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The Role of Arthroscopy in Mini-Invasive Treatment of Tibial Plateau Fractures

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1. Introduction

The treatment of tibial plateau fractures represents a challenge in current activity of an orthopedic surgeon, because these kind of fractures have an intraarticular trajectory. It is important in this kind of fractures to have a good mobility after treatment (Mills & Nork SE, 2002). Instead of the standard treatment with one or two plates and screws, one should try to use the reduction of the fracture's fragment with Kirschner wires under Rx control and fix the fragments with K wires, screws and external fixation (Marsh et al., 1995; Morandi & Pearse, 1996). Open reduction and internal fixation has a significant complication rate and this has encouraged interest in percutaneous techniques, most of which associate arthroscopy and fluoroscopy. Arthroscopy is useful to provide a good view of the articular surface and allows assessment of associated intra-articular lesions.

The objectives of this treatment are to obtain a good articular congruity, axial alignment, joint stability and functional motion.

2. Method

Minim invasive treatment and arthroscopic postreduction control are performed based on the Schatzker's classification, (Buchko & Johnson, 1996; Cristea et al., 2010; Kenneth A.E.& Kenneth J. K., 2006).

3. Diagnostic

The clinical diagnostic is sustained by the following clinical signs:

- swelling of the knee;
- hemarthrosis;
- pain;
- varus or valgus tibial deviation;
- impossible weight bearing;
- restriction for active movements of the knee joint.

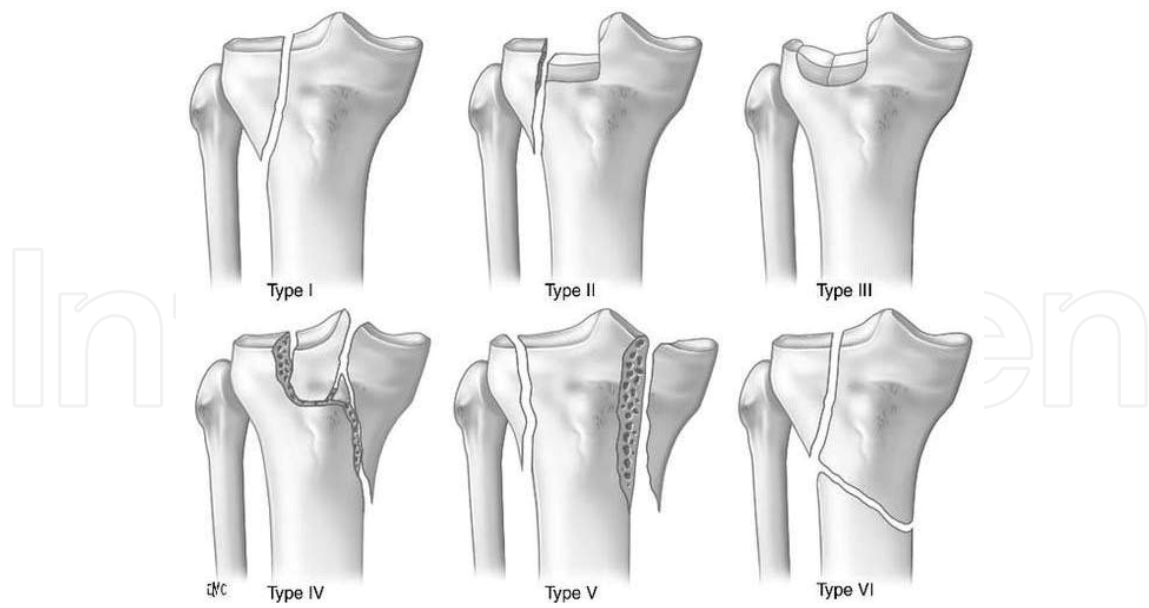


Fig. 1. Schatzker's Classification

3.1 Radiological diagnostic

Different kinds of Xray exposures are used :

- antero-posterior;
- lateral;
- oblique internal or external;
- in tension-evaluate the reduction (ligamentotaxis)

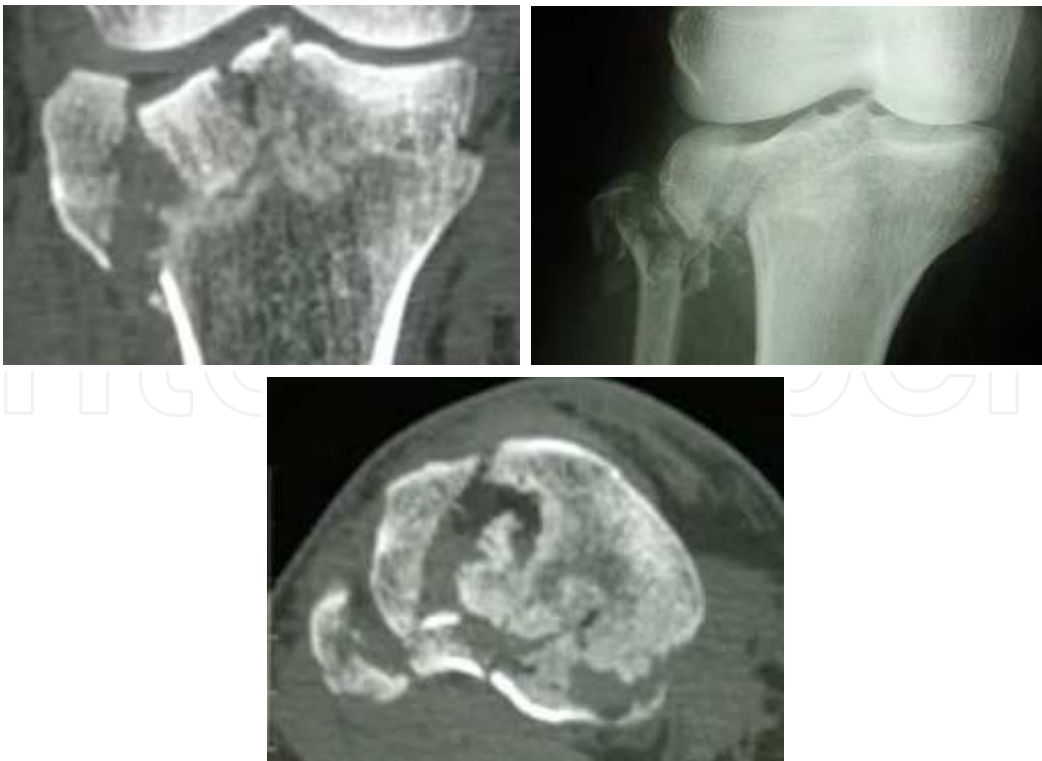


Fig. 2. Schatzker's V - CT and X Ray aspects

3.2 CT diagnostic

Using the reconstruction in sagittal and coronal plane of the images more information about the type and localization of the fracture is obtained (Rafii et al., 1987). CT exam is mandatory for the surgical treatment planning in type IV, V and VI Schatzker. By all experience of using CT and Xray exams, after several different cases, the surgeon will understand the fracture aspect only by Xray exams.

4. Surgical treatment

Most surgeons use different kind of plates with screws with open reduction of the fracture:

- "L" plate;
- LC DCP plate;
- two plates;
- plate and external fixation.

The minimal invasive surgical treatment of these kind of fractures should be done under fluoroscopic and arthroscopic control.

This technique is particularly adapted to each Schatzker type, inspite of others (Casteleyn & Handelberg, 2001) considering a limited role of arthroscopy only in relative simple split, depression and split-depression fracures.

The patient is under spinal anesthesia, then the fragments of the fracture are identified using Xray control. The reduction of the fracture is then attempted by flexion, extension, traction (ligamentotaxis) (Sirkin et al., 2000).

Standard arthroscopic portals can be used, joint irrigation is mandatory with a low pressure gravity feed, and a tourniquet is always necessary to reduce bleeding. Some arthroscopic surgical experience is necessary. The scope must be left for a few seconds in the same position in order to flush the blood and visualise the lessions. Prolonged operation time may lead to increased fluid effusion with compartmental syndrome or deep venous thrombosis.

The technique will be described particularly adapted to each Schatzker type.

In case of fractures with pure cleavage, split fractures, K wires are inserted rectangularly on the fracture's line, subchondral, under Xray and arthroscopic guidance. Eventually compression forces are applied by putting cannulated cancellous screws in paralel planes.

In case of fractures with depression, a K wire is inserted in the depressed bone fragment. Then this bone fragment is lifted under Xray and arthroscopic control and then another K wire is inserted through these reduced bone fragments, subchondral. Eventually compression forces are applied by putting cancellous screws in paralel planes.

In case of cominated fractures, cleavage and depression a K wire is inserted through the fracture's cleavage directly in the depressed bone fragment, and this depressed bone fragment is lifted using strong forces till the K wire is bend, under Xray and arthroscopic control. Then another K wire is inserted through these reduced bone fragments, perpendicular to the cleavage fracture, then compression forces are applied by putting paralel cancellous screws. After the alignment of the articular surface is obtained these fragments are fixed with cancellous screws or another K wire. In case of cominuted fractures, first the depression is reduced and then the cleavage. The forces applied on the K wire for the alignment of the fracture are very strong (Cristea et al., 2010).

In case of Schatzker type V-VI external fixation is used after obtaining the alignment of the articular surface (Cristea et al., 2010).

Indirect reduction techniques have the advantage of minimal soft tissue stripping and fragment devitalization (Kenneth A.E.& Kenneth J. K., 2006). For badly comminuted fractures an external fixator is used such as femoral – tibial distractor, eventually articulated. Closed methods are preferred in order to elevate depressed fragments, which can be carried out under fluoroscopic or arthroscopic guidance (Buchko & Johnson, 1996; Cristea et al., 2010). Bone tamps are placed under image and the depressed segments are elevated. Accuracy of reduction may be checked with the aid of the arthroscope. In type IV-VI because there are significant forces, lag screws alone are not sufficient to stabilize these fractures and external fixation is used.



Fig. 3. External fixator and minim invasive reduction under X ray and arthroscopic control – intraoperative aspects



Fig. 4. Minim invasive reduction under X ray and arthroscopic control – intraoperative aspects

4.1 Asociated meniscal and ligamentous lesions

Diagnosis and immediate treatment of associated meniscal lesions by partial meniscectomy and debridement can be performed during initial arthroscopy. These may account for a lower incidence of degenerative changes in arthroscopically treated fractures cases. The

collateral ligaments sprains do not require surgical treatment. They can be further protected during mobilisation with an articulated cast-brace or a rehabilitation brace when the joint immobilisation is not necessary. The ACL lesions are reevaluated after the fracture healing and late reconstruction could be necessary.

Various lesions of soft tissue are associated with tibial plateau fractures. These are usually neglected by most traumatic surgeons. All the meniscus lesions type, capsular disruption, intraarticular haematomas, osteochondral small fragments, ACL various lesions or collateral ligaments are associated with tibial plateau fractures.

Based on the OR findings, in our opinion, the following classification of soft tissue lesions should be added to each type of Schatzker fractures:

- A1-without lesions of the meniscus or ACL
- A2-with tears of the meniscus - repaired by excision and debridement
- B1-lesions of the meniscus - which must be sutured
- B2-fracture of the tibial plateau spine - which must be repaired in emergency
- C1- with desinsertion of ACL from femoral insertion - which should be repaired in emergency
- C2-with irreparable rupture of ACL, which can be repaired later in another surgical session.



Fig. 5. Minimally invasive reduction of complex fracture which includes the tibial plateau. X ray and Arthroscopic control - after reduction

4.2 Author's experience and statistical analysis

Between 2006-2010 we had 398 tibial plateau fractures and for 262 we used surgical treatment. Of those 68% were external plateau fractures; 18% were internal plateau fractures and 14% were bilateral plateau fractures. We saw a great discrepancy between radiology and CT. On the Xray and CT we follow and appreciate the displacement degree, fracture's type and indication of treatment (Tscherné & Lobenhoffer, 1993).

We obtained very good results in 80% of cases, but also we have one case with infection after a month which necessitate extraction of the screws and wires; in 15% of cases we obtained a mobility of the knee around 95-105 degree of flexion; in 4% of cases we were not able to restore the entire surface of the tibial plateau.



Fig. 6. X ray Pre and postoperative aspects

The statistical analysis was obtained with the use of SASTM computer software, version 9.1.3, Cary U.S. To compare the subgroups on the basis of quantitative variables, a Student test was used. For the qualitative variables, a Pearson's χ^2 was used or a Fisher's exact test if the theoretical numbers were too low.. The degree of significance chosen for the overall risk of the first case was fixed at 5 % in both situations.

In our study several international systems of evaluation were used (KOOS scores, IKS, Lysholm, Tegner and Rasmussen) thus permitting a comparison with a larger number of literature series. In general our functional results were satisfying and comparable to other series.

In table 1 and 2 we compare our results with other international studies in literature.

	Scheerlin C.K., 1998	Cassard, 1999	Rossi,2008	Siegler, 2009	Our series, 2010
Number of patients	52	44	57	28	262
Number of follow-up patients	38	44	46	21	184
Average age	47	46	48	43	51
Average follow-up (months)	62	69	60	59,5	60
Associated lesions (%)	53,8	—	39	32,1	63
Meniscal lesions (%)	—	—	28	7,1	53
ACL Lesions (%)	—	—	11	3,6	10
Postoperative complications (%)	15,4	—	3,5	0	4,9
IKS average	—	92	93,2	85,2	93
IKS functional average	—	96	94,8	91	95
Clinical Rasmussen average	—	—	28,2	25,5	9
Radiological Rasmussen average	—	—	—	25,5	9
Arthrosis Xray (%)	28,9	20	8,6	47,6	25
Malalignment (%)	15,8	—	8,7	32,1	4,9

ACL : anterior cruciate ligament ; IKS : International Knee Society.

Table 1. Mean results of tibial plateau fractures.

	Bobic, 1993	Cassard, 1999	Mazoue, 1999	Gill, 2001	Kieffer, 2001	Roerdink, 2001	Asik 2002	Pogliacomi, 2005	Levy, 2008	Kayali, 2008	Siegler 2009	Our series, 2010
Number of patients	31	26	17	25	29	30	48	19	16	21	28	262
Average age	44,4	42,3	43,6	45,2	47,4	72	39	36	44,8	41	43	51
Average follow-up (months)		32,7	14,6	24	25,1	36	36	12	41	38	59,5	60
Meniscal lesions (%)	23	30,8	29,4	36	13,8	40	47,9	22,2	56,2	42,8	7,1	53
ACL Lesions (%)	13	11,5	5,9	32	10,3	6,6	6,2	11,1	6,2	0	3,6	10
Postoperative complications (%)	6,4	7,7	17,6	0	6,9	3,3	4,2	—	0	0	0	4,9
IKS average	—	94,1	—	—	—	—	—	—	—	—	85,2	93
IKS functional average	—	94,7	—	—	—	—	—	—	—	—	91	95
Lysholm average	—	—	80,9	—	—	—	—	—	—	—	86	92
Clinical Rasmussen average	—	—	—	27,5	—	—	—	—	29,25	—	25,5	9
Radiological Rasmussen average	—	—	—	—	—	—	—	—	16,87	—	8	9
Arthrosis Xray (%)	—	26,3	21,4	—	12,9	—	63	27,8	12,5	24	47,6	25
Malalignment (%)	—	10,5	—	—	6,9	—	—	—	12,5	—	32,1	4,9

Table 2. Short term results of the tibial plateau fractures

ACL : anterior cruciate ligament ; IKS : International Knee Society.

We reduced the infection rate by:

- reduced time of surgery;
- minimal dissection;
- extraperiosteal dissection;
- minimal size of implants;
- antibiotics.

We use anticoagulant therapy for thrombembolism profilaxy. There were no DVT or pulmonary embolism (PE) complications in our series. There was no compartmental syndrome in our series due to low pressure during joint irrigation in arthroscopy, no pump was used.

5. Postoperative care

5.1 Deep venous thrombosis (DVT) prevention

As tibial plateau fractures are associated with considerable soft tissue trauma and sometimes with prolonged operation times using a tourniquet, DVT is not a rare complication (Williams et al., 1995).

The use of one of the low-molecular-weight heparins is advisable. One should prolong their use for more than 3 weeks until the complete mobilisation of the knee and the patient. Foot and calf mechanical compression devices can also be used with success. Compressive antithromboembolic stockings are always mandatory.

5.2 Mobilisation

Once a satisfactory fracture reduction and stabilisation have been obtained, the immediate mobilisation is done. The soft tissue and skin coverage lesions are limited. Immediate continuous passive motion (CPM) can be beneficial for the restoration of the articular homeostasis and the remodelling of the small articular fragments. When the external fixator locks the knee, a stable construct to early mobilisation of the patient is mandatory. In generally at 3-6 weeks the articular mobility is achieved, depending of the fracture type and stability of the fixation.



Fig. 7. X ray Pre and postoperative aspects



Fig. 8. X ray Pre and postoperative aspects

5.3 Weight-bearing

In general, walking with crutches with minimal load bearing is possible after a few days. In simple fractures, or stable construct fixation full bearing is allowed at 10-12 weeks. The articulated cast braces or rehabilitation braces can be useful in early rehabilitation. Secondary, progressive impaction of the depressed zone can occur due to weight bearing, even 4 to 5 months postoperatively, especially in obese patients or those with osteoporotic bone.

6. Complications

The risk of infection is reduced due to: shortened time of surgery, minimal dissection, extraperiosteal dissection, minimal size of implants, antibiotics. The implants ablation and antibiotics resolve that rare complication, while in classical open surgery the rate of infections and stiffness is 10 %.

Posttraumatic arthritis in 4a patient with bicondylar fracture could be a good indication for total knee replacement. In only 4% of cases the restore of the entire surface of the tibial plateau was not achieved. The varum deviation was finally observed in 3% of patients, with maximum value of 5°.

7. Conclusion

This kind of articular fractures requires perfect alignment of fracture's fragments. It is difficult to treat these fracture especially type V and type VI Schatzker.

Beside the standard treatment with one or two plates and screws, one could use the reduction of the fracture's fragment with K wire under Xray and arthroscopic control, and then fix the fragments with K wire and screws. First of all it is important to establish the fracture's type. Schatzker classification is commonly used for their identification. The preoperative planning is necessary and also the X-ray and CT scan. For this technique different kind of material is used: K wire, screws, external fixation, fluoroscope, and arthroscopy.

The role of arthroscopy in these fractures is twofold: 1. To confirm the quality of a good reduction, 2. To accurately asses and treat the associated lesions of the soft tissue - menisci, cruciate ligaments, capsular disruption.

This minimal invasive technique is useful for the treatment of this kind of fractures and in most cases has good outcome.

Good results are obtained by using this method (Cristea et al., 2010) in the surgical treatment of tibial plateau fractures. This technique is adapted to resolve all tibial fractures type, not only Schatzker I - III, like some authors (Siegler et al., 2011).

The advantages of this method are: minimal blood lost, small infection rate, good mobilization of the knee without pain, cheaper implants, reproductibility of the technique, it can be made in emergency, cost - efficient.

A single dose of antibiotics is administrated during surgery and anticoagulant for thrombembolism prophylaxis is done.

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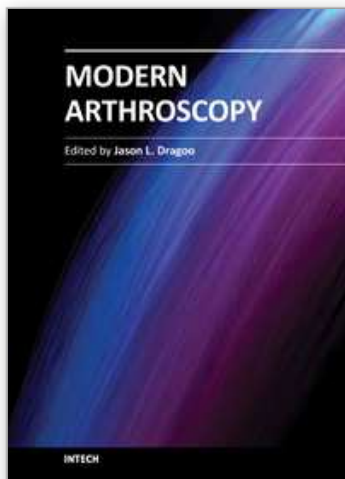
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