

# Presoaking of Hamstring Autografts in Vancomycin Decreases the Occurrence of Infection Following Primary Anterior Cruciate Ligament Reconstruction

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*Investigation performed in Clínica Alemana–Universidad del Desarrollo, Santiago, Chile*

**Background:** Postoperative septic arthritis is an uncommon but potentially devastating complication after anterior cruciate ligament (ACL) reconstruction. Our group started presoaking grafts with vancomycin to decrease this risk.

**Purpose:** To compare the rate of septic arthritis in primary hamstring autograft ACL reconstruction with and without vancomycin-pres soaked grafts.

**Study Design:** Cohort study; Level of evidence, 3.

**Methods:** Consecutive periods were studied, inclusive of April 2013 through October 2015 (pre-vancomycin protocol) and November 2015 through May 2018 (vancomycin protocol). A total of 490 patients were included in the study: 230 in the pre-vancomycin protocol and 260 in the vancomycin protocol. All patients who underwent a primary hamstring autograft ACL reconstruction by 2 senior surgeons during the periods studied were included. The final outcome studied was occurrence of highly probable postoperative septic arthritis in both groups. Diagnosis of probable septic arthritis was made by clinical diagnosis as well as cytological analysis of joint aspiration (cell count >50,000/ $\mu$ L and >90% neutrophils). Statistical analysis was performed with the Fisher exact test. Significance was set at  $P < .05$ .

**Results:** Four cases of probable postoperative septic arthritis were noted in the pre-vancomycin protocol (1.7%; 2 cases per surgeon), while no cases of septic arthritis were noted in the vancomycin protocol during the study period ( $P < .05$ ). Diagnosis was made at a mean 21.7 days (range, 16-25 days). *Staphylococcus epidermidis* was isolated in 2 cases, and in the other 2 cases, no organism was isolated.

**Conclusion:** Presoaking of hamstring autografts in vancomycin for primary ACL reconstruction prevented the occurrence of postoperative septic arthritis during the study period as compared with no soaking of the grafts.

**Keywords:** ACL; infection; vancomycin; presoaking; septic arthritis

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Ethical approval for this study was obtained from Clínica Alemana–Universidad del Desarrollo.

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Postoperative septic arthritis is an uncommon but potentially devastating complication after anterior cruciate ligament (ACL) reconstruction. Different studies range the incidence rate from 0.14% to 1.8%.<sup>7,15,17,18,20</sup> The use of hamstring autograft, concomitant open surgical procedures, drains, and previous surgery on the same knee have been related to a higher risk of this complication.<sup>17</sup>

Intravenous (IV) prophylactic antibiotics have been shown to reduce postoperative infection significantly. Described IV administrations in knee surgery include at least 10 minutes before tourniquet inflation, 15 to 120 minutes before skin incision, or 30 to 60 minutes before the start of the procedure.<sup>5,8</sup>

Pérez-Prieto et al<sup>11</sup> published a study with the idea of identifying the point during the graft harvest/preparation process that the graft could be contaminated. They took

samples of the graft during harvesting and preparation with this purpose. Their results showed 7 cases (14%) of graft contamination. In 5 cases (10%), the graft was contaminated during preparation, and in 2 cases (4%), the graft was contaminated during harvesting.

Using the rationale that a contaminated graft could be the main cause of postoperative septic arthritis and in an effort to maximize the antibiotic efficacy of the graft, Vertullo et al<sup>19</sup> described the “vancomycin wrap” technique in 2012. The practice involves wrapping a swab around the ACL graft before placement onto a tray or into a sterile plastic bag, at which point vancomycin solution is added, thus soaking the swab. Their first study showed a decrease in the infection rate in ACL reconstruction from 1.4% to 0%. In the next years, a number of studies using the same protocol have appeared, all of them confirming the results of Vertullo and colleagues.<sup>9,10,12,13</sup>

The rationale for the use of vancomycin lies in its pharmacokinetic properties, which make it an ideal agent.<sup>7</sup> These include low allergenicity, heat stability, safety for local use, and large volume of distribution. It has a bactericidal action against skin commensals such as *Staphylococcus aureus* and coagulase-negative staphylococci, which are by far the most common pathogens isolated in ACL reconstruction infection.<sup>20</sup>

We previously published the infection rate after 11 years (January 2000–May 2011)<sup>2</sup> of experience with hamstring ACL reconstruction in our group, with 0.45% of all patients acquiring septic arthritis. In local institutional reviews, a rise in the infection rate between April 2013 and October 2015 was noted. Because of that concern, we decided to initiate the presoaking of our autograft hamstring grafts with vancomycin and to study the results.

The main objective of this study was to compare the rate of septic arthritis with this protocol (hamstring grafts presoaked with vancomycin) against the immediate previous period, in which we did not use the protocol. Our hypothesis was that the group with vancomycin-pres soaked grafts will report a lower rate of septic arthritis than the group without presoaked grafts.

## METHODS

We conducted a retrospective review in which we included consecutive patients who underwent arthroscopic primary ACL reconstruction with a hamstring autograft by 2 senior surgeons in our group (D.F., R.C.; both fellowship trained and each with 30 years of experience). Institutional review board approval was obtained for this study.

Patients were divided into 2 consecutive periods: April 2013 to October 2015 (pre-vancomycin protocol, group 1) and November 2015 to May 2018 (vancomycin protocol, group 2). The final outcome was the presence of postoperative septic arthritis in both groups. The exclusion criteria included use of non-hamstring autograft, ACL revisions, multiligament surgery, bilateral surgery, and open concomitant procedures.

A total of 490 patients receiving unilateral hamstring autograft ACL reconstructions were included in the study:

358 males (73%) and 132 females (27%). The mean age was 29.1 years (range, 15–54 years). Group 1 consisted of 230 patients (pre-vancomycin protocol), and group 2 consisted of 260 patients (vancomycin protocol). A total of 150 patients in group 1 (65.2%) and 185 patients in group 2 (71.1%) received a 5-strand hamstring graft; the rest received a 4-strand graft.

The surgical technique consisted of hamstring autograft ACL reconstruction with a cortical button (ACL TightRope; Arthrex) on the femoral side and a BioComposite interference screw (Arthrex) on the tibial side. Hamstring graft preparation was done by avoiding the incidence of grafts thinner than 8 mm, in which case a 5-strand technique was used, as previously published by our group<sup>3</sup>; if the graft was thicker than 8 mm, a standard 4-strand technique was used. The former case resulted in increased graft manipulation as compared with the traditional double semitendinosus and gracilis graft (4-strand). In the pre-vancomycin protocol period, all patients received preoperative IV antibiotics. In the following period (vancomycin protocol), all patients received preoperative IV antibiotics, and the graft was presoaked in a vancomycin solution according to Vertullo et al.<sup>19</sup>

The prophylactic antibiotic protocol consisted of a single 2-g dose of preoperative IV cefazolin or a single 1-g dose of preoperative IV vancomycin if a penicillin allergy was reported. Presoaking of the graft was done by wrapping the harvested hamstring graft after its preparation in a surgical sponge that had been previously soaked in a 5-mg/mL vancomycin solution. A surgical sponge is preferred over putting the graft directly in the solution, which can alter the graft diameter because of the fluid absorption.<sup>1</sup> The vancomycin solution was prepared by dissolving 500 mg of vancomycin powder in 100 mL of sterile saline solution. The graft remained wrapped for at least 15 minutes while the arthroscopic stage of the reconstruction was performed.

Diagnosis of probable septic arthritis was defined as a patient presenting clinically with erythema and/or a swollen knee and/or loss of range of motion and/or local heat. Any suspicious case underwent arthrocentesis, with the synovial fluid sample undergoing cytological analysis and culture testing. Cell count >50,000/ $\mu$ L plus >90% neutrophils and/or a positive culture was listed as a highly probable diagnostic factor for septic arthritis.<sup>14</sup>

Minimum follow-up was listed as 5 months, which was considered necessary to significantly exceed the upper range for the detection of septic arthritis according to our previous study<sup>2</sup> (30 days). The operating surgeon conducted every follow-up visit.

Statistical analysis was performed with Stata (v 14.0; StataCorp). The Fisher exact test was used to analyze the categorical outcome of “septic arthritis” versus “no septic arthritis.” Significance was set at  $P < .05$ .

## RESULTS

Four probable postoperative septic arthritis cases were diagnosed in the pre-vancomycin protocol (group 1) for a 1.7% rate of infection during that period, with all of them

having received 5-strand grafts. No septic arthritis was noted in the vancomycin protocol period (group 2) ( $P < .05$ ). The 4 probable postoperative septic arthritis cases presented at a mean 21.7 days after the ACL reconstruction (range, 16-25 days). *Staphylococcus epidermidis* was isolated in 2 cases, and in the other 2 patients, no organism was isolated in the cultures. The 4 patients underwent arthroscopic lavage and either antibiogram-directed IV antibiotics in the cases where the microorganism was isolated, or empiric IV antibiotics in the cases where no microorganism was isolated. All patients achieved complete eradication of the infection and graft preservation.

## DISCUSSION

Our study confirmed the results of previous studies<sup>9,10,12,13,19</sup> in that no infection in ACL reconstruction was reported with hamstring grafts presoaked with vancomycin. The infection rate in the period immediately previous to the use of this protocol was in the upper level of the reported ranges (1.7%), while no infection was noted during the use of the protocol. An explanation of this rise in the infection rate as compared with the previous report made by our group<sup>2</sup> could be the longer manipulation time needed to construct a 5-strand graft as compared with a regular double semitendinosus and gracilis graft. As reported by Pérez-Prieto et al,<sup>11</sup> the largest source of contamination of a graft is during preparation. Fortunately, their study showed that when the grafts were soaked in vancomycin solution, no bacterial growth was observed in any graft sample.

In the first study reporting the results of this technique, Vertullo et al<sup>19</sup> compared 285 patients (group 1) who underwent ACL reconstruction with a hamstring autograft with preoperative IV antibiotics and 870 patients (group 2) who underwent ACL reconstruction with a vancomycin-pres soaked hamstring autograft as well as preoperative IV antibiotics. In group 1, a total of 4 postoperative joint infections were documented (1.4%). In group 2, no infections (0%) were recorded.

Subsequently, Pérez-Prieto et al<sup>12</sup> presented an 8-year experience in cases of primary ACL reconstruction using both hamstring and patellar tendon autografts. There were 810 and 734 patients in group 1 (pre-vancomycin period) and group 2 (vancomycin period), respectively. Fifteen cases of knee joint infections were identified in the series, with all occurring on group 1, representing an infection rate of 1.85% in comparison with 0% in group 2.

The same group that published the first study on the topic<sup>19</sup> published a follow-up study<sup>13</sup> of its previous report, adding more patients and follow-up time to the study. The authors reported no infections in 1585 individuals who underwent ACL reconstruction with a hamstring autograft over a 13-year period.

Offerhaus et al<sup>10</sup> reported a 2% postoperative deep knee infection rate without using vancomycin-pres soaked grafts and a 0% infection rate when using vancomycin-pres soaked grafts. In addition, they reported that the use of vancomycin did not increase the risks of graft failure, poor clinical

scores, or arthrofibrosis. Regarding the safety of vancomycin use in graft tendons, Schüttler et al<sup>16</sup> published a biomechanical model in porcine tendons. In their study, they found no signs of biomechanical impairment in tendons after the use of vancomycin wraps.

The strength of this study is that it is the first on the topic that reports the use of 5-strand grafts. New methods to handle an insufficient hamstring preparation autograft diameter<sup>6</sup> lead to a longer time of graft preparation and manipulation, which could increase the risk of contamination and cause a joint infection. Confirming the complete eradication of septic arthritis cases in this series makes vancomycin presoaking one of the pillars of a safe hamstring graft preparation technique.

The main limitation in this study is its observational nature. As it is a retrospective design with a lack of randomization, no level 1 or level 2 evidence can be taken from it. Despite this, the study confirms what has been previously published and adds further cases to a very useful and inexpensive technique for eliminating the infection risk of hamstring autograft ACL reconstructions. Another limitation is the fact that only 2 patients had documented microbial growth, a factor that can put into question the diagnosis of septic arthritis. However, approximately 20% of cases of suspected septic arthritis have negative cultures of synovial fluid on solid media, and the cutoff values used in this study for the diagnosis (cell count  $>50,000/\mu\text{L}$  and  $>90\%$  neutrophils) make septic arthritis a highly probable diagnosis.<sup>4</sup>

## CONCLUSION

Vancomycin presoaking of hamstring autografts in ACL reconstruction prevented the occurrence of postoperative septic arthritis during the studied period as compared with the immediately previous period, in which no vancomycin-pres soaked grafts were used. This finding confirms what has been already published in previous studies.

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