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ORIGINAL STUDY

Early primary total knee replacement for complex proximal tibia fractures in elderly and osteoarthritic patients

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Complex intra-articular fractures of the proximal tibia are difficult to treat, especially in the elderly osteoporotic patient. Pre-existing osteoarthritis, cartilage damage during trauma, suboptimal reduction and fixation due to poor bone stock and/or secondary displacement frequently lead to poor outcome. After osteosynthesis rehabilitation is cumbersome as patients have been non-weight bearing for long periods of time and secondary total knee arthroplasty can be challenging.

For these reasons, we investigated the possibility to perform a total knee arthroplasty with or without adjuvant osteosynthesis as a primary treatment in elderly and/or osteoarthritic patients with complex tibial plateau fractures. Between 2002 and 2009, 12 patients (mean age : 73 years (58-81)) with an AO-41 fracture type B1 (1), B3 (8) and C3 (3) were treated with a primary total knee arthroplasty within three weeks from their trauma. Most patients (7/12) were allowed early full-weight bearing.

One patient died due to an unrelated cause ; the remaining eleven were reviewed at a mean follow-up period of 31 months (5 w-81 m). At final follow-up the median knee score was 78 (50-100) and the function score 58 (0-100) : 7/11 patients had an excellent result, while 1/11 had a fair and 3/11 a poor result. Fair and poor results were mostly related to pre-existing poor general condition and/or concomitant disease. Most patients were satisfied and only minor short- and long-term complications were noted. There was no need for revision surgery. Our limited series of well-selected elderly and/or osteoarthritic patients with a complex tibial plateau fracture treated with primary total knee arthroplasty yielded encouraging results.

INTRODUCTION

Tibial plateau fractures in the elderly are common ; they represent about 24% of all intra-articular proximal tibia fractures (*5*). These fractures are problematic in many respects. First, due to osteoporosis, fixation failure of standard plate and screw osteosynthesis is frequent (*12,17,22*). Although this can be improved with newer angle-stable devices (*6*), adequate reduction remains challenging. Second, extensive soft tissue stripping can lead to wound (*23*) and bone necrosis and can result in delayed union or non-union (*4*). Third, most types of fracture fixation do not allow immediate full-weight bearing, which interferes with early rehabilitation and reintegration. This can lead to increased costs and worse outcome as demonstrated for hip

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fracture (*11*). Finally, the combination of osteoarthritis and cartilage damage during trauma may result in poor long-term outcome even when an adequate reduction and fixation can be obtained. A three-fold increase in degenerative changes has indeed been reported after tibial plateau fractures (*19*).

Traditionally, complex displaced intra-articular fractures of the proximal tibia are treated by open reduction and internal fixation (ORIF) (*9*), external fixation (*9*), and eventually secondary total knee arthroplasty (TKA) (*18,22*) in case of failure. However, secondary total knee arthroplasty is challenging. Difficulty in achieving ligament balance, extensor mechanism scarring, patellar maltracking, and the necessity to restore axial alignment will have to be addressed (*23*). Moreover, a compromised soft tissue envelope often leads to wound problems (*23*) and the presence of infection (6 to 28% after ORIF of tibial plateau fractures (*13*)) is problematic. Compared to non-infected osteosyntheses it increases the likelihood of reintervention by a factor four (*13*).

Although primary hip arthroplasty for femoral neck fractures is a well-accepted treatment option (*14*), this has not been the case for knee arthroplasty in the presence of a tibial plateau fracture. However, primary total knee replacement has the potential to bypass many of the above-mentioned difficulties and can limit the number of interventions in a selected group of patients. Moreover, advances in implant technology and increased experience with TKA revision surgery can contribute to the success of this procedure. We investigated the feasibility of the procedure in a limited and well-selected group of elderly and/or osteoarthritic patients. We report on the early and medium-term results.

MATERIAL AND METHODS

Between 2002 and 2009, 12 patients with a closed displaced tibial plateau fracture underwent a primary TKA within three weeks from their trauma and were included in this retrospective study. In order to be eligible for primary TKA, patients had to be able to walk prior to their fracture. They were either at least 70 years old with poor bone quality and presenting with a tibial plateau fracture that would be difficult to treat with ORIF, or they were at least 55 years old and presented severe and invalidating concomitant knee osteoarthritis. Delayed TKA performed more than three weeks after trauma or TKA after failed ORIF were excluded.

Experienced knee arthroplasty and knee revision surgeons (PPC : 3, FH : 4, TS : 5) operated upon all patients in the orthopaedic and trauma department of the Universitair Ziekenhuis Brussel. The pre-operative and immediate postoperative patient evaluation was based on the medical files and the standard radiographs as well as the pre-operative computed tomography scans. Fractures were classified according to the AO classification (AO-41 : fractures of the proximal segment of the tibia (*3*)) and the degree of pre-operative knee osteoarthritis and/or osteoporosis was evaluated. The operation time and implant type were retrieved from the operation protocol.

Final evaluation of 11 patients was carried out in 2009 and 2010. By then one patient had died due to an unrelated cause after hip fracture surgery. Clinical evaluation was performed according to the Knee Society Score (KSS). Both, the Final Knee score and Function Score were calculated (*10*). Radiological evaluation was performed with standard anteroposterior, lateral and skyline patella views. Fracture healing, implant positioning and signs of implant loosening were registered. Within three months after surgery, complications were described as being short-term. After that, they were considered as long-term complications.

RESULTS

Demographics and fracture type

In this study a total number of 12 patients (nine women, three men) underwent primary total knee replacement within three weeks after sustaining a complex intra-articular proximal tibia fracture (table I). At the time of intervention the mean age was 73 years (range : 58-81).

According to the AO classification one patient had a 41-B1 fracture (lateral split), eight a 41-B3 fracture (lateral split-depression), and three a 41-C3 fracture (complex lateral and medial plateau fracture with a metaphyseal component and an avulsion of the tibial spine) (table I). All fractures were unilateral, seven at the left-hand-side and five at the right-hand-side. Six patients suffered a low-energy trauma, two of them sustaining a C3 fracture. The

remaining six suffered a high-energy trauma, resulting in one C3 fracture. Concomitant fractures were observed in three patients : one ipsilateral ankle fracture treated by six weeks of non-weight bearing cast immobilization, one ipsilateral anterior and posterior pelvic ring fracture treated with 6 weeks of partial-weight bearing and one contralateral four-part humeral head fracture treated by shoulder arthroplasty three days after the TKA.

Main reasons for primary TKA included : the fracture morphology in three cases (two C3 fractures and one B3 fracture with ligamentous injury), the presence of severe concomitant osteoporosis in two cases and the presence of concomitant pre-existing osteoarthritis in seven cases (five tricompartimental, one lateral and one with only "slight" attrition).

Hospitalisation and surgery

Nine patients were admitted immediately after trauma, two sustained an accident the day before and one presented only after two weeks. The mean time interval between admission and surgery was three days (range : 1-6). Ten patients had a general and two a loco-regional anaesthesia. All patients received a single-shot antibiotic prophylaxis and were operated under pneumatic tourniquet.

The mean duration of surgery was 115 minutes (range : 80-195). In all cases we used an all-cemented posterior stabilized (11/12) or constrained condylar (1/12) TKA with a stemmed tibial component bypassing the fracture area (table I). The stem was cemented in only two cases (fig 3) but graft impaction was deemed necessary in five and aug-

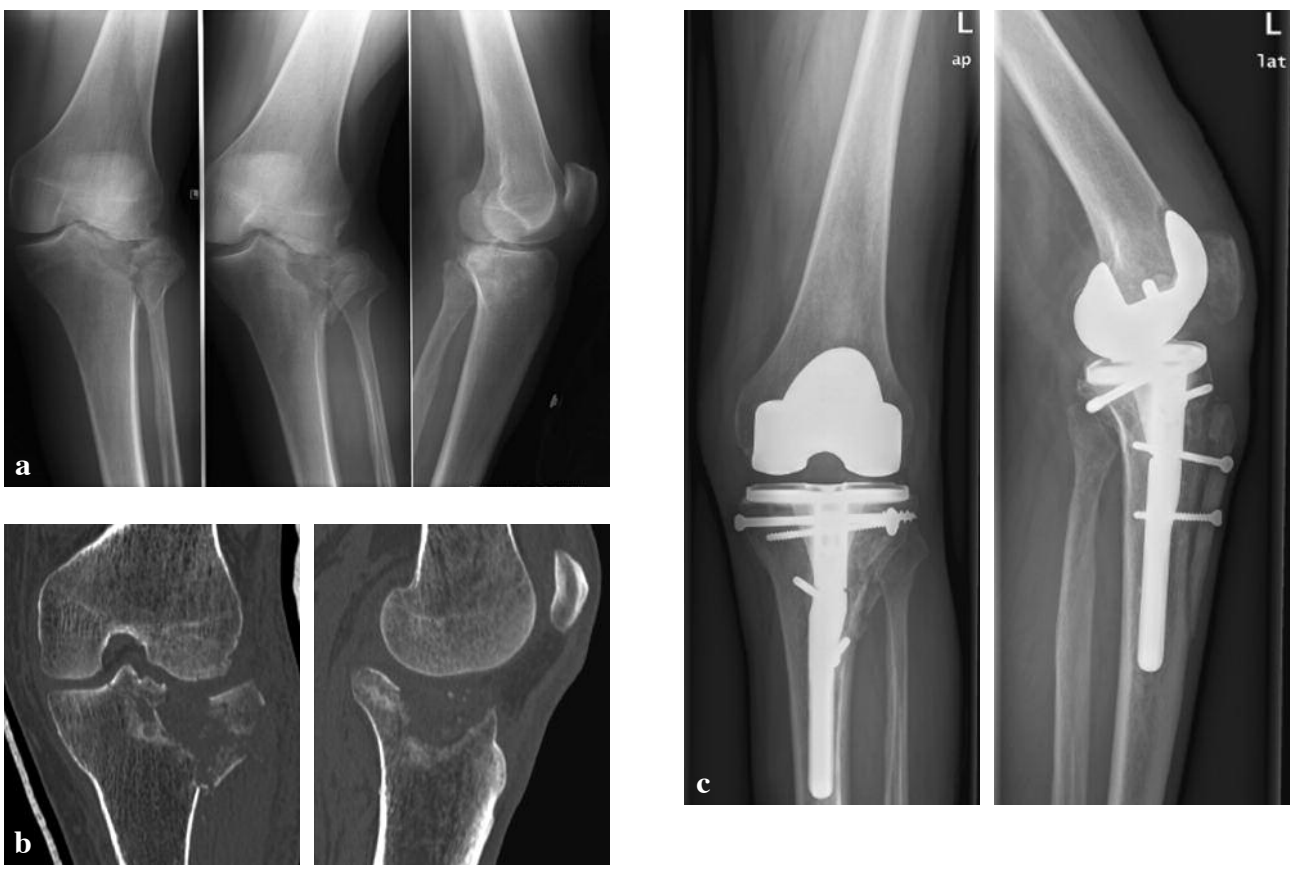


Fig. 1. — Pre-operative radiographs (a) and computer tomography scan (b) of a 58-year-old patient with a severe comminuted lateral tibial plateau fracture type B3. Postoperative radiographs (c) after TKA through a lateral approach with a tuberosity osteotomy.

Table I. — Summary of the patients treated with a TKA for a tibial plateau fracture

Age (years)	AO-41	Type TKA	Osteosynthesis	Patellar Resurfacing	Complications	Immediate weight bearing	Pain	ROM (°)	KSS Final	KSS Function
71	B1	Nexgen PS®	Screws	Yes	None	FWB	None	0/0/100	90	5
58	B3	Nexgen PS®	Screws	Yes	Arthrofibrosis	NWB ankle fracture	None	0/0/110	100	100
67	B3	Nexgen PS®	None	Yes	None	FWB	Moderate Continuous	0/0/120	54	45
71	B3	Nexgen PS®	None	Yes	Haematoma + Late periprost-hetic fracture	FWB	Moderate Occasional	0/0/120	50	0
72	B3	Nexgen PS®	Plate + Screws	Yes	DVT + Superficial infection	FWB	Mild Occasional	0/0/120	94	40
73	B3	Nexgen LCCK®	None	Yes	Haematoma	PWB	None	0/0/130	95	100
77	B3	Nexgen PS®	None	Yes	None	FWB	None	0/0/95	80	100
81	B3	Balansys®	None	No	None	FWB	Moderate Continuous	0/0/120	54	10
77	B3	Nexgen PS®	Screws	No	None	FWB	Died before FU			
68	C3	Nexgen PS®	Plate + Screws	Yes	None	NWB	Mild Stairs	0/0/120	89	75
76	C3	Nexgen PS®	Plate + Screws	No	None	PWB	Moderate Occasional	0/0/120	65	90
81	C3	Nexgen PS®	Screws	Yes	Haematoma	PWB	Pelvic fracture	None	0/0/120	89

FWB : Full-weight bearing ; PWB : Partial-weight bearing ; NWB : non-weight bearing.

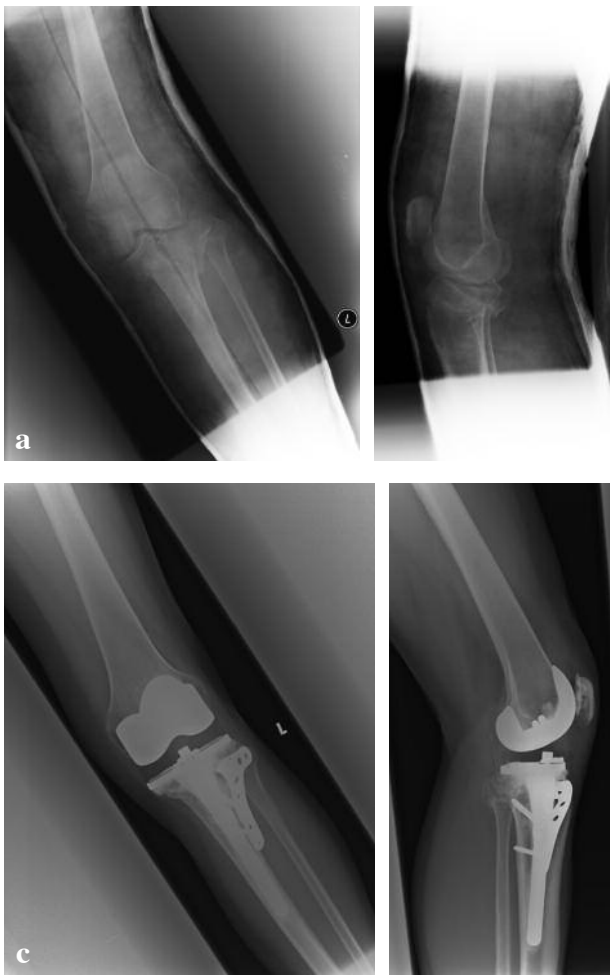


Fig. 2. — Pre-operative radiographs (a) and computer tomography scan (b) of a 68-year-old patient with a severe comminuted metaphyseal tibial plateau fracture type C3. Postoperative radiographs (c) after TKA supplemented with a lateral buttress plate.

mentation blocks in two patients (one 14 mm lateral and one 5 mm medial). In seven cases, additional fixation of the tibial plateau was performed with screws and/or a plate (table I, fig 1 & 2). All but one knee were operated through a standard medial parapatellar approach. The remaining one had a lateral parapatellar approach with a tibial tuberosity osteotomy. The mean thickness of the tibial polyethylene inserts was 11.5 mm (range : 9-17 mm) and ten arthroplasties had a patellar resurfacing. Only the CCK TKA had a stemmed femoral component.

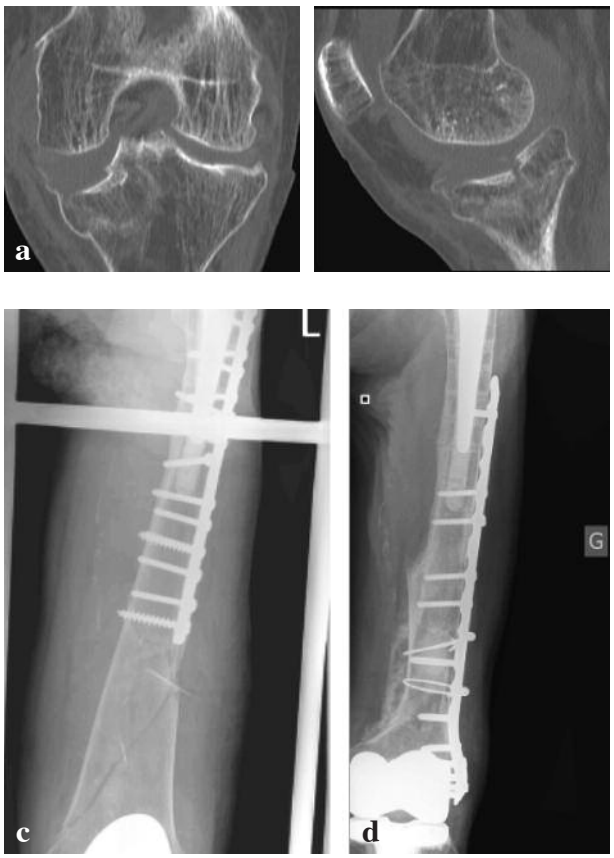
Postoperative treatment

Rehabilitation during hospital stay was not very different from our standard elective TKA scheme and included intensive passive motion on a CPM machine and early walking rehabilitation. However, only seven patients were allowed full-weight bearing (four unprotected but two with an extension brace and one with an articulated rehab brace). The remaining five patients were restricted in terms of weight bearing, two of them because of concomitant fractures (table I).

Postoperatively, an average of one unit of packed cells (range : 0-2) was transfused including one patient with a bleeding bulbar ulcer. Patients were discharged from the hospital after reaching full extension and a flexion of 80° to 90°. The mean hospital stay in the orthopaedic ward was 18 days (range : 14-23). All patients received antithrombotic prevention with low-molecular weight heparin (LMWH) and stockings for six weeks.

Complications

Complications during hospital stay were rather inconspicuous and occurred in four out of twelve patients (table I). Three developed a haematoma with spontaneous recovery and one obese patient had a deep venous thrombosis and a superficial infection. The thrombosis was treated successfully with a therapeutic dose of LMWH and local measures sufficed for the infectious problem.



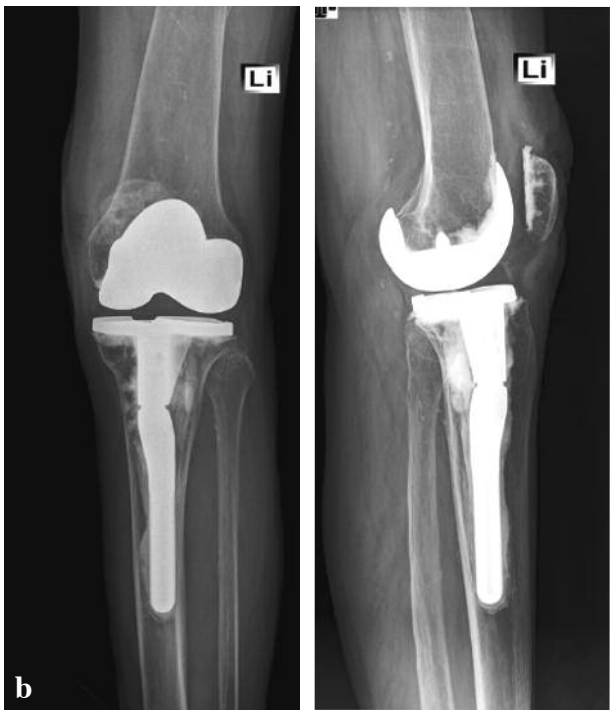


Fig. 3. — Pre-operative computer tomography scan (a) of a 71-year-old lady with a comminuted lateral tibal plateau fracture type B3. Postoperative radiographs (b) after TKA. Periprosthetic fracture (c) four years after TKA treated with a locking plate and cables (d).

A 58-year-old man showed signs of arthrofibrosis eight months after surgery and seemed non-compliant with physiotherapy. However, at final follow-up he unexpectedly made an spontaneous recovery.

Long-term complications included one lady who sustained a periprosthetic femoral fracture four years after her tibial plateau fracture. However, that high-risk patient had previously undergone a hip replacement complicated by a periprosthetic hip fracture treated with a plate and screw osteosynthesis (fig 3).

Results at recent survey

At a mean final follow-up of 31 months (range : 5 w-81 m), eleven out of twelve patients were available for clinical and radiological evaluation and one patient had died after hip fracture surgery.

Clinically, nine patients had a normal knee alignment and two showed a discrete valgus alignment compared to the contralateral side. The mean knee flexion was 115.9° (95-130°), the three knees with a C3 fracture had 120° of flexion, and those with a concomitant fracture fixation about 115°. No patients presented a hyperextension. At final follow up, five patients had no pain at all. However, the remaining six presented mild or moderate pain mainly in the upper half of the tibia (table I).

The median final knee score was 78 points (range : 50-100) and the median function score 58 (range : 0-100). Seven patients were rated as excellent, one as fair and three as poor. However, many patients presented concomitant age- and health-related complaints and this had a major impact on the outcome of the TKA and the Knee scores. Radiologically, no signs of loosening were seen and no implant revisions were necessary.

DISCUSSION

This study reports on 12 elderly and/or osteoarthritic patients with a tibial plateau fracture treated with an early stage TKA. At a mean follow-up of 31 months and according to the Knee Society Score, most patients (7/11) had an excellent result. However, we had also one fair and three poor results due to severe concomitant comorbidities but also due to residual pain mainly in the upper half of the tibia. We argue that, in these well-selected cases, primary TKA offers advantages in terms of early mobilisation and faster rehabilitation combined with a decreased probability of reoperation. The goal was to limit functional impairment and to allow these patients to return as fast as possible to their pre-fracture surrounding. Although that approach is not new for femoral neck (*14*) or humeral head fractures (*7*), only very few small-size studies (*2,12,15,16,20*) investigated that possibility at the knee.

In our series, all patients were treated with an all-cemented posterior stabilised (11/12) or LCCK (1/12) TKA with a stemmed tibial component. Although it is obvious that C-types of fractures involving the metaphyseal region of the proximal femur need distal anchorage, Schwarz *et al* (*20*) suggested that some split depression fractures (B3) could be treated with standard implants. However, in our series the degree of comminution combined with extensive osteoporosis made us choose for a more distal anchorage in all cases. On the other hand, we tried to avoid cementing the stem as we felt this might compromise the possibilities of revision in case of infection for instance. The major drawback of that strategy might be the relatively high prevalence (3/11) of mild or moderate tibial mid-shaft pain, which has however not been reported in previous series.

All metaphyseal (type C) and three out of eight unicondylar (type B) fractures were stabilised by a plate and or screws prior to cementing of the tibal component. In general the osteosynthesis material was well tolerated and only two patients had mild complaints. Although not all other series report on that particular point (*2,15,16*), it is clear that other authors have adopted the same strategy before (*12, 15,16*).

Compared to previous studies (*12,15,16,20*) we were rather conservative in the use of constrained implants and we did not feel there was a need for hinged prostheses. An LCCK TKA with a stemmed femoral component was used in only one case with severe medial ligament instability. We believe that stemmed femoral components should be avoided whenever possible because many of these patients have or will have their proximal femur instrumented either by a hip arthroplasty or osteosynthesis material for a hip fracture. As such, the stress riser between the stemmed femoral component and the hardware in the proximal femur could increase the risk of periprosthetic fractures. Despite avoiding stemmed femoral components, one of our patients sustained a periprosthetic femoral fracture. However, that patient was extremely osteoporotic and had suffered a hip fracture treated by hip arthroplasty and a subsequent periprosthetic femoral fracture treated with a long plate reaching the distal third of the femur.

The overall complication rate was comparable to other series (*16,20*) and lower than after secondary joint replacement (*8,13,18,23*). Especially the absence of deep infection and loosening or secondary displacement should be emphasised. This could allow for a more aggressive rehabilitation scheme with earlier full weight bearing even in patients with a comminuted metaphyseal fracture. This approach seems to have been the rule in other series, which made a more profuse use of cemented tibial stems (*2,12,15,16*). However, concomitant pelvic or lower limb fractures might be a limiting factor.

Functional outcome was certainly not perfect but was comparable to previous series (*2,12,15,16,20*). However, it is clear that, as in hip fractures, the tibial plateau fracture population is very different from that of elective TKA. As such, functional results are often a reflection of the patient's general condition in this specific population.

The major shortcomings of our paper are : the retrospective character of the study, the absence of a control group, the relatively small number of

patients and the limited period of follow-up. This precludes statistical analysis or subgroup analysis. Nevertheless, this is one of the largest series with one of the longest follow-ups. It emphasises the feasibility of the intervention and reports acceptable short-term results, which is the main goal in this patient population.

CONCLUSION

Performing primary total knee replacement for tibial plateau fractures with or without a metaphyseal component, is a safe procedure resulting in acceptable functional results and only minor short- and medium-term complications. However, the procedure should be reserved for elderly patients with a fracture that would be difficult to fix due to severe comminution and/or poor bone quality or, in those patients with pre-existing osteoarthritis that would be candidates for a TKA anyway. It could also be considered in elderly patients with deficient co-ordination ability that would not be able to unload their knee after fracture fixation (*12,15,16,20*). On the other hand, the procedure is technically demanding and should only be undertaken by experienced knee arthroplasty surgeons having all necessary material at hand, i.e. stem extensions, augmentation blocks, constrained implants and osteosynthesis material.

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