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ORIGINAL ARTICLE • KNEE - ARTHROPLASTY

Knee arthrodesis with modular nail after failed TKA due to infection

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Abstract
Introduction Knee arthrodesis is an established procedure for limb salvage after failed total knee arthroplasty (TKA) in cases of recurrent infection, soft tissue damage, reduced bone stock or with a deficient extensor mechanism. Walking with an arthrodesis is more efficient and less costly in terms of energy expenditure than above-knee amputation. Surgical options include an arthrodesis nail, external fixator or compression plate. We present our results of knee arthrodesis using the modular Wichita Fusion Nail® in patients after infected TKA.
Methods Fifteen patients with irretrievably failed TKA, due to infection, who underwent arthrodesis with the Wichita Fusion Nail® from 2004 to 2012 were retrospectively reviewed to assess fusion rate, time to fusion, complication rate, including new infections, and ambulatory status.
Results Three patients were lost to follow-up. Mean follow-up was 33 months (6–132 months). At their most recent follow-up, all patients were walking with full weight bearing on a fused arthrodesis. Mean time to union was 9 months (3–29 months). Three patients necessitated a revision arthrodesis to achieve union after a mean of 5 months after the last procedure.
Conclusion Arthrodesis with the Wichita Fusion Nail® provides satisfactory results in patients with failure after infected TKA, with 75 % primary union rate and no new or persistent infection at last follow-up visit. Although burdened with a high complication rate, it represents an acceptable option for limb salvage in this particular pathology.

Keywords Knee arthrodesis · Infected TKA · Modular nail

Introduction

Knee arthrodesis is an established option for limb salvage after failed total knee arthroplasty (TKA) in cases of recurrent infection, soft tissue damage, or reduced bone stock or with a deficient extensor mechanism [1–4].

This procedure following infected TKA has shown an acceptable fusion rate, which varies from 68 to 95 % according to the studies [2, 5, 6], and provides the patient with a stable and sensate limb for walking with lower energy expenditure than alternatives such as above-knee amputation or resection arthroplasty. Energy expenditure with walking is 25 % greater for patient with above-knee amputation than with knee arthrodesis [7–9].

External fixation, compression plating or intra-medullary rods are available for knee fusion.

Since Charnley's paper on arthrodesis of the knee, published in 1960, it is well established that rigid fixation, interfragmentary compression and maximum bone contact are key factors to obtaining fusion [8, 10, 15–17]. Intramedullary nailing has been shown to provide better fusion rate than other techniques [2, 5, 8, 10–14].

Modular nails such as the Wichita Fusion Nail® (WFN) represent an interesting alternative to long rods. Its design provides intra-operative compression across the osteotomised surfaces, excellent bending rigidity in all planes and

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good rotational stability. It is implanted through a single incision and allows immediate post-operative weight bearing [18].

Fusion rate for knee arthrodesis using the WFN varies from 8 to 100 % according to the studies [4, 18–22]. These results represent fusion rate for different indications. Fusion rate after prosthetic infection varies from 67 to 100 % [18, 19, 21–23].

The purpose of this study is to analyse the results of our experience with knee arthrodesis after infected TKA focused on fusion rate, time to fusion and ambulatory status.

Materials and methods

Series

We analysed a consecutive series (from 2004 to 2012) of 15 patients who underwent a knee arthrodesis with Wichita Fusion Nail® for infected TKA by a single surgeon (O.B).

The mean number of prior intervention was 4.5 (range 2–10). The indication for arthrodesis was recurrent infection in three cases, soft tissue damage in four and a deficient, unreconstructable extensor mechanism in the remaining eight (Fig. 1).

They all had a two-stage procedure with TKA removal and implantation of gentamicin- and vancomycin-impregnated spacer followed by arthrodesis after microorganism-adapted antibiotic therapy (Fig. 2). Mean interval between removal of the TKA and arthrodesis was 8.5 weeks (range 2–23 weeks).

Two patients needed a tissue coverage procedure. One (case 3) needed a fascio-cutaneous flap and the other (case 7) a latissimus dorsi free flap to cover bone and implants.

Fig. 1 Preoperative soft tissue damage with underlying infected TKA

Mean age of the patients was 67 years (range 42–87 years).

Surgical procedure

All of the procedures were performed through an anterior approach. After removing the spacer, extended debridement was undertaken followed by femoral and tibial osteotomies, oriented to provide fusion in almost full extension. After introduction of the femoral and the tibial part of the nail, compression was achieved with the compression screw. Full weight bearing was begun immediately post-operatively.

Methods

Patients were retrospectively reviewed on medical records to assess fusion rate, time to fusion, complications and ambulatory status.

We considered that fusion was acquired when three out of four cortices were fused on plain X-rays of the knee and painless walking was possible.

This study was approved by the local ethics committee.

Results

Results are presented in Table 1

Three patients were lost to follow-up before fusion of the arthrodesis. Mean follow-up was 33 months (range 6–132).

Nine patients had a primary fusion (75 %) after a mean time of 4 months (range 3–6). The three remaining patients needed revision arthrodesis. The overall mean time to fusion was 9 months (range 3–29) including non-union and re-intervention time. Fusion occurred in an average of 5 months (range 3–6) after the last procedure.

At their most recent follow-up, all patients were walking with full weight bearing on a fused arthrodesis.

Complications

Three patients needed a surgical revision for non-union or wound dehiscence.

One patient (case 7) who had a latissimus dorsi free flap (LDFF) for arthrodesis coverage needed a revision arthrodesis using 2 LCP plates 7 months after the first attempt of arthrodesis because of non-union. Five weeks after re-intervention, he needed a surgical revision of the LDFF because of wound dehiscence. Fusion was acquired 3 months after revision arthrodesis (Fig. 3).

Another patient (case 5) had a surgical revision of arthrodesis using 2 LCP plates 10 months after primary

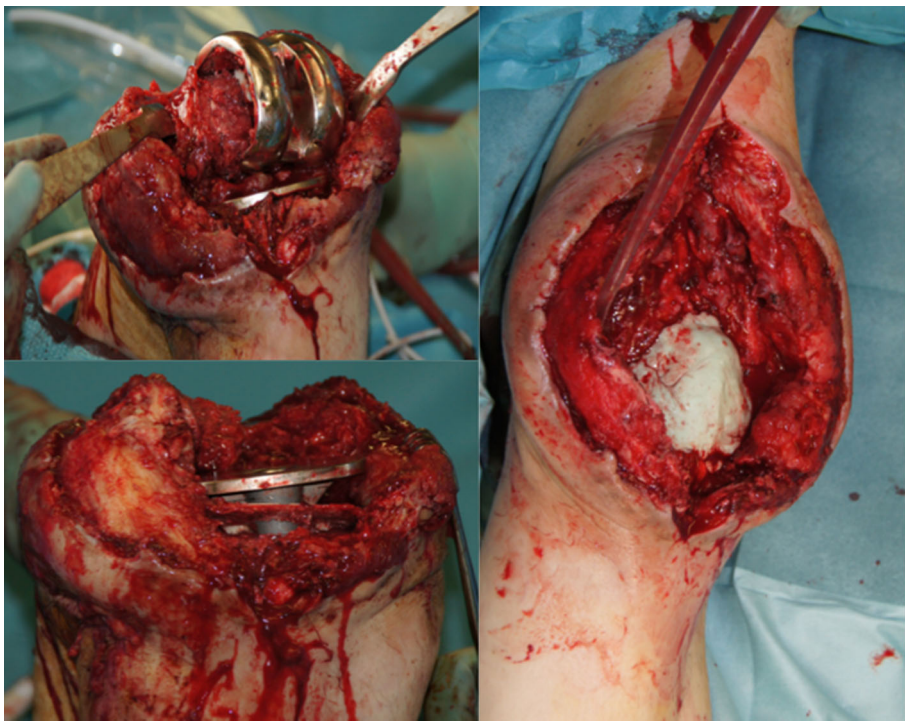

Fig. 2 Intra-operative pictures of TKA removal (*left*) and cement spacer implantation (*right*)

Table 1 Results of our series at last follow-up

Case	Age	Indication	Number of prior intervention	Follow-up (months)	Time to fusion	Ambulatory status	Complication
No. 1	58	Recurrent infection	5	132	6	Full weight bearing	Surgical revision 4 years after primary arthrodesis because of suspected deep infection
No. 2	42	Unreconstructable extensor mechanism	5	11	4	Full weight bearing	–
No. 3	68	Soft tissue damages	2	61	3	Full weight bearing	–
No. 4	63	Recurrent infection	5	35	29	Full weight bearing	Re-arthrodesis for non-union
No. 5	62	Soft tissue damages	5	38	25	Full weight bearing	Re-arthrodesis for non-union
No. 6	65	Unreconstructable extensor mechanism	4	12	6	Full weight bearing	–
No. 7	50	Recurrent infection	10	55	10	Full weight bearing	Re-arthrodesis for non-union
No. 8	64	Unreconstructable extensor mechanism	4	7	6	Full weight bearing	–
No. 9	80	Unreconstructable extensor mechanism	6	6	6	Full weight bearing	Peroneal nerve palsy
No. 10	80	Unreconstructable extensor mechanism	5	17	6	Full weight bearing	–
No. 11	60	Soft tissue damages	3	13	3	Full weight bearing	–
No. 12	74	Unreconstructable extensor mechanism	2	10	4	Full weight bearing	–

arthrodesis because of symptomatic non-union. Nine months later, he had a two-stage procedure using T2 long nail and 2 LCP plate because of non-union with suspicion of infection and a surgical wound revision because of dehiscence after 10 days. All samples were negative, and post-removal antibiotherapy stopped before revision arthrodesis (15 days of iv and local antibiotherapy). Fusion was acquired 6 months after last procedure.

The third patient who required revision (case 4) was seen at the 3-month follow-up appointment. Her progress was good with full weight bearing without pain and fusion in progress. We did not see her until she represented

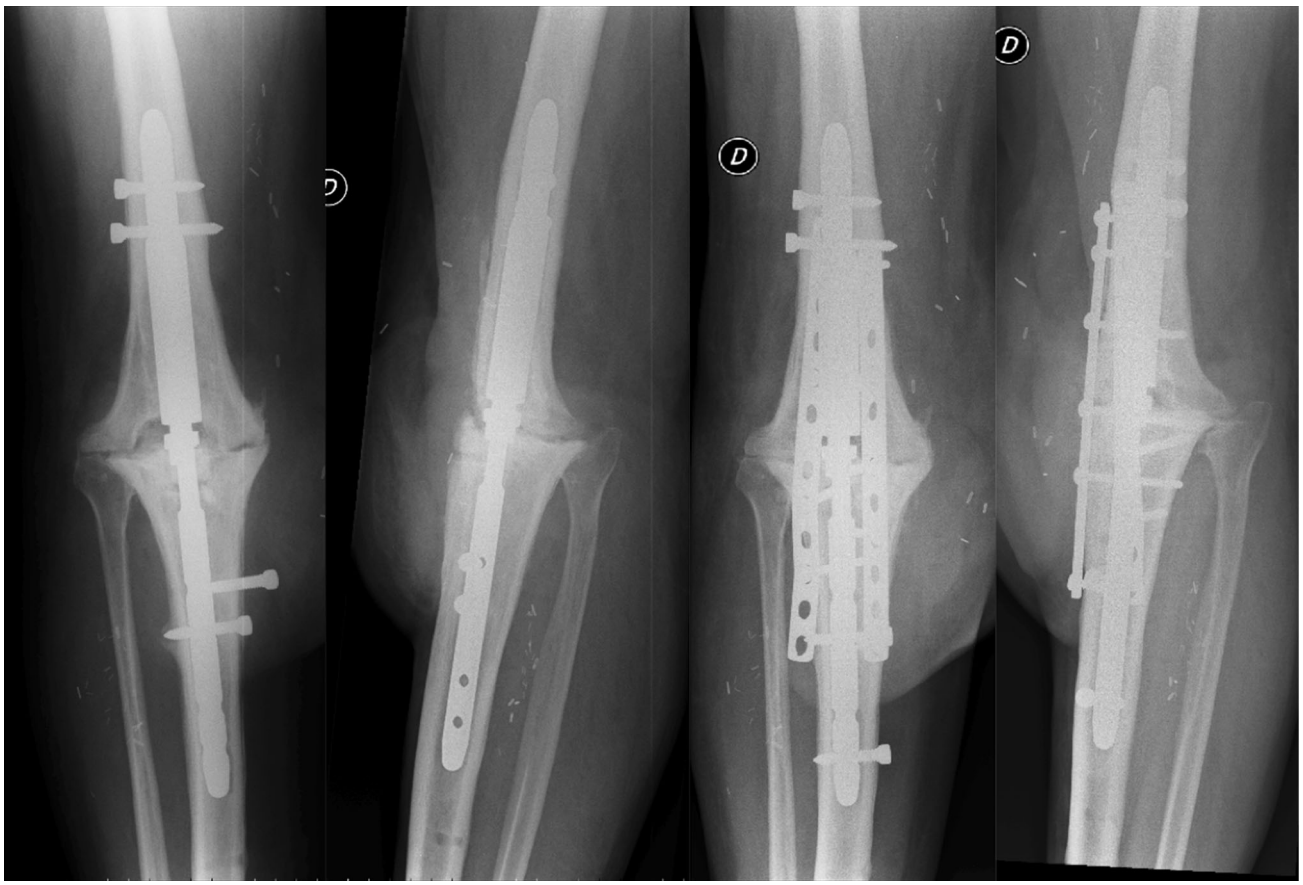

Fig. 3 *Left* AP and lateral view of the knee showing non-union 6 months after arthrodesis *Right* AP and lateral view 3 months after re-intervention showing acquired fusion

20 months later with knee pain. She had a non-union with tibial nail fracture. She underwent a revision arthrodesis with WFN and 2 LCP plates. Fusion was acquired 6 months later.

One patient (case 1) had a surgical revision 4 years after primary arthrodesis because of suspected deep infection. She had fever with knee pain without signs of loosening or local swelling. We performed deep debridement and took tissue samples. Arthrodesis was reinforced with bone graft and 2 LCP plates. All samples were negative, and antibiotherapy was stopped after 10 days.

One patient (case 9) presented with peroneal nerve palsy due to per-operative stretching, from which he never completely recovered. At last follow-up, he presented a M2 paresis of dorsiflexion of the left foot.

Discussion

Knee arthrodesis is a recognised treatment option for limb salvage in case of failure of TKA due to infection.

Many authors have demonstrated the superiority of the intra-medullary nail for arthrodesis of the knee compared to the external fixator regarding the consolidation rate, mainly in cases of bone defect or suboptimal bony contact [1, 2, 5, 10, 14, 17, 24, 25]. In addition, external fixation requires a non-weight-bearing period, can be complicated with pin track infection and can be poorly tolerated by patients [14, 22, 26]. The consolidation rate for knee arthrodesis using a long nail varies in the literature from 80 to 100 % [1, 5, 12–14, 24].

The long intra-medullary nail enables dynamic compression during walking promoting fusion, but makes the dissemination of germs in the diaphysis of the two bones possible [27].

Modular nails represent an interesting alternative to long rods. It provides intra-operative compression across the bone surfaces and dynamic compression during mobilisation, and it is implanted through a single incision [18].

The modular nail, relative to long nail, mainly offers the advantage of allowing full weight bearing immediately after the procedure due to bending rigidity in all planes and

good rotational stability. It can be implanted in patients with ipsilateral THA [28].

The modular nail is proven to be technically difficult to remove. It often causes significant bone loss. However, authors published series with modular nail removal without incident [18, 29].

Our study shows a primary fusion rate of 75 % with a mean time to fusion of 4 months, which is comparable to other studies that use a modular arthrodesis nail in this situation. Fusion rate varies in the literature from 67 to 100 % [18, 19, 21–23], and the mean time to fusion is from 4 to 9.8 months [4, 19, 20, 22]. These results are comparable to those obtained after arthrodesis performed with a long nail [12, 13, 24, 30, 31].

The eradication of the infection before performing arthrodesis with a two-stage management showed higher fusion rates and faster healing compared to one-stage treatment [5, 13, 28, 32].

All patients in our study underwent two-stage treatment. First, we removed the prosthesis and introduced an antibiotic-loaded cement spacer. Then, we performed arthrodesis after appropriate antibiotic therapy based on intra-operative samples and implant sonication.

In our series, we did not have any re-infection. The re-infection rate varies in the literature from 0 to 29 % after arthrodesis using a modular nail in case of infected TKA [19, 20, 22, 23].

Our case series study has some drawbacks. It is a retrospective study with a small series without a comparative group. However, it does present the results of arthrodesis of the knee using a modular fusion nail, performed specifically for failed infected TKA, in a consecutive series of patients, by a single surgeon in a single institution. The management of infection was two-stage procedures for all patients.

This treatment provided all our patients a stable, sensate and painless limb for full-weight-bearing ambulation. Two-stage management of infection was not complicated by any re-infection. The fusion rate and time to fusion in our series are comparable to those of others presenting results of knee arthrodesis after infected TKA using a modular nail.

In conclusion, these data show that knee arthrodesis with a modular fusion nail provides satisfactory results in patients after infected TKA due to good interfragmentary compression and good primary stability with an acceptable failure rate.

Compliance with ethical standards

Conflict of interest None.

Ethical approval All procedures performed in our study were in accordance with the ethical standards of the national research committee. Study Number 430/13, 07.11.2013 approval by CER-VD.

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