

Our medium-term functional and radiological outcomes in revision total knee arthroplasty

Huseyin Ozdemir¹, Sehmuz Kaya^{2*}, Cihan Adanas³, Abdullah Yalcin Tabak⁴

¹Special Level Hospital, Orthopedy, Zonguldak, Turkey

²University of Health Sciences, Van Training and Research Hospital, Orthopedy, Van, Turkey

³Department of Orthopedy, Faculty of Medicine, Van Yuzuncu Yil University, Van, Turkey

⁴Department of Orthopedy, Faculty of Medicine, Amasya University, Amasya, Turkey

ABSTRACT

To investigate the medium-term outcomes of the patients who underwent revision total knee arthroplasty, and to come to a conclusion regarding the efficacy of the method by comparing these with literature data.

34 knees of 33 patients who underwent revision knee arthroplasty operation between January 2008 and January 2012 and were sufficiently followed-up were included into this study. Single-stage revision knee arthroplasty was performed for 25 knees for aseptic reasons, and two-stage revision knee arthroplasty was performed for 9 knees for septic reasons. For all patients, alpha, beta, gamma, sigma and total valgus angles were measured in pre- and post-operative anteroposterior (AP) X-rays and lateral X-rays based on American Knee Society radiological assessment form. For all patients, pre- and post-operative American Knee Society knee score and functional score was assessed. As laboratory work-up, all patients' pre- and post-operative erythrocyte sedimentation rate, C-reactive protein, white blood cells values were compared.

The patients' mean knee score and functional score was detected to be 34.7 (4-57) and 33.5 (5-55), respectively, and to be 78.2 (62-90) and 73.8 (50-90) after revision. In pre-operative assessments performed based on Knee Society radiographic assessment form, mean alpha angle was found to be 95.3 (77-103), mean beta angle to be 84.8 (71-100), mean gamma angle to be 5.8 (0 - 30), mean sigma angle to be 83.3 (49-97), and mean total valgus angle to be 0.1 (-13 - 12). In post-operative assessments, mean alpha angle was found to be 94.7 (90-99), mean beta angle to be 88.4 (84-92), mean gamma angle to be 3.7 (0 - 10), mean sigma angle to be 88.1 (85-92), and mean total valgus angle to be 3.1 (-1 - 8).

We think that when revision knee arthroplasty operation is performed for proper indication and according to the surgical technique, it is a highly effective and preferable method in decreasing the pain severity and improving the life quality of the patients.

Key Words: Arthroplasty, Revision, Knee

Introduction

Arthroplasty is an operation which is performed to provide painless motion to the joint and bring function to the muscle, connective and other soft tissues controlling the joint (1). Procedures to regain knee joint functions which are impaired for any reason started around 19th century. The first study in this field was performed in 1827 by Barton. Barton tried to bring motion to the knee joint by creating pseudoarthrosis via osteotomy (2).

The objective in total joint arthroplasty is to alleviate the pain, to provide motion and to correct deformity by protecting the stability at the same time. Today, these goals are met to a large extent using successfully administered joint prostheses (2). However, there are still many issues which need to be solved including prosthesis design, durability, suitability for the bone, fixation techniques and ease of revision. This study aimed to investigate the

medium-term outcomes of the patients who underwent revision total knee arthroplasty, and a conclusion was made regarding the efficacy of the method as a result of the comparison with literature data.

Materials and Method

The files of all patients who underwent revision knee arthroplasty for any reason from January 2008 to January 2012 were reviewed. For the patients with sufficient follow-up, final follow-up was performed and their latest clinical status, laboratory results, X-rays and knee score questionnaires were updated, and their functional and radiological outcomes were explored. 34 knees of 33 patients with sufficient follow-up with 26 (78.8%) of them being women and 7 being men (21.2%) were included into this study. As statistical method, dependent samples t test was used. In patient files, their personal

*Corresponding Author: Sehmuz Kaya, MD, University of Health Sciences, Van Training and Research Hospital, Orthopedy, Van, Turkey
65 000

E-mail: drschmuzkaya@gmail.com, Tel: 90 (544) 442 20 75

Received: 14.01.2018, Accepted: 14.05.2018

information, medical histories, pre-operative physical examination findings, routine laboratory work-up data, operation data, post-operative follow-ups, developed complications, and physical examination and laboratory data in routine follow-ups were reviewed. All patients were called back for follow-up. For patients who cannot be reached, information in the last follow-up visit was used. For all patients, alpha, beta, gamma, sigma and total valgus angles were measured in pre- and post-operative anteroposterior (AP) X-rays and lateral X-rays based on American Knee Society radiological assessment form. For all patients, pre- and post-operative American Knee Society knee score and functional score was assessed. As laboratory work-up, all patients' pre- and post-operative erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), white blood cells values were compared. Based on American Knee Society functional scoring system, knees with a score of 100–85 were considered to be perfect, with a score of 84-70 to be good, with a score of 69-60 to be moderate and with a score of less than 60 to be poor.

Cultures were taken from synovial fluid. In cases undergoing two-stage revision surgery due to total knee prosthesis infection, following the removal of prosthesis, debridement and taking samples for tissue culture, antibiotic-loaded cement was hand-molded and placed in the joint. After the results of culture and antibiogram taken in intra-operative period came back, the patients were consulted to infectious diseases clinic, and antibiotherapy was organized based on their recommendations. Infected cases were called back for follow-ups every two weeks after discharge, and upon the clinical, laboratory and radiological eradication of the infection, after a mean of 160.9 (68-269) days revision total knee arthroplasty was performed in the second session. Patients with no problem on the wound site and whose outpatient parenteral antibiotherapy was planned by infectious diseases clinic were discharged provided that they return for follow-up on post-operative day 21. Following follow-ups were scheduled to be on week 6, months 3, 6, 9, and 12, and then every 6 months.

Statistical Analysis: Arithmetic mean values and lower and upper values of the descriptive statistical data of the patients were given. In addition, the values are distributed in percent. As statistical method, dependent samples t test Kolmogorov-Smirnov test, Paired-Samples T test and Wilcoxon Signed Ranks test were used. All statistical analyses were performed using SPSS version 19 for Windows (SPSS Inc., Chicago, USA). Two- sided p values <0.05 were regarded as statistically significant.

Results

Revision total knee prosthesis was applied to the right knees of 12 patients, left knees of 20 patients, and both knees of 1 patient. The patients' mean age was 69.6 (55-83), the female patients' mean age was 68.7 (55-80), and the male patients' mean age was 72.5 (63-83). The patients' mean follow-up duration was 20.5 (6-49) months. Revision knee arthroplasty was performed due to aseptic loosening in 18 (52.9%) knees, infection in 9 (26.5%), and instability in 7 (20.6%). When the etiologic reasons of primary prosthesis were reviewed, they were detected to be performed on rheumatoid arthritis background in one patient, psoriatic arthritis background in one patient, and osteoarthritis background in remaining patients. Long-stem AGC Dual Articular 2000 was used in 33 knees to which revision knee arthroplasty was performed, and Mutars rotational hinged tumor resection prosthesis was used in 1 knee.

34 knees of 33 patients included into the study were assessed based on Knee Society scoring system. Mean knee score and functional score was detected to be 34.7 (4-57) and 33.5 (5-55), respectively, and to be 78.2 (62-90) and 73.8 (50-90) after revision. When pre- and post-operative values of the knee score and functional score were statistically compared, the difference was significant. According to this scoring system, knees with a score of 100–85 were considered to be perfect, with a score of 84-70 to be good, with a score of 69-60 to be moderate and with a score of less than 60 to be poor. Based on pre-operative knee score, all cases were assessed to be in poor condition. Distribution of the cases based on the post-operative knee scores; 7 knees (20.6%) were perfect, 23 (67.6%) were good and 4 (11.8%) were moderate. Distribution of the cases based on the function scores; 6 knees (17.6%) were perfect, 20 (58.8%) were good, 6 (17.6%) were moderate, and 2 (5.9%) were poor.

Based on Knee Society scoring system, the mean pain score of the patients was 17.1 in pre-operative period, and improved by 24.2 points and increased to 41.3 in post-operative period. When pre- and post-operative values of the pain score were statistically compared, the difference was significant ($p < 0.001$). Distribution of pain scores of the patients in pre-operative and post-operative periods are shown in table 1.

Mean maximum flexion degree of the cases was 68.2 (30-95) before the operation and 96.2 (45-120) after the operation. When maximum flexion degrees of the cases were statistically compared, the difference was found to be significant ($p < 0.001$).

Table 1. Based on Knee Society scoring system, distribution of pain scores of the patients in pre-operative and post-operative periods

Pain scores	Pre-operative n (%)	Post-operative N (%)
0	4 (11.8)	–
10	7 (20.6)	–
20	18 (52.9)	–
30	5 (14.7)	8 (23.5)
40	–	7 (20.6)
45	–	13 (38.2)
50	–	6 (17.6)

Table 2. The radiographic measurement values of patients and statistically comparison

	Preoperative mean	Postoperative mean	P value
Alpha angle	95.3 (77-103)	94.7 (90-99)	0.501
Beta angle	84.8 (71-100)	88.4 (84-92)	0.004
Gamma angle	5.8 (0 - 30)	3.7 (0 - 10)	0.009
Sigma angle	83.3 (49-97)	88.1 (85-92)	0.023
Total valgus angle	0.1 (-13 -- 12)	3.1 (-1 -- 8)	0.005

Mean flexion contracture of the cases was 2.29 before the operation, and flexion contracture was not detected in any patient after the operation. None of the patients had loss of motion compared to the pre-operative status, and increase in the range of motion was obtained after the operation.

In pre-operative assessments performed based on Knee Society radiographic assessment form, mean alpha angle was found to be 95.3 (77-103), mean beta angle to be 84.8 (71-100), mean gamma angle to be 5.8 (0 - 30), mean sigma angle to be 83.3 (49-97), and mean total valgus angle to be 0.1 (-13 - 12). In post-operative assessments, mean alpha angle was found to be 94.7 (90-99), mean beta angle to be 88.4 (84-92), mean gamma angle to be 3.7 (0 - -10), mean sigma angle to be 88.1 (85-92), and mean total valgus angle to be 3.1 (-1 - -8). Mean pre- and post-operative radiographic assessment values of the patients and their statistical comparison are shown in table 2.

In final follow-ups of the cases after the operation, more-than-2mm of radiolucent area was not detected in any zone. Revision knee arthroplasty was performed due to aseptic loosening in 18 (52.9%) knees, infection in 9 (26.5%), and instability in 7 (20.6%). In 9 knees to which revision was performed due to septic reasons, mean pre-operative white blood cell counts was 10300/mm³, mean ESH was 41.8 mm/h and mean CRP level was 13.2 mg/L. In final follow-up after the operation, mean white blood cell counts was 7200/mm³, mean ESH was 29.1 mm/h and mean CRP level was 2.1 mg/L

(Table 3).

In 25 knees to which revision was performed due to aseptic reasons, mean pre-operative white blood cell counts was 8200/mm³, mean ESH was 30.8 mm/h and mean CRP level was 2.4 mg/L. In final follow-up after the operation, mean white blood cell counts was 7900/mm³, mean ESH was 23.4 mm/h and mean CRP level was 1.5 mg/L (Table 4).

In the culture results of the patients assessed to be septic, *methicillin-resistant staphylococcus aureus infection* (MRSA) growth was detected in 2 (22.2%). No growth was detected in the cultures of remaining 7 (77.8%) patients. Antibiotic-loaded spaces was used and two-stage revision arthroplasty was performed in all patients to whom revision was performed due to septic reasons. Upon clinical, laboratory and radiological eradication of the infection after a mean of 160.9 (68-269) days, spacer was removed in the second session, large debridement was performed and revision total knee arthroplasty was performed.

Antibiotic-loaded cement prepared with 1 g of vancomycin per 40 g of cement was used in 4 of the patients who underwent two-stage revision, and ready-to-use antibiotic-loaded cement prepared with 0.5 g of gentamycin per 40 g of cement was used in the remaining 5. Ready-to-use antibiotic-loaded cement prepared with 0.5 g of gentamycin per 40 g of cement was used in all of the patients who underwent revision due to aseptic reasons.

In 34 knees which underwent revision knee arthroplasty, the mean duration of hospitalization was 21.4 days (10-55), it was 25.9 days (10-55) in 9

Table 3. In cases to which revision was performed due to septic reasons, white blood cell, erythrocyte sedimentation rate and C-reactive protein levels

	Preoperative mean	Postoperative mean	P value
White blood cell/mm ³	10300	7200	0.286
Erythrocyte sedimentation rate/mm/h	41.8	29.1	0.050
C-reactive protein/mg/dl	13.2	2.1	0.008

Table 4. In cases to which revision was performed due to septic reasons, white blood cell, erythrocyte sedimentation rate and C-reactive protein levels

	Preoperative mean	Postoperative mean	P value
White blood cell/mm ³	8200	7900	0.846
Erythrocyte sedimentation rate/mm/h	30.8	23.4	0.087
C-reactive protein/mg/dl	2.4	1.5	0.820

knees which underwent revision knee arthroplasty due to septic reasons, and 19.8 days (10-43) in 25 knees which underwent revision knee arthroplasty due to aseptic reasons.

The mean duration between primary knee arthroplasty and revision knee arthroplasty was 45.2 months (13-68) in 9 knees which underwent revision knee arthroplasty due to septic reasons, and 69.6 months (15-148) in 25 knees which underwent revision knee arthroplasty due to aseptic reasons.

In order to resolve the defects formed in femur and tibia after prosthesis removal and debridement during the operation, graft pressing method was used in 16 (47.1%) cases, and augmentation block in 9 (25.5%) cases (augmentation block to femur in 5 cases, to tibia in 3 cases, and to both in 1 case).

4 (11.8%) patients had serous discharge from wound site in early post-operative period. No patient had re-infection or aseptic loosening. No patient had implant malposition.

Discussion

With the technological advancements in implant design and development in surgical techniques, the successful results of the primary total knee arthroplasty operations are increasing, and their indications are getting expanded to include young and active patients. As a natural consequence of this, the number of the performed revision total knee arthroplasty operations is also increasing. When revision knee arthroplasty operations are compared to the primary knee arthroplasty operations, they are more difficult in terms of surgery, and more costly as the used implants are more complex and

expensive, the hospitalization period is longer, operation takes longer, complication rates are higher, and antibiotherapy takes longer especially in infected knees (1).

When we reviewed the reasons for revision knee arthroplasty, Saleh et al. (3) states the reasons as infection (38%), instability (27%), aseptic loosening (16%), periprosthetic fractures (7%), patellar problems (8%), and unexplained pain (4%). In their case series, Deehan et al. (4) determined aseptic loosening in 46% of the patients, instability in 15%, bone loss and fracture in 10%, infection in 6%, pain in 5%, movement restriction in 4% and polyethylene abrasion in 4%. In their aseptic single-stage revision knee arthroplasty series, Malviya et al. (5) detected the reasons as aseptic loosening in 46% of the patients, instability in 32%, unexplained pain 9%, polyethylene abrasion in 13% and other reasons in 6%. In our study, we detected the reasons for revision as aseptic loosening in 52.9% of the patients, infection in 26.5%, and instability in 20.6%. When we compared our results to the literature, while the rates of the patients especially undergoing revision knee arthroplasty for septic reasons vary greatly, we think that reasons for revision in our study are consistent with the literature.

Regardless of the indication for revision, we see that the reason that they accept revision operation is the pain affecting their daily activities. In our study, we scored the level of pain based on Knee Society Arthroplasty Scoring System (a score of 50 means no pain, and 0 means severe pain). Based on this, the mean pain score of the patients was 17.1 in pre-operative period, and improved by 24.2 points and increased to 41.3 in post-operative period. When pre- and post-operative values of the pain score were statistically compared, the difference was

significant ($p < 0.001$). We can say that revision knee arthroplasty operation reached its goal as significant decrease was observed in pain levels of the patients after the operation and that the patients are satisfied with the operation.

When we review the literature regarding the follow-ups of the patients who underwent revision knee arthroplasty, we see the following results: In their study, F. Hardeman et al. (6) detected the mean pre-operative American knee society knee score to be 27.6 and post-operative to be 71.5, and the mean pre-operative function score to be 27.5 and post-operative to be 53.3. In their study, Azzam et al. (7) detected the mean pre-operative American knee society knee score to be 43 (11-94) and post-operative to be 76 (17-100), and the mean pre-operative function score to be 47 (20-80) and post-operative to be 64 (20-100). In their study in 96 infected knees which underwent two-stage revision, Haleem et al. (8) found the pre-operative median American knee society knee score to be 49 (4-85), and post-operative median knee score to be 89 (35-97). Median functional score was 5 (0-80) before the operation, and increased to 50 (0-100) after the operation. In our study, 34 knees of 33 patients included into the study were assessed based on Knee Society scoring system. Mean knee score and functional score was detected to be 34.7 (4-57) and 33.5 (5-55), respectively, and to be 78.2 (62-90) and 73.8 (50-90) after revision. When pre- and post-operative values of the knee score and functional score were statistically compared, the difference was found to be significant ($p < 0.001$) and consistent with the literature. With regards to the evolution of the knee score and functional score of the patients who underwent revision knee arthroplasty in our clinic, we can say that revision operations are successful and reached their goal. Mean maximum flexion degree of the cases was 68.2 (30-95) before the operation and 96.2 (45-120) after the operation. Mean flexion contracture of the cases was 2.29 before the operation, and flexion contracture was not detected in any patient after the operation. None of the patients had loss of motion compared to the pre-operative status, and significant increase in the patients' ranges of motion was obtained after the operation.

If bone loss or poor bone quality is present, it is very difficult to obtain sufficient stability using standard prostheses in revision surgery. Use of long stems fixated by cemented or uncemented method may augment the fixation of the prostheses. Use of long stems may block stress distribution and negatively affect prosthesis fixation, thereby cause osteopenia and periprosthetic fractures. In their study in 40

cases underwent revision with cemented long stem, Murray et al. (9-13) reported that at the end of 4.8 years of follow-up very good results have been obtained and no poor outcome has been observed for the prosthesis fixation they used. In our study, uncemented long stem was used in 34 knees of 33 patients who underwent revision knee arthroplasty, and none of the cases developed a long stem-related complication.

Infection is one of the most undesirable complications affecting TKA patients, and one of the most important reasons for revision knee arthroplasty. Successful results have been reported in the treatment of infected TKA for single-stage or two-stage revision knee arthroplasties, and while the choice of method to be used is still controversial, general opinion is that two-stage revision would a more accurate approach (2). In their study in which the results of 10 patients who underwent two-stage total knee arthroplasty and 4 patients who underwent single-stage total knee arthroplasty due the infection, Sener et al. (14) have reported that they detected 10% re-infection rate in two-stage revision application and 50% in single-stage applications. In their 6-year follow-up in single- and two-stage re-implantations in a series consisting of 385 infection knee prostheses, Bengtson et al. (15) did not find any significant difference. Booth and Lotke (16) have reported that perfect and good results were obtained in 21 of 25 cases who underwent two-stage re-implantation, and 1 case developed infection after revision. Whiteside (17) has reported infection only in 1 case at the end of 35-month follow-up of 33 cases who underwent two-stage revision with uncemented prostheses. In their study in 53 patients with 56-month of follow-up, Lonner et al. (18) have treated the infected knee prostheses using antibiotic-loaded spacer, and observed the re-infection rate to be 17%.

For two-stage revision operations, two methods with and without antibiotic-loaded spacer have been described in the literature (18). In our clinic, the method with antibiotic-loaded spacer is preferred. We, thereby, aim to reach high local antibiotic concentration without its systemic toxicity, to keep joint capsule which is emptied after debridement, surrounding muscle tissue and ligaments at proper tension, and to improve the patient's comfort by increasing the stability between two stages. The duration of spacer in our patients who underwent two-stage revision had a mean of 160.9 (68-269) days. When we review the literature, the mean duration of spacer appears to be 6 weeks (18). While our duration is long, we think that it is necessary to wait clinical, laboratory and radiological eradication

of the infection for re-implantation.

Antibiotic-loaded cement prepared with 1 g of vancomycin per 40 g of cement was used in 4 of the patients who underwent two-stage revision, and ready-to-use antibiotic-loaded cement prepared with 0.5 g of gentamycin per 40 g of cement was used in the remaining 5. Ready-to-use antibiotic-loaded cement prepared with 0.5 g of gentamycin per 40 g of cement was used in all of the patients who underwent revision due to aseptic reasons. When we review the literature, antibiotic-loaded cement use in revision knee arthroplasty is recommended by many authors.

White blood cell count, ESR, CRP levels were used for the infection follow-up. In 9 knees to which revision was performed due to septic reasons, mean pre-operative white blood cell count was 10300, mean ESH was 41.8 mm/h and mean CRP level was 13.2 mg/L. In final follow-up after the operation, mean white blood cell count was 7200, mean ESH was 29.1 mm/h and mean CRP level was 2.1 mg/L. In the last follow-ups, decrease was observed in white blood cell count, ESR and CRP levels, but the decrease in CRP levels was more significant. Also, when we review the literature, we see that CRP is stated to be the first parameter returning back to normal levels in post-operative period, and it is the most sensitive and specific laboratory work-up for the diagnosis of infection (19). In our study, two-stage revision knee arthroplasty was performed in all of 9 cases who underwent revision knee arthroplasty due to infection and single-stage revision knee arthroplasty was performed in 25 knees due to aseptic reasons, and none of the patients developed re-infection. Our mean follow-up period was 20.5 months (6-49), and while its shorter than the literature data, the fact that no re-infection was developed also shows that the operations were successful.

As a result, when revision knee arthroplasty operation is performed for proper indication and according to the surgical technique, it is a highly effective and preferable method in decreasing the pain severity and improving the life quality of the patients. Two-stage revision knee arthroplasty together with proper antibiotherapy for the treatment of total knee arthroplasty infection is an efficient method of treatment.

References

1. Tew M, Forster IW. Effect of knee replacement on flexion deformity. *J Bone Joint Surg* 1987; 67: 395-399.

2. Guyton JL. Arthroplasty of ankle and knee. Canale T (Editör). *Campbell's Operative Orthopaedics*. 10. edition. St. Louis: Mosby-Year Book, Inc 2003; 243-298.
3. Hungerford DS, Kenna RV, Krackow KA. The porous coated anatomic total knee. *Orthop. Clin. North Am* 1982;13: 103-122.
4. Hungerford DS, Kenna RV. Preliminary experience with a total knee prosthesis with porous coating used without cement. *Clin. Orthop* 1983; 176: 95-117.
5. Hungerford DS, Krackow KA. Total joint arthroplasty of the knee. *Clin. Orthop* 1985; 192: 23-33.
6. Guyton JL. Arthroplasty of ankle and knee. Canale T (Editör). *Canale & Beaty: Campbell's Operative Orthopaedics*, 11th ed 2007; 241-314.
7. Ranawat CS. Survivorship analysis and results total knee arthroplasty. Eightto 11 year follow-up study. *Clin Orthop* 1988; 226: 6-12.
8. Saleh KJ. Current status of revision total knee arthroplasty how do we assess results. *JBJS* 2003; 85: 18-22.
9. Deehan DJ, Murray JD, Birdsall PD, Pinder IM. Quality of life after knee revision arthroplasty, *Acta Orthopaedica* 2006; 77: 761-766.
10. Malviya A, Brewster NT, Bettinson K, Holland JP, Weir DJ, Deehan DJ. Functional outcome following aseptic single-stage revision knee arthroplasty *Knee Surg Sports Traumatol Arthrosc* 2011; 1786-1784.
11. Hardeman F, Favril JLA, Witvrouw E, Bellemans J, Victor J. Predisposing factors which are relevant for the clinical outcome after revision total knee arthroplasty, *Knee Surg Sports Traumatol Arthrosc* 2012; 20: 1049-1056.
12. Azzam K, Parvizi J, Kaufman D, James J, Sharkey PF, Austin MS. Revision of the Unstable Total Knee Arthroplasty, *The Journal of Arthroplasty* 2011; 26: 8.
13. Haleem AA, Berry DJ, Hanssen AD. Mid term to long term followup of two stage reimplantation for infected total knee arthroplasty. *Clin Orthop* 2004; 428: 35-39.
14. Murray PB, Rand JA, Hanssen AD. Cemented long stem revision total knee arthroplasty. *Clin Orthop* 1994; 309: 116-123.
15. Hoeffel DP, Rubash HE. Revision total knee arthroplasty. Current rationale and techniques for femoral component revision. *Clin Orthop* 2000; 380: 116-132.
16. Insall JN, Dethmers DA. Revision of total knee arthroplasty. *Clin Orthop* 1982; 170: 123-130.

17. Bertin KC, Freeman MAR, Samuelson KM, Ratcliffe SS, Todd RC. Stemmed revision arthroplasty for aseptic loosening of total knee replacement. *J Bone Joint Surg* 1985; 67: 242-248.
18. Whiteside LA. Cementless reconstruction of massive tibial bone loss in revision total knee arthroplasty. *Clin Orthop* 1989; 248: 80-86.
19. Şener N, Tözün İR, Şengün M. Total diz artroplastisi revizyonlarımız. *Acta Orthop Traumatol Turc* 31 1997; 492-497.
20. Goksan SB, Freeman MAR. One stage reimplantation for infected total knee arthroplasty. *JBJS* 74b 1992; 78-82.
21. Booth Jr RE, Lotke PA. The results of spacer block technique in revision of infected total knee arthroplasty. *Clin Orthop* 1989; 248: 57-60.
22. Whiteside LA: Treatment of infected total knee arthroplasty. *Clin Orthop* 1994; 299: 169-172.
23. Lonner JH. Results of two stage revision of the infected total knee artroplasty. *The American journal of the knee surgery* 2001; 14: 65-68.
24. Niskanen RO, Korkala O, Parnmo H: Serum C-reactive protein levels af ter total hip and knee arthroplasty. *J Bone Joint Surg* 1996; 78: 431-433.