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Revision of the Sheehan total knee arthroplasty

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Abstract The use of the Sheehan knee prosthesis extended from 1971 to 2002. It incorporated a semi-constrained hinge with intra-medullary stems cemented into the femur and tibia. While some authors have reported excellent short-term results, others have reported revision rates of up to 31% at 5–10 years. The aim of this study was to review the senior author's experience in revising these arthroplasties. We review 54 Sheehan total knee replacements and discuss the difficulties encountered during first and subsequent revisions and the often-complex reconstruction techniques used to overcome these.

Résumé L'utilisation de la prothèse de genou de type Sheehan s'est étendue de 1971 à 2002. Elle comportait une charnière semi-contrainte avec des tiges intra-médullaires cimentées dans le fémur et le tibia. Tandis que d'excellents résultats à court terme ont été rapportés par quelques auteurs, un taux de révision jusqu'à 31% à 5–10 ans a été rapporté par d'autres. Le but de cette étude était examiner l'expérience de l'auteur senior dans la révision des prothèses de Sheehan. Nous avons examiné 54 prothèses et discutons les difficultés rencontrées pendant l'arthroplastie initiale et les révisions ultérieures ainsi que les techniques souvent complexes de reconstruction utilisées pour les mener à bien.

Introduction

The ability to perform a simple and safe operation to ensure stability, freedom from pain and to restore functional and structural integrity to the arthritic joint has been addressed for many years. Much of what is known about modern arthroplasty has been derived from many years of experience with various implant designs. Complexities in knee arthroplasty not only arise from the initial joint replacement but also extend to the measures to be taken should failure occur. In today's era, criteria for success have radically changed, and there is ever increasing pressure to equate this with the restoration of normality.

The Sheehan total knee arthroplasty was introduced into clinical use in 1971 [9, 10]. It was a revolutionary design for the day. The prosthesis has a stable polycentric mechanism, which allows axial rotation as well as simulating other knee movements. The technique of implantation is relatively simple, preserving the patella and collateral ligaments [4]. The femoral components are made in mirror images for left and right knees. It has two separate bearing surfaces, with a gap for the stabilising stud, "rugby ball", of the tibial component, which interlocks between the femoral bearing surfaces and engages an inner radius, thus ensuring stability. When the knee is fully extended, the tibial stud fits into the intercondylar notch of the femoral component, thus preventing axial rotation. In 30° of flexion, the condyles show gradual widening of the intercondylar gap to allow approximately 30° of axial rotation when the knee is flexed to a right angle. Both femoral and tibial components are stemmed to enhance fixation and component alignment. They are cemented into the femur and tibia. There were a number of design changes over the years [10], including the addition of an anterior flanged femoral component to facilitate patellar re-surfacing.

While clinically excellent short-term results have been reported by some authors [2, 4, 9, 10], revision rates of up to 31% at 5–10 years have been reported by others [3, 7]. The large amount of bone stock removed during the insertion of the Sheehan arthroplasty and the presence of

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osteolysis, can make future revision procedures extremely challenging [5, 6].

The aim of this study was to review the senior author's experience in revising Sheehan total knee arthroplasties. We discuss the difficulties encountered during first and subsequent revisions and the techniques used to overcome these.

Materials and methods

This study includes 54 revision procedures of 33 Sheehan total knee arthroplasties in 29 patients. There were 15 men and 14 women, ranging in age from 26 to 78 years. The average age at time of revision operation was 67.5 years. The initial diagnosis was osteoarthritis in 13 patients and rheumatoid arthritis in 16 patients. The primary indication for the original operation was pain that significantly limited daily activities following failure of all modalities of non-surgical management. The reasons for subsequent revisions were recorded. All patients were scored using the Knee Society Index of Severity Instrument [8]. The operative details were assessed and technical difficulties at the time of surgery noted. Pre-operative and early post-operative complications relating to the revision procedure were also noted.

Results

In our series of 54 revision procedures (29 patients), 33 were first revisions and 21 were second or further revision procedures. The average time to first revision was 11.3 (range 1–18) years. The indications for first revision are listed in Table 1. Following a first revision, 12 patients went on to require a second revision, and nine patients required three or more procedures. Overall, four patients required an arthrodesis, and one patient required an amputation.

The procedures required for first revision were not particularly difficult in 22 cases. Eighteen were revised to a second Sheehan knee arthroplasty. Indications for this type of revision were painful bony impingement in 11, tibial stud fracture in five and component loosening in two. Four cases did not involve changing the prosthesis. Two very low demand patients only required bony resection for painful bony impingement, and a further two cases needed soft-tissue releases for patella tracking problems. The 11

more challenging procedures were performed in patients whose knees had reduced bone stock, massive osteolysis and/or global instability.

Of the 12 patients who went on to require a second revision, eight involved replacement of the prosthesis, one had an arthrodesis, two required soft-tissue release and one required the use of an external fixator for management of a periprosthetic fracture. Of the eight patients who underwent prosthesis replacement, two prostheses were replaced with a new Sheehan prosthesis while six were replaced with other types of prostheses.

Nine patients required a tertiary revision: five sustained a peri-prosthetic fracture, three required an arthrodesis and one went on to have an amputation following a failed second revision for infection.

Discussion

Revision of a Sheehan knee arthroplasty is potentially one of the most difficult and demanding operations in elective orthopaedic surgery. Several factors need to be taken into account before embarking on this type of surgery. It is vital that the patient and his/her family fully understand that any proposed operation is a salvage procedure and may, in fact, be the first stage of an above-knee amputation. The surgeon must see and assess the patient at length. The age of the patient and their level of daily activity will help dictate the type of prosthesis to be used. Elderly, low-demand patients with significant bone loss and instability and all

Fig. 1 AP X-ray of a patient with bilateral Sheehan knee prostheses. The right side required a revision for gross instability. Note the massive osteolysis in both femur and tibia with associated sinking of the tibial components causing bony impingement. In earlier models, the rugby stud of the tibial component was integrated with the metal of the prosthesis while in later models, the rugby stud was a separate polyethylene insert.

Table 1 Indications for first revision of Sheehan total knee arthroplasty

Bony impingement	11
Tibial stud fracture	5
Varus/valgus instability >30°	4
Aseptic loosening	4
Infection	3
Polyethylene wear	3
Dislocation	1
Patella problems	2

patients with major bone loss and instability are more suitable for a hinged prosthesis (Figs. 1, 2). However, constrained prostheses are generally not suitable for younger or high-demand patients. These patients require more extensive operations using an un-constrained, stemmed prosthesis.

Patients should be made aware of the increased risk of infection given the length of time it takes to perform these revisions. There is a significant risk of supra-condylar fractures (Fig. 3) both per- and post-operatively, especially in the rheumatoid patient and particularly in patients who have had an anterior flanged femoral component [1]. The anterior flange of the femoral component of the Sheehan prosthesis only allows for a wafer-thin layer of anterior femoral cortex, thereby increasing the risk of fracture. The risk of future failure is real, and attempts by anyone to minimise this risk should not be tolerated.

Accurate pre-operative planning is best achieved with good quality, 100%-sized, weight bearing antero-posterior and lateral knee X-rays. These will allow accurate measurements, which are particularly important if custom-made prostheses are being used. These radiographs should also be used to establish the extent of any erosion of the

Fig. 2 Lateral X-ray of the knee of a patient with gross instability following tibial stud fracture. There is extensive osteolysis of the distal femur and proximal tibia

Fig. 3 AP X-ray of a patient's knee after cable-plate fixation for periprosthetic fracture following revision of a Sheehan knee prosthesis to a fully constrained prosthesis.

femoral condyles, to exclude any evidence of fracture at the supra-condylar level and to detect lucency around the cement mantle. In the majority of cases, there is excellent interdigitation of the femoral cement into femoral bone. This cement mantle can be used to support the revision prostheses.

Frequently, with the passage of time, the tibial component and its surrounding cement mantle will show some subsidence [7]. Any protrusion of the tibial component through the wall of the tibia should be noted. Attempts at arthrodesis in the presence of lower-femoral and upper-tibial bone loss are technically extremely difficult and achieve poor results (Fig. 4). Unless infection is present, a better option in such patients is the insertion of a stemmed, hinged prosthesis.

Firmly fixed femoral components can easily be removed by using a custom-made slap-hammer device. The gripping end inserts under the rims of the femoral component, leaving the cement mantle in position. The tibial component can be removed by combining the use of the Sheehan tibial holding device and a fine tungsten-tipped osteotome inserted through the upper tibia to lie under the eggcup part of the tibial component. Co-ordinated slapping of the Sheehan tibial holding device and of the osteotome will allow for relatively easy removal of the tibial component. In general, the distal femoral cement at the condylar level is removed, and the more proximal cement can be used to

Fig. 4 Attempted arthrodesis for infected revision of a Sheehan knee prosthesis and periprosthetic fracture. This patient subsequently required an above knee amputation for non-union.

support a stem of a hinged prosthesis. Most of the tibial cement will need to be removed to accommodate even the shortest stem for a revision tibial component.

Replacement of the original prosthesis with a new Sheehan knee prosthesis was done when there was adequate bone stock, relatively little osteolysis and a relatively stable knee. The technique employed was to remove the fixed prosthesis, ream the underlying cement canal and fix the new prosthesis in place with liquid bone cement. Attempts to remove all the old cement were not necessary.

The more challenging procedures were performed in patients whose knees had reduced bone stock, massive osteolysis and/or global instability. In these cases, revision involved the removal of all components, bone cement and the often-extensive hypertrophic synovium, which could be black due the carbon-impregnated polyethylene. This was usually followed by the insertion of a more constrained

prosthesis with or without the use of autograft or impaction bone graft. We found that the Scorpio single-axis total knee system provided good results, allowing precise positioning of the tibial tray, for optimal tibial coverage where there was extensive bone loss.

In considering relatively high-demand younger patients, we would advise removal of the Sheehan prosthesis and all the cement from the femur. In the tibia, only the cement in the proximal two thirds should be removed, leaving a distal cement plug within the tibia. A plastic plug can be inserted into the femur to a pre-determined level. At this stage, both the femoral and tibial canals are filled with impacted allograft, and the tourniquet can be released.

Appropriate instrumentation for the chosen implant can be used. Canals are prepared through impacted bone to accept the appropriate length and diameter of the femoral and tibial stems. Bone clamps and cerclage wires are used early to prevent fracture if such a complication is anticipated. Where a pre-operative periprosthetic fracture exists, a custom-made stem will be required.

While the Sheehan knee arthroplasty was of great benefit to many patients, it has inherent problems. This paper shows that the Sheehan prostheses did not necessarily fail early, and with time, we can expect many more to present for revision. The high complication rate and the need for complex reconstructive techniques attest to the difficulty of these operations. Some of the problems are the legacy of the prosthetic design, which should be borne in mind when taking on these cases.

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