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Retrospective Study

Anterior Cruciate Ligament (ACL) Reconstruction Using Hamstring Autografts Infused in vancomycin Lowers the Risk of Infection Following Surgery Without Impairing Knee Function: A Retrospective Study

Hatim Mohammed AlShareef*[1], Abdulaziz Ahmed Munshi[2], Hatim Adnan Almagrabi[2], Ahmed Elbarbary[1], Salwa Mohammed Imran[3] and Wafa Mohammed[4]

[1]*Department of Orthopedic, King Fahad Armed Forced Hospital, Saudi Arabia, Jeddah*

[2]*Facility of Medicine, Umm-AlQura University, Makkah, Saudi Arabia*

[3]*Facility of Medicine, Xuzhou Medical University, Jiangsu, China*

[4]*Facility of Medicine, Shandong First Medical University, Taian, China*

***Corresponding Author:** Hatim Mohammed AlShareef, Department of Orthopedic, King Fahad Armed Forced Hospital, Saudi Arabia, Jeddah.

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Abstract

Background: Post-operative infection after the ACL reconstruction (ACLR) is a potentially devastating post-operative complication. The patient presents with knee sepsis, pain, effusion, redness, erythema, a rise in C-reactive protein, and an increased white blood cell count. Early recognition and treatment are vital. However, prophylactic treatments can work wonders in preventing or decreasing the mortality rates associated with sepsis. This study was conducted to determine if using a vancomycin-soaked hamstring graft during ACLR can reduce the risk of post-operative infection compared to traditional prophylactic antibiotics.

Methods: A retrospective comparative study of 295 consecutive patients who had undergone ACLR within 4 years to demonstrate the effectiveness of vancomycin-soaked hamstring autograft on lowering post-operative infection versus traditional prophylactic IV antibiotics only. The patients were divided into two groups depending on pre-soaked vancomycin hamstring autograft. Both groups received pre-operative prophylactic IV antibiotics, but only group 2 (n = 60) underwent ACLR with autografts pre-soaked in 500 mL of 1-mg/mL solution of vancomycin for an average of 20 - 30 minutes. The ACLR procedures were performed by 4 sports medicine fellowship-trained orthopedic surgeons, and only one surgeon used pre-soaked vancomycin hamstring autografts (supportive for using the method of a vancomycin-soaked hamstring graft during ACL). The other three surgeons used a traditional prophylactic antibiotic only (Not supportive of using the method of a vancomycin-soaked hamstring graft during ACLR). This study was conducted retrospectively from July 2019 to July 2022 at King Fahad Armed Forced Hospital. Institutional review board approvals were obtained from the same hospital, and all patients provided informed consent for participation in the surveillance study. IRB application number (REC 609), Date: 22/August/ 2023.

Results: The present study included 295 patients, of whom (20%, n = 60) received grafts of vancomycin and (80%, n = 235) received only traditional prophylactic antibiotics. In the vancomycin-soaked group, there was no infection (0%, n = 0). While all patients who developed post-infectious disease were members of the traditional prophylactic antibiotic group (1.3%, n = 3). The value of the effect size for the Oxford scale as a whole is equal to 0.98, which indicates that there is a great effect of vancomycin-soaked hamstring autograft and anterior cruciate ligament (ACL) reconstruction on improving the patient's condition. that the use of vancomycin-soaked hamstring graft during ACLR can reduce the risk of postoperative infection compared with conventional prophylactic antibiotics because sig. = 0.000 < 0.05 for the test of Mann-Whitney.

Conclusion: The current study adds to the body of literature regarding the benefits of soaking hamstring grafts in vancomycin, despite the benefits of this technique, it is not commonly used locally, further studies with larger sample sizes are needed to give further insight.

Keywords: *Anterior Cruciate Ligament Reconstruction (ACLR); Vancomycin-Soaked Hamstring Autograft; C-Reactive Protein*

Introduction

Anterior cruciate ligament reconstruction (ACLR) is a widely performed orthopedic procedure, and its popularity has grown in recent years [1]. The incidence of ACLR is 0.03% per person annually and can reach 3.7% in professional athlete groups [2]. While infection following ACLR surgery is rare, it poses a significant threat, leading to delayed recovery, revision surgeries, and diminished outcomes [3,4].

In a comprehensive analysis by Bansal., *et al*. It was found that patients who develop septic knee arthritis after ACLR have worse outcomes compared to those who do not acquire infection, resulting in an incidence of septic knee arthritis after ACLR with an autograft of 0.19% (95% CI 0.03 - 0.43%) [5]. Compared to alternative grafts, hamstring autografts pose a greater risk of infection following ACLR [6].

The contamination that occurs during the preparation and harvesting of the autograft is the main source of infection, which is particularly evident [7]. This contamination introduces bacteria into the knee when the graft is being inserted [7]. The main pathogens responsible for causing septic arthritis after ACLR are *Staphylococcus aureus* (*S. aureus*), and various species of Coagulase-negative *Staphylococci* [7]. In addition, the vulnerability to infection following ACLR is heightened by specific risk factors including diabetes, smoking, BMI, or prior open surgery [8].

Diagnosing septic arthritis after ACLR presents a considerable challenge during the initial post-operative phase [9]. This difficulty arises from the potential misinterpretation of common symptoms such as knee swelling, inflammation, and stiffness as normal post-surgical conditions [9]. The accurate diagnosis is confirmed through the essential utilization of vital laboratory markers, particularly the erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) [9]. It is worth emphasizing that the synovial fluid aspirate remains the most reliable diagnostic tool for detecting infection [9].

Immediate intravenous antibiotics and joint debridement administration are crucial for treating post-ACLR infection [9]. Preventive steps are crucial for decreasing sepsis-related mortality rates [10]. Many studies have proven that applying vancomycin-soaked solution to ACL autografts has demonstrated remarkable effectiveness in preventing bacterial contamination while maintaining graft integrity [10]. However, there is not yet a comprehensive policy recommendation that calls for pre-soaking all grafts in vancomycin. This may be due to several reasons, including that the majority of studies focused on HT grafts and their effectiveness has not been proven for other types of grafts, Decreased "graft maturation" in vancomycin-soaked grafts, as well as greater incidence of graft ruptures between 6 and 12 months of follow-up. These unanswered questions appear to have led to a widespread lack of acceptance of vancomycin preinfusion, with underuse reported in some countries [11].

Doctors in Saudi Arabia, like other doctors in other countries where this technique is not widely used, have concerns about applying a vancomycin-soaked solution to autografts of the anterior cruciate ligament, and most doctors resort to the traditional technique. Based on the above, this study aims to determine whether the use of vancomycin-soaked hamstring graft during ACLR can reduce the risk of postoperative infection compared with conventional prophylactic antibiotics. This was applied to patients at King Fahd Military Hospital in Saudi Arabia. The importance of the study stems from enriching scientific research and providing a scientific basis for doctors to support previous research, whether in terms of the effectiveness of applying or not applying a hamstring graft soaked with vancomycin during ACLR.

Materials and Methods

A retrospective comparative study of 295 consecutive patients who underwent ACLR was conducted by extracting patient data using the Medical Record Number (MRN) at King Fahad Armed Hospital from July 2019 to July 2022 to demonstrate the effectiveness

of vancomycin-soaked hamstring autograft on lowering post-operative infection versus traditional prophylactic IV antibiotics only. The patients were divided into two groups depending on pre-soaked vancomycin hamstring autograft; both groups received preoperative prophylactic antibiotics. Group 1 (n = 235) received ACLR with traditional prophylactic antibiotics, and group 2 (n = 60) who underwent ACLR received pre-soaked vancomycin. All procedures were performed by 4 sports medicine fellowship-trained orthopedic surgeons; only one of them was using pre-soaked vancomycin hamstring autograft, which could explain the low number of patients in the pre-soaked vancomycin group. The other three surgeons used a traditional prophylactic ACLR. During the entire duration of the study, the patient's evaluation was conducted utilizing the oxford knee score for 18 months to make sure the knee restored agility and function and the patient could resume sports. All ACL-deficient knee patients were included. Exclusion criteria included those undergoing revision ACLR.

All patients underwent preoperative screening for skin lesions, rashes, or infections; if necessary, surgery was postponed. The analysis of patient charts allowed us to gather important information about the patients, such as their age, body mass index (BMI), and smoking habits which could increase the risk of post-operative infection. A nonsmoker was defined as a patient who had not smoked in the past or who had completely quit smoking at least six months before surgery. Returning to the operation room for irrigation and debridement (I&D) within 90 days after the ACLR surgery was considered an infection.

ACLR is diagnosed clinically by a history of a traumatic event to the knee joint, a positive Lachmann test, and an MRI confirming an ACL rupture. All surgeons use a hamstring autograft. Depending on the demands of each patient, the individual surgeons decide whether to perform surgery or not and when to do it. It is standard practice to administer preoperative antibiotic prophylaxis to patients undergoing ACLR surgery, and cefazolin is typically given to those without a known allergy to cephalosporins. This helps to prevent postoperative infections and promote quicker healing. Prophylaxis antibiotics were given intravenously (IV) within one hour before the skin incision, as is normal procedure. No patient had a reported allergy to vancomycin. To keep more caution from post-operative infection as it is fatal, the graft preparation during surgery included the use of a vancomycin solution. The grafts were soaked in 500 mL of 1-mg/mL solution of vancomycin for an average of 20 - 30 minutes. After preparation, the grafts were wrapped in a sterile gauze sponge soaked in vancomycin. The approvals were granted by the institutional review boards of the King Fahad Armed Forced Hospital and all patients provided informed consent for the surveillance study. IRB application number (REC 609), Date: 22/August/ 2023. The data was collected using Microsoft Excel spreadsheets, it was then transferred and analyzed using Statical Package for Social Studies (SPSS) Version 26. Frequency was calculated for categorical variables such as procedure and usage of vancomycin. The Mann-Whitney test was used to determine the association between the use of vancomycin with reducing post-operative infection. The effect size was calculated to measure the effect of vancomycin-soaked hamstring autograft and anterior cruciate ligament (ACL) reconstruction on improving the patient's condition was studied over 18 months.

Results

The analyses encompassed a broad spectrum of patients, with an average age that ranged from 20 to 45 years. The patients had an average age of 32 years. The mean BMI of 28 ± 5 indicated a blend of individuals who are in good health and slightly overweight, with BMI values varying from 23 to 33. This profile coincides with the overall patient population requiring ACLR. The data revealed a significant prevalence of smokers within the patient cohort, with 242 individuals (82%, n = 242) actively engaging in smoking. The impact of smoking on the risk of infection necessitates further investigation, as it is a widely recognized factor for surgical site infections (Table 1).

Table 2 shows (Descriptive statistics for components of oxford knee score), from which we find that for the first group, the highest average was awarded to question 12 (Trouble with walking downstairs) with mean (3.97) and std. deviation (0.181), followed by question

Characteristic		Frequency	Percentage
Age		20-45 years old	27.5 years old
BMI		28 ± 5	29.5
Smoking status	Negative	53	18.0%
	Positive	242	82.0%

Table 1: *Descriptive analysis.*

11 (Doing household shopping alone) with mean (3.92) and std. deviation (0.279). The lowest average was awarded to question 3 (Trouble with transport) with a mean (of 3.82) and std. deviation (0.469), followed by question 2 (Trouble with washing and drying) with mean (3.8) and std. deviation (0.514). For the second group, the highest average was awarded to question 12 also with a mean (3.81) and std. deviation (0.528), followed by question 11 with a mean (3.73) and std. deviation (0.585). The lowest average was awarded to question 4 (Walking time before severe pain) with a mean (of 3.46) and std. deviation (1.019), followed by question 8 (Pain in bed at night) with mean (3.51) and std. deviation (0.853).

The effect of vancomycin-soaked hamstring autograft and anterior cruciate ligament (ACL) reconstruction on improving the patient's condition was studied over 18 months. Through a comparison between the scores of patients who were treated without vancomycin and those who were treated with vancomycin.

The effect size calculates the extent of change measured in a standardised way which allows comparison between methods. It is calculated as the difference between the mean of scores without vancomycin and with vancomycin, divided by the standard deviation of the without vancomycin scores. Effect sizes of 0.2, 0.5 and 0.8 are regarded as small, medium, and large degrees of change, respectively. Table 2 indicates that the value of the effect size for the oxford scale as a whole is equal to 0.978436, which indicates that there is a great effect of vancomycin-soaked hamstring autograft and anterior cruciate ligament (ACL) reconstruction on improving the patient's condition.

		Group 1 (n = 295)		Group 2 (n = 60)		Effect sizes
	Items	Mean	Std. Deviation	Mean	Std. Deviation	
1	Usual level of knee pain	3.85	0.444	3.64	0.728	0.288462
2	Trouble with washing and drying	3.8	0.514	3.57	0.739	0.311231
3	Trouble with transport	3.82	0.469	3.53	0.856	0.338785
4	Walking time before severe pain	3.9	0.354	3.46	1.019	0.431796
5	Pain on standing up from sitting	3.83	0.457	3.54	0.856	0.338785
6	Limping when walking	3.83	0.457	3.52	0.824	0.376214
7	Difficulty with kneeling	3.83	0.457	3.6	0.788	0.291878
8	Pain in bed at night	3.85	0.444	3.51	0.853	0.398593
9	Work interference due to pain	3.9	0.354	3.69	0.663	0.316742
10	Sense of knee instability	3.93	0.252	3.71	0.625	0.352
11	Doing household shopping alone	3.92	0.279	3.73	0.585	0.324786
12	Trouble with walking downstairs	3.97	0.181	3.81	0.528	0.30303
	Total	3.8694	0.15674	3.6076	0.26757	0.978436

Table 2: *Mean, std. deviation and effect sizes of the knee questionnaire determined in 255 patients.*

Our current investigation was composed of a thorough total of 295 individuals who underwent ACLR surgery. Most of these patients (86%, n = 252) received arthroscopic ACLR in their right knee. Furthermore, a significant proportion of the population (80%, n = 235) solely received standard prophylactic measures without the application of vancomycin-soaked grafts. Notably, only three patients developed post-operative infections, and strangely, none of them belonged to the vancomycin cohort. For additional information about the characteristics of the patients, please refer to table 3.

Characteristic		Frequency	Percentage
Procedure	ACLR left knee	43	14.0%
	ACLR right knee	252	86.0%
Usage of Vancomycin	Did not use vancomycin	235	80.0%
	Used vancomycin	60	20.0%
Post-operative Infection	Negative	292	99.0%
	Positive	3	1.0%

Table 3: *Characteristics of patients included in the study (N = 295).*

To find the relationship between the use of grafts immersed in vancomycin and the reduction in the incidence of postoperative infections we will use a Mann-Whitney test because the data is not normally distributed. Table 4 shows (the result of the Mann-Whitney test), from which we find that the use of vancomycin-soaked hamstring graft during ACLR can reduce the risk of postoperative infection compared with conventional prophylactic antibiotics because sig.=0.000 < 0.05.

Items	Grading for the Oxford Knee Score			Total	Sig.
	Moderate to severe knee arthritis	Mild to moderate knee arthritis	Satisfactory joint function		
Patients who did not develop post-operative infection	1 (0.43%)	2 (0.851%)	232 (98.7%)	235	.000
A patient who developed a post-operative infection	0 (0%)	0 (0%)	60 (0%)	60	
Total	1	2	292	295	

Table 4: *Association of vancomycin-soaked graphs with grading for the oxford knee score (N = 295).*

Discussion

Despite the small number of patients, our study indicates that protective vancomycin-soaked hamstring autografts together with prophylactic IV antibiotics could reduce the contamination rate afterward ACLR compared with traditional prophylactic IV antibiotics alone. Our study is consistent with a systematic review done on the postoperative infection after ACLR shows that the incidence of knee septic arthritis after ACLR is minimal [12]. Out of a total of 35,795 ACLR cases with traditional prophylactic IV antibiotics, there were only 246 cases of infections, resulting in a post-operative infection rate of 0.68% (with a range of 0.14%-2.6%), yet it represents a potentially perilous occurrence for surgeons [12]. In our study, the occurrence rate stood at 1.3% among the group that solely received intravenous antibiotic prophylaxis, a figure that closely aligns with the findings in the existing literature.

In our study, we chose vancomycin for soaking protective autografts because of its effectiveness against not the bacteria causing the infection on the one hand, and the other hand because it is less toxic to local tissues than other antibiotics. This is consistent with a meta-analysis conducted by Antoci., *et al*. which demonstrated that the application of vancomycin to covalently coated titanium prosthetic implants effectively prevented *S. aureus* attachment, growth, and biofilm development [13]. Likewise, hamstring tendons, like other autografts, lose their blood supply after harvest, making them susceptible to colonization by biofilm-producing microorganisms such as *staphylococci*.

In addition to demonstrating the effectiveness of vancomycin soaking in protecting autografts from postoperative infections, a review study, encompassing 5,075 subjects, with 2099 patients receiving pre-operative prophylaxis antibiotics, reports 44 cases (2.1%) of early septic arthritis. While no instances (0%) of infection were reported following ACLR in the 2976 cases involving vancomycin-soaked grafts [14]. In literature, many review studies show that pre-soaked hamstring autograft in vancomycin can reduce the likelihood of infection after ACLR [15,16].

In contrast, one of the studies found that vancomycin powder was not effective in preventing infections [17]. This could be because the group receiving vancomycin treatment was sicker in many ways than the control group.

During our study, the group that received pre-soaked vancomycin for their hamstring grafts did not show any signs of infection. However, a significant association could not be confirmed. The current study adds to the body of literature that vancomycin-soaked grafts provide an effective means of delivering antibiotics to inhibit the growth of bacteria locally.

Although the current study delivered multiple points of strength. To our knowledge, it is the only study that investigated the usage of vancomycin-soaked grafts in the region and recorded the incidence rate of infection with and without this technique. However, the study was faced with multiple challenges which brought forward the need for more research on the matter, the current study was limited to a single center, multicentral studies with a larger sample size and more detail regarding the additional benefits of this technique are recommended.

Conclusion

This study demonstrates the importance of using vancomycin-soaked grafts to reduce postoperative infections during surgery. The results suggest that the use of these vancomycin-soaked grafts protective hamstring autografts together with prophylactic IV antibiotics could reduce the contamination rate afterward ACLR compared with traditional prophylactic IV antibiotics alone. Despite the advantages of this technique, it is not widely used locally. Further studies with large sample sizes provide further insights.

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