Original article

Mid-Term Results of Two-stage Revision Total Knee Arthroplasty for Infected Total Knee Arthroplasty

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Abstract

Introduction. *Today, knee arthroplasty is one of the most common surgical procedures. Infection after endoprosthetics is the most dangerous complication in patients who have undergone total knee arthroplasty, which negatively affects the prognosis. Most cases of infection develop within the first 2 years after surgery, and the frequency is 1.5%, and after that it decreases to 0.5%.*

Material and Method. *When a study group of 31 patients (22 female, 9 male) who were diagnosed with infected knee prosthesis and underwent two-stage revision knee prosthesis as a treatment method; the mean age of all patients (31 patients) was 68.78 years. In our study by using the American knee association scoring system; preoperative knee scores of 31 patients who underwent two-stage revision surgery were 35.43 ± 7.14, while this parameter was found to be 83.27 ± 8.89 postoperatively (p <0.01).*

Conclusion. *We believe that two-stage revision surgery is an effective method in the treatment of infection that develops after primary total knee arthroplasty application.*

Restoration of the joint line in accordance with the anatomical structure will positively affect the clinical results, and the use of a long stem to increase the stability of the prosthesis is appropriate for successful results, especially in the cases with bone defects.

Key words: *Total Knee Arthroplasty, Two-Stage Revision Surgery, Infected Knee Prosthesis.*

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Introduction

Joint replacements one of the most common surgical procedures currently. As a result of technical and surgical developments compared to 30-40 years ago, the risk of prosthetic infections has decreased considerably [1,2]. Infection is the most feared complication that worsens the outcome in patients undergoing total knee arthroplasty (TKA) [3]. In a study done by Kurtz et al. involving 69.663 patients who underwent total knee prosthesis between 1997-2006; prosthetic infection was detected in 1.400 patients [4]. Most of these infections developed within the first 2 years after the operation and the incidence was reported as 1.5%. After two years, this rate has been determined as 0.5%.

According to the onset time, prosthesis infections are divided into 3 stages as early infections, delayed infections and late infections. Early infections are the infections that occur within the first 3 months after joint replacement. Delayed infection is the infections that develop within 3-24 months after joint replacement. Late infections are infections that occur 24 months after joint replacement. While early and delayed infections develop during the operation, late infections occur as a result of hematogenous spread (from a source such as the urinary system, skin and vascular catheter). Prosthesis infections are divided into 4 types according to the onset time and clinical factors.

Positive intraoperative culture is the growth of the same microorganism in at least two cultures taken during the operation. Early postoperative infection is an infection that develops within one month after the operation. Late chronic infection is an infection that develops one month after the operation and has subacute and insidious clinical symptoms. Acute hematogenous infection is called an infection with symptoms of acute infection in a functioning joint.

Staphylococcus aureus and Gr (-) bacillus are the most common microorgamisms in the early infections In the delayed infections coagulase negative staphylococci and Staph. are more common, while in the late prosthetic infections aureus, Staf. epidermidis, Gr (-) bacillus, and especially E. Coli, were found to be the most common microorganims. In a study involving 50 patients with late-type prosthesis infection, the average emergence of clinical findings was found to be 5 years. In this study, Staf. aureus and Gr (-) bacillus are the most frequently isolated microorganisms [5]. Growing microorganisms can vary depending on the type of implant and the underlying disease [6]. Culture negativity can sometimes be seen in prosthetic joint infections with clinical signs and symptoms [7].

Material and method

When 31 patients, composing of 22 female and 9 male, who were diagnosed with infected knee prosthesis and who underwent revision knee prosthesis as a treatment method, were examined.The mean age in all patients (31 patients) was 68.78 years ±10.61, and 73.27 years±16.67 in males and 67.31 years ± 12.39 in females (Table 1).

Underlying chronic diseases (rheumatoid arthritis, hypertension, atherosclerosis heart disease (ASKH), diabetes mellitus…) were detected in 25 of the patients (80.6%). When the underlying diseases were examined, ASHH (51.6%) was detected in 16 patients. When we look at the clinical symptoms of all cases included in the study, the most three common symptoms are; pain n28 patients (90.3%), joint swelling in17 patients (54.8%) and fistula

in5 patients (16.1%). Second stage revision knee prosthesis implantation was applied to 25 patients, while 6 patients underwent second stage revision surgery after the 2nd debridement and antiotherapy. The mean time between spacer application and second stage revision surgery was 12.3±1.81 weeks in patients who underwent two-stage revision surgery. This period was found to be 11.8±2.31 weeks for males and 12.4±1.92 weeks for females. Considering the follow-up period after the second stage operation of male and female patients who underwent two-stage revision surgery, the mean follow-up period was found to be 60.5 months ± 16.17. The average of this period was found 56.8 months ±24.5 in male patients; 61.4 months ± 12.8 in female patients.

Table 1 - Demographic information

		Female	Male
Number of Patient		22	9
Age		67.31±12,39 years	73.27± 16.67 years
Side	Right	13	5
	Left	9	4
Time between first surgery and primary care revision		32±10.36 week	28±18.61 week
The average time between the first and second stages in patients undergoing two-stage revision		12.4±1.92 week	11,8±2.31 week
Average follow-up periods for patients undergoing two-stage revision surgery		61.4±12.8 week	56.8±24.5 week

Intraoperative cultures were performed at least two weeks after the patient's current antibiotic therapy was discontinued [8]. Cultures were taken from at least three different regions. The material taken directly was placed in the culture tube as stated before in the literature [8, 9]. After the culture was taken, it was delivered to the laboratory as soon as possible and cultivated. It should be kept in mind that the culture reproduction is between 65–94%

[9]. In Berbari et al. study, culture negativity was found at a rate of 7% in 897 patients with prosthetic joint infection [10]. When we look at the antibiotics placed in cement in the literature, it is seen that vancomycin, tobramycin, teicoplanin, gentamicin are used [11-13]. In our patients, we used antibiotic cement prepared with 4 g vancomycin in 40 gr gentamicin cement. No toxicity was observed in any of our patients, and we think that high success was achieved

in the eradication of the infection. If the time between two stages of revision is short, the infection will be difficult to eradicate; some studies have shown that if it is long, it increases the rate of recurrent infection [14,15].

In addition, it is known that during long waiting times there is a decrease in bone mineral density, muscle atrophy becomes more common and all of these make rehabilitation after the second stage operation difficult [14,15]. Better results were obtained with revisions performed at 6 weeks at the earliest [16]. In the study conducted by Hoffman AA et al., waiting times is reported as 12 weeks (4-58 weeks) on average [12]. The mean time between the two stages in our patients was 12.3 weeks and the median was 10 weeks, and it was found to be compatible with the literature. However, in our case, the reasons for the long duration of this period were, in some of our patients there were not culture reproduction but we still wanted to be sure of the eradication of the infection due to the empirical antibiotic treatment, and we wanted to wait for the skin problems of the patients with active fistula mouth to be eliminated.

Considering the eradication of the infection while deciding on the second stage revision surgery; it is recommended that antibiotherapy should be stopped for at least two weeks, aspiration should be performed on the knee joint, and culture together with biochemistry studies should be performed [11,17]. However, there are also authorities who argue that a decrease in ESR, CRP value and clinical examination would be sufficient [12]. It is stated that an antibiotic with high efficacy for the microorganism that grows in culture, parenteral administration for at least two weeks and a total of 6 weeks of antibiotherapy will be sufficient [18]. When we look at the average follow-up periods as being 60.5 months ± 16.17 for patients who underwent two-stage revision due to infection, and our mid-term results seem to be consistent with the literature. There was no growth in the preoperative culture of the 3 patients who did not have any growth in the current culture. Culture was taken from all patients who underwent two-stage revision surgery during the operation, and growth occurred in 22 (70.9%) of them. Two separate microorganisms (Staphylococcus aureus and Pseudomonas aeruginosa) grew in one patient (Table 2).

Table 2 - Distribution of microorganisms grown in peroperative culture

Microorganism	Number of Patient	%
Coagulase (-) staphylococcus	7	31.8
Staphylococcus aureus	6	27.2
Escherichia coli	2	9.1
Pseudomonas aeruginosa	2	9.1
Acinetobacter baumannii	1	4.5
Streptococcus mitis	3	13.6
Klebsiella pneumoniae	1	4.5
Enterococcus faecalis	1	4.5
Toplam	22	100

In 9 patients who had two-stage revision surgery, the treatment was started empirically where as in the others the treatment started according to the culture results. In the treatment of the patients after the first stage revision surgery, 11 patients were given combination therapy, while other patients were given monotherapy. Combination therapy was given to all patients after the second stage revision surgery. Teicoplanin + ciprofloxacin combination was preferred in 7 patients after the first operation in patients with Gram (+) growth. Teicoplanin treatment was given to only 2 patients. Teicoplanin + ciprofloxacin was preferred in 7 patients, Teicoplanin + Rifampicin in 2 patients and Vancomycin + Rifampicin in 2 patients as a combination in MRSA, MSSA and MRSE treatments. After parenteral treatments, Ciprofloxacin + Rifampicin were given to 3 patients as oral therapy; Ciprofloxacin + Fusidic acid were used in 7 patients. In the treatment of prosthetic joint infections caused by Gram (-) factors, Imipenem + Amikacin was given to 3 patients and Meropenem + Colistin was given to 2 patients. In the following oral treatments, quinolone-based treatments; 4 patients received Ciprofloxacin + Rifampicin and 1 patient received Ciprofloxacin + TMP-SMX.

Table 3 - Statistical comparison of preoperative and postoperative knee score, function score, flexion degree and flexion contracture of patients who underwent two-stage revision

	Preoperatif	Postoperatif	P value
Knee Society Score	35.43± 7.14	83.27± 8.89	P<0.01
Function Score	34.97 ± 10.23	77.34 ± 13.67	P<0.01
Flexion degree	40.13±11.32	105.41±9.87	P<0.01
Flexion contracture	3.76±5.47	1.32±2.02	P<0.020

Kim Y.S. using the American knee association scoring system found that the preoperative American knee association score was 33.8 points, the postoperative score was 85.3 points (p<0.01), and the functional scoring was 35 points in the preoperative scoring, 87.5 points in the postoperative scoring (p<0.01). In their study, they found that the range of motion of the patients increased from 69.8 preoperatively to 102.8 postoperatively (p<0.01) [19]. In our study using the American knee association scoring system; preoperative knee scores of 31 patients who underwent two-stage revision surgery were 35.43±7.14, while this parameter was found to be 83.27±8.89 postoperatively. These values are statistically, significant (p<0.01). Similarly, when functional scores were compared, the preoperative value was 34.97±10.23, while the postoperative value was 77.34±13.67. In the statistical comparison of these data, a significant improvement was achieved with p<0.01. Looking at joint range of motion; preoperative mean flexion

degrees of patients who underwent two-stage revision surgery increased from 40.13±11.32 to 105.41±9.87 postoperatively (p<0.01). Flexion contracture, on the other hand, decreased from 3.76 ± 5.47 preoperatively to 1.32± 2.02 postoperatively (p<0.02) (Table 3).

Discussion

Complications after total knee arthroplasty requiring revision surgery can be seen in the form of infections (38%), instability (27%), aseptic loosening (16%), periprosthetic fractures (7%), patellar problems (8%), unexplained pain (4%)

There are numerous studies suggesting various recommendations for the treatment of infections after total knee prosthesis, such as antibiotherapy, debridement, resection arthroplasty, single or two-stage revision prosthesis, arthrodesis, and even amputation [20-22].

Reinfection rates have been reported as 0%, 5%, 9.1% and 11% in single-stage infected knee prosthesis. The largest series was reported by Singer where 63 infected prosthesis were studied. He reported that no re-infection was detected in the 24-month examination [23-26].

Studies have reported successful results ranging from 85% to 100% with a two-stage revision in the treatment of knee and hip replacement infections [27].

Highly successful results are obtained with a good planning and timing, in the second-stage revisions. Reinfection rates are 7%, 13%, 17% and 28% in studies including more than 100 patients in two-stage revision knee prosthesis. 239 patients underwent two-stage revision. The aim of that study is to calculate the time without infection, they reported a success rate of 85% in 5 years and 78% in 10 years. In our study, 6.5% re-infection was detected, and it was found to be compatible with the literature [28].

Laboratory parameters such as ESR, CRP, and BK are used while diagnosing an infection. While these parameters increase after surgical trauma other than infection, they return back to their normal values within weeks. Here, we see that the CRP value regresses to normal limits faster than the ESR [29]. Current studies emphasize that ESR> 30 mm/ hour, however, CRP>10 mg/L should be interpreted in favor of infection [30].

CRP is not a sufficient marker for infection. In the study done by Kusuma et al., they could not find a definitive marker for diagnosing an infection [31]. Only very high CRP values are significant. Alijanipours et al. stated that they also advocate to be based on higher values of serum inflammatory markers [32]. IL-6 and procalcitonin have also come into use, but they emphasized that none of them could be more sensitive than CRP [33].

According to the literature, bone scintigraphy with technetium 99 has a high sensitivity but a low specificity in detecting infection. Especially in the early postoperative period, increased bone remodeling makes it difficult to diagnose an infection. The use of technetium 99-labeled monoclonal antibodies in scintigraphy increases the specificity [9].

In our study, technetium 99 scintigraphy could be performed in 5 of the patients diagnosed with infected knee prosthesis. All patients' results were reported to be consistent with the infection. If scintigraphy will be used to distinguish between infection and aseptic loosening, it is stated that using it together with labeled leukocytes will give more reliable results.

Cultures were taken from all patients who underwent two-stage revision during the operation, and 22 (70.9%) of them were reproduced. Two separate microorganisms grew in one patient. It has been found that intraoperative culture results are more effective and reliable. Examination of deep tissue cultures taken intraoperatively is considered to be the gold standard method for diagnosing an infection.

Conclusion

The clinical results of revision knee prosthesis are not as good as the results of primary arthroplasty. Short-term follow-up studies have shown worse clinical outcomes and higher complication rates. Long-term follow-up is limited to early stage revision prosthesis with minimal modularity. Diagnosis of periprosthetic joint infections is quite difficult. For this reason, it is necessary to develop the most appropriate and highly reliable diagnostic tools and to increase scientific studies [34].

The two-step revision arthroplasty technique using a modified joint spacer is a safe and effective method in the treatment of infected TKA (Case1-2). This procedure improves patient function and compliance with treatment, and both stages provide joint stability and mobility in the inter-revision period [19]. Revision knee prosthesis applications are a surgery with complications that are open to surprises. In the treatment of an infected knee prosthesis, the difficulty of the surgical technique appears to be an important problem due to the disrupted anatomy of the infection. In the first stage, the debridement to be made in the revision is wide, the careful removal of the prosthesis and the placement of antibiotic-loaded cement, sufficient time for IV appropriate antibiotherapy, and the repair of bone losses in the second stage revision are essential for clinical success.

In the treatment of infection that develops after primary TKA, the restoration of two-stage revision surgery in accordance with the effective anatomical structure will positively affect the clinical results and it will be appropriate to use a long stem to increase the stability of the prosthesis, especially in the cases with bone defects. It should not be forgotten that many difficulties such as high infection rate, insufficient bone quality, difficulties in maintaining soft tissue balance, multiple joint involvement and insufficient immobilization of the patient should be fought in patients with rheumatoid arthritis.

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Тізе буынын толық эндопротездеуден кейінгі кезеңде жұқпа енуі жағдайларында екі кезеңді қайта толық эндопротездеудің орта мерзімді нәтижелері

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Түйіндеме

Кіріспе. *Қазіргі таңда тізе буынын эндопротездеу ең кең тараған хирургиялық ем түрі болып табылады. Тізе буынын толық эндопротездеуден кейін жұқпаның қосылуы бұл науқастарда кездесетін аса қауіпті асқыну болып табылады және осы жағдай клиникалық болжамға теріс әсер етіп жатады. Жұқпаның қосылуы отадан кейінгі алғашқы екі жыл ішінде 1,5% жағдайда кездессе, одан кейінгі жылдары аталмыш көрсеткіш 0,5% дейін сирейді.*

Материалдары мен әдістері. *Зерттеуге отадан кейін тізе буыны эндопротезінің жұқпасы дамыған 31 науқас (22 әйел мен 9 ер адам) қатысты. Барлық науқастарға тізе буынының екіншілікті толық эндопротездеуі жүргізілген болатын. Науқастардың орташа жасы 68,78 жасты құрады. Біздің зерттеу жұмысымызда Америкалық тізе буыны қауымдастығының балл жүйесі қолданды. Тізе буынының екіншілікті толық эндопротездеуі жүргізілген науқастардағы отаға дейінгі көрсеткіш 35,43±7,14 балл болса, осы көрсеткіш отадан кейінгі кезеңде 83,27 ± 8,89 балл болды (p <0,01).*

Қорытынды. *Біз екі кезеңді ревизиялық эндопротездеу әдісін тізе буынының толық эндепротездеуінен кейін жұқпаның қосылуы жағдайларын хирургиялық емдеудің тиімді жолы деп санаймыз.*

Анатомиялық құрылымына сай буын сызығын қалпына келтіру оң клиникалық нәтижеге қол жеткізуге өз септігін тигізеді. Ал протездің қалпын тұрақтандыру үшін ұзын аяқшаны қолдану сүйек тінінің ақауы болған жағдайда буын қызметін қалпына келтіруге мүмкіндік береді.

Түйін сөздер: *тізе буынын толық эндопротездеу, екі кезеңді ревизиялық хирургия, жұқпа қосылған тізе буынын эндопротездеу.*

Среднесрочные результаты двухэтапного повторного тотального эндопротезирования коленного сустава при инфицировании

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Резюме

Введение. *На сегодняшний день эндопротезирование коленного сустава является одной из самых распространенных хирургических процедур. Инфицирование после проведенного эндопротезирования - наиболее опасное осложнение у пациентов, перенесших тотальное эндопротезирование коленного сустава, которое отрицательно влияет на прогноз. Большинство случаев инфицирования развивается в течение первых 2-х лет после операции, а частота составляет 1,5%, а после снижается до 0,5%.*

Материалы и методы. *В исследовании участвовали 31 пациентов (22 женщины, 9 мужчин), у которых было диагностировано инфицирование коленного сустава после вмешательства. Всем пациентам было проведено повторное тотальное эндопротезирование коленного сустава. Средний возраст пациентов составил - 68,78 лет. В нашем исследовании использовалась балльная система оценки Американской ассоциации коленных суставов. Дооперационная оценка коленного сустава у 31 пациентов, перенесших двухэтапную ревизионную операцию, составила 35,43±7,14 балла, а в послеоперационном периоде этот показатель составил 83,27 ± 8,89 баллов (p <0,01).*

Выводы. *Мы считаем, что двухэтапное ревизионное эндопротезирование является эффективным методом лечения при инфицированном тотальном эндопротезировании коленного сустава.*

Восстановление линии сустава в соответствии с анатомической структурой положительно влияет на клинические результаты, а использование длинной ножки для увеличения стабильности протеза способствует восстановлению функции сустава, особенно в случаях дефекта кости.

Ключевые слова: *тотальное эндопротезирование коленного сустава, двухэтапная ревизионная хирургия, эндопротезирование инфицированного коленного сустава.*