Infection cure rate and functional results after 40 two-stage and 28 one-stage cemented reimplatations for knee prosthesis infected by methicillin resistant staphylococcus aureus

Wyniki kliniczne i funkcjonalne 40 jednoetapowych i 68 dwuetapowych rewizji cementowanych endoprotez kolana z powodu infekcji gronkowcem złocistym metycylnoopornym

Ireneusz Babiak1,2, Rafal Majkusiak1,3
1 Department of Orthopedics and Traumatology, Medical University of Warsaw, Warsaw, Poland
2 Department of Orthopaedics, Mediciver Hospital, Warsaw, Poland
3 Department of Orthopaedics, Hospital de Mérida, Mérida, Spain

Abstract

Introduction. The study compares infection cure rate and functional results after one- and two-stage revision of total knee prosthesis due to MRSA infection.

Material and methods. Results of 28 one-stage cemented revisions with addition of 5% of vancomycin and 40 two-stage revisions with hand-made, articulating cement spacer containing 5% of vancomycin were compared. The average follow up was 4.5 years (3 to 7.5 years). Functional results were assessed in HSS, HKASS and WOMAC scores. As good result the lack of clinical, radiological and biochemical signs of infection, more than 61 points in HSS score and more than 50 points in HKASS score were assumed. Results were statistically analysed.

Results. The infection cure rate was 95% after two-stage reimplantation with articulating spacer and 89.3% after one-stage revision. Functional results in HSS score were significantly better after two-stage reimplantations than after one-stage reimplantations (average 78.9 points vs 65.8 points, p-value 0.05; CI 95%: 72.4-95.6%). The satisfaction with treatment on HKASS scale was higher after two-stage than after one-stage revision (average 78.5 points vs 68.3 points), but not statistically significant.

Conclusions. The study demonstrated better cure rate and functional results after two-stage reimplantation with hand-made, articulating cement spacer containing 5% of vancomycin – as compared to one-stage reimplantation using the same acrylic cement for prosthesis fixation performed due to infection of knee prosthesis with MRSA.

Key words: infected total knee prosthesis, MRSA, one-stage reimplantation, two-stage reimplantation, functional results

Streszczenie

Wstęp. W badaniu porównano wyniki leczenia infekcji i wyniki czynnościowe po jedno- i dwuetapowej rewizji całkowitej protezy kolana z powodu zakażenia MRSA.

Materiał i metody. Porównywano wyniki 28 jednoetapowych rewizji cementowych z dodatkiem 5% wankomycyny i 40 dwuetapowych rewizji z ręcznie wykonanym spacerem z cementu akrylowego zawierającym 5% wankomycyny. Średni okres obserwacji wynosił 4,5 roku (od 3 do 7,5 roku). Wyniki funkcjonalne oceniono w punktach HSS, HKASS i WOMAC. Jako dobry wynik przyjęto brak objawów klinicznych, radiologicznych i biochemicznych zakażenia, ponad 61 punktów w skali HSS i ponad 50 punktów w skali HKASS. Wyniki poddano analizie statystycznej.

Wyniki. Wskaźnik wyleczenia infekcji wynosił 95% po reimplantacji dwuetapowej ze spacerem arytkulaacyjnym i 89,3% po rewizji jednoetapowej. Funkcjonalne wyniki w skali HSS były istotnie lepsze po rewizjach dwuetapowych niż po jednoetapowych (średnia 78,9 punktów w porównaniu z 65,8 punktami, p-wartość 0,05; CI 95%: 72,4-95,6%). Wysoka zadowoloność z leczenia na skali HKASS była wyższa po rewizji dwuetapowej (78,5 vs 68,3 punkty), ale nie była statystycznie istotna.

Wnioski. Badanie wykazało lepsze wyniki odnośnie wyleczenia infekcji i wyniki funkcjonalne po dwuetapowej rewizji z ręcznie wykonanym spacerem arytkulaacyjnym zawierającym 5% wankomycyny – w porównaniu z jednoetapową reimplantacją z użyciem tego samego cementu akrylowego, wykonywanej z powodu infekcji protezy kolana MRSA.

Słowa kluczowe: zakażenie endoprotezy stawu kolanowego, MRSA – gronkowiec złocisty oporny na metycylinę, rewizja jednoetapowo z powodu infekcji, rewizja dwuetapowa z powodu infekcji, wyniki czynnościowe
Introduction

The aim of the study is to compare infection cure rate and functional results after one- and two-stage cemented reimplantations of knee prosthesis infected with MRSA.

The prevalence of early prosthetic joint infection (PJI) after total knee arthroplasty (TKA) is estimated as 0.25-0.5% [1,2]. In the survey of 6489 TKA reported by Peersman the overall early deep infection rate after primary TKA was 0.39% and 0.97% after revision TKA respectively [2]. Progress in understanding patophysiology of PJI, as well as introduction of antibiotic-loaded cement spacers improved the results of therapy [3]. The aim of therapy of infected TKA is to control the infection and to maintain good function of the knee after revision operation. Despite differences in preferred attitude to this problem in Europe and USA, generally recommended methods of therapy for early PJI is debridement, whereas for late infection one- or two-stage reimplantation [1]. Arthrodesis or definitive removal of prosthesis are considered to be less satisfactory as reimplantation. It is also believed that the results of revision due to PJI are worse than for aseptic loosening [4,5,6].

Methycillin resistant Staphylococcus aureus (MRSA) is thought to be more difficult to treat than methycillin sensible Staphylococcus aureus (MSSA). Preferred treatment option modalities for MRSA prosthesis infection usually include removal of implant, vancomycin intravenous therapy for 4-6 weeks, and reimplantation of a new prosthesis after at least 6-8 weeks interval. Two-stage reimplantation seems to be safer as regards infection cure rate, although function of the knee with mobile spacers seems not to satisfyingly replace physiological pattern of knee motion and spacer usually require protected weight bearing with knee orthosis which can lead to worse functional results. In turn, one-stage reimplantation of TKA in MRSA infection is thought to carry higher risk of infection relapse, but expected functional results after one-stage reimplantation should be superior to two-stage due to avoidance of the interval combined with protection of the knee with spacer.

Material and method

The prospective study includes patients treated due to infected TKA in the period 1997-2010.

Only cases in which cultures from biopsies from the area of the prosthesis revealed methicillin resistant Staphylococcus aureus (MRSA) were included to the study. In all patients late infection was diagnosed according to McPherson classification [7]. The average follow up is 4.5 years (range 3 to 7.5 years) after last revision operation. Initially 76 patients were included, and 68 terminated the study. Eight patients did not complete the study: six did not agree to the final examination and two died of cardiac causes in the remote period after the surgery. There were 42 women and 26 men; 38 left and 30 right knees. The age at primary replacement ranged from 30 to 77 years (average 63 years). In 40 cases two-stage and in 28 cases one-stage reimplantations has been performed.

Selection criteria for two-stage revision has been as follows: visible soft-tissue infiltration and significant biofilm formation on the implant-bone interface (irrespective of preoperative identification of causative bacteria). During the two-stage revision an articulated, hand-made spacer was used, made from acrylic cement which was factory loaded with low-dose gentamicin (below 1 g per 40 g of cement), with addition of 5% of vancomycin. The selection of vancomycin was made based on the culture from joint aspiration before revision operation. For MRSA 2 g of vancomycin was added to 40 g of acrylic cement. During spacer interval patients were allowed to walk with protected weight-bearing and enhanced to knee exercises. Intravenous therapy with vancomycin for two weeks was administered. The 2nd stage was attempted after at least 6-8 week interval – after clinical assessment of the knee and negative cultures from the aspirate from the knee with the spacer. All reimplantations during the 2nd stage were cemented with the use of acrylic cement with admixture of 5% of vancomycin – according to cultures from the biopsies taken during the 1st stage. Selection criteria for cemented one-stage reimplantations with acrylic cement containing 5% of vancomycin were: preoperative identification of MRSA as causative pathogen upon joint aspiration and the absence of soft-tissue infiltration as well as the absence of significant biofilm in the medullary cavity after removal of implants. After implantation of a new prosthesis either in two- or one-stage manner, in all cases of infections caused with MRSA, systemic vancomycin intravenous therapy combined with oral rifampicin therapy 600mg for 2 weeks was administered out continued with oral therapy with rifampicin 600 mg daily and ciprofloxacin, levofloxacin or trimetoprim-sulphamethoxasole for additional 4 weeks.

After termination of the treatment the result of the last performed operation has been evaluated. Cure of infection has been assessed based on clinical examination, C-reactive protein (CRP) level, white-blood cell count (WBC) and X-ray of the knee, where the presence of scalloping, periostitis, or loosening of implant, instability and sings of cement damage were analysed. Functional results has been assessed using the Hospital for Special Surgery Knee-Rating Score (HSS) and the Hip and Knee Arthroplasty Satisfaction Scale (HKASS) [8]. The functional score HSS is based upon assessment of pain, joint function, range of motion, strength of quadriceps muscle, deformity and instability of the joint. Based on the total points gained the knee function has been scored as very good (over 85 points), good (70-84 points), satisfactory (60-69 points) and poor (below 60 points). The HKASS scale assesses satisfaction with the outcome of treatment in relation...
to the four parameters: pain, work, recreation, and overall satisfaction. For every question patient has four possible answers; each answer is scored from 0 to 3. Total score obtained after summing up the points in the four groups is multiplied by 8.33. Results locate within scale from 0–10. As a satisfactory result of the operation on this scale a value greater than or equal to 49.98 was assumed. WOMAC scale assesses the quality of life in 24 questions ranked in three main groups: pain (5 questions), joint stiffness (two questions) and difficulty in performing activities of daily living (ADL) (17 questions). Answers to each question were derived using a visual analogue scale (VAS). To evaluate changes after treatment, for each question patient pointed two answers: the actual status, and before revision surgery. Each scale domain (pain, stiffness and function) was evaluated separately. On the WOMAC scale the result is inversely proportional to the value obtained – the smaller the sum of points obtained for each domain, the result is better. Statistical analysis has been performed using the analysis of variance (ANOVA) or Kruskal–Wallis test, when applying of ANOVA assumptions were not met. When ANOVA showed significant differences, the averages scores were compared for each type of revision using the least significant difference. Assumed level of significance (p-value) was 0.05. Calculations were performed using EPI-INFO package and EXCEL. The study was performed following the Declaration of Helsinki principles and informed consent was obtained from study subjects.

Results

As good outcome lack of clinical and radiological signs of inflammation, normal CRP and WBC values, as well as more than 61 points in HSS and more than 50 points in HKASS score has been assumed. Poor result has been the presence of clinical signs of active infection, or/and elevated CRP or WBC, less than 60 points on HSS scale and below 49.98 points on the HKASS scale. Infection healed in 63 from 68 cases (92,15%): in 95% cases of two-stage reimplantations the result was better. Statistical analysis has been performed following the Declaration of Helsinki principles and informed consent was obtained from study subjects.

Table 1. Clinical and functional results in HSS, HKASS and WOMAC scores after 68 revisions of the knee prosthesis due to infection.

<table>
<thead>
<tr>
<th>Assessment score</th>
<th>Two-stage revision</th>
<th>I-stage revision</th>
</tr>
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<tbody>
<tr>
<td>Clinically free from infection</td>
<td>38/40 (95%)</td>
<td>25/28 (89.3%)</td>
</tr>
<tr>
<td>HSS – average value</td>
<td>78.9</td>
<td>65.8</td>
</tr>
<tr>
<td>HKASS – average value</td>
<td>78.5</td>
<td>68.3</td>
</tr>
<tr>
<td>WOMAC score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain preop.</td>
<td>70.3</td>
<td>70.4</td>
</tr>
<tr>
<td>Pain postop.</td>
<td>14.0</td>
<td>22.4</td>
</tr>
<tr>
<td>Stiffness preop.</td>
<td>66.7</td>
<td>73.0</td>
</tr>
<tr>
<td>Stiffness postop.</td>
<td>15.0</td>
<td>31.3</td>
</tr>
<tr>
<td>Function preop.</td>
<td>76.4</td>
<td>73.1</td>
</tr>
<tr>
<td>Function postop.</td>
<td>28.9</td>
<td>41.9</td>
</tr>
</tbody>
</table>

Fig. 1. Average knee function in HSS score after revision and satisfaction in HKASS score after revision for MRSA infection.

Fig. 2. Average knee pain in WOMAC score – before and after revision for MRSA infection.
Discussion

The assessment of the treatment strategy of PJI of knee joint is focusing mainly on the efficacy in eradication of the infection itself, especially in MRSA infections. Less attention is given to the functional results and satisfaction with the treatment, which are usually assumed to be inferior to those due to aseptic loosening. Published cure rates for MRSA infections after one-stage revisions ranges 53%-100% and after two-stage revisions with different types of spacers 82%-100% respectively, with the superiority of articulating spacers [9-12]. In our study the cure from infection was obtained in 63 from 68 knees after all types of revisions at follow up 3 to 7.5 years. Cemented, two-stage reimplantations with articulating spacer made of acrylic cement containing 5% of vancomycin have been superior to one-stage reimplantations with the same cement composition as regards cure rate (95,0% vs 89,3%).

Comparative studies of functional outcomes of septic TKA revisions show both similar or worse results as compared to aseptic revisions. In the study by Musil functional results were good after all aseptic TKA revisions whereas after only 69% of septic revisions [4]. Barrack found significantly worse range of motion, the postoperative Knee Society clinical score and worse activities of daily living after 28 two-stage septic TKA revisions with spacer compared with 99 aseptic revisions [5]. Only degree of satisfaction with the treatment in both groups has been equal. In the study by Wang aseptic revisions have had significantly better knee scores and ranges of motion than septic revisions, but their pain, functional scores and degree of satisfaction were similar in 85% of patients [6]. Other studies have shown comparable functional results after aseptic and septic TKA reimplantations. In the study by Ghanem septic revision patients (22) had worse initial SF-36 physical and mental scores and WOMAC functional scores than the noninfected group (71), but after 2-year follow-up both groups gained similar functional and mental outcomes [13].

Functional results after one- and two-stage revision of infected TKA are also inconsistent.

Older studies present worse results after two-stage revisions compared to one-stage. Superiority of two-stage revision was noted by Morrey, who assessed various treatment options in 73 infected TKA and found good functional results after only 5 from 15 one-stage reimplantations [9]. In the study by Singer higher knee scores were noted after 63 one-stage septic TKA revisions, than after two-stage revisions [11]. Comparative functional results has been found in the study by Jämsen, pointing the superiority of articulating spacers over static spacers [10]. Similarly – advantages of articulating spacers, which contributed to 90% of good and excellent results with average HSS score after revision 89 points showed the study by Hoffman [12]. In our group of 68 infected TKAs best functional outcomes in HSS score with an average of 78.9 points has been found after two-stage revisions with articulating spacer, which were statistically significantly better than after one-stage revisions with average outcome on HSS scale 65.8 points.

It is also believed that infection, especially with MRSA causes hypertrophic scar formation around the joint, which is responsible for worse knee joint function after septic revision. Dunn assessed results of 6 TKA revisions for MRSA infection with the use of static spacer and compared with 9 cases revised for non-MRSA infection and 30 cases revised for aseptic failure [14]. There were no differences in range of motion, WOMAC score, Activities of Daily Living Score, Knee Society scores, and SF-36 between MRSA, non-MRSA and aseptic revisions. Hirakawa assessed influence of virulence of bacteria on outcome of septic revisions and found 80% reimplantation success rate for knees with low-virulence organisms (coagulase-negative Staphylococci, Streptococci), 71.4% with polymicrobial organisms, and 66.7% with MRSA [15].

In our study we compared overall infection cure rate of the postoperative Knee Society clinical score and worse activities of daily living after 28 two-stage septic TKA revisions with spacer compared with 99 aseptic revisions [5]. Only degree of satisfaction with the treatment in both groups has been equal. In the study by Wang aseptic revisions have had significantly better knee scores and ranges of motion than septic revisions, but their pain, functional scores and degree of satisfaction were similar in 85% of patients [6]. Other studies have shown comparable functional results after aseptic and septic TKA reimplantations. In the study by Ghanem septic revision patients (22) had worse initial SF-36 physical and mental scores and WOMAC functional scores than the noninfected group (71), but after 2-year follow-up both groups gained similar functional and mental outcomes [13]. Functional results after one- and two-stage revision of infected TKA are also inconsistent.
lococcal therapy consisting of 2 week of intravenous vancomycin combined with oral rifampicin and followed by oral rifampicin combined with ciprofloxacin, levofloxacin or trimetoprime-sulfamethoxasole for additional 4 weeks. In all 68 knees infected with MRSA, acrylic cement factory loaded with low-dose gentamicin (less than 2,5%) has been additionally loaded with vancomycin at a dose of 5% – based on the culture from pre-operative joint aspiration or intraoperative biopsy from the 1st stage in two-stage reimplantation. Functional results of one- and two-stage reimplantations in this homogenous group of knee MRSA PJIs were evaluated. Generally good infection cure rate and functional results were achieved. After the average follow up of 4.5 years the cure rate after one-stage reimplantations ranged 89.3% and after two-stage reimplantations with spacer ranged 95%. Functional results measured in HSS score after two-stage reimplantations for MRSA infections has been significantly better than after one-stage reimplantations (78.9 vs 65.8 points). Also the satisfaction with treatment measured in HKAS scale in our cohort has been higher after two-stage than after one-stage revision (78.5 vs 68.3 points), although not statistically significant. Improvement in pain after the surgery, improvement in average knee stiffness and improvement in postoperative function measured in the WOMAC score – all the parameters were better after two-stage than after one-stage reimplantations for MRSA infection of TKA, but the differences were not statistically significant.

The limitation of our study is the fact that it covers a small cohort of patients without control group of aseptic revisions and relatively small number of cases in each revision group. However, we have compared our results with those of previous studies, with comparable material. Although the small sample size statistical analysis was performed.

Conclusions

The study demonstrated better cure rate and better functional results after two-stage TKA reimplantations with handmade, articulating cement spacer containing 5% of vancomycin performed due to MRSA infection of knee prosthesis – as compared to one-stage reimplantations using the same acrylic cement composition for prosthesis fixation.

References