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Research Article

Contaminated Anterior Cruciate Ligament Graft: Effect On Maximum Tensile Force After Being Rinsed With Gentamicin Or Chlorhexidine

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Abstract

Purpose: To compare the maximum tensile force (MTF) of Semitendinosus (ST) and Gracilis (G) after being rinsed with Chlorhexidine or Gentamicin.

Methods: Experimental Study. Eight consecutive patients with anterior cruciate ligament (ACL) injury and reconstructed with ST- G technique were recruited. After the tibial fixation, the excess graft was cut with a scalpel, and a tail of each tendon was washed for 8 minutes in a solution containing 50ml of 2% Chlorhexidine and the other pair in 100ml of 0.9% Sodium Chloride solution + 80mg Gentamicin. The MTF was tested on a universal tensiometer Tinius-S Olsen® H5K, at a speed of 5 mm per minute. Before testing, the graft diameter was measured with a digital micrometre. The data is presented in median and interquartile range, nonparametric median test for unpaired data was performed to compare MTF per diameter of the graft.

Results: 30 graft tails were analysed, 14 G and 16 ST. The median MTF per diameter for Chlorhexidine group was 91 N/mm [80 - 101] and gentamicin group was 86 N/mm [70 - 103], the difference did not reach significant difference (p = 0.36).

Conclusions: No differences between in MTF after the rinse with Chlorhexidine or Gentamicin was found. Therefore, both options are valid after contamination graft.

Keywords: *ACL Graft Contamination; Graft Biomechanics; Maximum Tension Force; ACL Reconstruction*

Abbreviations

ACL: Anterior Cruciate Ligament; Cm: Centimeter; G: Gracilis; Mg: Milligram; Mm: Millimeter; MTF: Maximum Tensile Force; N: Newton; ST: Semitendinosus

Introduction

Graft contamination during a reconstruction of the anterior cruciate ligament (ACL) of the knee is rare, but a risk for the development of septic arthritis [1,2]. There are protocols for treatment of the contaminated graft which include the use of gentamicin and chlorhexidine 2%, obtaining a rate of negative cultures above 90% [3].

However, once the treatment is done, it is not known how gentamicin or chlorhexidine affects the biomechanics of the graft. The present study aimed to compare the maximum tensile force of Semitendinosus (ST) and Gracilis (G) after rinsed with chlorhexidine and gentamicin, for making a better decision after graft contamination. The null hypothesis is that both do not alter the maximum tensile strength of the graft.

Methods

Experimental study. Our institutional ethics review board approved this study, and all participants provided informed consent. Eight consecutive patients with complete ACL injury that underwent ACL reconstruction were recruited. Reconstruction with a quadruple hamstrings graft (Semitendinosus and Gracilis) was performed in all cases. Patients younger than 18 years were excluded.

ACL Surgery was performed on a regular basis. All patients received Spinal anaesthesia and were positioned in supine. After the hamstring graft was fixated to the tibia, the remnant that was protruding from the tibia was cut with a cold scalpel, then the patient's wounds were closed as usual, so no intervention was done in the ACL graft of the patient. Immediately and outside the operation room, one tail of the surplus tendon was washed for 8 minutes in a solution with 50 ml of 2% chlorhexidine (Dichlorexan®, Distributed by DIFEMPHARMA®) and the other in 100 ml of 0.9% Sodium Chloride + 80mg Gentamicin (Sanderson®). Subsequently, they were kept at a low temperature (-10°C).

Then, in a mechanical laboratory the maximum stress force was tested using a Tinius Olsen H5K-S® universal tensiometer (Serial No. 0138794, figure 1) at a test speed of 5 millimeters per minute. Before the test, the graft diameter was measured with a digital micrometre (precision: hundredth). Remnant less than 1cm were excluded. After the study tissue was eliminated as biological material amlording with our institution protocols.

Figure 1: Tinius Olsen H5K-S® Universal Tensiometer (Serial No. 0138794) at a test speed of 5 millimeters per minute.

Data was presented with median and interquartile range (P75-p25). For statistical inference, the tension per millimetre of graft thickness was calculated and compared between the chlorhexidine-washed group versus Gentamicin using the non-parametric median comparison test. Stata v11.2 (StataCorp LP, College Station, Texas, USA), and a probability lower than 0.10 is considered significant. STATA® v11.2.

Results

Eight consecutive patients were recruited, obtaining 32 graft tails. 2 tails were not tested because of insufficient length to be placed on the tensiometer (< 1 cm). Therefore, 30 tails, 14 Gracilis and 16 Semitendinosus were analysed (Table 1).

	$n°_1$	Chlorhexidine 2%	$n°_2$	Gentamicin 80 mg/100 ml	
ST	8	188N [151 - 224]	8	177N [120 - 219]	0.79
G	8	116N [106 - 146]	7	106N [54 - 163]	0.56
MTF/Diameter		91N/mm [80 - 101]		86 N/mm [70 - 103]	0.36

Table 1: *Maximum tension in newtons (N) by type of tendon and treatment. Also, in the last row shows the tension per section area for each type of treatment received by the graft. The last column shows the probability obtained by the comparison test of medians.*

**MTF= Maximum Tensile Force*
***N= Newton*
****$N°_1$= Number of graft tails tested with Chlorhexidine*
*****$N°_2$= Number of graft tails tested with gentamicin*

The median diameter of the Semitendinosus tails was 2 mm [1.5 - 2.25] and Gracilis 1.4 mm [1.2 - 1.5]. The median maximum tension per section area was 87 N/mm [71 - 97] for Gracilis and 95 N/mm [83 - 102] for Semitendinosus.

The results between the two treatments for each graft (Semitendinosus and Gracilis) and the maximum tension per section area are shown in table 1 and figure 2. There is a tendency towards higher maximum tension force for the grafts washed with chlorhexidine when analysed by graft and by maximum tension per graft diameter, however, in both analyses, results do not reach statistical significance.

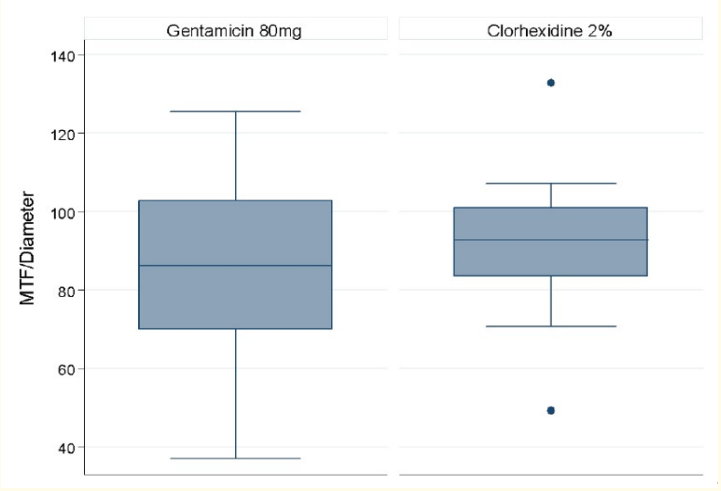

Figure 2: Distribution of the maximum stress in Newton by the diameter of each tail tested according to the type of treatment (MTF = Maximum Tensile Force).

Discussion

Graft contamination during anterior cruciate ligament reconstruction is a problem, given the potential risk of septic arthritis, which affects final functional outcome [4,5]. The incidence of positive cultures published when a graft falls to the ground is 60%, which presumably increases the risk of septic arthritis post-surgery [6].

The most critical action to avoid graft contamination is prevention. Given the measures taken in the operative room the incidence of this intraoperative complication is low [7]. Nevertheless, it may omlur, so surgeon must be prepared to make correct decisions.

The current consensus in case of contamination regardless of the type of autograft (bone tendon bone or hamstrings) is to perform a wash with physiological serum and an antibiotic or disinfectant for 8 minutes [8,9]. The most recommended are gentamicin and chlorhexidine 2% achieving negative cultures of about 100% [10]. There are no established guidelines for allografts.

In the present study, it is shown that washing the graft with either product is equivalent concerning maximum tension per graft diameter, so it is established that from the mechanical point both are similar. If we add the existing evidence regarding microbiology, both products are equivalent to use them in case of graft contamination.

This work was performed in the context of anterior cruciate reconstruction; however, this should be extrapolated to other ligamentous reconstructions in which autografts are used, like knee posterior cruciate ligament or shoulder coracoacromial ligament to note a few.

Limitation of the Study

One limitation of this study is the absence of a control group; however, the study design seeks to answer the question once the graft is already contaminated, that is, it has already fallen to the ground. Therefore, the surgeon given the current consensus must perform the wash with one or other agent. The study delivers relief that independently the product used the maximum graft tension is the same.

Conclusions

There are no biomechanical differences between washing the graft with chlorhexidine or gentamicin, presenting similar maximum stress levels, therefore, in case of graft contamination, the use of both is useful and safe.

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Conflict of Interest

Authors declares that they have no conflict of interest.

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