

## WHAT IS CORRELATED WITH FUNCTIONAL OUTCOMES OF SURGICALLY TREATED TIBIAL PLATEAU FRACTURES?

*CERRAHİ TEDAVİ EDİLEN TİBİA PLATO KIRIKLARININ FONKSİYONEL SONUÇLARIYLA NE İLİŞKİLİDİR?*

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### ÖZET

**AMAÇ:** Bu yazıda amaç kilitli plak, konvansiyonel plak, çift plak ve ilizarov fiksasyonu ile tedavi edilmiş tibia plato kırıklarının sonuçlarını, kırık tipini ve enerjisini göz önüne alarak karşılaştırmak ve de osteoartrit derecesi, radyolojik parametrelerle korele etmektir.

**GEREÇ YÖNTEM:** 2000-2007 tarihleri arasındaki bütün tibia plato kırıklı hastalar gözden geçirildi (23 erkek, 16 kadın; ortalama yaş 49; dağılım 18-84 yaş). Hastalar Rasmussen fonksiyonel diz skoru (RFK), Rasmussen radyolojik iyileşme skoru (RRH) ve de Kell Lawrance osteoartrit derecelendirmesine göre değerlendirildi.

**BULGULAR:** Konvansiyonel kilitli plağın RFK, RRH skorları kilitli plak, çift plak ve de ilizarovdan yüksekti ( $p<0.05$ ). Kilitli plak grubunun RRH skoru ilizarov grubundan yüksekti ( $p<0.05$ ). Düşük enerjili kırık grubunun RFK, RRH skorları yüksek enerjili gruptan yüksekti ( $p<0.05$ ). Yüksek enerjili kırık patterninde gruplar arası skorlarda fark yoktu ( $p>0.05$ ). Korelasyon analizinde, fonksiyonel, radyolojik skorlar arasında pozitif, osteoartrit derecesi, radyolojik skorlar arasında negatif korelasyon bulundu. Osteoartrit derecesi ve fonksiyonel diz skoru arasında korelasyon saptanmadı ( $p>0.05$ ).

**SONUÇ:** Kısa-orta dönem prognoz muhtemelen diz stabilitesi, dizilimine bağlı olarak osteoartrit ikincil derecede öneme sahip gözükmemektedir ki bu durum uzun dönem takiplerde değişebilir.

**Anahtar Kelimeler:** Tibia-plato-osteosentez-osteoartrit

### SUMMARY

**OBJECTIVE:** To compare the results of tibia plateau fractures treated by locked plate, conventional plate, double plate and ilizarov fixation with special reference to the energy and the fracture and correlate with degree of osteoarthritis and radiological parameters.

**METHODS:** All patients with tibial plateau fractures between 2000-2007 were reviewed (23 men and 16 women; mean age 49.43 years; range between 18-84 years). The patients were evaluated according to Rasmussen functional knee score (RFK), Rasmussen radiological healing score (RRH), Kell Lawrance grading of the osteoarthritis (KL). Correlation analysis between parameters was made.

**RESULTS:** Conventional unlocked plate had higher RFK, RRH scores than locked plate, double plate and ilizarov groups ( $p<0.05$ ). RRH score of locked plate group was higher than ilizarov group ( $p<0.05$ ). However low energy group had higher scores than high energy group ( $p<0.05$ ). Scores did not differ for high energy between the groups ( $p>0.05$ ). At the correlation analysis, there were positive correlations between functional, radiological scores and negative correlation between degree of osteoarthritis and radiological scores. There was no correlation between the degree of osteoarthritis and the functional scores ( $p>0.05$ ).

**CONCLUSION:** Short to medium prognosis probably depends on the alignment, stability of the knee while osteoarthritis seems to be secondarily important which may change at longer term follow-up.

**Key words:** tibia-plateau-fracture-osteosynthesis-osteoarthritis

## INTRODUCTION

Operative treatment of tibial plateau fractures is challenging. Recent advances in the techniques of fixation of these fractures, like the development of locked plating and minimal invasive approaches changed the treatment strategies of these fractures.<sup>1</sup>

Treatment of bicondylar high energy tibial plateau fractures possess a further challenge for the orthopaedic surgeon that there is no consensus on how best to approach the treatment of these fractures.<sup>2</sup> Similar outcomes were reported comparing two plate fixation versus ilizarov fixation and locked plate versus two plate fixation of the bicondylar fractures.<sup>3,4</sup>

It would seem logical to expect a more limited outcome in very displaced and comminuted patterns of fracture. However, a study which compares the outcomes after different patterns is not yet available. A favourable result seems to be achievable for low-energy injuries.<sup>5,6</sup> Furthermore correlation between functional outcomes, radiological parameters or the degree of osteoarthritis have not been delineated clearly in the literature.

Purpose of the present study is to compare the results of four different treatment modalities for tibial plateau fractures; locked plate, conventional plate, double plate, ilizarov fixation. With special reference to the energy and the fracture (low energy; Schatzker type 1+2+3 +4 and high energy; Schatzker type 5+6 and correlate with degree of osteoarthritis, functional score and radiological parameters.<sup>7</sup>

Hypothesis of the study was ilizarov fixation would be no different than all other study groups and high energy fracture group would have a similar prognosis with low energy fracture group.

## PATIENTS AND METHODS

Patient records from 2000 to 2007 were reviewed. Acute tibial plateau fractures and patients that were able to walk without any assistance were included at the study. Exclusion criteria were old fractures (>3 weeks after the initial injury), Gustilo type 3B and type 3C open fractures and ipsilateral femur fractures. 39 patients were eligible for the study and included.

Patient case histories were reviewed to determine patient demographics, mechanism and nature of the injuries, operative procedures and complications. Initial trauma radiographs (plain films and/or CT's if available)

were evaluated and the tibial plateau fractures were classified according to Schatzker's classification.<sup>7</sup>

There were 23 men and 16 women. The average age was 49.43 years with a range between 18-84 years. Two fractures were classified as Schatzker I, 11 were Schatzker II, 9 were Schatzker III, one was Schatzker IV, 5 were Schatzker V, 11 were Schatzker VI.

There were thirteen open fractures and these were classified according to Gustilo—Anderson classification.<sup>8</sup> Two were type I, 10 were type II, one was type III.

Patients with open wounds underwent surgical debridement within 8 h of injury, subsequently received tetanus prophylaxis and intravenous antibiotics.

Circular external fixations were generally two or three ring or half-ring constructs with tensioned fine-wires used at the tibial plateau, and fine-wires distally. All patients had limited open reduction or percutaneous fixation with olive wires at the time of frame application (Fig 1a-c). Patients in the double plate group were treated with dual plate fixation (an anterolateral Tor L-shaped buttress plate plus a posteromedial limited contact dynamic compression plate).

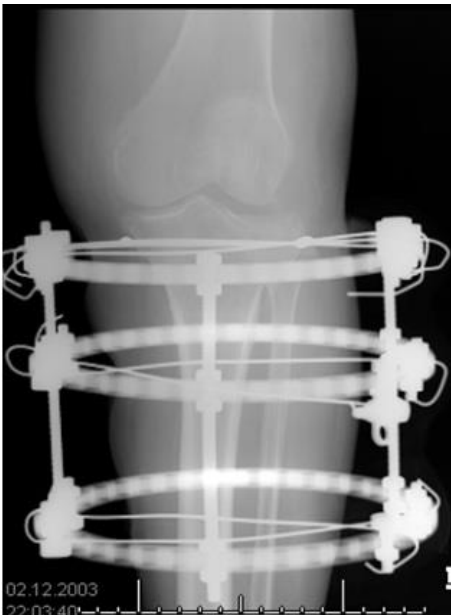
The remaining patients were treated with single Locked plate (Fig 2a, b) or conventional plate (five or nine holes, Synthes, Switzerland) through an anterolateral exposure according to the standard procedure described by AO/ASIF.

Postoperatively, each limb was strictly elevated until soft tissue oedema was no longer a concern. Patients were started on range of motion exercises as soon as possible. Weight bearing was not permitted until significant union was radiologically evident.

At the final follow-up patients were evaluated using the Rasmussen functional knee score (RFK), Rasmussen radiological healing score (RRH) systems.<sup>9</sup> Degree of osteoarthritis was graded and scored depending on Kell Lawrance classification system.<sup>10</sup> Correlation analysis was performed between the variables of age, follow-up time, RFK, RRH scores and Kell Lawrance grade.

### Statistical analysis

Kruskal-wallis test was used to detect a difference for variables among groups. When a difference was detected for a given variable, mann-whitney test was used to compare groups to detect the source of the difference. Statistical significance was set at a p value <0.05.

**Fig 1a.** Schatzker type 2 fracture.**Fig 1b.** Ilizarov fixation**Fig 1c.** Knee Xray after implant removal

## RESULTS

The fractures healed in all cases. Time to full weight bearing ranged from 5 weeks to 32 weeks with an average of 9.3 weeks. The follow-up period ranged from 18 months to 79 months with an average of 37 months. Complications included pin tract infection in 2 cases (improved with local treatment and a short course of systemic antibiotics), one superficial infection and one deep vein thrombosis at locked plate group that were treated conservatively.

4 treatment groups did not differ for the demographic variables (sex, age), prevalances of subtypes of Schatzker classification and Gustilo Anderson fracture types ( $p > 0.05$ ). Kruskal –Wallis test analysis determined a difference for RFK, RRH scores between groups ( $p < 0.05$ ) (Table I). Conventional unlocked plate had higher RFK, RRH scores than locked plate, double plate and ilizarov groups ( $p < 0.05$ ). RRH score of locked plate group was higher than ilizarov group ( $p < 0.05$ ) while double plate group did not differ for two scoring systems compared to locked plate or ilizarov groups ( $p > 0.05$ ).

Comparison of low energy (n:23) and high energy fracture (n:16) groups, yielded no difference for demographic variables (sex, age), prevalances of subtypes of Schatzker classification and Gustilo Anderson

**Fig 2a.** Schatzker type 6 fracture



**Fig 2b.** Locked plate fixation.



classification ( $p>0.05$ ). However low energy fracture group had higher RFK score ( $26\pm3$  vs  $22\pm6$ ), RRH score ( $14\pm2$  vs  $12\pm2$ ) than high energy fracture group ( $p<0.05$ ). Subgroup analysis for high energy fractures yielded no difference for ilizarov, double plate and the locked plate ( $p>0.05$ ).

At the correlation analysis there were positive correlations between RFK, RRH scores and between Kell

Lawrance grade, age and/or follow-up time ( $p<0.05$ ). Although there was no correlation between Kell Lawrance grade, RFK score there was a negative correlation between Kell Lawrance grade and RRH score. Again RFK, RRH scores did not correlate with age and follow-up time.

#### DISCUSSION

Main findings of this study were radiological score of locked plate group was better than ilizarov group while unlocked plate group was better than all groups. High energy plateau fractures (Schatzker type5+6) yielded worse results than low energy fractures.

Recently no difference between circular external fixator and double plating was reported at two year postoperatively however because circular fixator results in a shorter hospital stay, a marginally faster return of function, and similar clinical outcomes and because the number and severity of complications is much higher with open reduction and internal fixation, authors concluded that circular external fixation is an attractive option for high energy fractures.<sup>3</sup> Similar to that study, present study failed to show difference between ilizarov fixations, double plate osteosynthesis at minimal 1.5 years postoperatively.

At another study, Jiang et al<sup>4</sup> reported similar outcomes for locked plate and double plating at the treatment of high energy tibial plateau fractures. However postoperative malalignment incidence was higher at locked plate group. Present study reported the similar findings that clinical, radiological scores were not different among two groups however unlike the study by Jiang et al, radiological score tended to be higher at locked plate group possibly due to higher incidence of low energy fractures.

Surprisingly unlocked conventional plating had the highest radiological, clinical scores among the groups. Possible explanation is that unlike other groups there was not either open or high energy fracture at unlocked plate group.

Optimal implant for the tibial plateau fracture fixation, especially the high energy, is still under investigation.<sup>1</sup> Soft tissue injury and bony comminution make traditional techniques of open reduction and internal fixation unsuitable. However with the usage of limited open

**Table I.** Demographic variables (age, sex), fracture characteristics (fracture subtype, open vs closed classification according to Schatzker, Gustillo Anderson classifications), functional, radiological scores of the groups (n: number, SD: standart deviation, F/M: Female/Male, Rasmussen functional knee score (RFK), Rasmussen radiological healing score (RRH).

Groups (n)	Age (mean±SD)	Sex(F/M)	Schatzker (I,II,III,IV,V,VI)	Gustillo Anderson (0,1,2,3)	RFK Score (mean±SD)	RRH score (mean±SD)
Locked plate (13)	48±13	6/7	-,4,5,-,-,4	11,-,1,1	24±4	15±2
Unlocked plate (8)	52±18	5/3	2,4,2,-,-,-	8,-,-,-,-	28±1	16±2
Ilizarov (11)	52±18	4/7	-,3,2,1,3,2	5,-,6,-	21±6	11±2
Double plate (7)	44±12	¼	-,,-,-,-,2,5	2,2,3,-	24±2	13±1

reduction and fixation with circular external fixation or locked plating still resulted at suboptimal results.<sup>4,11-15</sup>

Locked plate group had better radiological scores than ilizarov group which did not result in better clinical scores. Suboptimal minimal open reduction or fixation with olive wire with ilizarov fixation, compared to open reduction achieved at locked plate groups possibly resulted at worse radiological scores. Additionally there was no difference for high energy fracture between two. At the second part of the study, we aimed to find whether there is a difference for low energy fracture (Schatzker I+II+III) and high energy fractures (Schatzker IV+V) as the difference between two groups is not so clear that possible worse results attributable to high energy group is possibly due to soft tissue complications and wound healing problems.<sup>1</sup> Still no relation with fracture configuration of complete articular type fractures and functional outcome was reported.<sup>16</sup> However at the present study it is proven that high energy fractures yield lower functional and radiological scores.

Last at assesment of the results and correlation of the variables between eachother was performed. Present study found no correlation between functional scores and the degree of osteoarthritis instead a positive correlation between functional scores and radiological scores were found. This might clarify questions regarding the importance of quality of articular reduction on the effect of functional outcomes that at short to medium follow-up, osteoarthritis does not develop or progress to have functional importance while malalignment 'varus/valgus', knee stability are probably more important functionally.<sup>17-20</sup> Varus/valgus alignment scoring rather than the degree of articular congruency at Rasmussen radiological scoring system probably resulted a positive correlation with the functional scores at the present study.

Articular incongruency and later osteoarthritis development might affect the functional results at longer term follow-up supporting this is, Katsenis et al<sup>16</sup> reported deterioration of the radiological scores 5 years postoperatively compared to 3 years postoperatively while no effect at functional results could be demonstrated. Also knee osteoarthritis development was reported to occur six to eight years following intraarticular fractures about the knee injury with few changes seen thereafter.<sup>19</sup>

There exist some limitations. First is the retrospective design of the study that although main demographic variables were similar among the groups various other confounding variables were not controlled. Second patient number is low at each group that potential beta error could be eliminated by a larger study with more patients.

## CONCLUSION

Double plate was not different from locked plate or circular external fixator groups while locked plate resulted better radiological scores than circular external fixator group. Higher energy fracture had worse results than low energy group. Functional outcomes dependent on the radiological scores but not the degree of osteoarthritis. Depending on these locked plate seem advantageous over the other implants however high energy fracture have worse prognosis which seems to be independent of fixation technique and the soft tissue complications. Short to medium prognosis probably depends on the alignment, stability of the knee while osteoarthritis seems to be secondarily important which may change at longer term follow-up.

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