Revision Total Knee Arthroplasty
Causes of failure, bone loss management and outcomes

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The objectives of the current study were to identify the causes leading to revision knee arthroplasty, analyse implant choices and assess the short-term outcome. The current study is a retrospective on including a group of 33 patients operated between Jan 2013-Dec 2016 in a single institution. Data was collected from the Romanian National Arthroplasty Register. The cause for revision surgery was noted, as well as the type of implant used during the surgical procedure. The bony defect was classified according to the Anderson Orthopaedic Research Institute (AORI) Classification and the reconstruction method was analysed. Functional outcome was assessed using Oxford Knee Score preoperatively and at one year follow-up. Infection was the cause of failure in 18 cases, aseptic loosening in 11 cases, malposition of implants in 2 cases, instability in 1 case and periprosthetic fracture in 1 case. Revision implants were chosen based on joint stability and degree bone loss. The preferred implant was a condylar constrained knee type (20 cases), followed by a rotating hinge type (5 cases). An unconstrained implant was used in 2 cases. Six infected cases required an arthrodesis of the knee. Based on the AORI Classification, there were 10 type III defects, 14 type IIB, 8 type IIA and only one type I defect. Metal augments were preferred for reconstruction of bone defects. Bone graft was used in 8 cases. The mean Oxford Knee Score was 15 pre-op (12-20) and 38 post-op (32-45). Implant survival at final follow-up was 100%. The most common cause of failure of primary total knee arthroplasty is prosthetic joint infection. Bone defects can be addressed using metal augments or bone allograft. Postoperative functional outcome is improved irrespective of the type of implant used.

Keywords: revision, knee arthroplasty, bone defect, infection

Total knee arthroplasty is the most successful and effective procedure for patients with osteoarthritis. Most modern implants have survival rates of more than 15 years in over 90% of the cases, if implanted correctly [1, 2]. Although the rate of revision surgery has dropped mainly because of improved implant designs, refined surgical techniques and improved infection control, the number of revision surgeries has increased significantly because of the increased need for primary TKA in the general population [3, 4]. Even though the results for primary TKA are excellent, revision knee arthroplasty is indispensable for a variety of patients which present with gradual wear of implants with time, infection, malpositioning, instability and periprosthetic fractures [5]. Unfortunately, the outcomes of revision knee arthroplasty are not as good as those of primary surgery mainly because of the technical difficulties associated with this type of surgery such as management of bone loss, soft tissue handling and healing and difficult postoperative rehabilitation [6-8]. The objectives of the current study were to evaluate the most common causes leading to failure, the type of implants used and assess short term outcomes.

Experimental part

The present study was approved by the Institutional Review Board. The study is a retrospective one, including 33 patients operated at Foisor Clinical Hospital for revision total knee arthroplasty (TKA) between January 2013 and December 2016. There were 11 males and 22 females included in the study. The mean age at the time of surgery was 65 years (49-78) and the mean follow up was 18 months (12-45). Patient data was collected from the Romanian Arthroplasty Register.

The cause for revision was identified and in the case of infection the diagnosis was established based on the international accepted criteria for prosthetic joint infection [9]. The type of implant used during the surgical procedure was noted for all the patients included in the study (primary, semi-constrained and fully-constrained implants).

The degree of bone loss for each case was classified using the Anderson Orthopaedic Research Institute (AORI) Classification [10] on standing antero-posterior and lateral x-rays and was revised at the end of the surgery based on the intraoperative findings. Bone defects due to osteolysis or generated after removal of the cement or primary implants were managed according to the surgical technique, either with cement, bone graft or metal augments.

Knee function was assessed using the Oxford Knee Score both pre-operatively and at the final follow-up. At final follow-up a radiologic evaluation of standing antero-posterior and lateral x-rays was carried out in order to evaluate the signs of implant loosening.

All patients followed the same recovery protocol, with passive and active range of motion and quadriceps strengthening exercises started at 24 h post-op.

Results and discussions

The cause for revsion arthroplasty was prosthetic joint infection (fig. 1) in 18 cases (54.5%) followed by aseptic loosening in 11 cases (33.3%), malpositioning of implants in 2 cases (6.06%), instability in one case (3%) and periprosthetic fracture in one case (3%). Out of the 11 patients operated for aseptic loosening, 2 were operated for early loosening (earlier than 12 months) generated by poor cementation at the time of the primary surgery. The two cases revised for implant malpositioning, had a

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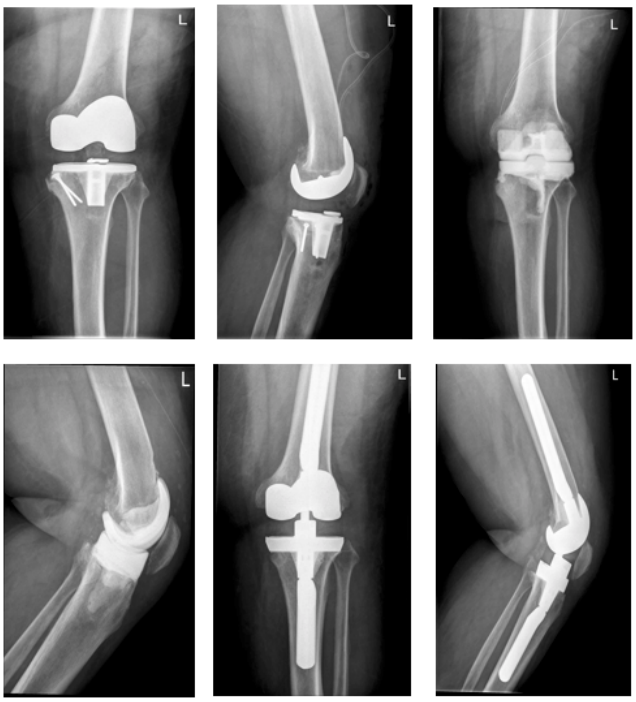

Fig.. 1 Prosthetic joint infection treated with two-stage revision

mechanical axis deviation of more than 10° off from the accepted limb axis position of 3-7 degrees valgus [11]. There was one case revised for instability reasons at 4 months post-operatively, following disruption of the medial collateral ligament during the primary surgery (fig. 2). The periprosthetic fracture case involved a comminutive fracture of the distal femur with loosening of the implant.

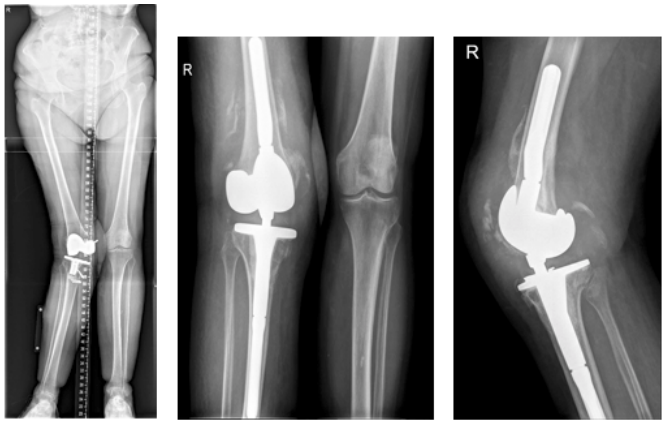

Fig. 2. Revision knee arthroplasty following joint instability

According to the AORI classification there were 10 type III defects (bone loss which includes a major part of either femoral condyle or tibial plateau associated with deficient metaphyseal support), 14 type IIB defects (loss of cancellous bone in the metaphyseal segment which involves both condyles or tibial plateaux), 8 type IIA defects (metaphyseal damage with loss of cancellous bone present in one condyle or plateau) and one type I defect (minor defects that do not compromise component stability). Metal augmentation was the preferred method for reconstruction of bone defects in 21 patients, both at the level of the tibia and of the femur (table 1, fig. 3). Morselised bone allograft was used in 8 cases in order to fill cavitary defects.

The appropriate revision implant was chosen depending on the degree of bone loss and joint stability. The preferred implant was a condylar constrained knee type (CCK) which was used in 20 cases. A hinged prostheses was used in 5 cases and a primary implant was used in two cases. In 6 infected cases, an arthrodesis was performed because of

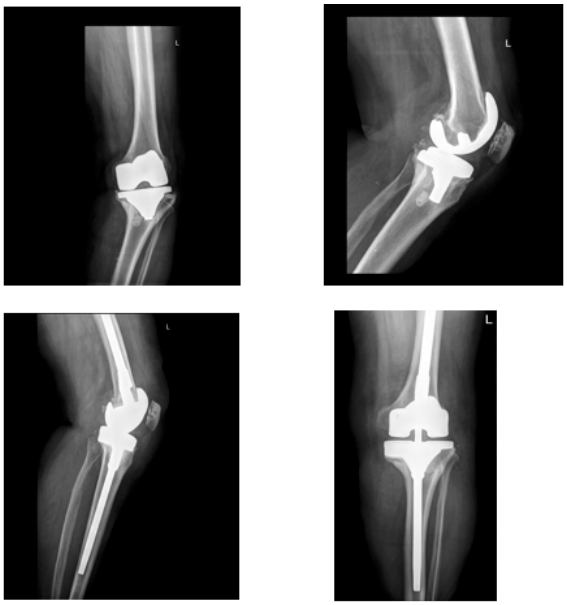

Fig. 3. Metal augment used for reconstruction of medial tibia plateau defect

Table 1
USAGE OF METAL AUGMENTS

Level of augmentation	Number
Femur	4
Tibia	6
Femur and tibia	11

severe bone loss or because of the important associated co-morbidities, in order to reduce the risks of multiple surgical procedures.

The mean pre-op score was 15 (12-20) and the mean post-op value was 38 (32-45). Implant survival at final follow-up was 100%. Most studies on knee revision arthroplasty show favourable and encouraging results with success rates and patient satisfaction between 40-89% [8, 12-14]. One important aspect for a succesful procedure is represented by the post-operative management and rehabilitation protocol. Analgesic models that rely on post-operative pain relief and antiinflamatory medication as well as femoral nerve blocks are implemented in order to provide comfort for the patient and facilitate an early pain-free and accelerated rehabilitation [15-19].

Revision surgery is complex, resource demanding and with a high rate of complications [11, 20]. The main causes of failure of TKA are well defined in the literature, with aseptic loosening, mechanical wear, infection, instability and periprosthetic fractures being the most significant [6]. In our study, the main causes of failure leading to revision are similar to those from the literature, with infection and aseptic loosening being the leading causes [21, 22]. Implant and surgical technique development has decreased the rate of revision for aseptic complications, however the number of septic revisions has increased significantly. This may be a relative increase due to the reduction of aseptic failure.

Many studies have advocated that the post-operative clincal results of cases revised for infection are inferior to those of cases revised for aseptic reasons [23-25]. There are however other studies that demonstrate similar outcomes between septic and aseptic revision knee arthroplasty [26, 27]. The current study demonstrates that

the use of articulated antibiotic loaded cement spacers results in improved clinical outcomes as demonstrated by the Oxford Knee Score. The role of the spacer, besides delivering antibiotics, is to restore and maintain soft tissue tension.

In our series, most cases were managed with a condylar constrained knee implant regardless of the level of bone loss. Only a few cases, all of them with severe bone defects (type II B or type III) required a hinged prostheses because of severe instability generated by collateral and capsular injury, associated with massive loss of bone stock. Although a hinged implant solves the problem in these cases, we must consider that the forces transmitted to the implant and fixation surfaces are greater and this can lead to early aseptic loosening. However, this may just be a supposition as there are studies which show survival rates similar to other types of implants [28]. Thorough pre-operative planning is necessary for proper implant choice and for precise measurment of desired implant position and size, stem lenght and bone defect size. Preoperative measurements are compared to the postoperative measurements of the check x-rays for case analysis and medico-legal purpose. All images should be stored in the PACS system of the institution for a minimmum of 10 years [29].

In 6 cases a knee arthrodesis was performed. Artrhodesis was chosen for elderly patients with multiple comorbidities and fragile soft tissue envelope, that had low functional demands and were at risk for multiple sugeries [30, 31].

Although the current line of implants seems to be able to solve the problems encountered in most cases, personalised implants and augments that fill bone defects preciseley without need for more bone resection and intelligent interfaces of implants that adapt to the forces transmitted during gait can be the future and may lead to greater patient satisfation and implant survival [32].

The main limitation of the current study is represented by short follow-up period. Longer follow-up is necessary for confirming the encouraging short results obtained with revision knee arthroplasty.

Conclusions

The most common cause of failure of primary total knee arthroplasty is prosthetic joint infection. Bone defects can be addressed using metal augments or bone allograft. Postoperative functional outcome is improved irrespective of the type of implant used. Implant survival on the short term was obtained in all cases.

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