosening were noted

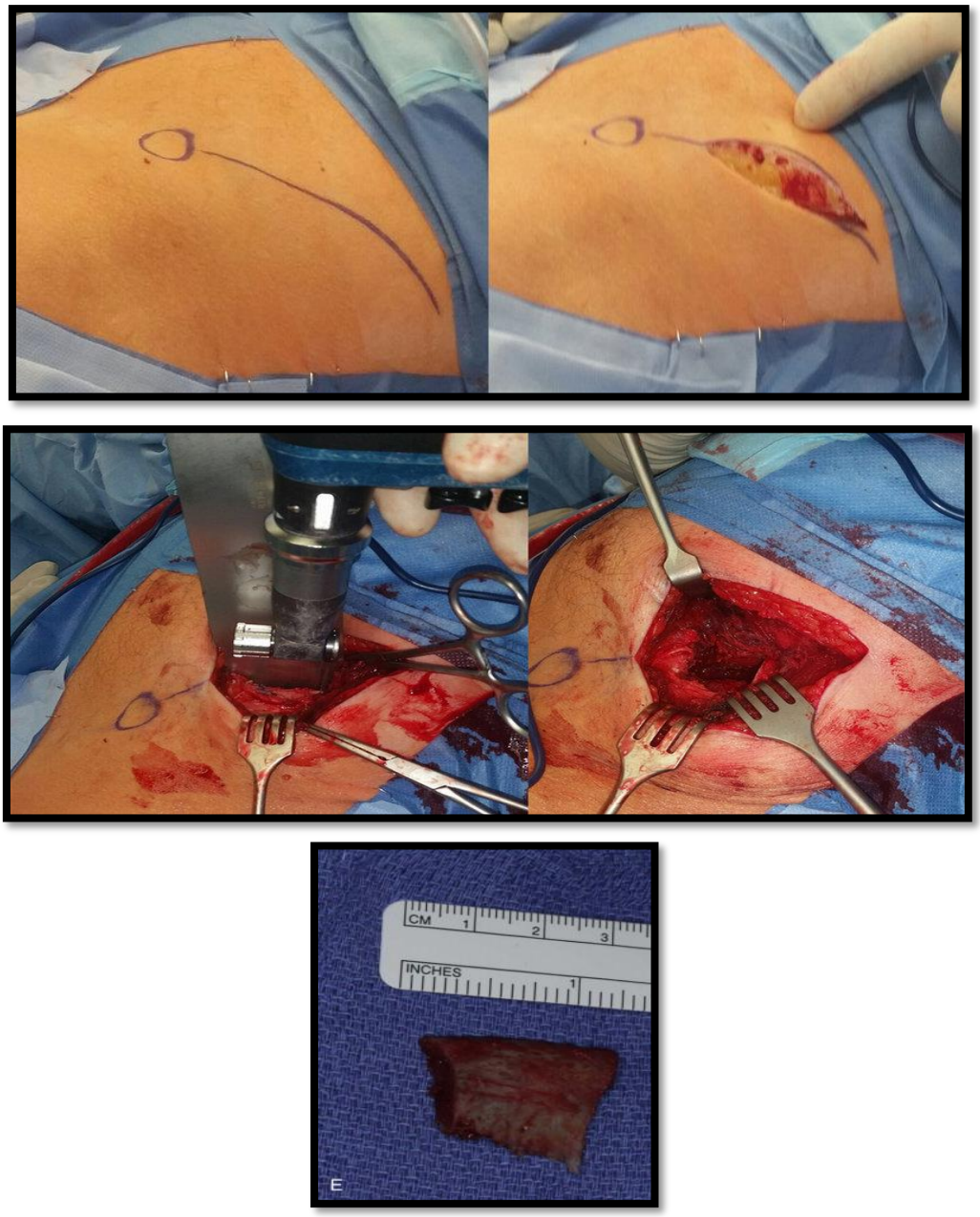
After 3 months: Knee society's revised HSS knee rating, Hardware problem, knee stiffness, Other complications, Patient satisfaction are noted.

INSTRUMENTS

CALICIUM HYDROXYAPATITE CRYSTALS.

LOCKING SCREWS AND PLATES

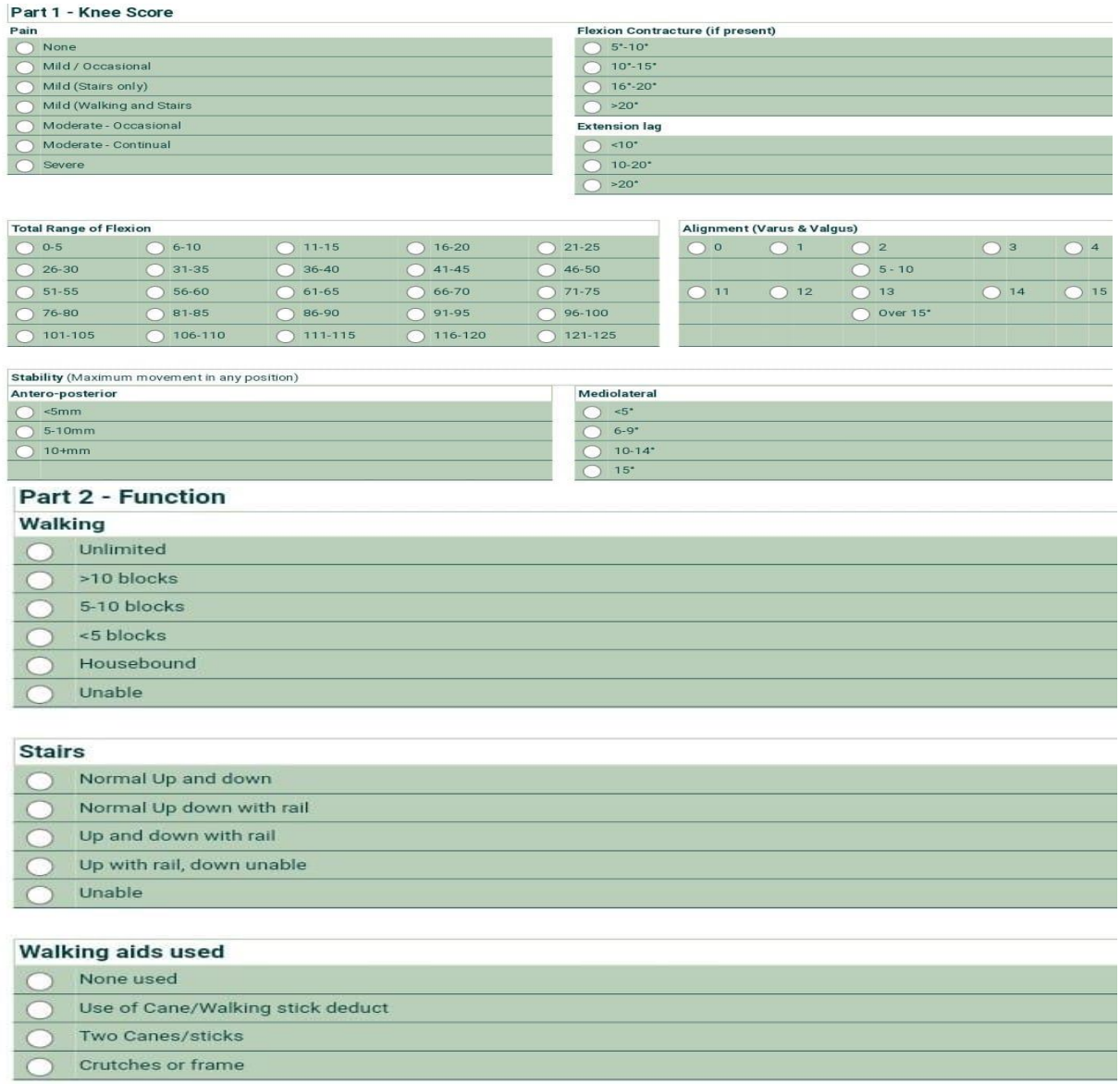
ILLAC BONE GRAFT



KNEE SCORE (INSALL MODIFICATION - 1993)[65]

This scoring system is the version of the knee score as modified by Dr. John Insall in 1993. The scoring system combines a relatively objective **Knee Score** that is based on the clinical parameters and a **Functional Score** based on how the patient perceives that the knee functions with specific activities. The maximum Knee Score is 100 points and the maximum Functional Score is 100 points. To calculate the two scores the answers to the questions and the findings on the examination are given a value based on the results. To obtain the Knee Score and the Functional Score the result of each question is totaled. Notice that some results are negative to denote that they are deductions to the score.

KNEE SOCIETY SCORE



Part 1 - Knee Score

Pain

- None
- Mild / Occasional
- Mild (Stairs only)
- Mild (Walking and Stairs
- Moderate - Occasional
- Moderate - Continual
- Severe

Flexion Contracture (if present)

- 5°-10°
- 10°-15°
- 16°-20°
- >20°

Extension lag

- <10°
- 10-20°
- >20°

Total Range of Flexion

0-5	6-10	11-15	16-20	21-25
26-30	31-35	36-40	41-45	46-50
51-55	56-60	61-65	66-70	71-75
76-80	81-85	86-90	91-95	96-100
101-105	106-110	111-115	116-120	121-125

Alignment (Varus & Valgus)

0	1	2	3	4
		5 - 10		
11	12	13	14	15
		Over 15°		

Stability (Maximum movement in any position)

Antero-posterior

- <5mm
- 5-10mm
- 10+mm

Mediolateral

- <5°
- 6-9°
- 10-14°
- 15°

Part 2 - Function

Walking

- Unlimited
- >10 blocks
- 5-10 blocks
- <5 blocks
- Housebound
- Unable

Stairs

- Normal Up and down
- Normal Up down with rail
- Up and down with rail
- Up with rail, down unable
- Unable

Walking aids used

- None used
- Use of Cane/Walking stick deduct
- Two Canes/sticks
- Crutches or frame

INFERENCE OF INSALL'S KNEE SCORE

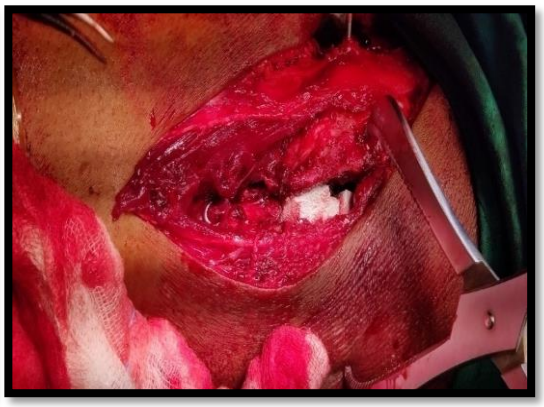
Score	Inference
80-100	Excellent
70-79	Good
60-69	Fair
Below 60	Poor

HYDROXYAPATITE CRYSTALS
CASE-I

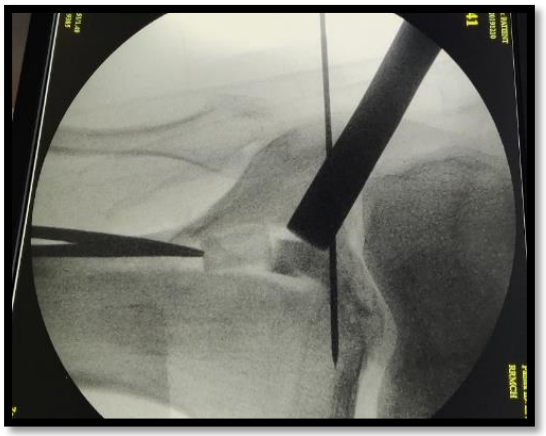
PRE OPERATIVE X-RAY.

POSITION.

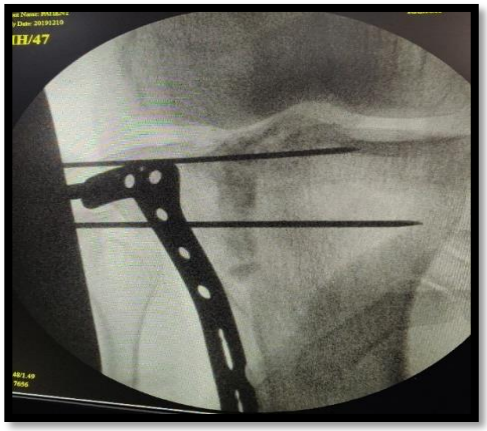
SKIN INCISION.



HYDROXYAPATITE CRYSTALS.



INTRA-OP C-ARM IMAGING.



INTRA OP IMAGE OF PLATING AND REDUCTION UNDER C-ARM.

PLATE FIXATION WITH SCREWS. SKIN CLOSURE

BONE GRAFT AS VOID FILLER.

PRE OP X-RAY NTRA-OP PICTURE – CORTICAL WINDOW.

BONE GRAFT AS VOID FILLER. INTRA OPC-ARM IMAGING AFTER ELEVATION

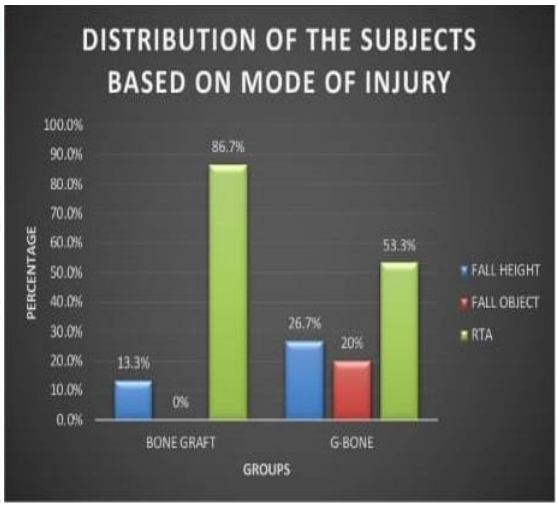
INTRA-OP C-ARM IMAGE AFTER ELEVATION ,BONE GRAFT PLACEMENT AND PLATE FIXATION..

POST-OP X-RAY

RESULTS

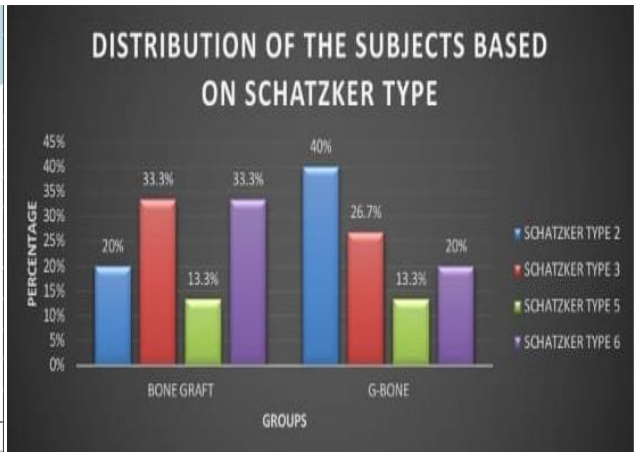
MODE OF INJURY:

Mode of injury		VOID FILLER		Total
		BONE GRAFT	G-BONE	
FALL HEIGHT	Count	2	4	6
	%	13.3%	26.7%	20.0%
FALL OBJECT	Count	0	3	3
	%	0.0%	20.0%	10.0%
RTA	Count	13	8	21
	%	86.7%	53.3%	70.0%
Total	Count	15	15	30
	%	100.0%	100.0%	100.0%
Chi-square value- 4.85				
p value- 0.08				



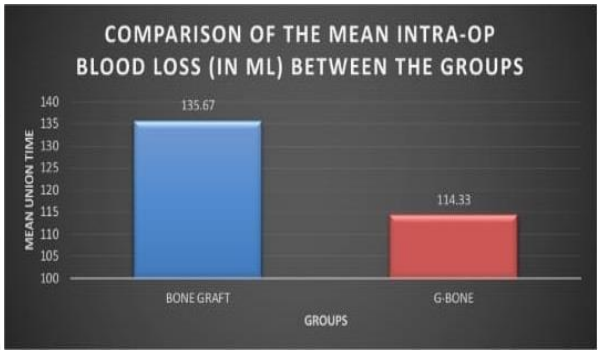
TYPE OF FRACTURE:

SCHATZKER TYPE		VOID FILLER		Total
		BONE GRAFT	G-BONE	
2	Count	3	6	9
	%	20.0%	40.0%	30.0%
3	Count	5	4	9
	%	33.3%	26.7%	30.0%
5	Count	2	2	4
	%	13.3%	13.3%	13.3%
6	Count	5	3	8
	%	33.3%	20.0%	26.7%
Total	Count	15	15	30
	%	100.0%	100.0%	100.0%
Chi-square value- 1.61				
p value- 0.65				



COMPARISON OF THE MEAN INTRA-OP BLOOD LOSS (IN ML) BETWEEN THE GROUPSUSING INDEPENDENT SAMPLE T TEST

Groups	Minimum	Maximum	Mean	S.D	Mean diff	p value
Bone-Graft	115	160	135.67	20.07	21.33	0.005*
G-bone	100	145	114.33	18.69		



COMPARISON OF THE MEAN OPERATIVE TIME BETWEEN THE GROUPS USING INDEPENDENT SAMPLE T TEST

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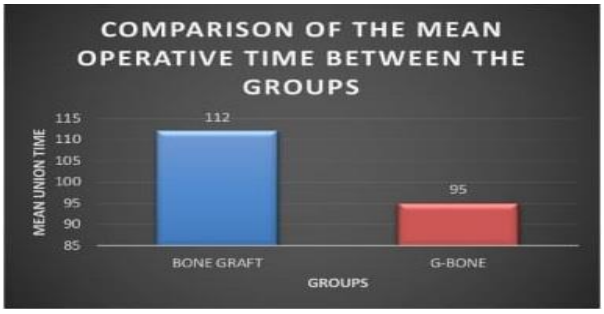
Groups	Minimum	Maximum	Mean	S.D	Mean diff	p value
Bone-Graft	105	120	112.00	7.746	17.00	0.001*
G-bone	90	105	95.00	7.319		

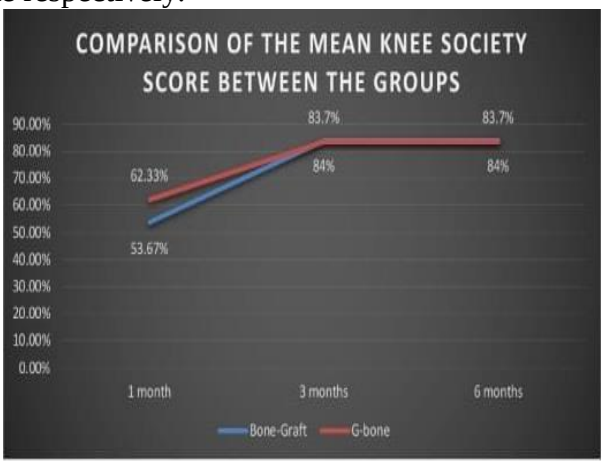


COMPARISON OF THE MEAN KNEE SOCIETY SCORE BETWEEN THE GROUPS USING INDEPENDENT SAMPLE T TEST

In our study knee society score was calculated for both the groups at the end of 1 month, 3 months and 6 months. Results showed mean of 53.67 % and 62.33% for bone graft and G-

bone respectively at the end of 1 month, At the end of 3months and 6 months it showed mean of 84.0% and 83.7% for bone graft and G-bone respectively.

Time intervals	Groups	Minimum	Maximum	Mean	S.D	Mean diff	p value
1 month	Bone-Graft	45.0%	60.0%	53.67%	7.19%	-8.67	0.001*
	G-bone	55.0%	65.0%	62.33%	4.17%		
3 months	Bone-Graft	75.0%	90.0%	84.0%	5.7%	0.03	0.86
	G-bone	75.0%	90.0%	83.7%	4.8%		
6 months	Bone-Graft	75.0%	90.0%	84.0%	5.7%	0.03	0.86
	G-bone	75.0%	90.0%	83.7%	4.8%		

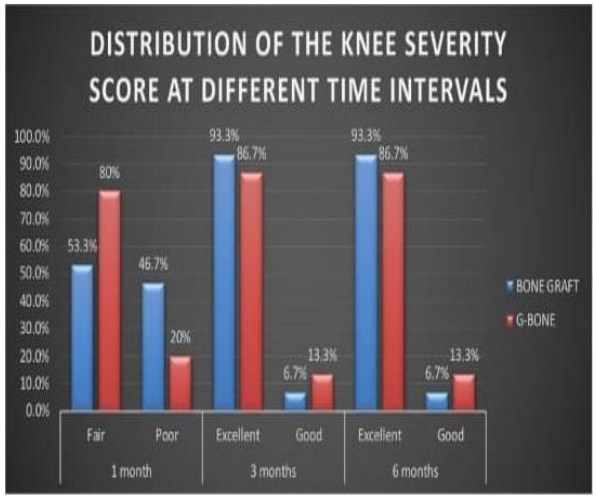


DISTRIBUTION OF THE KNEE SEVERITY SCORE AT DIFFERENT TIME INTERVALS

Fair results were seen in 53.30% of patients treated with bone graft and 80% of patients treated with hydroxyapatite crystals at end of one month, where as 46.70% of patients treated with bone graft and 20% of patients treated with hydroxy apatite crystals showed poor result at end of one month.

93.3% of patients treated with bone graft and 86.7% patients treated with hydroxyapatite crystals showed excellent results, and 6.7% of patients treated with bone graft and 13.3% of patients treated with hydroxyapatite crystals have shown good results at end of 3 and 6 months.

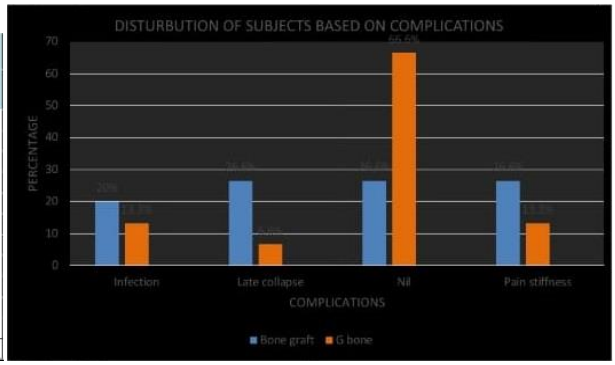
Time intervals	KSS		VOID FILLER		Total	Chi-square value	p value
			BONE GRAFT	G-BONE			
1 month	Fair	Count	8	12	20	2.4	0.12
		%	53.30%	80.00%	66.70%		
	Poor	Count	7	3	10		
		%	46.70%	20.00%	33.30%		
3 months	Excellent	Count	14	13	27	0.37	0.54
		%	93.3%	86.7%	90.0%		
	Good	Count	1	2	3		
		%	6.7%	13.3%	10.0%		
6 months	Excellent	Count	14	13	27	0.37	0.54
		%	93.3%	86.7%	90.0%		
	Good	Count	1	2	3		
		%	6.7%	13.3%	10.0%		



COMPLICATIONS:

The following were the complications seen in this study of 30 patients, 16.7% had infection,16.6% had late collapse and 20 % has pain and stiffness.

Complications		VOID FILLER		Total
		BONE GRAFT	G-BONE	
Infection	Count	3	2	5
	%	20%	13.3%	16.7%
Late collapse	Count	4	1	5
	%	26.6%	6.6%	16.6%
Nil	Count	4	10	14
	%	26.6%	66.6%	46.6%
Pain/stiffness	Count	4	2	6
	%	26.6%	13.3%	20%
Total	Count	15	15	30
	%	100.0%	100.0%	100.0%
Chi-square value- 5.2381				
p value- 0.15				



DISCUSSION

The main purpose of the study is to comparefunctionaloutcome of the surgery in both the study groups : hence all the patients that included in the study are of the operative group. We have not included any conservatively managed patients. Cast, bracing and external fixator is not done in any of the patient as this is not considered as a preferred modality of the treatment. Our study shows the comparison between functional outcome for elevated depressed tibial plateau fractures of those treated with autogenous bone graft and hydroxyapatite crystals.

The ideal treatment for these fractures of the tibial plateau remains controversial. Open reduction and rigid internal fixation achieves the goals of anatomic articular congruity and mechanical alignment restoration, while allowing early knee mobilization. But open reduction and internal fixation specifically through compromised soft tissue, has historically been associated with major wound complication. Alternate methods of treatment have been described, each with its own merits and demerits[69].

Tibial plateau fractures are more commonly seen in the younger age group due to high-energy trauma like in RTAs.

This study group comprises of 30 patients with schatzker type II, III, V, and VI with depressed tibial plateau fractures were identified and divided into 2 groups, all the patients were treated by elevation of depressed tibial condyle fracture, patients in group A have been operated by using bone graft as void filler and patients in group B have been operated by using hydroxy apatite as void filler, 15 in each group.

The aim study is to evaluate the usage of hydroxyl apatite crystals(G-Bone) in adult tibial condyle fractures with depression (Schatzker'stypeII, typeIII, type V and typeIV) and to compare and analyses the functional outcome with that of autologous bone grafting.

We selected 30 cases of adult tibial condyle fractures, during October 2019 to May 2021. All the cases had more than 10mm of depression and belonged to Schatzker's type II, III, V&VI. We had 9 cases of schatzker's type II ,9 cases of type III,4 cases of type V and 8 cases of type VI that were randomly divided into two groups, one treated with G-Bone and the other with autologous bone grafting.

The youngest patient in our series was 21 years and the eldest was 60 years with the average being 39.87 years for bone graft and 36.93 years for hydroxyapatite.

We had 23 male cases and 7 female cases with a ratio of 3:1 male preponderance. Of the 30 cases, 7 cases had compound fractures, 4 with Gustilo- Andersons Grade II and 3 with grade I injury.

The common mode of injury in our study was road traffic accident(RTA) and the others being fall from height and fall of heavy objects. In our study we had 18 cases involving the

left side and 12 cases involving the right side.
In our study the associated injuries varied from 1cases of ipsilateral femur fractures & 2 cases of ipsilateral patellar fractures. There were 3 ipsilatral upper limb injuries and 2 contralateral upper limb injuries The lower limb injuries included 2 cases of ipsilateral malleolar fracture , one contralateral malleolar fracture, One each case of ipsilateral and contra lateral metatarsal fractures and one case of ipsilateral femoral condyle fracture.
Associated fracture of the ipsilateral extremity makes the treatment of tibial plateau fractures much more complex and the results are less predictable.
According to Schatzker.Jet.al (1979) the generally acceptable principle was rigid fixation of all the associated fracture in order to start early rehabilitation. All associated fractures were treated surgically except for the metatarsal fractures.
Sarmientoet.al (1979) in a study of 106 fractures concluded that the condition of fibula determine the angulatory behavior of the tibial condyle fractures. Hence all tibial condyle fractures with loss of fibular buttressing were supplemented with buttress plating in our study.
All the cases were evaluated with antero posterior and lateral view radiography of the tibial condyle .10- 15 degree caudally tilted plateau view was needed to delineate the articular step off due to 10-15 degree posterior slop of tibial articular surface.
CT Scanning was mandatory in all cases as it indicates the amount of tibial plateau depression, the articular comminution and the fracture pattern.
Routine blood investigations were carried out for all patients along with cardiac evaluation for those above 35 years of age.
All cases were operated by antero-lateral approach. In type II,V&VI fractures, the depressed articular fragment was elevated and supplemented either with autogenous bone graft or hydroxyl apatite crystals. The reduced fracture was fixed with buttress plate and cancellous screws. In the type III fractures, a cortical window was created and the depressed plateau was elevated and supplemented with autologous bone graft(or) hydroxyl apatite crystals.
The articular congruity was evaluated under image intensification. The fracture was fixed with cancellous screws after achieving anatomical reduction. In all patients with type III fractures above the age of 45 , a buttress plate was added with the cancellous screws. All the case of type II&III were commenced on range of motion at the end of first post operative week.
For type V&VI and open fractures, ROM exercises were started at the end of second week. All cases were radiologically evaluated at 4 weeks interval for fracture union and graft incorporation.
In the group with autologous bone graft radiological evidence of union was seen at 11 weeks in type III fractures and after 12 weeks in type II,V&VI fractures. No evidence of incorporation of G-Bone was seen even at 2 years follow-up.
Full weight bearing was allowed after evidence of radiological union among the bone graft group and at 12 weeks in the hydroxyl apatite group irrespective of the radiological incorporation.
All patients were evaluated at the end of 1,3 and 6 months duration using knee Society's score, knee rating score and the results were expressed in percentage based both on schatzker's type & management modality.
Knee society score was calculated for both the groups at the end of 1 month, 3 months and 6 months. Results showed mean of 53.67 % and62.33% for bone graft and G-bone respectively at the end of 1 month, At the end of 3months and 6 months it showed mean of 84.0% and 83.7% for bone graft and G-bone respectively.

Fair results were seen in 53.30% of patients treated with bone graft and 80% of patients treated with hydroxyapatite crystals at end of one month, where as 46.70% of patients treated with bone graft and 20% of patients treated with hydroxy apatite crystals showed poor result at end of one month.

93.3% of patients treated with bone graft and 86.7% patients treated with hydroxyapatite crystals showed excellent results, and 6.7% of patients treated with bone graft and 13.3% of patients treated with hydroxyapatite crystals have shown good results at end of 3 and 6 months. But over all when compared there was no significant difference between functional outcome between both the groups.

Post operative complications included infection in 3 patients treated with treated with bone graft and 2 patients treated with hydroxyapatite crystals out of which 3 were open fractures, All infected cases were effieciently treated with appropriate antibiotics. In one case treated with G-Bone infection was not controlled and infection subsided one year after the implant removal.

Late collapse was seen in 4 patients treated with bone graft and 1 patient treated with hydroxyapatite crystals late collapse of tibial plateau was seen in type III&VI tibial condyle fractures.

Pain and stiffness was reported among 4 patients treated with bone graft and and 2 patients treated with hydroxyapatite .

No vascular (or) neurological complication was noted in any of the cases.

In our study we have calculated the amount of intra operative blood loss in both the groups ,maximum being 160ml for bone graft and 145ml for G-bone and minimum of 115 for bone graft and 100 for G-bone and mean of 135.67 for bone graft and 114.33 for G-bone ,this is due to reason that additional blood loss which occur while harvesting the graft.

In our study on calculating the intra operative time taken in both the groups time taken for bone graft was more maximum being 120 minutes and mean being 112 minutes, where as for group treated with G- bone maximum time was 105 minutes and mean was 95 minutes ,this could be attributed to the fact that extra time taken to harvest the graft.

The incidence of late collapse of the tibial plateau was also significantly reduced in the G-Bone group.

CONCLUSION

The correct method of management of intra - articular fractures of the proximal tibia depends on good clinical judgment. If rational treatment is to be instituted, the surgeon must have sound knowledge of the personality of the injury and a clear understanding of knee examination, imaging studies and must be familiar with the variety of techniques available at present for treating tibial condyle fractures.

The outcome of the high energy complex tibial plateau fracture depends on triplet parameters. Firstly by the condition of the soft tissue. Secondly by the restoration of congruence of the articular surface. Lastly by the stability of the mechanical environment which is achieved by fixation.

The conclusions of this study are:

1. Tibial plateau fractures commonly occur in men around the 4th decade due to road traffic accidents.
2. Conventional radiographs are not sufficient for proper classification of these fractures. Routine CT scan should be done for proper classification of these fractures and to define the articular surface incongruity.

3. Proper Schatzker classification of tibial plateau fractures is essential as is influence the plan of management.
4. Fracture stabilization by rigid internal fixation results in early functional recovery and low incidence of stiffness.Perfect anatomical reduction is the key to this which can be achieved either by open reduction or closed reduction with the aid of image intensifier and sub-meniscal arthrotomy.
5. While fixing the depressed tibial condyle fractures (Schatzker's type II,III,V&VI), elevation of articular surface and maintaining the congruity of articular surface is the most essential step which determines the outcome of the fixation. For this traditionally autologous bone graft has been used for filling the metaphyseal defects. However using autologous bone graft has following disadvantages.
1) Chances of late collapse of articular surface because of early incorporation of bone graft.
2) Presence of donor site morbidity.

The usage of G-Bone has following advantages;
1) Less operative time
2) No additional graft site morbidity
3) No need of prolonged anaesthesia
4) The mechanical strength of the G-Bone is more than that of autologous bone graft. Hence G-Bone allows the patient for early weight bearing without complications like late collapse and loss of fixation
5) G-Bone is biocompatible and non-immunogenic .
6) Less intra-op blood loss
Even is the absence of radiological incorporation of G-Bone, it prevents late collapse of articular surface with its inherent mechanical strength and at the same time it avoids donor site morbidity. Even though autologous bone graft is being used traditionally as a void filler in tibial condyle fractures, G-Bone offers a better viable alternative to autologous bone graft.

LIMITATION OF STUDY

This study has some limitation. Conclusion drawn from this analysis cannot be generalized because of
Small number cases
Short duration
Surgery was performed by different surgeons with variation in exposure and technique which could be a confounding factor in assessing the outcome.
MRI scan was not done and various ligament and meniscus injury were not managed, thus soft tissue could have effect on outcome.

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