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Intramedullary knee arthrodesis as a salvage procedure after failed total knee replacement

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Abstract Septic and aseptic loosening with or without extensive bone loss after total knee replacement are the most common indications for knee fusion. Both external fixation and intramedullary nailing can be used for the treatment, though the latter appears to be the method of choice for most patients. Nine patients were treated after a total knee replacement failure using intramedullary nailing. A long intramedullary nail with a proximal interlocking screw was used in five cases, and a customised nail was used in four cases. Successful fusion occurred in eight of nine patients (89%). Average time for the joint union was 6.5 months, and average operative blood loss was 860 ml. In two patients, iliac crest and patellar bone graft were also used. In conclusion, intramedullary nailing can give excellent results in achieving knee fusion after a failed knee replacement as it allows early weight bearing and at the same time offers stability, pain relief, and a high rate of union, even though the surgical technique is demanding.

Résumé Les descellements septiques ou aseptiques avec ou sans perte de substance osseuse massive après remplacement total du genou sont les indications les plus fréquentes de l'arthrodèse du genou. Deux systèmes peuvent être utilisés pour cela, une fixation externe ou un clou centro médullaire, ce dernier apparaissant comme un traitement de choix pour la plupart des patients. 9 patients ont été traités après échec de prothèses totales du genou, à l'aide d'un clou centro médullaire. Ce clou centro médullaire avec un verrouillage proximal a été utilisé dans 5 cas et un clou sur mesure dans 4 cas. La fusion osseuse a été réalisée pour 8 patients sur 9 (89%). Le temps moyen pour obtenir la fusion a été de 6,5 mois et la perte sanguine post-opératoire de 860 ml. Chez deux patients,

une greffe iliaque avec utilisation de la rotule comme greffe ont été utilisées. En conclusion, l'enclouage centromédullaire a donné d'excellents résultats dans la recherche d'une arthrodèse après l'échec d'une prothèse totale du genou. Elle permet un appui immédiat précoce et une bonne stabilité.

Introduction

Chronic infection, instability, persistent pain, or massive bone loss, where revision is not possible, are some of the indications for knee fusion. Infection rates after total knee replacement (TKR) range from 1 to 15%. Rheumatoid arthritis, diabetes mellitus, obesity, chronic use of corticosteroids, poor vascularity, prolonged hospital stay, and skin lesions are some of the risk factors for infection.

Both indications and techniques of knee arthrodesis have changed over the last three decades. Compression arthrodesis, which uses external fixators or plates, and intramedullary fixation, which uses different kinds of nails, have been reported in the literature with varying rates of success, the latter being more successful [8, 20, 26]. Arthrodesis of the knee may be the treatment of choice after failed TKR [5, 8, 18, 22, 26].

This study presents the treatment course and subsequent results of arthrodesis in patients treated with long intramedullary nails, giving emphasis to the technique and the complications.

Patients and methods

The records of nine female patients treated for failed total knee replacement with intramedullary nailing in our institution from 1992 until 2002 were retrospectively reviewed. Mean age of the patients was 67.5 years (range 50 to 76). The right knee was affected in six patients and the left in the remaining three. The average time elapsed from the first operation was 2.8 years (2 to 5 years). Follow-up ranged between 24 and 30 months, and all patients were

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Table 1 Data of 9 patients who underwent intramedullary arthrodeses of the knee

Case	Age (years)	Preoperative diagnosis	Blood loss No loss of Blood (ml)	Previous operations (after TKA)	Rod desing bone graft	Type of nailing	Time to union (mths)	Complications, shortening	Followup (months)
1	76	TKA Aseptic loosening	1300 ml	Revision TKA, arthrodesis (DCP plate)	Long nail (Orthofix) Iliac crest + patella	Static	6.5	Dynamization at 5 months 3.5 cm	30
2	66	TKA Septic loosening (<i>Staphyl. epidermidis</i>)	325 ml	EF (AO), Ilizarov	Long nail (custom made)	Dynamic (PL)	7.5	1.5 cm	26
3	65	TKA Septic loosening (<i>Staphyl. aureus</i> MR)	600 ml	EF (Hoffman)	Long nail (Orthofix)	Dynamic (PL)	5.5	3.5 cm	24
4	50	TKA. Aseptic loosening	350 ml	Ilizarov, EF (Hoffman-monotubular)	Long nail (custom made)	Dynamic (PL)	Nonunion	Trochanteric fracture, chronic osteomyelitis, nail removal 4 cm	24
5	75	TKA. Septic loosening (<i>Staphyl. aureus</i>)	700 ml	Tension band (patella, K-W), tension band (patella, ethibon), EF (AO)	Long nail (custom made)	Dynamic (PL)	5	2 cm	26
6	73	TKA. Septic loosening (<i>Staphyl. epidermidis</i>)	650 ml	EF (AO)	Long nail (lamex)	Dynamic (PL)	4	Abduction pain (nail removal) 1 cm	24
7	72	TKA Aseptic loosening	1100 ml	None	Long nail (Orthofix)	Static	8	Dynamization at 5 months 3.5 cm	27
8	68	TKA Aseptic loosening	950 ml	None	Long nail (Orthofix) Patella	Dynamic (PL)	6	5.5 cm	25
9	70	TKA Septic loosening (<i>Staphyl. epidermidis</i>)	1250 ml	EF (AO)	Long nail (custom made)	Dynamic (PL)	4.5	1 cm	26

TKA: total knee arthroplasty, EF: external fixation, PL: proximal locking

subjected to routine postop clinical and radiological examination. Four patients had aseptic loosening with irreparable bone loss, whereas the other five had septic loosening alone. Among the four patients with aseptic loosening, only two were initially treated with intramedullary knee arthrodesis. One had a previously failed DCP plate (case 1, Table 1), and the other had had external fixation (case 2, Table 1) (AO/ASIF Synthes, Switzerland).

All patients with septic loosening were initially stabilised with an external fixator (3 AO type, 1 Hoffman type, and 1 Ilizarov) after surgical debridement followed by intramedullary nailing (as a second procedure) 3 to 6 months later, when infection was eradicated (ESR and CRP returned to normal values).

A single, long intramedullary nail was used in all cases. In four patients the nail was custom-made (Stryker), whereas in the remaining five patients Grosse-Kempf Stryker-Howmedica-type nails were used. Bone graft from iliac crest and patella was used in two patients with extensive bone loss. In seven cases the type of nailing was dynamic with central locking, while in the other two a static nailing was performed.

The mean surgical time was 2.8 h (1.5 to 3.5 h). Mean blood loss during the operations was approx. 860 ml (325 to 1300 ml). In all cases a blood cell saver system was used allowing an accurate measurement of the intraoperative blood loss to be established.

Up to three surgical procedures were carried out before definitive intramedullary arthrodesis was performed (Table 1). The pathogenic bacteria responsible were *Staphylococcus epidermidis* in three cases, MRSA (methicillin-resistant *Staphylococcus aureus*) in one case, and *Staphylococcus aureus* in the last case. Shortening of the entire leg was measured as the difference in the preoperative and postoperative whole leg length X-ray films.

Union was confirmed both clinically and radiologically with absence of pain, lack of micromotion, and obvious trabecular bone bridging to the fusion site on two planes (frontal and sagittal) on plain X-ray films (Fig. 1).

Fig. 1 Trabecular bone bridges the fusion site on two planes (frontal and sagittal) on plain X-ray films

Preoperative planning

Single long-leg scanograms (anteroposterior view) were used in all patients in order to estimate the accurate length and medullary canal dimensions of both tibia and femur. Knowledge of the exact medullary canal dimensions provided the opportunity on one hand to avoid over-reaming the medullary canal and on the other, to achieve adequate stability.

In those cases where a custom-made rod was used, we tried to prevent overcorrection of the valgus or varus deformity as well as anterior angulation of the knee, whilst achieving the best possible tibiofemoral contact.

Surgical technique

The patient was in a supine position on a conventional operating table and a small sand bag was placed underneath the buttock of the affected side. The leg was then prepared and draped with sterile drape from the buttock to the toes.

The knee was approached via a midline incision. In cases of septic loosening, removal of the implants and surgical debridement, including excision of necrotic bone and avascular soft tissues, were always performed. After shortening, the knee was temporarily stabilised by means of external fixators. In cases of aseptic loosening, removal of implants or external fixators followed by insertion of a straight guide wire from the knee into the greater trochanter. With the thigh held in adduction, the guide wire was forwarded to pierce the tip of the greater trochanter and then came out of the skin. Reaming of the femur was performed in a conventional way (antegrade fashion) over this guide wire up to a predetermined width. Reaming of the tibia was subsequently performed in the conventional way. Prior to tibia-to-femur approximation, the nails were flexed to 5° by means of conventional bending pliers. The nail was inserted by hand or, exceptionally, by light hammering.

Results

A solid osseous fusion was achieved in eight patients (89%). Due to infection, one nail had to be replaced by an external fixator before callus maturation. The average time to union was 6.5 months (range 4 to 8 months). Mobilisation of the patients began on the first postoperative day, while all patients were encouraged to bear their full weight from the second postoperative day. The mean hospital stay was 11 days (6 to 20 days). All five patients with septic loosening received appropriate antibiotic therapy for 6 weeks following the operation depending on the sensitivity of the causative bacterium. Methicillin-resistant *Staphylococcus aureus* was isolated in one patient for whom the therapy continued for a total of 2 months.

Mean leg shortening was estimated at 3 cm. In three patients the shortening was less than 1.5 cm, in five 1.5 to

3 cm, and in only one with severe bone loss the shortening was 5 cm.

Seven of the patients reported no knee pain postoperatively, while two, with occasional aching, had to receive anti-inflammatory medication on a regular basis. Three months postoperatively, six patients could walk unaided, whereas one had to use a cane occasionally and two patients had to use two canes most of the time.

Delayed union occurred in two patients in whom a static nailing was performed due to extensive bone loss. In these patients (cases 1 and 7, Table 1) dynamisation was performed with removal of the distal screws under local anaesthesia, 5 months after the nail insertion. Union was finally achieved after 2 months in both of the patients.

In one case (case 4, Table 1) a subtrochanteric fracture occurred during the operation due to the lateral insertion of the nail. The fracture was treated with circlage wire and one free screw (Fig. 2), resulting in varus deformity of the femoral neck (Fig. 3). In the same case, low-grade infection occurred, despite adequate intravenous antibiotic therapy. Exchange of the nail for external fixation resulted in bone union 4 months later.

Pain over the greater trochanter during walking occurred in one patient (case 6, Table 1). Since 12 months had passed since the operation and a solid osseous fusion was established, we removed the nail, achieving total pain relief.

Discussion

Septic failure or aseptic loosening with irreparable bone loss after TKR remains a difficult problem. Patients unable to tolerate multiple surgical procedures or suffering from severe medical problems like immunodeficiency are not

Fig. 2 Subtrochanteric intraoperative fracture treated with circlage and one free screw

Fig. 3 Varus deformity of femoral neck 6 months postoperatively

the best candidates for a revision. A second attempt to revise a failed total knee arthroplasty may lead to extensive bone loss and soft tissue problems, making arthrodesis a very difficult task or a procedure with bad functional results such as extreme limb shortening. Thus the assumption that arthrodesis of the knee is always possible as a salvage procedure appears to be invalid.

Professor Albert [4] was the first to describe a knee fusion in an unstable knee due to poliomyelitis. Over the last decade many methods using various devices have been reported for arthrodesis of the knee. External fixators [14, 16], plates [20], intramedullary nails [7, 8, 22, 26], Ilizarov method [21], and hybrid frames [24] are some of the devices that have been used.

Each method of arthrodesis is associated with different rates of success and complications. The clinical outcome and time of fusion depend on the cause of failure and the previous interventions in the affected knee. A wide range of success rates (25 to 100%) has been reported [10, 12, 13, 22].

The most popular method is external fixation. Charnley [2] was one of the first to popularise external fixation as a reliable method of knee fusion in 1960, reporting a 98% rate of fusion. Twenty-seven years later, Rand et al. [22] reported a 71% rate of success using a biplane external device. With pin track infections and a high percentage of re-operations, Thornhill et al. [23] reported a 33% need for other surgical procedures. Lucas and Morrey [19] were the first to use double plating for knee fusion, while Nichols et al. [20] reported a 100% success rate using dual plates, but only in 11 patients.

Many authors have shown that intramedullary nailing can provide adequate knee stability [11, 12, 15, 22]. The results of arthrodesis by intramedullary nailing have been better than those with external fixation in most reports in the literature [1, 3, 5, 25, 26]. Domingo et al. [6] reported a fusion rate of 90% using the Wichita fusion nail, a short intramedullary nail that allows intraoperative compression at the level of the joint line. In the same study the success rate using other techniques was only 52%. The only problem in the group treated with intramedullary nailing was a mid-calf pain, for the first 2 months, in all but one patient.

This method offers advantages such as no need for any external support, immediate walking ability with full weight bearing, and rapid rehabilitation, the only disadvantage being shortening of the leg. This surgical technique is demanding, but with careful preoperative planning this can be tackled successfully.

Our 89% success rate using intramedullary nailing is similar to that of many others authors. Donley et al. [7] reported a success rate of 85%, Ellingsen and Rand [8] a success rate of 88%, whereas Wilde and Sterns in a review reported an overall success rate of 84% [26].

There was no breakage of the nail as described in other studies [7, 8, 11], but unfortunately we had two intertrochanteric fractures of the femur, as described by other authors [9, 15]. We believe that these complications are caused mainly by the use of single, long nails.

Another interesting fact is that only one case of non-union was observed in our series, which is very important considering that the most frequent complication of knee arthrodesis is nonunion [11, 13, 17]. We believe that the low rate of non-union was related to the use of autologous bone graft.

Severe leg shortening occurred in only one patient because the bone ends of distal femur and proximal tibia were cut in order to improve bone contact as much as possible. Nail migration 1.5 cm over the tip of the great trochanter was observed in only one case, resulting in local discomfort until knee fusion was accomplished and the nail could be removed. This could have been avoided by proximal locking. In all but two of our cases, proximal interlocking nailing was used to avoid nail migration and promote bone compression on the fusion site. In the two cases with severe bone loss, static nailing was performed in order to maintain leg length.

In conclusion, intramedullary nailing can give excellent results in achieving knee fusion after a failed knee replacement as it allows early weight bearing and at the same time offers stability, pain relief, and a high rate of union, even though the surgical technique is demanding.

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