

Acute Infection in Total Knee Arthroplasty (TKA): Is Early Open Débridement with Polyethylene Liner Exchange (ODPLE) Really Effective?

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Received: November 10, 2015

Revised: December 14, 2015

Accepted: December 17, 2015

Published online: December 23, 2015

ABSTRACT

Background: Open débridement with polyethylene liner exchange (ODPLE) is an attractive strategy for the treatment of a total knee arthroplasty (TKA) with acute infection. **Purpose:** The purpose of this article is to review the literature on acute infection after TKA with the aim of answering the following four questions: (1) Is ODPLE really effective? (2) What is the success rate of ODPLE? (3) Which factors can predict control of TKA acute infection after early ODPLE? (4) Is the success rate of two-stage revision for infection diminished after a failed early ODPLE? **Methods:** The search engines were MedLine, EMBASE and the Cochrane Library. The keywords used were: acute TKA infection. Fifty-three articles were found until 20 October 2015. Of those, only thirteen were selected and reviewed because they were strictly focused on the topic and the questions of this article. **Results:** Although the level of evidence of published papers is low, the mean success rate in postoperative acute infections ranged between 35% and 95%, and between 50% and 85% 70% in acute hematogenous infections. The only factor that can predict control of infection after ODPLE is the type of infected organism (Staphylococcus aureus 7% success rate, Staphylococcus epidermidis and Streptococcus species 47% success rate). The success rate of two-stage revision is diminished after a failed ODPLE (66% success rate). **Conclusions:** ODPLE should be considered as a

viable treatment option for acute prosthetic joint infection following TKA. The promptness of ODPLE is of paramount importance for success of the procedure. In Staphylococcus aureus infections the mean success rate is 7%, while in Streptococcal or Staphylococcus epidermidis species the mean success rate is 47%. The success rate of two-stage revision for infection is diminished after a failed ODPLE (66% mean success rate). It seems that acute infections after TKA in the presence of Staphylococcus aureus must be treated by a two-stage revision arthroplasty.

Key words: Acute infection, Total knee arthroplasty, Open débridement and polyethylene liner exchange

Rodriguez-Merchan EC. Acute Infection in Total Knee Arthroplasty (TKA): Is Early Open Débridement with Polyethylene Liner Exchange (ODPLE) Really Effective? *International Journal of Orthopaedics* 2015; 2(6): 462-465 Available from: URL: <http://www.ghrnet.org/index.php/ijo/article/view/1476>

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INTRODUCTION

While infection in total knee arthroplasty (TKA) is a relatively infrequent complication, it can be devastating in terms of morbidity and cost. The risk of infection ranges from 0.5% to 2% for primary TKAs. The treatment for acute prosthetic knee infection is currently under debate^[1-4]. Early open débridement with polyethylene liner exchange (ODPLE) is an attractive, but often ineffective strategy for the treatment of a TKA with acute infection^[1-13].

The purpose of this article is to review the literature on acute infection after TKA with the aim of answering the following four questions: (1) Is ODPLE really effective? (2) What is the success rate of early ODPLE? (3) Which factors can predict control of infection after early ODPLE; (4) Is the success rate of two-stage revision for infection diminished after a failed early ODPLE?

METHODS

A review has been performed on the efficacy of early ODPLE. The search engines were MedLine (PubMed), EMBASE and the Cochrane Library. The keywords used were: acute TKA infection. Fifty-three articles published in English were found until 20 October 2015. Of those, only 13 were selected and reviewed because they were strictly focused on the topic and the questions of this article. Figure 1 shows flow chart used for the eligibility selection of the included studies.

RESULTS

The types of studies found are of a low level of evidence. Therefore, the main limitation of this study is that it is based on papers with a poor level of evidence. It seems ODPLE is not effective in most cases of acute infection after TKA. Therefore, in these cases, a two-stage revision arthroplasty must be indicated^[1-13].

Regarding the success rate of ODPLE, in a series, 35% of patients successfully retained their components at a mean follow-up of 4 years (average duration of symptoms before debridement was 9 days)^[5]. Only 8% of those who had an infection with *Staphylococcus aureus* was treated successfully, compared with 56% of patients who had infections, with either *Staphylococcus epidermidis* or a *Streptococcal* species. A high failure rate suggests that immediate component removal should be considered in the presence of acute *Staphylococcus aureus* infection in TKA. ODPLE for acute *Streptococcal* or *Staphylococcus epidermidis* species has better success, but should be performed as soon as possible after the onset of symptoms. Chiu and Chen^[6] analyzed patients with deep infection after revision TKA. Using the classification of Tsukayama *et al*^[7], the average successful implant salvage was 70% at a minimum follow-up of 3 years. However, likelihood of success depended on the type of infection: patients with Type I (acute postoperative) infections and patients with Type III (acute hematogenous) infections retained their prostheses more often than patients with Type II (late chronic) infections^[6]. Kim *et al*^[8] determined the infection control rate after ODPLE. The minimum follow-up was 2 years (mean, 5.6 years; range, 2-8 years). All patients with early superficial postoperative infection, 94% of patients with early deep postoperative infection, 96% of patients with late chronic infection, and 86% of patients with acute hematogenous infection maintained functioning knee prosthesis at the final follow-up (95% on average). In a recent study, Koh *et al*^[13] found that the overall success rate of ODPLE was 71 %, and early postoperative infection and acute hematogenous infection had a success rate of 82 and 55 %, respectively. Success rate was associated with a shorter symptom duration in patients with acute hematogenous infections. However, success was not influenced by the type or virulence of the causative microorganisms.

Concerning factors that can predict control of infection after ODPLE, Gardner *et al*^[10] sought to identify factors that would predict control of infection after ODPLE. They identified patients with culture-positive periprosthetic infection who underwent ODPLE. Failure was defined as any reoperation performed for control of infection or the need for lifetime antibiotic suppression. Patients were followed prospectively for a minimum of 1 year (mean, 5 years; range, 1-9 years). Fifty-seven per cent of patients failed ODPLE. Failure rates tended to differ based on primary organism: 71% of *Staphylococcus aureus* periprosthetic infection failed versus 29% of *Staphylococcus epidermidis* (success rates were 29% and 71%, respectively). Age, gender, or measures of comorbidity did not influence the risk of failure. There was no significant difference in

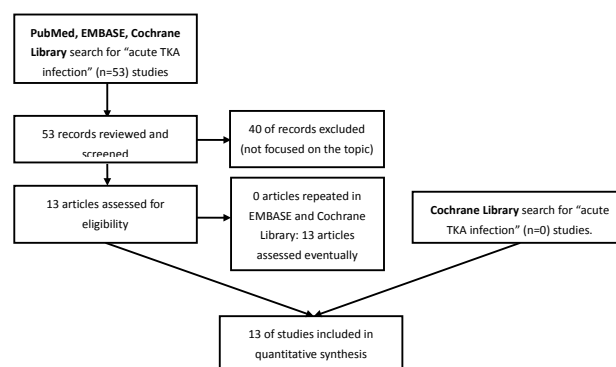


Figure 1 Flow chart for the eligibility selection of the included studies.

failure rate (58% versus 50%) when ODPLE was performed greater than 4 weeks after TKA. After a failed ODPLE, 75% of failures went on to an attempted two-stage revision procedure. In only 60% of these cases was the two-stage revision successful. Although C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) are well established in the diagnosis of infection, no role currently exists for them in predicting the outcomes of ODPLE for the treatment of acute hematogenous TKA infection^[11].

Regarding the re-revision rate due to infection after two-stage reimplantation performed for failed ODPLE, Sherrell *et al*^[12] determined the re-revision rate due to infection after two-stage revision performed for failed ODPLE of infected TKA. They performed a multicentre retrospective review of periprosthetic knee infections treated with a two-stage procedure. Selection criteria for the study included initial treatment with ODPLE and subsequent two-stage revision surgery. Failure of two-stage revision was defined as the need for any additional surgery due to infection. Of the knees that had undergone previous ODPLE, 34% failed subsequent two-stage revision and required re-operation for persistent infection. The failure rate in this series of two-stage revisions for periprosthetic knee infection in patients treated with previous ODPLE was considerably higher than previously reported failure rates of two-stage revision. Factors affecting the failure rate may include host quality, thoroughness of ODPLE, and organism virulence. ODPLE, while initially attractive, may lead to high failure rates of subsequent two-stage revision arthroplasty. Table 1 summarizes the main characteristics and clinical efficacy of the included studies on ODPLE.

DISCUSSION

The purpose of this article is to review the literature on acute infection after TKA with the aim of answering the following four questions: (1) Is ODPLE really effective? (2) What is the success rate of early ODPLE? (3) Which factors can predict control of infection after ODPLE? (4) Is the success rate of two-stage revision for infection diminished after a failed ODPLE? With the limitation that the level of evidence of published papers is low, ODPLE for acute *Streptococcal* or *Staphylococcus epidermidis* species had better success (nearly 47% on average), but likely should be done early (few days) from the onset of symptoms. In *Staphylococcus aureus* infections ODPLE is not recommendable (only 7% mean success rate).

It has been found that ODPLE is effective in 65% of cases on average. In other words, it seems that the procedure is not very effective in acute infections after TKA. Moreover, the failure rate in this series of two-stage revisions for periprosthetic knee infection in patients treated with previous ODPLE is considerably higher than previously reported failure rates of two-stage revision.

Table 1 Summary of the main characteristics and clinical efficacy of the included studies on early open débridement with polyethylene liner exchange (ODPLE). TKA = Total Knee Arthroplasty.

Author	Year	Characteristics	Clinical efficacy
Deirmengian <i>et al</i> [5]	2003	Thirty-one TKAs with acute gram-positive infections, seen during a 10-year period, were treated with open débridement, component retention, and antibiotics. The average duration of symptoms before débridement was 9 days (range, 1-40 days), and 78% of débridement were done within 10 days of the onset of symptoms.	Eleven (35%) of the 31 patients successfully retained their components at most recent followup, without ongoing infection (mean, 4 years; range, 2-10 years). Only one (8%) of the 13 who had an infection with <i>Staphylococcus aureus</i> was treated successfully, compared with 10 (56%) of 18 patients who had infections, with either <i>Staphylococcus epidermidis</i> or a streptococcal species. The difference between these groups was statistically significant. The success rate of débridement of acute infections in TKA varied significantly depending on the involved pathogen. A high failure rate suggests that immediate component removal should be considered in the presence of acute <i>Staphylococcus aureus</i> infection in TKA. Débridement for acute streptococcal or <i>Staphylococcus epidermidis</i> species has better success, but likely should be done within 2 to 3 days from the onset of symptoms.
Chiu and Chen [6]	2007	The authors analyzed 40 patients with deep infection after revision TKA. These patients had no prosthesis loosening or malalignment. Using the classification of Tsukayama <i>et al</i> , 20, and 10 patients had Types I (acute postoperative), II (late chronic), and III (acute hematogenous) infections, respectively. All had surgical débridement and parental antibiotics with retention of their existing prostheses. The patients were followed for a minimum of 3 years (range, 36-143 months).	Successful implant salvage was achieved in 12 of the 40 patients (30%). However, likelihood of success depended on the type of infection: patients with Type I infections (seven of 10) and patients with Type III infections (five of 10) retained their prostheses more often than patients with Type II infections (zero of 20). The authors recommended early débridement and retention of the prosthesis.
Kim <i>et al</i> [8]	2011	The authors retrospectively reviewed 114 patients with 116 infected TKAs. They determined the infection control rate after initial treatment, repeated débridement and two-stage TKA. They evaluated the functional and radiographic results using the Knee Society and Hospital for Special Surgery knee scoring systems. The minimum followup was 2 years (mean, 5.6 years; range, 2-8 years).	The overall infection control rate was 100% in all patients. All patients with early superficial postoperative infection, 94% of patients with early deep postoperative infection, 96% of patients with late chronic infection, and 86% of patients with acute hematogenous infection maintained functioning knee prosthesis at the final followup. One hundred nine of the 114 patients could walk with no or only slight pain and maintained functioning knee prostheses. These 109 patients had stable fixation of the TKA prosthesis to host bone. The techniques proposed by the classification effectively controlled infection and maintained functional TKA with firm fixation of the TKA prosthesis in most patients. Repeated débridement and two-stage TKA further improved the control of infection and functional TKA after initial treatment.
Konigsberg [9]	2013	22 TKA treated for acute hematogenous infections were reviewed by the authors.	All patients underwent irrigation and débridement and exchange of the modular components. At a mean of 56 months (range, 25-124 months) recurrent infection, requiring surgery, developed in 21% of the joints. Irrigation and débridement for the treatment of an acute hematogenous infection was successful in the majority of patients (76% survivorship at 2 years). Non-staphylococcal infections had a particularly low failure rate (96% survivorship at 2 years).
Gardner <i>et al</i> [10]	2011	The authors identified 44 patients (44 knees) with culture-positive periprosthetic infection who underwent ODPLE. Failure was defined as any reoperation performed for control of infection or the need for lifetime antibiotic suppression. Patients had been followed prospectively for a minimum of 1 year (mean, 5 years; range, 1-9 years).	Twenty-five of the 44 patients (57%) failed ODPLE. Of these 25 patients, two had one additional procedure, 21 had more than one additional procedure, and two required lifetime antibiotic suppression. Failure rates tended to differ based on primary organism: 71% of <i>Staphylococcus aureus</i> periprosthetic infection failed versus 29% of <i>Staphylococcus epidermidis</i> , although with the limited numbers these differences were not significant. Age, gender, or measures of comorbidity did not influence the risk of failure. There was no difference in failure rate (58% versus 50%) when the ODPLE was performed greater than 4 weeks after index TKA. After a failed ODPLE, 19 of the 25 failures went on to an attempted two-stage revision procedure. In only 11 of these 19 cases was the two-stage revision ultimately successful. Eradication of infection with ODPLE in acute TKA infections is unpredictable; certain factors tend toward increased success but no firm algorithm can be offered. The success of two-stage revision for infection may be diminished after a failed ODPLE.
Stryker <i>et al</i> [11]	2013	The total joint registry at the authors' institution was reviewed to identify all patients who underwent irrigation and débridement with insert exchange for a diagnosis of acute hematogenous infection of a primary TKA. Patient medical records were then reviewed for preoperative white blood cell count and CRP and ESR levels; interval from symptom onset to surgery; infecting organism; and any additional surgery for infection. Average patient age was 72 years (range, 51-91 years). Forty-four patients were men and 26 were women. Mean follow-up was 54 months (range, 12-176 months). Seventy-two procedures (69 patients) met the inclusion criteria.	Of these, 20 (28%) additional procedures for infection were performed and were classified as treatment failures. Average CRP was 173.7 mg/L in the successful group and 159.0 mg/L in the failed group ($P= .31$). Mean ESR at the time of irrigation and débridement with insert exchange was 61.3 mm/hr in both groups ($P= .49$). Although CRP and ESR are well established in the diagnosis of infection, no role currently exists for them in predicting the outcomes of irrigation and débridement with insert exchange for the treatment of acute hematogenous TKA infection. The roles of CRP and ESR are well established in the diagnosis of total joint infection. However, it is not entirely clear what value preoperative CRP and ESR have in predicting outcomes following irrigation and débridement with insert exchange for acute hematogenous TKA infection.
Sherrell <i>et al</i> [12]	2011	The authors determined the revision rate due to infection after two-stage reimplantation performed for failed irrigation and débridement of infected TKA. They performed a multicenter retrospective review of periprosthetic knee infections treated with a two-stage procedure from 1994 to 2008. Selection criteria for the study included initial treatment with irrigation and débridement and subsequent two-stage revision surgery.	Failure of two-stage revision was defined as the need for any additional surgery due to infection. Of the 83 knees that had undergone previous irrigation and débridement, 28 (34%) failed subsequent two-stage revision and required reoperation for persistent infection. The failure rate in this series of two-stage revisions for periprosthetic knee infection in patients treated with previous irrigation and débridement is considerably higher than previously reported failure rates of two-stage revision. Factors affecting the failure rate may include host quality, thoroughness of débridement, and organism virulence. Patients and surgeons must understand that irrigation and débridement, while initially attractive, may lead to high failure rates of subsequent two-stage reimplantation.

CRP: C-reactive protein; ESR: erythrocyte sedimentation rate; CRP: C-reactive protein. ESR: Erythrocyte sedimentation rate.

Regarding the success rate of ODPLE, acute Streptococcal or Staphylococcus epidermidis species has been shown to have better success rate than in Staphylococcus aureus species^[1]. Chiu and Chen recommended ODPLE^[2]. Kim *et al*^[4] reported an infection control rate of 100%. All patients with early superficial postoperative infection, 94% of patients with early deep postoperative infection, 96% of patients with late chronic infection, and 86% of patients with acute hematogenous infection maintained functioning knee prosthesis at the final follow-up. In acute hematogenous infection survivorship of ODPLE at 2 years was 76%^[5]. Non-staphylococcal infections had a particularly low failure rate (96% survivorship at 2 years).

Concerning factors that can predict control of infection after ODPLE, failure rates tended to differ based on primary organism: 71% of Staphylococcus aureus periprosthetic infection failed versus 29% of Staphylococcus epidermidis^[6]. There was no difference in failure rate (58% versus 50%) when ODPLE was performed greater than 4 weeks after index TKA. The success of two-stage revision for infection may be diminished after a failed early ODPLE^[6]. The roles of CRP and ESR are well established in the diagnosis of total joint infection. However, it is not clear what value preoperative CRP and ESR have in predicting outcomes following ODPLE for acute hematogenous TKA infection^[7].

Regarding the re-revision rate due to infection after two-stage revision performed for failed ODPLE, it was 66%. The failure rate of two-stage revision for periprosthetic knee infection in patients treated with previous ODPLE is considerably higher than previously reported failure rates of two-stage revision. ODPLE, while initially attractive, may lead to high failure rates of subsequent two-stage revision^[8]. Tables 2 and 3 summarize the main data of the literature related to some questions of this article.

In conclusion, ODPLE should be considered as a viable treatment option for acute prosthetic joint infection following TKA. The promptness of ODPLE is of paramount importance for success of the procedure. ODPLE for acute Streptococcal or Staphylococcus epidermidis species has better success than for acute Staphylococcus aureus species. The failure rate of two-stage revision in patients treated with previous ODPLE is considerably higher (66%) than previously reported failure rates of two-stage revision. A two-stage revision arthroplasty must be indicated in acute infections after TKA. The author would like to point out that the published studies have a low grade of evidence. Therefore, my suggestion for the future is that well-designed studies are needed to confirm the conclusions of this review.

CONFLICT OF INTEREST STATEMENT

The authors certify that they have no commercial associations (e. g. consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

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Table 2 Mean success rates and mean follow-ups in acute postoperative infection after total knee arthroplasty (TKA) in the literature. NA: Not available.

Author	Mean Success Rate	Mean Follow-Up
Deirmengian <i>et al</i> [5]	35%	4 years
Chin and Chen [6]	70%	3 years
Kim <i>et al</i> [8]	95%	5.5 years
Gardner <i>et al</i> [10]	40%	5. years
Koh <i>et al</i> [13]	82%	NA

Table 3 Mean success rates and mean follow-ups in acute hematogenous infection after total knee arthroplasty (TKA) in the literature. NA: Not available.

Author	Mean Success Rate	Mean Follow-Up
Chin and Chen [6]	50%	3 years
Kim <i>et al</i> [8]	85%	5.5 years
Konigsberg <i>et al</i> [9]	75%	4.6 years
Koh <i>et al</i> [13]	55%	NA

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