Is a Single Dose of Antibiotic Prophylaxis Sufficient to Prevent Infections in Total Joint Arthroplasty?

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Abstract

Introduction: Prosthetic infection is a serious complication that can develop after knee and hip arthroplasty and remains a common reason for revision surgery. Guidelines recommend various measures to prevent infection, howewer some professional associations argue that there is insufficient evidence for single-dose antibiotic prophylaxis. Our study compares the outcomes of patients receiving short- and long-term antibiotic prophylaxis in arthroplasty surgery.

Materials and Methods: In this retrospective study of 424 patients undergoing knee or hip arthroplasty, two prophylaxis protocols were compared. Group 1 (190 patients, 44.8%) received cefazolin pre- and postoperatively on day 1, while **g**roup 2 (234 patients, 55.2%) received extended cefazolin (5 days postoperatively) and oral amoxicillin clavulanic acid (5 days). Early postoperative infection rates were evaluated.

Results: In this study, 83.4% of 424 patients who underwent total knee and hip arthroplasty were female. Knee and hip operations were performed in 86.8% and 13.2% of the patients, respectively. The mean age did not show a statistically significant difference. There was no significant difference between the groups in terms of periprosthetic infection rates (p=0.828). Postoperative wound complications were seen in 34 (18%) patients in group 1 and 44 (19%) patients in group 2, but this difference was not statistically significant (p=0.704). No significant difference in wound complications and prosthesis infection rates was found between group 1 and group 2 patients with risk factors (p>0.05).

Conclusion: In primary joint arthroplasty, extended oral antibiotic prophylaxis did not provide additional protection against single-day antibiotic prophylaxis. The results were similar in both risk and non-risk groups. Considering antibiotic resistance, side effects and costs, it is concluded that extended prophylaxis is unnecessary. However, further large-scale studies on this subject are required.

Key words: Arthroplasty; hip replacement; knee replacement; prosthesis-related infections; antibiotic prophylaxis.

Introduction

Total knee and hip arthroplasty are surgeries that significantly improve the quality of life of patients with osteoarthritis. Prosthesis infection, which is among the complications of this surgery, is one of the worst complications that may cause patient morbidity (1). Although all scientific recommendations are followed to avoid prosthesis infection, infection is still the first most common reason for the need for revision in total knee arthroplasty and the third most common reason in total hip arthroplasty (2,3). To prevent prosthesis infection, attention to many parameters such as ideal operating theatre conditions, early withdrawal of the postoperative urinary catheter, cleaning of the hair in the surgical field, and blood glucose regulation are clearly recommended in the guidelines (4). Although the guidelines have clear recommendations regarding the timing and dosage of antibiotic prophylaxis, orthopedic surgery associations have objections on this issue (5-7). In the recommendations of organizations such as Center for Disease Control (CDC), World Health Organization (WHO), Surgical Care Improvement Project, it has been stated that single dose antibiotic prophylaxis is sufficient in clean and clean contaminated surgical procedures (4,5,8,9). However, national associations such as American Association of Hip and Knee Surgeons, UK Department of Health, British Orthopedic Association have stated their objections on the subject. They stated that there is not enough scientific evidence to apply single dose antibiotic prophylaxis in arthroplasty surgery and the situation is controversial (6,10,11). Although the guidelines of organizations such as the CDC state that a single-dose antibiotic regimen is sufficient, there are also studies that have found that in the daily practice of orthopedic surgeons, single-dose antibiotic administration will still not be sufficient and that orthopedic surgeons who prefer prolonged antibiotic prophylaxis are close to half. The main reason for this is that infection complications in arthroplasty surgery are more morbid than other system surgeries. In case of

infection after arthroplasty, the concern that a difficult process for both the patient and the surgeon may start with revision surgeries has been put forward (12). For total hip and total knee arthroplasty, controversy remains about the optimal duration of prophylactic antibiotics, although more-recent studies do not support the use of antibiotics past 24 hours postoperatively In our study, we compared the results of patients who received antibiotic prophylaxis for preoperatively (60 minutes before), on the day of operation and the following day with those who received prolonged antibiotic prophylaxis in patients who underwent primary total knee and primary total hip arthroplasty to help resolve this complexity.

Materials and Methods

Patient files and data from the hospital database were analyzed. This retrospective study included 424 adult patients who underwent primary total knee and primary total hip arthroplasty between January 2013 and December 2022. Patients with a history of preoperative antibiotic use for another reason, penicillin allergy and patients whose outpatient clinic records could not be accessed were excluded. Age, gender, underlying risk factors (diabetes mellitus, smoking, obesity, rheumatic diseases) and postoperative complications were analyzed. In group 1, 190 (44.8%) patients received a single dose of 2 g IV cefazolin within 30 minutes preoperatively, followed by 3x1 g IV cefazolin prophylaxis on the day of operation and postoperative day 1. In addition to the same prophylaxis protocol, 234 (55.2%) patients in group 2 received 3x1 g IV cefazolin for 5 days postoperatively, followed by oral amoxicillin clavulanic acid prophylaxis for 5 days (Figure 1). Similar methods were applied to both groups of patients to prevent infection. Detailed preoperative anamnesis was taken and examinations were performed to exclude any foci of infection in the body. Patients were given a bath 1 day preoperatively. Any body hair in the incision area was shaved on the operating table. Preoperative skin cleansing was performed with povidone iodine. Tourniquets were used in all patients undergoing total knee arthroplasty and gentamicin bone cement was used for implant placement. Surgical wound dressings (drapes) were used. Double gloves were used during surgery. Low pressure irrigation was used during surgery. Drain and urinary catheter were removed on the first postoperative day.
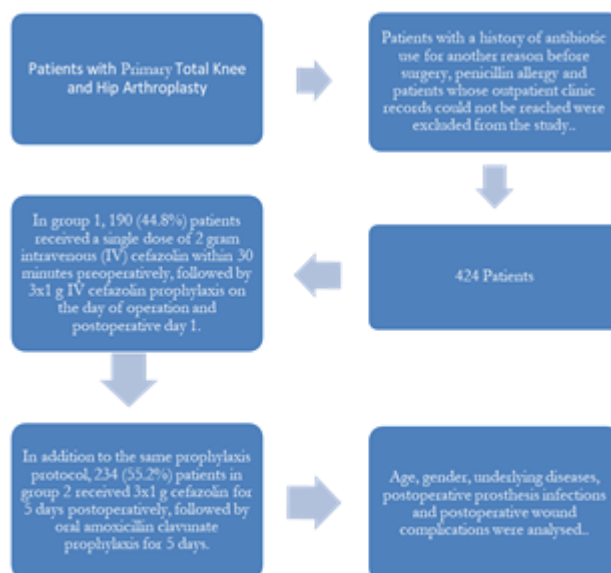

Figure 1: Work Flow Chart

All patients were mobilized on the first postoperative day. The mean duration of hospitalization was 5 days in both groups. Patients who developed early postoperative infection (within the first 1 month after the operation) were included in the study to evaluate the effectiveness of the duration of antibiotic use. Patients were diagnosed according to the Musculoskeletal Infection Society (MSIS) criteria.

Ethical consent: The study was initiated with the approval of the Yüzüncü Yıl University Faculty of Medicine Non-interventional Clinical Researches Ethics Committee (Date: 2023, Decision No: 2023-12-03).

Statistical analysis: The data of both groups were analyzed with SPSS version 26 after appropriate coding. Continuous numerical variables (age) were checked with normality tests (Kologorov-Simirnov, Histogram). Mean and standard deviation values were given for normal distribution. Percentages and frequencies were given for categorical and nominal variables. The relationship between the duration of antibiotic administration and other variables was compared by Chi-square test. Pearson's Chi-square test or Fisher's exact test was used according to the place. Student-t test was used for comparison of means. Statistical significant level (Type-1 error level) was considered as 5%.

Results

Of the 424 patients included in the study, 354 (83.4%) were female. The number of patients who underwent total knee arthroplasty was 368 (86.8%) and the number of patients who underwent total hip arthroplasty was 56 (13.2%). There were 190 patients in group 1 and 234 patients in group 2. The mean age of the patients was 63.97±7.35 years in group 1 and 63.03±8.02 years in group 2 and this difference was not statistically significant. There was no statistically significant difference between the underlying diseases of the patients in the groups (Table 1). There was no significant difference between group 1 and group 2 in prosthesis infection rates until the 3rd postoperative month (p=0.828). Periprosthetic infection was seen in only 5 (1%) of 424 patients.

Table 1: Comparison of the underlying diseases of the groups

Underlying Diseases	Group 1 (190) n (%)	Group 2 (234) n (%)	p
Diabetes mellitus	25 (13.2)	24 (10.2)	0.354
Smoking	38 (20)	48 (20)	0.930
Obesity	66 (34.7)	80 (34.2)	0.906
Rheumatic diseases	3 (1.6)	5 (2.1)	0.675

Table 2: Comparison of prosthesis infection rates of patients with and without risk for infection in group 1

Group 1		Prosthesis Infection				p
		Negative		Positive		
		n	%	n	%	
Smoking	Negative	151	99.3	1	0.7	0.286
	Positive	37	97.4	1	2.6	
Diabetes Mellitus	Negative	163	98.8	2	1.2	0.580
	Positive	25	100.0	0	0.0	
Obesity	Negative	123	99.2	1	0.8	0.649
	Positive	65	98.5	1	1.5	
Rheumatic Diseases	Negative	185	98.9	2	1.1	0.85
	Positive	3	100.0	0	0.0	

Table 3: Comparison of prosthesis infection rates of patients with and without risk for infection in group 2

Group 2		Prosthesis Infection				p
		Negative		Positive		
		n	%	n	%	
Smoking	Negative	186	98.9	2	1.1	0.549
	Positive	45	97.8	1	2.2	
Diabetes Mellitus	Negative	208	99.0	2	1.0	0.185
	Positive	23	95.8	1	4.2	
Obesity	Negative	153	99.4	1	0.6	0.233
	Positive	78	97.5	2	2.5	
Rheumatic Diseases	Negative	226	98.7	3	1.3	0.797
	Positive	5	100.0	0	0.0	

Of the 5 patients who developed infection, 3 were in group 2 and 1 of the 3 patients in group 2 was found to be infected after total hip arthroplasty and the other 2 were found to be infected after total knee arthroplasty. Two were in group 1 and 1 of the 2 patients in group 1 was found to be infected after total hip arthroplasty and the other was found to be infected after total knee arthroplasty. The postoperative wound complications of the patients included delayed wound healing, separation of the wound lips, skin necrosis, prolonged discharge from the wound site, superficial or deep haematoma formation, allergic reaction to plaster, suture material or dressing materials, bullae formation on the skin, fat necrosis and bleeding. Postoperative wound complications developed in 34 patients (18%) in group 1 and 44 patients (19%) in group 2, and the

difference between the groups was not statistically significant (p=0.704). There was no statistically significant difference in the rate of other wound complications and prosthesis infection in patients at risk for prosthesis infection in group 1 and group 2 (Table 2-5).

Table 4: Comparison of postoperative wound complications rates between patients at risk for infection and patients without risk in group 1

Group 1		Postoperative Wound Complications				
		Negative		Positive		
		n	%	N	%	p
Smoking	Negative	125	82.2	27	17.8	0.774
	Positive	32	84.2	6	15.8	
Diabetes Mellitus	Negative	135	81.8	30	18.2	0.447
	Positive	22	88.0	3	12.0	
Obesity	Negative	105	84.7	19	15.3	0.308
	Positive	52	78.8	14	21.2	
Rheumatic Diseases	Negative	155	82.9	32	17.1	0.462
	Positive	2	66.7	1	33.3	

Table 5: Comparison of postoperative wound complications rates between patients at risk for infection and patients without risk in group 2

Group 2		Postoperative Wound Complications				
		Negative		Positive		
		n	%	n	%	p
Smoking	Negative	153	81.4	35	18.6	0.883
	Positive	37	80.4	9	19.6	
Diabetes Mellitus	Negative	169	80.5	41	19.5	0.404
	Positive	21	87.5	3	12.5	
Obesity	Negative	126	81.8	28	18.2	0.736
	Positive	64	80.0	16	20.0	
Rheumatic Diseases	Negative	185	80.8	44	19.2	0.277
	Positive	5	100.0	0	0.0	

Discussion

The development of infection after prosthetic surgery is an important problem for both the surgeon and the patient. Preoperative, intraoperative and postoperative precautions are required to prevent periprosthetic joint infections. Prophylactic antibiotic administration is one of these measures. The antibiotic prophylaxis has been proven to be effective in reducing surgical site infections with scientific data at a high level of evidence. However, it cannot be said that a consensus on the timing and type of prophylaxis has not yet been reached for orthopedic surgery and especially for arthroplasty (1). Engesaeter et al. (13) found less infection and aseptic loosening after multiple antibiotic prophylaxis compared to single antibiotic prophylaxis in their observational study. In the conclusion of a meta-analysis examining antibiotic prophylaxis in total knee and hip arthroplasty, it was stated that postoperative antibiotic prophylaxis did not decrease the rate of surgical site infection (14). In the CDC guideline for the prevention of surgical site infections in

2017, it is among the strong recommendations that postoperative antibiotics should not be given after closure of the surgical site in clean wounds, even if there is a drain (5). However, this is worrying because the guideline is based on only 6 orthopedic studies (15). In a systematic review conducted in 2019 on antibiotic prophylaxis in primary hip and knee arthroplasty, it was mentioned that the studies examined on the subject were not new and not at a high scientific evidence level (10). Although the guidelines state that prophylaxis given in multiple doses is not superior to single-dose antibiotic prophylaxis, it has been observed that the studies cited by the relevant guidelines while making their recommendations have been criticized as being few and insufficient in terms of orthopedic surgeries in which implants are placed. It has been reported that the adequacy of single dose prophylaxis should be decided as a result of comprehensive and arthroplasty-specific studies to be conducted on the subject (6). When the findings of our study were analyzed, we did not find a significant difference between the infection rates of the group given antibiotic prophylaxis and the group not given antibiotic prophylaxis in the postoperative period. This finding is consistent with the existing literature. In studies conducted by considering risk factors such as increased body mass index (BMI), smoking, diabetes, chronic kidney disease, previous myocardial infarction, autoimmune disorders and *Staphylococcus aureus* colonization for the development of periprosthetic infection, it has been observed that the high-risk group given prolonged antibiotic prophylaxis has better results than the high-risk group not given prophylaxis (15-17). However, in our study, we observed that antibiotic prophylaxis given to the high-risk group only on postoperative day 1 was sufficient to prevent prosthesis infection. There are also publications in the literature supporting us and indicating that the results were similar despite prolonged oral antibiotic prophylaxis in patients with risk factors (7). In the study of Karender et al. (7) extended oral antibiotic prophylaxis after primary total knee arthroplasty and total hip arthroplasty did not reduce rates of wound complications or early periprosthetic joint infection. Considering the possible complications of antibiotic use, cost and the risk of development of antibiotic resistance, it seems that it would be more appropriate not to give prolonged oral antibiotic prophylaxis as a result of our study. However, on the other hand, the fact that infection still ranks first among the causes of revision surgeries, the concerns of

orthopedic surgeons performing arthroplasty and publications with different results seem to complicate the decision on the duration of antibiotic prophylaxis.

Study limitations: The study is limited by its retrospective and small sample size, but prospectively collected data were utilized to strengthen its accuracy. It would have enriched the study to mention how treatment was performed after prosthesis-related infections. It would have given clearer results to report whether the prosthesis brands used in the groups were the same.

Conclusion

In our study, we concluded that prolonged oral antibiotic prophylaxis is useless against single day antibiotic prophylaxis in preventing prosthesis infection in primary joint arthroplasty. The results were similar both in the group at risk for prosthesis infection and in the group not at risk. Considering the side effects and financial burden that may develop due to antibiotic resistance and antibiotic use, we think that it is pointless to give prolonged oral antibiotic prophylaxis in patients. However, the details of antibiotic prophylaxis in primary hip and knee arthroplasty will be clarified with more comprehensive prospective studies.

References

1. Veltman ES, Dirk JF, Nelissen RGHH, Poolman RW. Antibiotic prophylaxis and DAIR treatment in primary total hip and knee arthroplasty, a national survey in the Netherlands. J Bone Jt Infect 2018; 3.1: 5-9.
2. Bozic KJ, Kurtz SM, Lau E, Ong K, Vail TP, Berry DJ. The epidemiology of revision total knee arthroplasty in the United States. Clin Orthop Relat Res 2010;468(1):45-51.

3. Kamath AF, Ong KL, Lau E, Chan V, Vail TP, Rubash HE, et al. Quantifying the burden of revision total joint arthroplasty for periprosthetic infection. J Arthroplasty 2015;30(9):1492-1497.

4. Rosenberger LH, Politano AD, Sawyer RG. The surgical care improvement project and prevention of post-operative infection, including surgical site infection. Surg Infect (Larchmt) 2011;12(3):163-168.

5. Berríos-Torres SI, Umscheid CA, Bratzler DW. Healthcare Infection Control Practices Advisory Committee. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. JAMA Surg 2017;152(8):784-791.

6. CDC Guideline: Post-Operative Prophylactic Antibiotics. [https://www.aahks.org/position-statements/use-of-antibiotics/] (Accessed: 23.10.2023)

7. Carender CN, DeMik DE, Glass NA, Noiseux NO, Brown TS, Bedard NA. Do Extended Oral Postoperative Antibiotics Prevent Early Periprosthetic Joint Infection in Morbidly Obese Patients Undergoing Primary Total Joint Arthroplasty? J Arthroplasty 2021;36(8):2716-2721.

8. Ban KA, Minei JP, Laronga C, Harbrecht BG, Jensen EH, Fry DE. American College of Surgeons and Surgical Infection Society: Surgical Site Infection Guidelines, 2016 Update. J Am Coll Surg 2017;224(1):59-74.

9. WHO global guidelines for the prevention of surgical site infection. [https://cdn.who.int/media/docs/default-source/integrated-health-services-(ihs)/infection-prevention-and-control/ssi/ssi-outline.pdf?sfvrsn=8ecce6e1_5] (Accessed: 23.10.2023)

10. Slobogean GP. CORR Insights®: Is There a Difference in Infection Risk Between Single and Multiple Doses of Prophylactic Antibiotics? A Meta-analysis. Clin Orthop Relat Res 2019;477(7):1591-1593.

11. Gordon Bannister. Prımary Total Hıp Replacement: A Guide To Good Practice, British Orthopaedic Association. [https://britishhipsociety.com/wp-content/uploads/2020/12/2012-nov_boa-blue-book.pdf] (Accessed: 23.10.2023)

12. Gans I, Jain A, Sirisreetreerux N, Haut ER, Hasenboehler EA. Current practice of antibiotic prophylaxis for surgical fixation of closed long bone fractures: a survey of 297 members of the Orthopaedic Trauma Association. Patient Saf Surg 2017;11:2.

13. Engesæter L, Lie SA, Espehaug B, Furnes O, Vollset SE, Havelin LI. Antibiotic prophylaxis in total hip arthroplasty Effects of antibiotic prophylaxis systemically and in bone cement on the revision rate of 22,170 primary hip replacements followed 0-14 years in the Norwegian Arthroplasty Register. Acta Orthopaedica Scandinavica 2003;74(6):644-651.

14. Thornley P, Evaniew N, Riediger M, Winemaker M, Bhandari M, Ghert M. Postoperative antibiotic prophylaxis in total hip and knee arthroplasty: a systematic review and meta-analysis of randomized controlled trials. CMAJ Open 2015;3(3):E338-343.

15. Kheir MM, Dilley JE, Ziemba-Davis M, Meneghini RM. The AAHKS Clinical Research Award: Extended Oral Antibiotics Prevent Periprosthetic Joint Infection in High-Risk Cases: 3855 Patients With 1-Year Follow-Up. J Arthroplasty 2021;36(7S):S18-S25.

16. DeFrancesco CJ, Fu MC, Kahlenberg CA, Miller AO, Bostrom MP. Extended Antibiotic Prophylaxis May Be Linked to Lower Peri-prosthetic Joint Infection Rates in High-Risk Patients: An Evidence-Based Review. HSS J 2019;15(3):297-301.

17. Inabathula A, Dilley JE, Ziemba-Davis M, Warth LC, Azzam KA, Ireland PH, et al. Extended Oral Antibiotic Prophylaxis in High-Risk Patients Substantially Reduces Primary Total Hip and Knee Arthroplasty 90-Day Infection Rate. J Bone Joint Surg Am. 2018;100(24):2103-2109.