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Original Article

Study of Surgical Management of Bicondylar Fracture Tibia

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Abstract

Introduction: Knee joint is the complex and most commonly injured now because of increased road traffic accidents, sports-related injuries, and other less violent trauma that frequently can produce them, especially in elderly patients with osteopenia. As it is a superficial joint, it is more exposed to external forces and gets easily injured. Tibial plateau fractures involve the articular surface of the proximal tibia but exclude small rim avulsions that occur in conjunction with knee dislocations and proximal tibia fractures. Tibial plateau fractures represent a wide spectrum that ranges from simple injuries to complex fracture patterns.

Materials and Methods: Patients satisfying the inclusion criteria, admitted to Ramkrishna Care Hospital, Raipur (C.G.), were included in the study. As per the previous record of the last 4 years (2018–2021), the prevalence of bicondylar fracture tibia with indicated inclusion criteria in our hospital is 1.96 (P). Minimum sample size N= $[(1.96)]^2*p*(1-p))/e^2=29.58$. e=precision kept at 5%=0.05. 1.96=Z score at a 5% significance level. On calculation, we found the minimal sample size to be 29.58. Hence, we included 30 patients in the present study.

Results: The results of the present study, comprising 30 patients, observed the outcomes of surgical management of bicondylar fracture tibia at Ramkrishna Care Hospital, Raipur, Chhattisgarh, from March 2022 to March 2023, which were analyzed and tabulated.

Conclusion: These fractures are associated with gross swelling, blisters, poor skin condition, and often a risk of compartment syndrome, so the timing of surgery is the single-most preventing factor to avoid post-operative infections or dehiscence. To reduce skin-related problems and to achieve reasonable alignment, spanning external fixators should be applied at an early stage and kept until the acute phase is over. Counseling regarding provisional external fixators and delayed definitive surgery must be done in detail with patient's family.

Key words: Fracture, Surgery, Tibia

INTRODUCTION

The knee joint is a complex and most commonly injured joint now because of increased road traffic accidents (RTAs), sports-related injuries, and other less violent trauma that frequently can produce them, especially in elderly patients with osteopenia. As it is a superficial joint, it is more exposed to external forces and gets easily injured.[1]

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Tibial plateau fractures involve the articular surface of the proximal tibia but exclude small rim avulsions that occur in conjunction with knee dislocations and proximal tibia fractures. Tibial plateau fractures represent a wide spectrum that ranges from simple injuries to complex fracture patterns.

Nowadays, injuries severe soft-tissue injuries associated with fractures around the knee are critically important. Certain fracture patterns have a high risk of limb-threatening complications, such as compartment syndrome, but for other patterns, these risks are negligible. Hence, these things should be thoroughly assessed on a priority basis.

The complex biomechanics of its weight-bearing position, complex ligamentous stability, and articular congruency of

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the knee joint are the main reasons why these fractures are a matter of concern to surgeons. Bicondylar fractures of the tibia, classified as Schatzker V and VI fractures, are largely part of the AO-OTA "C" type fractures [Arbeitsgemeinschaft für Osteosynthesefragen (German for Association for Study of Internal Fixation)– Orthopedic Trauma Association].

Surgical fixation of bicondylar tibial plateau fractures is challenging because of the geographic complexity and compromise of the surrounded complex soft tissue. Treatment goals include the preservation of soft tissues, restoring articular congruity and metaphyseal-diaphyseal dissociation (MDD), and correction of anatomic alignment in the lower extremities. The status of local soft tissues is one of the most important factors in deciding the timing and modality of definitive management, while the prognosis and assessment of post-operative results are chiefly based on adequate fixation and the early establishment of post-operative range of motion.

Non-operative treatment of bicondylar fractures in the era before the use of internal fixation yielded "acceptable results", as shown by Rasmussen in the early 1970s and in a 20-year follow-up by Lansinger *et al*.[2] The main complications of non-operative management included stiffness and malunion. With increasing patient expectations and the recognition of complications of non-operative treatment, operative management assumed ascendancy. Traditional techniques of open reduction and rigid internal fixation of both condyles through a single anterior incision needed soft-tissue stripping and, not unexpectedly, were associated with wound healing complications when adopted for all bicondylar fractures.[3,4] Fine-wire external fixation as a means of reassembling the MDD gained popularity,[5,6] but it had its own unique complications, such as the risks of septic arthritis of the knee due to intra-articular wire placement and the pin site infection.

Buttressing of both the medial and lateral compartments with conventional double plating is the gold standard for managing bi-condylar fractures because this may provide sufficiently rigid fixation to prevent medial collapse and subsequent varus deformity. However, this may require excessive dissection through injured soft tissue, leading to wound complications or compromised osteosynthesis.[7-9] The introduction of advanced instrumentation, such as locking plate systems, and techniques for internal fixation, such as minimally invasive plate osteosynthesis (MIPO), have changed the nature of treatment for these fractures over the last decade.[10] MIPO, with its key benefit of preserving the intact soft-tissue envelope, is the representative biological plate technique. The less-invasive stabilization system (LISS) developed by Synthes is representative of locking plates that offer multiple points of fixed-angle contact between the plate and screws, aiming to decrease the tendency toward angular deformity. A lateral locking plate can provide adequate stability for comminuted or osteoporotic plateau fractures and may offer an alternative to additional medial buttressing, thus avoiding further stripping of soft tissue.[11-14] However, studies revealed a higher rate of malreduction and fixation with unilateral locked plating using the LISS technique than that with conventional double plating.

MATERIALS AND METHODS

Study Site

Ramkrishna Care Hospital, Raipur, CG.

Study Population

Bicondylar fracture cases satisfying the inclusion criteria and willing to take part in the study were included in the study.

Study Design

A prospective, observational study.

Sample Size

Patients satisfying the inclusion criteria, admitted to Ramkrishna Care Hospital, Raipur (C.G.), were included in the study. As per the previous record of the last 4 years (2018–2021), the prevalence of bicondylar fracture tibia with indicated inclusion criteria in our hospital is 1.96 (P).

Minimum sample size $N= [(1.96)]^{2}*p*(1- p))/e^{2}=29.58$.

e=precision kept at 5%=0.05

1.96=Z score at 5% significance level

On calculation, we found the minimal sample size to be 29.58. Hence, we included 30 patients in our study.

Study Period

March 2022–March 2023.

Exclusion Criteria

All patients, with bicondylar tibial fractures except those described under the exclusion criteria.

- Patients with an age above 18 years
- Patients with an age below 18 years
- Patient with an extra-articular fracture
- Patient with an open fracture
- Patient with a pathological fracture
- Patients with fractures involving the ipsilateral intra-articular distal femur
- Patients with a severe head injury with an initial Glasgow coma scale of <8
- Previously non-ambulatory patients.

Methodology

Ethical clearance

Before commencement, the study was approved by the Ethical and Research Committee, Ramkrishna Care Hospital, Raipur, C.G.

Informed consent

Patients fulfilling the selection criteria were selected. They were briefed about the nature of the study. A written informed consent was obtained from the selected patients (Annexure).

Immediate management

After the patient is hospitalized, a thorough history of the patient and/or attendants is elicited to reveal the mechanism of the injury and the severity of the trauma. All patients should be assessed as per the ATLS® protocol[15] (Advanced Trauma Life Support, American College of Surgeons) and should be examined thoroughly to assess their general condition, associated systemic disease, and associated injuries, which are to be documented in the patient pro forma.

The injured part needs to be examined locally to access soft tissues and bony injuries as per the standard method, and periodic local observations should be carried out in order to rule out any impending compartment syndrome. Distal vascularity should be assessed by dorsalis pedis artery and posterior tibial artery pulsations, capillary filling, pallor, and paresthesia over toe tips.

The involved limb should be immobilized on the above-knee POP slab and kept elevated. Pain should be managed using analgesics.

Imaging

Standard radiographs in anterior-posterior (AP) and lateral views should be taken to confirm the diagnosis and also to know the type of fracture. The fracture fragments were analyzed and classified according to the AO classification. A computed tomography (CT) scan using 3 mm cuts is the investigation of choice for an accurate assessment of the fracture. The axial cuts are studied to understand the direction of the fracture lines, especially those of the medial condylar fragment. The sagittal and coronal reconstructions provide an estimation of metaphyseal bone loss and the position of depressed articular fragments. Hence, it should be done in most of the cases for a better understanding of the fracture pattern. Mui *et al.*[16] have shown that CT scans have a high specificity with regards to ligamentous injuries in tibial plateau fractures but are poor in assessing meniscal injuries.

Magnetic resonance imaging (MRI) should be done for suspected ligamentous and soft-tissue injuries. Mustonen *et al.*[17] found a 36% incidence of meniscal injury, diagnosed by MRI, in tibial plateau fractures but could not find any correlation with fracture type or amount of fracture depression.

Anesthesia

The procedure can be performed under spinal, epidural, or general anesthesia.

Surgical procedures

Goals of treatment include restoration of articular congruity, restoration of MDD, axial alignment, joint stability, and functional motion.

Surgical Approaches:

- As pre-operative planning, the surgical approach[18] would be decided (open or minimally invasive)
- A unilateral anterolateral single-incision approach with an additional Lag screw for fixation or buttressing at the medial condyle was employed
- A double-incision approach[19] uses a posteromedial incision to stabilize medial the condyle fragment, and then the lateral condyle fracture is approached through a separate anterolateral incision.

Indications for surgery:

- Displaced and unstable tibial plateau fractures
- Displaced medial plateau fractures and lateral plateau fracture patterns where valgus alignment will occur without surgically reducing and fixing the fracture.

Fixation would be performed as per fracture morphology. Various options used for fracture fixation would be:

- Open reduction and internal fixation (ORIF) with buttress plates and screws
- ORIF with buttress plates, screws, and bone grafting
- External fixator
- External fixation with minimal internal fixation.

A post-operative X-ray would be taken a day after surgery. Reduction would be judged satisfactory if there is joint depression of ≤4 mm and/or plateau widening of ≤5 mm compared with the width of the distal femoral condyles.[20] Condylar widening should be obtained by measuring the total width of the tibial plateau just below the joint line and measuring the width of the femoral condyles just above the joint line. These two measurements are normally equal.[21]

Depending on the fracture configuration and stability of the reduction achieved, mobilization should be planned. In most cases, the following protocol would be followed:

- Day 1: static quadriceps exercises
- Day 3: active knee mobilization exercises
- Day 7: non-weight-bearing crutch walking

- 6th week onward: partial weight bearing
- 12th week onward: full weight bearing, as per healing seen on X-ray.

In all surgeries, wounds were closed over suction drains, and the drains were removed after 48 h. Injectable antibiotics were given for 3–5 days. Wound inspection would be done on the 3rd, 5th, 8th, and 10th days with stitch removal. The total hospital stay should be noted.

Follow-Up

The patients would be followed for the 3rd, 6th, and 12th weeks, and then every 6 weeks until 6 months.

The range of movements of the knee should be assessed, and an AP and lateral X-ray would be taken to assess implant position and fracture union. Though there are many scores, for example, Neer Score, HSS Knee Score, SF-36 Score, WOMAC Score, and Rasmussen Score, for knee function evaluation mentioned in the contemporary literatures. Hsu *et al.*[22] in 2001 and Oh *et al.*[23] in 2006 used the modified Rasmussen score to evaluate their results. We will use the Modified Rasmussen score[22] and the Oxford knee score for our study, as these scores are simple, easy to use, and practically applicable in our scenario. Details of these scores are seen in the table.

Statistical Analysis

- Continuous data will be summarized as mean ± SD (standard deviation), while discrete (categorical) data will be in number and percentage
- Quantitative data will be analyzed by mean, SD, Paired, and unpaired *t*-test
- Qualitative data will be analyzed by percentage, chi-square test, and Fisher exact test
- Statistical significance $P > 0.05$ is not significant. $P < 0.05$ is significant, and $P < 0.01$ is highly significant.

Statistics software, SPSS 16.0.

Scale 1: Oxford knee score[23]

1. How would you describe the pain you usually have in your knee? None Very mild Mild Moderate Severe	2. Could you kneel down and get up again afterwards? Yes, easily With little difficulty With moderate difficulty With extreme difficulty No, impossible
3. Have you had any trouble washing and drying yourself (all over) because of your knee? No trouble at all Very little trouble Moderate trouble Extreme difficulty Impossible to do	4. Are you troubled by pain in your knee at night in bed? Not at all Only one or two nights some nights Most nights every night
5. Have you had any trouble getting in and out of the car or using public transport because of your knee? (With or without a stick) No trouble at all Very little trouble Moderate trouble Extreme difficulty Impossible to do	6. How much has pain from your knee interfered with your usual work? (including housework) Not at all A little bit Moderately Greatly Totally
7. After a meal (sat at a table), how painful has it been for you to stand up from a chair because of your knee? Not at all painful slightly painful moderately pain very painful Unbearable	8. Could you do household shopping on your own? Yes, easily With little difficulty With moderate difficulty With extreme difficulty No, impossible
9. Have you been limping when walking, because of your knee? Rarely/never Sometimes or just at first often, not just at first Most of the time All of the time	10. Could you walk down a flight of stairs? Yes, easily With little difficulty With moderate difficulty With extreme difficulty No, impossible
11. For how long are you able to walk before the pain in your knee becomes s eve re? (With or without a stick) No pain>60 min, 16–60 min 5–15 min Around the house only Not at all - severe on walking	12. Have you felt that your knee might suddenly give away or let you down? Rarely/Never sometimes or just at first often, not at first Most of the time all the time

Each question has scored from 0 to 4 according to answer

Maximum	48
Excellent	40-48
Good	30-39
Fair	20-29
Poor	< 20

Scale 2: Modified Rasmussen score[22]

Criteria for clinical assessment	
(A) Subjective	**Points**
Pain	
None	5
Occasional pain, needs no medication	4
Pain after strenuous activity	3
Pain after mild activity	2
Constant pain	1
Walking capacity	
Normal	5
Outdoor walking >1 h	4
Outdoor walking <1 h	3
Walking with aid	2
Wheelchair/bedridden	1
(B) Objective	**Points**
Total range of motion	
Full	5
>120°	4
90°–120°	3
<90°	2
<60°	1
Stability	

Normal	5
Unstable at 20°–30° flexion	3
Unstable with knee extension	1
Maximum	20
Excellent	18–20
Good	16–17
Fair	13-15
Poor	<13

Criteria for radiological assessment	Points
Articular depression	
None	4
<2 mm	3
3–4 mm	2
>4 mm	1
Varus/Valgus	
None	4
<5°	3
6°–10°	2
>10°	1
Condylar widening	
None	4
<5 mm	3
6–10 mm	2
>10 mm	1
Osteoarthrosis	
No progression	4
Mild progression	2
Evident progression	0
Maximum	16
Excellent	15–16
Good	13–14
Fair	10–12
Poor	<10

RESULTS

The present study, comprising 30 patients, observed the outcomes of surgical management of bicondylar fracture tibia at Ramkrishna Care Hospital, Raipur, Chhattisgarh, from March 2022 to March 2023. The following are the observations made and the available data analyzed as follows:

Etiological Distribution

In our study, the most common etiology was RTA in 25 (83.33%) patients, while falling from height was ascertained in 5 (16.67%) patients.

Side of Involvement

Among the 30 cases included in the study, the right side was involved in 18 (60%) patients, and the left side was involved in 12 (40%) patients.

Type of Fractures

In this series, fractures were classified according to Schatzker's classification system. 19 fractures (63.33%) were of Schatzker type V, and 11 fractures (36.67%) were of Schatzker type VI.

Table 1: Distribution according to etiology

Etiology	No. of patients	Percentage
Road traffic accident	25	83.33
Fall from height	5	16.67
Total	30	100

Table 2: Side of involvement

Side	No. of cases	Percentage
Right	18	60
Left	12	40
Total	30	100

Table 3: Type of fractures

Type of fracture	No. of cases	Percentage
Type V	19	63.33
Type VI	11	36.67
Total	30	100

Table 4: Methods of treatment

Method of treatment	No. of cases	Percentage
Single plate+CCS	10	33.33
Dual plate	19	63.33
Ring Fixator	1	3.33
Total	30	100

CCS: Cannulated cancellous screw

Table 5: Complications

Complications	No. of cases	Percentage
Infection	2	6.67
Hardware related complication	1	3.33
Knee stiffness	4	13.33
Varus deformity	1	3.33
Articular depression	2	6.67
Condylar widening	1	3.33

Table 6: Clinical scores of the patients

Results	No. of cases	Percentage
Excellent	6	20.00
Good	20	66.67
Fair	3	10.00
Poor	1	3.33
Total	30	100

Table 7: Radiological scores of the patients

Results	No. of cases	Percentage
Excellent	8	26.67
Good	15	50.00
Fair	7	23.33
Poor	0	0.00
Total	30	100

Table 8: Oxford knee score of the patients

Results	No. of cases	Percentage
Excellent	8	26.67
Good	16	53.33
Fair	6	20.00
Poor	0	0.00
Total	30	100

Table 9a: Clinical assessment

Gender	Excellent	Good	Fair	Poor	*P*-value
Male	6	14	3	1	>0.05 NS
Female	0	6	0	0	

Table 9b: Radiological assessment

Gender	Excellent	Good	Fair	Poor	*P*-value
Male	7	11	6	0	>0.05 NS
Female	1	4	1	0	

Table 10a: Clinical assessment

Side	Excellent	Good	Fair	Poor	*P*-value
Right	4	12	2	0	>0.05 NS
Left	2	8	1	1	

Table 10b: Radiological assessment

Side	Excellent	Good	Fair	Poor	*P*-value
Right	6	8	4	0	>0.05 NS
Left	2	7	3	0	

Table 10c: Clinical assessment

Age	Excellent	Good	Fair	Poor	*P*-value
≤40	2	8	2	0	>0.05 NS
>40	4	12	1	1	

Radiological assessment

Age	Excellent	Good	Fair	Poor	*P*-value
≤40	2	7	3	0	>0.05 NS
>40	6	8	4	0	

Table 10d: Clinical assessment

Type	Excellent	Good	Fair	Poor	*P*-value
V	4	13	2	0	>0.05 NS
VI	2	7	1	1	

Methods of Treatment

In the study, depending on pre-operative fracture configuration assessment, each case was individually planned, and we utilized various treatment modalities like

Table 10e: Radiological Assessment

Type	Excellent	Good	Fair	Poor	*P*-value
V	5	10	4	0	>0.05 NS
VI	3	5	3	0	

Table 10f: Clinical assessment

Procedure	Excellent	Good	Fair	Poor	*P*-value
SP+CCS	2	7	1	0	>0.05 NS
DP	3	13	2	1	
RF	1	0	0	0	

SP: Single Plating, CCS: Cannulated cancellous screw, DP: Dual plating, RF: Ring fixator

Table 10g: Radiological assessment

Procedure	Excellent	Good	Fair	Poor	*P*-value
SP+CCS	2	5	3	0	>0.05 NS
DP	5	10	4	0	
RF	1	0	0	0	

SP: Single Plating, CCS: Cannulated cancellous screw, DP: Dual plating, RF: Ring fixator

Table 11a: Radiological assessment

Gender	Excellent	Good	Fair	Poor	*P*-value
Male	7	12	5	0	>0.05 NS
Female	1	4	1	0	

Table 11b: Radiological assessment

Side	Excellent	Good	Fair	Poor	*P*-value
Right	6	9	3	0	>0.05 NS
Left	2	7	3	0	

Table 11c: Radiological assessment

Age	Excellent	Good	Fair	Poor	*P*-value
≤40	2	7	3	0	>0.05 NS
>40	6	9	3	0	

Table 11d: Radiological assessment

Type	Excellent	Good	Fair	Poor	*P*-value
V	5	10	4	0	>0.05 NS
VI	3	6	2	0	

Table 11e: Radiological assessment

Procedure	Excellent	Good	Fair	Poor	*P*-value
SP+CCS	2	5	4	0	>0.05 NS
DP	5	11	2	0	
RF	1	0	0	0	

SP: Single Plating, CCS: Cannulated cancellous screw, DP: Dual plating, RF: Ring fixator

single plating+cannulated cancellous screw (SP+CCS), dual plating (DP), and ring fixator (RF).

Complications

The total incidence of knee stiffness complications in the study population was 4 (13.33%) patients. The complications were two cases of Infection and two cases of articular depression. Hardware-related complications occurred in 3.33% of the cases. 1 case developed varus deformity, and 1 case developed condylar widening. However, overall, 7 (23.33%) cases had shown complications such as knee stiffness found along with other complications, articular depression, varus deformity, and condylar widening.

Evaluation of Results

The assessments of results were made using the modified Rasmussen scoring system (based on clinical and radiological assessment) and the Oxford knee score.

Clinical scores of the patients

In this study, using the Modified Rasmussen Scoring System, the clinical Scores of the patients were 06 (20.00%) excellent results, 20 (66.67%) good results, 3 (10.00%) fair results, and 1 (3.33%) poor results.

Radiological scores of the patients

Among the 30 cases included in the study, using the Modified Rasmussen Scoring System, on radiological assessment, we had 8 (26.67%) excellent results, 15 (50.00%) good results, 7 (23.33%) fair results, and 00 (00%) poor results.

Oxford knee score of the patients

Using the Oxford Knee Score, we had 8 (26.67%) excellent results, 16 (53.33%) good results, 6 (20.00%) fair results, and 00 (00%) poor results.

Associations of Results

Evaluation according to the modified Rasmussen score

Gender distribution

Results of clinical and radiological outcome of our study are independent of gender.

Side distribution

Results of clinical and radiological outcome of our study are independent of side of involvement.

Age distribution

Results of clinical and radiological outcome of our study are independent of age.

Distribution according to type of fracture

Results of clinical and radiological outcome of our study are independent of type of fracture.

Distribution according to procedure done

Results of clinical and radiological outcome of our study are independent of type of procedure done.

Evaluation according to oxford knee score

Gender distribution

In our study, results according to the Oxford Knee Score are independent of gender.

Side distribution

In our study, results according to the Oxford Knee Score are independent of side involvement.

Age distribution

In our study, results according to the Oxford Knee Score are independent of age.

Distribution according to type of fracture

In our study, results according to the Oxford Knee Score are independent of type of fracture.

Distribution according to procedure done

In our study, results according to the Oxford Knee Score are independent of type of procedure done [Tables 1-11].

DISCUSSION

High-energy bicondylar tibial plateau fractures remain a challenge to the orthopedic surgeon. The ideal treatment for these fractures has been a matter of debate for several years. With the advent of two-wheeler vehicles with high power, the incidence of these fractures is becoming a routine presentation. Rash driving and a lack of following traffic rules had added to incidence.

Earlier, these fractures were treated mostly by conservative and semi-invasive methods like external fixation. Gradually, consensus started shifting to ORIF at an appropriate time. Achieving good reduction and stable fixation of sparing knee joint is a challenging task in external fixation. The use of ORIF techniques has historically been associated with wound complications, especially when a single midline incision is used. The earlier reports of internal fixation with plates by Young and Barrack,[7] Moore *et al.*[8] and Mallik *et al.*[24] had unacceptably high rates of deep wound infection. Uhl *et al.*[25] reported post-operative skin infection and osteomyelitis in 42% and 33% of patients treated with dual plates. With the evolution of surgical techniques and better imaging modalities, internal fixation became the modality of choice.

For bicondylar fractures, good articular reduction is an important goal of surgery to get good knee function. Keeping this in mind, we employed different methods of surgical

fixation as per fracture configuration. In our study, many fractures were temporarily stabilized using spanning external fixator while waiting for the skin condition to improve. The timing of surgery is very important so as to reduce the incidence of infection and dehiscence. Achieving good reductions and optimum fixation enabled us to start early and aggressive knee rehabilitation, thus giving excellent functional outcomes in our series. Regaining a full range of movement depends on early and aggressive knee mobilization. Patient compliance in physiotherapy is equally important.

We feel that ORIF of high-energy tibial plateau fractures give excellent to good functional outcomes with minimal soft-tissue complications. The minimally invasive approach should be utilized wherever possible, preventing soft-tissue problems, thus avoiding wound healing issues. Tissue handling has to be gentle and judicious pre-operatively.

There have been concerns that the associated soft-tissue injury may lead to wound complications after internal fixation of tibial plateau fractures. These issues led to the increased use of external fixation and limited internal fixation for complex fractures of the tibial plateau in some series. For the temporary stabilization, we used in a few of our cases, spanning external fixators until soft-tissue situation improved in 1–2 weeks.

This study was undertaken to assess the functional outcome of a surgically managed bicondylar tibial plateau fracture. We evaluated our results and compared them with those obtained by various other studies.

Our study was conducted to assess the functional outcome of bicondylar fracture tibia treated by various techniques, its complications, and comparison with other treatment modalities in the literature in a total of 30 patients who satisfied the defined inclusion and exclusion criteria at Ramkrishna Care Hospital, Raipur, Chhattisgarh, from March 2022 to March 2023. The following observations are made, and the available data analyzed are as follows:

Age Distribution

The age incidence in our study shows an average of 45 years (range 23 years–63 years), which is comparable to that reported by various other studies, where the average age ranged from 40 years to 54 years.

Studies	Min. age (in years)	Max. age (in years)	Mean age (in years)
Stevens *et al*. (2001)[26]	18	77	40
Oh *et al*. (2006)[27]	36	78	54
Prasad *et al*. (2013)[28]	22	61	40
Pun *et al*. (2014)[29]	22	61	44
Khatri *et al*. (2016)[30]	18	60	43
Our study	23	63	45

Sex Distribution

Our study shows a male preponderance, with 24 (80%) male patients and 6 (20%) female patients among a total of 30, with a ratio of 4:1, which shows similarity with other studies in the literature.

Studies	Male (%)	Female (%)
Stevens *et al*. (2001)[26]	69.56	30.44
Oh *et al*. (2006)[27]	78.26	21.74
Prasad *et al*. (2013)[28]	82.5	17.5
Pun *et al*. (2014)[29]	95.23	4.77
Khatri *et al*. (2016)[30]	96.77	3.23
Our study	80.00	20.00

Mode of Injury

In our study, RTA predominates, causing 83.33% of the fractures, and has been similarly reported as a major mode of injury in most other studies.

Studies	RTA in %	FFH in %	Others
Stevens *et al*. (2001)[26]	56.52	19.56	23.91
Oh *et al*. (2006)[27]	69.56	30.43	Nil
Prasad *et al*. (2013)[28]	80	20	Nil
Khatri *et al*. (2016)[30]	93.54	4.85	1.61
Our study	83.33	16.67	Nil

RTA: Road traffic accident

Type of Fractures

In our study, the fractures were classified according to SCHATZKER classification. Schatzker type V was the most common pattern encountered in our study.

Studies	Schatzker Type V	Schatzker Type VI
Prasad *et al*. (2013)[28]	50	50
Pun *et al*. (2014)[29]	52.38	47.62
Khatri *et al*. (2016)[30]	40.32	59.68
Our Study	63.33	36.67

Complications

Infection

In this study, infection was seen in 2 (6.67%) patients, while Oh *et al*. (2006)[27] noted 4.3% and Prasad *et al*. (2013)[28] noted 9.52% infection in their series.

Studies	Percentage
Oh *et al*. (2006)[27]	4.3
Prasad *et al*. (2013)[28]	9.52
Our Study	6.67

Varus deformity

Varus deformity was seen in 1 (3.33%) patients, which was associated with knee stiffness.

Varus deformity	Percentage
Oh *et al*. (2006)[27]	8.7
Prasad *et al*. (2013)[28]	2.5
Pun *et al*. (2014)[29]	4.76
Our Study	3.33

Articular depression

In our study, articular depression was seen in 2 (6.67%) patients while it was 10% in the study of Prasad *et al.* (2013)[28] and 19.05% in the study of Pun *et al.* (2014).[29] Both cases were associated with knee stiffness.

Articular depression	Percentage
Prasad *et al.* (2013)[28]	10
Pun *et al.* (2014)[29]	19.05
Our study	6.67

Oh *et al.* (2006),[27] Prasad *et al.* (2013),[28] and Pun *et al.* (2014)[29] found no case of non-union in their series, which is comparable to our series, while we found condylar widening with knee stiffness in 1 (3.33%) of our patients.

Assessment of Results

In this study, using the Modified Rasmussen Scoring System, the clinical score of the patients were 6 (20.00%) excellent results, 20 (66.67%) good results, 3 (10.00%) fair results, and 1 (3.33%) poor results.

Studies	Excellent	Good	Fair	Poor
Oh *et al.* (2006)[27]	15	8	0	0
Our study	6	20	3	1

In this study, using the Modified Rasmussen Scoring System, on radiological assessment, we had 8 (26.67%) excellent results, 15 (50.00%) good results, 7 (23.33%) fair results, and 00 (00%) poor results.

Studies	Excellent	Good	Fair	Poor
Oh *et al.* (2006)[27]	18	3	1	0
Our study	8	15	7	0

For evaluation of results, we also used the Oxford Knee Score in our study. We had 8 (26.67%) excellent results, 16 (53.33%) good results, 6 (20.00%) fair results, and 00 (00%) poor results. We have compared our results with other studies done in the past, as shown below.

Studies	Excellent	Good	Fair	Poor
Prasad *et al.* (2013)[28]	16	16	8	0
Lee *et al.*[31]	9	6	0	0
Our study	8	16	6	0

CONCLUSION

The present study was undertaken to assess the management of bicondylar fractures of the tibia by various surgical modalities. The following conclusions were drawn from our study:

- The incidence of complex bicondylar fractures is on the rise. This is primarily due to high velocity RTAs involving mostly two-wheelers
- Male preponderance is seen in tibial condyle fractures, which is due to their more involvement in outdoor activities
- These fractures are associated with gross swelling, blisters, poor skin condition, and often a risk of compartment syndrome, so the timing of surgery is the single most preventing factor to avoid post-operative infections or dehiscence
- To reduce skin-related problems and achieve reasonable alignment, spanning external fixators should be applied at an early stage and kept until the acute phase is over. Counseling regarding provisional external fixators and delayed definitive surgery must be done in detail with the patient's family
- Pre-operative planning is a must. A CT scan gives the exact anatomy of the fracture pattern, helps in deciding the type of implant, and also guides about the surgical approach to be used
- Articular restoration is a must to prevent late secondary osteoarthritis
- The void created by the elevation of the depressed fragment must be filled by a solid and sturdy tri-cortical graft.
- Early mobilization not only gives good knee ROM but also restores the patient's confidence, resulting in better compliance.

Overall speaking, the surgical rationale for treating a bicondylar fracture depends on an understanding of the fracture, proper imaging, sound surgical technique, good fixation, and early mobilization. Proper post-operative care and rehabilitation also play a key role in recovery.

Strengths of the Study

The study includes different modalities of treatment with varied fracture patterns, which is quite inclusive of different factors.

Drawbacks of the Study

The sample size and duration of the study are rather less to draw more defined conclusions. The study does not have a control group and does not employ double blinding and randomization. So, further research in this regard is extremely needed.

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