Early mechanical failure in total knee arthroplasty

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Abstract Early mechanical dysfunction of a total knee arthroplasty (TKA) is a challenging problem in terms of causality and solutions. The current strategy in our department is to perform a complete TKA revision rather than the less invasive partial procedures when a clear mechanical cause of failure has been found. In this investigation, we assessed 21 patients who underwent complete TKA revision in 2003–2004 in our institution within the first two years following the index TKA. Various clinical presentations included pain, stiffness, instability, and femoro-patellar signs. These corresponded to implant size, position, and fixation issues. The IKS knee score/function significantly increased from 47/47 to 85/78 at follow-up (six months minimum). Compared to the data in the literature, this systematic full revision seems to be a reasonable approach. This attitude takes advantage of the modularity of the implants for allowing perioperative adjustments of position, fixation, and constraint. Based on the results of our study, we propose a list of six mechanical pitfalls to be evaluated in the case of early dysfunction: frontal misalignment, sagittal overstuffing or malpositioning, axial malrotation, poor bone fixation, inappropriate constraint or ligamentous balance, and inappropriate level of the joint space.

Résumé L'échec mécanique précoce d'une prothèse totale du genou (PTG) pose des problèmes difficiles en termes d'analyse des causes et des solutions chirurgicales possibles,

notamment par réintervention partielle. Notre stratégie actuelle est de réaliser un changement complet de la prothèse (RPTG) lorsqu'au moins une cause mécanique a été mise en évidence, de façon claire. Dans cette étude 21 cas de RPTG précoce ont été analysés. Sur le plan clinique ces patients présentaient tous des douleurs associées de raideur, instabilité ou de signes fémoro-patellaires. Ceux-ci correspondaient toujours à un défaut technique initial. Les scores IKS genou et fonction ne sont améliorés de façon importante après la révision complète, passant de 47/47 à 85/78 à six mois minimum d'évolution. La comparaison de nos résultats avec les données de la littérature sur les révisions partielles a montré que notre attitude radicale était raisonnable. Après cette étude, nous proposons 6 pièges mécaniques qui doivent être recherchés lorsque l'on se trouve confronté à un dysfonctionnement précoce de PTG: le un mal positionnement des implants dans le plan frontal, un mal positionnement ou un excès d'encombrement dans le plan sagittal, une mal rotation axiale des pièces, un défaut de fixation pour les prothèses scellées, l'utilisation d'un degré de contrainte inapproprié, enfin, un trouble lié à la hauteur de l'interligne articulaire (rotule).

Introduction

Total knee arthroplasty (TKA) has become a successful procedure for treating various forms of severe knee arthropathies, with a ten-year survival rate of primary TKA of various designs ranging from 92 to 100% reported in the most recent studies [8, 10, 16, 17]. Both posterior-stabilised or cruciate-retaining TKA show good results, usually failing as result of wear and aging of the material. Factors concerning the polyethylene composition of the implants, secondary osteolysis, and ultimately loosening of

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the implants are the usual causes of failure after normal use [15]. Late TKA revision (TKAR) in this context has been widely investigated [6, 13, 14].

However, the results of a significant proportion of TKA are either immediately disappointing or become so shortly thereafter [3, 5, 15]. In the absence of infectious complications or complicating medical conditions, mechanical failure in these cases is usually due to the inappropriate adjustment of the TKA, including type, size, and position problems, which could have largely been avoided [7]. The difficulty is then to identify the origin of the dysfunction in the recently implanted TKA and to decide what corrective surgery shall be performed to fix the problem definitively. While partial compensatory procedures, including tibial tubercle osteotomy, soft tissue plasty, and partial revision, are often possible, our current therapeutic strategy tends to be more invasive, consisting of complete TKA revision, when the cause of the early dysfunction has clearly been demonstrated.

The goal of this study was to investigate our cases of early complete TKA revision with a systematical change of both femoral and tibial implants simultaneously, with the aim of assessing the results of this radical approach and retrospectively analysing the indications.

Materials and methods

Twenty-one patients had complete revisions of their TKA for early mechanical dysfunction in 2003–2004 at our institution; late revisions and infection cases were excluded from the study (43 TKA revisions in total). Early dysfunction was defined as the absence of pain relief after TKA or knee pain returning during the first two years post-TKA. The study cohort consisted of 15 women and six men, and the average age at the time of surgery was 71 years. The revision procedure occurred one to four years after the index TKA, and there were 18 different types of TKA from 20 different orthopaedic surgery departments, including one case from our institution. The index TKA was cemented in all cases. It was cruciate-retaining implant in ten cases and a posterior-stabilised implant in 11 cases. Seven patients had already had partial revision procedures involving surgery of the extensor apparatus (plasty of the patellar ligament: three cases; tibial tuberosity transposition: three cases), knee arthrolysis (one case), and tibial insert exchange (one case).

The cause of the failure was determined by a combination of clinical and radiological observations, including standard incidences, full-leg standing X-ray, and computed tomography (CT)-scan measurements of the rotational positioning of the implants in the horizontal plane. In addition, the diagnosis of infected TKA was eliminated by

systematically carrying out a knee aspiration for bacteriological investigation before surgery. The IKS score was assessed pre-operatively and at follow-up (six months minimum).

NexGen (Zimmer, Warsaw, Ind.) modular implants were used for the revision as these enabled a peroperative precise adjustment of the TKA, including the possible addition of femoral or tibial augmentation blocks, the use of femoral or tibial stem extensions, and the final choice of the tibial insert accounting for the degree of constraint. All new implants were cemented.

Results

The average IKS knee score/function was 47/47 preoperatively, and the average range of motion was 87° in flexion/extension. All patients reported pain. Knee pain was associated with stiffness in eight cases, laxity or instability in six cases, and femoro-patellar problems in seven cases. Clinical and radiological investigation revealed the improper selection of the femoral implants with an oversized femoral component in three cases in which the sagittal overstuffing was accounting for knee stiffness (two cases) and femoro-patellar pain (one case). In five cases, the stiffness was related to the excessive tension of the posterior cruciate ligament in posterior retaining prosthesis. Early secondary breakage of the posterior cruciate ligament was responsible for knee instability in one case. Early loosening of the femoral implant was present in four cases, including three cases of obvious subsidence leading to laxity and instability. Internally rotated femoral components were present in six of the seven patients suffering from femoro-patellar pain or instability. The tibial insert was loosened in four of these patients, including one case of subsidence in varus leading to laxity and instability. Uni- or multi-planar malposition of a well-seated tibial insert was encountered in five patients (tibial varus in one case; negative tibial slope in one case; excessive tibial slope in one case; internal rotation of the tibial insert in three cases). In some cases, multiple causes of dysfunction were associated (Fig. 1).

The degree of constraint was finally chosen during the TKAR procedure using trial inserts. The prosthesis was posterior-stabilised in 13 cases and constrained-condylar in eight cases. The patellar implant was changed in only two cases: once for loosening and once for excessive thickness.

At follow-up, the average IKS knee score/function was 85/78 and the range of motion was 108°. Improvement of the knee score and range of motion were significant ($p < 0.005$, paired Wilcoxon test).

Fig. 1 Example of multi-factorial cause of early mechanical failure: **a** varus of the tibial implant, **b** negative sacral slope and patella bara, **c** internal rotation of the femoral implant, **d** internal rotation of the tibial implant

Discussion

We report here our investigation of a continuous series of patients who had complete revision of their TKA for early mechanical dysfunction. All cases were due to technical problems during the primary implantation, most of which would have been avoidable. The complete revision procedure immediately improved the clinical outcomes.

The complete revision of a TKA in the early post-implantation period was a difficult decision, which required the careful analysis of each case. We recommend the evaluation of each of the six following potential mechanical problems: frontal misalignment, sagittal overstuffing or

malpositioning, axial malrotation, poor bone fixation, inappropriate constraint or ligamentous balance, and inappropriate level of the joint space. In all these cases, our strategy was to begin again with a new arthroplasty rather than using limited corrective procedures.

In some cases, the decision was easy: failed cruciate-retaining TKA obviously required a full revision. In other cases, the early complete revision of posterior-stabilised TKA might appear as a radical approach since it meant the removal of well-fixed and sometimes well-positioned implants. However, an analysis of the literature on late TKA revision supported the use of the radical strategy with early dysfunction as well. Mackay et al. [12] recommended

avoiding the retention of a secure femoral component when changing the tibial component. In a recent paper, Fehring et al. [4] demonstrated significant better outcomes (IKS score) with full component revision than with partial component revision (either tibial or femoral) for wear problems, specifically in cases of instability. In a population of revised TKA for extensor problems, Conney et al. [2], showed that the five-year and the ten-year risk of reoperation were the lowest following a revision of all three components than after any other procedure. In addition, Leopold et al. [9] showed that isolated revision of the patellar component was associated with a low rate of success for femoro-patellar problems. In the case of stiffness, Babis et al. [1] reported poor results with early isolated tibial insert exchange, whereas Lo et al. [11] reported two successful cases of complete TKAR with reducing the size of the femoral component.

The modularity of the implants made the reconstruction more comfortable by allowing peroperative adjustments of size, position (augmentation block), fixation (stem), and, specifically, the degree of constraint. Based on preoperative knowledge of the cause of dysfunction of the former TKA, which revealed which parameters to be modified and the preoperative testing, the systematically complete revision was successful in all cases.

For various patients in our series, complete TKA revision provided immediate satisfactory outcomes. The opposition between the above-mentioned limited success of partial procedures reported in the literature and the current reliability of complete TKA revision suggests that surgeons should dare to act more invasively when treating early TKA dysfunction. Provided that a mechanical cause of dysfunction (single or multiple factors) has clearly been established, the radical attitude of beginning again with a new TKA seems to be a reasonable option to us. In this context, an exhaustive preoperative investigation is necessary for the diagnosis, demonstration of causality, and technical planning. However, further prospective investigations are needed to evaluate the indications of early complete revision.

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