ACTA
ORTHOPAEDICA
et
TRAUMATOLOGICA
TURCICA

Author's translation
Acta Orthop Traumatol Turc 2007;41(1):1-6

The results of arthroscopically assisted circular external fixation in bicondylar tibial plateau fractures

Bikondiler tibia kırıklarında artroskopi destekli eksternal fiksatör osteosentezi sonuçları

Erbil OGUZ,[1] Ibrahim YANMIS,[1] Mustafa KURKLU,[2] A. Sabri ATESALP,[1] Cemil YILDIZ[1]

Gülhane Military Medical Academy, Faculty of Medicine, Dept. of Orthopaedics and Traumatology

Amaç: Bikondiler tibia plato kırıklarının, artroskopi eşliğinde sirküler eksternal fiksatör ile tedavi sonuçları değerlendirildi.

Çalışma planı: Bikondiler tibia plato kırığı olan 13 hasta (12 erkek, 1 kadın; ort. yaş 27; dağılım 18-37) artroskopi kontrolünde sirküler eksternal fiksatör ile tedavi edildi. Kırık nedenleri dokuz olguda trafik kazası, iki olguda spor yaralanması, iki olguda yüksekten düşme idi. Sekiz olguda açık kırık vardı. Olgular travma sonrası ortalama iki gün içerisinde kliniğimize getirildi. Yumuşak doku lezyonlarına (menisküslerde yırtık ve eklem içinde zedelenmiş kıkırdak bölgeleri) traşlama ve eksizyon uygulandı. Kırıklar Schatzker sınıflamasına göre sınıflandırıldı; fonksiyonel değerlendirmede Lysholm ve Gillquist diz skorlaması kullanıldı. Ortalama takip süresi 35 ay (dağılım 16-38 ay) idi.

Sonuçlar: Hiçbir olguda ameliyat öncesi ve sonrasında nörovasküler patolojiye rastlanmadı. Lysholm ve Gillquist diz skorlamasına göre iki olguda çok iyi, altı olguda iyi, dört olguda orta, bir olguda kötü sonuç elde edildi. Takip sonundaki ortalama diz skoru 82.46 bulundu. Kötü sonuç alınan hastada diz ekstansiyon ve fleksiyonunda önemli kısıtlılık gelişti. Ameliyat sonrasında iki hastada yüzeyel yumuşak doku enfeksiyonu, altı hastada çivi dibi enfeksiyonu görüldü.

Çıkarımlar: Bikondiler tibia plato kırıklarında artroskopi desteği ile uygulanan sirküler eksternal fiksasyonun iyi sonuç için yeterli olduğu görüldü.

Anahtar sözcükler: Artroskopi; kırık tespiti, eksternal; tibia kırığı/cerrahi.

Objectives: We evaluated the results of arthroscopically assisted circular external fixation in bicondylar tibial plateau fractures.

Methods: The study included 13 patients (12 males, 1 female; mean age 27 years; range 18 to 37 years) who were treated with circular external fixation under arthroscopic control for bicondylar tibial plateau fractures. The causes of fractures were traffic accidents in nine cases, sport injuries in two cases, and fall from height in two cases. Eight patients had open fractures. The mean time from injury to presentation was two days. Soft tissue injuries were treated with curettage and excision. The fractures were classified according to the Schatzker's system. Functional results were assessed using the knee scoring system of Lysholm and Gillquist. The mean follow-up period was 35 months (range 16 to 38 months).

Results: There was no neurovascular pathology in any of the cases preoperatively and postoperatively. Lysholm and Gillquist knee scores were very good in two patients, good in six patients, moderate in four patients, and poor in one patient. The mean knee score was 82.46. The patient with the poor result had significant limitation in knee extension and flexion. Postoperative complications included superficial soft tissue infection in two patients and pin tract infection in six patients.

Conclusion: Arthroscopically assisted circular external fixation of bicondylar tibial plateau fractures is efficient to obtain satisfactory functional results.

Key words: Arthroscopy; fracture fixation, external; tibial fractures/surgery.

Correspondence to: Dr. Erbil Oguz. Gulhane Military Medical Academy, Faculty of Medicine, Dept. of Orthopaedics and Traumatology, Etlik, Ankara. Phone: +90312 - 304 18 62 Fax: +90312 - 304 55 05 e-mail: erbiloguz@yahoo.com

Received: 07.11.2005 **Accepted:** 12.02.2007

Tibia plateau fractures are classified by AO and Schatzker classifications.[1,2] Bicondylar tibia plateau fractures addressed as Schatzker type 5 and 6. These are the most problemeatic types of proximal tibia. Fracture of both condyles causes to difficulties of surgical treatment.[3,4]

Because of the both condyles are fractured using of buttress plate from one side due to shothness of other colon and leads to tibia-vara and tibia-valga. [5] Using two plate from both sides needs to wide exposure and increases the possibility of infection and soft tissue problems. It is clear that these type of high energy injuries always have soft tissue lesions.[6]

Fluoroscopy and arthroscopy are two basic methods of the restoration of joint surface in the treatment of intra articular fractures.[5] It is stated that arthroscopy is not superior to fluoroscopy in the control of the intra articular fracture reductions. Arthroscopy is less invasive method and provides better intraarticular vision and treatment opportunities at the same session and examination of the intraarticular structures, and to enable the extripation of the little bone fragments within the joint.[6,7] In bicondylar tibia plateau fractures, the combination of the Circular External Fixation (CEF) technique and arthroscopy is the eligible treatment choice to provide the restoration of the articular surface and anatomical reduction in the fracture by the manipulation, and to allow for the motion in the early term postoperatively.[8-12]

In this study, we have aimed at comparing the literature knowledge and the results of the series including 13 cases which we applied CEF by the arthroscopic observation and manipulation in the treatment of bicondylar tibia plateau fractures.

Patients and methods

13 cases with bicondylar tibia plateau fractures (Schatzker type 5 and 6) were treated by applying CEF, together with the arthroscopic observation and manipulation between March 1996 and November 2001. 12 of the patients were male and one of them was female. The mean age was 27(18-37). Inclusion criterias was bicondylar fracture, irregularity on the surface of tibial articular surface and being free cartilage fragments in the joint and sensorial structures frustrating the vision. The reasons of the fractures are the traffic accident in 9 patients, sports in 2 patients and falling down in 2 patients. There was open fracture in 8 cases (6 type-1 and 2 type-1). Patients were admissioned to the clinic in 2 days after the trauma. (Table 1). In clinical and radiological evaluation, the fracture fragments and the joint surface were evaluated in details, using the computerized tomography and plain X-rays in all patients. (Figure 1a,b) There was no neurovascular pathology associated with the fracture in the patients.

Surgical Technique

All patients were operated in supine position by applying pneumatic tournament under spinal anesthesia. Arthroscopic attempt was made by exposuring the standard medial and lateral ports at the same time (Figure- 2a). Scope was inserted in this port. The joint was washed up by saline. The leakage of the fluid into the tissues around the joint was diminished by keeping the other port open continuously. After the free cartilage fragments in the joint and sensorial structures frustrating the vision were excised, manipulation for the reduction was performed by checking the irregularity on the joint surface. The irregularity between the joint surfaces was corrected at the same time with the applications by using the hook in inferior joint and joker in exterior joint. The depression in the medial plateau in 4 cases was elevated by the elevator through the cortical window with the cortical window with the anteromedial little incision. And spongious iliac autograph was placed under it. After the reduction was performed two guide K-wires were applied and reduction was controlled by flouroscopy. Then two olived K-wires, parallel to each other cross wisely were applied for the compression of the fragments. These K-wires were stretched on to the ring cross wisely under the arthroscopic inspection (Figure- 2c,d). Then the stabilization of the fragments was controlled by hook under the arthroscopic inspection. The fixation was completed by applying the other K-wires on to the same CEF ring. The other intraarticular structures were evaluated under the arthroscopic examination. Meniscal lesions were treated by performing the partial menisectomy. Small condral or osteocondral fragments were removed (Figure-2a,b). Then, the stabilization was completed by adding two ring in the distal part of the tibia.

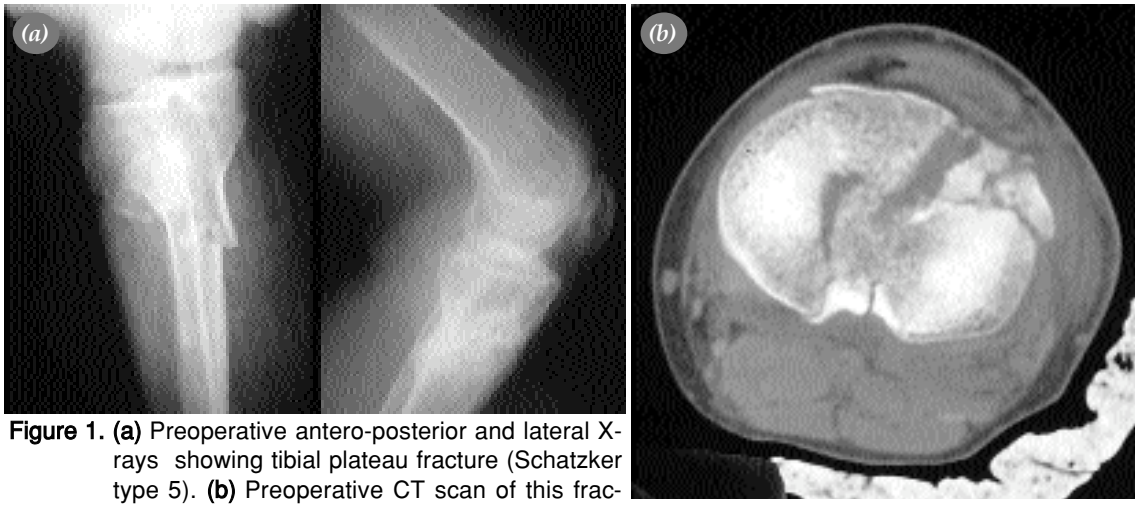

Figure 1. **(a)** Preoperative antero-posterior and lateral X-rays showing tibial plateau fracture (Schatzker type 5). **(b)** Preoperative CT scan of this fracture.

Prophylactic antibiotics with the first generation cephalosporins of 2x1gr were administered intravenously during three days postoperatively. Active and passive knee exercises without weight were started in the first day after the operation. The care of the pin ends was trained to the hospitalized patients in mean 15.2 days (9-23). After the discharge, they were controlled radiologically in regular intervals monthly (Figure-3). Partial loading (1/2) for the side extremity after the 3rd week post operatively, and complete loading after the mean 1.5 months, depending on the position of the fracture were applied. Knee functions have been evaluated by Lysholm's and Gillquist's knee scores.[13] This scoring system was developed for grading of knee ligament surgery results, but it gives a good reflection of the functional outcome after tibia plateau fractures as well.[4] Scoring is achieved by the examination and the inquiry of knee functions (55 points), pain (30 points), activities (45 points), anatomical structure (5 points) and ROM (10 points). All scorings were performed by members of the surgical team of this study. CEF frames were removed in 18.3 weeks[14-19] observing the radiological union. After the removal of the frames the cases keeped free for motion. The mean follow-up period is 26.6 months.[16-38]

Results

There were perfect results for 2 patients, good for 6 patients, mild for 4 patients and bad for one patient according to the Lysholm's and Gillquist's knee scores.[13] The mean knee score in the end of the follow-up time of the cases is 82, 46 and it has been summarized in table 1.

There were superficial soft tissue infection in 2 patients (%15, 3) and pin-tract infection in 5 patients (%38, 46) as a postoperatively complication. Two patients with the soft tissue infection received antibioterapy administration and were given the cure

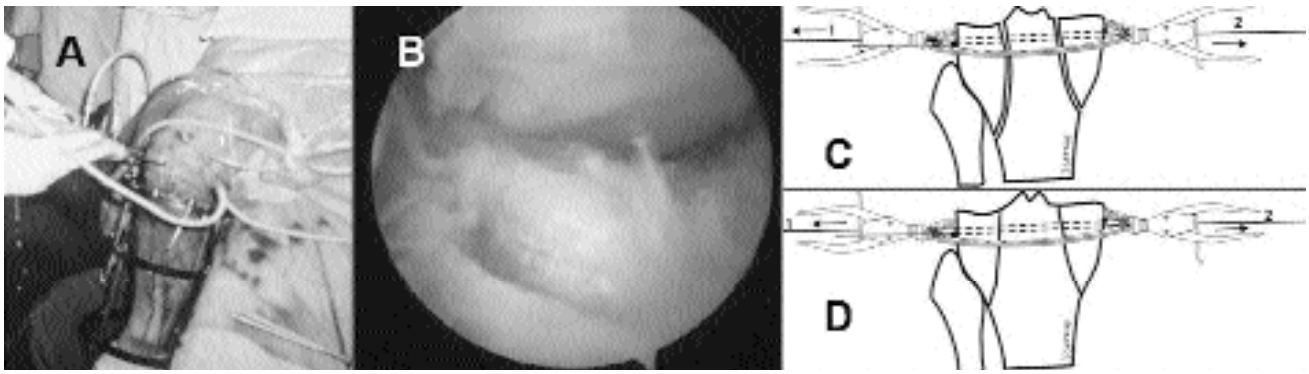

Figure 2. **(a)** Intraoperative picture, **(b)** Arthroscopically image, **(c)** Two olived K-wires, parallel to each other cross wisely were applied for the compression of the fragments, **(d)** K-wires were stretched on to the ring cross wisely under the arthroscopic inspection.

Table 1. Long term period (postop 26.6 month) outcomes of our cases according to Lysholm & Gillquist knee scores [13]

Outcome	Range of score	Number of the Patients
Excellent	98-100	0
Good to excellent	93-97	2
Fair to good	82-92	6
Fair	66-81	4
Poor	≤65	1

following the dressing according to the culture-antibiogram results. Pin infections were treated by the dressing with oxygen-water. There was a significant limitation in the knee flexion and extension in the patient that we obtained the bed result (%7,69). There were a full knee extantion and the mean 114, 9 degrees (90-135) of the knee flexion in all patients except this patient in the end of the 6 Th months following the removal of the frame.

There were no profound vein thrombosis and compartment syndrome in any cases.[11,12] Angulations deformity and neurovascular complication were not observed at the end of the treatment.

Discussion

The treatment of Schatzker type 5 and 6 fractures in the tibia plateau fractures in the tibia plateau fractures by the conventional methods is difficult and unpromising. [14-15] As for De Coster, the results in these fractures by the traction and after the bracing treatment are unsuccessful[16]. Metaphisial fracture components can not be ruled out by this method.[14] In open reduction and plaque-screw applications, when immobilization was made in a single colon, shortening and varus-valgus deformities occur in the other colon.[4, 13, and 17] The plaque applications in both sides is the technique both leading to the soft tissue pathologies and difficult.[2, 18] When rigid fixation is not performed, Long-term immobilization of the joint is necessary. This situation leads to the artrofibrosis and the motion limitation.[16] The infection risk is high in the cases undergoing the wide exposure because the plaque

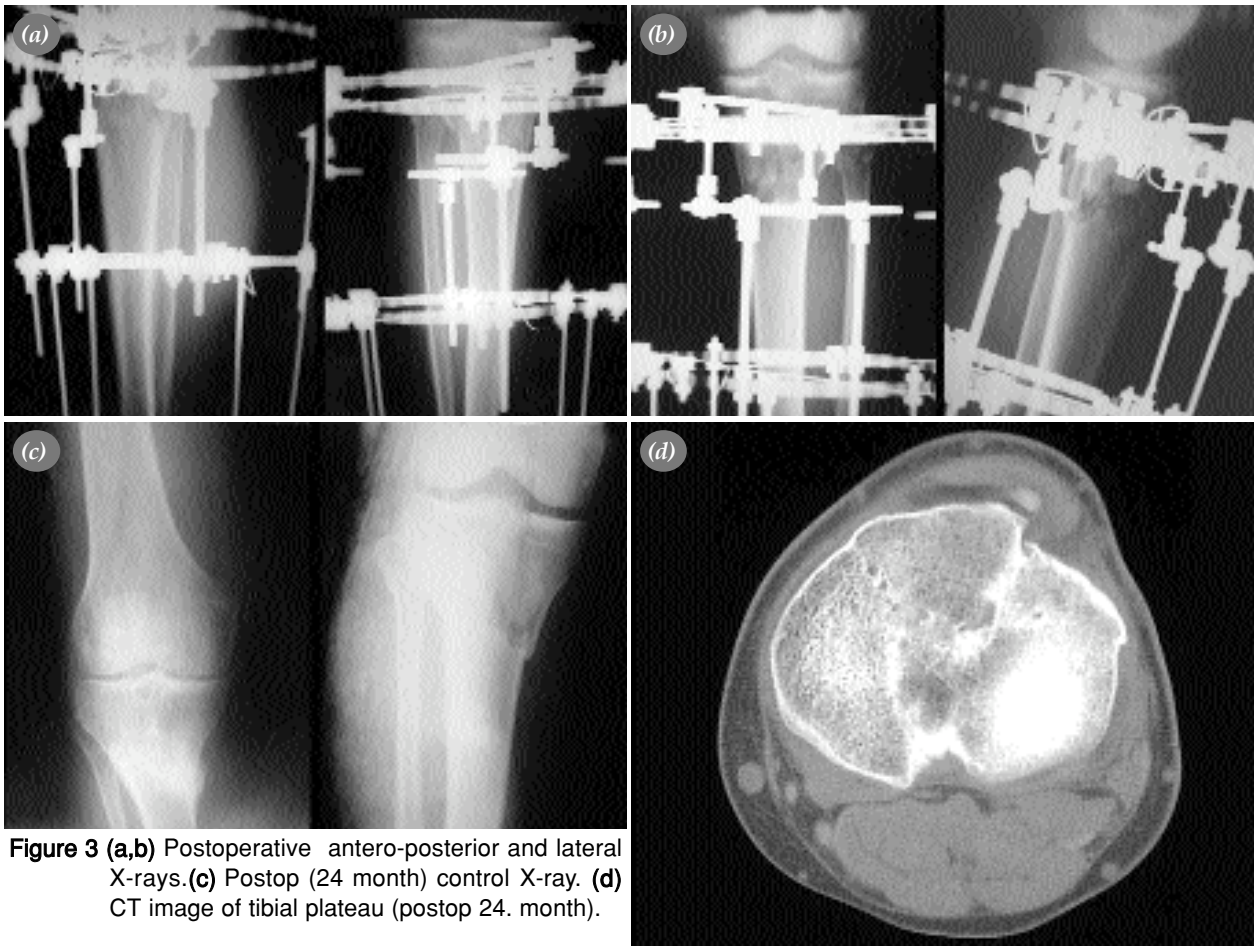

Figure 3 (a,b) Postoperative antero-posterior and lateral X-rays.**(c)** Postop (24 month) control X-ray. **(d)** CT image of tibial plateau (postop 24. month).

application has been performed in both colons, and the ones having especially the skin problems[4, 5, 9, and 17]

There was no infection in 8 with bicondylar tibia plateau fractures of 11 patients which Moore plaque screw and internal fixation were applied.[17] Young emphasized that internal fixation extended the operation time, and caused the additional damage in the soft tissue, and increased the risk of infection. The infection was seen in 7 of 8 cases in the study by young [19].

In the series by Tscherne et al, after the open reduction and internal fixation, profound vein thrombosis (%6), profound tissue infection (%4), compartment syndrome and posttraumatic arthritis are the most common complications.[4] There was no profound vein thrombosis or profound soft tissue infection in our cases. Superficial soft tissue infection was seen in two patients. They were cured by antibiotheraphy and the dressing follow-up in these patients. When the plateau fractures which Tscherne et al treated by the open reduction method were evaluated by Lysholm scale, they determined the mean point as 71.[4] In our series this point is mean 82, 4. If the number of our cases as much as in the literature the mean point may be less then 82.4. Sirkin emphasized that percutaneus fixation in this region was successful in split unicondilar fractures but inadequate in bicondilar fractures.[14]

Single or two-planned external fixators can also be used for the tibia plateau fracture treatments. But Geller et al suggested that CEF had more significant advantages than these fixators in the study which they performed on cadavers [15]. Fragments are detected by K-wires, and reduction and compression are provided by the olive wires in CEF [10, 11, and 20]. We also benefited from this advantageous characteristic of CEF in the surgical application.

In CEF systems, thin wires can also be applied at 2 mm below the joint surface if necessary. This provides the advantage for the arrangement of the joint surface. But in uni or bi planed external fixators by the thick pins, this distance is much longer.[5, 11] This low distance between the pins may be a reason of intraarticular infection. We we used prophylactic antibiotics and performed daily fastidious dressing of pin bases. There were %46 pin tracts infection in our cases but any intraarticular infection.

Additionally, union can be stimulated, making compression-distraction by CEF. The reduction of the fragments is possible by modifying on the frame especially in the postoperatively follow-up period. Thanks to all these advantages, CEF is often preferable method in especially Schatzker type 5-6 in tibia plateau recently.[10-20] Pin tract infections which are commonest problem in CEF has been seen in our 5 cases and ruled out by only dressing with oxygen-water.

Kenedy and Bailey suggested that the joint surface would not be completely restored in type 6 fragment fractures in his experimental studies [21]. Shybut and Spiegal admitted the depressions up to 1 mm in the restoration of the joint surface.[22] Lefkoe and Linias have shown that osteoarthritis develops when a step-off of the articular cartilage (2mm to 5 mm).[23, 24] Yetkinler et al showed that the open reduction without restoring the plateau in the tibia plateau fractures having the central depression would not be successful in the biomechanics studies they performed in cadavers [25]. Therefore, in the treatment of the intraarticular fractures, the regularity on the joint surface should be almost made. This process can be performed not only directly artrotomy but even indirectly fluoroscopy. It is essential that inferior coronal ligament should be excised and that meniscus should be elevated by arhrotomy with the full vision.[4, 5, and 13] This also leads to new morbidity. In recent years, the reduction by arthroscopy and the evaluation of the intraarticular structure have become more and more popular. The reason is that arthroscopy is less invasive method and provides better intraarticular vision.[7,9,26] During this process, it must be remembered that vision magnified in scophy. It is stated that arthroscopy is not superior to fluoroscopy in the control of the intra articular fracture reductions [6, 11]. But the most important advantages of arthroscopy are to provide the treatment opportunities at the same session and examination of the intraarticular structures, and to enable the extripation of the little bone fragments within the joint.[7]

Tibia tilt of 10-15 degrees in tibia plateau makes difficult to obtain the net vision by fluoroscopy. For better vision, the joint should be distracted. For this reason, serum physiologic is administered intraarticulary. This may cause that the fluid leads to the compartment syndromes, leaving the joint.[6, 11] This risk is also present for the arthroscopic applications. But this risk can be diminished by never using arthropomp and keeping the canula open continuously in arthroscopic

applications. We applied the intraarticular wash up continuously by the plastic canula which we inserted from a port, opening the medial and lateral ports at the same time. Thus, the leakage of the fluid to the supraarticular soft tissues was protected. This was-up provided that we received a good vision by cleaning up the bleeding which leaks from the fracture lines to the joint.

Consequently, CEF applications under the arthroscopy are rather successful method in the treatment of Schatzker type 5-6 fractures of tibia plateau. We believe that this minimal invaziv method which has not lead to the additional morbidity and combined the advantages of arthroscopy and CEF will increase the success rate of rigid fixation and early motion admitted as the main treatment principle of the fractures around the joint, and will decrease the complications.

References

1. Müller ME, Nazarian S, Koch P, Schatzker J, editors. The comprehensive classification of fractures of long bones. Berlin: Springer-Verlag; 1990.
2. Schatzker J, McBroom R, Bruce D. The tibial plateau fracture. The Toronto experience 1968--1975. Clin Orthop Relat Res 1979;(138):94-104.
3. Honkonen SE. Indications for surgical treatment of tibial condyle fractures. Clin Orthop Relat Res 1994;(302):199-205.
4. Tscherne H, Lobenhoffer P. Tibial plateau fractures. Management and expected results. Clin Orthop Relat Res 1993;(292):87-100.
5. Watson JT. High-energy fractures of the tibial plateau. Orthop Clin North Am 1994;25:723-52.
6. Koval KJ, Sanders R, Borrelli J, Helfet D, DiPasquale T, Mast JW. Indirect reduction and percutaneous screw fixation of displaced tibial plateau fractures. J Orthop Trauma 1992; 6:340-6.
7. Caspari RB, Hutton PM, Whipple TL, Meyers JF. The role of arthroscopy in the management of tibial plateau fractures. Arthroscopy 1985;1:76-82.
8. Kim HS, Jahng JS, Kim SS, Chun CH, Han HJ. Treatment of tibial pilon fractures using ring fixators and arthroscopy. Clin Orthop Relat Res 1997;(334):244-50.
9. Fowble CD, Zimmer JW, Schepsis AA. The role of arthroscopy in the assessment and treatment of tibial plateau fractures. Arthroscopy 1993;9:584-90.
10. Stamer DT, Schenk R, Staggers B, Aurori K, Aurori B, Behrens FF. Bicondylar tibial plateau fractures treated with a hybrid ring external fixator: a preliminary study. J Orthop Trauma 1994;8:455-61.
11. Mallik AR, Covall DJ, Whitelaw GP. Internal versus external fixation of bicondylar tibial plateau fractures. Orthop Rev 1992;21:1433-6.
12. Stamer DT, Schenk R, Staggers B, Aurori K, Aurori B, Behrens FF. Bicondylar tibial plateau fractures treated with a hybrid ring external fixator: a preliminary study. J Orthop Trauma 1994;8:455-61.
13. Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. Am J Sports Med 1982;10:150-4.
14. Sirkin MS, Bono CM, Reilly MC, Behrens FF. Percutaneous methods of tibial plateau fixation. Clin Orthop Relat Res 2000;(375):60-8.
15. Geller J, Tornetta P 3rd, Tiburzi D, Kummer F, Koval K. Tension wire position for hybrid external fixation of the proximal tibia. J Orthop Trauma 2000;14:502-4.
16. DeCoster TA, Nepola JV, el-Khoury GY. Cast brace treatment of proximal tibia fractures. A ten-year follow-up study. Clin Orthop Relat Res 1988;(231):196-204.
17. Moore TM, Patzakis MJ, Harvey JP. Tibial plateau fractures: definition, demographics, treatment rationale, and long-term results of closed traction management or operative reduction. J Orthop Trauma 1987;1:97-119.
18. Fernandez DL. Anterior approach to the knee with osteotomy of the tibial tubercle for bicondylar tibial fractures. J Bone Joint Surg [Am] 1988;70:208-19.
19. Young MJ, Barrack RL. Complications of internal fixation of tibial plateau fractures. Orthop Rev 1994;23:149-54.
20. Morandi M, Pearse MF. Management of complex tibial plateau fractures with the Ilizarov external fixator. Tech Orthop 1996,11:125-31.
21. Kennedy JC, Bailey WH. Experimental tibial-plateau fractures. Studies of the mechanism and a classification. J Bone Joint Surg [Am] 1968;50:1522-34.
22. Shybut GT, Spiegel PG. Symposium. Rigid internal fixation of fractures. Tibial plateau fractures. Clin Orthop Relat Res 1979;(138):12-7.
23. Lefkoe TP, Trafton PG, Ehrlich MG, Walsh WR, Dennehy DT, Barrach HJ, et al. An experimental model of femoral condylar defect leading to osteoarthrosis. J Orthop Trauma 1993;7:458-67.
24. Llinas A, McKellop HA, Marshall GJ, Sharpe F, Kirchen M, Sarmiento A. Healing and remodeling of articular incongruities in a rabbit fracture model. J Bone Joint Surg [Am] 1993;75:1508-23.
25. Yetkinler DN, McClellan RT, Reindel ES, Carter D, Poser RD. Biomechanical comparison of conventional open reduction and internal fixation versus calcium phosphate cement fixation of a central depressed tibial plateau fracture. J Orthop Trauma 2001;15:197-206.
26. Bernfeld B, Kligman M, Roffman M. Arthroscopic assistance for unselected tibial plateau fractures. Arthroscopy 1996;12:598-602.