

Biofilm adhesion on polypropylene and nylon sutures in clinical crown lengthening surgery: controlled clinical trial

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ABSTRACT

Objective. The aim of this study was to compare biofilm adherence in polypropylene versus nylon sutures in clinical crown lengthening surgery on anterior teeth.

Material and methods. This controlled clinical trial was conducted in 2019 at the Dental Center and the Microbiology Laboratory of the Antenor Orrego Private University, with 30 patients undergoing clinical crown lengthening surgery for prosthetic reasons of an anterior tooth who met the established selection criteria. Participants were chosen using the non-probabilistic selection method, and the reliability was determined by calibration using an intra-evaluator (0.984) and an inter-evaluator (0.978) with an independent collaborator. The bacterial adhesion of polypropylene and nylon threads was compared seven days after surgery using the paired-sample Student's t-test and also compared to a control. A significance level of 5% was considered.

Results. Initially, there were 37 patients, of whom 7 were eliminated because they lost their suture threads. There is a significant difference ($p=0.001$) between the adherence of biofilm in polypropylene sutures compared to nylon after clinical crown lengthening surgery.

Conclusion. Polypropylene suture adheres less biofilm compared to nylon in clinical crown lengthening surgery.

Keywords: biofilm, crown lengthening, nylon, oral surgery, polypropylene, sutures

INTRODUCTION

Clinical crown lengthening (CCL) is the surgical procedure that allows gum and/or bone tissue to expose a greater amount of dental structure, allowing the rest to ensure a good marginal seal and adequate retention for restorations. The surgical method will depend on aesthetics, crown-root ratio, root shape, dental position, and height of the keratinized gingiva [1-5].

This procedure aims to reposition the tissues apically to increase the coronal height [6,7], reestablishing the biological space that is the union of supracrestal connective and epithelial tissues, which

occupy the space between the base of the gingival sulcus and the crest alveolar [8-11].

The techniques and materials chosen in all oral surgery procedures should promote good closure and healing of the surgical space. To the extent possible, dental surgical procedures should be completed with suture stitches for closure and definition of the wound. These sutures are chosen based on the surgical site, biocompatibility, ease of handling, strength, and durability [12,13].

An infection could happen if the operated tissues are not properly treated, which is generally associated with the local bacterial flora due to biofilm [14,15].

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The use of sutures plays an important role in wound healing, allowing good positioning of post-surgery tissues, maintaining hemostasis, and reducing postoperative pain. Those are classified according to origin (natural and synthetic), structure (monofilaments and multifilaments), and biological properties (absorbable and non-absorbable) [16,17].

A suture must have tensile strength, stability, security, and flexibility to prevent damage to the oral mucosa. In addition, the sutures provide a suitable surface for adherence and biofilm formation, protecting exogenous bacteria from the host's defense mechanism. For this reason, special attention should be paid to the characteristics that prevent this problem [15,17-19].

Among the non-absorbable synthetic suture materials, we find polypropylene and nylon. The first one has high tensile strength and does not cause tissue reaction [17,20]; while nylon presents regular ease of handling and knot security. In general, both have low tissue reactivity and low biofilm adherence compared to multifilament sutures, such as silk or polyglactin 910 [12,15,17,20-21]. However, clinicians prefer the last one because monofilament sutures are more difficult to manipulate and have sharp ends that can irritate oral tissues [12,17,20-21].

Not enough studies compare these types of sutures, and it's necessary for the correct closure of the surgical wound, minimizing post-operative problems, and allowing the dental surgeon to choose the type of suture by always using scientific evidence.

Given that sutures can initiate surgical site infection, clinical evidence-based choice is necessary to prevent this process. Therefore, the present study aimed to compare the adherence of biofilm in polypropylene versus nylon sutures after coronary lengthening surgery.

MATERIAL AND METHODS

The present clinical study, where both sutures were put on the same patient, was carried out between April and October 2019 at the Dental Center and the Microbiology Laboratory of the Antenor Orrego Private University with the proper authorization of the Postgraduate School (RD N° 0373-2019-EPG-UPAO).

A pilot study was conducted where microbial adhesion to sutures in colony-forming units (CFU) was measured. Reliability was determined by calibration of the principal investigator, using Cohen's Kappa test, both intra-evaluator (0.984) and inter-evaluator (0.978) with an independent collaborator, a microbiology technician from the University. To determine the sample size, data from this pilot study and the formula for comparison of means of inde-

pendent groups were used, which were $\alpha=0.050$, $\beta=0.050$, $1-\alpha/2=0.975$, $Z_{1-\alpha/2}=1.960$, $1-\beta=0.950$, $Z_{1-\beta}=1.645$, Polypropylene group variance = $5.30E-06$, Nylon group variance = $1.29E-04$, $x_1 - x_2 = -0.012$. The development of the formula showed a minimum size of 12 suture threads per group; however, for the present study, we worked with 30 polypropylene sutures, 30 nylon sutures, and 30 controls, each of which was made of the same material.

The patients selected for the study were between 18 and 35 years of age, in good general health, and indicated for crown lengthening surgery due to prosthetic requirements in the anterior tooth, which was to be performed in the Periodontics II course of the Stomatology Program. Patients excluded had concurrent orthodontic treatment, smokers, or consumed drugs that could interfere with the results of the study.

The patients were selected by non-probabilistic sampling for convenience, and the importance of their participation in the study was explained to them, and if they voluntarily accepted, they proceeded to deliver the informed consent to be signed. During the study, the patient who did not comply with the post-surgical indications, abandoned treatment, partially or lost the suture, or developed any post-surgical complication unrelated to what was intended to be evaluated was eliminated: bleeding, infection, injury to adjacent soft and bony tissues, etc.

The present work is a thesis to obtain a master's academic degree and was registered in the Postgraduate School (Resolution No. 0373-2019-EPG-UPAO), the permission of the Principal of the Stomatology Program and the Bioethics Committee of the Antenor Orrego Private University (RD N° 287-2019-UPAO), considering the ethical principles of the Declaration of Helsinki and the General Health Law of Peru (Law No. 26842).

Before starting the surgery, the operating students were trained to comply with the study protocol, and during the procedure, it was verified that it was carried out without inconvenience. Before the surgical procedure, all patients approved for periodontal surgery in the Periodontics II subject must comply with having an O'Leary index <20% and the 0.12% chlorhexidine-based mouthwash. After lengthening the clinical crown, suturing was done by placing two simple interrupted stitches in the same surgical site, one made with propylene (6-0, TC 15 LOT 10253329) and the other made with nylon (6-0, TC 15 LOT 10470216), with an approximate distance of 1cm between them.

Postoperative indications were the same for all patients: after surgery was done, they had to take medication naproxen 500 mg every 12 hrs for 3 days in case of pain, use a mouthwash chlorhexidine 0.12% every 12 hours for 7 days, brush their teeth after every time they ate and provide the corre-

sponding care for wound care and sutures. The patient was kept in contact until the day of control.

Seven days after surgery, in addition to postoperative evaluation, the suture stitches were removed, cutting a 1-cm segment exposed in the oral cavity from each thread to be analyzed in test tubes containing 200 ul of Luria Bertani culture (LB culture). This culture contains casein peptone and yeast extract that provide the medium with the necessary nutrients for the optimal development of most microorganisms. Also, sodium chloride helps maintain osmotic balance (Sodium chloride 5.0, yeast extract 5.0, casein peptone 10.0 (pH 7.2±0.2). The same was done with the control stitches: one segment of 1 cm was cut from each control suture of sterile polypropylene and nylon to be analyzed in test tubes containing the LB culture (Figure 1). Then, they were taken to the microbiology laboratory, where the tubes were shaken for two minutes. The absorbance was read using the Thermo Scientific Multiskan GO 51119200 spectrophotometer (200-1000 nm) manufactured in Japan by Thermo Fisher Scientific Corporation (Figure 2). Only 0.5 ml was removed with a lab pipette from the LB culture and placed in small sample reservoir plates with wells. These plates were entered into the machine and then hit start to begin with the reading.

The data obtained were processed automatically in the statistical program SPSS Statistics 22.0, to be presented in tables with means, standard deviation

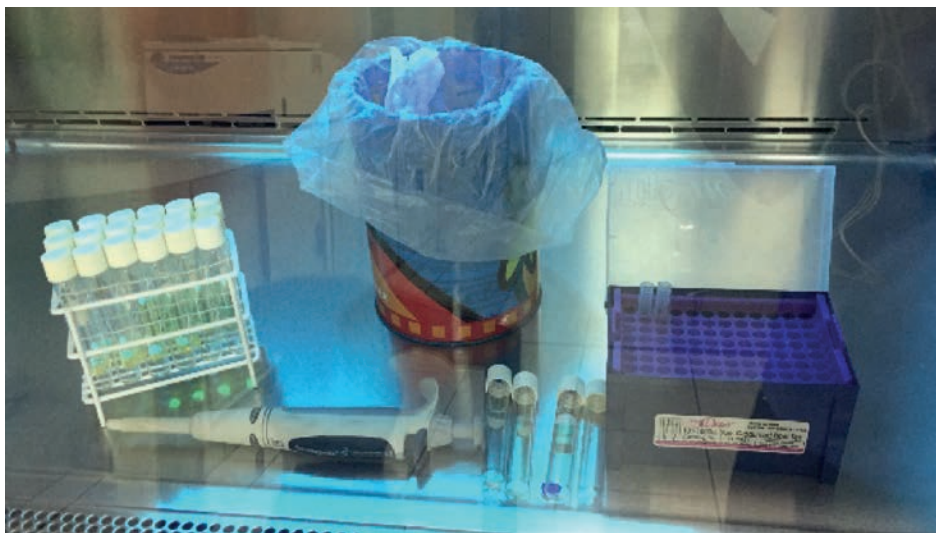


FIGURE 1. Micropipette to extract the LB culture from the tubes with nylon and propylene sutures in a sterile environment behind a window wall

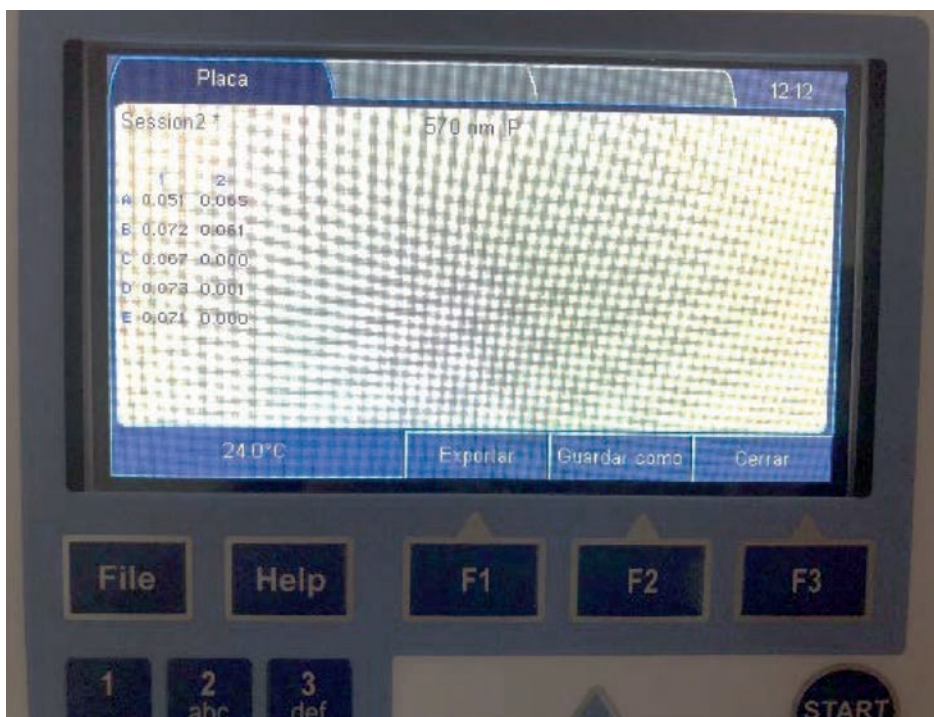


FIGURE 2. Readings in the spectrophotometer. Nylon suture vs nylon control and propylene suture vs propylene control

tions, and confidence intervals. The bacterial adhesion of polypropylene and nylon yarns was compared using the paired-sample Student's t-test and also compared to a control. A significance level of 5% was considered.

RESULTS

Since there are many types of sutures, the best one for each procedure must be carefully selected because they have special characteristics like resistance, stability, and flexibility, among others [17]. This study was conducted to compare two types of sutures (polypropylene and nylon) to establish which was better in biofilm adhesion after crown lengthening.

In the present study, we initially worked with 37 patients, of whom 7 were eliminated because they lost their suture threads. Of the 30 that remained, 28 were women (93.3%) and 2 were men (6.7%).

When comparing the postoperative bacterial adhesion of both sutures, a difference was found between them ($p=0.001$), corresponding to greater adhesion of bacteria to the nylon thread (0.074 ± 0.0053 AU) compared to the polypropylene (0.069 ± 0.0037 AU) (Table 1). Readings of absorbance don't have a measured unit due to its dimensionless value, known as "AU" (absorbance units).

TABLE 1. Biofilm adhesion on polypropylene suture vs nylon, post crown lengthening surgery

Descriptive statistics	Polypropylene	Nylon
N	30	30
Mean (AU)	0.069	0.074
Standard deviation	0.0037	0.0053
Minimum n° (AU)	0.064	0.065
Maximum n° (AU)	0.075	0.088

* $p<0,05$: statistically significant, $p>0,05$: NS; $t= 6.456$; $p=0.001$

Tables 2 and 3 show that the polypropylene and nylon sutures presented greater bacterial adhesion than their corresponding controls ($p=0.001$ for both).

TABLE 2. Biofilm adhesion on polypropylene suture vs control post crown lengthening surgery

Descriptive statistics	Polypropylene	Control	CI 95%	
			IL	SL
N	30	30	0.0018 AU	0.0056 AU
Mean (AU)	0.069	0.065		
Standard deviation	0.0037	0.0033		
Minimum n° (AU)	0.064	0.059		
Maximum n° (AU)	0.075	0.068		

* $p<0,05$: statistically significant, $p>0,05$: NS; $t= 4.005$; $p=0.001$

SD: Standard deviation; CI: Confidence interval; IL: Inferior limit; SL: Superior limit; t: Student t-test; NS: Non significant; p: Probability

TABLE 3. Biofilm adhesion on nylon suture vs control post crown lengthening surgery

Descriptive statistics	Polypropylene	Control	CI 95%	
			IL	SL
N	30	30	0.075 AU	0.0122 AU
Mean (AU)	0.074	0.063		
Standard deviation	0.0053	0.0031		
Minimum n° (AU)	0.065	0.059		
Maximum n° (AU)	0.088	0.070		

* $p<0,05$: statistically significant, $p>0,05$: NS; $t= 8.474$; $p=0.001$

SD: Standard deviation; CI: Confidence interval; IL: Inferior limit; SL: Superior limit; t: Student t-test; NS: Non significant; p: Probability

DISCUSSION

The sutures must have certain properties so that the recovery of the surgical patient doesn't have complications. Among these characteristics are resistance to traction, stability, safety, and flexibility, which are necessary to avoid damaging the oral mucosa. In addition, they must avoid bacterial adherence and contamination of the wound; despite this, the sutures are foreign materials that allow the accumulation of bacteria [17,19].

In this regard, Tummalapalli et al. [21] report that in surgery, there is a high risk of contamination due to bacteria from the environment that adhere to the materials used, as is the case with sutures. This adherence and colonization can result in infection, complications of surgery, trauma, and/or the need for increased postoperative care, such as additional antibiotic treatment. This was not seen in the present study, despite the type of sutures, because of the post-procedure instructions given to patients on taking care of the wound and keeping it clean as much as possible. Furthermore, the sutures chosen for this work tend to adhere to smaller amounts of biofilm, as indicated by Faris et al. [16] and Dragović et al. [18] stated in their article.

In this work, we decided to use a monofilament suture for crown lengthening like polypropylene and nylon to avoid as much as we can the bacterial adherence, finding that the best suture is polypropylene, confirming what the studies of Faris et al. [16], Dragovic et al. [17] and Gazivoda et al. [22] found. According to their studies, sutures adhere to bacteria as they are foreign materials in the mouth. However, due to their composition, monofilament sutures also do that in a lesser way. This allows a lower risk of infection and, therefore, better closure and healing of the wound after surgery, especially in sectors where aesthetic results are compromised [22].

Albertini et al. [25] and Zhuang et al. [26] stated in their studies that aerobic and anaerobic bacteria, such as *Peptostreptococcus* spp., *Prevotella interme-*

dia, *Actinomyces* spp., *Capnocytophaga*, *Enterococci*, *Streptococci*, and *Staphylococcus aureus*, can be present in oral postoperative infections. According to evidence, the risk of oral infection and colonization of these bacteria depends on bacterial adhesion and properties of suture materials along with oral wound care. That is why, in our study, we tried to preserve oral hygiene with post-operative instructions to all patients.

This finding reinforces what was reported in the review by Burckhardt et al. [23], where they conclude that the best suture for the buccal region in periodontal and peri-implant surgeries is polypropylene 6-0 due to its better adaptation and stability of the wound, in addition to recommending nylon 6-0 to be used in interdental sutures, especially in the molar area. Paolantoni et al. [24] I also agree with the above, suggesting using non-absorbable sutures such as polypropylene or monofilament or expanded polytetrafluoroethylene for crown lengthening procedures in anterior sectors.

However, it is also important to remember that bacterial adherence is conditioned by factors such as oral hygiene, which depends on each patient, as well as post-surgery wound care [12,17]. That's why we were very careful about the post-surgery instructions and the follow-up appointments with each patient.

The limitations of the study were the loss of some suture threads, possibly due to poor suturing techniques or difficulties of the students. However, these patients were withdrawn from the study, which meant that they were no longer considered.

It is suggested to investigate with a larger population comparing the two sutures in other types of oral surgeries to understand their advantages and disadvantages better. Also, more studies are required to compare these sutures, considering factors like age, educational level, and oral hygiene,

among other factors that may interfere with the findings.

In future research, it is important to longitudinally evaluate the behavior of sutures in different surgical procedures and patient conditions so that clinicians can choose the best materials based on scientific evidence.

In the present investigation, the polypropylene suture had less adherence to biofilm compared to nylon, thus reducing the possibility of contamination of the wound. These findings show that for this type of procedure, it's best to use polypropylene, and it should be taken under consideration by all clinicians who perform this type of surgery, including clinics where students do their clinical practice.

CONCLUSION

Polypropylene suture adheres less biofilm compared to nylon in clinical crown lengthening surgery.

Funding and competing interests:

The authors declare that this work was self-financed and there is no conflict of interest.

Ethics approvals:

For the present work, authorization was obtained from the Postgraduate School, the Principal of the Stomatology Program and the Bioethics Committee of the Antenor Orrego Private University (RD N°287-2019-UPAO), based on the principles of the Helsinki Declaration of the World Medical Association, in its most recent version; and also in articles 15°; 25°; 28 of the General Health Law of Peru. (Law No. 26842).

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