Print ISSN: 2321-6379
Online ISSN: 2321-595X

Original Article

Comparative Evaluation of the Microbial Contamination of Various Suture Materials Used During Implant Placement: An *Ex Vivo* Study

Shubham Nihar Mehta

Consultant Prosthodontist and Implantologist, Vadodara, Gujarat, India

Abstract

Background: This study evaluated the bacterial adhesion on three different types of commercially available non-resorbable suture material (silk, Teflon-coated polyester poly-tetra-fluoro-ethylene [PTFE], and proline) used during implant surgery.

Methods: The study was a randomized clinical trial on a total of 180 partially or completely edentulous participants of either sex (102 males and 78 females) and age group above 18 years of age on whom three different suture materials were clinically placed on implant sites and the bacterial contamination between the suture materials, that is, silk, proline, and PTFE was then tested with the help of laboratory procedures after retrieving the sutures clinically and culturing the sutures in different media.

Results: The mean colony-forming unit (CFU) of silk was the highest followed by Proline and PTFE the least (PTFE < Proline < Silk). Comparing the mean CFU of three different sutures, analysis of variance and Tukey test also showed similar ($P > 0.05$) CFU between all the three sutures.

Conclusion: PTFE suture is best recommended for suture placement after implant placement with regard to the least microbial contamination followed by proline suture and the least favorable being silk suture.

Key words: Bacteria, Implant, Poly-tetra-fluoro-ethylene, Suture

INTRODUCTION

Since the turn of the century, sutures have been considered to be one of the most effective and useful method for the closure of surgical incisions and have becomes an integral part of most of all surgical procedures and, henceforth, correct closure and stabilization of surgical wound margins influence the success of a dental implant procedure.[1,2]

Depending on the materials used for the production of the suture surgical threads, sutures can be broadly categorized on the basis of natural and synthetics, on the basis of their origin, on the basis of being absorbable and non-resorbable, on the basis of their biological behavior and finally, on the basis of their structure, namely, monofilament, multifilament, and pseudo-monofilament.[3]

Hypoxic environment can be created by bacterial accumulation at the surgical site within and around the wound as well as inhibiting the activity of fibroblasts, which results in delayed wound healing.[4]

Although, the infection at surgical site is further aggravated by the formation of biofilm, wherein the encapsulated bacteria exists within a self-secreted extracellular polymeric slime matrix composed of polysaccharides, proteins, and nucleic acids.[5,6]

Surgical silk a non-absorbable, multifilament suture of organic origin retrieved from cocoons of silk worm constituted for the 70% by natural proteins and for the 30% by stranger material and dyed black is most widely used for the various surgical procedures in oral implantology. Unfortunately, the braided nature of the silk suture provokes bacterial adherence, resulting in a more intense

Access this article online

www.ijss-sn.com

Month of Submission : 07-2022
Month of Peer Review : 08-2022
Month of Acceptance : 08-2022
Month of Publishing : 09-2022

Corresponding Author: Shubham Nihar Mehta, Consultant Prosthodontist and Implantologist, Vadodara, Gujarat, India.

and prolonged inflammatory response in gingival mucosa than the various new synthetic materials.[3]

Synthetic multifilament sutures such as Teflon-coated polyester poly-tetra-fluoro-ethylene (PTFE) grant ease of handling are characterized by a high resistance to traction, with superior and great flexibility, with a minimal tissue reaction, due to a biological and chemical inertia.[3]

Proline is a synthetic, monofilament, and non-absorbable polypropylene suture. Its advantages include minimal tissue reactivity and durability with an excellent tensile strength. Disadvantages include fragility, high plasticity, high expense, and difficulty of use as compared to standard nylon sutures.[7]

Therefore, the bacterial adherence of three different suture materials was evaluated on the basis of colony counts established, after culturing the sutures in different culture media.

MATERIALS AND METHODS

Study Design

The study was a randomized clinical trial on a total of 180 partially or completely edentulous participants from those attending the outpatients Department of Prosthodontics Crown Bridge and Implantology of either sex (102 males and 78 females) and age group above 18 years of age having no periodontal, systemic disease or psychosis, and requiring implant rehabilitation were selected.

Methodology

Implant surgical procedure

After implant placement, primary closure was done alternatively using black braided silk (Mersilk 4-0, Ethicon India Pvt. Ltd., Mumbai, Maharashtra, India), Teflon-coated polyester (PTFE) (Dental-A 4-0,CMC Medical Devices, Malaga, Spain) and Proline (polypropylene) sutures (Steriline Polypropylene-blue, 4-0, Peters Surgical India Pvt. Ltd., New Delhi, India). Buccal flaps were sutured using simple interrupted stitches. However, the three different suture materials were used in different patients to intraindividually compare bacterial colonization. All sutures were placed and removed by the same skilled operator to eliminate interexaminer variability.

A minimum of three knots per patient was tested for each type of suture. Follow-up visits were performed at 7 days after insertion.

Suture retrieval and sample culture

Sutures were removed with sterile instruments and then were placed in tubes diluted with 1 ml of normal sodium chloride saline (NS, Jedux Parenteral Pvt. Ltd., Barabanki, Uttar Pradesh, India). The collected samples were then immediately transported in sterile plain Vacutainer (Avantor Performance Materials Pvt. Ltd., Silvassa, Dadra and Nagar Haveli, India) [Figure 1].

Suture fragments were homogenized for 3 × 1min in an ultrasound bath and were shaken vigorously on the vortex mixer. Following vortexing, serial dilutions of normal sodium chloride saline were then made for each sample. Selective culture media was inoculated to detect microorganisms using a colony formation unit per unit surface area (colony-forming unit [CFU]/surface).

Sabouraud's dextrose glucose agar plates (HiMedia Laboratories, Mumbai, Maharashtra, India) supplemented with chloramphenicol was used for the identification of fungi. Blood agar plates (HiMedia Laboratories, Mumbai, Maharashtra, India) [Figure 2] were used for the detection of oral streptococci. MacConkey agar plate (HiMedia Laboratories, Mumbai, Maharashtra, India) was used for

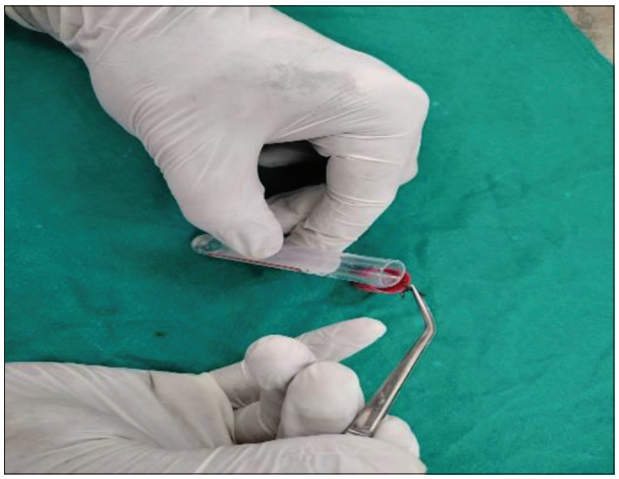


Figure 1: Suture collection in plain Vacutainer

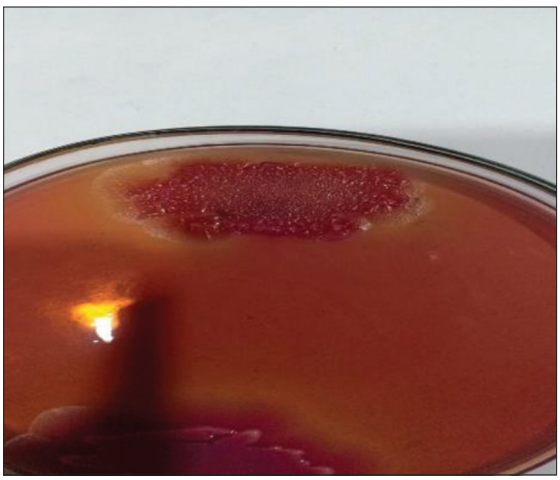


Figure 2: Colony-forming unit units on MacConkey agar plate

the detection of *Staphylococcus aureus* and Escherichia *coli*. These plates were then placed in GasPak jars to produce an anaerobic atmosphere with AnaeroGen. Colony counts were performed at 24, 48, and 72 h after incubation for each type of plate.

Dilution parameters and sample processing parameters for the *ex vivo* study were calculated according to the results obtained in the *in vitro* study.

RESULTS

This study evaluated and compared the microbial contamination of three different types of commercially available non-resorbable suture materials, namely, silk, Teflon-coated polyester (PTFE), and proline. Four bacterial strains, namely, *Streptococcus mutans*, *S. aureus, E. coli*, and *Candida albicans* were isolated and compared. Total 720 samples, 60 per suture per microorganism were screened.

The outcome measure of the study was the bacterial adhesion (i.e., CFU) around the three different suture materials which were assessed at 7–10 days after insertion of the implant.

The CFU of four different microorganisms (*S. mutans*, *S. aureus*, *E. coli,* and *C. albicans*) over three sutures (silk, PTFE, and proline) is summarized in Table 1 and also depicted in Graph 1. The CFU ($\log_{10}$ CFU/surface) of *S. mutans*, *S. aureus*, *E. coli,* and *C. albicans* ranged from 2.60 to 6.95, 2.78 to 7.48, 2.30 to 5.30, and 2.95 to 5.78, respectively, with mean (±SE) 4.81 ± 0.18, 4.85 ± 0.12, 3.56 ± 0.18, and 4.26 ± 0.26, respectively, and median 4.54, 4.70, 3.54, and 4.00, respectively. The mean CFU of *S. aureus* was the maximum followed by *S. mutans*, *C. albicans,* and *E. coli* the minimum (*E. coli* < *C. albicans* < *S. mutans* < *S. aureus*).

Comparing the mean CFU of four different microorganisms, analysis of variance (ANOVA) showed significantly different CFU among the microorganisms ($F = 6.85$, $P < 0.001$) [Table 2].

Further, comparing the difference in mean CFU between four different microorganisms, Tukey test also showed significantly ($P < 0.001$) different and lower CFU in *E. coli* as compared to both *S. mutans* and *S. aureus* [Table 2 and Graph 2]. However, it did not differ ($P > 0.05$) between other microorganisms (i.e., *S. mutans* and *S. aureus*, *S. mutans* and *C. albicans*, *S. aureus* and *C. albicans*, and *E. coli* and *C. albicans*), that is, found to be statistically the same. In other words, bacterial adhesions differ significantly between microorganisms.The CFU of four different

Table 1: The distribution and comparison of CFU (log10 CFU/surface) among four different microorganisms

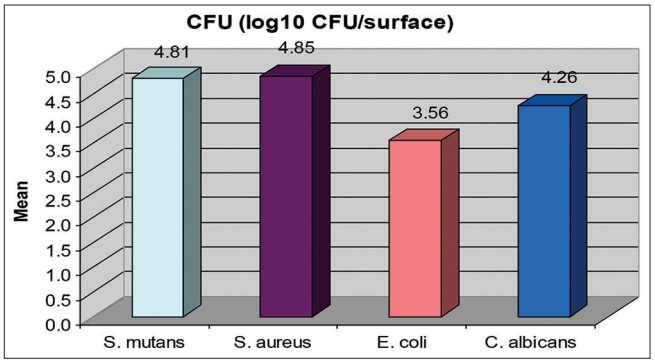
Microorganism	*n*	CFU (log10 CFU/surface) (Mean±SE)	F value	*P* value
Streptococcus mutans	64	4.81±0.18	6.85	<.001
Staphylococcus aureus	97	4.85±0.12		
Escherichia coli	20	3.56±0.18		
Candida albicans	11	4.26±0.26		

CFU: Colony-forming unit

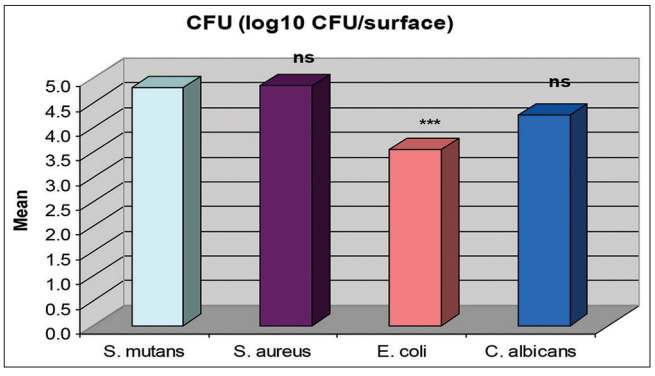
Table 2: Comparison (*P* value) of difference in mean CFU (log10 CFU/surface) between four different microorganisms by Tukey test

Comparison	Mean diff.	q value	*P* value	95% CI of diff.
S. mutans versus *S. aureus*	-0.04	0.29	>0.05	−0.5526–0.4725
S. mutans versus *E. coli*	1.25	5.63	<0.001	0.4298–2.061
S. mutans versus *C. albicans*	0.55	1.96	>0.05	−0.4871–1.591
S. aureus versus *E. coli*	1.29	6.06	<0.001	0.5036–2.067
S. aureus versus *C. albicans*	0.59	2.15	>0.05	−0.4208–1.604
E. coli versus *C. albicans*	-0.69	2.14	>0.05	−1.888–0.5013

diff: Difference, CI: Confidence interval, q value: Tukey test value. CFU: Colony-forming unit, *S. mutans: Streptococcus mutans, C. albicans: Candida albicans, E. coli: Escherichia coli*



Graph 1: The mean colony-forming unit (CFU) ($\log_{10}$ CFU/surface) of four different microorganisms



Graph 2: Comparison of difference in mean colony-forming unit (CFU) ($\log_{10}$ CFU/surface) between four different microorganisms. $^{ns}P > 0.05$ or $^{***}P < 0.001$ as compared to *Streptococcus mutans*

microorganisms was summarized in mean ± SE and compared by ANOVA (*F* value).

DISCUSSION

Surgical site infection is a common problem encountered after every surgical intervention. The formation of bacterial biofilm by attachment to the underlying foreign body or to the tissue substratum is another complication of any surgery. Hence, this study investigated different suture materials used at surgical sites and their contribution to surgical site infection. It was shown that any suture material can host or harbor bacterial biofilm formation, but not all suture materials are necessarily equivalent in this regard.[8]

Sutures used in the present study belong to the group of non-absorbable sutures; in particular, silk is a multifilament suture of organic origin and PTFE and proline suture are synthetic absorbable suture.

In support to this study, Edlich *et al.* also found same results as less accumulation of bacteria was seen around PTFE and proline sutures in comparison to silk sutures but, furthermore, put forth a statement denoting that the chemical structure of the suture was found to be the most important factor in the development of surgical infection rather the physical configuration.[9]

In contrary to this study, Racey *et al.*, 1978, and Banche *et al.*, 2007, found that silk has been a favored suture material in oral implantology, used as a comparison standard in assessing the usability and it is the most common suture material used.[10]

This study strongly indicates that, whenever possible, the first choice of suture between the present tested materials should be PTFE suture, but according to this study, there is a negligible amount of difference between PTFE and proline suture on the basis of the quantitative and qualitative parameters.

CONCLUSION

Within the limitation of this study, it was concluded that:

1. After 72 h of incubating the silk sutures, proline sutures, and PTFE suture in different culture media, four microorganisms were isolated to be *S. aureus*, *S. mutans*, *E. coli*, and *C. albicans* with the highest mean CFU units seen in *S. aureus* and the least mean CFU units seen in *E. coli*.
2. Higher CFUs of all four isolated microorganism were found in silk sutures as compared to proline suture with the least found in PTFE suture after 72 h of culturing the suture in different culture media.
3. PTFE suture is best recommended for suture placement after implant suture with regards to the least microbial contamination followed by proline suture and the least favorable being silk suture.

ACKNOWLEDGMENT

We would like to acknowledge our study participants, data collectors, and district social experts who kindly participated in this study.

REFERENCES

1. Ercan UK, Ibis F, Dikyol C, Horzum N, Karaman O, Yıldırım Ç, *et al*. Prevention of bacterial colonization on non-thermal atmospheric plasma treated surgical sutures for control and prevention of surgical site infections. PLoS One 2018;13:e0202703.
2. Mahesh L, Kumar VR, Jain A, Shukla S, Aragoneses JM, González JM, *et al*. Bacterial adherence around sutures of different material at grafted site: A microbiological analysis. Materials (Basel) 2019;12:2848.
3. Minozzi F, Bollero P, Unfer V, Dolci A, Galli M. The sutures in dentistry. Eur Rev Med Pharmacol Sci 2009;13:217-26.
4. Bucknall T.E. The effect of local infection upon wound healing: An experimental study. Br J Surg 1980;67:851-5.
5. Gristina AG, Price JL, Hobgood CD, Webb LX, Costerton JW. Bacterial colonization of percutaneous sutures. Surgery 1985;98:12-9.
6. Hall-Stoodley L, Costerton JW, Stoodley P. Bacterial biofilms: From the natural environment to infectious diseases. Nat Rev Microbiol 2004;2:95-108.
7. Prolene Polypropylene Suture (package insert) Bridge Water. New Jersey: Ethicon Inc; 2016.
8. Kathju S, Nistico L, Tower I, Lasko LA, Stoodley P. Bacterial biofilms on implanted suture material are a cause of surgical site infection. Surg Infect (Larchmt) 2014;15:592-600.
9. Banche G, Roana J, Mandras N, Amasio M, Gallesio C, Allizond V, *et al*. Microbial adherence on various intraoral suture materials in patients undergoing dental surgery. J Oral Maxillofac Surg 2007;65:1503-7.
10. Racey GL, Wallace WR, Cavalaris CJ, Marguard JV. Comparison of a polyglycolic-polylactic acid suture to black silk and plain catgut in human oral tissues. J Oral Surg 1978;36:766-70.

How to cite this article: Mehta SN. Comparative Evaluation of the Microbial Contamination of Various Suture Materials Used During Implant Placement: An *Ex Vivo* Study. Int J Sci Stud 2022;10(6):12-15.

Source of Support: Nil, **Conflicts of Interest:** None declared.