

3D Reconstruction CT in Fractures around Knee Joint

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ABSTRACT

To study the spectrum of fractures on 3D reconstruction in CT of knee joint in all cases of knee trauma referred from OPD and casualty department of Sree Balaji Medical college, Chennai. o compares findings of 3D CT with conventional radiographs. Total patients examined CT with 3D reconstructions shows a higher specificity than conventional radiography. As well as number of patients identified in different types of tibial plateau fracture were more in case of examination with CT with 3D reconstructions than with plain radiography. The present study of 50 patients attempts to determine the role of 3D reconstruction in CT of fractures around knee joint.

Key words: 3D reconstruction, CT, Fracture, Knee joint

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INTRODUCTION

The knee joint is complex joint and is the commonly injured joint now days because of increased traffic accident, and sports related injuries. Being superficial joint and more exposed to external forces, this joint easily gets injured. Fractures around the knee in adults account for only 2% of all the fracture. Fractures around the knee are often complex injuries that present to the surgeon with numerous potential complications. Radiography can detect fracture comminution of fracture fragments and displacement of tibial plateau fractures to certain extent [1-3]. Trauma to knee joint is a significant cause of morbidity in trauma patients. Fractures around the knee joint present with numerous complications, which presses for affirmative diagnosis. An accurate diagnosis regarding the type and extent of injuries is crucial as it effects the treatment plan and helps to opt for the most effective surgical or medical treatment. This requires a thorough physical examination and a proficient diagnostic tool

[4]. With the advancing surgical techniques, the imaging of knee becomes more imperative. Knee joint is a complex joint with many components which make it vulnerable to a variety of injuries that includes fractures, sprain, dislocation, and ligament tears. Knee is the most common part to be injured due to a twisting or bending force as experienced in falls or accidents. Prognosis of knee injury depends on type and severity of injury and the need for physical therapy or surgery [5]. 3D CT is an excellent modality for evaluation of the knee joint as it helps in better demonstration of fracture fragments and extent of fracture in complex anatomical location. Even though radiography can detect fractures in majority of cases it cannot detect subtle fracture, depression of fracture fragments, intra articular fragments and displacement of fragments which play an important role in pre-operative planning can be adequately evaluated by 3D CT. The added information provided affects patient management as well as plan intervention. 3D imaging helps in better demonstration of fracture fragments and their relative position [5]. It confirms the fracture as its equivocal on radiograph and also determines the extent of fracture in complex anatomical region. Post intervention status evaluation has a greater accuracy with 3D CT. disarticulation of the joint

at 3D workstation removes overlying unaffected bone and improves visualization of underlying articular fractures of knee joint [6]. Multiline 3D CT produce high quality images which demonstrates relation between hardware, bone and bone fragment. With the advancing algorithm and precision in data acquisition techniques 3D CT has become a necessary complement to traditional CT in management of knee trauma. A well-known disadvantage is exposure to radiation and inability to detect ligament injuries. However, with advancing generation of CT low dose examination may be considered. There is no involvement of additional scanning or radiation in reconstruction of images 3D volume rendering and MPR is a valuable tool interpretation knee fracture. 3D reconstruction is useful to assess bony architecture in large comminuted fracture, displaced fracture involving multiple plane. This study was undertaken to evaluate fractures around knee joint using 3D reconstruction in CT [7].

MATERIALS AND METHODS

Study design: Prospective, descriptive statistical analysis evaluation of 50 patients with knee joint fractures was undertaken by 3D reconstruction in CT referred from orthopedics and emergency department of Sree Balaji medical college.

Source of data: All patients were referred from department of orthopedics and emergency from Sree Balaji medical college.

Method of data collection

Duration of study: Aug 2016 to Oct 2018.

Sample size: 50.

Inclusion criteria

All the patients presenting with knee fracture following trauma having positive plain radiograph findings.

Patients suspected of fractures clinically with subtle or negative plain radiograph.

Description of fracture

Lateral plateau with depression, lateral plateau with central depression, medial plateau fracture, comminuted fracture with dissociation from tibial metaphysis.

Plain radiograph correlation-Positive/Negative.

Joint effusion-Present/Absent.

Hemarthrosis-Present/Absent.

Associated soft tissue injury-Present/Absent.

Analysis of data

Surgery: Carried out in OT by orthopedic surgeon were indicated for therapeutic purpose.

Research hypothesis: Findings of 3D Reconstruction in CT were evaluated in fractures around knee joint.

RESULTS

The purpose of the present investigation was to study the spectrum of 3D reconstruction in CT of knee joint in all cases of knee trauma, grading of various knee injuries based on laid down criteria and comparison of findings of 3D CT to with conventional radiograph referred from OPD and casualty department of Sree Balaji Medical College, Chennai over a period of two year from August 2016 – October 2018. A descriptive statistical analysis consisting of 50 patients with fracture around knee joint is undertaken to study the spectrum of 3D CT findings. All patients were evaluated for tibial plateau fracture, femoral condyle fracture, fibula fracture, patella fracture joint effusion, hemarthrosis and other injuries associated with soft tissues. The CT where images were obtained with the help of Hitachi Eclis 8 Slice Scanner. Images were processed on a PC, using commercially available software. The processed images included sagittal and coronal 3D reformatted images. The evaluation began with 2D transverse CT images, followed by a 3D reconstruction view. The patients were placed in supine position with the feet forward. The maximum course range of the table is sufficient to allow an examination starting from the top of the pelvis to the foot on the side to be operated. Knee's series include the entire knee joint (10 cm above and below the joint).

Observation and results

The results were described and observed for the following objectives.

Study of the spectrum of 3D reconstruction in CT of knee joint in all cases of knee trauma.

Grading of various knee injuries on the basis of laid down criteria.

Comparison of findings of 3D CT to with conventional radiograph in selected cases.

Analysis of data.

Study of 3D reconstruction in CT of knee joint in all cases of knee trauma under different age groups.

The study was conducted on four different age groups of patients which comprised of total 50 patients with knee joint fractures. The study was undertaken by 3D reconstruction in CT. The results for the distribution of number of patients showed that out of 50 patients studied maximum number of patients around 60% of the total were fall under the age group 31-40 years, followed by the age group of 21-30 years which comprised of 26% of the total trauma cases. Whereas the minimum percentage of knee joint fractures i.e., about 2% were observed for the patients falls under the age group of 51-60 years. The results were presented in the Table 1 and explained by the Figure 1.

Grading of various knee injuries on the basis mode of injury

Out of 50 patients studied mode of trauma is maximum for road and traffic accident i.e., 72% of patients, followed by the patients injured with slip fall i.e., 14%. However, the 12% of patients get injured by assault and minimum numbers of cases (i.e., 2%) were observed to get injured during sports. The results were depicted in tabular form in Table 2 and Figure 2 for the different modes of study under present investigation.

Table 1: Age distribution.

Age	No. of patients	Percentage
21-30	13	26%
31-40	30	60%
41-50	6	12%
51-60	1	2%
Total	50	100%

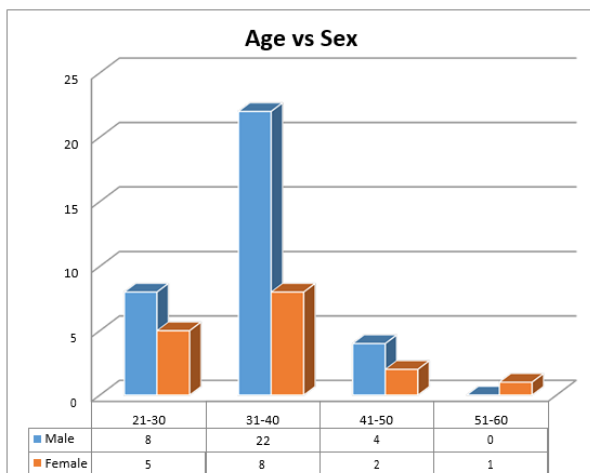


Figure 1: Shows the age vs. sex.

Table 2: Mode of injury.

Mode of Injury	No. of cases	Percentage
RTA	36	72
Slip fall	7	14
Assault	6	12
Sports Injury	1	2
Total	50	100

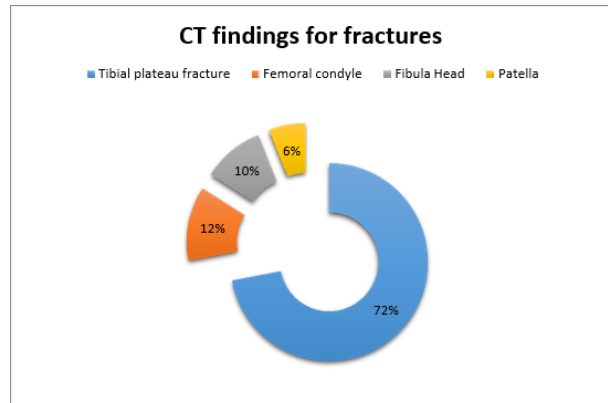


Figure 2: CT findings.

A male patient aged 23 with history of RTA showing fracture of lateral tibial condyle without depression (Schatzker Type I) and lateral femoral condyle. The study of other associated condition depicted in table 6 shows that 70% of patients are identified for Soft tissue injury and comprised of 35 cases. However, 64% of patients reported joint effusion with total number of 32 cases under study and 32% patients were identified for Haemarthrosis with the help of 3D reconstruction in CT (Table 3 and Figure 3).

Table 3: Associated conditions.

Associated condition	No. of cases(n=50)	Percentage
Joint effusion	32	64
Haemarthrosis	16	32
Soft tissue injury	35	70

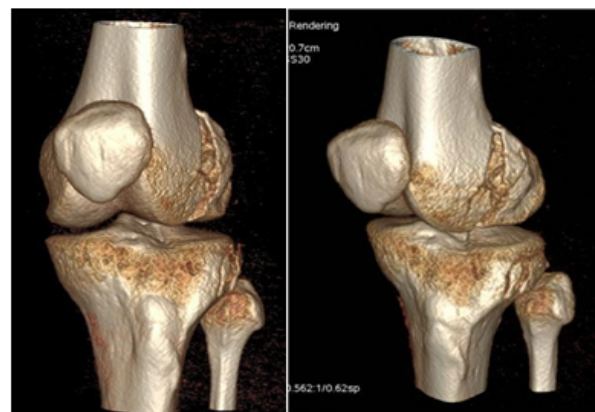


Figure 3: Grading of various knee injuries on the basis associated conditions.

Frequency of different types of Tibial plateau fractures identified by 3D CTs

Total numbers of 50 cases were investigated out of which 36 patients showed tibial plateau fractures, examined with the help of CT with 3d reconstructions which accounts about 72% of total cases under examination. Among different types of plateau fractures, type III fractures are more common which accounts for about 26% with 13 individuals, followed by type IV fracture which accounts 16% for eight patients. Whereas type II and type VI tibial plateau fractures accounts for 14% and 10%, for seven and five individuals respectively. However only three patients with accounts for 6% of the total number of CT examination reported type I of tibial plateau fractures. Although none of the patient reported type V tibial plateau fracture. The percentage of different type of tibial plateau fractures along with their frequency were presented in Table 4 and graphically represented in Figures 5-7.

Table 4: CT findings vs. X-ray findings for incidences of different types of fractures in the patients taken for the study (n=50).

Fracture type	CT findings	X-ray findings
Tibial Plateau	36	24
Femoral Condyle	6	6
Fibula Head	5	4
Patella	3	2
Total	50	36

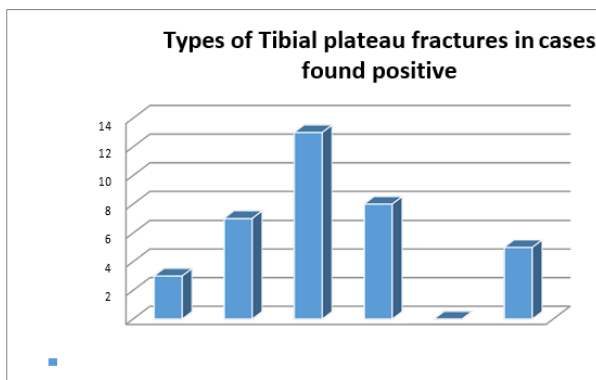


Figure 5: Frequency of different types of Tibial plateau fractures by 3DCT.



Figure 6: CT vs X-ray findings for different fractures in observed cases (n=50).



Figure 7: 3D-CT-based bone shape analysis.

DISCUSSION

The role of 3D CT has steadily increased in evaluation of patients with knee trauma. Computed tomography has an important role in evaluating fractures shown on radiographs, and for delineating fractures before surgery. Complete evaluation of knee structures such as tibial plateau was not possible by other modalities such as plain radiography, fluoroscopy and ultrasonography. Multiplanar reconstruction provides significant improvement in assessing these structures. 3D-CT-based bone shape analysis has also shown reliability in repeated measurements, which is required when measuring relevant morphologic features in clinical assessment and further research [8]. In his study out of 1050 fractures, 650 (61.9%) were seen in males and 400 (38.1%) were seen in females. The difference was statistically significant. In our study out of total 50 patients studied 34 patients were male A case of 65-year-old male patient demonstrates comminuted fracture involving the lower pole of patella. Fractured patella separated into two half and 16 were the females injured with the knee fractures comprised of 68% and 32%, respectively [9]. In our study maximum number of 30 trauma cases

for the patients belonging to the age group of 31-40 years, knee joint fracture is more common in males comprised of 22 cases and 8 were the females with knee joint fracture. This age group were followed by the male and female patients (08 and 05, respectively) belonging to age group of 21-30 years, comprised of total 13 patients with knee joint fractures. Whereas patients under the age group of 51-60 years were minimum as well as none of the male patients reported knee joint fracture. However, only one female reported this injury in this age group [10].

In a study classification system for tibial plateau fractures is widely used by orthopedic surgeons to assess the initial injury, plan management, and predict prognosis. Many investigators have found that surgical plans based on plain radiographic findings were modified after preoperative computed tomography (CT). CT image is more accurate than plain radiography for Schatzker classification of tibial plateau fractures, and use of cross-sectional imaging can improve surgical planning. Our study is done by studying fractures of knee by 3DCT evaluation and multi planar reconstruction of images. Using these reconstructed coronal images and sagittal images with VR images allowed us to make accurate, reproducible, and appropriate evaluations of proximal tibial fracture patterns and depressions [11]. In a study Sixteen consecutive patients with tibial plateau fractures were investigated by standard radiography and computerised axial tomograms (CT scans). It was found that CT scanning proved most helpful for classifying the type of fracture, for evaluating the degree of comminution, and for measuring displacement. Which was in concordance with our study [12]. Majority of fractures are Schatzker Type II. However, in our study we found that among different types of plateau fractures, type III fractures are more common which accounts for about 26 % with 13 individuals, followed by type IV fracture which accounts 16 % for eight patients. Whereas type II and type VI tibial plateau fractures accounts for 14% and 10%, for seven and five individuals respectively. However only three patients with accounts for 6% of the total number of CT examination reported type I of tibial plateau fractures. Although none of the patient reported type V tibial plateau fracture [13]. In his study series of 409 patients found that 356 patients

had knee fracture A total of 451 fractures were found in all anatomic regions: distal femur (n=49), proximal tibia (n=307), patella (n=23), and proximal fibula [14]. The three main injury mechanisms were traffic accident, a simple fall, and sport. In our study studied mode of trauma is maximum for road and traffic accident i.e., 72% of patients, followed by the patients injured with slip fall i.e., 14%. However, the 12% of patients get injured by assault and minimum numbers of cases (i.e., 2%) were observed to get injured during sports [15]. In his study showed that CT, reviewers modified the classification in 66% of cases and treatment plan in 49%. In our study the classification was modified on 50% of patients after CT. In our study other associated condition depicted that 70% of patients are identified for Soft tissue injury and comprised of 35 cases. However, 64% of patients reported joint effusion with total number of 32 cases under study and 32% patients were identified for Haemarthrosis.

CONCLUSION

- Tibial plateau fractures are the most common among knee joint fractures.
- 3D CT is an excellent noninvasive imaging modality that generates high quality of images in a reduced time. It can accurately detect, characterize, and evaluate fractures around knee joint. It helps in arriving at a correct diagnosis thereby further guiding management of patient.
- 3DCT has a higher sensitivity than conventional radiography for evaluation of fractures around the knee joint.
- 3DCT is a better predictor for fractures around the knee joint than conventional radiography.

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ETHICAL APPROVAL

The study was approved by the institutional ethics committee.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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