Functional interest of an articulating spacer in two-stage infected total knee arthroplasty revision

T. Classen a,⁎, M. von Knoch b, M. Wernsmann a, S. Landgraeb a, F. Löer a, M. Jäger a

a Orthopaedic Department, University of Duisburg – Essen Medical School, Hufelandstrasse 55, 45147 Essen, Germany
b Orthopaedic Department, Hospital of Bremerhaven, Bremerhaven, Germany

A R T I C L E   I N F O
Article history:
Accepted 31 January 2014

Keywords:
Knee
Total knee arthroplasty
Infection
Two-stage revision
Articulating spacer

A B S T R A C T
Introduction: Deep periprosthetic infection is one of the most serious complications after total knee replacement. The two-stage procedure with implantation of a temporary cement spacer and later re-implantation of a revision total knee prosthesis is an accepted procedural standard. The use of articulating spacers has been proposed to enhance ease of revision and functional results.

Patients and methods: Twenty-three patients treated with an articulating spacer were retrospectively studied. All patients had undergone a two-stage surgery. The infected prosthesis was explanted and the femoral component was sterilized and re-implanted. On the tibial side a block of gentamicin-loaded bone cement was produced intraoperatively using specially manufactured templates. Eighteen total knee arthroplasty revisions and 5 arthrodeses were finally performed.

Results: A total of three (13%) re-infections occurred 5–20 months after revision total knee arthroplasty in a mean follow-up period of 47 months. Prior to re-implantation, flexion with the articulating spacer ranged between 15 and 100° (mean 68 ± 28°). The average postoperative flexion after re-implantation of total knee replacement was 105 ± 11°.

Conclusion: The articulating spacer used in this study appears to be as effective as the standard procedures in terms of re-infection risk rate and postoperative range of motion recovery.

Level of evidence: Level IV.

© 2014 Elsevier Masson SAS. All rights reserved.

1. Introduction

Deep periprosthetic infection is one of the most serious complications after total knee arthroplasty. The treatment is difficult, and the postoperative results after re-implantation of a total knee prosthesis (TKP) are usually worse than after aseptic revision [1,2]. The two-stage procedure with removal of the prosthesis, implantation of an antibiotic-impregnated spacer and subsequent re-implantation of a revision TKP has become an established method of treatment. Success rates vary between 88 and 98% [2–9]. Other methods such as lavage, debridement and antibiotic therapy or a single-stage procedure with exchange of the prosthesis in late and chronic infections usually do not show these success rates [10–13]. However, use of non-articulating cement spacers results in restricted mobility and instability of the knee because of prolonged immobilization, leading to limited function [5,8,14]. Moreover, implanting a revision TKP in patients with a non-articulating spacer is a more difficult procedure, because of scar tissue, which, for example, makes osteotomy of the tuberosity or a quadriceps snip necessary, and because of greater bone loss when using a static as opposed to an articulating spacer [6,8]. In addition, patients with a static spacer are more likely to suffer wound healing disorders and thrombosis [15,16]. Therefore, the system of an articulating cement spacer was developed in which the femoral component of the primary TKP is re-sterilized and then re-implanted. Hofmann et al. replaced the tibial component with a cement spacer and used also a PE-inlay [8,17]. Fehring et al. used also an articulating spacer but they used a cement spacer to replace both the femoral and tibial components [6]. The advantage of this method lies in the considerable improvement in the range of motion of the knee joint and the increased mobility of patients [3,8,17]. Re-implantation of a revision TKP therefore leads to a better functional outcome [5].

We retrospectively analyzed 23 patients treated with an articulating cement spacer without a PE-inlay because of deep periprosthetic infection after total knee arthroplasty. The aim of this study was to analyze to what extent the postoperative range of motion and re-infection rates differ in comparison to other methods of treatment. We hypothesized that the postoperative range of motion is better with articulating spacers than in standard cases.

Please cite this article in press as: Classen T, et al. Functional interest of an articulating spacer in two-stage infected total knee arthroplasty revision. Orthop Traumatol Surg Res (2014), http://dx.doi.org/10.1016/j.otsr.2014.01.010

⁎ Corresponding author.
E-mail address: timclassen@gmx.de (T. Classen).

http://dx.doi.org/10.1016/j.otsr.2014.01.010
1877-0568/© 2014 Elsevier Masson SAS. All rights reserved.
motion would be as good as articulating cement spacer with a PE-inlay and better as with static spacer. Re-infection rates should be smaller as with articulating cement spacer with a PE-inlay because of the missing foreign material.

2. Patients and methods

Approval was obtained from the Ethics Committee of the Medical Faculty of the University of Duisburg-Essen (Ethics Number: 08-3883). A total of 23 consecutive patients (17 women and 6 men; mean age: 66 years [37–81 years] at the time of primary implantation) treated in our clinic between 2003 and 2008 with an articulating spacer because of deep periprosthetic infection were analyzed retrospectively. All deep periprosthetic infection after total knee arthroplasty that occurred more than 6 weeks after primary implantation were treated with the method described. The infection was confirmed by a positive microbiologically culture. These were mainly from the Staphylococcus group (n = 13), followed by Streptococci group (n = 4) and other pathogen species (Table 1).

The average implant survival rate of the primary prosthesis was 5 years (3 months–20 years), so that the average age of the patients at the time of explantation was 71 years (41–83 years).

The surgical procedure included removal of the tibial and femoral components. Furthermore, all the cement remnants were removed and extensive debridement as well as jet-lavage was performed. Then the femoral component was re-sterilized using plasma sterilization and re-implanted. A tibial plateau of the necessary thickness was formed of bone cement (PMMA: revision bone cement with 2% gentamicin sulfat [Palacos® R+G, Heraeus Medical]) using a specially made silicone mould. To avoid greater bone loss in the next operation the bone cement used to fix the femoral component and the tibial spacer hardened lightly for about 5 to 6 minutes so that it was viscous enough not to fix deeply with the bone. Antibiotics according to the patients’ antibiograms were not added. A PE-inlay was not used (Figs. 1 and 2). Postoperatively, patients were mobilized on forearm crutches with their knee stabilized in an orthosis fixing the knee in extension and with foot sole contact. In addition, passive mobilization of the knee was performed under the supervision of a physiotherapist.

After implantation of the spacer the patients received intravenous antibiotics according to their antibiogram for two weeks. These were then continued for another four weeks orally. Thereafter, the antibiotics were discontinued for two weeks and then the knee joint was punctured. If the microbiologically cultures and the cell count were without pathological findings and CRP levels were under 3 mg/dl (normal range: 0.01 to 0.5 mg/dl), a revision total knee prosthesis was re-implanted or arthrodesis was performed.

The articulating spacer was left in situ for a mean period of 184 days (76–359 days). The longer period in situ in some of the cases was not due to surgical reasons, but was related to other diseases of the patients. The average period between re-implantation and follow-up examination of re-infection was 47 months (19–103 months). The average period between re-implantation of TKP and follow-up examination of postoperative range of flexion was 9.5 months (1.5–58 months).

We investigated any co-morbidities of the patients that may have had an influence on immune defense and wound healing, and determined the Charlson Comorbidity Score [18]. Also any postoperative complication was noted as well as the bone defects described in the surgical report.

Eight of the patients, who are no longer undergoing treatment in our clinic, were interviewed by telephone to find out if the revision total knee replacement was still in situ or if there had been a re-infection in the meantime. Since we were not able to investigate the range of motion of these patients at the latest follow-up, we had to rely on previous examinations. The other patients presented in our clinic and we were able to carry out a follow-up examination.

Please cite this article in press as: Classen T, et al. Functional interest of an articulating spacer in two-stage infected total knee arthroplasty revision. Orthop Traumatol Surg Res (2014), http://dx.doi.org/10.1016/j.otsr.2014.01.010
The data were collected in an Excel file (Microsoft Corp., Redmond, USA) and then examined with regard to means and standard deviation.

3. Results

3.1. Technique

Overall, 18 revision TKP (3 hinged total knee prostheses) and five arthrodesis nails were implanted (3 because of large bone defects and 2 after failure of TKP revision) (Fig. 3). Intraoperatively there were no new bone defects at the time of re-implantation compared to the implantation of the articulating spacer. Only one patient had an infraction of the dorso-medial part of the tibia at the time of implantation of the articulating spacer. This dorso-medial part of the tibia had been bursted out up to the re-implantation.

During re-implantation of the revision TKP, tuberosity osteotomy was performed in three patients. In one patient this was because the spacer had already been exchanged once before because the surgeon had intraoperatively discovered signs of infection (see below). The second patient had a patella baja and severe chronic polyarthritis. In this case the spacer had also dislocated after a fall on the knee, so the patient was treated with a Miconor orthosis. In the third patient a superficial wound revision had to be performed with the spacer in situ while the patient was still in hospital because of disturbed wound healing. Here also the cicatization was too extensive.

3.2. Infectious results

In two patients the spacer was exchanged at the planned re-implantation of a revision TKP because the surgeon discovered intraoperatively signs of infection. However, in neither of the patients was proof of the presence of pathogens found in the preoperative puncture nor in the intraoperative swab and histopathological examination. Furthermore, the patients’ inflammatory markers were within the normal range (CRP: 1.35 and 1.11 mg/dl, leukocytes: 10.4 and 9.1 T/μl).

In three patients (13%) re-infection occurred after 5, 9 and 20 months after re-implantation of a revision TKP. In all three patients the pathogen was different from the one found in the primary infection (primary pathogen) (Table 2). Two of the three patients with re-infection had co-morbidities (obesity, coronary heart disease, COPD, emphysema, myocardial infarction, peripheral vascular disease and chronic renal failure).

Table 2

<table>
<thead>
<tr>
<th>Primary pathogen</th>
<th>Secondary pathogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>β-haem. Streptococcus (r)</td>
<td>Staphylococcus epidermidis (s)</td>
</tr>
<tr>
<td>Gemella morbillorum (r)</td>
<td>Proteus mirabilis (s)</td>
</tr>
<tr>
<td>Staphylococcus epidermidis (s)</td>
<td>Enterococcus faecalis (r)</td>
</tr>
</tbody>
</table>

r: resistant to gentamicin; s: sensitive to gentamicin.

3.3. Range of motion

The preoperative range of flexion with the primary TKA was on average 79 ± 27° (10–115°). The extension deficit was 5 ± 7°. The range of motion of the knee for flexion, with the spacer in situ, was on average 68 ± 28° (15–100°) with a mean extension deficit of 4 ± 5°. The postoperative range of flexion with the remaining 18 revision TKP was on average 105 ± 11° (80–130°) (Table 3).

4. Discussion

Articulating spacers are usually implanted according to the method described by Hofmann et al. [8,17]. The femoral component is re-sterilized and a new PE-inlay is inserted which rests on the tibial cement block. Re-sterilized femoral components, however, have been shown to have a significant advantage regarding the later range of flexion compared to static spacers, and no significant differences in the re-infection rate have been found [5].

In the present study the femoral component was also re-sterilized and then re-implanted. However, no PE-inlay was used and the tibial cement block was formed in a silicone mould specially for this purpose. With this system an articulating spacer is used in combination with a re-sterilized femoral component, thus providing the previously described advantages. It is important that patients are informed explicitly about the use of a re-sterilized femoral component, because the prosthesis is not primarily intended for this purpose and therefore not approved. This procedure constitutes an individual attempt to heal the patient’s infection. As mentioned before, we do not use a PE-inlay, as additional foreign material increases the risk of bacterial colonization. The theoretical advantage of our system could not be proved in this study because the re-infection rate is 13% and therefore at a similar level to that in previous studies (4–12%) with a similar pathogen spectrum and using a PE-inlay [3,5,6,8]. However, in this study the primary pathogen was not detected in any of the re-infections. The new infection was caused by a different pathogen in every case. The detection of different pathogens at re-infection is already known from previous studies dealing with the articulating spacer [2,5,7,8]. In most studies, as well as re-infections with different pathogens, there were also re-infections with the same pathogen. Only one study reported re-infections which were all due to different pathogens [5]. Therefore, the secondary infection may be a recurrence of the primary infection which was a mixed infection or it may be a completely new infection. At the time of the study only one puncture and two swabs of the explanted components was made intraoperatively in our clinic. Today it is established to take at least five samples for microbiological analysis.

Other studies show that the risk for wound healing disorders, thrombosis, bone loss and extensive cicatization is greater when using a static spacer [6,8,15,16]. Nevertheless in this study there was one patient with disturbed wound healing so that a superficial wound revision had to be performed. In three patients a tuberosity osteotomy has to be performed at the time of re-implantation because of extensive cicatration and patella baja. Postoperative thrombosis or greater bone loss did not occur in the time the articulating spacer was in situ. The bone loss should be reduced by using cement that lightly hardened for about 5 to 6 minutes so that it
is viscous enough not to fix deeply with the bone. So it is possible to get the spacer out without any bone loss. At the same time the connection between cement and bone is not stable enough for weight bearing. Therefore the patients were mobilized on forearm crutches with their knee stabilized in an orthosis fixing the knee in extension and only with foot sole contact.

The maximum range of flexion with the articulating spacer in the present study was between 15°–100°. Previous studies showed a range of flexion of between 10°–130° with the spacer in situ. The postoperative range of flexion after implantation of a revision TKA (105°) was also similar to that of previous studies (between 94.5 and 115°) [3,4,7,8,17–20].

In our opinion there is no need for the implantation of a PE-inlay because it has no advantage. Although we cannot prove it in the end as part of this study the implantation of the PE-inlay could be a further target for pathogens. The functional results without the PE-inlay are as good as these of previous studies with PE-inlay.

**Disclosure of interest**

The author declares that he has no conflicts of interest concerning this article.

**References**


**Table 3**

Articulating spacer: literature review.

<table>
<thead>
<tr>
<th>References</th>
<th>Number of patients</th>
<th>Re-infection (%)</th>
<th>Re-infection with the same pathogen</th>
<th>Range of flexion with spacer [average (maximum flexion)]</th>
<th>Postoperative range of flexion [average (maximum flexion)]</th>
<th>Follow-up (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson et al. [3]</td>
<td>25</td>
<td>1 (4%)</td>
<td>1</td>
<td>112</td>
<td>115</td>
<td>54 (24–108)</td>
</tr>
<tr>
<td>Cucker [4]</td>
<td>44</td>
<td>1 (2,3%)</td>
<td>1</td>
<td>110 (45–125)</td>
<td>112 (45–125)</td>
<td>65 (24–120)</td>
</tr>
<tr>
<td>Haddad et al. [7]</td>
<td>45</td>
<td>4 (8,9%)</td>
<td>1</td>
<td>71,2 (10–130)</td>
<td>94,5 (20–135)</td>
<td>48 (20–112)</td>
</tr>
<tr>
<td>Hofmann et al. [8]</td>
<td>50</td>
<td>6 (12%)</td>
<td>2</td>
<td>91</td>
<td>104</td>
<td>73 (24–150)</td>
</tr>
<tr>
<td>Hofmann et al. [17]</td>
<td>26</td>
<td>0</td>
<td>0</td>
<td>82</td>
<td>106</td>
<td>31 (12–70)</td>
</tr>
<tr>
<td>Park et al. [19]</td>
<td>16</td>
<td>1 (6,3%)</td>
<td>7</td>
<td>80 (50–140)</td>
<td>108 (85–140)</td>
<td>29 (25–45)</td>
</tr>
<tr>
<td>Pietsch et al. [20]</td>
<td>33</td>
<td>3 (9,1%)</td>
<td>1</td>
<td>83 (40–120)</td>
<td>100 (70–140)</td>
<td>47 (31–67)</td>
</tr>
<tr>
<td>Present study</td>
<td>23</td>
<td>3 (13%)</td>
<td>0</td>
<td>68 (15–100)</td>
<td>105 (80–130)</td>
<td>47 (19–101)</td>
</tr>
</tbody>
</table>