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Effect of Mouthwashes on the Tensile Strength of Poliglecaprone and Polyglactin Absorbable Sutures – An In Vitro Study.

[1]Dr Ishita Kamal Jain, II Year MDS, Department of Periodontics, Mahatma Gandhi Mission's Dental College & Hospital, Navi Mumbai, Maharashtra, India.

[2] Dr. Sarika S Shetty, Reader, Department of Periodontics, Mahatma Gandhi Mission's Dental College & Hospital, Navi Mumbai, Maharashtra , India.

Corresponding Author: Dr Ishita Kamal Jain, II Year MDS, Department of Periodontics, Mahatma Gandhi Mission's Dental College & Hospital, Navi Mumbai, Maharashtra, India.

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Abstract

Objective: To evaluate the effect of mouthwashes on the tensile strength of poliglecaprone and polyglactin absorbable sutures.

Material and Methods: This In vitro study was conducted on 240 samples of poliglecaprone and polyglactin absorbable sutures of 4-0 gauge. Tensile strength of the sutures was assessed at specified time periods: preimmersion, 3, 7, 10, 14 days after immersion in 0.2% chlorhexidine and 0.075% cetylpyridinium. Each specimen was stretched to failure and the tensile strength was recorded in Newton and tabulated for analysis.

Result: The reduction in the tensile strength was not significant in both poliglecaprone and polyglactin sutures on day 3 when immersed in artificial saliva, chlorhexidine and cetylpyridinium chloride, but the strength decreased significantly on day 14. At the 14th day, polyglactin sutures retained more than two-thirds of their original tensile strength, while poliglecaprone sutures retained around one-third of the original strength.

Conclusion: The current study concludes that the mean tensile strength is significantly different as a function of immersion media and time frame. Cetylpyridinium chloride mouthwash can be prescribed as an alternative to chlorhexidine mouthwash after using either poliglecaprone 4-0 or polyglactin 4-0 sutures.

Keywords: Suture, Tensile strength, Poliglecaprone suture, Polyglactin suture, Chlorhexidine mouthwash, Cetylpyridinium chloride mouthwash.

Introduction

Suture, natural or synthetic is a biomaterial device. They are generally used to ligate the blood vessels and to approximate the tissue together. In 3500 BC, Egyptians have described the use of linen suture material for wound

closure. Use of animal hair, vegetable fibers, silk, leather, and gut have all been shown to be successfully used in wound closure.[1]

Sutures are categorized into natural or synthetic based on the source used to make them. Sutures are termed as absorbable or nonabsorbable, based on their capacity to resorb and degenerate. They can be fabricated in braided fashion and/or in a form of monofilament. 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. Many surgeons consider silk the standard of performance (superior handling characteristics) among non-resorbable suturematerials.[2=4] An advantage of absorbable sutures is that they generally do not require removal. [5]

Polyglycolic acid (PGA), polyglactin (PG), and chromic gut (CG) are commonly used bio-absorbable suture materials; they have shown to have desirable properties in relation to tissue reactions in the gut. [6] Poliglecaprone 25 (Monocryl_) is a monofilament synthetic absorbable surgical suture prepared from a copolymer glycolide and epsilon-capro-lactone. Polyglactin 910 (Vicryl) is a multifilament absorbable synthetic coated suture composed of 90% glycolide and 10% L-lactide. Due to various biomechanical and physical properties like reduction in bacteria biofilm adherence, degradation rate and better healing response, monocryl and vicryl are widely used [7-9]. Choosing the appropriate suture material should be based on the appropriate tensile strength, tissue biocompatibility, and resorption rates. [10]

Suturing plays a critical role in maintaining the tissue integrity of surgical wounds. A key aspect of acceptable wound closure is to assure that sustained approximation of flap margins remains stable over a particular time period. Stabilization and proper positioning of the surgical flap are important to achieve healing by primary intention. Improper positioning of the flaps can lead to delayed or compromised healing. To achieve wound closure it is necessary to obliterate the dead space, there should be even distribution of tension along deep suture lines, and maintenance of tensile strength across the wound until tissue tensile strength is adequate. [11]

There are various factors that make suturing a different phenomenon in dentistry when compared to suturing of other parts of the body. In the oral cavity, the sutures are under continuous mechanical forces from speech, saliva, mastication, facial expressions, bacterial proteolytic enzymes, alterations in the pH levels and vascularization [12-14] 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.[15-16]

Tensile strength of a suture is its ability to withstand stress during knotting [17]. It is a measure of time it takes for a suture to lose its 70% to 80% of initial strength. It is considered to be one of the most important mechanical characteristic of a suture. Initial tensile strength is a measure of the amount of tension applied in a horizontal plane necessary to break the suturing material [18]. For stabilization and securing the flaps with suture at the time of surgery, maintaining the basal tensile strength of suture material is very important. During the healing phase, sutures with insufficient tensile strength could break causing poor adaptation of the margins of the flap, subsequent deterioration of the affected sides and formation of hematoma [17 19].

There are studies that report that a suture's tensile strength may be affected by specific solutions or consumed fluids. An experimental study by *Ferguson* et al. shows a progressive loss of tensile strength in Vicryl suture materials when subjected to saliva, bovine milk, and soy

milk over a period of 35 days. [20] Saliva-soaked specimens show a more rapid loss of tensile strength than the other soaking liquids[20]. Another study reports that Vicryl shows better breaking strength compared to natural sutures. This is especially evident after immersion in physiological and acidic pH solutions. [21]

However, to the best of our knowledge, no study has compared the strengths of poliglecaprone and polyglactin suture materials over a 2 week time period, when exposed to commercial oral mouthwash chlorhexidine and cetylpyridinium chloride solutions.

The purpose of this study was to compare the tensile strength of two commonly used suture materials over a period of 2 weeks under artificial saliva and in two different commercial types of mouthwashes – chlorhexidine and cetyl pyridinium chloride.

Material and Method

Suture samples: Two types of absorbable sutures, multifilament coated polyglactin 910 (Vicryl – Ethicon by Johnson & Johnson private limited) and monofilament poliglecaprone 25 (Monocryl - Ethicon by Johnson & Johnson private limited) of 4-0 gauge were used in this study. These sutures were employed using a stratified randomized selection process. Each suture pack was utilized to create five suture specimens. Each sample was tied with a square surgeon's knot around flexible rubber tubing to permit for a uniform loop size that might be practical during the mechanical analysis phase. Once tied, the sutures were carefully slid off the tubing for testing.

Simulation of the oral environment: A biologic simulation of the oral environment was created in vitro by artificial saliva. This solution was maintained at a pH of 8.6 in an incubator at 37°C. The samples were placed in a container containing the artificial saliva simulating the oral environment and were maintained for a 2 week period in a non-tensioned state.

Experimental Conditions: The tested media included artificial saliva, 0.2% chlorhexidine gluconate (Hexidine 0.2 %) and cetylpyridinium chloride (Colgate Plax 0.075%). All solutions were maintained at standard pH levels throughout the timeframe as follows: 8.6 for artificial saliva, 8.4 for chlorhexidine, and 6.5 for cetylpyridinium chloride. All media were stored in an incubator at 37◦C. During the study period, the containers were replenished with media every 48 hours after rinsing with distilled water.

Tensile Strength: Tensile strength of the suture samples were tested at specified time periods: 1, 3, 7, 10, and 14 days after immersion. Tensile strength of the suture samples were measured using a universal Instron Testing System at a cross-head speed of 10 mm/minute. During the delivery of the suture specimen for testing, the knot was located midway between the base and the hook of the Instron machine. (Figure 1 and 2) Additionally, each specimen was stretched to failure and the tensile strength was recorded in (MPa) and tabulated for analysis.

Statistical analysis

Data obtained was compiled on a MS Office Excel Sheet (v 2010, Microsoft Redmond Campus, Redmond, Washington, United States). Data was subjected to statistical analysis using Statistical package for social sciences (SPSS v 21.0, IBM). Descriptive statistics like Mean & SD for numerical data has been depicted. Normality of numerical data was checked using Shapiro-Wilk test & was found that the data followed a normal curve; hence parametric tests have been used for comparisons. Inter group comparison (2 groups) was done using t test. Intra group comparison was done using repeated measures ANOVA (for >2 observations) followed by post Hoc test.

For all the statistical tests, $p<0.05$ was considered to be statistically significant, keeping α error at 5% and β error at 20%, thus giving a power to the study as 80%.

Results

Poliglecaprone and polyglactin sutures are absorbed by the process of hydrolysis. The reduction in the tensile strength was not significant in both poliglecaprone and polyglactin sutures on 3rd day when immersed in artificial saliva, chlorhexidine and cetylpyridinium chloride, but the strength decreased significantly on day 14th for all the groups. In the present study at the 14th day, polyglactin sutures retained more than two-third of their original tensile strength, while poliglecaprone sutures retained around one-third of their original strength.

Reduction in the tensile strength of Poliglecaprone suture was seen more in the chlorhexidine group as compared to artificial saliva and cetylpyridinium group at 14th day. (Table 1 and figure 3) Similarly reduction in the tensile strength of Polyglactin suture was seen more in the chlorhexidine group, followed by cetylpyridinium chloride group and least in the artificial saliva group. (Table 2 and figure 4)

Discussion

The present study aimed to test the effect of chlorhexidine and cetylpyridinium chloride mouthwashes on polyglactin 910 (Vicryl) and poliglecaprone 25 (Monocryl) sutures 4-0 gauge tensile strength. The selection of suture materials was supported by their versatility and recognition for various oral and periodontal surgical procedures. In addition, the choice of mouthwashes was supported on the frequent prescription of chemotherapeutic agents to regulate plaque formation. The duration of this study and the testing times was based on the clinical relevance of common oral surgical procedures.

Poliglecaprone and polyglactin sutures are absorbed by the process of hydrolysis.[22] At the 14-day post implantation period, polyglactin sutures retained more than two-thirds of their original tensile strength, while poliglecaprone sutures retained around one-third of their original strength. The current study found that the mean tensile strength was significantly different as a function of immersion media and time frame. Due to the morphology of poliglecaprone sutures, they tend to lose tensile strength in a shorter time. Mohammed Alsarhan et al in 2018 [23] tested the tensile strength of polyglactin and poliglecaprone suture material in different mouthwashes and got similar results as in the present study. L. K. McCaul et al in 2000 and B. Fomete in 2013 [24-25] had contradicting results as compared to the current study; they stated that antiseptic commercial mouthwashes had no significant difference in the loss of tensile strength of polyglactin sutures when subjected to chlorhexidine mouthwash. This discrepancy may be attributed to the limited duration of exposure of the polyglactin sutures to chlorhexidine mouthwash in these studies.

Poliglecaprone sutures showed a notable loss of strength when immersed in both chlorhexidine and cetyll pyridinium chloride mouthwashes as compared to polyglactin suture. The suture gauge was similar for both poliglecaprone and polyglactin, this inconsistency in the degradation can be due to the differences in their physical structures, as polyglactin is braided as well as a multifilament suture, giving it more resistance to hydrolytic degradation over longer time periods.

The reduction in the tensile strength was insignificant in both poliglecaprone and polyglactin on day 3 when immersed in artificial saliva, chlorhexidine and cetylpyridinium chloride but the strength decreased significantly on day 14. The pH of the medium is another factor that gains more importance in the resorption of suture materials. The pH levels were found to influence the performance of absorbable more than nonabsorbable

sutures.[21] Only alkaline conditions accelerate the degradation of synthetic, or "man-made," absorbable sutures.[18] In general, absorbable suture were more sensitive to the pH effect level than non-absorbable suture materials; within the same suture a strong alkaline condition would have a more adverse effect on the strength of suture materials than physiologic and acidic pHs.[22]

Figures & Tables

Figure 1: Measurement of tensile strength of Poliglecaprone suture using Instron machine

Figure 2 : Measurement of tensile strength of Polyglactin suture using Instron machine

Figure 3: Tensile strength of Poliglecaprone suture - inter group comparison between different media

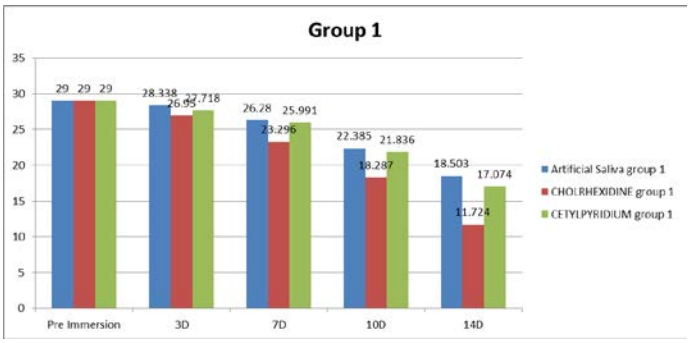

Figure 4: Tensile strength of Polyglactin suture - inter group comparison between different media

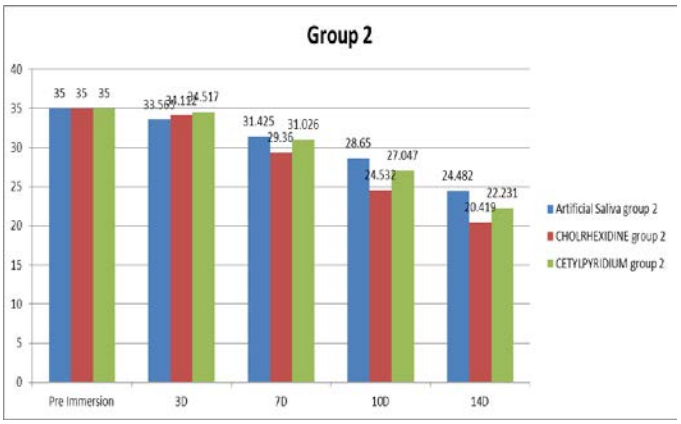

Table 1: Tensile strength of Poliglecaprone suture - inter group comparison between different media

	Artificial Saliva group 1	Cholrhexidine group 1	Cetylpyridium group 1
Pre Immersion	29	29	29
3D	28.338	26.95	27.718
7D	26.28	23.296	25.991
10D	22.385	18.287	21.836
14D	18.503	11.724	17.074

Table 2: Tensile strength of Polyglactin suture - inter group comparison between different media

	Artificial Saliva group 2	Cholrhexidine group 2	Cetylpyridium group 2
Pre Immersion	35	35	35
3D	33.565	34.112	34.517
7D	31.425	29.36	31.026
10D	28.65	24.532	27.047
14D	24.482	20.419	22.231

Conclusion

The current study concludes that the mean tensile strength is significantly different as a function of immersion media and time frame. Physical characteristics of the suture strength and stability are influenced by the commercial mouthwashes to an extent. It may also have an impact on the healing of the surgical wound.

Cetylpyridinium chloride mouthwash can be prescribed as an alternative to Chlorhexidine mouthwash after using either Poliglecaprone 4-0 or Polyglactin 4-0 sutures.

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