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Research

Evaluating the Efficacy and Comparison of Pre-Soaked Suture Material in Various Antibiotics: A Randomized Control Trial

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Abstract:
The present study evaluates and compares the efficacy of different antibiotic pre-soaked sutures in reducing oral microbiome. The patients who indicated for routine dental extraction and require simple interrupted suturing were the study subject. 3-0 black braided silk suture is pre-soaked in the three different antibiotic preparation. The total of 40 patients were divided into four groups which allocated randomly. Group A- Extraction site suturing with Metronidazole pre-soaked suture (experimental group). Group B- Extraction site suturing with black braided silk suture (control group). Group C- Extraction site suturing with Doxycycline pre-soaked suture (experimental group). Group D- Extraction site suturing with cefixime pre-soaked suture (experimental suture). On seventh day, the suture was removed aseptically for microbial analysis of colony-forming units per millilitre (CFU/mL). The comparison of $\log_{10}$ CFU/mL done among the four groups. The detailed comparison of CFU/ml between groups. Although Group B conventional multifilament silk sutures showed the highest median log CFU (8.18), followed by Groups C and D (6.23), and Group A metronidazole pre-soaked sutures showed a comparatively lower median (5.32), these differences were not statistically significant. The present study concluded that metronidazole pre-soaked group shows highest reduction in microbial colony and but not statistically significant.

Keywords: Antibiotic pre-soaked sutures; metronidazole; doxycycline; cefixime; colony forming unit.

INTRODUCTION

The oral cavity hosts a diverse microbiome, which are referred to as microflora.(1) A mutually beneficial relationship exists between the microflora and the oral cavity. The Commensals benefit from oral cavity without harming the environment while preventing the pathogenic species from harming the mucosa. When the equilibrium breaks, the bacteria become pathogenic which causes disease.(2) Socket healing is crucial after tooth extraction.(3) Wound healing in the oral cavity is completely different from general wound healing which is influenced by functional movement of oral tissue and colonization of oral microbiome which leads high chance of wound infection.(4) Healing of extraction site is influenced by soft tissue handling while extraction of tooth, proper adaptation of tissue edges, selecting proper suture material and suturing technique, tissue

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response and bacterial colonization while wound healing differs based on the type of suture material used for wound closure.(4)Types of suture material include natural or synthetic, absorbable or non-absorbable, coated or non-coated, monofilament or multifilament.(5,6) Among these multifilament suture favours the growth of bacterial colonies than monofilament suture, despite having good suture stability.(7) Body's immunity is adequate for these bacterial colonies but in certain instances like immunocompromised patients these colonies can cause surgical site infection.(8) It is important to understand the risk factors for implementing effective preventive measures to attain uneventful healing of wound.(9) In an effort to minimize bacterial colonization on suture surfaces. Commercially triclosan-coated sutures represent one such innovation; however, evidence regarding their efficacy shows adequate antimicrobial activity to prevent in-vitro colonization by oral microbiome.(10) Furthermore, the high cost and limited availability of commercially manufactured antibacterial sutures restrict their routine use in many clinical settings. Consequently, the practice of pre-soaking sutures in readily available antibiotic has gained attention as a practical, low cost and customizable alternative. This approach offers the advantage of utilizing familiar antibiotic agents with well-established safety profile. However, systematic in-vitro evaluation is required to determine the antimicrobial effectiveness of such antibiotic pre-soaked suture materials and to guide their clinical translation.(11–13) The present study aims to evaluate and compare the antimicrobial efficacy of sutures pre-soaked in metronidazole, cefixime, and doxycycline – three commonly used different class of antibiotics with distinct antimicrobial spectra – against microbial colonization relevant to oral surgical wounds. The findings of this study may provide insights into affordable and adaptable strategies for reducing suture related surgical site infections in oral surgical practice.

MATERIALS AND METHODS

In our clinical trial study, we included 40 consented healthy individuals of age group of 18-70 years who were indicated to undergo extraction under Local anaesthesia. The patients were divided into four groups for the study, each consisting of 10 Patients. (Fig 1)

1) **Group A**: Individuals who were given antibiotic metronidazole 0.5% (200mg/40ml) pre-soaked 3.0'Black braided silk in a simple interrupted fashion without any antibiotics.
2) **Group B**: Individuals included without any pre-soaked 3.0'Black braided silk in a simple interrupted fashion with postoperative oral prophylactic antibiotic amoxicillin 500mg thrice a day.
3) **Group C**: Individuals who were given antibiotic Doxycycline(100mg/100mg) pre-soaked 3.0'Black braided silk in a simple interrupted fashion without any antibiotics.
4) **Group D**: Individuals who were given antibiotic cefixime (200mg/100ml) pre-soaked 3.0'Black braided silk in a simple interrupted fashion without any antibiotics.

Antibiotic suture preparation:

Preparing antibiotic solution by diluting each antibiotic in laboratory distilled water in aseptic condition to achieve equivalent microbial activity.(13)

- Metronidazole: 0.5% w/v (200 mg/ 40 ml)
- Cefixime: 200mg/100ml
- Doxycycline: 100mg/100ml

Sterile 3.0'Black braided silk suture was then soaked in the prepared antibiotic solution up to 1 hour before suturing the extraction site in simple interrupted fashion. (Fig 2)

Inclusion criteria:

- Healthy Patients aged 18 to 70 years.
- Patients indicated for routine dental extraction.

Exclusion criteria:

- Patients on drugs that affect the healing of surgical site e.g. Aspirin, NSAIDS, Steroids and cytotoxic drugs.
- Patients who have taken any antibiotics 2-3 weeks before the extraction.
- Patients with known allergic to metronidazole, cefixime and Doxycycline.
- Patient with systemic conditions like diabetes mellitus, Immunocompromised conditions.
- Extraction indicated due to periapical pathology.
- Patient with oral infection and with deleterious habits.

- Patient not consented for the study.
- Patient lost to follow up.
- Pregnancy and lactating mother or oral contraceptives.
- Patients under radiotherapy or chemotherapy.

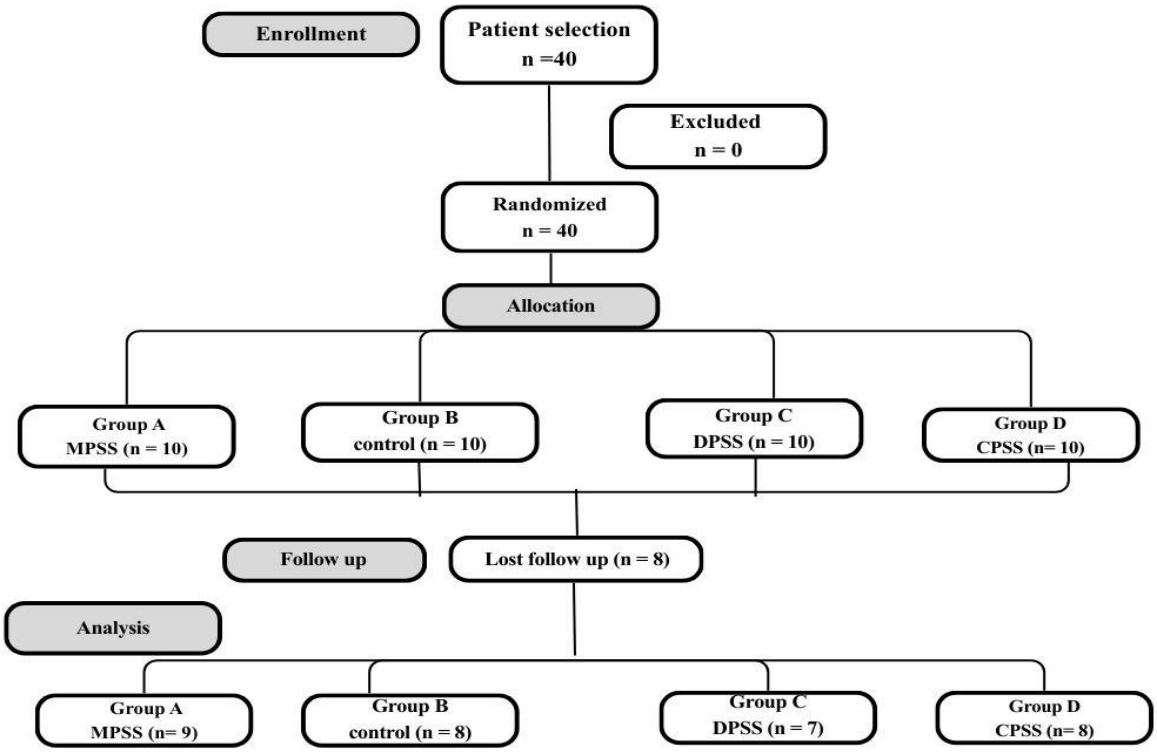

Figure 1: Consort flowchart. n- no. of patients, MPSS- Metronidazole pre-soaked sutures, DPSS- Doxycycline pre-soaked sutures, CPSS- Cefixime pre-soaked sutures.

Study procedure:

The Present study was designed as a single blinded Randomized clinico-microbiological study to evaluate and compare the antimicrobial efficacy of sutures pre-soaked in three different antibiotic preparation formulated to achieve equivalent antimicrobial activity in comparison with conventional sutures.

The study was conducted in the Department of oral and Maxillofacial surgery at Tagore dental college and hospital in collaboration with orange labs of Saveetha Institute of medical and technical science for microbiological assessment, following approval from Institution Ethical committee (IEC: IEC/TDCH/84/2025). The trial was registered prior to participant enrolment (CTRI register number: CTRI/2025/11/097229).

Patients requiring routine dental extraction were selected based on the inclusion and exclusion criteria following atraumatic tooth extraction under aseptic conditions, wound closure was performed using the allocated antibiotic pre-soaked 3.0'Black braided silk suture. These sutures were left in situ for 7 days. On the seventh postoperative day, the sutures were aseptically removed without contamination from adjacent tissues and immediately transferred into sterile Brain-Heart infusion broth tubes for microbiological analysis of colony forming unit.

Microbiological assessment:

Colony forming unit:

Suture materials were aseptically collected from patients. Each sample was promptly inoculated into sterile Brain Heart Infusion (BHI) broth and incubated to facilitate microbial recovery. Following incubation, aliquots were uniformly spread (lawn culture technique) onto Brain Heart Infusion (BHI) agar plates under sterile conditions. The inoculated plates were incubated aerobically at 37 °C for 24 hours. After the incubation period, visible colonies were enumerated manually. The microbial load was

calculated and expressed as colony-forming units per millilitre (CFU/mL). (Fig.3i, 3ii, 3iii, 3iv)

Statistical analysis:

Data were analysed using the statistical package SPSS software and the level of significance was set at $p < 0.05$. Descriptive statistics was performed to assess the mean and standard deviation of the respective groups. Normality of the data was assessed using Shapiro–Wilkinson test. Analysis between three groups was done using Kruskal–Wallis, followed by post-hoc pairwise comparisons using Dunn's test with Bonferroni adjustment revealed no statistically significant differences between four study groups (all adjusted $p > 0.05$).

RESULTS AND DISCUSSION:

A total of 40 patients with 8 drop out were included in the study and randomly divided into four groups. The data were assessed for normality prior to statistical analysis using Shapiro–Wilk test. The results indicated that the distribution of values significantly deviated from normality ($p < 0.05$), showed noticeable skewness in data. The assumption of normality was not met, and non-parametric statistical tests were considered for analysis. The comparison of $\log_{10}$ CFU/mL among the four groups demonstrated no statistically significant difference (Kruskal Wallis test, $p = 0.29$). The detailed comparison of CFU/ml between groups are presented in Table 1 and Fig.4. Although Group B conventional multifilament silk sutures showed the highest median log CFU (8.18), followed by Groups C and D (6.23), and Group A metronidazole pre-soaked sutures showed a comparatively lower median (5.32), these differences were not statistically significant. Post-hoc pairwise comparisons using Dunn's test with Bonferroni adjustment revealed no statistically significant differences between any of the study groups (all adjusted $p > 0.05$). Although Group B demonstrated higher median log CFU values compared to Group A, this 7difference did not reach statistical significance ($p = 0.52$) (Table 2)

Dental extraction is a routinely performed minor surgical procedure; however, it involves deliberate distribution of oral mucosal barrier, exposing underlying tissues (14) and creation of a wound environment that is highly susceptible to microbial contamination. The oral cavity harbours a defence and diverse microbial ecosystem, and following extraction, the surgical site is immediately exposed to saliva, blood and food debris. The tissues trauma and microbial challenge causes extraction wounds at risk of delayed healing and postoperative infection.(3) Normal healthy wound healing progresses through well-coordinated phases of haemostasis, inflammation, proliferation and remodelling.(15) Bacterial contamination, especially during the early inflammatory phase can prolong inflammation and impair subsequent healing events.[18] The oral microbiota was predominantly distributed among four major phyla: Bacteroidetes, Firmicutes, Fusobacteria and proteobacteria.(1) The study of microorganism which highly seen in healthy wound and dry socket shows that fusobacteria were significantly high in dry socket cases. Functional analysis revealed an increased prevalence of anaerobic associated metabolic pathways in dry socket when compared with healthy controls.(1)At the extraction site, genera such as prevotella and fusobacteria where more abundant surgical site infection predominantly involve anaerobic and facultative anaerobic organism.(1) Reduced oxygen tension within extraction sockets further favours the growth of obligate anaerobes, making effective local microbial control an essential component of postoperative care.(1,16) Suture materials, while indispensable for wound approximation and stabilization, may inadvertently contribute to microbial persistence at the surgical site.(17) Types of suture material include natural or synthetic, absorbable or non-absorbable, coated or non-coated, monofilament or multifilament.(18) Among these multifilament suture favours the growth of bacterial colonies than monofilament suture, despite having good handling characteristics and knot security.(19) The multifilament architecture of black braided silk shows patchy biofilm growth in the braided groove between the filaments, which can act as a continuous source of contamination at the wound margin.(20) Numerous comparative studies on microbial adherence in suture materials concluded that higher amount of adherence seen in Multifilament Sutures than Monofilament sutures.(21–24) After suturing, loop of the sutures embedded in the tissues and ears of suture bathed in saliva, shows mean concentration of approximately 7.5×10^8 microorganism/ml.(25) Various studies conducted to minimize microbial colonization on suture surface which leads to the novel strategy of antimicrobial coated sutures and this shows a decrease in the number of microorganisms adhered to the surface of

suture.(9,25,26) Soumya et al. study of In-vitro comparison of triclosan coated suture with non-coated suture pseudomonas aeruginosa was resistant to both (27) and the similar study of Leaper D et al., concluded Pseudomonas Aeruginosa revealed innate resistance to triclosan because of its multidrug efflux pumps in that bacterial cell which removes triclosan. (28) Karde et al. reported that concentration of aerobic and anaerobic bacteria was significantly reduced in triclosan coated suture than chlorhexidine coated suture but in non-coated suture the concentration of bacteria was high.(26) Lubna layeequa et al. study of comparison between betadine impregnated sutures with silk suture material shows substantial reductions in bacterial adherence and healing was uneventful on both suture material.(12) The present study employed the antibiotic of three different class that has various range of action against gram-positive and gram-negative bacteria and also due to its affordability and accessibility. The use of medicines should ensure safe, effective and economical for patient health care. Metronidazole, a Nitroimidazole derivative, it is one of the most widely prescribed antimicrobial agents due to its activity against anaerobic bacteria and protozoa which is bactericidal by damaging the DNA of bacteria.(29) Cefixime, a 3rd generation cephalosporin which is bactericidal by inhibiting synthesis of cell wall through its penicillin binding protein and antimicrobial action mainly against streptococci, Staphylococcus Aureus and especially beta lactamases producing bacteria.(30) Doxycycline, a second-generation tetracycline which has mechanism of action that inhibiting the bacterial protein synthesis, thereby suppressing the bacterial growth causing bacteriostatic action shows antimicrobial action against Gonorrhoea, Haemophilus, Staphylococcus Aureus, Fusobacterium.(31) In this study, we evaluated the colony forming unit associated with three different class of pre-soaked sutures and conventional multifilament sutures. However antibiotic pre-soaked sutures show a reduction in bacterial colonization, the difference was not statistically significant. This may be influenced by factors such as variation in oral microflora, Sample collection, handling and the quantity of microbial load retrieved from the sutures. Therefore, antibiotic pre-soaked sutures may have potential benefits, the results of the present study do not demonstrate a statistically significant advantage over conventional sutures.

Figure 2: Materials used - Metronidazole 400mg, Doxycycline 100mg, cefixime 200mg, sterile distilled water and Ethicon 3'0 black braided silk suture.

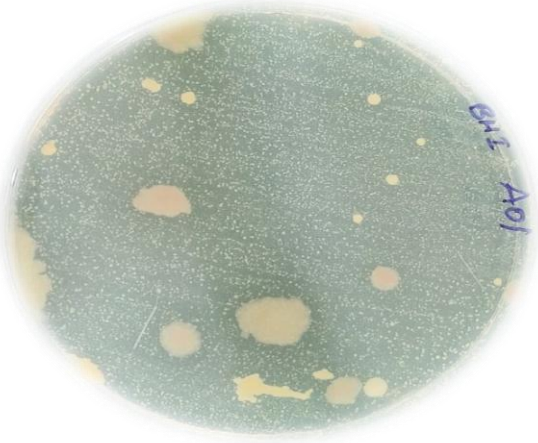

Figure 3(i): Colony forming unit of Sample AO1 of Group A which is metronidazole shows 2.069×10^5 CFU/ml

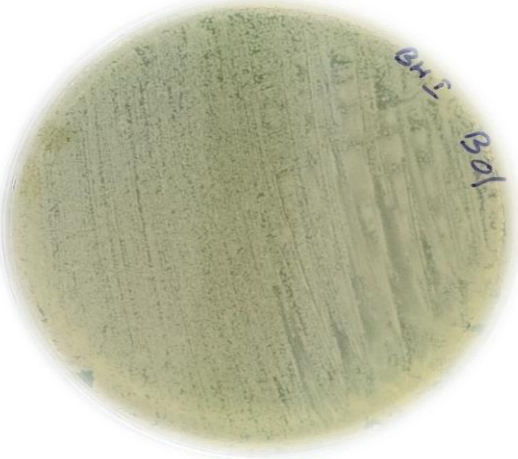

Figure 3(ii): Colony forming unit of Sample BO1 of Group B which is Control group shows Pseudomembranous growth

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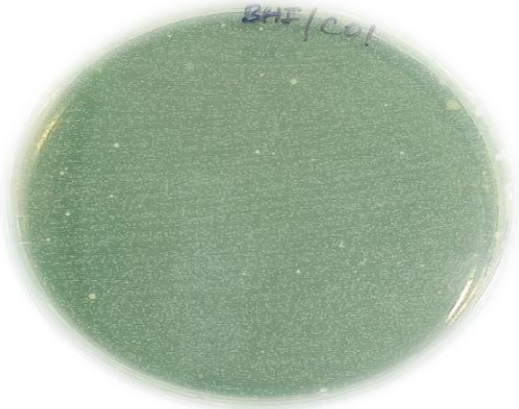

Figure 3 (iii): Colony forming unit of Sample CO1 of Group C which is Doxycycline group shows 1.5×10^{8} CFU/ml

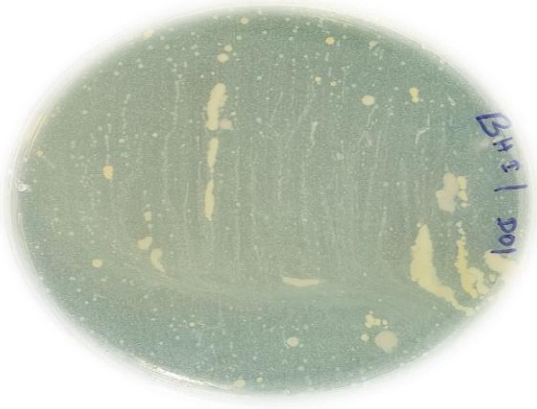

Figure 3 (iv): Colony forming unit of Sample DO1 of Group D which is Cefixime group shows 1.5×108 CFU/m

***Table 1** : Comparison of Log_{10} CFU/mL Among Study Groups Using the Kruskal–Wallis Test (p-value <0.05 shows statistically significant)*

Group	Log Mean ± SD	Median (IQR)	p-value
Group A	4.89 ± 3.95	5.32 (0 – 8.18)	0.29
Group B	7.18 ± 1.96	8.18 (8.18 – 8.18)	
Group C	6.05 ± 2.47	6.23 (4.26 – 8.18)	
Group D	5.88 ± 2.68	6.23 (3.63 – 8.18)	

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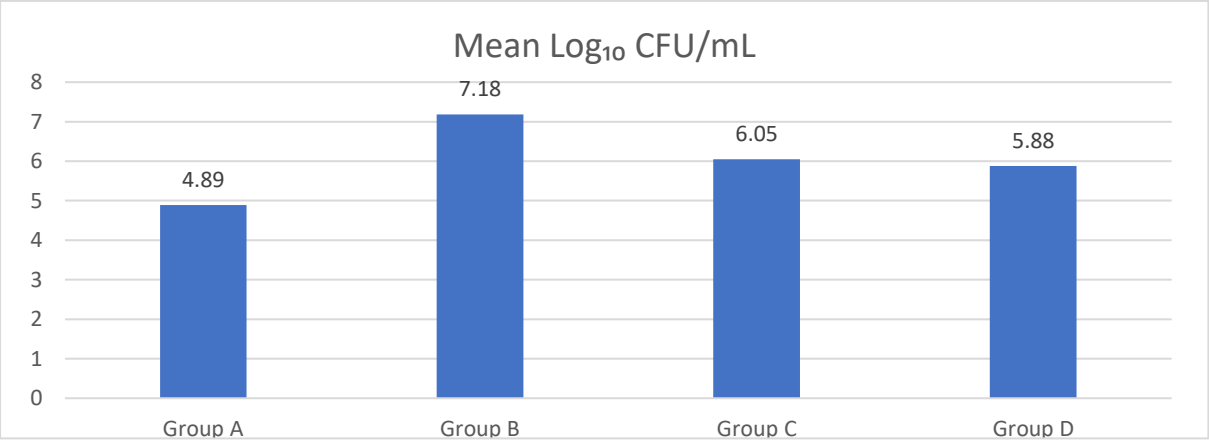

Figure 4: The graph illustrates the mean log_{10} CFU/mL values for four different groups. Among them, Group B recorded the highest mean microbial load (7.18 log_{10} CFU/mL), indicating substantially greater bacterial growth compared to the other groups. Group C (6.05 log_{10} CFU/mL) and Group D (5.88 log_{10} CFU/mL) showed moderate counts, with Group C slightly higher than Group D. In contrast, Group A exhibited the lowest mean value (4.89 log_{10} CFU/mL), suggesting comparatively reduced bacterial presence.

Table 2: Dunn's Test with Bonferroni**.** Pairwise Comparison of Log_{10} CFU/mL Between groups revealed no statistically significant differences between any of the study groups (all adjusted $p > 0.05$). Although Group B demonstrated higher median log CFU values compared to Group A, this 7difference did not reach statistical significance ($p = 0.52$)

Comparison	Z value	Adjusted p-value
A vs B	−1.72	0.52
A vs C	−0.84	1
A vs D	−0.73	1
B vs C	0.96	1
B vs D	1.14	1
C vs D	0.18	1

CONCLUSION:

There was no statistically significant reduction in the microbial colonization in antibiotic pre-soaked black braided silk sutures compared with conventional suture without any antibiotic pre-soaked on seventh day. The metronidazole pre-soaked group show highest reduction of microbial colony among the other group. All dentist while closing extraction site should consider about bacterial adherence of suture materials and the reaction of tissue to the microbial accumulation. Further studies should focus on improved and standardized methods of isolated sample collection without any adjacent oral mucosal contamination and ensure uniform microbial recovery from sutures to improve the accuracy and consistency of bacterial quantification.

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CONFLICT OF INTEREST:

No conflict of interest.

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