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Senthilnathan Arumugam
Professor and Unit Chief, Department of Orthopaedics, Rajah Muthiah Medical College and Hospital, Annamalai University, Chidambaram, Tamil Nadu, India

Raghulraj Sundaramoorthy
M.S Ortho, Postgraduate Student, Department of Orthopaedics, Rajah Muthiah Medical College and Hospital, Annamalai University, Chidambaram, Tamil Nadu, India

Prabhakar Ramabadran
Lecturer, Department of Orthopaedics, Rajah Muthiah Medical College and Hospital, Annamalai University, Chidambaram, Tamil Nadu, India

Balamurugavel PS
Lecturer, Department of Orthopaedics, Rajah Muthiah Medical College and Hospital, Annamalai University, Tamil Nadu, India

Correspondence
Senthilnathan Arumugam
Professor and Unit Chief, Department of Orthopaedics, Rajah Muthiah Medical College and Hospital, Annamalai University, Chidambaram, Tamil Nadu, India

Role of computerized tomography in management of complex high energy tibial plateau fractures

Senthilnathan Arumugam, Raghulraj Sundaramoorthy, Prabhakar Ramabadran and Balamurugavel PS

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Abstract
Introduction: Tibial Plateau fractures are some of the commonest fractures that occur and comprise 1% of all fractures. Plain X - ray radiography has been routinely employed over the period of years to diagnose and treat tibial plateau fractures. Careful preoperative planning using CT scans has shown better radiological outcomes postoperatively.
Aims and Objectives: To evaluate the role of CT scans in the management of tibial plateau fractures.
Materials and Methods: 30 cases of tibial plateau fractures admitted and treated at Rajah Muthiah Medical College and Hospital, Annamalai University, Chidambaram between May 2016 to September 2018 were taken into the study and evaluated using Rasmussen's knee scoring for functional outcome and 18 cases had CT scan of knee preoperatively whereas 12 cases had plain X rays.
Results: Two cases who had preoperative isolated X rays without CT scans had superficial surgical site skin infection and one among them required subsequent bone grafting and additional lateral plating Most patients who had isolated X rays for preoperative evaluation had comparable functional outcome with the patients who had preoperative CT scan although intraoperative time duration was relatively more compared to the patients who had preoperative CT scans.
Conclusion: Although three dimensional CT scans of the proximal tibia provide accurate delineation of the fracture configuration, and may even reveal what plain X rays fail to show, they are not as mandatory so as to affect the functional outcome following fracture fixation provided the surgeon expects and is prepared to deal with the newly discovered intraoperative fracture configuration.

Keywords: Computerized tomography, management, energy tibial plateau fractures

Introduction
Tibial Plateau fractures are some of the commonest fractures that occur and they prove to be extremely challenging to treat even for an experienced orthopaedic surgeon. Tibial Plateau fractures comprise 1% of all fractures [1]. Plain X - ray radiography has been routinely employed over the period of years to diagnose and treat tibial plateau fractures. Tibial plateau fractures include a large number of fracture patterns. A number of classifications have been proposed to categorize these fractures to guide preoperative planning [2, 3]. Careful preoperative planning using CT scans has shown good radiological and clinical outcomes postoperatively. Among the low socioeconomic patients where CT scans are not affordable, relatively feasible X rays needs to provide all the information required for fracture fixation. In this study we assess the functional outcome following fracture fixation among patients who undergo CT scans of the affected knee and those who don't thereby depicting the role of CT scans in the management of tibial plateau fractures.

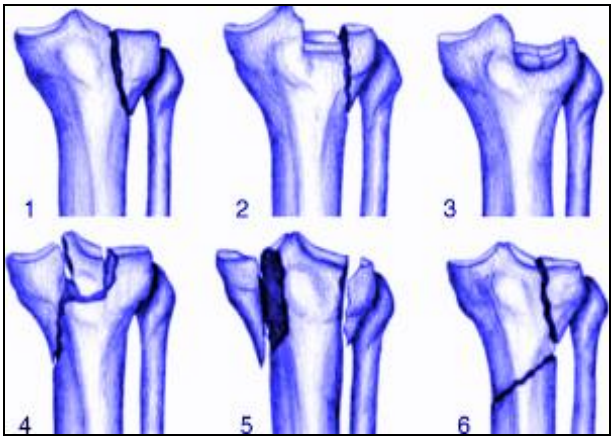
Materials and methods
30 tibial plateau fracture patients who were admitted and treated at Rajah Muthiah Medical College and Hospital, Annamalai University, Chidambaram between May 2016 to September 2018 were taken into the study and evaluated using Rasmussen's knee scoring for functional outcome and 18 cases had CT scans of knee preoperatively whereas 12 cases had only entero posterior and lateral view plain X rays. The overall sex ratio was 26: 4 (Male: Female)

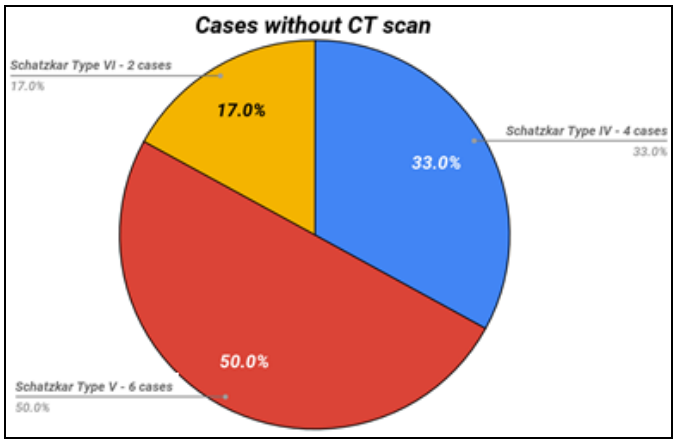
Gender	With CT scan	Without CT scan
Male	16	10
Female	2	2

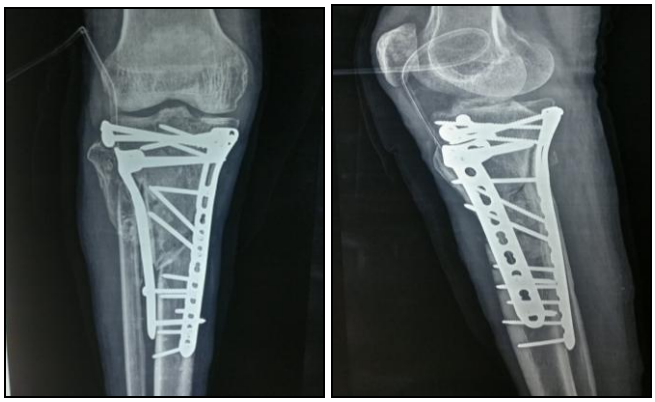
All cases had immediate immobilization with above knee plaster slabs and limb elevation on Braun's frame. Surgery was delayed until edema had subsided with adequate ice fomentation and anti-edema medications. All cases were operated by three different surgeons who used intraoperative fluoroscopy, tourniquet and radiolucent bolster routinely and the approach adopted was modified Lobe Hoffer approach for posteromedial plating and the conventional anterolateral approach for lateral plating. The post-operative protocol followed was, Static quadriceps exercises, toe mobilization exercises given from 2nd post-operative day, Suture removal done after 2 weeks, Non weight bearing knee mobilization started from 3rd week, Partial weight bearing after 6 weeks, Full weight bearing after radiological union at the end of 12 weeks post - op. Functional outcome was analysed at final follow up.

Results

Among the patients who underwent CT scans [18 cases], the mean age was 34.6 yrs (range 28 - 61 years), 95% (17) cases had RTA as mechanism of injury, 5% (1 case) had self-fall. 69% (12 cases) had tibial plateau fractures in the Right knee and the remaining 31% (6 cases) had fractures on the left side. All 18 cases were closed fractures 65% (12 cases) were Schatzker type V, 20% (4 cases) were type IV, and 15% (2 cases) were type VI. 50% (9 cases) had Dual Plating and 50% (9 cases) had posteromedial plating with additional cannulated cancellous screw fixation done on the lateral tibial plateau. Mean follow up was up to 9 months. Average time to achieve full radiological union (crossing of trabeculae across the fracture site) was about 4 months and 1 week. All patients had satisfactory radiological outcome except in 1 patient where there was an articular step off of 4 mm. Rasmussen's score at final follow up was excellent in 3 cases and good in 9, fair in 6 cases.

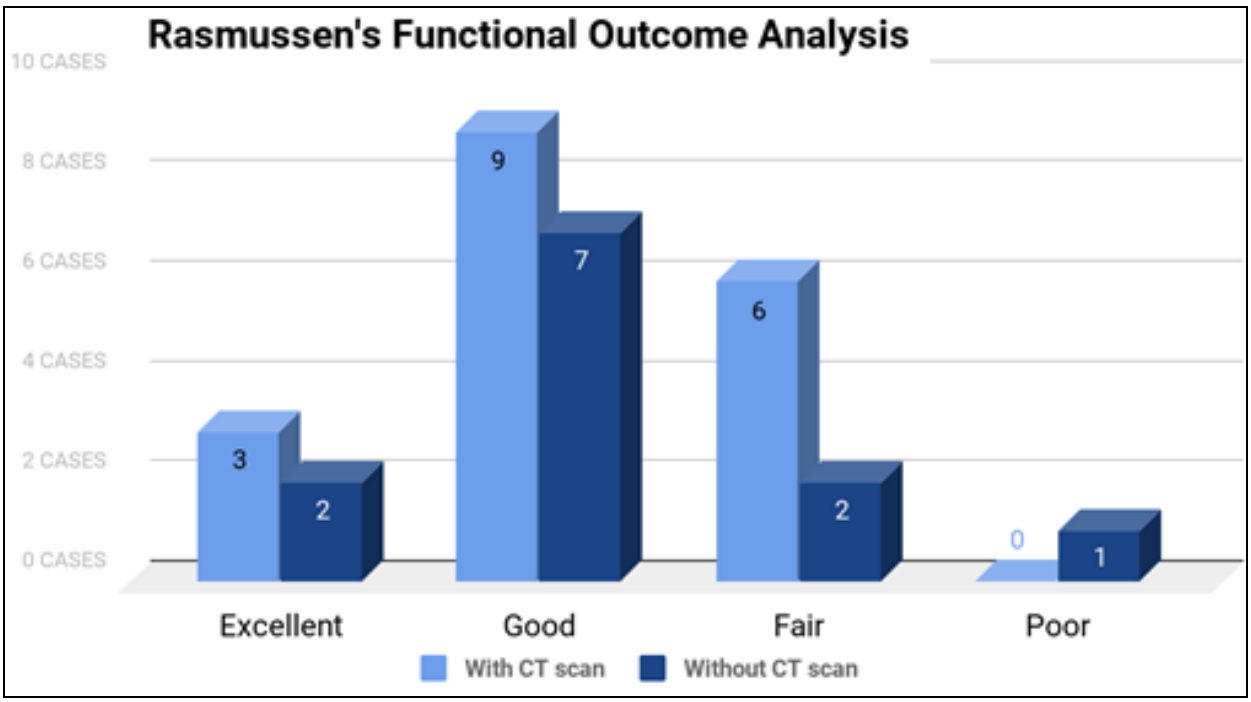






Among the patients who did not undergo CT scans [12 cases], 4 cases had additional internal and external rotation X ray views to assist the surgeon. The mean age was 38.2 yrs (range 31-69 years), 92% (11) cases had RTA as mechanism of injury, 8% (1 case) had self-fall. 83% (10 cases) had tibial plateau fractures in the Right knee and the remaining 17% (2 cases) had fractures on the left side. 16% (2 cases) were Grade 1 compound, and one among them had superficial surgical site infection and the other required subsequent additional lateral plating with iliac crest bone grafting. 50% (6 cases) were Schatzker type V, 33% (4 cases) were type IV, and 17% (2 cases) were type VI. 42% (5 cases) had Dual

Plating and 58% (7 cases) had posteromedial plating with additional cannulated cancellous screw fixation done on the lateral tibial plateau. Mean follow up was up to 8.6 months. Average time to achieve radiological union was about 4 months and 2 weeks. All patients had near anatomical fixation and no particular incongruity. Most patients who had isolated X rays for preoperative evaluation had comparable functional outcome with the patients who had preoperative CT scan although intraoperative time duration was marginally high (mean 12.4 minutes) compared to the patients who had preoperative CT scans. Rasmussen's score at final follow up was excellent in 2 cases and good in 7, fair in 2 cases and poor in 1 case.



Discussion

Traditionally, the management of tibial plateau fractures is based on two-dimensional classification systems such as the Schatzker classification. Several studies have noted computed tomography (CT)-based three-dimensional configuration of the fracture pattern was important in the treatment of tibial plateau fractures. In recent years, ‘‘three-column fixation’’ technique to treat the multilane complex tibial plateau fractures, which is based on three-dimensional configuration of the fractures [4].

Brunner *et al*. (2010) [5]. Analysed 55 tibial plateau cases and suggested that computed tomography scanning improved the inter- and intra-observer reliability of the OTA/AO, the Schatzker, the Hohl classification and recommended CT scan for preoperative planning in complex tibial plateau fractures which require more detailed information regarding the localization and presence of split and depression zones or where the contra-lateral plateau has been affected.

Martijn A. J. te Stroet *et al*. (2011) [6]. Analysed 15 X rays and their CT scans and suggested that the use of CT scan in addition to the plain radiographs in tibial plateau fractures did not result in a better intra- and intero bserver agreement for treatment plan. Considering additional costs and radiation, the routine use of a CT scan for tibial plateau fractures was questionable according to their study. The clinical implication of their study was that surgeons should classify a tibial plateau fracture based on a series of plain radiographs and set up a treatment plan and only when there are specific questions concerning the treatment plan remain, that a CT scan should be considered.

Yan-Ling Hu *et al*. (2009) [7]. Analysed 21 tibial plateau fractures with their Three-dimensional CT scans and concluded that it is a more reliable radiographic modality than 2D CT in evaluation of fracture patterns.

Robert Pätzold *et al*. (2017) [8]. Suggested that classification scheme based on the 3D imaging of bicondylar proximal tibial fractures denotes a reliability of clinical relevance.

Chan *et al*. (1997) [9]. After analysing 21 tibial plateau fractures, suggested that Class was changed in an average of 12 percent of cases after addition of CT scans. Treatment plan was changed an average of 26 percent of the time after addition of CT scans.

Wicky *et al*. (2000) [10]. Analysed 42 tibial plateau fractures and found 43% cases were underestimated by plain X rays and surgical plan was modified in 59% of cases thereby suggesting CT 3D reconstructions gives a better and more accurate depiction of the tibial plateau fracture and allows a more precise pre-operative planning.

Although most of these studies suggest 3D CT imaging a better modality of demarcating the fracture pattern, they used kappa values for inter ob server reliability none of them included the postoperative outcome following fixation. As all the previous studies suggest CT scans provide a better angle at the fracture pattern, but we found that it did not significantly influence the functional outcome following fracture fixation.

Conclusion

Although three dimensional CT scans of the proximal tibia provide accurate delineation of the fracture configuration, and may even reveal what plain X rays fail to show, they are not as mandatory so as to affect the functional outcome following fracture fixation provided the surgeon expects and is prepared to deal with the newly discovered intraoperative fracture configuration with an armamentarium of implants.

Limitations

All cases were not operated by the same surgeon. The sample

size, follow up period and the duration of the study was less compared to most of the other studies.

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