TWO-STAGE EXCHANGE OF INFECTED KNEE ARTHROPLASTY WITH AN PROSTHESIS-LIKE INTERIM CEMENT SPACER

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Two-stage revision in infected knee arthroplasty is standard practice. One problem during the interim period is soft tissue fibrosis. Attempts have been made to preserve leg length and ligament length by introducing spacers, usually made out of antibiotic-loaded bone cement.

We present a new interim prosthesis, which is made intra-operatively out of polymethylmethacrylate (PMMA). Antibiotic-loaded cement provides a therapeutic level of antibiotics in the periarticular soft tissue.

We report the results in ten patients, who were treated with this prosthesis-like spacer and were prospectively studied. After an average follow-up of 13.5 months, there was no recurrent infection.

Keywords : total knee arthroplasty ; revision ; infection ; spacer.

Mots-clés : prothèse totale de genou ; reprise ; infection ; espaceur.

INTRODUCTION

Infections following total knee replacements are among the most severe complications in endoprosthetic procedures. Early infections may be treated by systemic antibiotics and surgical debridement (2, 3, 13). In cases of late infection, a two-stage revision procedure, including removal of the infected prosthesis and filling the gap with various antibiotic-loaded cement bodies (solid spacers, antibiotic-loaded PMMA chains) remains the treatment of choice. Other operative treatments such as arthrodesis or above-knee amputation are very detrimental for the patient.

Exchange operations for infected knee arthroplasties may be done in a one-stage (14) or two-stage (15) revision. The one-stage procedure has the advantages of a single operation, shorter hospitalization, better mobility and lower costs for the medical health system (6, 15). One of the most severe disadvantage is a higher incidence of persistent or recurrent infection (5, 6, 15).

Two-stage revisions include removal of the infected prosthesis in the first operation and reimplantation of a prosthesis in the second stage, after adequate treatment of the infection. One of the main problems in two-stage revision is soft tissue fibrosis with shortening of the leg length and immobilization of the patient during the interim period.

This soft tissue scarring may be avoided with an external fixation (5) or using a cement spacer (2, 3, 4, 7, 8, 9, 14, 17). Patients treated with a solid cement spacer have often shown a poor range of motion postoperatively.

We present a prosthesis-like cement spacer, which is made out of PMMA. Bone cement is enriched with effective antibiotics, based upon the antibiogram.

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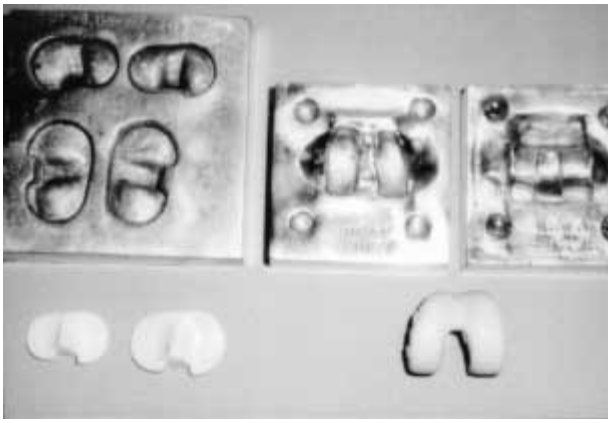

Fig. 1. — Special aluminium molds

The aim of such articulating spacers is to avoid soft tissue fibrosis during the interim period as well as to ensure better conditions for the subsequent reimplantation. The design of this cement spacer is comparable to that of an unconstrained condylar prosthesis.

MATERIAL AND METHODS

The prosthesis-like interim spacer is made intraoperatively with special molds ([1]), made of polyoxymethylene (POM), a thermoplastic material (fig. 1). The spacer is made out of PMMA , enriched with effective antibiotics. PMMA is filled into both parts of the special POM molds and compressed during polymerization. The spacer comes without any other foreign materials such as metal or polyethylene, which is an important advantage. The result of this preparation is a prosthesis-like tibial and femoral component of PMMA (fig. 2).

All patients with a late infection following total knee arthroplasty were included in this prospective study. The diagnostic criteria of a late infection included anamnestic data, clinical signs, xrays as well as technetiumbone scan. The infection was confirmed with blood tests (white blood cell count, erythrocyte sedimentation rate, C-reactive protein) and preoperative joint aspiration and culture.

Intraoperative management

After arthrotomy of the knee joint, using the previous approach, a swab test was taken of the joint fluid, followed by extensive irrigation of the joint and surrounding soft tissue and radical debridement with synovectomy. All components of the artificial knee, including the old cement layer, were removed. At the same time, another surgeon prepared the interim cement spacer using 80 g commercial Refobacin-Palacos® (Merk, Germany), using special molds. In all patients, Refobacin-Palacos® was enriched with vancomycin (2 g vancomycin /40 g Refobacin-Palacos®).

Fig. 2. — Prosthesis-like spacer made of PMMA

After hardening, the components were shaped for precise fitting. The stems of the components were formed by cutting a surgical glove so as to cover the walls of the tibial and femoral canal, to prevent the cement from adhering to bone. With the glove inside the medullary canal, cement was injected using a cement syringe. The components of the spacer were then placed onto the cement and were finally pressed together after reducing the knee joint. The cement was allowed to cure, while the knee was extended under moderate traction.

(1) Spacer molds are available via T. Regitz, Kaiserstraße 32, 66459 Kirkel, Germany.

Fig. 3. — Intraoperative appearance with an implanted spacer

The glove inserted into the medullary canal facilitated removal of the tibial and femoral components and of the stem.

The tibial and femoral cement spacer were then implanted using bone cement only on the tibial and femoral cuts to facilitate their explantation in the subsequent second-stage operation (fig. 3). A drainage without suction was inserted into the joint and the wound was closed in a bended knee position. Fig. 4 shows the postoperative x-ray.

Postoperatively, all patients were treated with systemic intravenous antibiotic therapy (cephalosporine), followed by oral administration of cephalosporine for an additional four weeks.

Postoperative physiotherapy included active and passive motions related to the patient's pain levels. All patients were treated with intravenous pain medication during the first 3 days postoperatively, followed by oral administration of tramadol-HCL (3 × 100 mg/day) and metamizol-Na (4 × 500 mg/day). They were mobilized with partial weight bearing using two walking aids.

Explantation of the interim cement spacer and reimplantation of a total knee prosthesis was done after a period of 6 to 12 weeks, when the inflammatory blood tests (CRP) were back to normal levels. Criteria for healing the infection were negative inflammatory blood tests and normal local conditions of the knee joint, besides good general health conditions. The second-stage operation included another debridement and cemented fixation of the tibial and femoral component with Refobacin-Palacos. The patella, which had not been resurfaced during the primary knee replacements, was not replaced during the revision operation.

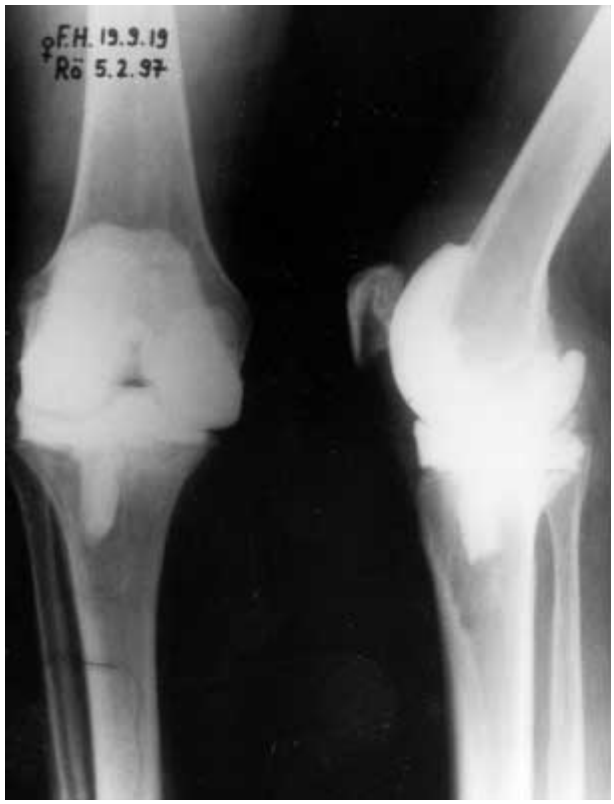

Fig. 4. — Xray of the spacer

All patients were clinically evaluated using the HSS-Score (13) prior to the operation, at the end of the interim period and at follow-up after an average period of 16.9 months postoperatively (range 6 to 26 months).

RESULTS

Ten patients (three male, 7 female, average age 66.1 years) with late infection following knee arthroplasty were treated with this method (table I) and evaluated 6 to 26 months postoperatively (average length of follow-up 18.1 months). The diagnostic criteria of a late infection included clinical signs, blood tests (white cell count, ESR, CRP) and results of joint aspiration. In four cases, no pathogen could be isolated, as these patients received antibiotic therapy prior to joint aspiration. In these cases increased CRP levels, an elevated sedimentation rate and intraoperative pathology were used as criteria for infection.

Table I. — Patients and results

No.	age	sex	pathogen	Duration of interim period (weeks)	clinical outcome / follow-up (months)
1	77	female	none	12	free of infection / 26
2	69	male	Staph.epidermidis	10	free of infection / 9
3	69	female	Pseudomonas aerug.	6	free of infection / 36
4	76	female	Staph. epidermidis	10	free of infection / 14
5	56	female	none	8	free of infection / 12
6	73	female	Proteus mirabilis	6	free of infection / 12
7	63	female	E. coli	6	free of infection / 6
8	54	female	none	6	free of infection / 16
9	59	male	none	8	free of infection / 25
10	65	male	Staph. aureus	10	free of infection / 13

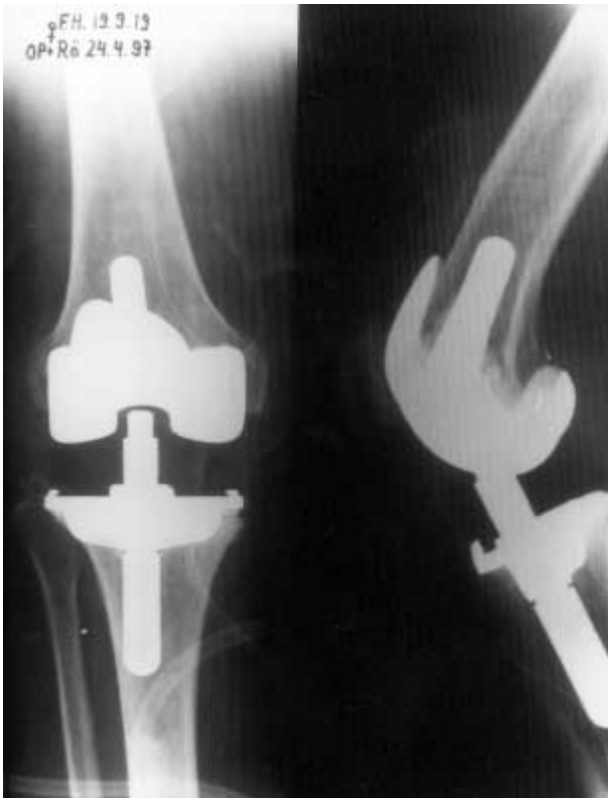

Fig. 5. — X-ray after spacer removal and knee replacement

There were no intraoperative or postoperative complications. The average duration of the interim period was 8.2 weeks (range 6-12 weeks).

Due to bone defects, we reimplanted a GSB prosthesis in four cases. A PFC condylar knee was reimplanted in two patients, an Interax knee in the other four.

At follow-up (average 18.1 months after reimplantation), all patients were free of infection. Eight of the 10 patients showed full extension of the knee joint, while the others had a mild flexion contracture of 5°. All but one patient showed an increase in ROM after reimplantation of a TKR. The average flexion increased from 70.5° preoperatively to 88.5° at follow-up. The average extension was similar to the preoperative situation (-0.5° preoperatively versus 0° at follow-up).

The overall range of motion increased from 69° preoperatively to 86.5° at follow-up. The HSS-Score showed an improvement from 39.1 (range 18-53) preoperatively to 42.0 (range 20-70) at the end of the interim period and to 63.8 (range 22-85) at follow-up (table II).

DISCUSSION

The most important principles in the treatment of infected knee arthroplasties are healing of the infection and preservation of joint function. Owing to the higher incidence of reinfection following one-stage procedures (5, 6, 15), the two-stage regimen is usually considered the therapeutic concept of choice. Soft tissue retraction could be avoided as well as the formation of solid bone osteophytes bypassing the knee joint line, thanks to the temporary implantation of joint spacers (4, 14).

Other procedures available for the treatment of infected joints, such as external fixation have the disadvantage of possible pin tract infection with the danger of consecutive osteomyelitis.

Table II. — Clinical outcome before and after spacer implantation (range of motion)

No.	passive ROM (extension/flexion) preoperatively (degrees)	passive ROM (extension/flexion) at follow-up after TKR-reimplantation (degrees)	HSS before spacer implantation	HSS at the end of interim period	HSS at follow-up after reimplantation of TKR
1	0/0/95	0/5/90	48	55	47
2	5/0/40	0/0/100	45	50	70
3	0/10/20	0/0/20	18	22	20
4	0/0/50	0/0/90	46	53	66
5	0/0/100	0/0/85	53	53	67
6	0/5/50	0/0/80	38	49	83
7	0/0/90	0/0/100	39	37	66
8	0/0/65	0/0/80	36	33	69
9	0/0/110	0/0/120	33	30	85
10	0/5/85	0/5/110	35	38	65
average	overall ROM 69°	overall ROM 86.5°	39.1	42.0	63.8

Knee spacers can be divided into „articulating“ and „non-articulating“ spacers. Non-articulating spacers are helpful for infection healing but they do not allow a significant joint mobility during the interim period (3, 13, 17). Our experience showed that restriction of joint motion during the interim period causes severe adhesions of the suprapatellar recesses, followed by shortening of the quadriceps tendon.

Infected joints can be treated with antibiotic-loaded PMMA chains around a temporary prosthesis or with one of the following articulating spacer types :

1. Handmade antibiotic-loaded cement spacers including foreign materials such as PE-inlays or a bicondylar femoral prosthesis (6)
2. Handmade antibiotic loaded cement spacers without other foreign materials (7, 10, 14, 15, 18)

Antibiotic chains around a temporary prosthesis allow for early mobilization with a stable joint, without leg length discrepancies (13).

Handmade spacers made of foreign material should guarantee an early onset of joint motion with partial weight bearing. Mobilisation avoid periprosthetic osteopenia (6). Disadvantages of this method are the implanted foreign materials (polyethylene or metal) with the danger of infection persistence (19). Handmade antibiotic-loaded cement spacers without other foreign materials have a greater antibiotic-releasing surface. Due to their handmade construction, these spacers are incongruent and show increased cement wear and increased stress on the tibial and femoral fixation.

The interim prosthesis presented here is a combination of a cement spacer with a design of an unconstrained prosthesis. The advantages of this spacer are local release of antibiotics and improved mobility ([2]).

We suggest that this spacer, with relatively good congruence of the tibial and femoral component, leads to decreased cement wear. Additionally, partial weight bearing and physiotherapy avoid atrophy of muscles and inactivity-related osteopenia, as well as fibrosis of soft tissue such as ligaments and capsule. Postoperative mobilization is also essential to avoid thromboembolic and cardio-pulmonary complications and to achieve better conditions for reimplantation.

The optimal time for reimplantation in a two-stage revision of an infected knee joint remains

(2) Kelm J., Siebel T., Regitz T. Antibiotic release in molded PMMA knee spacers. Unpublished data, 1997.

controversial. Basically, the decision may be based upon normal inflammatory parameters and the local conditions of the knee and the patient's general health conditions, which are fundamental for the second operation.

When antibiotics release out of the cement spacers becomes insufficient and the infection is clinically still present, we recommended an exchange of the interim prosthesis. Most authors favor an interim period of 6 to 12 weeks (1,6, 7, 13, 15, 17, 18, 19). Others recommend a longer period up to 17 months (2). The lengths of interim periods depend on the clinical and inflammatory conditions. After a period of about two weeks, most of the antibiotics are released out of the cement spacer.

Schurman *et al*. (12) showed in an animal study with cemented arthroplasties, that the synovial concentration of gentamycin was decreased to 0.5 µg/ml 10 days postoperatively. Biopsies of cement surrounding soft tissue showed that antibiotic concentrations are below the recommended therapeutic levels, one month postoperatively.

The nature of the bone cement has an important influence on the pharmacological kinetics of antibiotics. (16, 19). Exposure to local antibiotic drugs such as antibiotics released from bone cement may cause allergies (12, 16). Finally, the mechanical stability of cement is decreased by a high quantity of antibiotics (> 4 g antibiotics/40 g PMMA) (16).

In conclusion, the two-component, antibiotic-loaded cement spacer presented is an alternative tool in two-stage revision of infected knee arthroplasties. The spacer is made of Refobacin-Palacos without any other foreign material. It prevents soft tissue retraction and fibrosis and facilitates the subsequent second-stage surgery.

The optimal time for reimplantation is important for the clinical outcome and should be considered critically, as should the choice of antibiotics and type of cement.

REFERENCES

1. Abendschein W. Salvage of infected total hip replacement : Use of antibiotic/PMMA spacer. Orthopedics, 1992, 15, 228-229.
2. Booth R. E., Lotke P. A. The results of spacer block technique in revision of infected knee arthroplasty. Clin. Orthop, 1989, 248, 57-60
3. Cohen J. C., Hozack W. J., Cuckler J. M., Booth R. E. Jr. Two-stage implantation of septic total knee arthroplasty. J. Arthroplasty, 1988, 3, 369-377
4. Gusso M. I., Capone A., Civini R., Scoccianti G. The spacer block technique in revision of total knee arthroplasty with septic loosening. Chir. Organi Mov., 1995, 80, 21-27
5. Hanssen A. D., Trousdale R. T., Osmon D. R. Patient outcome with reinfection following reimplantation for infected total knee arthroplasty. Clin. Orthop., 1995, 321, 55-67
6. Hofmann A. A., Kane K. R., Tkach T. K., Plaster R. L., Camargo M. P. Treatment of infected total knee arthroplasty using an articulating spacer. Clin. Orthop., 1995, 321, 45-54.
7. Kirschner S., Werner A., Walther M., Rader C. P., Gohlke F. E. Versorgung mit anatomischen Spacern bei chronischem Endoprotheseninfekt am Knie. Orthopädische Praxis, 2000, 36, 422.
8. Küsswetter W., Martini F. Zweizeitige Revisionsendoprothetik am Kniegelenk. Z. Orthop., 1997, 135, 7-9.
9. McMaster W. C. Techniques for intraoperative construction of PMMA spacer in total knee revision. Am. J. Orthop, 1995, 24, 178-180.
10. McPherson E. J., Lewonowski K., Dorr L. Brief communication. techniques in arthroplasty. J. Arthroplasty, 1995, 10, 87-89.
11. Ranawat C. S., Shine J. J. Duo-Condylar total knee arthroplasty. Clin. Orthop, 1973, 94, 185-195.
12. Schurman D. J., Trindade C., Hirshman H. P., Moser K., Kajiyama G., Stevens P. Antibiotic-acrylic bone cement composites. J. Bone Joint Surg., 1978, 60-A, 978-984.
13. Scott I. R., Stockey I., Getty C. J. Exchange arthroplasty for infected knee replacements. J. Bone Joint Surg., 1993, 75-B, 28-31.
14. Trepte C. T., Puhl W. Revisionseingriffe bei aseptisch und septisch gelockerten Knieendoprothesen. Z. Orthop., 1989, 127, 315-321.
15. Trepte C. T., Bodenburg R. Der septische Prothesenwechsel unter Verwendung eines Zweikomponentenspacers. Orthop. Praxis., 1996, 11, 775.
16. Trippel S. B. Current concepts review. Antibiotic-impregnated cement in total joint arthroplasty. J. Bone Joint Surg., 1986, 68-A, 1297-1302.
17. Whiteside L. A. Treatment of infected total knee arthroplasty. Clin. Orthop., 1994, 299, 169-172.
18. Wilde A. H., Ruth J. T. Two-stage implantation in infected total knee arthroplasty. Clin. Orthop.,1988, 236, 23-35.
19. Zimmerli W. Pathogenese und Therapie von orthopädischen Implantatinfektionen. Abstract International AFOR Meeting, Valbella/Switzerland, 23.02-01.03.1997.

SAMENVATTING

T. SIEBEL, J. KELM, M. PORSCH, W. H. NEUMANN, T. REGITZ. Het gebruik van een gearticuleerd metacrylaat spacer bij de revisie in twee tijden van geïnfecteerde knieprotheses.

Revisie in twee tijden is een standaard regime bij geïnfecteerde knie protheses.
Meestal wordt de ruimte geschapen door het verwijderen van de prothesis opgevuld met een metacrylaat spacer doordrenkt van antibiotica, om in afwachting van de tweede tijd verkorting en ligamentaire contractie door fibrosis te voorkomen.
De schrijvers stellen een nieuwe tijdelijke prothesis voor, gemaakt intra-operatief uit methylmetacrylaat, doordrenkt met antibiotica in een dosis voldoende hoog om een therapeutisch effect in de omgevende weke weefsels te bereiken.
Het resultaat van dergelijke aanpak werd prospectief gevolgd in tien gevallen. Er was geen herval van infectie na een gemiddelde opvolging van 13.5 maanden. De gemiddelde beweeglijkheid bij de laatste controle bedroeg 86.5°.

RÉSUMÉ

T. SIEBEL, J. KELM, M. PORSCH, W. H. NEUMANN, T. REGITZ. Reprise en deux temps des prothèses de genou infectées avec un espaceur articulé en ciment acrylique.

La reprise en deux temps d'une prothèse de genou infectée est de pratique courante. Un des problèmes qui se pose est celui de la fibrose des tissus mous au cours de la période intermédiaire entre les deux temps chirurgicaux. Pour conserver la longueur du membre et la tension des ligaments, on a eu recours à des espaceurs, généralement réalisés au moyen de ciment acrylique imprégné d'antibiotique.
Les auteurs présentent une nouvelle prothèse temporaire en ciment acrylique, qui est réalisée en peropératoire. Le ciment imprégné d'antibiotique fournit un taux thérapeutique d'antibiotique dans les tissus mous périarticulaires.
Les auteurs rapportent les résultats obtenus chez 10 patients qui ont été traités en recourant à cet espaceur articulé et qui ont été suivis prospectivement. Il n'y avait aucune récidive infectieuse avec un suivi de 13,5 mois. L'amplitude moyenne de flexion au dernier recul était de 86,5°.