RESEARCH ARTICLE

Evaluation of Metronidazole and Povidone Iodine Coated *Vs* Non-Coated Sutures Against Specific Periodontal Pathogens: A Comparative Analysis

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ABSTRACT
Sutures are essential after surgery as they allow for tissue re-approximation, stimulate early healing, and regulate bleeding. To avoid postoperative suture related complications like surgical site infection due to wicking effect, various antimicrobial agents have been incorporated into sutures. In this study, black silk suture was scoured for impurities and coated with metronidazole and povidone-iodine for comparison with the uncoated suture. Blood agar plates were prepared and inoculated with putative periodontal pathogens. The three groups of sutures were studied for their action against specific microbe by measuring the zone of inhibition. Based on the statistical analysis, it is established that povidone iodine and metronidazole coated suture have higher antimicrobial efficacy when compared to non-coated suture against anaerobic periodontal pathogens.

Keywords: Sutures, Metronidazole hydrochloride, Povidone iodine, , Drug delivery system, Gram negative bacteria
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INTRODUCTION

Biofilm is a multi-layered structure made up of extracellular polymeric matrixes that house microbial communities. Compared to their planktonic counterparts, the microbial communities within the biofilm exhibit greater resilience to antimicrobial therapy.[1] Sutures are crucial for healing of wounds following surgical intervention and are left at the site for a minimum of five to seven days.[2] Sutures used in periodontal therapy exhibit unique behaviour compared to their counterparts in other body regions due to various factors such as the physiological tissues involved, salivary secretion, high vascularization, and speech, mastication, and swallowing functions.[3] Surgical site infections (SSIs) are associated to wounds following invasive surgical procedures and are a significant contributor to infections related to healthcare. Regardless of the material utilized, microbes are become increasingly resistant to systemic therapies, and their colonization of the suture is a foreseeable consequence.[4] Due to the superior handling qualities, silk suture is acknowledged by many surgeons as the gold standard among natural suture materials.[5] Triclosan, chlorhexidine, and other natural substances like aloe vera, turmeric, neem oil, etc. have all been used to coat the suture materials in periodontal surgeries in an effort to reduce surgical site infections.[6] Metronidazole is a member of the nitroimidazole drug group, which preferentially targets anaerobes without interfering with commensal aerobic flora. Resistance to this class of medication is extremely uncommon.[3] Povidone iodine's broad spectrum antibacterial action, biofilm penetration capacity, lack of resistance, anti-inflammatory qualities, and low cytotoxicity have all been mentioned as significant factors, and nil adverse effects on wound healing have been evident in clinical practice.We have designed this invitro study to evaluate the antimicrobial efficacy of non-coated sutures and those coated with metronidazole and povidone iodine by assessing the zone of inhibition against periodontal putative pathogens.

MATERIALS AND METHODS

This invitro study was authorised by the institutional ethics committee (CSP/23/JUL/131/600).

Three different types of suture materials were utilized in this study to compare the antimicrobial efficacy . In periodontal therapy, braided black silk is the most often utilized suture material. So, we decided to coat braided black silk with povidone iodine and metronidazole in order to compare the efficacy with non-coated suture. In this study we categorised BBS coated with povidone iodine as Group A , BBS coated with metronidazole as Group B and the non-coated BBS suture as control group C.

Preparation of Antibacterial Coated Suture

Scouring of suture

The pretreatment and antibacterial coating of sutures was done according to Shanmugasundaram et al.[7] Following a half-hour immersion in 1% sodium hydroxide, braided black silk suture (4-0) was rinsed with distilled water. This pretreatment process of removing the natural and added impurities to improve the absorbency is termed ‘scouring of the suture’.[8]

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Preparation of metronidazole and povidone iodine coated suture

4g chitosan was agitated with 2% aqueous acetic acid solution for 1hr at 60°C to prepare the chitosan solution. The prepared chitosan solution was added with 10g of sodium alginate polymer and continuously stirred for 10mins. For approximately two hours, the scoured suture material was immersed in this solution and later, the material was dried for five minutes at 80°C.[8]

For group A and B polymer coated suture was immersed in povidone iodine and metronidazole solution separately for 24hrs and then dried at room temperature for another 24hrs.(Figure1) The coated sutures group A and B, and group C were cut into equal lengths of 4cm.

Determination of Microbiological Parameters

Agar diffusion test was used to evaluate the microbiological efficacy. The agar plates are incubated with 5 putative periodontal pathogens- Fusobacterium nucleatum, Porphyromonas gingivalis, Aggregatibacter actinomycetemcomitans, Prevotella intermedia, Tanerella forsythia.

The culture media employed was blood agar at room temperature. After preparing the inoculum, the colonies were moved to the agar plates using a loop. Using broth, the inoculum's turbidity was visually adjusted to match a 0.5 McFarland turbidity standard.

The excess was removed after 15 minutes by rotating a sterile cotton swab soaked in the inoculum against the tube wall above the liquid. The agar plate was rotated around 60 degrees in between streaking to guarantee uniform distribution, and then the entire surface was swabbed three times. The inoculated plate was left to stand for at least three minutes but no more than fifteen minutes before wells were prepared, and it is crucial to avoid colliding into the petriplate's sides. To make the stock solution, 10 mg of the chemical was dissolved in 1 milliliter of DMSO. The substance was regularly added to the agar plate, and it was incubated for 15 minutes. They were maintained in the incubator at 37°C for 18 to 24 hours. Only when the lawn

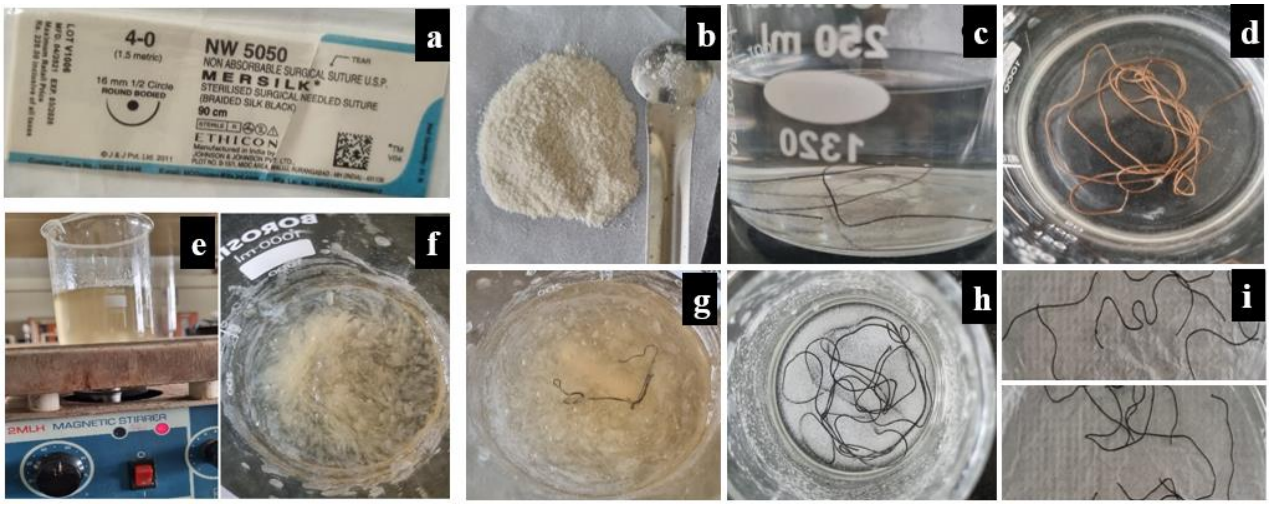

Figure 1 : Procedure for preparation of povidone iodine coated and metronidazole coated sutures. (a) Mersilk (4-0) (b)1% sodium hydroxide (c) Suture placed in 1% NaOH (d) Scoured suture (e) Chitosan alginate solution placed on a stirrer (f) Prepared chitosan-alginate solution (g) Sutures immersed in chitosan-alginate solution (h) Suture placement in metronidazole and povidone iodine coated sutures (i) Povidone iodine and metronidazole coated suture sample.

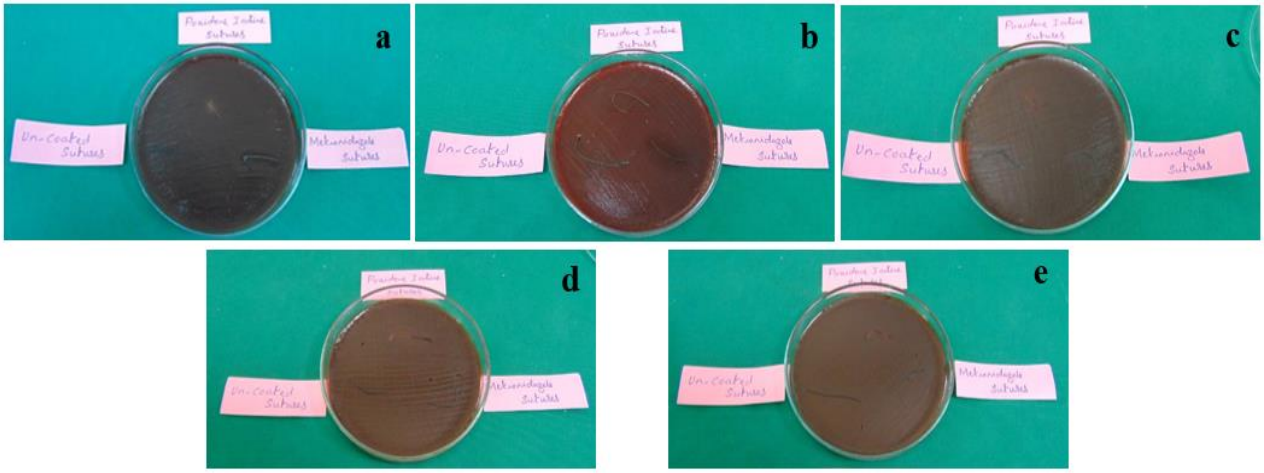

Figure 2: Zone of inhibition around uncoated, metronidazole and povidone iodine coated sutures against various periodontal pathogens (a) Fusobacterium nucleatum (b) Aggregatibacter actinomycetemcomitans (c) Tanerella forsythia (d) Porphyromonas gingivalis (e) Prevotella intermedia

Table 1: Intergroup comparison of metronidazole, povidone iodine coated and non-coated sutures against various periodontal pathogens

Pathogens	Dependent Variable		Mean Difference	Std. Error	p-value
A. actinomycetemcomitans	Povidone iodine coated	Metronidazole coated	-20.00000*	5.35413	.017
		Uncoated	0.00000	5.35413	1.000
	Metronidazole coated	Uncoated	20.00000*	5.35413	.017
F. nucleatum	Povidone iodine coated	Metronidazole coated	-11.00000	6.12826	.368
		Uncoated	4.00000	6.12826	1.000
	Metronidazole coated	Uncoated	15.00000	6.12826	.150
P. gingivalis	Povidone iodine coated	Metronidazole coated	8.00000*	2.05480	.017
		Uncoated	8.00000*	2.05480	.017
	Metronidazole coated	Uncoated	0.00000	2.05480	1.000
P. intermedia	Povidone iodine coated	Metronidazole coated	6.00000*	.47140	.017
		Uncoated	6.00000*	.47140	.017
	Metronidazole coated	Uncoated	0.00000	.47140	1.000
T. forsythia	Povidone iodine coated	Metronidazole coated	5.00000*	.47140	.017
		Uncoated	5.00000*	.47140	.017
	Metronidazole coated	Uncoated	0.00000	.47140	1.000

of growth was confluent or almost confluent, the plates were read. Three agar plates were used for the individual placement of the sutures coated with metronidazole, coated with povidone iodine, and uncoated. There was a disc diffusion test. Using a measuring equipment, the zone of inhibition was measured to the closest whole millimeter. A single examiner performed all of the measures.

The tests were repeated thrice for each of the coated and non-coated sutures to enhance the reliability of the results and to rule out the possible errors and inconsistencies.

Statistical Analysis

Data gathered was statistically analyzed, and descriptive statistics like mean and standard deviation were calculated. Non-parametric tests have been used for intergroup comparison as the gathered data did not follow a normal curve. Intergroup comparison of zone of inhibition (three groups) was done using Kruskal Wallis test (Table1) succeeded by pairwise comparison using post-hoc Dunn test (Table2). For all the statistical tests, p-value < 0.05 and $p < 0.01$ were considered to be statistically significant and statistically highly significant respectively**.**

RESULTS

The zone of inhibition surrounding each coated and uncoated suture against the culture of A.actinomycetumcomitans, F.nucleatum, P.gingivalis, P.intermedia, T.forsythia were measured in this study. The mean zone of inhibition for metronidazole coated suture against the A.actinomycetumcomitans was found to be 20±11.35mm whereas povidone iodine coated suture and uncoated suture showed resistance. Incase of F.nucleatum, the mean zone of inhibition for metronidazole coated suture was found to be 15±13.00mm whereas for povidone iodine coated suture showed 4mm and uncoated suture showed resistance. The mean zone of inhibition for povidone iodine coated suture against the P.gingivalis, P.intermedia and T.forsythia was found to be 8±4.35mm, 6±1mm and 5±1mm respectively whereas metronidazole coated and uncoated suture showed resistance. The brief of the comparative analysis is given in the table 3.

DISCUSSION

A plethora of microorganisms inhabit our oral cavity. Sutures used for various dental procedures are constantly bathed in saliva. The criteria for suture usage in dental surgical procedures include knot stability, minimal tissue trauma, tensile strength, biocompatibility and low adhesion of microorganisms. Bacterial adhesion and biofilm formation are tend to be seen on sutures, grafts, membranes, implants, and dental prostheses.[9] Earlier studies examined the host's tissue inflammation in order to determine how a suture might affect the host environment. In most cases, the investigations revealed that braided sutures caused more inflammation than monofilament sutures.[10] This is due to the capillary action and wicking effect of the multifilament suture. According to Bhardwaj et al.,the bacterial adherence of multifilament silk suture and monofilament PTFE suture did not differ statistically significantly.[11] Natural material, silk is the commonly used suture material for periodontal flap surgical procedures. The braided silk thread represents a group of natural and non-absorbable sutures. It is indicated as first choice of material due to its low inflammatory response (compared to other natural threads), knot strength, relatively low cost, comfort and ease of use.[12]

Eventhough the multifilamentous nature of suture plays an important role in adherence of microorganisms, characteristics such as the type of material and diameter of suture are indispensable. Therefore in our study, we have used the multifilament silk suture of same diameter(4-0) and length(4cm) for comparison. Earlier studies showed that antimicrobial sutures demonstrated superior bacteriostatic and bactericidal activities against non-coated

Table 2 : Post-hoc Dunn test for comparing multiple pairs of mean after Kruskal Wallis test

Pathogens	pair	No.	Mean	Standard Deviation	p-value
A. actinomycetemcomitans	Povidone iodine coated	3	0.0000	0.00000	.022*
	Metronidazole coated	3	20.0000	11.35782	
	Uncoated	3	0.0000	0.00000	
	Total	9	6.6667	11.50000	
F. nucleatum	Povidone iodine coated	3	4.0000	0.00000	.116
	Metronidazole coated	3	15.0000	13.00000	
	Uncoated	3	0.0000	0.00000	
	Total	9	6.3333	9.35414	
P. gingivalis	Povidone iodine coated	3	8.0000	4.35890	.022*
	Metronidazole coated	3	0.0000	0.00000	
	Uncoated	3	0.0000	0.00000	
	Total	9	2.6667	4.55522	
P. intermedia	Povidone iodine coated	3	6.0000	1.00000	.022*
	Metronidazole coated	3	0.0000	0.00000	
	Uncoated	3	0.0000	0.00000	
	Total	9	2.0000	3.04138	
T. forsythia	Povidone iodine coated	3	5.0000	1.00000	.022*
	Metronidazole coated	3	0.0000	0.00000	
	Uncoated	3	0.0000	0.00000	
	Total	9	1.6667	2.54951	

sutures.[1] Both the metronidazole-coated and povidone-iodine-coated sutures in the current study demonstrated a considerable zone of inhibition; nevertheless, there was a statistically significant difference between the two sutures, with the non-coated suture showing the lowest zone of inhibition for F. nucleatum species. Chitosan, an polycationic compound has added advantages of wound healing, haemostasis, anti-microbial, and anti-inflammatory actions.[13] In a similar study, Lubna et al compared betadiene coated suture and non-coated silk suture, where he concluded that povidone iodine coated sutures yielded lowest counts of aerobic and anaerobic microorganisms.[14] Likewise in our study, there was a significant increase in the zone of inhibition against Porphyromonas gingivalis, Aggregatibacter actinomycetemcomitans, Prevotella intermedia, and Tanerella forsythia. The nitro group in metronidazole is lowered in a periodontally affected niche when oxygen tension is low. This causes non-specific binding to the bacterial DNA, thereby causing destruction.[15] Correspondingly, the local action of the metronidazole being coated on sutures was demonstrated via the measurement of zone of inhibition that showed a significant difference against Aggregatibacter actinomycetemcomitans. The efficiency of sutures coated with metronidazole and povidone iodine in comparison to uncoated sutures, to best of our knowledge, has not been assessed in any vitro trial.

Table 3: Summary of the comparative analysis

Microorganisms	Group A	Group B	Group C
A.actinomycetemcomitans	-	+	-
P.gingivalis	+	-	-
T.forsythia	+	-	-
P.intermedia	+	-	-
F.nucleatum	+	+	-

However, this study has a few limitations, including the need to evaluate the various parameters such as tissue interactions and wound healing effects. The physical characteristics of the novel antimicrobial coated sutures, including tensional strength, knot stability and sustained drug release rate should also be evaluated. Another notable limitation is that saliva and GCF can be used as the medium to check the efficacy of povidone iodine coated and metronidazole coated sutures at specific sites. Future research is needed in this particular field to conduct large-scale invivo clinical trials and further widen the awareness of the necessity of using various antimicrobial-coated sutures to protect the operative site postoperatively with negligible complications.

CONCLUSION

The current research demonstrates that sutures coated with povidone iodine and metronidazole are more effective at combating anaerobic periodontal microorganisms and can be used as a substitute for sutures that are uncoated. However, larger clinical trials are required for future commercial use of the novel-coated sutures.

REFERENCES

1. Chua RAHW, Lim SK, Chee CF, et al. Surgical site infection and development of antimicrobial sutures: A review. *Eur Rev Med Pharmacol Sci*. 2022;26(3):828-845. doi:10.26355/eurrev_202202_27991
2. Karde PA, Sethi KS, Mahale SA, Mamajiwala AS, Kale AM, Joshi CP. Comparative evaluation of two antibacterial-coated resorbable sutures versus noncoated resorbable sutures in periodontal flap surgery: A clinico-microbiological study. *J Indian Soc Periodontol*. 2019;23(3):220-225. doi:10.4103/jisp.jisp_524_18
3. Banche G, Roana J, Mandras N, et al. Microbial adherence on various intraoral suture materials in patients undergoing dental surgery. *J Oral Maxillofac Surg*. 2007;65(8):1503-1507. doi:10.1016/j.joms.2006.10.066
4. Mirghani R, Saba T, Khaliq H, et al. Biofilms: Formation, drug resistance and alternatives to conventional approaches. *AIMS Microbiol*. 2022;8(3):239-277. doi:10.3934/microbiol.2022019
5. Faris A, Khalid L, Hashim M, et al. Characteristics of suture materials used in oral surgery: Systematic review. *Int Dent J*. 2022;72(3):278-287. doi:10.1016/j.identj.2022.02.005
6. Masood R, Hussain T, Umar M, Azeemullah AT, Areeb T, Riaz S. In situ development and application of natural coatings on non-absorbable sutures to reduce incision site infections. *J Wound Care*. 2017;26(3):115-120. doi:10.12968/jowc.2017.26.3.115
7. Shanmugasundaram OL, Gowda RM, Saravanan D. Drug release and antimicrobial studies on polylactic acid suture. *Int J Biotechnol Mol Biol Res*. 2011;2:80-89. doi:10.5897/IJBMBR.9000013
8. Banodkar AB, Nandgaonkar VP, Gaikwad RP, Fernandes LC, Patil CL, Batho AD. Comparative evaluation of the efficacy of a novel tetracycline-coated suture with triclosan-coated and noncoated sutures on bacterial load reduction: A prospective *in vitro* study. *J Indian Soc Periodontol*. 2022;26(6):539-543. doi:10.4103/jisp.jisp_453_21
9. Otten JE, Wiedmann-Al-Ahmad M, Jahnke H, Pelz K. Bacterial colonization on different suture materials--A potential risk for intraoral dentoalveolar surgery. *J Biomed Mater Res B Appl Biomater*. 2005;74(1):627-635. doi:10.1002/jbm.b.30250
10. Masini BD, Stinner DJ, Waterman SM, Wenke JC. Bacterial adherence to suture materials. *J Surg Educ*. 2011;68(2):101-104. doi:10.1016/j.jsurg.2010.09.015
11. Tanisha Bharara N. Comparative Evaluation of Microbial accumulation of Periodontal Pathogens on polytetrafluoroethylene suture (PTFE) & Silk suture following Periodontal Surgery. *Annals of RSCB* [Internet]. 2021Jun.23 [cited 2024Nov.24];25(6);13241-. Available from: http://www.annalsofrscb.ro/index.php/journal/article/view/8112
12. de Castro Costa Neto O, Lobo LA, Iorio NLP et al. Oral bacteria adherence to suture threads: An in vitro study. *Oral Maxillofac Surg*. 2015;19(3):275-280. doi:10.1007/s10006-015-0487-4
13. Yilmaz Atay H. Antibacterial activity of chitosan-based systems *Functional Chitosan*. 2020;457-489. doi:10.1007/978-981-15-0263-7_15
14. 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. doi:10.5005/jp-journals-10015-1790
15. Serbanescu MA, Oveisi M, Sun C, Fine N, Bosy A, Glogauer M. Metronidazole enhances killing of *Porphyromonas gingivalis* by human PMNs. *Front Oral Health*. 2022;3:933997. doi:10.3389/froh.2022.933997