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A PRAGMATIC ASSESSMENT OF DISPLACED FRACTURES OF TIBIAL PLATEAU FIXED BY DUAL INCISION AND PLATING TECHNIQUE: A PROSPECTIVE STUDY.

Orthopaedics

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ABSTRACT

Background: Displaced Tibial Plateau fractures are complex injuries, which have significant effect on the patients mobility and hence activities of daily living. Various surgical procedures have been used to treat these fractures, such as Bridging external fixator, Hybrid and ring external fixation, Conventional Plating as in unilateral locking plate or dual plating, LISS and more recently, arthroscopic assisted fixation. We intended to assess the outcome of Dual incision and Dual plating fixation system for these fractures, focusing on the original (2010) and revised (2016) 3 column concept, by CT evaluation.

Materials and methods: We prospectively studied 56 patients, with complex Tibial plateau fractures, upon whom, we operated from in between January 2016 to December 2018 (36 months) in our institute. Fracture pattern was classified according to the established Schatzker Classification. However the surgical planning and execution was not dictated by the Schatzker Classification, but instead, we were guided by the original (2010) and revised (2016) 3 column fixation concept, popularized by Hoekstra et al;. Clinical and Functional assessment was done by Bostman Scoring System, Honkonen Jarvinen criteria, Lysholm knee score and the Tegner Activity scale. Radiological assessment was done using Rasmussen Grading Score and the Honkonen Jarvinen criteria. Minimum follow-up period was for atleast 12 months (Range: 12 to 47 months).

Results: Among our 56 patients, the clinico-radiological union time was 17.2 weeks (range: 15.5to 23 weeks). In our clinico-functional Score of scores, we obtained nearly 84% (n=47) cases, in the good to excellent category. Radiological Score of scores managed to be at a reasonable 62.5% (n=35) in the good to excellent category. Overall the Clinico-functional scores, outweighed positively the radiological scores, by a factor of plus 21.5% (n=12).

Conclusion: For Displaced Tibial bi-condylar fractures, bi-pillar dual incision and dual plating does give good to excellent functional outcomes and a reasonably good radiological outcome.

KEYWORDS

Displaced tibial plateau fractures, Dual Plating, Honkonen Jarvinen criteria, Bostman scoring system, Lysholm Knee score, Tegner activity scale, Rasmussen grading score, 3 column concept of tibial plateau fractures.

1. INTRODUCTION:

1.1 Knee joint is a major weight bearing joint. Complex intra-articular tibial plateau fracture patterns can be an immense surgical challenge to the Orthopaedic surgeon. Tibial Plateau fractures constitute about one percentage of all adult fractures. The 3rd to the 5th decade of life is the period of their frequent occurrence. In young adults, RTA, vehicular bumper strike injuries, fall from significant height are among the common modes of direct injuries. In the osteoporotic elderly, however trivial falls, are a sufficient cause to manifest these injuries. Usually Schatzker[1] Type V and VI fractures occur due to high velocity vehicular trauma. Twenty to forty percent of the plateau of tibia fractures, are thus caused by a high impact trauma. In these fractures, complicating the already grievous fracture pattern, are the co-accompaniment of injuries, to the sub-adjacent, vein, artery, nerve, the stabilizing ligaments, the intra-articular menisci and the crucial cruciate ligaments. Associated compartment syndrome, is yet another area of serious surgical concern. By resorting to early surgical intervention to restore the anatomic and articular congruity to as close as natural, it enables us to initiate early knee mobilization and thereby restore muscle bulk and the power of the Quadriceps and Hamstring group of muscles.

1.2 Apart from being advantageous from the anatomic point of view, restoration of articular congruity and a stable fixation allows for an early knee mobilization. Among a wide gamut of operative management, dual plating executed via two incisions, is a preferred technique, as it has its own advantages, when compared to other modalities of treatment such as lateral locking plate alone, hybrid external fixator, Ilizarov and LISS. This prospective study is done to assess the efficacy of dual incision and dual plating, in the management of Schatzker Type V and VI fractures. However, from the point of surgical planning and execution, the principles enshrined in the original (2010)[2] and the revised (2016)[3] 3 column concept, were meticulously adhered to. Clinico-functional assessment was done by Bostman Scoring System[4], Honkonen Jarvinen criteria[5], Lysholm knee score[6] and the Tegner Activity scale[7]. The Radiological assessment was done using Rasmussen Grading Score[8] and Honkonen Jarvinen criteria[5].

2.MATERIALS AND METHODS:

2.1 Our study was a prospective study, conducted in the Department of Orthopaedics, Chettinad Hospital and Research Institute, Kelambakkam, Chennai from January 2016 to December 2019 [48 months of study, in which the recruitment of patients was from January 2016 to December 2018 (36 months)], so that the minimum follow-up period was of atleast 12 months. (Range: 12 to 47 months). All the patients had given a written consent, for publication of their clinical and radiological data and appropriate clearance, was obtained from the institutions research and ethical committee.

2.2 Inclusion criteria:

Patients with displaced intra-articular tibial plateau fractures, who are fit to be classified as Schatzker Type V and VI, provided that:

1) Both males and females, in the age group between 20 to 59 years.
2) The criteria of depression with displacement of articular surface shall be greater than 4 mm.
3) The cases were confined to upto the open fractures as defined to within the Type II Gustillo-Anderson classification.

2.3 Exclusion criteria:

Patients presenting with the following situations were excluded:

1) Open type fractures of Gustillo-Anderson Type III and above.
2) Pathological fractures due to metabolic bone disease.
3) Previous knee fractures or those who had previously undergone procedures for IDK.
4) Associated neuro-vascular injury, head injury, complex pelvic fractures or major chest injury.

3. MATERIALS AND METHODS:

All adult skeletally matured patients fulfilling the aforesaid inclusion criterion in the assigned time-frame were included in the study.

3.1 Pre-operative management:

Patients were received upon arrival, at the trauma center and initially stabilized, to achieve adequate haemostasis, following which intra-muscular analgesics were administered. An IV line was then secured. The traumatised lower extremity was rested in a Thomas or a Bohler Braun splint and then transferred for appropriate imaging studies.

With adequate traction, an Above Knee posterior slab was applied. Distally, the slab was slit open, in order to check for distal pulses intermittently.

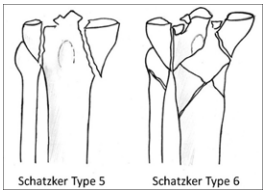


Fig.1(a): Schatzker[1] Type V and VI

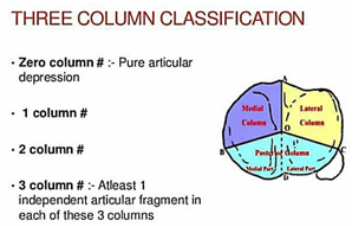


Fig.1(b): 3 Column concept of Luo[2]

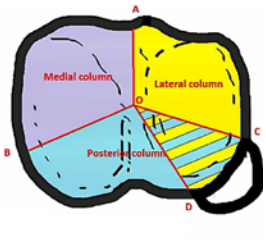


Fig.2: Revised 3 Column Concept of Hoekstra[3].

3D reconstructed CT scan was done to assess the fracture geometry pattern and then classified as per Schatzker classification. MRI was also done as a routine to establish any associated meniscal, cruciate or ligamentous injuries, in order to document and address them later arthroscopically or otherwise. Surgical planning was done, after analyzing the geometry of the fracture based on the 3 Column tibial plateau concept of Luo[2] and Hoekstra[3].

Patients were observed for swelling and skin blisters. Surgery was undertaken, as soon as the edema subsided.

3.2 Surgical procedure: Intra-op protocol:

Pre-operatively, IV antibiotics (cefoperazone + sulbactam 1.5 gram) were started, after a test dose, upon induction of anaesthesia. (Illustrated in a step-wise manner)

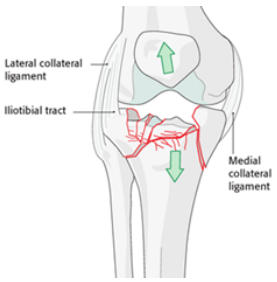


Fig. 3[9]: Ligamentotaxis was done for the primary reduction of the major fracture fragments.

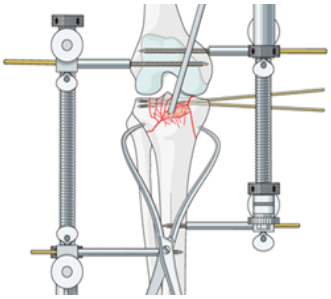


Fig. 4[9]: Reduction and bone grafting are done, so that the depressed fragments are gently elevated and the sub-articular defect are packed with autograft.

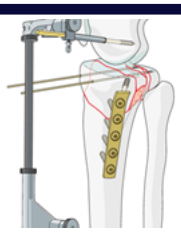


Fig. 5[9]: Medial or Postero medial column fixation was carried out usually first and the plate was secured with bicortical screws.

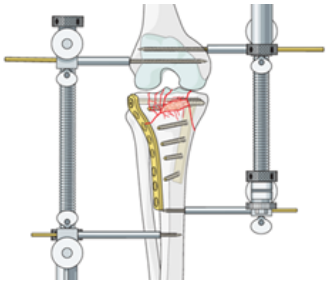


Fig. 6[9]: Subsequently, Lateral or the Postero-lateral column fixation was done. The proximal most screw was effectively used to achieve, the lag effect.

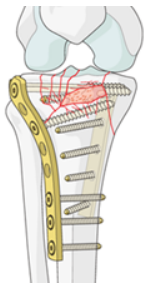


Fig. 7[9]: Upon Final osteosynthesis, a C-arm image was obtained to ensure near anatomical restoration of the articular surface and the fixated knee taken through a ROM of the knee, being operated upon.

The patient was placed in supine position, with a folded pillow under the injured knee and a sand bag, under the ipsilateral gluteal region, for the antero-lateral approach. A sand bag was also used, under the contra-lateral hip, with figure of four position, of ipsilateral leg for the postero-medial approach. A radiolucent operating table was used for all cases. Femoral distractor, when needed, was used. First indirect fracture reduction was achieved with longitudinal traction under C-arm guidance. Percutaneous Kirshner-wires were used temporarily, to fix the fragments in a reduced position. We typically fixed the condyles on the medial side first. If the medial condyle was grossly comminuted, we then opted to fix the lateral condyle, in order to restore the original height of the proximal tibia. Every effort was made to restore the anatomical relationship of the joint surfaces and also to align any rotatory malalignment that may be, concomitantly present.

In a postero-medial approach, to the proximal tibia, an approximately 6 cm incision over the postero-medial border of the proximal tibia was made. After opening subcutaneous fat, the long saphenous vein and saphenous nerve were identified and preserved. Pes anserinus expansions were then identified. Fracture in the Tibia was then approached after incising the Pes anserinus longitudinally, in the line of the skin incision. The Gastrocnemius muscle, was then gently freed from its postero-medial surface, by a careful blunt dissection.

The fracture fragments were then visualized and subsequently reduced under the C-arm guidance. For any articular depression, a bone punch was used to elevate the depressed portion and the void was filled with native bone graft. The reduced fragments were then fixed with a 3.5 mm proximal tibial T or an L Buttress Plate or a Recon plate with appropriate screws, after requisite contouring.

The lateral condyle fracture was then approached antero-laterally. A "S" shaped incision was made starting from about 5 cm proximal to the joint line curving the incision anteriorly over the Gerdy's tubercle and then, extending it distally by about 2 cm lateral to the anterior border of tibia. The Joint capsule was subsequently incised. Tibialis anterior

muscle was then elevated by careful blunt dissection.

Under C-arm guidance, fracture fragments were reduced and fixed with LCP. If a depression was present in the articular surface, then elevation was followed by autologous iliac bone grafting. A drain was kept for both the individual wounds.

3.3 Potential complications at the intra-operative stage include:

a) Articular damage.
b) Vascular and nerve injury (peroneal nerve in particular, with the lateral approach incision and retraction).
c) Compartment syndrome. (Post-op or implant induced).

The surgeon should be apprehensive and look out for either or all these complications during and after surgery. Mandatorily, we did not close the fascia, in order to prevent any instance of compartment syndrome.

3.4 Post-operative protocol:

Well-padded sterile compression dressing was applied and reinforced with the Robert Jones compressive bandage. Knee was not immobilized. Drain was removed on POD 2. Active isometric quadriceps exercises were encouraged as early as the patient could tolerate and co-operate. The sutures were removed on POD 12. Patient was discharged with advice of non-weight bearing and walker walking, after suture removal (range: 12-22 days; mean 14.5 days).

3.5 Follow-up:

Patients were reviewed in our Out Patient Department, at an interval of every 2 weeks, for the first 6 weeks and the X-rays were taken at every visit for checking the implant position. Toe-touch weight bearing was started after 8 weeks. Thereafter, X-rays were taken on a monthly basis, until features of radiological union and subsequent consolidation were evident and further clinically, the fracture site had become painless. After this, full weight-bearing was permitted, which was usually after 14 to 18 weeks. After 6 months of surgery, patients were reviewed every 3 months, for a minimum period of upto 12 months.

3.6 Assessment:

Fracture pattern was classified according to Schatzker Classification[1]. Clinical and Functional assessment was done by Bostman Scoring System[4], Honkonen Jarvinen criteria[5], Lysholm knee score[6], Tegner Activity scale[7]. Radiological assessment was done using Rasmussen Grading Score[8], Honkonen Jarvinen criteria[5]. The Clinico-functional and radiological outcomes of our study were evaluated and tabulated, only after atleast 12 months of surgical intervention. Thus the, minimum follow-up period was for atleast 12 months (Range: 12 to 47 months).

4 RESULTS:

Table 1: Age and Sex Distribution :

Age (in years)	No: of patients		Total	Percentage
	Male 'n_1'	Female 'n_2'	(n_1+n_2)=N	
20-29	11	03	14	25%
30-39	19	08	27	48.22%
40-49	09	02	11	19.64%
50-59	03	01	04	7.14%
Total n_1/n_2/N	42	14	56	100%
Percentage	75%	25%	100%	100%

Table 2: Sex Wise Side Distribution:

Sex	Right 'n_1'	Left 'n_2'	Total (n_1+n_2)=N	Percentage
Male	29	13	42	75%
Female	9	5	14	25%
Total n_1/n_2/N	38	18	56	100%
Percentage	67.86%	32.14%	100%	100%

Table 3: Functional Outcome Distribution According To Bostman[4] Scoring System :

Rating	No: of Patients	Percentage
Excellent n_1	15	26.79%
Good n_2	32	57.14%
Unsatisfactory n_3+n_4	9	16.07%
Total N=(n_1+n_2+n_3+n_4)	56	100%

Table 4: Lysholm Knee Score[6]: Clinico-functional outcomes with point-range :

S. No:	Parameter/ Max points	Excellent 'n_1'	Good 'n_2'	Fair 'n_3'	Poor 'n_4'	Total n_1+n_2+n_3+n_4=N
1.	Limp (5)	11	27	9	9	56
2.	Support for walk (5)	15	30	7	4	56
3.	Locking of knee (15)	13	32	8	3	56
4.	Giving way (25)	17	34	3	2	56
5.	Pain (25)	19	33	2	2	56
6.	Swelling (10)	27	22	4	3	56
7.	Stair Climbing (10)	17	36	2	1	56
8.	Squatting (5)	12	28	12	4	56
9.	Mean Percentage	29.24%	54.02%	10.49%	6.25%	100%

Table 5: The Tegner activity knee score[7] outcomes with point-range:

S. No:	Parameter	Excellent (more than 90) 'n_1'	Good (84 to 90) 'n_2'	Fair (65 to 83) 'n_3'	Poor (less than 65) 'n_4'	Total N=(n_1+n_2+n_3+n_4)
1	Functionality scores achieved	19	29	4	4	56
2	Rounded mean percentage	33.93	51.79	7.14	7.14	100%

Table 6: HJ clinical outcome[5]:-

Criteria	Excellent 'n_1'	Good 'n_2'	Fair 'n_3'	Poor 'n_4'	Total N=(n_1+n_2+n_3+n_4)
Extension lag	13	30	3	10	56
Knee flexion	15	31	5	5	56
Thigh atrophy	14	33	4	5	56
Knee Instability	15	32	6	3	56
Mean percentage	25.45%	56.25%	8.04%	10.26%	100%

Table 7: HJ functional outcome[5]:

Criteria	Excellent 'n_1'	Good 'n_2'	Fair 'n_3'	Poor 'n_4'	Total N=(n_1+n_2+n_3+n_4)
Walking	15	32	5	4	56
Stair climbing	17	36	2	1	56
Squatting	12	28	12	4	56
Jumping	11	26	16	3	56
Duck walking	9	24	16	7	56
Mean percentage	22.86%	52.14%	18.22%	06.78%	100%

Table 8: Case Distribution According To Rasmussen[8] Radiological Grading :

Grading	No: of Patients	Percentage
Excellent 'n_1'	15	26.79%
Good ' n_2'	21	37.50%
Fair 'n_3'	11	19.64%
Poor 'n_4'	9	16.07%
Total N=(n_1+n_2+n_3+n_4)	56	100%

Table 9: HJ radiological outcome[5]:

Criteria	Excellent 'n_1'	Good 'n_2'	Fair 'n_3'	Poor 'n_4'	Total N=(n_1+n_2+n_3+n_4)
Plateau tilt	10	19	13	14	56
Varus/ Valgus tilt	15	21	6	14	56
Articular Step-off	13	23	4	16	56
Condylar widening	14	22	10	10	56
Joint space narrowing	16	22	14	4	56
Mean percentage	24.29%	38.21%	16.79%	20.71%	100%

Table 10: Score of scores: Clinico-functional:
Pragmatic outcome comparisons as a percentage deviation from Bostman Scoring System[4] :

Rating	(As Percentage)Bostman Scoring System BASE SCORE.	(As Percentage) Lysholm Knee Score ± from base score.	(As Percentage)Tegner activity score ± from base score.	(As Percentage)Hankone n Jarvinen Clinical score ± from base score.	(As Percentage)Hankonen Jarvinen Functional score ± from base score.
Excellent	26.79%	29.24% +2.45	33.93% +7.14	25.45% -1.34	22.86% -3.93
Good	57.14%	54.02% -3.12	51.79% -5.35	56.25% -0.89	52.14% -5.00
Fair + Poor (unsatis--factory)	16.07%	16.74% +0.67	14.28% -1.79	18.30% +2.23	25.00% +8.93

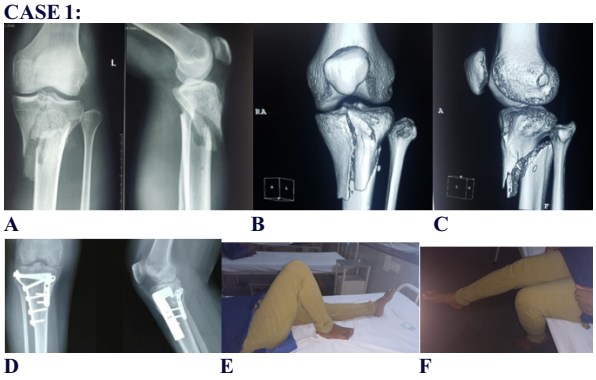
Table 11: Score of scores: Radiological:
Pragmatic outcome comparisons as a percentage deviation from Rasmussen Grading System[8]:

Grading	(As percentage) Rasmussen Grading System (base Score).	(As percentage) HJ radiological score ± from base score.
Excellent	26.79%	24.29% – 2.50
Good	37.50%	38.21% + 0.71
Fair	19.64%	16.79% – 2.85
Poor	16.04%	20.71% + 4.64

RESULTS:

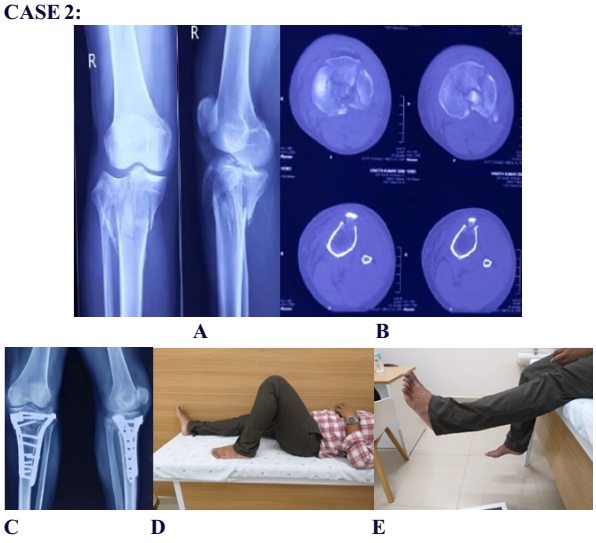
Among our recruits of 56 patients, spread over a period of 36 months, 68% (n=38), were in the age bracket of 30 to 49 years. Our male to female ratio was, at 3:1. The right to left sidedness of injury, stood at 2:1. High velocity RTA, was our major mode of injury, at 69.64% (n=39). The clinico-radiological union time was at 17.2 weeks (range: 15.5 to 23 weeks). The average time of clinico-radiological follow-up, was 20 months (range: 13 to 35 months). The average ROM at knee achieved was 117 degrees (range: 90 to 125 degrees). Deep wound infections, with some wound necrosis, developed in 19.64% (n=11) patients, requiring debridement and skin grafting. None of our cases, in question required any fascio-cutaneous flaps. Knee Stiffness, as determined by ROM knee of 100 degrees to 90 degrees constituted 25% (n=14), of our operated cases. In 5.36% (n=3) cases, we had a varus angulation of 18 degrees and in 3.57% (n=2) cases, we had a valgus angulation of 10 degrees. LLD of range 2.4 cm to 3.9 cm was recorded in 10.71% (n=6) cases, who managed well with heel and sole raise footwear. In our clinico-functional score of scores, we obtained nearly 84% (n=47) cases, in the good to excellent category. Strikingly however, our radiological Score of scores managed to be at a modest 62.5% (n=35), in the good to excellent category. Overall, the Clinico-functional scores, outweighed positively the radiological scores, by a factor of plus 21.5% (n=12).

CASE 1:



A) Pre-operative X-ray AP and Lateral shows Schatzker VI tibial plateau fracture.
B and **C)** Pre-operative 3D reconstructed CT image.
D) Post-operative X-ray shows Dual plating of tibial plateau at 6 months follow-up.
E and **F)** Range of Movement at the end of 1 year follow up.

CASE 2:



A) Pre-operative X-ray AP and Lateral shows Schatzker V tibial plateau fracture.
B) Pre-operative CT image.
C) Post-operative Xray shows Dual plating of tibial plateau at 6 months follow-up.
D and **E)** Range of Movement at the end of 1 year follow-up.

DISCUSSION:

Table 12: Pragmatic Parameter Comparison Of Our Study With Other Contemporary Surgical Studies:

S. No:	Parameter	Kulkarni[10] et al;	Mayank patel[11] et al;	Qadir A[12] et al;	Caner[13] et al;	Sinha[14] et al;	Manjunath[15] et al;	Raghavendra[16] et al;	Our study Denish et al;
1.	No: of patients N	30	28	90	20	60	30	24	56
2.	Average age (in years)	31.7	38.5	38.6	51.25	47.3	42.8	44.2	45
3.	M:F (as ratio)	9:1	5:1	-	3:1	9:1	7:3	-	3:1
4.	Mode of injury as RTA	80%	75%	-	55%	95%	97%	-	70%
5.	Injury sidedness R:L (as ratio)	-	-	-	1:1	2:1	3:7	-	7:3
6.	Injury to surgery time (in days)	6.9	7.0	21.0	8.15	-	5.3	5.75	5.50
7.	Average Duration of surgery (in minutes)	139.7	-	-	-	104	-	-	102
8.	Autologous Bone Grafting (as percentage)	-	-	78.7%	-	-	-	-	66%
9.	Time for Bone union (in weeks)	14.37	-	18	14	16.25	-	-	17.2
10.	Average Follow up (in months)	-	6	24	25.9	12.05	-	24	20.0
11.	Average Knee ROM(in degrees)	110°	-	125°	120°	-	126°	-	117°
12.	Good to Excellent Outcome (as percentage)	83%	93%	77%	80%	85%	96%	79%	84%

A Pragmatic parameter comparison of our study with other similar contemporary studies for displaced tibial plateau fractures, intervened upon surgically, has been illustrated in the above table and is self-explanatory.

Fractures of bi-condylar tibial plateau have a notorious background of causing devastating complications.[10]

Proponents of arthroscopically assisted percutaneous pin fixation, like Gaunche et al[17] and Chan et al[18]; have been, reiterating this fact, time and again. But even in their hands, as highlighted by Sirkin et al[19]; arthroscopic surgical interventions work best for simple split depression and local compression fractures and therefore not suitable for grossly displaced bi-condylar tibial plateau fractures, as also emphasized by Mahadeva et al[20];.

Needless to say that, apt surgical timing after injury, is vital[10]. Surgical intervention for PTPF has specific goals, like articular congruous restoration, by near anatomic reduction and surgical fixation which should be light, at the same time rigid, inorder that early protocols for rehabilitation, can be initiated[14]. These factors are imperative in order to achieve, beyond reasonably good functional outcomes and for minimizing post operative complications, as emphasized by Mc Laurin et al;[21] and Shah et al;[22]. Wound dehiscence in the treatment of bi-condylar tibial plateau fractures by dual plate fixation, as commented by Higgins et al[23] is an expected complication, which did also develop in our series, at 19.64% cases (n=11). In pre-operative planning, it may not be an exaggeration, to stress upon the need of a 3D CT imaging, as highlighted by Bhattacharyya et al[24];. This particular view is also supported by Chan et al[18], Barei et al[25] and Hackl et al[26];.

In concordance with the study of Sinha et al[14]; our clinico-functional score of good to excellent category was 84% (n=47/56) as against 85.4% (n=25/30), of the former author. In both the studies of ours and that of Sinha et al[14]; the results were in startling contrast to that of the study of Lee et al;[27] and Chang et al;[28] who did not attribute any significant functional gain upon using the dual-pillar plating system. This can be explained on the basis that our surgical planning conformed to the earlier 3-column concept[2] (Fig.1b) and later to the revised 3-column classification[3] (Fig.2), rather than to the Schatzker[1] classification. Upon critical review of our table 10, Score of scores, compiled with regard to our clinico-functional outcomes, it is but obvious that the Hankonen Jarvinen[5] scoring system, is by far the most sensitive, as it includes parameters like Knee extension lag, squatting, jumping and duck walking, among the other criterias, which are not a part of Bostman score[4]. In a similar observation, regarding the higher sensitivity of Honkonen Jarvinen[5] Radiological outcome is deduced, in comparison to the Rasmussen[8] Radiological grading (Table-11).

CONCLUSION:

For Displaced Tibial bi-condylar fractures, bi-pillar dual plating gives, beyond reasonably good, functional outcomes. As deduced from our Table 10 and 11, we conclude that the radiological parameters and outcomes (62.5%) as in these cases tend to lag behind, the clinico-functional outcomes (75%). However, the latter has a greater significance for the patient and the shadows and images, with their due respect (the imaging features), have to be treated aloof and in a different platform. Our good to excellent Clinico-functional score of 84%, are in tandem with the publications of Kulkarni et al;[10] (83%) and that of Sinha et al;[14] (85%).

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