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Comparative Evaluation of The Effect of Two Commercially Available Mouthwashes on The Tensile Strength of Silk Suture –An in Vitro Study

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Abstract

Introduction: Suturing plays a critical role in maintaining the tissue integrity of surgical wounds. The tensile strength of suture materials is one of the important mechanical characteristics that indicate its ability to withstand stress during knotting.

Objective : To compare the effect of artificial saliva , 0.2% chlorhexidine gluconate mouth wash and 0.2% chlorhexidine gluconate with Hyaluronic acid 0.1% mouth wash (clohex heal) on the tensile strength of silk suture .

Methodology: Sixty 3-0 silk suture specimens, 15mm length (3 groups, 20 in each) were immersed in three different solutions for 14 days .Tensile strength was tested using Universal Testing machine.

Result: There was a significant decrease in the tensile strength for 3-0 silk suture after day 10 and 14, regardless of the immersion solution. Chlorhexidine significantly reduced the tensile strength of 3-0 Suture when compared with saliva and clohex heal group.

Conclusion: All the solution has a significant effect on tensile strength of silk sutures and hence clinician should be cautious when prescribing commercial mouthwashes for patients with silk sutures.

Keywords: Tensile Strength, Suture, Mouth Wash.

Introduction

Suture materials play an important role in healing, maintaining tissue integrity and approximation of flap margins over a certain period [1]. Failure in achieving wound closure may lead to delayed healing or wound dehiscence with subsequent functional and aesthetic complications[2]. Suturing in dentistry is different from suturing in the other parts of the body because of the type of tissues involved, the constant presence of saliva, high tissue vascularization, and functions related to speech, mastication, and swallowing[3]. Appropriate sutures require specific physical characteristics and properties, such as good tensile strength, dimensional stability, lack of memory, knot security, and sufficient flexibility to avoid damage to the oral mucosa.[4,5]

The strength and adherence of the sutured tissue increase over time, and investigators[6] have noted that a significant increase in flap strength is achieved between 1 and 2 weeks. Suture material of insufficient strength can result in untimely suture breakage, leading to poor adaptation of the surgical flaps and inducing the healing of tissues by secondary intention.[7]

Sutures can be divided into bioabsorbable and non-resorbable types based on their physical degradation and resorption in the tissues. Non-resorbable sutures are made of materials that are durable and resist dissolution in reaction to oral fluids, saliva, and serum. However, non-resorbable sutures need to be removed, which necessitates another appointment, and they can become an irritant if a part inadvertently remains after suture removal. Many surgeons consider silk the standard (superior handling characteristics) among non-resorbable suture materials.[8-10]

The selection of appropriate suture material is a critical step that is based on appropriate tensile strength, tissue biocompatibility, and resorption rates. Multifilament suture is preferred over monofilament suture due to its ease of manipulation, better knot property, and lack of sharp edges that cause less irritation to oral tissues. Due to ease of handling, silk suture is preferred in oral, periodontal and endodontic surgeries. In the dental literature, there seems to be a greater emphasis on tissue response to suture materials than on the assessment of the physical and bio-chemical properties of the suture materials .[6-8]

Suture materials are under continuous mechanical forces from mastication, speech, facial expressions, alteration in pH levels, bacterial proteolytic enzymes, saliva, and vascularization[11]. The tensile strength of suture materials is one of the important mechanical characteristics that indicate its ability to withstand stress during knotting[12]. Maintaining the basic tensile strength of suture material is of absolute importance for stabilizing and securing the sutured flaps at the time of surgery until the time of removal. Prescribing antiseptic mouthrinses is a common practice following periodontal surgical procedures but the impact of these on suture materials has not been completely evaluated.[13] A recent report suggests that antiseptic solutions have an impact on the failure load of sutures. In general, practitioners tend to rely on the package insert for information regarding the properties and durability of the sutures[14]. Studies [15,16,18] have examined the tensile strength and resorption rates of different suture materials, they found that the tensile strength of the sutures decreased over time and was dependent on the rate of resorption. However, to the best of our knowledge, only limited studies have compared the tensile strengths of silk suture materials over time under simulated oral conditions. Hence the present In vitro study aims to compare the effect of two commercially available mouthwashes 0.2% chlorhexidine gluconate and a newly marketed

mouthwash 0.2% chlorhexidine gluconate with Hyaluronic acid 0.1 % on the tensile strength of silk suture.

Methodology

Suture Material and Medium

3.0 silk suture (Mersilk 3.0) was obtained from sterile, unexpired and commercially available packets in this In Vitro research. They were divided into three groups. Every group comprised of 20 suture specimens, 15mm in length (total 60 suture specimens included). • Group 1 (control): Silk suture in artificial saliva • Group 2 (test 1): Silk suture in Clohex mouth wash • Group 3 (test 2): Silk suture in Clohex heal mouth wash Each specimen was tied around an wooden stick throughout the study. The suture specimen to be evaluated was carefully slid off the tubing for evaluation[18].

Preparation of Artificial Saliva

The biology of the oral milieu was replicated In vitro through the use of artificial saliva. The solution was prepared at a pH of 7.4 and kept in an incubator at 37°C. The specimens were positioned in a container of artificial saliva. This was prepared using the following agents in precise magnitudes: potassium dihydrogen phosphate (KH2PO4) 0.9 mmol/L, potassium chloride (KCl) 50 mmol/L, calcium chloride (CaCl2) 1.5 mmol/L, and tris buffer 20 mmol/L [19].

Immersion of Sutures in Mouthwashes

Medium that was used for immersion of sutures were 0.2% chlorhexidine gluconate and 0.2% chlorhexidine gluconate with Hyaluronic acid 0.1 %. The pH of the solution was preserved at 7.4 all through the study period, At every 48 hour intervals, the containers were rinsed using distilled water and reloaded with fresh media.

Assessment of Suture Tensile Strength (Fig – 1)

Each sample was prepared with a knot around two metal poles installed in the universal testing machine with a fixed distance of 15.0 mm between the two poles. The tensile strengths of the suture samples were tested at specific times: preimmersion (baseline) and postimmersion at 1, 7, 14 days. Tensile strength evaluation of the suture specimens were performed at a cross-head speed of 25 cm/minute. Every sample was stretched to failure and the utmost load was documented in Newtons (N) followed by tabulation for evaluation. Utilizing the equation T =F/A the tensile strength (T) was measured: where F is a force to failure (N) and A is a cross-sectional area fracture plane normal to fiber axis (m2)[20].

Study Setting

Study Site: Department of Dental material, Yenepoya dental college Yenepoya research centre, Yenepoya (deemed to be University), Mangalore.

Source of Data

The data were collected from three different groups

Group 1 (control): Silk suture in artificial saliva

Group 2: Silk suture in 0.2% chlorhexidine gluconate mouth wash (Clohex)

Group 3: Silk suture in 0.2% chlorhexidine gluconate with Hyaluronic acid 0.1 % mouth wash (Clohex Heal

Statistical Analysis

Descriptive and summary statistics was used to describe the follow up effect.

Two way repeated measure ANOVA method was used to test the tensile strength among the study group.

Bonferroni post hoc test was used for this analysis

Results

Observation 1: Intragroup

Table 1: Evaluation of tensile strength of 3-0 sutures immersed in different test solutions (n=15+15+15)

Descriptive					
Test solutions	Number of samples	Tensile strength (Mpa)	Std. Error	95% Confidence Interval for Mean	
				Lower Bound	Upper Bound
Group I	15	385.77±52.37	13.52	356.76	414.77
Group II	15	347.04±25.04	6.46	333.17	360.91
Group III	15	378.42±13.22	3.41	371.10	385.74
Total	45	370.41±37.63	5.61	359.10	381.71

The data represented in mean ± SD. Descriptive statistics for tensile strength measurements of samples subjected to different test solutions: saliva, chlorhexidine and clohex heal. Tensile strength was expressed in Mpa. With 95% Confidence Interval for Mean.

The table 1 displays the mean tensile strength values for each test solution, along with that of the standard error measurements. For group I, the mean tensile strength was 385.77 ± 52.37 Mpa. For group II, the mean was 347.04 ± 25.04 Mph, and for group III, the mean was 378.42 ± 13.22 N. The standard error was 13.52, 6.46 and 3.41 for group I, group II and group III respectively. Total value represents the overall statistics across all test solutions. The total number of samples tested was 45, and the mean tensile strength across all samples was 370.41 ± 37.63. The standard error for the total mean was 5.61. The 95% confidence interval for the total mean ranged from 359.10 to 381.71.

Observation 2: Intergroup

Table 2: Multiple comparisons of tensile strength of 3-0 suthure immersed in different test solutions (n=15+15+15)

Multiple Comparisons					
Group	Group	Mean Difference	Level of Significance	99% Confidence Interval	
				Lower Bound	Upper Bound
Group I	Group III	7.35	1.00	-31.71	46.41
	Group II	38.72	.011	-.33	77.79
Group II	Group I	-38.72	.011	-77.79	.33
	Group III	-31.37	.049	-70.44	7.68
Group III	Group I	-7.35	1.00	-46.41	31.71
	Group II	31.37	.049	-7.68	70.44

Data represents multiple comparisons of different test solutions, dependent variable of this comparison remains to be tensile strength. 99% confidence interval was used in this statistical analysis. Bonferroni post hoc test was used for this analysis. *p-Value < 0.05

The table presents the results of intergroup comparisons for the dependent variable "Tensile Strength" among the three groups: Saliva, Chlorhexidine, and Chlohex heal.

In comparison between group I and group III, the mean difference was 7.35, There was insignificant difference

(1.00) in the tensile strength when compared between both the groups at the 99% confidence level.

In comparsion between group I and group II, the results obtained showed the mean difference (38.72) between group I and groups II was statistically significant at the 99% confidence level, indicating that there was a significant difference (0.011) in tensile strength between these two groups. The tensile strength was decreased in the group II compared to the Saliva group.

In comparison of group III and group II, the results obtained showed the mean difference (31.37) between group III and group II was statistically significant at the 99% confidence level, indicating that there was a significant difference (0.049) in tensile strength between these two groups. The tensile strength was higher in the group III compared to the group II.

The results of the multiple comparisons suggest that group II has a significant effect on tensile strength compared to both group I and group III. (figure-3)

There was no significant difference in tensile strength between group I and group III solutions.

These findings provide valuable insights into the effectiveness of different solutions in influencing tensile strength and can inform decision-making in clinical or experimental settings.

Discussion

Suture pretensioning was done to determine the loads needed to untie the sutures.[21] The purpose of this study was to compare the effect of two commercially available mouthwashes 0.2% chlorhexidine gluconate and a newly marketed mouthwash 0.2% chlorhexidine gluconate with Hyaluronic acid 0.1 % on the tensile strength of silk suture. A single examiner carried out the entire study to minimize variability. Numerous researches [22–25] have looked into the tensile characteristics of different sutures. The selection of suture materials was based on their versatility and popularity for various oral and periodontal surgical procedures. In addition, the selection of mouthwashes was based on the frequent prescription of chemotherapeutic agents to control plaque formation[26]. We chose to study artificial saliva because previous studies observed a possible effect on suture strengths, while a dry condition was used to evaluate the unsoaked tensile strength of the same sutures over time. The duration of this study and the testing times were based on the clinical relevance of common oral surgical procedures[27]. The knots were pretensioned using a microtensile tester at progressively higher weights until they were stopped at 10.2 N, which appeared to be the perfect force to check the sutures for sliding. The clinical scenario does not indicate the force used in each case, but because of inflammation in the first 48 hours, there is typically more strain in the suture materials.[28] The methodology used for this research was established according to previous studies[22,30]

TS 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[31]

It can be observed from the results that a 3-0 silk suture material maintained their tensile load in all test solutions except group II, in which the tensile load reduced over time. Similarly, it can be observed that group I and group III maintained their tensile strengths at different time periods, whereas group II, shows a statistically significant decrease in tensile strength from baseline until day 14. The reason might be because, in contrast to other materials, which are synthetic, silk comes from natural sources and may therefore be more vulnerable to the action of proteolytic enzymes from the bacteria and the host. While most suture materials are polymers, silk is primarily made up of 30% gum and 70% protein

fibers, making it non-polymer. Additionally, Mersilk is braided to improve knot stability a crucial aspect of the wound-healing phase.[32]It is a common practice for oral surgeons to prescribe antiseptic mouthwashes following surgical procedures, but the effect of various antiseptic mouthwashes on sutures has not been entirely tested. Contradicting the current study 3hypothesis which stated that antiseptic commercial mouthwashes had an effect on the tensile strength of 3-0 silk suture materials. According to earlier research, absorbable materials exhibit greater tension resistance than non-absorbable materials[33].

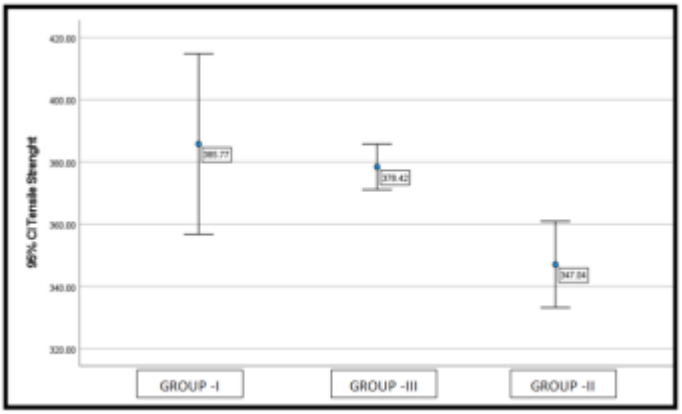
According to Khiste et al., polyglactin (Vicryl) sutures retain their tensile strength until day 10 and showed minimal strength by day 14[34]. However, Chu et al. report that Vicryl shows better breaking strength as compared to natural sutures. This is especially evident after immersion in physiological and acidic pH solutions. They also reported that from among the nonabsorbable sutures, silk appears to be the most susceptible to various pH conditions[35]. Jose Arce et al. have stated in their research that Teflon (PTFE) and polyglactin (Vicryl) sutures maintained their strength after 21 days of evaluation[36]. On the other hand, the monofilament and Polyglactin (Vicryl) displayed higher tensile strength as compared to BS (black silk) and PTFE[37-39.]

We recommend that in spite of the statistically significant reduction in strength of 3-0 silk suture in group II on 10th day, it retains approximately 90% of its strength until the 7th day, so can be recommended in surgical situations in which tissue immobilization of 5–7 days is sufficient to promote healing. At the same time, 0.2% chlorhexidine gluconate mouth wash (Clohex) should be prescribed as a mouthwash during the immediate postsurgical phase. However, if prolonged immobilization of 2 weeks is required, then 0.2% chlorhexidine gluconate with Hyaluronic acid 0.1 % mouth wash (Clohex Heal) should be preferred over 0.2% chlorhexidine gluconate mouth wash (Clohex).

However, our study has a few limitations that restrict the application of the results in the clinical scenario. We attempted to replicate the oral environment in terms of temperature and pH, but because this is an in vitro study, we were unable to include the microbial component, which could have a substantial impact on our results. The experimental setting did not allow for the replication of deglutition or speech, except from the impact of the various muscular movements associated with the functional elements of mastication. Additionally, there is scope for more research to examine the different type of sutures that should be used on the particular kinds of tissue

Figure 1: Assessment of Suture Tensile Strength

Figure 2: Armamentarium



Graph 1: Mean distribution of tensile strength of 3-0 sutures immersed in different test solutions (saliva, herbal, chlorhexidine) (n=15+15+15)

Conclusion

In conclusion, our findings suggest more evaluation of how commercial mouthwashes may influence the physical characteristics of the suture strength and stability and its impact during the healing period of surgical wounds .Under the limitation of the present study, it can be concluded that silk suture exhibit different properties under different circumstances, based on the period of immobilization required, pH variations expected and the mouthwash recommended for oral hygiene maintenance. All the test solutions have a significant effect on tensile strength of silk sutures and hence clinician should be cautious when prescribing commercial mouthwashes for patients with silk sutures. We recommend further testing with in vivo experiments in order to understand the molecular changes of sutures when exposed to chemicals in mouthwashes and to confirm the methods and clinical outcomes.

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