

An investigation of the effect of modified irrigation on the frequency of knee joint infection following Total Knee Arthroplasty (TKA)

Abstract

Background and purpose: Despite its effectiveness as a therapeutic intervention, Total Knee Arthroplasty (TKA) is sometimes followed by joint infection as a serious postoperative complication. This study aimed to investigate the effect of modified irrigation on the frequency of knee joint infection following TKA.

Methods: In this descriptive, cross-sectional study, the patients undergoing TKA in the non-educational medical centers in one city by single surgeon were investigated. For the selection of the patients to be included in the study, census sampling method was used. All these cases received irrigation of wound with 50ML of irrigation serum 1:10 beta dine and normal saline during TKA procedure. The demographic information about each patient education level, underlying diseases, the type of infection, and laboratory test results (including WBC, hemoglobin, ESR, creatinine, blood sugar, platelet count, urea, and PMN) was obtained from their medical records, from the patients themselves and their treating physicians. The obtained data were analyzed using SPSS Software.

Findings: 1201 patients including, 586 (48.8%) female and 615 (51.2%) male. with mean age 64.8 ± 6.1 years were studied. Acute or chronic deep infections was not observed in any patient in 2 patients, late hematogenous infection from respiratory and urinary systems were detected. Non-purulent wound drainage released from the surgical site in 11 patients. Also, lack of full closure of wound was observed in 4 of the patients under investigation. Fistula, however, was not observed in any patient.

Conclusion: As the result of using modified irrigation method after TKA, no occurrences of joint infection (acute or chronic) or fistula were observed. This method was only found to be associated with late hematogenous infection and other non-infectious complications such as non-purulent wound drainage and lack of full closure of wounds.

Keywords: Therapeutic Irrigation, Infectious Arthritis, Total knee replacement.

Accepted: : 35 days before printing

Dr. Mohammad ali Jafari zareh¹, Dr. Alireza Sadeghpour², Dr. Asghar Elmi³,
Dr. Amir Mohammad Navali⁴, Dr. Amin Moradi⁵, Dr. Hossein Akbari-Aghdam⁶

1. Orthopedic surgeon, Social Security Organization, Iran.

2. Orthopedic surgeon, Professor, Department of Orthopedic Surgery, Shohada Educational Hospital, Tabriz University of Medical Sciences, Tabriz, Iran.

3. Associate Professor of Orthopedics, Department of Orthopedics, School of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran.

4. Professor of Orthopedics, Department of Orthopedy, Tabriz University of Medical Sciences, Tabriz, Iran.

5. Associate Professor of Orthopedics, Department of Orthopedics, School of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran.

6. Associate Professor of Orthopedics, Department of Orthopedic Surgery, Isfahan University of Medical Sciences, Isfahan 81746-73461, Iran.

Corresponding Author:

Asghar Elmi

Email address:

elmimail@yahoo.com

Introduction

The need for Total Knee Arthroplasty (TKA) has recently been increasing all over the world. However, postoperative infection poses a major threat to the effectiveness of this surgical treatment^[1]. Various risk factors have been recognized for Prosthetic Joint Infection (PJI) including uncontrolled high blood sugar, obesity, smoking, drug abuse, and nasal colonization by staphylococcus aureus^[2,3]. The risk factors for PJI in hip or knee arthroplasty have been found to be male sex, congestive heart failure, diabetes mellitus, obesity, systemic neoplasia, chronic pulmonary disease, and hypertension. Moreover, alcohol abuse, immunosuppressive therapy, steroid treatment, and tobacco use have been reported as behavioral risk factors. Infectious risk factors, on the other hand, have been detected to be infections in the surgical site, postoperative infection in urinary system, and previous joint infections^[4]. In general, preventing PJI following TKA requires special strategies in relation to preoperative, intraoperative, and postoperative cares^[2]. Currently, the methods used for the prevention of PJI revolve around such issues as antibiotic prophylaxis, operating room conditions, surgical factors, and factors related to skin and wound^[3]. However, despite all of the efforts to prevent this complication, it still occurs in 0.5 to 1.9 % of TKAs^[5].

One of the various methods proposed for reducing the occurrence of PJI following TKA is Irrigation and Debridement (I&D). However, results have indicated that I&D has limited efficacy in controlling infections following TKA and should be used selectively in certain circumstances^[6].

Another way for reducing the occurrence of PJI is the intrawound application of vancomycin. Studies have shown that in addition to being safe and economical, this method can reduce the occurrence of PJI in subsequent follow-ups^[7].

Modified irrigation is defined as the continuous washing of surgical wounds. In this method, the entire wound is washed out every 5 minutes using a 50 cc Toomey syringe containing a mixture of irrigation serum. We have nominated this method as 'modified irrigation'.

Considering the previous studies and their failure to come up with a method to fully prevent PJI following TKA, it seems that alternative methods can be more effective in reducing the occurrence of this complication. Accordingly, we aimed in this study to investigate the effectiveness of our new method for the prevention of PJI, reducing the occurrence of PJI following TKA.

Methods

This study was a descriptive, cross-sectional study. Patients referring to the private medical centers in Ardabil for TKA constituted the statistical population of the study. Using census sampling technique, all of the patients undergoing TKA in these medical centers from 2016 to 2020 were investigated. This study was approved by the Research Ethics Committee of Ardabil University of Medical Sciences with the code of IR.ARUMS.REC.1399.340. A total of 1201 patients entered the study after signing a written informed consent. The exclusion criteria were: history of malignancy or infection, non-referral for follow-up investigations, and being discontent with the study circumstances. All the cases had received intraoperative wound irrigation with 50ML 1:10 mixture solution of betadine, and saline every 5 minutes. In detail, it could be said that during the surgery (as long as it takes), a 50 cc syringe filled with betadine solution diluted with normal saline with a dilution concentration of 1:10 is pushed into the prosthesis site every 5 minutes. For patients, vancomycin-containing bone cement was used. The surgery was performed using a

tourniquet. The average length of operations was one to one and a half hours.

The results of infection, and laboratory tests (including WBC, hemoglobin, ESR, creatinine, blood sugar, platelet count, urea, and PMN) was obtained via checking their medical records, asking their treating doctor, and getting information from the patients themselves. The surgeon carrying out TKA was the same for all of the patients. Telephone follow-ups were performed remotely in 3rd and 9th month, and symptoms related to PJI and symptoms such as pain, joint swelling, redness, mobility and joint motion limitation, fever and chills, and etc., were investigated. Any case with above-mentioned symptoms, underwent ultrasound images to confirm joint effusion, and subsequent joint fluid aspiration, culture, and smear. Chronic joint infection manifest which are detectable with CRP, ESR, D-Dimer tests. The patients in this study were also investigated in terms of these symptoms. In this study, all of the patients received routine antibiotic prophylaxis.

The data obtained were all fed into SPSS Software, Version 22. Then descriptive (mean, standard deviation, frequency, normality tests) and inferential statistics were used to analyze the data.

Results

Out of 1201 patients with TKA, 615 patients (51.2%) were male. The mean age of the patients was 64.8 ± 6.1 years. Their mean BMI was 29.2 ± 2.3 kg/m². 303 of the patients (52.2%) had underlying diseases, the details of which are presented in Table 1. The majority of the patients (84.1%) were either illiterate or had only elementary education (Table 2). Total joint arthroplasty was performed on the right knee in 653 cases (52.9%), on the left knee in 514 cases (42.8%), and on each right and left knee in 52 cases (4.3%) (Table 3).

Acute or chronic deep joint infections was not observed in any patient under investigation. Similarly, chronic infection was not observed in patient following the use of modified irrigation method.

Late hematogenous infection was observed in 2 patients (%0.16). One of them was a 72-year-old man whose lungs had been infected with pseudomonas prior to the development of this infection (identified by sputum microbial culture). The other one was a 56-year-old woman whose urinary system had been infected with E. Coli before

Table 1: Underlying diseases of the patients under investigation

No underlying conditions	diabetes	Hypertension	Diabetes & hypertension	Heart disease	Pulmonary disease	Renal disease	Rheumatic Disease
898 (74.8)	105 (8.7)	45 (3.7)	39 (3.2)	29 (2.4)	23 (1.9)	7 (0.6)	21 (7.1)

Table 2: Patients' education level

	Education			
	Illiterate and elementary school	Guidance school	High school and diploma	College Education
Frequency (percent)	1010 (84.1)	45 (3.7)	32 (2.7)	21 (1.7)

Table 3: Patients' laboratory findings

	Variable							
	Hemoglobin (g/dl)	Leukocyte (X10 ⁹ /L)	PMN percent	Platelet (X10 ⁹ /L)	Urea (mg/dl)	Creatinine (mg/dl)	blood sugar (mg/dl)	ESR (mm/hr)
Mean± SD	1.8±13.1	2.7±8.4	7.6±85.2	90.1±241.8	5±20.5	0.46±1.4	28.3±144.3	1.4±20.3

the development of late hematogenous infection (identified by microbial culture of urine). The diagnosis of infection in these two patients was confirmed with the results of joint aspiration and microbiological examinations (culture and smear).

As for non-infectious complications following TKA, non-purulent wound drainage was observed in 11 patients (%0.91) during the first week after the surgery. These patients were all aged and on steroid for the treatment of rheumatoid arthritis or kidney diseases. This complication was treated in all of the cases by immobilizing their joint in full extension. Moreover, lack of full closure of wound was observed in 4 of the cases (%0.33) 20 days after the surgery. After ruling out infection, this complication was also treated by debridement. Fistula was not observed in any of the patients investigated in this study.

Discussion

The aim of the present study was to investigate the effect of using a modified irrigation protocol at

surgery and its effect on occurrence of PJIs following TKA. In this method, the entire wound is washed out every 5 minutes using a 50 cc Toomey syringe containing a mixture of betadine and normal saline (1:10). In order to reach antimicrobial effectiveness, betadine needs to remain 10-15 minutes on the surgical field. Acute or chronic deep infection was not observed in any of the patients in this study. Also, only in 2 patients late hematogenous infection was observed in the respiratory and urinary systems. In a study conducted on I&D irrigation and debridement in 2018^[6], the 4-year degradation rate was found to be 57.4%, and the average survival rate was found to be 14.32 months. 5- year mortality was also reported to be 19.9%. Multivariate modeling revealed that the organism culture status was an independent predictor of I&D failure. Culture-negative status had a higher hazard for failure than culture-positive patients. Results also indicated that I&D was limited in controlling infections following TKA and should be used selectively in certain circumstances. Compared with the method proposed in the current study, I&D seems to be less effective.

In a study conducted by Mulpur et al.^[8] in 2024, the effectiveness of intrawound vancomycin in the prevention of periprosthetic joint infection after primary total knee arthroplasty was described as a prospective, double-blind, randomized controlled trial. The results of this recent study have stated that intrawound vancomycin powder does not seem to reduce the rate of PJI/SSI in primary knee arthroplasty, including high-risk groups. Their results showed that although it is safe from a renal point of view, intrawound vancomycin was associated with increased postoperative aseptic wound complications. Therefore, intralesional vancomycin may not be effective in reducing the rate of PJI in primary TKA.

In the study by Xu et al. in 2020^[9], which was a systematic review and meta-analysis on the efficacy and safety of intrawound vancomycin in primary hip and knee arthroplasty, it was stated that current studies show that intrawound vancomycin used in primary arthroplasty Hip and knee braces may reduce the incidence of PJI, but may also increase the risk of aseptic wound complications. In this systematic review, 9 studies including 4607 patients were included. Intralesional vancomycin was associated with a lower incidence of PJI (30 patients (1.20%) vs. 58 control patients (2.75%)) and concurrent acute kidney injury (four patients (0.28%) vs. four patients (0.35%)). However, vancomycin did not reduce the risk of surface infection (four patients (0.67%) versus six control patients (1.60%)) and was associated with a higher incidence of aseptic wound complications (23 patients).

In a study conducted by Patel et al.^[7], the efficacy and safety of intrawound application of vancomycin in TKA was evaluated. Patients in the control group (112 cases) and experimental group (384 cases) were matched in terms of their general characteristics and underlying diseases. The results revealed that the occurrence of all types of infections, including PJI, was lower in the experimental group. There were no significant differences between the two groups in terms of toxicity and acute kidney injury. Regarding 90-day rehospitalization rate, there was no significant difference between the two groups. However, rehospitalization due to infection was lower among the patients in the experimental group. These findings suggest that intrawound application of

vancomycin can be a safe and economical method for reducing PJI in subsequent follow-ups.

In another study, Petis et al.^[10] investigated long-term, clinical data obtained from the patients undergoing two-stage exchange protocol for the treatment of PJI after TKA. In their study, 245 knees undergoing TKA from 1991 to 2006 were selected to be analyzed. Then treatment with two-stage exchange protocol was undertaken due to the development of infections. Cumulative incidence of reinfection was 4% within 1 year, 14% within 5 years, 16% within 10 years, and 17% within 15 years. Factors that predicted reinfection included BMI of higher than 30 kg/m² and reoperation. Complications were predominantly related to surgical wound healing, which required reoperation in 5% of the knees.

In the study conducted by Koh et al.^[11], 11134 patients undergoing TKA were investigated. They found that reoperation had been performed on 357 patients, for which they identified 5 main reasons: PJI, aseptic loosening, patellofemoral arthritis, joint instability, joint stiffness, and arthrofibrosis (in the order ; the most to the least frequent). As some methods have proved to be effective in reducing joint infection, it has been recommended that different methods be compared with each other in terms of their effectiveness in reducing PJI following TKA.

In our study, acute or chronic joint infection was not observed in any case and only in two of, late hematogenous infection was detected. Moreover, non-purulent wound drainage was observed in 11 patients within the first week after surgery. Delay in wound closure was also observed 20 days after surgery. Fistula, however, was not observed in any of the patients under investigation in this study.

Factors such as uncontrolled high blood sugar, obesity, smoking, drug abuse, and nasal colonization by staphylococcus aureus have been recognized as risk factors for PJI^[3,10]. In a systematic investigation, male sex, congestive heart failure, diabetes mellitus, obesity, systemic neoplasia, chronic pulmonary disease, and hypertension were detected as potential risk factors for PJI following hip or knee arthroplasty. Behavioral risk factors included alcohol abuse, immunosuppressive therapy, steroid treatment, and tobacco use. Infectious risk factors, on the other hand, were infections in the surgical site, postoperative infections in the urinary system,

and previous joint infections^[2]. In the present study, TKA did not cause mortality among the patients.

In a meta-analysis conducted by Lum et al.^[12] on the mortality of patients with PJI, a total of 20719 cases were investigated. The mean mortality rate was reported to be 14.4%. The mortality rate following PJI within the first year was 4.33%, which increased by 3.13% each year. The 5-year mortality rate was 21.64%. The comparison of national mortality with the one-year mortality reported in this meta-analytic study revealed that the risk of death increased significantly following PJI in the knee (10). The difference between these findings and those of the current study might be related to the very low occurrence of joint infection among the patients investigated in the current study.

Based on the findings of the present study, we would like to suggest that modified irrigation can effectively prevent joint infection following TKA.

Lack of control group was one of the limitations of this study. While medical observance detailed surgical principles, operating room and personnel cleanliness, instrument, airflow, traffic in operating room, proper dropping, etc are essential parameters in PJI prevention, this irrigation may also have a role. It is recommended that further studies be conducted to replicate and validate the findings obtained in this study.

References

- 1 Tsikopoulos K, Meroni G. Periprosthetic Joint Infection Diagnosis: A Narrative Review. *Antibiotics (Basel)* 2023;12(10). <https://doi.org/10.3390/antibiotics12101485>. PubMed PMID: 37887186; PubMed Central PMCID: PMC10604393.
- 2 Rezapoor M, Parvizi J. Prevention of Periprosthetic Joint Infection. *J Arthroplasty* 2015;30(6):902-7. <https://doi.org/10.1016/j.arth.2015.02.044>.
- 3 Egerci OF, Yapar A, Dogruoz F, Selcuk H, Kose O. Preventive strategies to reduce the rate of periprosthetic infections in total joint arthroplasty; a comprehensive review. *Arch Orthop Trauma Surg* 2024. <https://doi.org/10.1007/s00402-024-05301-w>. PubMed PMID: 38635048.
- 4 Resende VAC, Neto AC, Nunes C, Andrade R, Espregueira-Mendes J, Lopes S. Higher age, female gender, osteoarthritis and blood transfusion protect against periprosthetic joint infection in total hip or knee arthroplasties: a systematic review and meta-analysis. *Knee Surg Sports Traumatol Arthrosc* 2021;29(1):8-43. <https://doi.org/10.1007/s00167-018-5231-9>. PubMed PMID: 30413860.
- 5 Alijanipour P, Heller S, Parvizi J. Prevention of periprosthetic joint infection: what are the effective strategies? *J Knee Surg* 2014;27(4):251-8. <https://doi.org/10.1055/s-0034-1376332>. PubMed PMID: 33322463; PubMed Central PMCID: PMC7768381.
- 6 Urish KL, Bullock AG, Kreger AM, Shah NB, Jeong K, Rothenberger SD. A Multicenter Study of Irrigation and Debridement in Total Knee Arthroplasty Periprosthetic Joint Infection: Treatment Failure Is High. *J Arthroplasty* 2018;33(4):1154-9. <https://doi.org/10.1016/j.arth.2017.11.029>. PubMed PMID: 29221840; PubMed Central PMCID: PMC5858958.
- 7 Patel NN, Guild GN, Kumar AR. Intrawound vancomycin in primary hip and knee arthroplasty: a safe and cost-effective means to decrease early periprosthetic joint infection. *Arthroplast Today* 2018;4(4):479-83. <https://doi.org/10.1016/j.artd.2018.07.011>. PubMed PMID: 30560180; PubMed Central PMCID: PMC6287227.
- 8 Mulpur P, Jayakumar T, Yakkanti RR, Apte A, Hippalgaonkar K, Annapareddy A et al. Efficacy of Intrawound Vancomycin in Prevention of Periprosthetic Joint Infection After Primary Total Knee Arthroplasty: A Prospective Double-Blinded Randomized Control Trial. *J Arthroplasty* 2024;39(6):1569-76. <https://doi.org/10.1016/j.arth.2024.01.003>. PubMed PMID: 38749600.
- 9 Xu H, Yang J, Xie J, Huang Z, Huang Q, Cao G, et al. Efficacy and safety of intrawound vancomycin in primary hip and knee arthroplasty. *Bone Joint Res* 2020;9(11):778-88. <https://doi.org/10.1302/2046-3758.9.11.BJR-2020-0190.R2>. PubMed PMID: 33135425; PubMed Central PMCID: PMC7649508.
- 10 Petis SM, Perry KI, Mabry TM, Hanssen AD, Berry DJ, Abdel MP. Two-Stage Exchange Protocol for Periprosthetic Joint Infection Following Total Knee Arthroplasty in 245 Knees without Prior Treatment for Infection. *J Bone Joint Surg Am* 2019;101(3):239-49. <https://doi.org/10.2106/JBJS.18.00356>. PubMed PMID: 30730483.
- 11 Koh CK, Zeng I, Ravi S, Zhu M, Vince KG, Young SW. Periprosthetic Joint Infection Is the Main Cause of Failure for Modern Knee Arthroplasty: An Analysis of 11,134 Knees. *Clin Orthop Relat Res* 2017;475(9):2194-201. <https://doi.org/10.3109/17453674.2016.1171639>. PubMed PMID: 28573549; PubMed Central PMCID: PMC5539036.
- 12 Lum ZC, Natsuhara KM, Shelton TJ, Giordani M, Pereira GC, Meehan JP. Mortality During Total Knee Periprosthetic Joint Infection. *J Arthroplasty* 2018;33(12):3783-8. <https://doi.org/10.1016/j.arth.2018.08.021>. PubMed PMID: 37887186; PubMed Central PMCID: PMC10604393.