

Comparative Evaluation of Silk Suture Material and Betadine-impregnated Suture Material in Oral Cavity: A Microbiological Study

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ABSTRACT

Aim: The main aim of the present study was to calculate the total colonies of microorganisms around coated and non-coated silk sutures and to evaluate antibacterial efficacy around betadine-coated sutures in comparison to silk sutures.

Materials and methods: The suture selected was 3-0 silk suture for the right side with a cutting needle and 3-0 silk suture dipped in betadine solution on the left side. The extraction on the right side and left side mandibular premolar teeth were done first and sutured with normal silk suture and betadine-coated suture, respectively, second visit, 2 mm of both the sutures were removed and sent for culture, the patient was recalled on the seventh day and the entire suture was removed and was sent for culture and the healing is recorded. On the third day, 2 mm of each stitch was sectioned, and on the seventh day, the entire stitch was removed, inoculated in 10 mL of sterile physiological saline, and vortexed for 5 minutes to release the microorganisms adhered to the suture material. The serially diluted suspension was seeded (spread plate method) with a different culture media. Following the incubation process, the colonies on each plate were counted per colony-forming units (cfu/mL). A paired *t*-test and independent *t*-test were done. A paired *t*-test is a statistical procedure used to determine the mean difference between two sets of observations is zero.

Results: The surface of silk suture as well as betadine-coated sutures, was covered with a thick layer of plaque and debris. The average contaminated area was smaller on betadine-coated suture materials, which was removed on the third then on the seventh day there were statistically significant differences between silk and betadine-impregnated sutures. Substantial reductions in bacterial adherence were observed on betadine-coated sutures compared with silk suture material. Both the types of sutures silk and betadine-coated suture healing was uneventful, even though organisms were more in normal silk suture.

Conclusion: The betadine-impregnated suture has a promising potential in preventing the colonization of pathogens around the extraction area. Betadine-impregnated suture material will reduce postoperative infection.

Clinical significance: This study gives data to guide the selection of suture materials for contaminated wounds or wounds at risk for developing an infection. The bacterial adherence of suture materials should be considered by all practitioners while closing wounds or debriding infected wounds. Hence, betadine-impregnated suture material will reduce postoperative infection.

Keywords: Antibacterial efficacy, Antibiotics, Bacterial adherence, Bacterial characterization, Betadine (povidone-iodine)-impregnated suture, Chlorhexidine, Mucous membrane.

World Journal of Dentistry (2021); 10.5005/jp-journals-10015-1790

INTRODUCTION

A suture is an appliance holding together the edges of the wound which are separated due to injury, extraction of the tooth, removal of an impacted tooth, etc. The application involves using a needle with an attached length of silk, thread, prolene, catgut, etc. The FDA first approved triclosan-coated sutures in 2002, which has been shown to reduce the chances of wound infection.¹

Silk is a type of suture material with good attainability and is used in dentistry quite frequently. They are used in different sizes and different shapes.² Sometimes the wound opens up due to incompatibility of the suture material. They play an important role in the closure, wound healing in an incision.³ Antibacterial sutures, such as, resorbable are coated with antibiotics, such as, triclosan and antiseptic, such as, chlorhexidine (CHX) which are available in the market can be used depending on the indications.⁴

Non-antibacterial coated sutures were used as comparators in this assessment Vicryl® (Ethicon), Monocryl® (Ethicon), PDS® II (Ethicon), etc. Adverse effects associated with the use of these include surgical wound infection, failure to provide passable wound supplement of the sites where expansion especially in elderly,

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How to cite this article: Layeequa L, Sequira J. Comparative Evaluation of Silk Suture Material and Betadine-Impregnated Suture Material in Oral Cavity: A Microbiological Study. *World J Dent* 2021;12(1):22–27.

Source of support: ICMR STS

Conflict of interest: None

stretching or dilatation, debilitated patients or in patients suffering from conditions which may delay wound healing, infection, minimal acute seditions tissue reaction, localized irritation, and poor blood supply at the wound location.⁴

Pathogens of the buccal cavity can adhere to sutures, devouring their passage into the surgical wound and causing infections. This is favored or prevented, depending on the adsorption properties

of the suture material during the postoperative period. It is almost impossible to clear bacteria that adhere to suture material once a biofilm has formed even after antibacterial coating which prevents bacteria build-up.⁵ Hence, suture materials applied during surgery carry an intrinsic risk of postoperative wound infections.⁶⁻⁸

Sutures used in the oral cavity are continuously immersed in saliva containing 7.5×10^8 microorganisms/mL. This results in the continuous imbibing of pathogens along the suture at the surgical site which results in an inflammatory response and surgical site infection (SSI).⁹ Studies regarding the use of antibiotic-coated sutures were conducted which had mixed results in the prevention of SSI.¹⁰⁻¹⁴ Some studies favored its usage in the prevention of bacterial load while others failed to demonstrate any added benefit. Triclosan and CHX are few examples of routinely used antibacterial agents to coat the surgical sutures. In intraoral surgery, sutures are faced with different bacterial species and the question arises whether the antibacterial-coated suture material has the same positive effects.

MATERIALS AND METHODS

In this research protocol, extraction and suturing were carried out in the oral and maxillofacial surgery department in Yenepoya Dental College and Hospital, and sample processing was done in Yenepoya Research Centre. Materials for this study were manufactured from Sri Durga laboratory equipment supplies, chemicals, diagnostics, and laboratory equipment, Mangaluru, Karnataka.

Twenty patients who were advised for the extraction of mandibular premolars of ASA grade I patients and aged between 18 years and 30 years were considered for this study. Patients who were taking antibiotics and oral infection cases were excluded. Reagents of Sabouraud dextrose broth (SDB), anaerobic basal broth (ABB), Mitis Salivarius agar base (MSAB), *Bacillus* differentiation agar (BDA), Thayer Martin medium base (TMMB), *Veillonella* agar base (VAB), nutrient broth (NB), Staph selective agar (SSA), *Lactobacillus* selective broth base (LSBB), and agar type I were prepared as per the instructions given in the container and autoclaved at 121°C at 15 psi for 20 minutes, cooled to room temperature and used. Yeast, anaerobic bacteria, *Streptococcus* spp., *Veillonella* spp., *Bacillus* spp., *Lactobacillus* spp., and *Staphylococcus* were isolated and incubated at 30–37°C for 16 hours, total bacterial load/count done with nutrient agar and was incubated at 37°C for 16 hours. Suturing was done with normal silk suture on the right side and the left side, it was done with betadine-coated suture. The suture selected was 3-0 silk suture for the right side with a cutting needle and 3-0 silk suture dipped in betadine solution on the left side. The extraction on the right side and left side mandibular premolar teeth were done first and sutured with normal silk suture and betadine-coated suture, respectively, second visit, 2 mm of both the sutures were removed and sent for culture, the patient was recalled on the seventh day and the entire suture was removed and was sent for culture and the healing was recorded. Each suture sample was collected in a sterile Eppendorf tube along with physiological saline with proper labeling (case number, patient OP number, date, day, and side of suture) and was analyzed in a microbiological laboratory to test its susceptibility for bacterial affixation. Information was given previously to all patients as well as written consent was taken. All participants were given instructions on standard principles of correct oral hygiene: 0.12% CHX oral rinse, twice daily for a week. Postsurgical medication for all patients consisted of diclofenac 50 mg 1/8 hours for 3 days. Follow-up visits on the third and seventh

day were performed. The suture material as mentioned above was sent to the research center for microbiological colonization study on the third and seventh day.

Stitch from each operated side was removed on the third and seventh day, in each patient. Each sample was collected on the third day, 2 mm of each stitch was sectioned, and on the seventh day, the entire stitch was removed, inoculated in 10 mL of sterile physiological saline, and vortexed for 5 minutes to release the microorganisms adhered to the suture material. The stock dilution was serially diluted up to 10 to 6.1 mL. The serially diluted suspension was seeded (spread plate method) with a different culture media. Following the incubation process, the colonies on each plate were counted per colony-forming units (cfu/mL). The results of each culture media of each sample were recorded.

STATISTICAL ANALYSIS

Paired *t*-test and independent *t*-test were done. The paired sample *t*-test has two competing hypotheses, the null hypothesis and the alternative hypothesis. The paired sample *t*-test hypotheses are formally defined below: the null hypothesis (H_0) assumes that the true mean difference (μ_d) is equal to zero. The two-tailed alternative hypothesis (H_1) assumes that μ_d is not equal to zero. The upper-tailed alternative hypothesis (H_1) assumes that μ_d is greater than zero. The lower-tailed alternative hypothesis (H_1) assumes that μ_d is less than zero. In the formulas above, the value of μ_d is unknown. In the independent *t*-test, independent-samples *t*-test the means between two unrelated groups on the same continuous, dependent variable are compared.

RESULTS

The study sample consisted of 20 patients aged between 18 years and 30 years. The discomfort was similar on both the sutures, the surface of silk suture and betadine-coated sutures that were covered with a thick layer of plaque and debris. Light debris appeared around the knot area around sutures after 3 days. On day 7, contamination could be seen in scattered areas along with the suture material. The average contaminated area was smaller on betadine-coated suture materials, which was removed on the third than on the seventh day, there were statistically significant differences between silk and betadine-impregnated sutures. According to the results, given in Table 1, there was a mean reduction of 74.88 and 66.55% on the third and the seventh day, respectively. Silk suture showed significantly higher values for both aerobes and anaerobes. Substantial reductions in bacterial adherence were observed on betadine-coated sutures compared with silk suture material. Both the types of sutures silk and betadine-coated suture healing was uneventful even though organisms were more in normal silk suture (Tables 2, 3 and Fig. 1).

DISCUSSION

Sutures used in oral surgery should avoid or limit bacterial adhesion and proliferation to those parts exposed to oral fluids. The multifilament suture is composed of several filaments braided together because the multifilament materials have increased capillarity, the increased absorption may act as a tract for the introduction of pathogens and can also cause tissue trauma. Sutures used in oral surgery should avoid or limit bacterial adhesion and proliferation to those parts exposed to oral fluids. Hence, microbial colonization on betadine-impregnated suture materials

from patients undergoing extraction was compared. In our study, betadine-impregnated suture showed a significant decrease in microbial count compared to normal silk suture. Klinge et al. studied the influence of the presence of either a monofilament or a multifilament mesh material on the bacterial infection risk *in vivo*. The study revealed that the increased surface area of multifilament meshes promotes the persistence of bacteria in the implant bed,

though this alone is not sufficient to create a clinically apparent infection. This might explain the development of mesh-related infections after a delay of several months or even years. The adherence of bacteria to the implant material depends on the surface area, which favors the use of monofilament materials.¹⁵ Henry-Stanley et al. conducted a study to compare the kinetic development of *Staphylococcus aureus* and *Enterococcus faecalis* on five surgical suture materials and to clarify factors that might influence this growth. *Staphylococcus aureus* and *E. faecalis* were recovered in greater numbers (typically $p < 0.01$) from braided than from monofilament suture, and the numbers of bacteria were greater (often $p < 0.01$) on sutures incubated in bacterial growth medium rather than tissue culture medium. Bacterial growth was favored on braided vs monofilament suture. *Staphylococcus aureus* adhered to suture material and formed a structure consistent with a bacterial biofilm.¹⁶

Table 1: Microbial reduction percentage from non-coated suture to betadine-coated suture

Bacteria/media	Percentage reduction from non-coated to coated (betadine)
Total bacterial count (NA)-day 3	67.85
<i>Lactobacillus</i> spp. (LSAB)-day 3	100.00
Yeast (SDA)-day 3	53.85
<i>Staphylococcus</i> spp. (SSA)-day 3	77.78
Anaerobic bacteria (ABB)-day 3	70.37
<i>Streptococcus</i> spp. (MSAB)-day 3	76.83
<i>Veillonella</i> spp. (VAB)-day 3	76.25
<i>Bacillus</i> spp. (BDA)-day 3	73.27
<i>Neisseria</i> spp. (TMMB)-day 3	82.03
Total bacterial count (NA)-day 7	59.69
<i>Lactobacillus</i> spp. (LSAB)-day 7	57.00
Yeast (SDA)-day 7	67.16
<i>Staphylococcus</i> spp. (SSA)-day 7	68.70
Anaerobic bacteria (ABB)-day 7	76.08
<i>Streptococcus</i> spp. (MSAB)-day 7	71.43
<i>Veillonella</i> spp. (VAB)-day 7	56.31
<i>Bacillus</i> spp. (BDA)-day 7	60.81
<i>Neisseria</i> spp. (TMMB)-day 7	85.39

Most studies conducted with sutures of this kind report a decline in the number of microorganisms adhered to their exterior. However, Storch et al. reported a decline of 96.7% with Vicryl® Plus suture after 48 hours in strains of *S. aureus*.¹⁷ Ming et al., in a similar study but using Monocryl® Plus suture, recorded a bacterial reduction in the order of 3.4 log and 2 log in strains of *S. aureus* and *E. coli*, respectively.¹⁸ Gómez-Alonso et al., in turn, obtained a decrease of about 87% with Vicryl® Plus suture previously infected with *S. epidermidis* and *E. coli*.¹⁹ Lastly, Marco et al., in a study using rats, reported a 66% reduction in cultures positive for *S. epidermidis*.²⁰ This study was based on microorganisms adhering to normal silk suture comparing it to silk suture dipped in betadine. Furthermore, to protect against colonization of the suture by organisms commonly associated with SSIs. In our study, the colonization rate of silk suture was 90 to 86% higher than with betadine-impregnated suture after 3 and 7 days, respectively. The complex adhesion mechanisms of the microorganisms that inhabit

Table 2: Comparison of bacterial count between the groups

	Group				p value
	Coated		Non-coated		
	Mean	Std. deviation	Mean	Std. deviation	
Total bacterial count (NA)-day 3	6.80	7.891	21.15	19.754	0.005
<i>Lactobacillus</i> spp. (LSAB)-day 3	0.00	0.000	0.20	0.894	0.324
Yeast (SDA)-day 3	11.70	37.943	25.35	70.590	0.451
<i>Staphylococcus</i> spp. (SSA)-day 3	3.30	8.486	14.85	38.866	0.202
Anaerobic bacteria (ABA)-day 3	24.30	52.814	82.00	146.666	0.106
<i>Streptococcus</i> spp. (MSAB)-day 3	27.15	32.623	117.20	123.253	0.003
<i>Veillonella</i> spp. (VAB)-day 3	15.50	19.349	65.25	74.173	0.006
<i>Bacillus</i> spp. (BDA)-day 3	8.50	14.623	31.80	38.530	0.016
<i>Neisseria</i> spp. (TMMB)-day 3	3.55	6.684	19.75	28.086	0.016
Total bacterial count (NA)-day 7	130.20	234.085	323.00	536.653	0.149
<i>Lactobacillus</i> spp. (LSAB)-day 7	4.45	19.901	10.35	40.057	0.559
Yeast (SDA)-day 7	54.10	114.253	164.75	292.781	0.124
<i>Staphylococcus</i> spp. (SSA)-day 7	21.80	53.793	69.65	144.845	0.174
Anaerobic bacteria (ABA)-day 7	167.30	233.196	699.55	655.609	0.002
<i>Streptococcus</i> spp. (MSAB)-day 7	229.95	172.590	804.85	437.701	<0.001
<i>Veillonella</i> spp. (VAB)-day 7	114.55	114.083	262.20	252.354	0.002
<i>Bacillus</i> spp. (BDA)-day 7	89.05	177.244	227.25	473.587	0.229
<i>Neisseria</i> spp. (TMMB)-day 7	31.40	55.206	214.85	280.485	0.007

An independent t-test is used to compare the groups. $p < 0.05$ indicates a significant difference

Table 3: Comparison of bacterial count between day 3 and 7

		Group					
		C			NC		
		Mean	Std. deviation	p value	Mean	Std. deviation	p value
Total bacterial count (NA)	Day 3	6.80	7.891	0.028	21.15	19.754	0.019
	Day 7	130.20	234.085		323.00	536.653	
<i>Lactobacillus</i> spp. (LSAB)	Day 3	0.00	0.000	0.330	0.20	0.894	0.261
	Day 7	4.45	19.901		10.35	40.057	
Yeast (SDA)	Day 3	11.70	37.943	0.026	25.35	70.590	0.014
	Day 7	54.10	114.253		164.75	292.781	
<i>Staphylococcus</i> spp. (SSA)	Day 3	3.30	8.486	0.086	14.85	38.866	0.063
	Day 7	21.80	53.793		69.65	144.845	
Anaerobic bacteria (ABA)	Day 3	24.30	52.814	0.007	82.00	146.666	<0.001
	Day 7	167.30	233.196		699.55	655.609	
<i>Streptococcus</i> spp. (MSAB)	Day 3	27.15	32.623	<0.001	117.20	123.253	<0.001
	Day 7	229.95	172.590		804.85	437.701	
<i>Veillonella</i> spp. (VAB)	Day 3	15.50	19.349	0.001	65.25	74.173	0.001
	Day 7	114.55	114.083		262.20	252.354	
<i>Bacillus</i> spp. (BDA)	Day 3	8.50	14.623	0.054	31.80	38.530	0.076
	Day 7	89.05	177.244		227.25	473.587	
<i>Neisseria</i> spp. (TMMB)	Day 3	3.55	6.684	0.032	19.75	28.086	0.005
	Day 7	31.40	55.206		214.85	280.485	

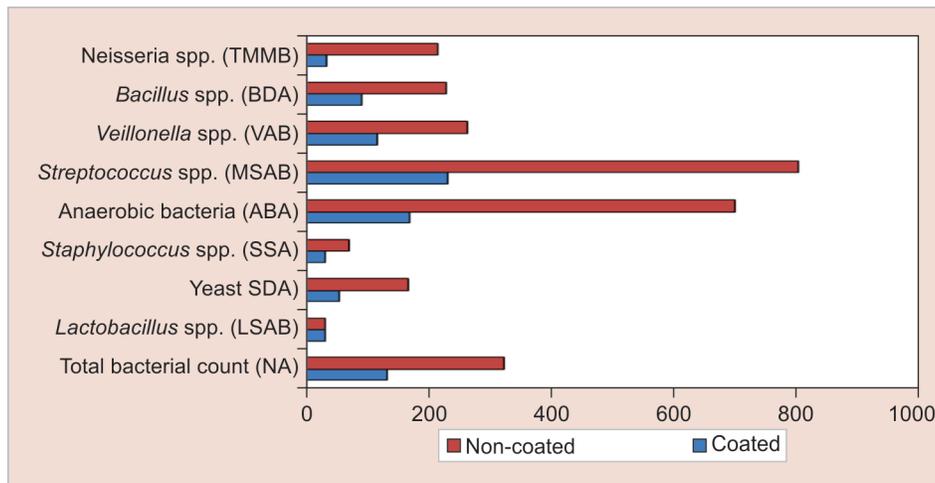


Fig. 1: Comparison of bacterial count between the groups on day 3 and 7

the oral cavity, the structural property of silk suture braiding, and the absence of sanitation during sample processing probably would explain this observation.^{21,22} Betadine (povidone-iodine) is an antiseptic component with bactericidal action. In our study, silk suture coated with betadine (povidone-iodine) was associated with a significant reduction of most microorganisms isolated during the third and seventh days. In an *in vitro* study, conducted by Ming et al., the diffusion pattern was maintained for up to 21 days. The opposite effect was recorded with a silk suture, however—a larger number of bacterial colonies being observed after 3 days (778 cfu/cm³) than after 7 days (468 cfu/cm³) of suture placement.²³ In our study, the number of bacterial species and colonies was greater in the case of both aerobic microorganisms and anaerobes on the silk suture material. The use of betadine suture yielded the lowest

counts of both aerobic (p = 0.007) and anaerobic organisms (p = 0.002). *Streptococcus* spp., *Neisseria* spp., and *Staphylococcus* spp. were most prevalent with both the sutures, followed by *Bacillus* spp., *Veillonella* spp., and yeast. The most important difference on the third day corresponded to the *Streptococcus* spp. (p ≤ 0.001). A mean reduction percentage found in the microbial count of silk suture and betadine-impregnated suture are *Lactobacillus* spp. (100%), *Neisseria* spp. (82.03%), *Staphylococcus* spp. (77.78%), *Streptococcus* spp. (76.83%), *Veillonella* spp. (76.25%), and *Bacillus* spp. (73.27%) on the third day and *Lactobacillus* spp. (57%), *Neisseria* spp. (85.39%), *Staphylococcus* spp. (68.70%), *Streptococcus* spp. (71.43%), *Veillonella* spp. (56.31%), and *Bacillus* spp. (60.81%) on the seventh day. However, the reduction of the total bacterial count was 67.85 and 59.69%, and the anaerobic bacteria count alone was

70.37 and 60.81% on the third and seventh day, respectively. The main objective of betadine sutures has been to reduce the microbial growth onto the surface of the suture material. To date, this is the first human study of antimicrobial action of betadine suture. Studies in different medical and surgical areas viz., brain surgery, pediatric surgery, cosmetic surgery, and oral surgery have evaluated antibacterial sutures. Probably, in our study, the prescription of CHX oral rinse in the postsurgical period may have masked the effect associated with future use. The presence of bleeding after extraction was similar with both types of sutures. Some experimental studies have reported a reduction in the inflammatory response and less bacterial colonization with standard Monocryl® suture.²⁴ No statistically significant differences were recorded in the level of pain experienced by the patients with the two suture materials. It should be noted that with both the suture material the patients reported tenderness due to the irritation caused by the suture extremities. In contrast, polyglactin 910 with triclosan to result in less pain, though the areas in which this suture material was used were less sensitive in the oral cavity. The present study compared the microorganisms in normal silk suture and silk suture with betadine-impregnated suture materials and its characteristic features and advantages in wound healing.

CONCLUSION

There was a significant effect in a microbial reduction in betadine-impregnated suture on both the third and seventh day. The betadine-impregnated suture has a promising potential in preventing the colonization of pathogens around the extraction area. This study gives data to guide the selection of suture materials for contaminated wounds or wounds at risk for developing an infection. All practitioners while closing wounds should consider the bacterial adherence of suture materials or debriding infected wounds. Hence, betadine-impregnated suture material will reduce postoperative infection. Further studies may be required to see the colony and healing in patients who are diabetic and other immune-compromised diseases.

CLINICAL SIGNIFICANCE

A comparison of microbial colonization was done between normal silk suture and betadine-impregnated suture material, the total colonies of microorganism and antibacterial efficacy as well as to evaluate the wound healing progress in patients.

Patients who were going to undergo orthodontic treatment were recruited for the study. Suturing was done with normal silk suture on the right side and the left side, it was done with betadine-coated suture. A 2-mm end of each suture was removed on the third day and the entire suture was removed on the seventh day and microbial colonization was observed.

There was no notable difference in the degree of infection in both the sutures (silk suture and betadine-impregnated suture). Healing was uneventful but when observed for microbial colonization silk suture material had a significantly higher number of microorganisms in both the third and seventh day, whereas betadine-impregnated suture material had comparatively less microbial count. Statistical analysis shows that there is a reduction in both aerobic and anaerobic microorganisms in betadine-impregnated suture on both the third and seventh day.

It would appear from these experimental studies that the use of silk suture material should be avoided in the wound and while doing

any oral surgeries, having known gross bacterial contamination. The development of wound infection in such infection could best be prevented using betadine-impregnated suture, the type of which would be dictated by clinical circumstances.

ETHICAL APPROVAL

This research has been approved by the ethics committee of the Yenepoya University (YEC-1/288/2019).

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