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# When the tendon autograft is dropped accidently on the floor: A study about bacterial contamination and antiseptic efficacy

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ABSTRACT

*Background:* Inadvertent contamination of the autograft can occur during anterior cruciate ligament (ACL) reconstruction if the autograft is dropped on the floor during surgery. A study was undertaken to determine the incidence of contamination when a graft is dropped on the operating room floor and the efficacy of antimicrobial solutions to decontaminate it.
*Methods:* Samples from 25 patients undergoing ACL reconstruction with a hamstring tendon were sectioned and dropped onto the floor. Cultures were taken after immersion in antiseptic solutions (a chlorhexidine gluconate solution (group 1), a povidone–iodine solution (group 2), and a sodium hypochlorite solution (group 3)). A fourth piece (group 0) was cultured without being exposed to any solution. Cultures of a floor swab were taken at the same time.
*Results:* The floor swab cultures were positive in 96% of cases. The rate of contamination was 40% in group 0, 8% in group 1, 4% in group 2, and 16% in group 3. There was a significant difference between groups 1 and 2 and group 0 ($p < 0.05$) but not between groups 3 and 0.
*Conclusions:* Immersing a graft dropped on the floor during surgery in a chlorhexidine gluconate solution or povidone–iodine solution significantly reduces contamination of the graft. Soaking of the hamstring autograft in one of these solutions is recommended in the case of inadvertent contamination.
*Clinical relevance:* Laboratory investigation (level 2).



## 1. Introduction

Anterior cruciate ligament (ACL) reconstruction is a common procedure. Inadvertent contamination of the autograft can occur if the ACL autograft is dropped on the floor during surgery [1]. There is no agreed upon protocol for management of this accident, and the literature is sparse on this topic [2–5]. This accident creates a major surgical dilemma and is not rare. Indeed, 25% of surgeons report an accidental contamination of an autograft in their practice [1]. Of these 25%, 75% of surgeons wash their graft in an antiseptic solution, 18% harvest a new autograft, either with an ipsilateral lateral bone–patellar–bone graft or with another graft on the contralateral knee, and 7% use an allograft [1]. Using another autograft increases the morbidity of the surgery with additional risk, and cleansing the graft prevents further patient morbidity but has a potential risk of postoperative joint infection. While other studies have investigated the effectiveness of decontamination of autologous and autograft tissues [2–5], or of bacitracin versus antiseptic solutions, no study has compared specifically the decontamination of hamstring autograft tissue by three different antiseptic solutions available in the operating room.

The purpose of this study is to determine the frequency of positive cultures from the hamstring autograft dropped onto the floor and the effectiveness of decontamination by various antiseptics. The hypothesis was that using a chlorhexidine gluconate solution, a 10% povidone–iodine solution, or a sodium hypochlorite solution for immersion of the dropped graft are all equivalent and valuable procedures in order to use a graft dropped during surgery for ACL reconstruction.

## 2. Methods

### 2.1. Study design

In a prospective study during ACL reconstruction with hamstring tendons for knee instability, the piece of the autograft that would normally be discarded was preserved. The surgery was performed in an operating room with positive pressure and with a protocol of cleaning before each procedure that was validated by the local committee of hygiene. Skin preparation was performed using 4% povidone–iodine solution (Betadine Scrub, Meda Pharma, Paris, France). The same protocol of antibiotic prophylaxis using second-generation cephalosporin

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(ceftriaxone, 2 g, single dose prior to incision) was used for all patients. Twenty-five pieces of tendon were collected and longitudinally sectioned into five fragments measuring between 5 and 10 mm in length. One fragment was stored on the table in a sterile saline (0.9% NaCl) solution for 15 min and was subsequently sent for culture and used as the control group (C) to determine the level of contamination of the implanted graft. The other four fragments were dropped on the operating room floor, left there for 15 s, and then retrieved with a separate pair of sterile forceps for each fragment. The first fragment (group 0) was cultured immediately without attempted sterilization. The three remaining fragments were placed in one of three different non-diluted antiseptic solutions without any rinsing or other mechanical attempts to cleanse the fragments: a 4% chlorhexidine gluconate solution (Hibiscrub 4%, Mölnlycke Health Care, Wasquetal, France) (group 1), a 10% povidone–iodine solution (Betadine, Meda Pharma, Paris, France) (group 2), and a 0.5 g/100 ml sodium hypochlorite solution (Dakin Cooper Stabilize, Cooperation pharmaceutique française, Melun, France) (group 3). After immersion for 15 min in the solution, the fragments were retrieved with sterile forceps and cultured immediately.

The five fragments and a cultured swab of the floor were sent to the bacteriology laboratory for analysis. Each specimen was cultured in tryptic soy agar for 3 days and in thioglycolate broth at 37 °C for 7 days. All positive cultures were identified by species by the hospital-based chief pathologist, and a profile of antibiotic resistance was obtained. The local ethics committee validated this protocol.

### 2.2. Statistical analysis

Data were summarized and standard descriptive statistics were presented. Fisher's exact test with a two-tailed $p$ value was used for comparison of the proportions of contaminated autografts in the five groups. A post hoc power analysis was conducted after the study, with the hypothesis that the theoretical rate of contamination of a sample dropped on the floor was the rate of contamination of group 0. The power and the level of statistical significance were set at 80% and 0.05, respectively.

## 3. Results

Samples from 25 cases were analyzed. The results are summarized in Table 1 and Fig. 1. None of the patients developed a postoperative infection. The swabs of the operating room floor were positive in 24 of the 25 specimens (96%). The swabs grew multiple species of staphylococci, and in one case a *Pseudomonas* species was recovered in the culture.

The cultures of specimens in group 0 (with untreated dropped grafts) were positive in 10 of 25 cases (40%). The species identified in this group were 90% concordant with the cultures of the swabs of the floor.

The cultures of the grafts soaked in chlorhexidine gluconate solution (group 1) were positive in two cases (8%). The species were *Aerococcus sanguinicola*, *Staphylococcus aureus*, and *Staphylococcus epidermidis*. The 10% povidone–iodine solution (group 2) produced a positive culture in one case (4%), which was *Staphylococcus capitis*. Graft cultures after immersion in the sodium hypochlorite solution (group 3) were positive in four cases (16%). The species that grew were *Staphylococcus hominis* (two cases), *S. capitis* (one case), and *Staphylococcus warneri* (one case).

The control fragment stored on the table (group C) was positive in three of 25 cases (12%). The species recovered were *S. hominis*, *S. capitis*, and *Candida parapilosis*. Only

**Table 1**
Culture results for each specimen.

| Specimen | Group C | Group 0 | Group 1 | Group 2 | Group 3 | Floor |
|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | S. epi<br>S. warneri |
| 2 | 0 | 0 | 0 | 0 | 0 | S. haemo |
| 3 | 0 | S. warneri | 0 | 0 | 0 | S. warneri |
| 4 | 0 | S. hominis | 0 | 0 | 0 | S. epi<br>S. haemo |
| 5 | S. hominis | 0 | Aero. sanguinicola | 0 | S. hominis | S. warneri<br>S. haemo |
| 6 | 0 | 0 | 0 | 0 | 0 | S. haemo |
| 7 | 0 | S. epi | 0 | 0 | 0 | S. epi |
| 8 | 0 | 0 | 0 | 0 | O | S. haemo |
| 9 | 0 | 0 | 0 | 0 | S. capitis | S. warneri<br>P. stutzeri |
| 10 | 0 | S. epi | 0 | 0 | S. warneri | S. warneri<br>S. epi |
| 11 | 0 | 0 | 0 | 0 | 0 | S. petten |
| 12 | 0 | 0 | 0 | 0 | 0 | S. warneri |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 0 | S. haemo | 0 | 0 | 0 | S. haemo<br>S. warneri |
| 15 | 0 | S. warneri | 0 | 0 | 0 | S. warneri |
| 16 | 0 | S. epi | 0 | 0 | 0 | S. epi<br>S. warneri |
| 17 | 0 | 0 | 0 | 0 | 0 | S. warneri |
| 18 | 0 | 0 | 0 | 0 | 0 | S. haemo<br>Micrococcus |
| 19 | S. capitis | 0 | S. aureus<br>S.epi | S. capitis | 0 | S. epi<br>E. coli |
| 20 | 0 | 0 | 0 | 0 | 0 | S. warneri |
| 21 | Candida | 0 | 0 | 0 | S. hominis | S. haemo |
| 22 | 0 | S. warneri | 0 | 0 | 0 | S. epi<br>S. hominis<br>S. warneri |
| 23 | 0 | 0 | 0 | 0 | 0 | S. haemo<br>S. epi |
| 24 | 0 | S. epi | 0 | 0 | 0 | S. warneri<br>S. epi |
| 25 | 0 | S. capitis | 0 | 0 | 0 | S. capitis<br>S. saprolyticus<br>S. epi |

0: negative culture; S. epi: *Staphylococcus epidermidis*; S. warneri: *Staphylococcus warneri*; S. hominis: *Staphylococcus hominis*; S. haemo: *Staphylococcus haemolyticus*; Aero. sanguinicola: *Aerococcus sanguinicola*; S. capitis: *Staphylococcus capitis*; P. stutzeri: *Pseudomonas stutzeri*; S. petten: *Staphylococcus pettenkofferi*.