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Research Article

Effect of 0.12% Versus 0.2% Concentrations of Chlorhexidine Mouthwashes on the Mechanical Properties of Synthetic Absorbable Suture Material (Polyglactin 910): An *In-Vitro* Study

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Abstract

Background: Sutures play a pivotal role in promoting healing in any surgical procedure. Reports suggest that antiseptic solutions have a direct impact on the failure load of sutures.

Objective: To evaluate the tensile strength, percentage elongation, and stiffness of polyglactin 910 suture material in two concentrations of chlorhexidine (CHX) i.e. 0.12% and 0.2% during a two-week period and to provide a data for better selection of chlorhexidine concentration.

Methodology: A total of 70 suture samples with a uniform length of 18cms were evaluated. At baseline (unstimulated environment), 10 sutures were tested. At day 7 and day 14, 10 samples in each group were tested; group 1: artificial saliva (stimulated environment), group 2: 0.12% chlorhexidine, group 3: 0.2% chlorhexidine. The mechanical properties were calculated using a universal testing machine (5KN, speed of 10mm/minute).

Results: Polyglactin 910 suture material showed maximum tensile strength in artificial saliva at day 7 (p= 0.005) and day 14. When comparing the two concentrations, 0.12% CHX showed better tensile strength at day 7 (p= <0.001) and day 14 (p= <0.001) post- immersion. 0.12% CHX showed better percentage elongation (p=<0.001) at day 7 and better stiffness (p=0.001) at day 14 while 0.2% CHX showed least stiffness (p=1.00) and better percentage elongation (p=0.14) at day 14 post-immersion.

Conclusion: The study suggests that both the concentrations of CHX mouthwash can be used safely with polyglactin 910 suture materials. Additional in-vivo experiments are required in order to understand the molecular changes of sutures when exposed to different chemical compositions of mouthwashes.

Keywords: Suture; Mouthwash; Chlorhexidine; Polyglactin 910

Introduction

A suture is a biomaterial device, either natural or synthetic, used to ligate blood vessels and approximate tissues together [1]. To eliminate dead space, evenly distribute tension along deep suture lines, and maintain tensile strength throughout the wound until tissue tensile strength is adequate are the objectives of wound closure [2].

In dentistry, suture-induced wound healing is more challenging than other parts of the body because of factors related to saliva, the quality of the tissue involved, high levels of vascularization and the dynamics of speech, mastication, and swallowing. The literature has assessed various types of suture materials for use in the oral cavity and the execution of surgical dental procedures requires a thorough understanding of these suturing materials and techniques [3].

The ideal suture material must possess a number of specific properties, including sufficient tensile strength, ability to elongate with tissue edema, biocompatibility, ease of use, good knot holding capacity, and the ability to degrade when used in internal wound closures. Clinically, inflammation of the surgical flaps dur-

ing wound healing may exert a certain degree of tension on wound edges and cause subsequent bridging of flap margins. Therefore, it is crucial to preserve the approximate wound edges using sutures with a suitable level of tensile strength and little tissue reactivity [4]. Suture materials with inadequate mechanical strength could rupture, leading to inadequate adaptation of the margins, hematoma, and deterioration of the affected site [5].

Based on their resorptive and degenerative capacity, sutures can be categorized into absorbable and non-absorbable. Polyglactin 910 is a commonly used synthetic resorbable suture material obtained from a copolymer of 90% glycolide and 10% L-lactide. The use of copolymers enhances its durability and extends its time frame in the oral cavity. These suture materials have a wide range of physical and biomechanical characteristics, including a low rate of bacterial biofilm adhesion, a superior healing response, and a reduced rate of degradation. These distinctive qualities contribute to their popularity and usage in a variety of periodontal and oral surgical treatments [6].

The efficacy of chlorhexidine (CHX) as a bacteriostatic and bactericidal agent in dental plaque control has long been proved and several comparative studies with other chemical agents found chlorhexidine to be the most effective; hence it is been considered as a "gold standard". It is a bis-biguanide formulation with cationic properties. Effect is dependent on dose, volume and frequency in determining the clinical response [7]. Following surgical operations, surgeons frequently recommend antiseptic mouthwashes, although the effects of different antiseptic mouthwashes on sutures have not been thoroughly studied [8]. To our best knowledge, no study has evaluated the mechanical properties of polyglactin 910 suture material over time when exposed to two commercially available chlorhexidine concentrations in periodontal practice i.e., 0.12% and 0.2%.

Therefore, the aim of the study is to assess and evaluate the tensile strength (TS), percentage elongation (PE) and stiffness of synthetic resorbable suture material- polyglactin 910 in two concentrations of chlorhexidine i.e., 0.12% and 0.2% during a two-week period.

Materials and Method

The present in-vitro study was carried out in the Department of Periodontics, Goa Dental College and Hospital, Bambolim, Goa, India with approval of the study protocol by the Institutional Ethical Committee. A total of 70 suture specimens-polyglactin 910 (VICRYL 4-0; Ethicon, Johnson and Johnson Pvt, Ltd, India) were tested. All the suture materials used in the study were of uniform gauge (4-0) and measured at a uniform length of 18cm.

Three different types of controlled test media were used to evaluate the physical properties of these suture materials.

- **Test group I:** 0.12% Chlorhexidine gluconate mouthwash (Colgate PerioGard® Rinse)
- **Test group II:** 0.2% Chlorhexidine gluconate mouthwash (Hexidine, ICPA Ltd.)
- **Test group III:** Artificial saliva (Nanochemazone®, ISO 9001-2015)

A customized artificial saliva formulation (pH = 6.8) was a positive control group.

An unstimulated environment (non-immersed specimens) was used as a negative control group.

10 suture material specimens were tested at baseline in an unstimulated environment. At Day 7 and Day 14, 10 suture material specimens each were tested in artificial saliva, 0.12% CHX and 0.2% CHX solutions (Figure 1). Tensile strength, percentage elongation and stiffness values were calculated using Universal Testing Machine (5KN, speed of 10mm/minute) at Praj Metallurgical Laboratory, Pune, Maharashtra, India (Figure 2).

Data management and analysis were performed using STATA (statistical software for data science by StataCorp LLC., version 15). The results of continuous measurements were presented as the mean and standard deviation (SD) across the study groups. Shapiro Wilks test was used as test of normality. A repeated ANOVA (Analysis of Variance) measure was used for inter-group and intra-group comparison. In the entire study, the p values less than 0.05 was considered to be statistically significant and p value <0.001 as highly statistically significant.

Figure 1: Suture specimens in different test media.

Results

Polyglactin 910 suture specimens showed maximum tensile strength in artificial saliva at day 7 (p = 0.005) and day 14 (p value = 0.056) when compared to 0.12% and 0.2% CHX. Maximum percentage elongation at day 7 was seen in artificial saliva (p = 0.89), while 0.12% CHX showed maximum percentage elongation at day 14 (p = 0.22) but were not statistically significant. 0.12% CHX showed maximum stiffness at day 7 (p = 0.053), while artificial saliva showed maximum stiffness at day 14 (p=0.34) which was not statistically significant (Table 1).

Figure 2: Suture material mounted between the crossheads of universal testing machine.

When comparing the two concentrations; 0.12% CHX showed better tensile strength at day 7 (p = < 0.001) and day 14 (p = < 0.001) post immersion. 0.12% CHX showed better percentage elongation (p =< 0.001) at day 7 and better stiffness (p = 0.001) at day 14 while 0.2% CHX showed least stiffness (p = 1.00) and better percentage elongation (p = 0.14) at day 14 post immersion (Table 2, Graphs 1-3).

Discussion

Understanding the mechanical and physical characteristics of frequently used suture materials is necessary for dental surgeons. At present, no suture material fulfils all the requisites of an ideal suture material. The majority of research on the tensile behaviour of suture materials that has been published mainly focusses on tensile strength with only few comprehensive publications on other characteristics such percentage elongation, modulus, and stress-strain curves.

TENSILE STRENGTH (MPa)				
0.12% CHX (Group I)		**MEAN**	**STANDARD DEVIATION**	**SHAPIRO WILK (P value)**
	DAY 7	16	0.37	0.594
	DAY 14	13.66	0.54	0.644
0.2% CHX (Group II)	DAY 7	14.88	0.96	0.997
	DAY 14	13.48	0.67	0.411
ARTIFICIAL SALIVA (Group III)	DAY 7	16.20	1.32	0.005*
	DAY 14	14.22	0.96	0.056*
CONTROL	DAY 0	19.67	0.74	0.505
PERCENTAGLE ELONGATION (%)				
0.12% CHX (Group I)	DAY 7	5.66	0.46	0.865
	DAY 14	6.28	0.51	0.226
0.2% CHX (Group II)	DAY 7	6.50	0.91	0.837
	DAY 14	5.24	0.55	0.835
ARTIFICIAL SALIVA (Group III)	DAY 7	7.21	1.04	0.897
	DAY 14	6.14	1.19	0.432
CONTROL	DAY 0	6.99	0.55	0.803
STIFFNESS (N/m)				
0.12% CHX (Group I)	DAY 7	2.91	0.35	0.053*
	DAY 14	2.15	0.32	0.974
0.2% CHX (Group II)	DAY 7	2.07	0.25	0.479
	DAY 14	2.26	0.35	0.976
ARTIFICIAL SALIVA (Group III)	DAY 7	2.27	0.35	0.486
	DAY 14	2.72	0.78	0.347
CONTROL	DAY 0	3.29	0.72	0.857

Table 1: Mean and standard deviation of tensile strength, percentage elongation and stiffness of suture material in relation to different test media and time points.

	0.12% CHX		0.2% CHX	
	Mean difference	**P value**	**Mean difference**	**P value**
Tensile Strength (MPa)				
Control V/S DAY 7	3.67	<0.001	3.47	**<0.001**
Control V/S DAY 14	6.0	<0.001	5.45	**<0.001**
Percentage Elongation (%)				
Control V/S DAY 7	1.33	<0.001	-0.22	0.86
Control V/S DAY 14	0.71	0.012	0.85	0.14
Stiffness (N/m)				
Control V/S DAY 7	0.37	0.23	0.00	1.00
Control V/S DAY 14	1.13	<0.001	1.01	0.003

Table 2: Comparison between 0.12% and 0.2% CHX and its effects on tensile strength, percentage elongation and stiffness of suture material in relation to different time points.

Graph 1: Mean difference of percentage elongation.

Graph 2: Mean difference of stiffness.

Graph 3: Mean difference of tensile strength.

The purpose of this study was to compare the effects of two different concentrations of mouthwash i.e., 0.12% and 0.2% chlorhexidine on polyglactin 910 suture material. The entire study was performed by a single examiner to minimize variability. Suture material was chosen based on their adaptability and popularity for a range of oral and periodontal surgical procedures. The selection of mouthwashes was based on the frequent prescription of chemotherapeutic agents to control plaque formation. We chose to analyse artificial saliva because earlier research suggested that it might have an impact on the tensile strength of sutures, whereas a dry environment was used to monitor the unsoaked tensile strength of the same suture material over time. Based on the clinical importance of frequent oral surgical procedures, the study's duration and testing intervals were determined.

Tensile strength of suture material can be defined as the ratio of maximum (tensile) load that a suture can withstand without breaking, while being stretched to the original cross-sectional area

of the given material [9]. In controlled *in vitro* and *in vivo* settings, a significant correlation between suture deterioration and tensile strength has been documented in the literature [4,10].

According to the results of the present study, the mean tensile strength varied significantly depending on the immersion medium and time period, polyglactin 910 suture material showed maximum tensile strength in artificial saliva at day 7 and day 14 when compared to 0.12% and 0.2% CHX. When comparing the two concentrations; 0.12% CHX showed better tensile strength at day 7 and day 14 post-immersion.

Khiste., *et al*. inferred that polyglactin 910 suture materials maintained their tensile strength until the 10th day but had minimal strength by the 14th day [11]. Awasthi N., *et al*. showed similar results wherein post-immersion in 0.2% CHX, the mean tensile strength of polyglactin 910 suture materials reduced from baseline to day 14 [12]. Similarly; Alsarhan., *et al*. demonstrated that Listerine and 0.2% Chlorhexidine mouthwashes substantially affected the physical properties of polyglactin 910 suture materials. Their strength decreased significantly on day 14 except in Listerine mouthwash [8].

Contradicting the current study hypothesis which states that antiseptic commercial mouthwashes have an effect on the tensile strength of polyglactin 910 suture materials, previous clinical studies by L.K Mc Caul., *et al*. and B Fomete., *et al*. found no significant difference in the loss of strength of polyglactin 910 suture materials when subjected to CHX mouthwash [13,14]. This discrepancy may be attributed to the limited duration of exposure of the suture materials to CHX mouthwash. Also, longevity rather than tensile strength was measured in these studies.

Percentage elongation of a material describes the change in length of the material, as compared to its original length, before the breaking point is reached; while stiffness is the extent to which an object resists deformation in response to applied forces. Kearney CM., *et al*. stated that incubation time significantly affected the percentage elongation for each suture material type in all culture media [15].

In this present study; 0.12% CHX showed better percentage elongation at day 7 and better stiffness at day 14 while 0.2% CHX showed least stiffness and better percentage elongation at day 14 post-immersion. Contrary to these results, Abullais., *et al*. observed that polyglactin 910 showed no difference in percentage elongation when immersed in 0.2% CHX [16].

Naleway., *et al.,* while evaluating the mechanical properties of suture materials in cutaneous surgery, were of the opinion that increased elongation would be advantageous in situations where tissue edema was expected postoperatively [17]. Similar ideology can be applied in periodontal surgeries wherein tissue edema may interfere with adequate adaptation of flap margins.

The present study has demonstrated a significant difference in the mechanical properties of polyglactin 910 suture materials depending on its environmental conditions. However, the limitations of the study include inability to evaluate factors such as dietary habits, smoking, comorbidities, and medications that can potentially alter the oral pH level and cause changes at the molecular level of suture material. Also, the effects of the diverse muscular actions related to the functional components could not be replicated in the experimental setup.

Conclusion

The present study suggests that both the concentrations of CHX mouthwash can be prescribed safely while using polyglactin 910 sutures. The concentration of 0.12% CHX gave better results in terms of tensile strength while 0.2% CHX showed higher percentage elongation and stiffness of the suture materials after two week period. However; further testing with *in vivo* experiments are required in order to understand the molecular changes of sutures when exposed to oral fluids.

Conflict of Interest

None.

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