

EXCISION ARTHROPLASTY FOR INFECTED CONSTRAINED TOTAL KNEE REPLACEMENTS

A. W. F. LETTIN, M. J. NEIL, N. D. CITRON, A. AUGUST

From St. Bartholomew's Hospital and the Royal National Orthopaedic Hospital, London

We have reviewed 15 patients with infected total knee replacements after removal of the prosthesis, rigorous debridement, antibiotic irrigation, and prolonged systemic antibiotics. Infection was permanently eradicated in all patients; they were left with a functioning limb, on which they could walk with either a caliper (8 patients), a simple splint (3), crutches, or sticks. Three were disappointed because of residual pain.

We believe that, if exchange arthroplasty is inappropriate, this procedure is preferable to arthrodesis or amputation for persistent and disabling infection, particularly where constrained artificial joints have been used.

Infection following total prosthetic replacement of the knee is potentially the most serious of complications. The reported incidence of deep infection around a variety of knee prostheses ranges from 0% to 23%, with an average of 5% (Insall, Thompson and Brause 1983). Early drainage and continuous irrigation with antibiotic solution, followed by long-term systemic antibiotics may control the infection indefinitely (Lettin et al 1984); sometimes a persistently discharging sinus in an otherwise symptomless knee is preferable to the uncertainty of revision. Should the discharge become unacceptable, the knee painful or the prosthesis loose, threatening the integrity of the bone, then removal of the prosthesis and all cement and infected material becomes necessary.

In the presence of constrained implants with long intramedullary stems and wide resection of the articular surfaces, bone loss may make exchange arthroplasty impossible, or arthrodesis difficult to achieve. Amputation may be seen as a last resort, but an artificial limb is often abandoned for a wheelchair. As an alternative, we have found that the removal of the implant and all

infected material with antibiotic irrigation has proved effective in eradicating infection and leaving a pain-free fibrous ankylosis. This may become sufficiently stable to allow weight-bearing without a caliper or brace, even in unpromising circumstances involving long-stemmed constrained implants.

PATIENTS AND METHODS

We removed infected total knee replacements from 19 patients from 1978 to 1986. One patient subsequently died from unrelated causes and three could not be traced. The other 15 patients were evaluated by an independent assessor at one to nine years after operation (average 4.2 years).

There were seven women and eight men from 54 to 84 years of age (average 70 years) at the time of review; four had suffered from rheumatoid arthritis and 11 from osteoarthritis. There were 11 Stanmore hinged prostheses (Figs 1 and 2) and one each of the Attenborough, Rotoflex, Shiers and Walldius designs. Ten patients had at least one operation on the affected knee before the definitive knee replacement was carried out. In two patients this had been an exchange arthroplasty for infection.

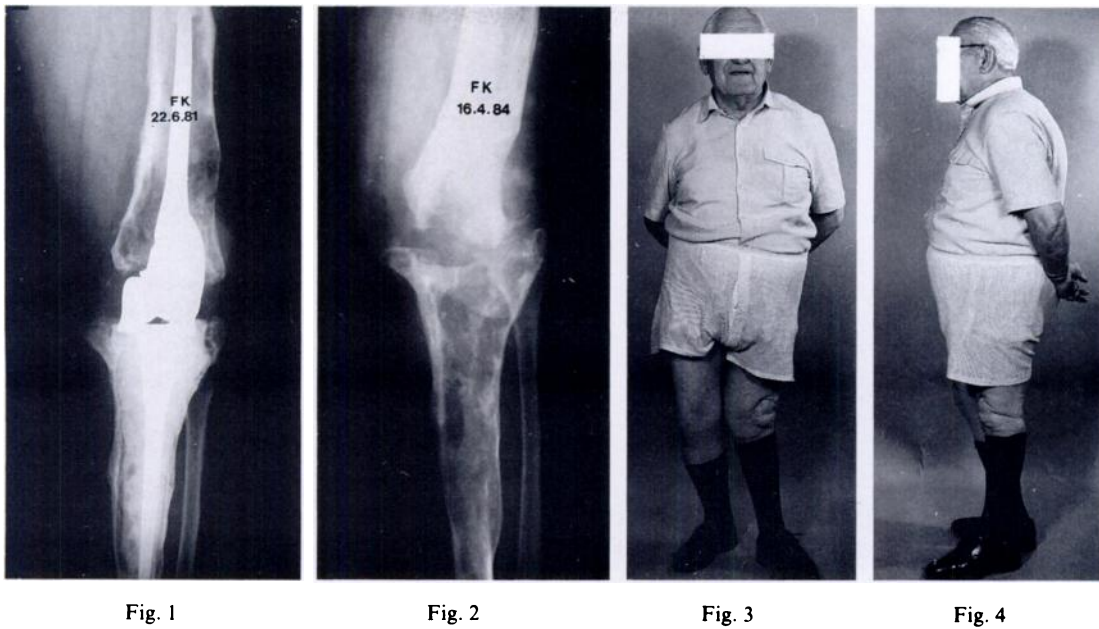
Technique. The prosthesis and all acrylic cement and necrotic tissue were removed through the original incision and a thorough debridement performed with a curette and a 'bottle brush'. Specimens of tissue from the prosthetic cement, and the bone-cement interfaces were cultured for aerobic and anaerobic organisms. After copious lavage, the tourniquet was released and after haemostasis the wound was closed in layers, leaving one

A. W. F. Lettin, MS, FRCS, Consultant Orthopaedic Surgeon
A. August, FRCS, Senior Orthopaedic Registrar
St. Bartholomew's Hospital, West Smithfield, London EC1A 7BE, England.

M. J. Neil, FRACS, Commonwealth Orthopaedic Registrar
N. D. Citron, MChir, FRCS, Senior Orthopaedic Registrar
Royal National Orthopaedic Hospital, 45-51 Bolsover Street, London W1P 8AQ, England.

Correspondence should be sent to Mr A. W. F. Lettin.

© 1990 British Editorial Society of Bone and Joint Surgery
0301-620X/90/2023 \$2.00
J Bone Joint Surg [Br] 1990; 72-B:220-4.



Case 5. Figure 1 - Radiograph two years after exchange arthroplasty with a Stanmore total knee replacement for deep infection. The prosthesis is loose and infected. Figure 2 - Eighteen months after removal of the prosthesis. Figures 3 and 4 - Five years after the removal of the prosthesis the knee is stable and pain free. The patient discarded his caliper after one year, and can walk with one elbow crutch for distances up to 1 km.

perforated plastic drainage tube in the medullary cavity of the femur and another in the tibia. A plastic backsplint was applied over a Robert Jones bandage.

The joint was irrigated continuously in all patients. A solution of ampicillin and cloxacillin in normal saline was used in two patients, and one of gentamicin in a third. One gram of cephadrine in one litre of normal saline was used in the remaining 12 patients, two to four litres of this fluid flowing in through the proximal tube and out through the distal tube into a closed (urine) collecting bag every 24 hours. Occasionally a Robert's pump was used to maintain the flow. This irrigation was usually discontinued after four or five days when leakage around the plastic tubes became excessive, soaking the dressings, but on one occasion the irrigation continued for 11 days and on another lasted for only 24 hours. Antibiotics were also administered systemically (the choice depending on the sensitivity of any organisms cultured), and continued for three to six months after the operation, depending on clinical progress.

The knee was immobilised in a plastic backsplint. This was supplemented by skeletal traction through a distal tibial pin in two patients who had severe postoperative pain for more than a few days. After two to three weeks, the wound had healed and the leg was sufficiently comfortable to allow measurements to be taken for a caliper. The knee was then immobilised in full extension in a lightly-padded plaster cylinder, in which the patient was discharged from hospital with crutches, taking partial weight on the affected leg. The cylinder was

removed four to six weeks later for the definitive fitting of a conventional weight-relieving caliper with a self-locking knee hinge.

RESULTS

Two patients remained in hospital for 93 and 102 days because of peri-operative medical problems, not related to the implant. Twelve patients were in hospital for between 15 and 37 days with a mean stay of 27 days, but one patient remained for two months until his caliper was fitted.

Infection. Pre-operative cultures from the discharging sinus yielded only one positive result, but organisms (two anaerobic) were cultured from specimens taken from 11 knees at the time of operation (Table I). In spite of the undoubted clinical infection of the prosthesis, no organisms could be cultured from four patients. All the wounds healed by first intention within two weeks of the operation and there was no recurrence of infection in any patient.

Pain relief. Seven patients were totally free of pain and five had mild pain that did not interfere with their activities or sleep. Three had more persistent pain and as a consequence were disappointed with the result of the operation.

Stability. One knee was completely stiff, though without bony fusion, and was therefore stable. In all but two other patients, the average arc of varus-valgus instability on weight-bearing was 20° or less (Figs 3 and 4). Five

Table I. Details and results of 15 patients after excision arthroplasty of the knee

Case	Age (yr) and sex	Original diagnosis	Side	Operations and date	Organisms isolated	Hospital stay (days)	Follow-up (years)	Pain	Short (cm)	Movement (degrees)†						Walking (metres)	Aids	Patient's opinion	HSS score
										F	HE	EL	V/Vi	20	20				
1	84 F	OA	R	High tibial osteotomy: 1975 Stanmore inserted: 1977 removed: 1978	<i>Staph. aureus</i>	23	9.5	Nil	3	70	0	0	20	20	500	Caliper	Satisfied	58	
2	54 F	OA	L	Shiers inserted: 1976 removed: 1978	<i>Strep. faecalis</i>	15	9.5	Nil	5	100	0	0	20	100	100	Caliper	Satisfied	66	
3	82 F	RA	R	Double osteotomy: 1974 Stanmore inserted: 1977 removed: 1979	Nil	31	7	Mild	5	0	0	0	0	Indoors	Zimmer splint	Non-committal	46		
4	57 M	RA	R	Attenborough inserted: 1978 removed: 1981	Nil	19	6	Mild	5	90	0	0	10	100	100	Nil	Satisfied	58	
5	72 M	OA	L	Stanmore inserted: 1976 exchanged: 1979 removed: 1982	<i>Staph. epidermidis</i>	24	5	Nil	4	95	10	20	10	1000	1 crutch	Satisfied	68		
6	74 F	RA	L	Walldius inserted: 1979 removed: 1982	Diphtheroids	32	5	Nil	4	30	10	10	20	100	Zimmer splint	Satisfied	51		
7	69 F	RA	R	Synovectomy: 1976 Stanmore inserted: 1982 removed: 1984	Nil	29	3.5	Nil	4	20	0	20	10	Indoors	2 sticks	Satisfied	58		
8	77 M	OA	L	Stanmore inserted: 1974 removed: 1984	Nil	37	3.5	Moderate	4	100	20	30	30	Indoors	2 sticks	Disappointed	46		
9	75 F	OA	L	Stanmore inserted: 1981 removed: 1984	<i>Pseudomonas</i>	30	3.5	Mild	5	35	0	5	20	1000	Caliper 1 stick	Non-committal	45		
10	73 F	OA	R	McIntosh inserted: 1971 Stanmore inserted: 1980 removed: 1984	<i>Anaerobic streptococcus</i>	93	3.5	Moderate	8	70	25	20	30	500	Caliper frame	Disappointed	29		
11	62 M	OA	L	High tibial osteotomy: 1980 Stanmore inserted: 1983 removed: 1984	<i>Anaerobic peptococcus</i>	26	3	Nil	6	100	10	0	>30	500	Caliper	Satisfied	59		
12	67 M	OA	R	Rotoflex inserted: 1976 exchanged: 1984 removed: 1986	<i>Staph. aureus</i>	34	1.5	Mild	5	20	0	5	20	Indoors	Caliper 1 stick	Non-committal	46		
13	74 M	OA	R	High tibial osteotomy: 1976 Stanmore inserted: 1977 removed: 1986	<i>Staph. aureus</i>	102	1.5	Mild	4	10	0	0	10	500	Zimmer splint	Satisfied	54		
14	66 M	OA	R	Howse inserted: 1983 Stanmore exchanged: 1984 removed: 1986	<i>Strep. faecalis</i> <i>Staph. epidermidis</i>	70	1.5	Moderate	4	30	0	0	0	500	Caliper	Disappointed	33		
15	59 M	OA	L	Medial meniscectomy: 1979 Double osteotomy: 1982 Stanmore inserted: 1984 removed: 1986	<i>Pseudomonas*</i> <i>Staph. epidermidis</i> Diphtheroids	23	1	Nil	4	20	0	0	10	1000	Caliper 1 crutch	Satisfied	63		

*isolated from the sinus; all others were from operative specimens

† F flexion; HE hyperextension; EL extensor lag; V/Vi varus/valgus instability

knees hyperextended, one by as much as 25° and seven had an extensor lag (Fig. 5). At first, all the patients used an ischial-bearing caliper but seven stopped using it at an average of 8.5 months after the operation; three still used a lighter splint and four used sticks or crutches. The need for a caliper did not appear to be related to the measured instability.

Range of movement. Five knees flexed to 90° or more (Fig. 6): these patients had the best functional results. The average range of knee flexion was 52° (0° to 100°).

Leg length. The mean discrepancy in leg length was 4.6 cm; this was readily corrected with a shoe raise.

Functional assessment. The function of each knee was assessed according to the BOA criteria (Aichroth et al 1978), after correcting leg length discrepancy with a shoe raise. Every patient was able to walk but only one could do this without a walking aid of any kind. The average walking ability was grade 3 on the BOA scale (up to 500 m – 10 to 30 minutes). All were able to sit comfortably, but were unable to get up from a chair without pushing off with their arms.

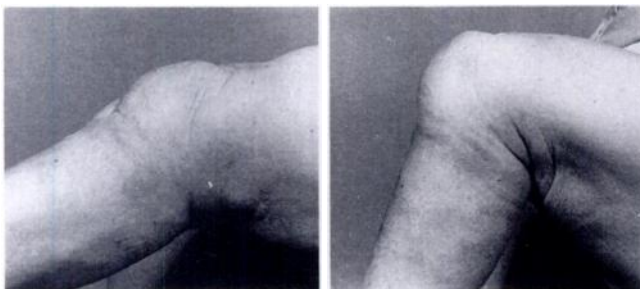


Fig. 5

Fig. 6

Case 5. Figure 5 – Active straight leg raising to show the extension lag.
Figure 6 – Active painless knee flexion to 95°.

The Hospital for Special Surgery knee arthroplasty rating system (Insall 1984) was also used to assess each knee. Nine scored 50 or more points (maximum 100); these patients were satisfied, whereas those with lower scores were non-committal (3) or disappointed (3).

DISCUSSION

All but one of the implants removed were constrained hinges of one design or another, that is of the type regarded as the most difficult to salvage. In every case the infection was eradicated at a single operation without prolonged immobilisation in hospital, except for reasons unrelated to the operation. It is possible that removal of the prosthesis and the infected material without antibiotic irrigation would have produced the same result, though Falahee, Matthews and Kaufer (1987) found that three

of 28 knees continued to drain for more than two years after a similar procedure but without antibiotic irrigation. In two of their cases drainage continued for seven and nine years in spite of repeated surgical debridement.

Most of our patients ended up with a pain free, or near pain-free limb with which they were satisfied and which allowed limited walking, often without a caliper. Those with more than mild residual pain, reducing activity and disturbing sleep, were disappointed. Almost certainly all the patients would have been better off with a successful exchange arthroplasty, had that been technically feasible (two patients had already had attempts at this). However, Rand and Bryan (1983) reported that pain-free walking was possible after exchange arthroplasty in only six of 14 patients, even though their original operation was a surface replacement.

Arthrodesis is notoriously difficult to achieve after failed knee replacement of any kind (Deburge 1976; Hagemann, Woods and Tullos 1978). Shea, Wynn Jones and Arden (1981) reported bony fusion in only five of 29 knees in which fusion was attempted, patients having spent an average of five months in hospital. Wade and Denham (1984) described their own technique of arthrodesis using compression fixation with multiple pins because of the high failure rate (39%) with conventional methods. This resulted in a satisfactory fusion in all six patients after four to six months. Johnson and Bannister (1986) believe that arthrodesis offers the best chance of a long-term pain-free gait, although only six of their 12 patients achieved bony fusion, and then only after a mean duration of immobilisation of 10 months and additional bone grafting in two cases. Five of their six failures walked without pain on a fortuitous fibrous ankylosis.

Wagh (1983) drew attention to the disadvantages of an arthrodesed knee in patients with rheumatoid arthritis and multiple joint involvement. Most elderly patients spend a considerable part of the day sitting and appreciate the ability to bend the knee and sit comfortably in a chair just as much as the ability to walk from one room to another. Only seven of 23 patients reported by Pring, Marks and Angel (1988) were regular daily walkers following above-knee amputation for failed total knee replacement and 20 used a wheelchair for some part of the day.

It would appear, therefore, that excision arthroplasty is preferable to both arthrodesis and amputation in the management of chronic infection, particularly with the constrained type of knee replacement. Falahee et al (1987) have used a similar technique for infected surface replacements. Removal of all foreign and infected material coupled with antibiotic irrigation is an effective means of eradicating infection and we agree with Insall (1984) that "in most instances the fibrous ankylosis of the knee provides a painless lower extremity allowing the patient to be brace-free". Excision arthroplasty does not

necessarily preclude further prosthetic replacement once the infection has been eradicated, should the surgeon and the patient so wish.

We have modified our treatment regime since completing this review. We now insert four chains of gentamicin beads into the medullary cavities of the femur and tibia instead of the irrigation tubes, and routinely use skeletal traction through a distal tibial pin. The beads and the pin are removed two weeks later, and the measurements are taken for a hinged plastic support, rather than a caliper, before the plaster cylinder is applied.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

REFERENCES

- Aichroth P, Freeman MAR, Smillie JS, Souter WA.** A knee function assessment chart. *J Bone Joint Surg [Br]* 1978; 60-B:308-9.
- Deburge A.** Guepar hinge prosthesis: complications and results with two years' follow-up. *Clin Orthop* 1976; 120:47-53.
- Falahee MH, Matthews LS, Kaufer H.** Resection arthroplasty as a salvage procedure for a knee with infection after a total arthroplasty. *J Bone Joint Surg [Am]* 1987; 69-A:1013-21.
- Hagemann WF, Woods GW, Tullos HS.** Arthrodesis in failed total knee replacement. *J Bone Joint Surg [Am]* 1978; 60-A:790-4.
- Insall JN.** ed. *Surgery of the knee*. New York, etc: Churchill Livingstone, 1984.
- Insall JN, Thompson FM, Brause BD.** Two-stage reimplantation for the salvage of infected total knee arthroplasty. *J Bone Joint Surg [Am]* 1983; 65-A:1087-98.
- Johnson DP, Bannister GC.** The outcome of infected arthroplasty of the knee. *J Bone Joint Surg [Br]* 1986; 68-B:289-91.
- Lettin AWF, Kavanagh TG, Craig D, Scales JT.** Assessment of the survival and the clinical results of Stanmore total knee replacements. *J Bone Joint Surg [Br]* 1984; 66-B:355-61.
- Pring DJ, Marks L, Angel JC.** Mobility after amputation for failed knee replacement. *J Bone Joint Surg [Br]* 1988; 70-B:770-1.
- Rand JA, Bryan BS.** Reimplantation for the salvage of an infected total knee arthroplasty. *J Bone Joint Surg [Am]* 1983; 65-A:1081-6.
- Shea JG, Wynn Jones CH, Arden GP.** A study of the results of removal of total knee prostheses. *J Bone Joint Surg [Br]* 1981; 63-B:287.
- Wade PJF, Denham RA.** Arthrodesis of the knee after failed knee replacement. *J Bone Joint Surg [Br]* 1984; 66-B:362-6.
- Waugh W.** The knee. In: Harris NH, ed. *Postgraduate textbook of clinical orthopaedics*. Bristol, etc: Wright PSG, 1983:586-94.