ORIGINAL STUDY

Osteosynthesis in Schatzker V and VI tibial plateau fractures in patients older than 65 years — one or two plates?

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Bicondylar tibial plateau fractures in elderly patients are rare. Indications for new locking precontoured plates with angular stability are increasing because of the powerful fixation in osteoporotic bone and possibility of percutaneous use. However, literature is lacking regarding these specific fractures.

To analyze the results of surgical management of bicondylar tibial plateau fractures (Schatzker classification types V and VI) in patients older than 65 years, comparing those treated with one locking plate and those with two plates.

19 patients were analyzed regarding these parameters: hemoglobin decrease, plates used, preoperative CT, loss of reduction or coronal alignment, time to consolidation, apparition of osteoarthritis, complications, visual analog scale and Oxford Knee Score (OKS).

Mean OKS was 36.8 (19–48), with 4 patients (21.05%) having excellent function and 13 (68.4%) moderate. There were only 2 wound infections and 2 varus collapses in the preoperative period. Eleven patients developed radiological osteoarthritis that was not present at the time of trauma.

Precontoured locking plates of bicondylar tibial plateau fractures in elderly patients provide mild to good function in approximately 90% of cases, although complications are observed in approximately 21% of patients.

Keywords: Tibial plateau ; fractures ; bicondylar ; elderly ; plate osteosynthesis.

INTRODUCTION

Schatzker V and VI tibial plateau fractures [18] in patients older than 65 years are infrequent [17]. Bicondylar fractures have a bimodal presentation. Those produced in young people are usually due to high-energy trauma; however, in elderly patients, bicondylar fractures are typically produced by a low-energy mechanism (e.g., a fall). Osteoporotic bone induces great comminution and soft tissue affectation [14]. These fractures can have a huge impact on the daily life of patients and can cause permanent disability [8]. Many concomitant factors (e.g., previous osteoarthritis, comorbidities, disability) can affect the definitive results [16,19].

Although these fractures have classically been managed conservatively, surgical treatment has gained importance in recent years and is now preferred. Osteosynthesis minimizes complications derived from prolonged immobilization and restores the articular surface and extremity alignment [2].

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External fixation, used as a damage control device in severe comminuted fractures, continues to be a valid alternative for definitive treatment for many surgeons [11,22]; however, plate fixation is the dominant technique at present [13, 20]. Precontoured locked plates provide angular stability, which has been found to be an important factor in increasing fixation in osteoporotic bone [2,3]. The possibility of percutaneous implantation is another advantage of these devices [9,13,14].

Improvements in treatment options for these fractures can have a high economic impact, due to the progressive increase in the elderly population and the fact that this population is increasingly more active [4]. However, studies about this pathology and group of people are lacking in the literature [5,6,10].

The primary objective of our study was to evaluate the radiological, clinical and functional results of bicondylar tibial plateau fractures (Schatzker types V and VI) [18] in patients older than 65 years, and to compare whether there were differences between those treated with one or two locking plates. As a secondary objective, we compared the results of the treatment depending on the use of preoperative computed tomography (CT) scan or not.

MATERIALS AND METHODS

Clinical archives were retrospectively reviewed and clinical and radiological evaluations were performed at the end of the follow-up. Inclusion criteria were bicondylar tibial plateau fractures, according to the Schatzker and AO classification systems [18,15]; patients older than 65 years at the time of the trauma; osteosynthesis with locking plates; and a minimum follow-up of 12 months after the surgery. The patients were selected from those who met all the criteria and who were treated in our center (a tertiary trauma hospital) between January 2007 and December 2012.

Senior surgeons experienced in fracture treatment performed all the surgeries. The surgeries were performed under intradural anesthesia, radioscopic control and ischemia of the extremity. Full non-weight-bearing mobility was allowed in the postoperative period. Bearing was allowed when the fracture was consolidated.

Less Invasive Stabilization System (LISS®, DePuy Synthes, Zuchwill, Switzerland) and Locking Compression Plate (LCP®, DePuy Synthes, Zuchwill, Switzerland) plates were used in all cases. These plates have the advantage of fixation with angular stability, because the screws are locked to the plate. Bone defects after reduction and fixation were filled with calcium phosphate cement (HydroSet®, Stryker, Kalamazoo, MI).

Age, sex, mechanism, preoperative and postoperative hemoglobin (Hb), complications (e.g., infection, secondary displacement, hardware intolerance) and preoperative CT scan were assessed from the clinical history.

Anteroposterior (AP) and lateral views, as well as full-leg-length AP long-standing radiographs were obtained for the radiological analysis. Time to consolidation and appearance of radiological osteoarthritis and the end of the follow-up that were not present at the trauma moment were assessed.

Fig. 1. – Tibial plateau angle (TPA), the angle between the diaphyseal axis of the tibia and the line between the borders of both tibial plateaus in anteroposterior view

In addition, the tibial plateau angle (TPA) (angle formed by the tibial diaphysis and the line between the borders of the tibial plateau in AP view) (Fig. 1) and the posterior slope angle (PSA) (angle between the anterior cortical border of the tibia and the line between the anterior and posterior cortices of the medial plateau in lateral view) (Fig. 2) were measured to assess the secondary loss of reduction. The femorotibial angle (FTA) (the angle between the femoral and tibial diaphysis) (Fig. 3) was used to analyze the extremity axis. Radiographs taken in the immediate postoperative period and at the end of follow-up were used. A commercial standard program of radiological analysis, AGFA RIS-PACS® (Agfa HealthCare, Belgium), was used.

Patients were reviewed at 6 weeks, 12 weeks, 6 months and 12 months after the surgery, and annually from then. The Oxford Knee Score (OKS) and visual analog scale (VAS) were used to evaluate the function and pain of the knee at the end of the follow-up.

Fig. 2. – Posterior slope angle (PSA), the angle between the anterior cortex of the tibia and the line between the anterior and posterior cortical borders of the medial tibial plateau in the lateral view
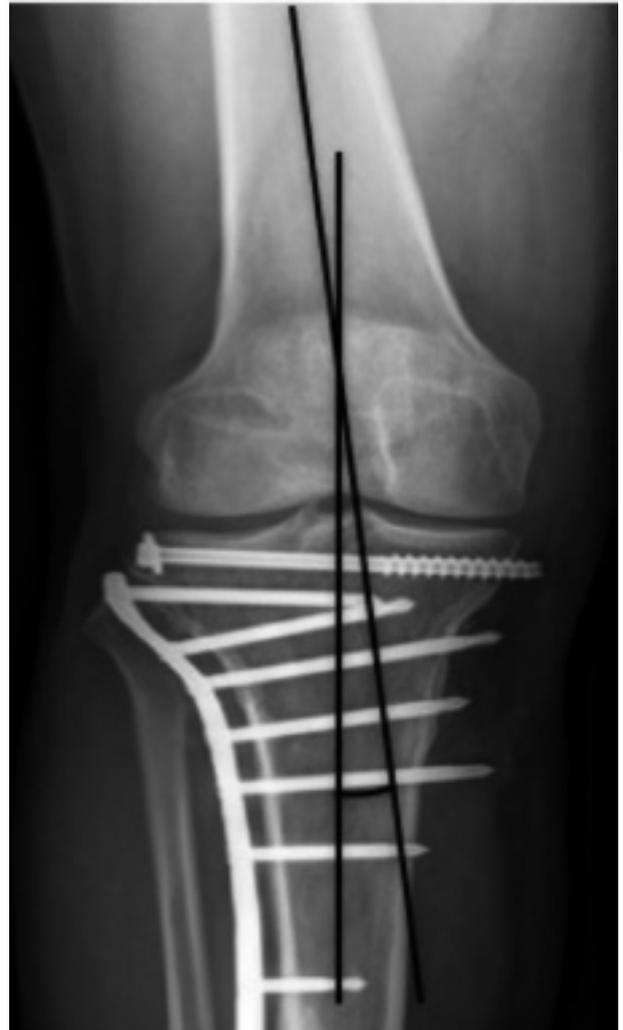
Fig. 3. – Femorotibial angle (FTA), the angle between the diaphyseal axis of the femur and the tibia

The statistical analysis was performed with the Statistical Package for Social Sciences (SPSS Inc, Chicago, IL). The Mann-Whitney test was performed for the quantitative variables and Fisher's exact test was used for the qualitative variables. A difference was established as significant if $P<.05$.

RESULTS

A total of 19 patients were treated (18 women and 1 man). The average age was 74.8 years (range 66–86). Most of the fractures were caused by low-energy trauma (casual fall in 68.4% of cases). There were 13 type VI fractures and 6 type V (Table I).

Average follow-up was 24.8 months (range 12–54). All the fractures were closed, but 4 fractures were managed with an external fixator in the emergency department because of severe soft tissue trauma, until definitive osteosynthesis.

Double plating was used in 7 cases, and 12 cases were treated with a single locking plate. Eight cases (42.1%) needed an osseous substitute during the surgery to fill the bone defect after the reduction. Age and plate distribution are shown in Figure 4. Preoperative CT was performed in 8 cases.

During the postoperative period, 2 cases of infection were resolved with surgical debridement and intravenous antibiotics, and 2 cases of varus collapse were observed. Total Hb diminished an average of 2.06 g/dL ± 1.35 in the single-plate group and 1.88 g/dL ± 0.84 in the double-plate group (P=.75) between the preoperative and postoperative status.

A total of 4 ± 1.1 months (range 3–6) were needed until total consolidation of the fracture and full weight bearing was allowed. The most frequent radiological complication at the end of follow-up was new degenerative changes (11 patients, 57.9%), which were not present at the trauma moment (Table II).

At the end of follow-up, 7 patients (36.84%) presented pain (VAS 0–6). Only 4 patients needed other surgery (2 infections and 2 hardware removals). The average OKS was 36.8 ± 8.53 (19–49), which is suggestive of mild to moderate osteoarthritis.

No statistical differences were observed (P>.05) between the single-plate and double-plate groups related to bone substitute, Hb decrease, loss of reduction, axial disturbance, time of consolidation, VAS, OKS and osteoarthritis development (Table III).

Table I. – Demographic data (F=female; M=male). AO= AO classification of fractures

| Patient	Age	Sex	Comorbidities	Mechanism of injury	AO	Schatzker	Days until surgery
1	72	F	Yes	Fall	41C3	VI	6
2	70	F	Yes	Pedestrian accident	41C1	V	7
3	67	F	Yes	Pedestrian accident	41C2	VI	7
4	83	F	Yes	Fall	41C2	VI	10
5	77	F	Yes	Pedestrian accident	41C3	VI	8
6	71	F	Yes	Fall	41C2	VI	9
7	68	F	Yes	Motor vehicle accident	41C1	VI	5
8	80	F	No	Motor vehicle accident	41C1	V	3
9	81	F	Yes	Fall	41C2	VI	6
10	70	F	Yes	Fall	41C3	VI	5
11	66	F	Yes	Fall	41C3	VI	5
12	86	F	Yes	Fall	41C3	VI	3
13	68	F	No	Fall	41C3	V	12
14	83	M	Yes	Pedestrian accident	41C3	VI	8
15	77	F	Yes	Fall	41C3	VI	8
16	73	F	Yes	Fall	41C1	V	2
17	83	F	Yes	Fall	41C1	V	6
18	75	F	Yes	Fall	41C1	V	4
19	72	F	No	Fall	41C1	VI	8
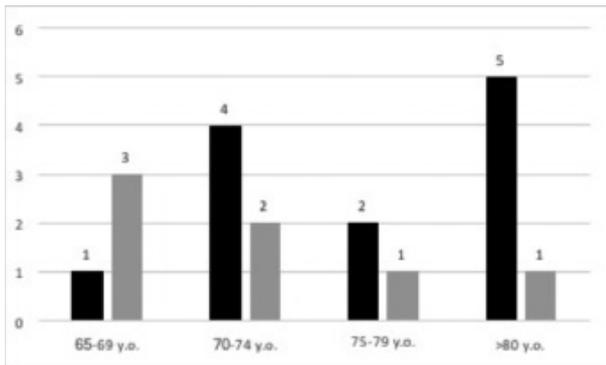
Fig. 4. – Age and number of plates distribution regarding the type of fracture in our series. Men are represented in black and women in grey color

No differences were observed between the use or not of preoperative CT scan in terms of Hb decrease, osteoarthritis, number of plates or bone substitutes.

DISCUSSION

Precontoured locking plates with angular stability are a good alternative over old plates for tibial plateau fracture treatment. They have the theoretical advantage of improved fixation in osteoporotic bone and the possibility of being used percutaneously *(3,9)*.

Progressive aging of the population and the fact that the elderly have become increasingly active have favored the increase of surgical treatment for these fractures and the use of locking plates.

Few studies in the literature are focused on the treatment of tibial plateau fractures in this segment of the population *(2,8,10)*. In addition, most mix data

Table II. – Radiological results at the end-point of follow-up in comparison with postoperative and hemoglobin (Hb) difference between preoperative and postoperative period. CT=computed tomography; PSA=posterior slope angle; TPA=tibial plateau angle

Patient	Number of plates	CT scan	Hb loss (g/dL)	PSA loss (degrees)	TPA loss (degrees)	Time to consolidation (months)	New signs of osteoarthritis
1	2	Yes	1.5	1	0	3	No
2	1	Yes	1.7	1	2	3	No
3	2	No	2.2	0	1	6	Yes
4	1	No	0.3	0	1	3	Yes
5	2	Yes	0.3	2	4	4	No
6	2	Yes	1.6	1	1	4	Yes
7	1	Yes	2.5	2	2	5	No
8	1	Yes	0.8	4	2	3	Yes
9	1	No	1.9	2	4	4	Yes
10	1	No	3.9	8	7	6	Yes
11	2	No	2.4	1	5	6	Yes
12	1	No	2.2	2	2	4	No
13	2	No	2.5	4	0	4	Yes
14	1	No	0	1	0	5	No
15	1	No	2.9	1	2	3	No
16	1	Yes	2.3	4	4	3	Yes
17	2	No	2.8	3	2	3	No
18	1	Yes	2	4	0	3	Yes
19	1	No	3.9	1	9	4	Yes

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from different types of fractures or are focused on a technique, such as the use of allograft *(2)*. To our knowledge, there are no studies focused mainly on bicondylar fracture treatment in this population.

It appears that the epidemiological pattern in elderly people is different from that in young people. In our series, there was just one man (5.26%), and more than two-thirds of the fractures were provoked by low-energy trauma (mainly casual falls). This pattern has also been observed in recent studies, in which the fractures in elderly people are more frequent in women, and are due to low-energy trauma *(4)*.

The primary objective of our study was to compare results of single-plate and double-plate management for the treatment of bituberosity tibial plateau fractures (Schatzker types V and VI) in elderly patients. Single-plate versus double-plate is a controversial topic in bicondylar tibial plateau fractures. Many studies aim to shed some light on this, but no superiority of one option over the other has been definitively demonstrated *(1,9,13,14)*. Some series have associated single-plating to more difficult reductions of the fracture and a loss of reductions in the mid-term *(14)*, although in others, single-plating appears to be a good option to achieve reduction and fixation of the fracture with fewer soft tissue and perioperative complications. Single-plating appears to be more accurate if the medial fragment has been adequately reduced *(9)*. Those who defend the double-plating option argue increased biomechanical stability *(7)* and the more accurate reduction of the fracture fragments *(13)*. However, the surgical time and perioperative complications could be superior, especially those related to soft tissue cover *(9)*. In our series, we did not observe differences related to perioperative complications, loss of reduction and functional results between single-plating and double-plating options.

The secondary objective of our study was to evaluate the influence on the result of preoperative CT scan. Currently, preoperative planning of articular fractures with CT scan is normal. However, it was not so frequent in our environment, especially in elderly patients or in noncomminuted fractures. Preoperative CT scan could be useful for posterior column fractures or to evaluate the comminution *(23)*. In our series, there are not differences between the use or not of preoperative CT scan, but the number of patients is too small to extrapolate statistical significance. Otherwise, low demand of function, previous articular degeneration *(21)* and re-establishment of a stable axis of the extremity *(12)* could be influencing factors to obtain good results in this population, even if the reduction is less accurate than that achieved with preoperative CT scan.

The main limitation of our study is the small number of patients. However, tibial plateau fractures are not frequent in elderly patients, especially bicondylar fractures. To our knowledge, there is no study investigating bicondylar tibial plateau fractures in patients older than 65 years treated surgically. Our study covers this lack of information in the literature. Although more studies should be carried out, a two-year follow-up is not too brief, considering that the patients are very old.

In conclusion, open reduction and internal fixation of bituberosity tibial plateau fractures with locking precontoured plates in patients older than 65 years appears to be a valid option, providing fair to good results in almost 90% of cases, although the complication rate is relatively high (21.05%). We did not find differences between single- versus double-plating and use or not of preoperative CT scan. More studies are needed to validate these data.

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