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Original Article

Arthroscopically-assisted Reduction and Internal Fixation (ARIF) of tibial plateau fractures: clinical and radiographic medium-term follow-up

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Summary. *Background and Aim of the work:* Tibial plateau fractures include a wide spectrum of lesions with potentially disabling sequelae. Arthroscopically-assisted Reduction and Internal Fixation (ARIF) is an alternative to traditional ORIF. The aim of this retrospective single centre study is to evaluate medium-term clinical and radiographic outcomes achieved in a consecutive series of patients treated with ARIF. *Methods:* 21 patients, with a mean age of 52.2 ± 13.4 years at surgery, were included. According to Schatzker classification, there were 9 type II, 10 type III, 2 type IV fractures. Associated intra-articular injuries (meniscal tears, tibial spine fractures, chondral lesions) were detected in 8 patients. At follow up, patients were clinically and radiographically evaluated according to knee ROM, KOOS, OKS and Rasmussen Clinical and Radiological Scores. *Results:* At an average follow-up of 84 ± 22.5 months, 18 patients were evaluated. Mean values recorded were the following: knee ROM 1° - 135°, OKS 41.6 / 48 ± 8.18, subscale KOOS scores ranged from 75% ± 25.4 (Quality of Life) to 91.1% ± 11.2 (Pain), Rasmussen Clinical e Radiological 27.2 ± 2.64 (14 excellent, 3 good, 1 fair) and 9.1 ± 0.64 (15 excellent, 3 good), respectively. Worse results were observed in 5 patients with pre-existing degenerative chondropathy. *Conclusions:* ARIF revealed to be an effective technique for surgical treatment of unicondylar tibial plateau fractures. Our findings support the favourable results reported by other authors. ARIF is not a simple technique and requires specific experience in knee arthroscopy and a steep learning curve. (www.actabiomedica.it)

Key words: tibial plateau fractures, arthroscopy, internal fixation, joint trauma, post-traumatic osteoarthritis

Introduction

Tibial plateau fractures are articular injuries commonly caused by high-energy traumas in young patients and low-energy traumas in old osteoporotic patients (1-3). They represent approximately 1% of all fractures (4), with an incidence of 10.3 per 100'000 person-year (5). The management of these fractures might be challenging: the goal is to achieve anatomical reduction and stable fixation, in order to allow early knee mobilization and complete ROM recovery. These are the assumptions to achieve an optimal clinical and functional outcome (6, 7). For this reason, if not appropriately treated, tibial plateau fractures can lead to severe disability with a significant social impact.

Fracture treatment depends on several factors such as fracture configuration, soft tissue condition, bone quality, patient's age and lifestyle (8). Due to the injury mechanism, these fractures are often associated with intra-articular lesions such as chondral damage, meniscal tear and ligament rupture (9, 10).

Arthroscopically-assisted Reduction and Internal Fixation (ARIF), initially described by Caspari et al. (11) and Jennings (12), has gained popularity as an

alternative treatment to Open Reduction and Internal Fixation (ORIF) particularly for unicondylar tibial plateau fractures (13, 14). The minimally invasive ARIF technique allows direct visualization of the joint space, providing a better control of articular surface reduction and the possibility of both evaluating and treating associated intra-articular lesions (9).

The purpose of this study is to report the medium-term clinical and radiographic outcome achieved in a series of patients, who underwent ARIF for tibial plateau fractures.

Materials and methods

This retrospective, single-center study was performed on a consecutive series of 21 patients, who underwent ARIF for tibial plateau fracture in the Orthopaedics and Traumatology Unit of the "Maggiore della Carità" University Hospital in Novara (Italy), between August 2009 and February 2017. All data were collected from divisional digital registries (database "AcceWeb", Hi.Tech Software Engineering, Bagno a Ripoli - FI, Italy; database "Ormaweb", Dedalus Italia, Firenze – FI, Italy) and from patients' medical records.

Data collection allowed to identify 24 patients treated with ARIF for tibial plateau fractures, but 3 patients were excluded because the initial arthroscopic procedure required the conversion to ORIF. Thus, the study included 21 patients (10 males and 11 females), with a mean age of 52.2 ± 13.4 years.

The most frequent mechanism of injury was a traffic-road accident, accounting for 11 cases (52.4%), 5 pedestrian accidents, 5 car or motorbike crashes and 1 bicycle accident. The remaining patients reported falls from a height in 8 cases (38.2%) and sports injuries in 2 cases (9.5 %).

All patients were preoperatively evaluated with radiographs and CT scans. According to Schatzker classification (15), there were 9 type II, 10 type III and 2 type IV tibial plateau fractures. The fracture involved the posterior portion of the tibial plateau in 8 patients (44.4%), 7 in the lateral and 1 in the medial condyle.

Eight patients presented concomitant traumatic intra-articular injuries: 3 meniscal tears (1 medial, 2 lateral), 3 tibial spine fractures and 2 chondral lesions of the femoral condyles. Seven patients showed preexisting chronic lesions: 5 degenerative chondropathy, 2 degenerative meniscopathy, 1 ACL rupture and 1 PCL partial lesion.

All the operations were performed by two surgeons experienced in knee arthroscopy, with the aid of fluoroscopy.

Fracture fixation was achieved with one screw in 2 patients, with two screws in 15 patients and with three screws in 2 patients; plate osteosynthesis was performed in 2 cases. Allogenic cancellous bone graft was used to fill a metaphyseal bone defect in one patient, while xenogenic bone chips were used in another one.

The tibial spine fractures were all treated with ARIF, using wire cerclage in 1 case and suture cerclage in 2 cases. Among patients with meniscal tears, selective meniscectomy was performed in three of them and meniscal suture in one.

All patients received a standardized post-operative rehabilitation protocol. Active knee motion started within 10 days after surgery and was gradually increased to reach 90° of flexion after 4 weeks. Progressive weight bearing with the aid of two crutches was allowed 8 weeks after surgery and full weight bearing without any aid after 12 weeks. X-rays were taken at 1, 3 and 6 months to check fracture healing.

At the time of this study, patients were clinically and radiographically evaluated. ROM measurement, Rasmussen Clinical Score (RCS) (16), Knee Injury and Osteoarthritis Outcome Score (KOOS) (17, 18) and Oxford Knee Score (OKS) (19, 20) were used for the clinical and functional assessment. Patients were also interviewed about their self-perception of therapeutic outcome, using a Likert scale with 5 levels of satisfaction, ranging from 1 (poor) to 5 (excellent).

Antero-posterior and latero-lateral radiographs were taken and compared to previous radiograms to calculate the Rasmussen Radiological Score (RRS) (16).

Continuous variables were described as mean ± SD, and their distribution within analysed subassemblies has been described using univariate linear regression. Student's t test was used for statistical analysis. For all analyses, a confidence interval level of 95% was selected (statistical significance set at p values of < 0.05). All the analyses were performed using the software "Stata 15".

Results

At an average follow-up of 84 ± 22.5 months (range, 33 - 119), 18 patients were available for evaluation. The remaining 3 patients from the study group were not evaluated: 1 patient was deceased and 2 were unreachable. All the enrolled patients agreed to attend this study and signed an informed consent for the anonymous collection of their data.

Mean age at surgery was 53.8 ± 13.7 years. Fractures included 7 Schatzker type II, 9 type III (Figure 1) and 2 type IV (Figure 2). The posterior portion of the tibial plateau was involved in 7/18 patients. Detailed data of these patients are reported in Table 1.

Average interval between trauma and surgery was 5.6 ± 3.6 days; mean surgical time was 95.6 ± 30.7 minutes and mean hospitalization after surgery was 2.9 ± 3.2 days.

Only one patient, a 45-year old woman also treated for a concomitant tibial spine fracture, did not fulfil the rehabilitation protocol because of joint stiffness. This was the only complication that occurred in the postoperative period and required releases after 5 and 10 months from ARIF (Figure 1).

During follow-up period, 3 patients underwent surgical removal of the hardware due to local tenderness (Figure 2).

Clinical evaluation at follow up revealed a mean knee ROM of 1° - 135°. The average values recorded for the KOOS, OKS and Rasmussen scoring systems are reported in Table 2. According to the Rasmussen scoring system, results were graded as excellent in 14 patients, good in 3 and fair in 1 patient for the Clinical assessment, while the Radiological assessment showed 15 excellent and 3 good scores.

No statistically significant differences were found among our population groups divided by gender, laterality or traumatic mechanism, in any scoring system. At the statistical analysis, the 7 patients with posterior portion involvement as well as the 8 patients with fracture-associated intra-articular lesions didn't show any significant difference compared to the rest of the sample in any score.

5 patients (27.8%), with pre-existing degenerative chondropathy, got lower scores than the rest of the sample resulting in statistically significant differences in KOOS, specifically for the subscale "Quality of life" (56.2% versus 82.2%, -26%, p=0.045), in OKS (35 vs 44.1, -9%, p=0.030), and in the RCS (25 vs 28, -3%, p=0.026) (Table 3). No statistically significant differences were found in RRS.

Patients reported an average subjective satisfaction degree of 4.56/5 ± 1 points (range, 2 to 5) on the Likert scale; 15/18 patients were satisfied or very satisfied (4 or 5 points).

Discussion

Tibial plateau fractures include a wide spectrum of lesions, ranging from simple patterns to very severe and complex injuries. Any treatment is aimed to anatomically reduce the articular surface, restore correct limb alignment and firmly fix fracture fragments, in order to allow early knee mobilization and reduce the risk of post-traumatic sequelae, especially knee osteoarthritis (8, 10).

These goals were traditionally pursued with ORIF, but during the last decades several authors reported good clinical and radiographic results with ARIF (8, 11, 12, 21-23), not only in the treatment of lateral tibial plateau fractures, but also for unicondylar medial fractures (13,14).

This retrospective study was performed on a consecutive series of patients treated with ARIF for Schatzker fracture types II, III and IV. At surgery time, arthroscopy was found to be very helpful in restoring the articular surface, particularly when depression was present. Moreover, it was useful to identify and treat associated intra-articular injuries, such as meniscal tears or tibial spine fractures. It has been reported that associated joint injuries occur in 30% to 71% of patients with tibial plateau fractures (9, 24); in our experience, they were found in 8/21 of the cases (38%).

One of the main concern with ARIF is the increased risk of postoperative compartment syndrome (23), particularly in case of fractures with diaphyseal involvement. However, a recent systematic review showed lower overall morbidity, better functional outcomes, and fewer perioperative complications with ARIF in comparison with open techniques (25). We did not observe any case of compartment syndrome,

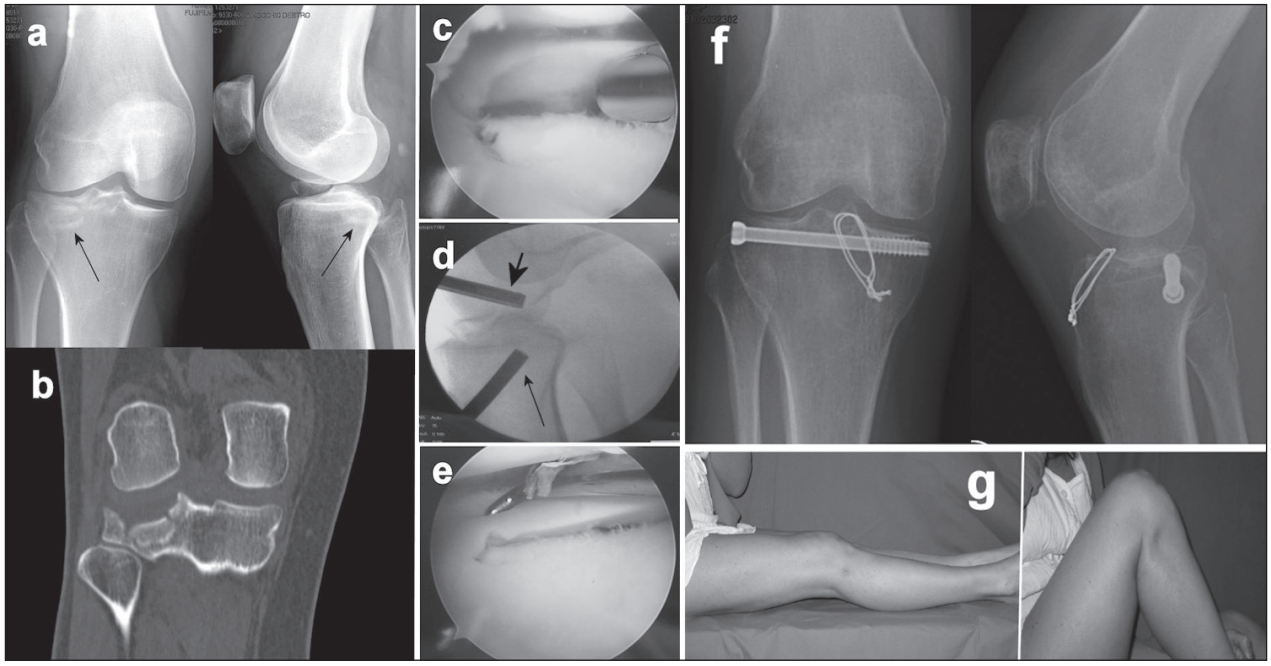

Figure 1. a) Schatzker type 3 fracture with a concomitant tibial spine fracture in a 45-year old woman. Arrows indicate the inferiorly displaced articular fragment. b) Coronal CT scan highlighting the depression of the articular surface. c) Arthroscopic view of the lateral knee compartment before ARIF. d) Intraoperative fluoroscopy to check the correct position of the impactor in elevating the depressed bone fragment. The thin arrow indicates the impactor and the large one points the arthroscope. e) Arthroscopic view showing restoration of the articular surface of the lateral tibial condyle after ARIF. f) Radiographic control 3 months after surgery showing the good anatomical result. Wire cerclages were used to treat the tibial spine fracture. The patient suffered joint stiffness and underwent two subsequent arthroscopic arthrolysis. g) Final knee ROM one year after index procedure: extension was not fully recovered.

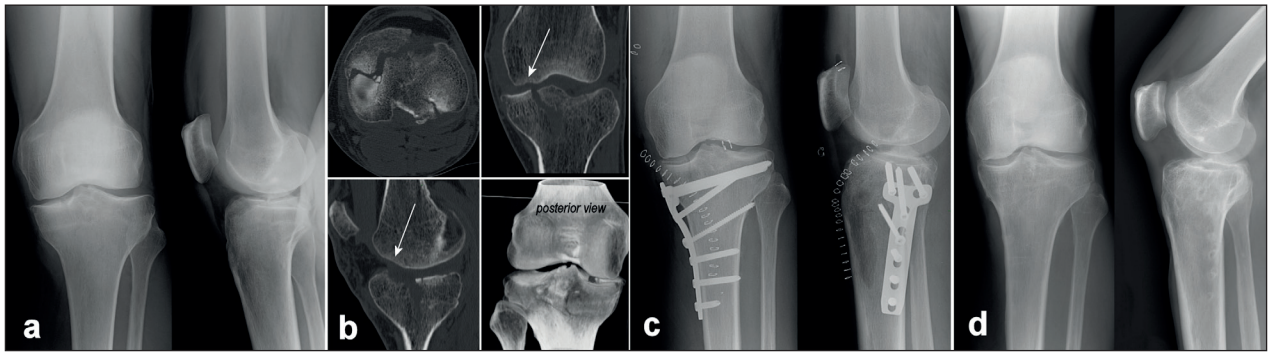

Figure 2. a) Schatzker type 4 fracture in a 52-year old man with chronic ACL tear. b) CT scan images show an associated chondral lesion of the medial femoral condyle in the coronal and sagittal views (white arrows). c) Postoperative radiograms after ARIF with plate. d) Radiographic control 8 years after ARIF: mild degenerative changes are evident in the medial compartment. Plate and screws were removed 2 years after index procedure because of local tenderness.

but this risk should not be underestimated. ARIF surgical time tends to be prolonged, especially with non-experienced surgeons, and fluid extravasation in the muscle compartments might occur and be relevant, also when treating simple fracture patterns.

The only postoperative complication in our series was joint stiffness, that was observed in a middle-aged woman with a concomitant tibial spine fracture. Delayed knee mobilization was the main cause of this condition and the patient eventually recovered after two arthroscopic releases.

At an average follow up of 7 years, the clinical

Table 1 - Demographic and anatomo-clinical data of patients evaluated at follow up

	Age / Gender	Follow-up *(months)*	Schatzker type	PPI	Associated knee injuries	Pre-existing knee lesions	Surgical treatment
1	45/ F	114	III	✓	Tibial spine fracture (*)	-	1 screw + WC
2	35/F	119	III	-	-	-	1 screw
3	35/M	114	II	-	Lateral meniscal tear (*)	-	2 screws + MS
4	64/F	101	III	-	Chondral lesion (lateral femoral condyle)	-	2 screws
5	52/M	93	IV	✓	Chondral lesion (medial femoral condyle)	Lateral DC, ACL rupture	Plate
6	75/F	80	II	-	-	Lateral DC	2 screws
7	54/M	33	III	-	-	-	2 screws
8	48/M	60	III	✓	Tibial spine fracture (*)	-	2 screws + SC
9	55/F	81	III	✓	-	-	3 screws
10	65/M	90	II	-	Lateral meniscal tear	-	2 screws
11	58/M	79	III	✓	-	-	2 screws
12	74/F	49	III	✓	-	Medial DC	2 screws
13	59/F	77	II	-		-	2 screws
14	49/M	89	II	-	Medial meniscal tear (*)	-	2 screws + SM
15	71/F	99	II	-	-	Med / Lat DC, medial DM (*)	2 screws + SM
16	43/M	71	II	-	-	Previous medial meniscectomy	3 screws
17	26/F	94	IV	-	-	-	2 screws
18	61/F	70	III	✓	-	Med DC, Lat DM PCL partial tear	2 screws + SM

Legenda: PPI = posterior plateau involvement; DC = degenerative condropathy; DM = degenerative meniscopathy; WC = wire cerclage; SC = suture cerclage; MS = meniscal suture; SM = selective meniscectomy; (*) = treated surgically during ARIF.

Table 2 - Outcomes at an average follow up of 84 months (range, 33 to 199)

		Mean ± DS	Range
Knee ROM		1° – 135°	Extension: 0-10° Flexion: 80°-150°
KOOS	*Pain*	91.1% ± 11.2	58.3% - 100%
	Symptoms	86.3% ± 15	53.6% - 100%
	Daily Activity	89.7% ± 16.3	30.9% - 100%
	Sport Activity (*)	78.5% ± 18.9	50% - 100%
	Life Quality	75% ± 25.4	25% - 100%
OKS		41.6 */ 48* ± 8.1	21 - 48
Rasmussen Scores	*Clinical*	27.2 */ 30* ± 2.6	19 - 30
Radiological		9.1 */ 10* ± 0.6	8 - 10
Satisfaction degree		4.56 */ 5* ± 1	2 - 5

(*) measured on 13/18 patients, because 5 patients didn't practice any sport

Table 3 - Scores comparison between patients with and without degenerative condropathy

		Patients WITH condropathy (*n* = 5)	Patients WITHOUT condropathy (*n* = 13)	*p value*
KOOS	*Pain*	83.3% ± 15	94% ± 8.3	*0.068*
	Symptoms	82,1% ± 19	87.9% ± 13.8	*0.484*
	Daily Activity	77.9% ± 27.6	94.2%± 6.6	*0.055*
	Sport Activity (*)	70%± 28.3	80%± 18.2	*0.514*
	Life Quality	56.2% ± 29.3	82.2%± 20.7	**0.045** *
OKS		35 ± 10.2	44.1 ± 5.9	**0.030** *
Rasmussen Scores	*Clinical*	25 ± 3.4	28 ± 1.8	**0.026** *
Radiological		8.8 ± 0.4	9.15 ± 0.7	*0.307*

Table 4 - Comparison between ARIF clinical series with similar samples and outcome measures

	n	Average age *(years)*	Schatzker type	Hospitalization *(days)*	Follow-up *(months)*	RCS	ROM *(ext – flex)*
Dall'Oca et al.	50	51 ± n.r.	I - VI	n.r.	73 ± n.r.	27.6 ± 2.6	n.r.
Duan et al.	39	35.9 ± 11.2	I - V	n.r.	34 ± 18	26 ± 3	1° - 130°
Gill et al.	25	45.2 ± n.r.	I - IV	1.6 ± n.r.	24 ± n.r.	27.5 ± n.r.	1° - 95°
Rossi et al.	46	48 ± 13.6	II - III	2.5 ± 1.1	60 ± n.r.	28.2 ± 1.4	n.r.
Siegler et al.	21	45 ± n.r.	I - III	5 ± N/A	59.5 ± n.r.	25.5 ± n.r.	1° - 131°
Verona et al.	19	45.5 ± 17.1	I - III	3.95 ± 1.3	41.9 ± 28.8	n.r.	n.r.- 128°
Present study	18	53.8 ± 13.7	II - IV	2.9 ± 3.2	84 ± 22.5	27.2 ± 2.6	1° - 135°

Legenda: RCS = Rasmussen Clinical Score; n.r. = not reported.

and functional status of most of the patients was excellent, with complete knee ROM recovery and very high scores in three different evaluating scales (KOOS, OKS and RCS). Less satisfactory results were achieved in 5 patients with pre-existing degenerative chondropathy. These changes by themselves might impair knee function, with the fracture being an additional detrimental factor for the joint. Other authors reported that pre-existing degenerative joint changes can negatively affect the outcome, regardless of the good reduction and fixation of the fracture (8). Nevertheless, no patients required total knee replacement that is commonly more demanding in posttraumatic cases previously synthesized with plating (26).

Radiographic evaluation with the RRS showed satisfactory results in most of the patients. However, a certain discrepancy between clinical and radiographic assessment was noticed: good radiographic results were observed in some patients who didn't achieve optimal clinical outcomes; likewise, excellent clinical results were sometime associated to less brilliant radiographic findings.

Patients' satisfaction for the therapeutic outcome was high: only 2 patients were somewhat disappointed by their final status. This finding correlates well with the high scores achieved with the KOOS and OKS scale, indicating a good life quality with maintenance of normal daily activities for most of the patients.

It's difficult to compare our results with the different series reported in literature, mainly because the evaluation methods are quite heterogeneous. Among the scoring systems used in the present study, the RCS was the most suitable for comparing our data to published studies with samples similar to ours (8, 13, 21, 22, 27,28). As shown in Table 4, our RCS is comparable to the scores reported by all the other authors. Among studies reporting also knee ROM, the average values are very similar, with the exception of one series, in which average flexion was limited to 95° (26). A statistical comparison with these results didn't show any significant difference.

Conclusions

Based on our experience, ARIF revealed to be a valid and reliable technique for unicondylar tibial plateau fractures treatment. Our findings are in accordance and support the favourable results reported by other authors. Worse outcomes seem to be related to pre-existing chronic knee lesions, namely degenerative chondropathy, and not to concomitant traumatic injuries.

ARIF is less invasive than ORIF and offers significant advantages, that include direct joint visualization during reduction of articular fracture fragments, easy recognition of concomitant intra-articular injuries and their possible treatment. It is not a simple surgical technique: it requires specific experience in knee arthroscopy and a steep learning curve.

Anatomical reduction and stable fixation are the ultimate goals in surgical treatment of tibial plateau fractures. If they cannot be accomplished with ARIF, it's advisable to convert the procedure to ORIF for not delaying the rehabilitation program and prevent post-traumatic sequelae.

Conflict of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

References

1. Court-Brown CM, Caesar B. Epidemiology of adult fractures: a review. Injury 2006; 37:691-7.
2. He Q fang, Sun H, Shu L yuan, Zhan Y, He C yan, Zhu Y, et al. Tibial plateau fractures in elderly people: an institutional retrospective study. J Orthop Surg Res 2018; 13:1–8.
3. Frattini M, Vaienti E, Soncini G, Pogliacomi F. Tibial plateau fractures in elderly patients. Chir Organi Mov 2009; 93:109–14.
4. Van Dreumel RLM, Van Wunnik BPW, Janssen L, Simons PCG, Janzing HMJ. Mid- to long-term functional outcome after open reduction and internal fixation of tibial plateau fractures. Injury 2015; 46:1608–12.
5. Elsoe, R., Larsen, P., Nielsen N et al., Elsoe R, Larsen P, Nielsen NPH, Swenne J, Rasmussen S, et al. Population-Based Epidemiology of Tibial Plateau Fractures. Orthopedics 2015; 38:e780–e786.
6. Cassard X, Beaufils P, Blin JL, Hardy P. Arthroscopic treatment of tibial plateau fractures. Report on 26 cases. Rev Chir Orthop Reparatrice Appar Mot 1999; 85:257–66.
7. Guanche CA, Markman AW. Arthroscopic management of tibial plateau fractures. Arthroscopy. 1993; 9:467–71.
8. Siegler J, Galissier B, Marcheix PS, Charissoux JL, Mabit C, Arnaud JP. Percutaneous fixation of tibial plateau fractures under arthroscopy: A medium term perspective. Orthop Traumatol Surg Res 2011; 97:44–50.
9. Stahl D, Serrano-Riera R, Collin K, Griffing R, Defenbaugh B, Sagi HC, et al. Operatively treated meniscal tears associated with tibial plateau fractures: A report on 661 patients. J Orthop Trauma 2015; 29:322–4.
10. Prat-Fabregat S, Camacho-Carrasco P. Treatment strategy for tibial plateau fractures: an update. EFORT Open Rev. 2016; 1:225–32.
11. Caspari RB, Hutton PM, Whipple TL, Meyers JF. The role of arthroscopy in the management of tibial plateau fractures. Arthroscopy 1985; 1:76–82.
12. Jennings J. Arthroscopic management of tibial plateau fractures. Arthroscopy 1985; 1:160–8.
13. Duan XJ, Yang L, Guo L, Chen GX, Dai G. Arthroscopically assisted treatment for Schatzker type I-V tibial plateau fractures. Chinese J Traumatol (Eng.) 2008; 11:288–92.
14. Pogliacomi F, Verdano MA, Frattini M, Costantino C, Vaienti E, Soncini G. Combined arthroscopic and radioscopic management of tibial plateau fractures: Report of 18 clinical cases. Acta Biomed 2005; 76:107–14.
15. Schatzker J, McBroom R, Bruce D. The tibial plateau fracture. The Toronto experience 1968-1975. Clin Orthop Relat Res 1979; 138:94–104.
16. Rasmussen PS. Tibial condylar fractures. Impairment of knee joint stability as an indication for surgical treatment. J Bone Joint Surg Am 1973; 55-A:1331-50.
17. Roos EM, Roos HP, Lohmander LS, Ekdahl C, Beynnon BD. Knee Injury and Osteoarthritis Outcome Score (KOOS) - Development of a self-administered outcome measure. J Orthop Sports Phys Ther 1998; 28:88-96.
18. Monticone M, Ferrante S, Salvaderi S, et al. Development of the Italian version of the knee injury and osteoarthritis outcome score for patients with knee injuries: Cross-cultural adaptation, dimensionality, reliability, and validity. Osteoarthr Cartil 2012; 20:330–5.
19. Dawson J, Fitzpatrick R, Murray D, Carr A. Questionnaire on the perceptions of patients about total knee replacement. J Bone Joint Surg Br 1998; 80-B:63–9.
20. Padua R, Zanoli G, Ceccarelli E, Romanini E, Bondì R, Campi A. The Italian version of the Oxford 12-item knee questionnaire - Cross-cultural adaptation and validation. Int Orthop. 2003; 27:214–6.
21. Rossi R, Bonasia DE, Blonna D, Assom M, Castoldi F. Prospective follow-up of a simple arthroscopic-assisted technique for lateral tibial plateau fractures: Results at 5 years. Knee 2008; 15:378–83.
22. Dall'Oca C, Maluta T, Lavini F, Bondi M, Micheloni GM, Bartolozzi P. Tibial plateau fractures: Compared outcomes between ARIF and ORIF. Strateg Trauma Limb Reconstr. 2012; 7:163–75.
23. Burdin G. Arthroscopic management of tibial plateau frac-

tures: surgical technique. Orthop Traumatol Surg Res 2013; 99(1 Suppl):S208-18.
24. Abdel-Hamid MZ, Chang CH, Chan YS, Lo YP, Huang JW, Hsu KY, et al. Arthroscopic Evaluation of Soft Tissue Injuries in Tibial Plateau Fractures: Retrospective Analysis of 98 Cases. Arthroscopy 2006; 22:669–75.
25. Chen XZ, Liu CG, Chen Y, Wang LQ, Zhu QZ LP, Chen XZ, Liu CG, Chen Y, Wang LQ, Zhu QZ, et al. Arthroscopy-assisted surgery for tibial plateau fractures. Arthroscopy. 2015; 31:143–53.
26. Vaienti E, Scita G, Ceccarelli F, Pogliacomi F. Understanding the human knee and its relationship to total knee replacement. Acta Biomed. 2017 Jun 7; 88(2 -S): 6-16.
27. Gill TJ, Moezzi DM, Oates KM, Sterett WI. Arthroscopic reduction and internal fixation of tibial plateau fractures in skiing. Clin Orthop Relat Res. 2001; 383:243–9
28. Verona M, Marongiu G, Cardoni G, Piras N, Frigau L, Capone A. Arthroscopically assisted reduction and internal fixation (ARIF) versus open reduction and internal fixation (ORIF) for lateral tibial plateau fractures: A comparative retrospective study. J Orthop Surg Res. 2019; 14:155.

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