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ORIGINAL ARTICLE

Primary total knee arthroplasty in the management of epiphyseal fracture around the knee[☆]

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Accepted: 19 April 2011

KEYWORDS

TKA;
Fracture;
Knee;
Osteoporosis;
Elderly

Summary

Introduction: Over the past few years the use of arthroplasty was broadened to treating complex epiphyseal fractures at the shoulder and elbow joints. Similar trends to treat this type of fractures at the knee are less documented. Based on a multicenter retrospective series study, the aims of this work is to evaluate the short term clinical results of total knee prostheses in the management of comminuted epiphyseal fractures around the knee, to identify the technical issues and fine tune the indications.

Material and methods: Following the initiative of the French Hip and Knee Society (SFHG) and the Traumatology Study Group (GETRAUM), 26 charts from eight different centers in France were included in this multicenter retrospective series. Inclusion criteria were: primary total knee arthroplasty (TKA) in the management of complex articular fractures involving the proximal end of the tibia or distal end of the femur. Surgical features were identified and complications were analyzed. The assessment protocol at last follow-up was standardized and included patient demographic data, analysis of the Parker and IKS scores.

[☆] The GETRAUM and SFHG, two SoFCOT affiliate societies, met to discuss a shared topic of interest at the interface between the elective orthopaedics and traumatology. The present article is the result of this discussion.

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Results: During the immediate postoperative period, six patients (23%) reported a general complication and four patients (15%) a local arthroplasty-related complication. At last follow-up (mean 16.2 months), the overall final Parker score was 6.3 (a mean decrease of 1.7) and the mean IKS knee score was 82 points for a mean function score of 54 points.

Discussion: Primary TKA is a suitable management option for complex fractures in autonomous elderly patients suffering from knee osteoarthritis. The key technical details of this procedure should be respected and meticulously planned to achieve optimal results and limit the risk of complications. This risk in these acute complex fractures remains higher than after conventional TKA but comparable to that observed after TKA for post-traumatic arthritis.

Level of evidence: IV; retrospective cohort study.

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Introduction

The indications for primary elbow [1–3] and shoulder [4,5] arthroplasty in the management of complex epiphyseal fractures have broadened over the past few years following the same process than displaced femoral neck fractures in elderly patients [6]. The issues are the same, combining first the difficulty or even impossibility to achieve a stable bone reconstruction using osteosynthesis due to osteoporosis and/or comminuted fracture and second the necessity for early functional recovery. In such context, reconstruction using arthroplasty may appear as the only surgical option available to meet these two requirements. Complex epiphyseal fractures around the knee are less frequent than femoral neck, shoulder or elbow fractures and account for about 1% of all emergency department admissions in France. This is why only a limited number of series from the literature have reported such experience. Wolfgang [7] has probably been the first one to report the results of a female patient suffering from rheumatoid arthritis and early managed with total knee arthroplasty (TKA) for fracture of the distal femoral epiphysis. Afterwards, isolated cases or short series have also been published [8–13] as summarized in Table 1. Two series should be underlined: the series of Rosen and Strauss [14] features a large sample of patients and a short follow-up period; Nourrisat et al. [15] acted as pioneers in our country since their series involved tibial fractures. However, these experiences do not orient towards prosthetic or conservative treatment options

since osteosynthesis whether in the proximal tibia [16–20] or distal femur [21–23] remains a complex procedure. Furthermore, these short series do not help determine the best management option despite the development of promising new techniques such as femoral retrograde nailing [24,25] or locking screw-plate in both sites [26,27]. We then hypothesized that primary arthroplasty may be a suitable alternative for very specific indications of complex epiphyseal fractures around the knee. Based on the study of a retrospective multicenter series, the aims were:

- 1) to evaluate the short term clinical results of primary TKA in the treatment of comminuted epiphyseal knee fractures;
- 2) to identify the technical issues related to the implantation and;
- 3) to precise the indications.

Material and methods

Study pattern

Following the initiative of the French Hip and Knee Society and the Traumatology Study Group (GETRAUM), a national survey was carried out between the 1st of January 2010 and the 30th of September 2010 to gather the observations from primary TKA in the management of comminuted epiphyseal knee fractures. Each of these two societies associated with the "Société Française de Chirurgie Orthopédique et Traumatologique" (SOFOT) asked its members to retrospectively include the cases. Inclusion criteria were: primary TKA in the management of complex articular fractures involving the proximal end of the tibia or distal end of the femur. Exclusion criteria were: pathologic fractures, fractures occurring close to an already implanted total knee prosthesis, revision procedures for failed osteosynthesis and revision procedures for failed orthopaedic treatment. Therefore, 26 observations from eight centers in France were included in this retrospective multicenter study. The evaluation protocol at last follow-up was standardized and included patient demographic data combined with analysis of the pre- and postoperative, Parker et al. [28] and Knee Society Knee and Function scores, Insall et al. [29]. Metaphyso-epiphyseal fractures of the distal femur and proximal tibia were classified according to Müller et al. [30]. Surgical data and reconstruction features were also

Table 1 Series of the literature reporting the results of total knee arthroplasty (TKA) in the management of distal femoral or proximal tibial articular fractures.

Reference	TKA for fracture of the distal femur	TKA for fracture of the proximal tibia
Bell [8]	13	—
Rolston [9]	4	—
Yoschino [10]	3	—
Nau [11]	3	3
Killian [12]	—	—
Moussamy [13]	—	—
Rosen [14]	24	—
Nourrisat [15]	—	4

Table 2 Distribution of inclusions in different centers and type of prosthesis implanted.

Center: number of cases	Year of record	Hinge	Rotating prosthesis	Resurfacing	Revision resurfacing
Grenoble: 7	1990/2005	—	—	7	—
Paris: 3	2004/2009	—	1	—	2
Marseille: 5	2009/2010	—	5	—	—
Montauban: 1	2008	—	—	1	—
Nantes: 4	2000/2009	1	2	1	—
Nimes: 1	2009	—	—	—	1
Toulouse/Purpan: 4	2000/2009	—	1	—	3
Toulouse/Rangueil: 1	2007	—	—	—	1
Total: 26	—	1	4	9	12

collected. All these data were collected in each center by an independent observer, then colligated on a data record and centralized on a common Excel file (Microsoft Office® 2007, USA).

The series

Eight centers provided a total of 26 complete observations from patients operated between 1990 and 2010 (Table 2). Patient population was composed of 21 females and five males of mean age 80.5 years (range, 70 to 98 years) and injuries included 18 domestic accidents, seven road traffic traumas and one skiing accident. At the time of trauma, 16 patients lived at home, alone or with family and were autonomous, four lived at home but were not independent and four lived in a residential home care. The mean pre-injury Parker score was 7.7, 14 patients had a maximum score of 9. The Parker's score was 6 or below in eight patients which corresponds to a limited functional and cognitive autonomy level. The mean ASA score was 2.2; in three patients, the ASA score was 1. One female patient suffered from polyarthritis combined with severe osteoporosis and 17 patients (65%) had osteoarthritis of the knee prior to fracture. The retrospective questioning of patients revealed that 13 (50%) of them complained of a lack of mobility, nine (34%) had mild pain, seven (27%) had low pain and one patient complained of severe pain; only nine patients (34%) were asymptomatic before trauma. Nine patients (34%) from the overall series had planned a TKA before the accident. The pre-existing degenerative lesion was patello-femoral in one case and involved the three compartments in 17 cases. Fractures involved the distal femoral epiphysis in 10 cases (one type B and nine type C), the proximal tibial epiphysis in 16 cases (eight type B and eight type C fractures).

The mean time between hospital admission and onset of surgery was 7.5 days (range, 1 to 22 days); in three patients, such delay was due to the presence of phlycten at the incision site. Surgery was performed by a senior operator in 20 out of 26 procedures, mainly under general anaesthesia (23 times). Resurfacing prostheses were implanted in 21 cases that is nine conventional resurfacing implants and 12 revision endomedullary implants, all being posterior-stabilized prostheses. Five rotating hinge prostheses (Fig. 1) and one simple hinge prosthesis were implanted. Among the various

implants, most prostheses were Nex Gen® RHK (Zimmer, Warsaw, IND, USA) and Scorpio® TS (Stryker, Kalamazoo, MI, USA.) with eight and four implantations respectively. A mid-line surgical approach was used in 24 cases (five of which were subvastus approaches) and a lateral approach was used in two cases due to the site of fracture. No osteotomy of the anterior tibial tubercle was necessary. An additional osteosynthesis was performed in eight cases by means of simple screwing in three cases, femoral cerclage wiring in three cases and proximal tibial plate in two cases (Fig. 2). Trabecular Metal® (Zimmer, Warsaw, IND, USA) wedges in five cases (one in case of tibial fracture) and cone-shaped augments in four cases were added to improve implant stability. In all other cases from the series requiring bone filling, bone from the patient was used.

The mean operative duration (for the 13 informed cases) was 124 min (range, 60 to 270 min). Blood transfusion was necessary in 21 patients with a mean number of 2.9 triggers. Mobilization was initiated after a mean period of 2.5 days (24 informed records) and weight-bearing was initiated after a mean period of 2.8 days (21 informed records). During the postoperative period, 19 patients were admitted in a rehabilitation center, four were discharged home and two were admitted in a residential home care.

Statistical analysis was performed using the Statis programme. The descriptive statistics included mean and extreme values.

Results

During the immediate postoperative period, six patients (23%) reported a general complication. One female patient died five days after surgery from a cerebral vascular attack (CVA); this octogenarian reported the lowest Parker score from the series (2/0/0) and her ASA score was 3. Two patients reported a spatial and temporal disorientation and one patient had a cerebrovascular accident, which resolved. Despite systematic prevention, two patients reported a phlebitis, one of which causing pulmonary embolism. Four patients (15%) reported an arthroplasty-related local complication: a wound complication in one case, which resolved and a common fibular nerve palsy. One patient had anterior tibial tubercle avulsion requiring revision. One case of incision site tissue necrosis leading to deep infection required prosthesis removal and secondary

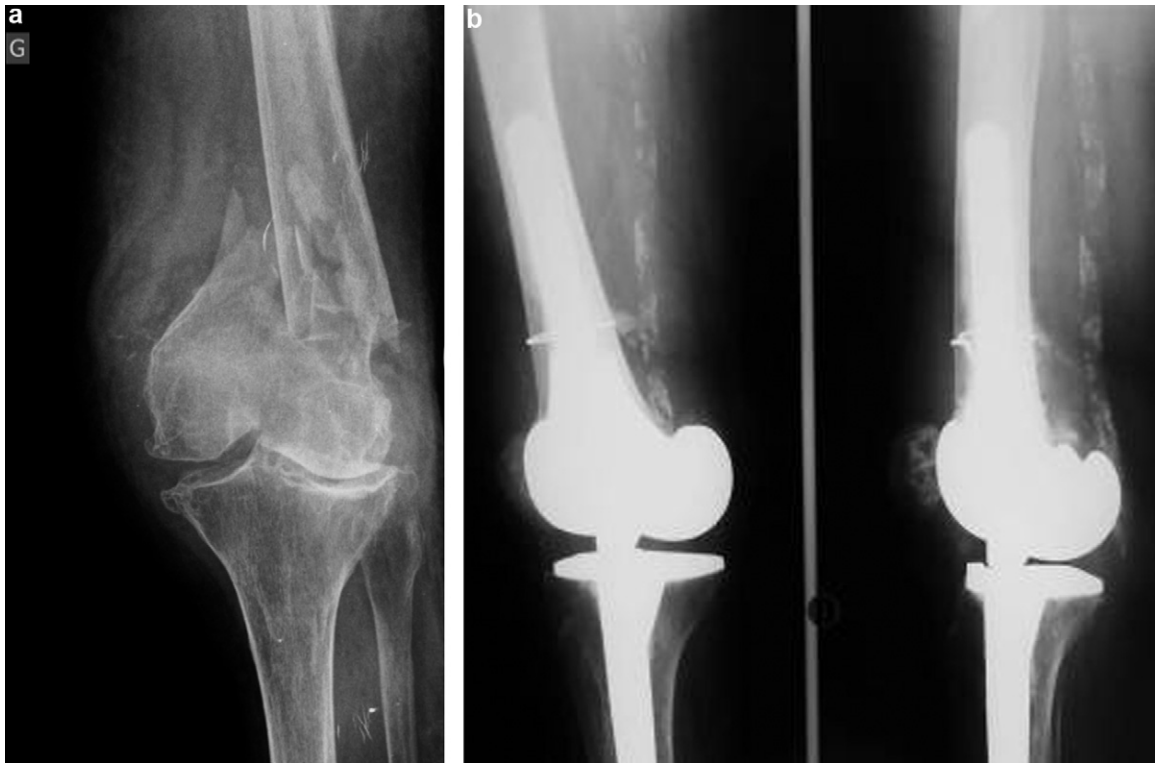


Figure 1 Ninety-five year-old female patient, Parker 9, ASA 2, known osteoarthritis of the knee, fall at home, supra and intercondylar fracture (a). Ligament preservation on the femoral side was not possible, a rotating hinge prosthesis was implanted combined with cerclage wiring osteosynthesis and cone-shaped Trabecular Metal® augment (Zimmer, Warsaw, IND, USA) with satisfactory radiographic stability at one-year follow-up (b).



Figure 2 Seventy-five year-old female patient, Parker 9, ASA 2, previous tibial plateau fracture with post-traumatic osteoarthritis of the knee. Domestic fall: supra- and intercondylar fracture (a) requiring intraoperative temporary stabilization of the fracture site then additional osteosynthesis (b).

arthrodesis. At last, one patient reported a femoral fracture occurring after a fall. Two mobilizations under general anaesthesia were performed during the first postoperative weeks.

The results were evaluated in 23 patients, excluding the female patient who died, the patient who underwent arthrodesis and the one patient lost to follow-up. The mean follow-up period was 16.2 months (range, 4 to 36 months); 17 patients were followed up for more than one year. At last follow-up, the place of residence was the same as in the pre-injury period for 19 patients whereas four patients previously living at home had been admitted to a community resident home after surgery. The final overall Parker's score averaged 6.3 that is a mean decrease of 1.7. The pre- and postoperative Parker's score was identical in 10 patients; A 2 to 3 points decrease was reported in 10 patients and three patients reported a decrease of more than 3 points. Over the 21 knees studied, the mean active flexion was 99° (75° to 140°). The mean active extension deficit was 4.1°; 13 out of the 18 evaluated patients did not demonstrate any flexum. The mean IKS knee score was 82 points. The function score was 54 points.

Discussion

According to our hypothesis, primary arthroplasty may be a suitable treatment option for knee trauma lesions in osteoporotic elderly patients. Based on the study of a retrospective multicenter series, the short term clinical results of primary TKA in the treatment of comminuted epiphyseal knee fractures, helped identify the technical-related problems during implantation and precise the indications. However this work reports major structural limitations. First, it is based on important inclusion bias: the number of cases included has probably remained lower than the number of total knee prostheses implanted for this indication in our country due to the limited publicity of this study. Moreover, the population of patients appears inhomogeneous when taking into account the variety of implants used, the time-spread of the study and the number of operators. Finally, all the records could not be assessed with the same exhaustiveness and exactness regarding item collection. However, despite these limitations, this series appears to be one of the most important among those published in the literature about primary TKA in the treatment of acute knee joint fracture.

Among a population of elderly patients, the number of distal femoral fractures and/or proximal tibial is quantitatively low. As for the whole limb fractures, there is a peak of frequency from the age of 70 to 80 years attributed to osteoporotic bone fragility and domestic falls due to clumsiness or fainting [31]. According to Kannus et al. [32], these injuries tend to decrease in elderly women. In the multicenter observational population study of the SOFCOT symposium, distal femoral and proximal tibial fractures respectively accounted for 1.6% and 0.8% of the elderly population older than 80 years [33]. During this symposium, only distal femoral fractures (18 cases) had been specifically studied underlying the predominance of simple fracture lines with rotating pattern and the poor general and functional prognosis within the six postoperative months. The

issue evoked in this study represents a small percentage of the whole daily traumatology cases but its management remains complex due to its rare occurrence. The indications for primary arthroplasty in the treatment of complex epiphyseal elbow [1–3] and shoulder [4,5] fractures in osteoporotic elderly patients have been increasing these past few years following the same process than that applied to hip fractures over these last few years. In such a context and despite osteoporosis as well as the impossibility for proper bone reconstruction, the aim is to achieve early functional and autonomy recovery. This issue has been rarely documented in the literature regarding knee fractures: primary TKA is rather selected for patients older than 70 years, with pre-existing symptomatic arthropathy, autonomous walking and well-preserved cognitive functions. The mean age of the patients operated on by Nau et al. [11] was 79 (range, 70 to 89). These patients suffered from evolved osteoarthritis of the knee and osteoporosis; the four patients reported by Nourrissat et al. [15] had a mean age of 82 years (75 to 86) and suffered from major pre-existing cartilage damages. The 24 patients operated on by Rossen and Strauss [14] had a mean age of 76 years (range, 68 to 85), five of them suffered from severe arthritis. Even in the absence of accurate clinical evaluation, the publications of Rosen and Strauss [14] and Nourrissat et al. [15] indirectly demonstrate good preservation of the cognitive functions of their patients. This series correlates those published in the literature since all the authors have selected this indication for a very specific category of patients. These last points are confirmed by a maximum preoperative Parker's score achieved in 54% and an ASA score at –2 in 73% of the operated patients from this series. Similarly, 69% of the patients suffered preoperatively from advanced cartilage defects and one third had considered a surgical treatment.

This series, as those reported in the literature, may not be strictly compared to osteosyntheses performed in the same category of patients and in similar locations. Non-operatively treated lesions were not associated with arthritic damages or did not demonstrate the same degree of comminution and partially involved the epiphysis [16,17,20]. Secondary prosthesis implantation in the management of fracture sequellae of the knee joint is a well-documented procedure in the literature. Papadopoulos et al. [34] in a series including 48 distal femoral fractures, underline the high incidence of postoperative complications (three infections, two loosening) as well as the poor results reported in particular regarding the range of motion. Weiss et al. [35] confirm these observations in a series of 63 ancient fractures of the tibial plateau secondarily managed by arthroplasty (three infections, five loosening) resulting in a revision rate of more than 20%. Based on the results of shorter series, Gerich et al. [36] and Saleh et al. [37] came to the same conclusions.

The functional results achieved in our series are comparable to those reported in the literature that is a loss of autonomy but a well-preserved joint function. These results are all the more confirmed in case of a preoperatively autonomous patient demonstrating a good general status. The rate of general and local complications is acceptable and directly linked to the preoperative status.

The technical difficulties related to implantation and in particular to bone cuts are comparable in both lesional

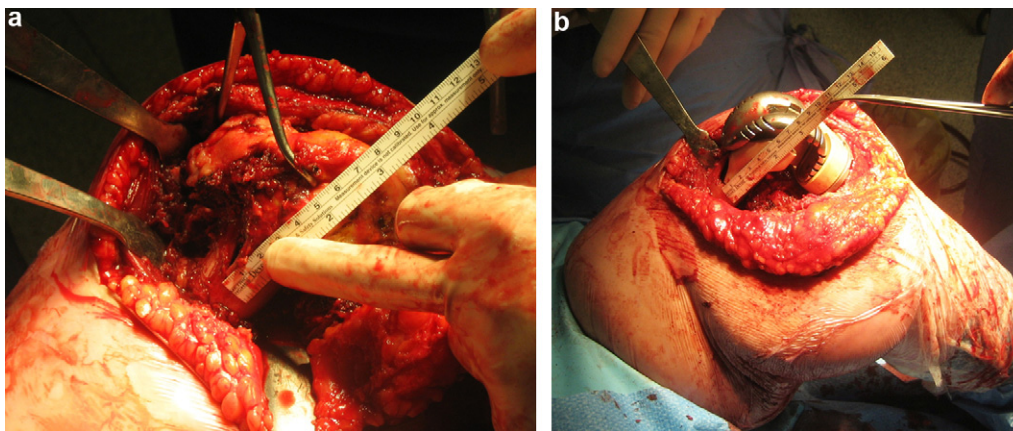


Figure 3 Intraoperative temporary fracture reduction for joint line assessment (a) and reproduction of the measurements on the trial and final implants (b).

categories, one of the two epiphyses being necessarily intact. These issues were resolved individually by the different operators but the details are rarely exposed in the publications. Therefore, Patterson et Earl [38] temporarily stabilize a supracondylar fracture by means of a centromedullary guide-pin then perform femoral bone cuts, insertion of the femoral implant and use a retrograde nail for definitive fracture site fixation. Nau et al. [11] do not provide any intraoperative technical details: they have implanted four cemented rotating hinge endomedullary stems (Link Endo model) and one resurfacing implant. Nourrissat et al. [15] advocate the use of constrained implants (Wallaby III and Axel), while fracture stabilization is ensured by anchorage and the use of a centromedullary stem. Rosen and Strauss [14] adopt a more extremist attitude which consists in the resection of the femoral epiphyseal-metaphyseal comminuted area and implantation of a modular implant (GMRS) as used in oncology. Therefore, only the broad technical lines may be taken from the literature. A less extreme management is recommended since stemmed implants provide a good primary stability while ensuring proper fixation of the fracture site. The choice between hinge prostheses and posterior stabilized implants depends on the degree of ligamentous damages; the second type of implants should be selected in order to preserve bone anchorage especially in the fracture site. This work allows to highlight the key technical points that should be respected and meticulously planned in order to achieve optimal results and reduce the risk of complications which incidence rate remains higher than that reported after conventional TKA but comparable to that observed after post-trauma TKA. Moreover, the patient and family should be informed of the rate of general complications which is similar to that reported with fractures of the proximal end of the femur in elderly patients. The first key point is proper selection of the type of implant and constraint: this choice is made within the range of implants usually selected by the operator. Accurate implant constraint should be determined during radiographic pre-operative planning: if the fracture line compromises the collateral ligaments (medial or lateral) in the femur or tibia, a rotating hinge prosthesis should be selected (Fig. 1). Joint line restoration and assessment of component rotation

is complex, particularly in patients with major epiphyseal femoral bone loss. Temporary fracture reduction will assist in determining the pre-injury joint line and rotation, based on significant landmarks around the fracture site (Fig. 2). If these landmarks cannot be obtained, the rules used in revision TKA with major bone loss should be applied to achieve an accurate distal femoral bone cut enabling joint line positioning 2.5 cm distal to the epicondyles and appropriate tibial cut enabling joint line positioning 1 cm above the fibular head. Once the joint line has been assessed, bone cutting is performed taking care to preserve as much bone as possible while stabilizing the temporary reduction using the cutting guide and forceps (Fig. 3). Bone cutting on the non-fractured femoral or tibial side is performed using conventional cutting guides from the instrumentation, by resecting the necessary and sufficient amount of bone required by the implant. In the presence of complex supra- and intercondylar fractures, preservation of the condyles

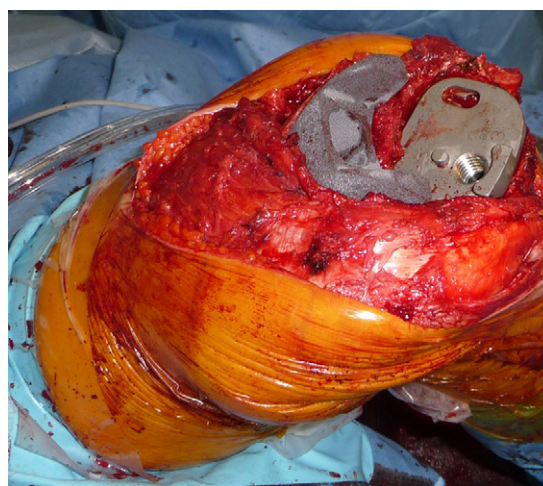


Figure 4 Due to the presence of comminuted fracture and/or osteoporosis, bone loss reconstruction may be necessary and managed using a cone-shaped metallic augument made from Trabecular Metal® (Zimmer, Warsaw, IND, USA) as an alternative option to allograft, to improve implant stability.

may sometimes be impossible (three cases). Component sizing is a delicate technical point: bone loss whether on the femoral or tibial side, may limit the use of conventional measurement guides especially in the femur. Therefore, a comparative measurement is made using the femoral trial implants as it is classically performed in the tibia. Due to the comminuted fracture and/or osteoporosis, the bony defect may require to be filled. A technical solution was submitted by one of the authors (S P): in five cases, wedges (one case of tibial fracture) or cone-shaped metallic augments (four cases) made from Trabecular Metal® (Zimmer, Warsaw, IND, USA) were added to improve implant stability (Fig. 4). In all other cases from the series requiring bone filling, bone was harvested from the patient. Since these lesions should be surgically managed [39,40], primary arthroplasty is part of the therapeutic options available in the presence of comminuted lesions; a senior operator familiar with prosthetic revision surgery should be in charge of this early urgent procedure.

Conclusion

In case of comminuted epiphyseal fracture of the knee joint, hardly reconstructible in elderly patients reporting satisfactory general and functional status but suffering from pre-existing arthritic lesions, the use of arthroplasty appears as a suitable treatment option as confirmed by this series and shown in the literature. The Parker's score is a simple and practical indicator for functional and cognitive levels: in addition to the previous conditions, the use of arthroplasty is debatable when the preoperative score is higher than 6. By using stemmed revision implants combined with modern cutting instruments, the implantation is accessible thus allowing early rehabilitation and aided walking. The indications for this surgery must be rigorously selected and should only complement osteosynthesis procedures, which remain the reference treatment option.

Disclosure of interest

Dr Sarraglia receives royalties from B-Braun.

Acknowledgements

The authors wish to acknowledge Dr R Bertin and L Soquet for their contribution in this study and the GETRAUM Group of Trauma Study as well as the Société Française de Chirurgie de la Hanche et du Genou (SFHG).

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