RESEARCH

KNEE ARTHRODESIS WITH COMPUTER-ASSISTED EXTERNAL FIXATOR SYSTEM AFTER PROSTHETIC JOINT INFECTION FOR ELDERLY POPULATION

Turkish Journal of Geriatrics
DOI: 10.29400/tjgeri.2023.331
2023; 26(1):60−67

Muharrem KANAR[1]
Necmi CAM[2]

Abstract

Introduction: This study aimed to evaluate the effectiveness of a computer-assisted circular external fixator used to achieve arthrodesis in elderly patients with failed infected total knee arthroplasty.

Materials and Methods: Retrospectively 11 patients who treated with arthrodesis between 2015 and 2020 were included in the study. The average age was 73.5 ±4.73 years (65–81). All patients had recurrent infections after total knee arthroplasty. Radiologic evaluations, the time for fusion, shortening of extremities, visual analog scale scores, Oxford knee scoring system, lower extremity functional scale of all patients were compared pre-and post-operatively. complications of the technique were noted.

Results: The mean follow-up was 33.7 ±12.85 (12–52) months. Fusion was achieved in all patients. The average limb length discrepancy after removal of the fixator was 46±0.78 (36–61) mm. The mean visual analog scale score measured pre-op was 6.91±0.94 (5–8), and after fixator removal they were measured as 2.36±0.92 (1–4). The mean Oxford knee score was 10.27±2.68 (4–14) pre-operatively and 28.64±2.69 (23–32) postoperatively. The mean, lower extremity functional scale was 17.06±9.38 (7.5–33.8) pre-operatively and 38.54±12.22 (21.3–56.3) postoperatively. No joint infection recurrence was seen post-operatively.

Conclusion: Arthrodesis is a suitable option for elderly patients with limited mobilization who are tired of repeated revision surgeries. Due to its high fusion and low complication rate, computer-assisted circular external fixator is an effective method in the treatment of difficult knee arthrodesis required after infected total knee arthroplasty.

Key Words: Arthroplasty, Replacement, Knee; Reoperation; Infection; Arthrodesis; External Fixators.

CORRESPONDANCE

[1]Muharrem KANAR

Phone : +905325100418
e-mail : dr.kanar@hotmail.com

Received : Nov 05, 2022
Accepted : Feb 06, 2023

[1] Şişli Hamidiye Etfal Training and Research Hospital, Orthopaedics And Traumatologia, Istanbul, Turkey

[2] Şişli Hamidiye Etfal Training and Research Hospital, Orthopaedics and Traumatologia, Istanbul, Turkey

INTRODUCTION

Infection of knee arthroplasty is feared and is one of the most catastrophic complications for that can accompany above-knee amputation. It can be seen at a rate of 0.4–2%, and it is quite difficult to treat (1).

Knee arthrodesis is a salvage procedure for end-stage periprosthetic joint infections. Also, massive bone and soft tissue loss and extensor mechanism disruption are caused by repeated operations or in cases of a patient's refusal to undergo revision arthroplasty after infected knee arthroplasty (2).

The main goals of knee arthrodesis in infected total knee arthroplasty (TKA) are to provide pain relief and stability of the extremity. Many methods have been described to achieve solid knee fusion: canulated screws, intramedullary nails, plate osteosynthesis, and external fixation, with rates of fusion ranging from 29% to 100%. The ideal method should have a high fusion rate with a low complication rate, minimal visits to the hospital, and a reduction in the need for further treatment. Normal anatomical alignment should be restored. It has been accepted that rigid fixation and compression reduce failure rates. The success of arthrodesis is determined by the patient's bone stock, independent of the technique and indication (3).

Arthrodesis of the knee can provide a stable and painless extremity on which patients can walk. The patient also had better functional outcomes than those encountered with amputation or suppressive antibiotic treatment. Therefore, arthrodesis procedures can be a choice for the management of persistent infection after failed multiple-stage revision arthroplasty (4).

Studies have shown that the success rates of TKA have increased. Therefore, the indication of total knee arthroplasty has expanded, and it has begun to be performed more in younger patients (5).

Because of the increasing knee arthroplasty, we believe that requirement the revision knee arthroplasty and arthrodesis will probably increase. In this study, we aimed to investigate the effectiveness of a computer-assisted circular external fixator (Ca-CEF) system for achieving knee arthrodesis in patients with failed infected TKA.

MATERIALS AND METHODS

In this study, we retrospectively evaluated elderly patients with infected knee arthroplasty who were treated with knee arthrodesis by a Ca-CEF (Spiderframe Tasarımmed, İstanbul, Turkey) between June 2015 and September 2020 and at least followed up six months after fixator removal in the Health Sciences University, Orthopaedic and Traumatology department , Şişli Hamidiye Etfal Training and Research Hospital. The exclusion criteria were the patient who was out of follow-up before the treatment was completed, the patient under 65 years, and the knee arthrodesis was not based on periprosthetic infection. Twelve patients who underwent arthrodesis after failed knee arthroplasty were retrospectively analyzed from hospital archive records. One patient died due to COVID-19 while his treatment was ongoing, and his follow-up was not completed. This patient was excluded from the study group. Eleven patients were included in our study; eight of the patients were female, and three were male. The average age was 73.5±4.73 (65–81) years. All patients had recurrent infections after TKA. Patients over 65 years with infected knee arthroplasty who has at least one major criteria of MSIS criteria (6), who did not recover despite at least three surgeries, and who accepted arthrodesis were included in the study.

The study protocol was approved by the Şişli Hamidiye Etfal Training and Research Hospital Ethics Committee (date: 02/02/2021, number:3119). Written informed consent was obtained from the patients or their legal guardians of each patient. The study was conducted according to the principles of the Declaration of Helsinki.

Surgery was performed by anteromedial parapatellar approach, which had also been used in previous arthroplasty surgery, was used. Firstly, spacers were removed, and joint debridement was applied to the patients then bone surfaces were prepared to improve the contact area by an electrical saw. Ca-CEF was applied, and intraoperative compression of the bone was performed in the operating room.

Postoperatively x-ray was evaluated for correct angulation of any plane or compression by Ca-CEF, if needed. The patients were mobilized by full weight bearing using crutches on the day after the operation. Systemic antibiotic treatment was started according to the post-operative positive cultures. After six weeks of systemic antibiotherapy, clinical and laboratory findings evaluated oral antibiotherapy according to the recommendations of the infectious disease consultation. Time for solid bone fusion, limb alignment and shortening of extremities (mm), recurrence of infection, visual analog scale (VAS), Oxford knee scoring (OKS) and lower extremity functional scale (LEFS) scores of all patients were compared pre-op and post-op (six months after fixator removal). Minor and major complications of the technique were noted.Patients details are summarized in Table 1.

RESULTS

The mean follow-up was 33.7 ±12.85 (12–52) months, and fusion was achieved in all patients. The average time for fusion was 7.7±1.84 months (5–11 months). (Figure 1). The average limb length discrepancy after removal of the fixator was 46±0.78 (36-61) mm. The mean VAS score measured pre-op was 6.91±0.94(5–8), after fixator removal 2.36±0.92(1–4). The average patient hospital stay was 16.8 (6–29) days. Mean OKS was 10.27±2.68 (4–14) pre-operatively, and 28.64±2.69 (23–32) postoperatively. Mean LEFS was 17.06±9.38 (7.5-33.8) pre-operatively, and 38.54±12.22 (21.3-56.3) was post-operatively. The decrease in the post-op VAS score and the increase in OKS and LEFS scores were found to be statistically significant compared

Table 1. Details of patients

Patient	Age	Gender	Side	Culture results	Follow -up (months)	Fusion time (months)	Shortness (mm)
1	72	Male	Left	MRSA	12	8	45
2	74	Female	Right	Candida albicans	21	7	55
3	65	Male	Right	Polimikrobial	52	9	36
4	71	Female	Left	Enterococcus fecalis	23	5	48
5	76	Male	Right	Klebsiella pneumoniae	34	6	5
6	79	Female	Right	Staphylococcus epidermidis	37	6	4
7	69	Female	Left	Pseudomonas aeruginosa	20	11	61
8	70	Female	Left	MRSA	43	6	44
9	77	Female	Right	Polimikrobial	39	9	38
10	76	Female	Left	Polimikrobial	44	10	41
11	81	Male	Left	Escherichia coli	46	7	54

MRSA: methicillin-resistant Staphylococcus aureus

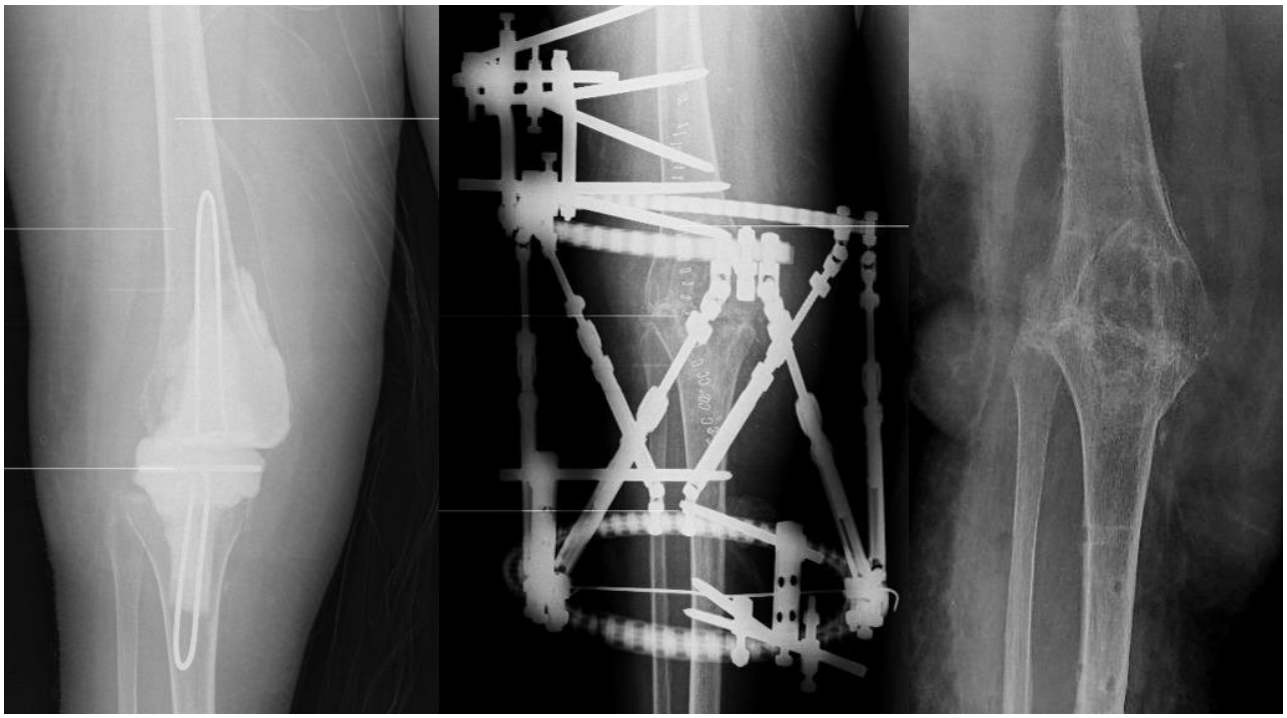

Figure 1. X-ray images before arthrodesis, after Ca-CEF application and after fixator removal are seen

to the pre-op values of the patients. Descriptive statistical results are summarized in Table 2.

Almost all patients had a low-grade pin-tract infection that treated with local wound care and antibiotherapy. Only two patients had to pins removed with local anesthesia. Clinically, all patients had stable knee arthrodesis, all patients were able to walk on their own, even four of them could walk without crutches during the last follow-up. No patient had a stress fracture or a refracture

Table 2. Statistical analysis of pain and functional scores

		Mean±SD	Min-Maks (Median)	p
VAS	Pre-op	6.91±0.94	5-8 (7)	0,003#
	Post-op	2.36±0.92	1-4 (2)	
	Variation Mean.±SD %95 CI)	4.55±1.29 (3.68-5.41		
OKS	Pre-op	10.27±2.68	4-14 (11)	<0,001*
	Postop	28.64±2.69	23-32 (29)	
	Variation Ort.±SD %95 CI)	18.4±1.9 (17.1-19.6)		
LEFS	Pre-op	17.06±9.38	7.5-33.8 (13.8)	<0,001*
	Post-op	38.54±12.22	21.3-56.3 (40)	
	Variation Ort.±SD %95 CI)	21.5±7.6 (16.4-26.6)		

VAS: Visual Analog Scale, OKS: Oxford Knee Scoring , LEFS: lower extremity functional scale
*Paired t Test #Wilcoxon Test

after fixator removal during the follow-up. No joint infection recurrence was seen in any of the patients. All patients reported mild pain but did not need any pain medication.

The alignment of fusion was noted mechanical axis deviation (MAD) from medially varus was noted as "+" and valgus was noted as "-". Mean coronal alignment was -2.4 mm and the range was + 2 to (-7) and mean sagittal plan alignment was 4.6 degrees (range was 0–10 degrees procurvatum). There was no recurvatum deformity.

Statistical analysis

SPSS 15.0 for Windows program was used for statistical analysis. Descriptive statistics were given as number and percentage for categorical variables, mean, standard deviation, median, minimum, maximum for numerical variables. When the differences of numerical variables in the dependent group provided the normal distribution condition, the Paired t test was analyzed with the Wilcoxon test when the condition was not met. The alpha significance level was accepted as $p<0.05$.

DISCUSSION

Revision after failed infected knee arthroplasty results in a higher complication rate, with a more unfavorable outcome in terms of pain and function. Multiple surgeries may be required (7). These patients also face potentially disastrous complications including above-the-knee amputation, and unfortunately death (8). Especially in elderly patients in order to avoid these complications, as a salvage surgery, the knee arthrodesis option should not be ignored.

Arthrodesis is a widely accepted surgery for failed TKA when further revisions are not desired for geriatric population. Recurrent infections, extensive bone defects, ligament instability, lack of extensor mechanism, and insufficient soft tissue coverage of the knee may require arthrodesis of the knee joint as a curative procedure for limb salvage. Arthrodesis restores good limb loading, reduces pain, eliminates infection and generally well tolerated by the elderly patients (9). Studies in the literature mention that even after achieving successful knee arthrodesis using any of various techniques, some patients have continued to experience mild pain but acceptable functionality (10). This also observed in our current study. All patients reported mild pain but did not need any medication.

Many techniques have been described for knee arthrodesis. External fixators (monolateral, circular), intramedullary nails, plates and screws are among the surgical methods that can be used. Each technique has its own positive and negative aspects. Regardless techniques stable and painless extremity with the eradication of infection is the main goal of knee arthrodesis after failed infected TKA. For a successful fusion the infection should be controlled, soft tissue problems should be eliminated. Two-stage procedure has high fusion rate of arthrodesis (11). We prefer two-stage procedure with Ca-CEF for high fusion rate.

An ideal arthrodesis should achieve a high rate of fusion with a low complication rate, allow early mobilization, and achieve normal anatomical alignment of the limb. The use of plate and screw is not preferred because of not allowing early weight bearing, soft tissue problems, and high infection recurrence rate. Most of the publications recommended intramedullary nail or external fixator in arthrodesis surgeries after infected TKA (11).

Intramedullary nail provides good stability, well tolerated and allows early weight bearing (11). Apart from this, there are also disadvantages compared to external fixators. Surgery time of the arthrodesis by intramedullary nail procedure is longer than the external fixator and reaming of the femur and tibia increases the risk of pulmonary embolism and can spread the infection along the medullary canal (9,12).

Therefore, the insertion of a long intramedullary nail is a challenging operation with a high risk of

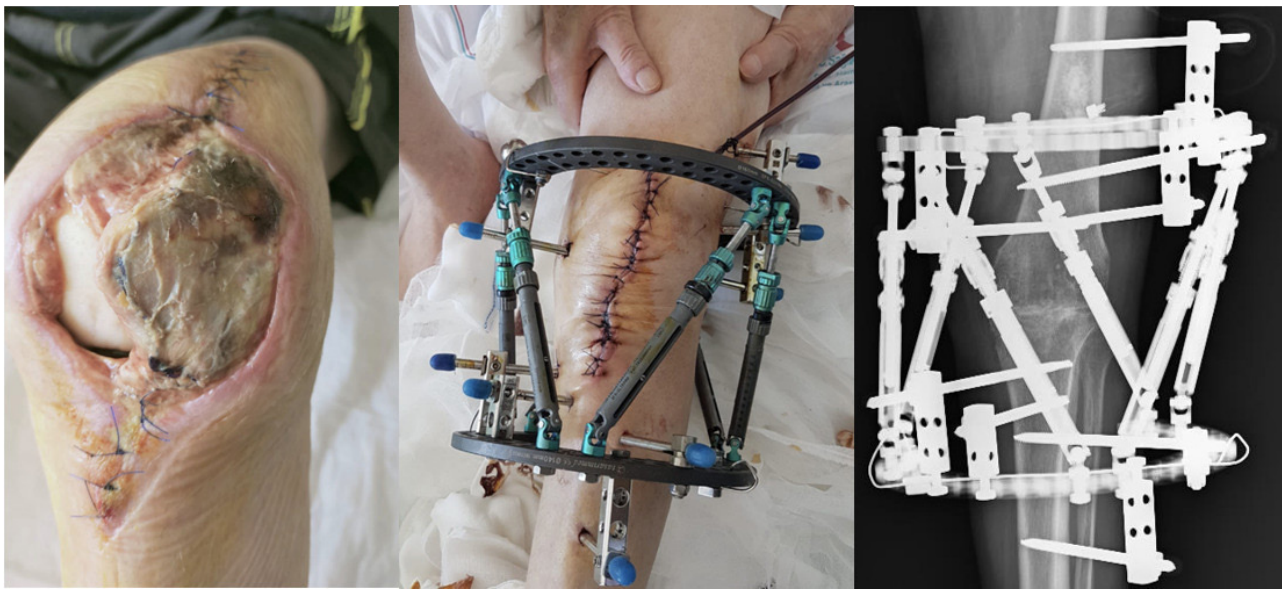

Figure 2. Patient who treated by Ca-CEF with soft tissue problem after infected TKA is seen

proximal femur fracture (12). In addition, external fixation provides intraoperative flexibility; it can be used in cases when medullary canal of femur has already been obliterated by an implant or anatomic deformities. It also allows performing reconstructive procedures in which cases had soft tissue problems. (Figure 2). External fixators are more advantageous in terms of infection recurrence because of there is no implant that remains in the body (10,11).

Parratte et al. reported complete remission of infection with external fixator arthrodesis in infected TKA (13). Also, in our patient group no infection recurrence was seen. When the results of arthrodesis applied with intramedullary nail after infected knee prosthesis are examined in the literature, fusion rates vary between 73.7% and 100%, and the average limb length discrepancy rates are between 28mm and 55mm (14-17). In our case series fusion was achieved in all patients and the average limb length discrepancy was 46mm. None of the patients requested limb-lengthening surgery, early removal of the fixator was their priority. The effective compression in the Ca-CEF while increasing the shortness, also positively affects to our fusion rates.

The fusion time of knee arthrodesis is longer than normal bone fracture healing (2). Comfort was decreased in external fixators when compared to internal fixations. Because of this treatment with fixators can negatively affects the social and emotional status of the patient (18). Some patients may even request the termination of the fixator without waiting for the completion of the treatment. There was no such request in our elderly patients. Because they were motivated when their pain subsided and they could walk on their own.

Classic complications of external fixators such as pin-tract infections and pin loosening, can often be seen. Klinger et al. conducted a study of 18 patients in which 100% developed pin-tract infections (19). In our study, pin-tract infection was observed in all patients, but most recovered with local wound care and antibiotic therapy. Only two patients had pin loosening in the proximal region. In these patients, loosened pins were removed with the help of local

anesthesia under outpatient conditions, and no additional surgical procedure was required. We predicted this in our patients and kept the number of Schanz applied to the proximal region to more than normal.

It is recommended to perform knee arthrodesis in 5-8 degrees of valgus, 0-15 degrees of flexion and 5-10 degrees of external rotation (2). When arthrodesis is performed with an intramedullary nail, this arthrodesis occurs with 2–5 degrees of varus, which theoretically causes same-side hip arthritis (20). In our study, an average of -2.1 mm MAD (valgus) was obtained after the fusion was completed. Using the advantage of Ca-CEF ability to correct in all directions, we achieved the desired arthrodesis angles in the fusion. There is no consensus on which position arthrodesis should be performed for the sagittal plane of knee arthrodesis. In our study, arthrodesis was planned in full extension with the aim of preventing the increase of shortness.

Artodesis can be applied with many external fixator systems. Although monolateral fixators are comfortable, but they are not very suitable for weight bearing. On the other hand, wires and Schanz screws at different angles in Ilizarov and other circular fixators resist high stability and dynamic axial stability versus torsional forces (20,21)

Full load with a circular fixator allows axial compression in the arthrodesis side axially, even after surgery, that increases bone regeneration. Ca-CEF systems, which can provide more rigid fixation according to the classical Illizarov systems and can be defined as a more advanced current version of the circular fixators, allow for the easy correction of deformities during the arthrodesis process in the post-operative period (22).

The indication of total knee arthroplasty is expanded, and it has begun to be performed more often in younger patients (5) Therefore, we believe that the need for arthroplasty revisions and arthrodesis surgeries will increase, and this study may be inspire for future studies with a larger sample.

Small sample size and retrospective design are limitations of our study .

We aimed to achieve better results by combining the stability of IM nails and the success of conventional ex-fixes in infection using Ca-CEF. This was supported by the fact that fusion was achieved in all patients and no recurrence of infection was observed.

In conclusion, Arthrodesis is a suitable option for elderly patients with limited mobilization who are tired of repeated revision surgeries. Due to its high fusion and low complication rate, Ca-CEF is an effective method in the treatment of difficult knee arthrodesis required after infected TKA.

REFERENCES

1. Peersman G, Laskin R, Davis J, et al. Infection in total knee replacement: a retrospective review of 6489 total knee replacements. Clin Orthop Relat Res. 2001;(392):15-23. (PMID: 11716377)
2. Balci HI, Saglam Y, Pehlivanoglu T, Sen C, et al. Knee Arthrodesis in Persistently Infected Total Knee Arthroplasty. J Knee Surg. 2016;29(7):580-88. (PMID: 26683977)
3. Vlasak R, Gearen PF, Petty W. Knee arthrodesis in the treatment of failed total knee replacement. Clin Orthop Relat Res. 1995;(321):138-44. (PMID: 7497659)
4. Wu CH, Gray CF, Lee GC. Arthrodesis should be strongly considered after failed two-stage reimplantation TKA. Clin Orthop Relat Res. 2014;472(11):3295-304. (PMID: 24488752)
5. Lonner JH, Hershman S, Mont M. Total knee arthroplasty in patients 40 years of age and younger with osteoarthritis. Clin Orthop Relat Res. 2000;(380):85-90. (PMID: 11064977)
6. Parvizi J, Zmistowski B, Berbari EF, et al. New definition for periprosthetic joint infection: from the Workgroup of the Musculoskeletal Infection Society. Clin Orthop Relat Res. 2011;469(11):2992-4. (PMID: 21938532)
7. Roman MD, Russu O, Mohor C, et al. Outcomes in revision total knee arthroplasty . Exp Ther Med. 2022;23(1):29. (PMID: 34824637)

8. Sierra RJ, Trousdale RT, Pagnano MW. Above-the-knee amputation after a total knee replacement: prevalence, etiology, and functional outcome. J Bone Joint Surg Am. 2003;85(6):1000-4. (PMID: 12783994)

9. Spina M, Gualdrini G, Fosco M, Giunti A. Knee arthrodesis with the Ilizarov external fixator as treatment for septic failure of knee arthroplasty. J Orthop Traumatol. 2010;11(2):81-8. (PMID: 20425133)

10. Mahmoud SS, Sukeik M, Alazzawi S, et al. Salvage Procedures for Management of Prosthetic Joint Infection After Hip and Knee Replacements. Open Orthop J. 2016 30;10:600-614. (PMID: 28144373)

11. Robinson M, Piponov HI, Ormseth A, et al. Knee Arthrodesis Outcomes After Infected Total Knee Arthroplasty and Failure of Two-stage Revision With an Antibiotic Cement Spacer. J Am Acad Orthop Surg Glob Res Rev. 20183;2(1):077. (PMID: 30211377)

12. Mabry TM, Jacofsky DJ, Haidukewych GJ, et al. Comparison of intramedullary nailing and external fixation knee arthrodesis for the infected knee replacement. Clin Orthop Relat Res. 2007;464:11-5. (PMID: 17471102)

13. Parratte S, Madougou S, Villaba M, et al. Knee arthrodesis with a double mono-bar external fixators to salvageinfected knee arthroplasty: retrospective analysis of 18 knees with mean seven-year follow-up. Rev Chir Orthop Repar Appar Mot2007;93(4):373–80. (PMID: 17646819)

14. De Vil J, Almqvist KF, Vanheeren P, Boone B, Verdonk R. Knee arthrodesis with an intramedullary nail: a retrospective study. Knee Surg Sports Traumatol Arthrosc. 2008 Jul;16(7):645-50. (PMID: 18373081)

15. Incavo SJ, Lilly JW, Bartlett CS, Churchill DL. Arthrodesis of the knee: experience with intramedullary nailing. J Arthroplasty. 2000 Oct;15(7):871-6. (PMID: 11061447)

16. Leroux B, Aparicio G, Fontanin N, et al. Arthrodesis in septic knees using a long intramedullary nail: 17 consecutive cases. Orthop Traumatol Surg Res. 2013 Jun;99(4):399-404. (PMID: 23623438)

17. Bargiotas K, Wohlrab D, Sewecke JJ et al. Arthrodesis of the knee with a long intramedullary nail following the failure of a total knee arthroplasty as the result of infection. Surgical technique. J Bone Joint Surg Am. 2007 Mar;89 Suppl 2 Pt.1:103-10. (PMID: 17332129)

18. Benson ER, Resine ST, Lewis CG. Functional outcome of arthrodesis for failed total knee arthroplasty. Orthopedics. 1998 Aug;21(8):875-9.(PMID: 9731669)

19. Klinger HM, Spahn G, Schultz W,. Arthrodesis of the knee after failed infected total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc. 2006;14(5):447-53. (PMID: 16133442)

20. Conway JD, Mont MA, Bezwada HP. Arthrodesis of the knee. J Bone Joint Surg Am. 2004;86(4):835-48. (PMID: 15069154)

21. Van Rensch PJ, Van de Pol GJ, Goosen JH, et al. Arthrodesis of the knee following failed arthroplasty. Knee Surg Sports Traumatol Arthrosc. 2014;22(8):1940-8. (PMID: 23708381)

22. Tan B, Shanmugam R, Gunalan R, et al. A Biomechanical Comparison between Taylor's Spatial Frame and Ilizarov External Fixator. Malays Orthop J. 2014;8(2):35-9. (PMID: 25279090)