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COMPARATIVE EVALUATION OF TENSILE STRENGTH BETWEEN TWO SURGICAL ABSORBABLE SUTURE MATERIAL IN THREE DIFFERENT SOLUTIONS: AN IN-VITRO STUDY

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ABSTRACT

Aim: The purpose of this study was to evaluate the tensile strength of surgical absorbable sutures over a period of 14 days in different solutions. **Methods:** A total number of 90 samples were divided into 2 groups [45 (4-0 chromic catgut) and 45 (4-0 monocryl)]. These groups were then further divided into 3 subgroups with 15 samples of each dispensed in 3 different solutions (Artificial Saliva, Chlorhexidine 0.2% and Listerine). From each subgroup 5 samples were examined at 1st day, 7th day and 14th day. Samples were then placed in an incubator at 37°C. Once tied, the sutures will carefully slid off the rubber tubing for testing. The tensile strength of the knot was evaluated by using Universal Testing machine. **Results:** Tensile strength of chromic catgut (Group A) was highly statistically($p<0.001$) lower as compared to monocryl (Group B) and at various time intervals (Day 1, Day 7 and Day 14) respectively in different solutions. On intragroup comparison, it was observed that there was a highly statistical significant decline in tensile strength in all three media as time of immersion increases. **Conclusions:** Tensile strength of monocryl was statistically higher as compared to chromic catgut. Listerine mouthwash largely reduces the tensile strength of chromic catgut (4-0) & monocryl (4-0) than chrohexidine and artificial saliva.

KEYWORDS: Tensile strength, chromic catgut, monocryl, Artificial saliva, 0.2% chlorhexidine, Listerine.

INTRODUCTION

Wound closure is the primary goal following the surgery. Failure in achieving wound closure may lead to delayed healing or wound dehiscence with subsequent functional and aesthetic complications.[1] There are different types of suture materials as well as suturing techniques available for dental surgical procedures. Use of suture materials for wound closure is an ancient art that dates back to Egyptian scrolls of 3500 BC that describe the use of linen to close wounds. Use of animal hair, vegetable fibers, silk, leather, and gut have all been shown to be successfully used in wound closure.[2] These materials are continuously exposed to mechanical forces from mastication, speech, facial expressions, alteration in pH levels, bacterial proteolytic enzymes, saliva, and vascularization. It is difficult to reduce mechanical forces across suture lines in the oral cavity. The most important characteristic of an acceptable suture material is the ability to protect wounds for optimal healing with minimal or no tension.[3] Deficiency in the strength of the suture material can result in untimely suture breakage, leading to poor adaptation of the surgical flaps and inducing the healing of tissues by secondary intention. Sutures are divided mainly into categories of synthetic or natural, and absorbable or nonabsorbable. Chromic catgut (natural) and monocryl (synthetic) are widely used absorbable suture materials. An advantage of absorbable sutures is that they generally do not require removal.[4]

Gut was first chromatized in 1876, which resulted in improved suture strength. "Gut" was processed intestinal material from oxen or sheep. Gut material was originally used for violin strings and obtained at musical instrument shops that provided "kits", thus the term kitgut or catgut. Catgut shows degree of inflammation which can interfere with wound healing due to the foreign body reaction, localized abscess formation and increased local tissue fluid associated with the inflammatory response. Monocryl (poliglecaprone 25) is a new synthetic, absorbable, undyed monofilament introduced by Ethicon in 1993. It is the most pliable of the monofilaments. The lack of stiffness provides excellent handling characteristics, facilitates knot tying and eliminates memory of the package. There is minimal tissue reaction

which is characterized primarily by macrophages, fibroblasts, a few lymphocytes, plasma cells and an occasional giant cell. Monocryl is not genotoxic, cytotoxic, pyrogenic, irritating or antigenic. There is no interference with local tissue response to bacterial contamination.

There is limited data available focusing on the comparison of the tensile strengths of absorbable suture materials in different solutions when exposed the oral enviornment. Hence the present study aims to compare the tensile strength of two different surgical absorbable sutures in three different solutions.

MATERIAL AND METHODS

In the present study, two different surgical absorbable suture materials were evaluated i.e. chromic catgut (4-0) and monocryl (4-0).

A total number of 90 samples were divided into 2 groups [45 (4-0 chromic catgut) and 45 (4-0 monocryl)]. These groups were then further divided into 3 subgroups with 15 samples of each dispensed in 3 different solutions (Artificial Saliva, 0.2% Chlorhexidine and Listerine). From each subgroup 5 samples were examined at 1st day, 7th day and 14th day. Each sample was tied with a surgeon's knot around flexible rubber tubing to allow for a consistent loop size that would be practical during the mechanical analysis phase. Samples were then placed in an incubator at 37°C. Once tied, the sutures will carefully slid off the rubber tubing for testing. The tensile strength of the knot was evaluated by using Universal Testing machine.

Preparation of artificial saliva

Artificial saliva was prepared by mixing the following chemicals in one litre of distilled water.

1) Sodium azide: 0.75 g
2) Potassium monohydrogen phosphate: 0.804 g
3) Calcium chloride: 0.166 g
4) Magnesium chloride: 0.059

Tensile strength

The tensile strength of the suture samples were tested at 1st day, 7th day and 14th days post immersion. The tensile strength was assessed using the Universal UltraTest machine (ACME Engineers, India. Model No. UNITEST-10). Each sample carefully slid off the rubber tubing and the suture was positioned with the knot pointed midway between both arms to allow for consistency in force distribution relative to the knot. Tensile strength assessment of the suture samples was done at a cross-head speed of 25 cm/min. Each specimen was stretched to failure and the maximum load was recorded in mega Pascal (MPa) and tabulated for analysis. Tensile strength assessment of the suture samples was done at a cross-head speed of 10mm/min. Each specimen was stretched to failure and the maximum load was recorded in megapascal (MPa) and tabulated for analysis.

Figure 1: Sutures dispensed in 3 different solutions (Artificial Saliva, 0.2% Chlorhexidine and Listerine).

Figure 2: The tensile strength was assessed using the Universal UltraTest machine (ACME Engineers, India. Model No. UNITEST-10)

STATISTICAL ANALYSIS

The results of continuous measurements were presented as the mean and standard deviation (min-max), with significance assessed at α = 0.05, estimated standard deviation of 1, and power of 0.83. A two-factor analysis of variance (ANOVA) followed by Unpaired't' test analysis was conducted to assess the tensile strength of materials over time and media. Statistical software, namely SAS 9.2 (SAS Institute Inc., Cary, NC, USA), SPSS ver. 15.0 (SPSS Inc., Chicago, IL, USA) was used for the analysis of the data.

RESULTS

All suture loops were intact at the end of their respective soaking periods and were suitable for mechanical testing. Each suture demonstrated an obvious breaking point during mechanical testing on the Universal testing Machine.

Tensile strength for chromic catgut and monocryl in three different solutions like artificial saliva, 0.2% chlorhexidine and Listerine at day 1 are listed in Table 1. At 1st day in artificial saliva, mean tensile strength in Group A (chromic catgut) and Group B (Monocryl) were 205.4 ± 5.59 MPa and 1413.4 ± 14.06 MPa and the difference was highly statistical significant (p<0.001). At 1st day in chlorhexidine solution, mean tensile strength in Group A (chromic catgut) and Group B (Monocryl) were 172.8 ± 3.7 MPa and 1303.2 ± 12.43 MPa and the difference was highly statistical significant (p<0.001). At 1st day in Listerine solution , mean tensile strength in Group A (chromic catgut) and Group B (Monocryl) were 148.2 ± 5.67 MPa and 1118.8 ± 11.77 MPa and the difference was found to be of highly statistical significance (p<0.001).

Tensile strength for chromic catgut and monocryl in three different solutions like artificial saliva, 0.2% chlorhexidine and Listerine at day 7 are listed in Table 1. At 7th day in artificial saliva, mean tensile strength in Group A (chromic catgut) and Group B (Monocryl) were 124. 6 ± 13.81 MPa and 826.2 ± 11.47 MPa and the difference was found to be of highly statistical significance (p<0.001). At 7th day in chlorhexidine solution, mean tensile strength in Group A (chromic catgut) and Group B (Monocryl) were 91 ± 17.07 MPa and 773.8 ± 9.33 MPa and the difference was found to be of highly statistical significance (p<0.001). At 7st day in Listerine solution, mean tensile strength in Group A (chromic catgut) and Group B (Monocryl) were 86.8 ± 4.71 MPa and 622.6 ± 14.75 MPa and the difference was found to be of highly statistical significance (p<0.001).
Tensile strength for chromic catgut and monocryl in three different solutions like artificial saliva, 0.2% chlorhexidine and Listerine at day 14 are listed in Table 1.

Table 1: Intergroup comparison of Tensile strength between chromic catgut (Group A) and monocryl (Group B) and at various time intervals (Day 1, Day 7 and Day 14) respectively.

1st DAY	ARTIFICIAL SALIVA MEAN (SD)	CHLORHEXIDINE MEAN (SD)	LISTERINE MEAN (SD)
GROUP A (CATGUT)	205.4 (5.59)	172.8 (3.7)	148.2 (5.67)
GROUP B (MONOCRYL)	1413.4 (14.06)	1303.2 (12.43)	1118.8 (11.77)
p value, Significance	p <0.001**	p <0.001**	p <0.001**
7th DAY	ARTIFICIAL SALIVA MEAN (SD)	CHLORHEXIDINE MEAN (SD)	LISTERINE MEAN (SD)
GROUP A (CATGUT)	124.6 (13.81)	91.0 (17.07)	86.8 (4.71)
GROUP B (MONOCRYL)	826.2 (11.47)	773.8 (9.33)	622.6 (14.75)
p value, Significance	p <0.001**	p <0.001**	p <0.001**
14th DAY	ARTIFICIAL SALIVA MEAN (SD)	CHLORHEXIDINE MEAN (SD)	LISTERINE MEAN (SD)
GROUP A (CATGUT)	27.8 (10.8)	19.8 (7.29)	15.2 (4.76)
GROUP B (MONOCRYL)	415.0 (14.17)	384.6 (9.91)	298.4 (17.72)
p value, Significance	p <0.001**	p <0.001**	p <0.001**

p >0.05 – not significant *p<0.05 – significant **p<0.001 – highly significant

At 14th day in artificial saliva, mean tensile strength in Group A (chromic catgut) and Group B (Monocryl) were 27.8 ± 10.8 MPa and 415 ± 14.17 MPa and the difference was found to be of highly statistical significance (p<0.001). At 14th day in chlorhexidine solution, mean tensile strength in Group A (chromic catgut) and Group B (Monocryl) were 19.8 ± 7.29 MPa and 384.6 ± 9.91 MPa and the difference was found to be of highly statistical significance (p<0.001). At 14th day in Listerine solution, mean tensile strength in Group A (chromic catgut) and Group B (Monocryl) were 15.2 ± 4.76 MPa and 298.4 ± 17.72 MPa and the difference was found to be of highly statistical significance (p<0.001).

On intragroup comparison of tensile strength in chromic catgut (Group A) at various time intervals (Day 1, Day 7 and Day 14) respectively, there was highly statistical significant decline (p<0.001) in mean tensile strength as the time duration of immersion in solution increases from baseline to 14th day. On intragroup comparison of tensile strength in monocryl (Group B) at various time intervals (Day 1, Day 7 and Day 14) respectively, there was highly statistical significant decline (p<0.001) in mean tensile strength as the time duration of immersion in solution increases from baseline to 14th day as shown in Table 2.

Table 2: Intragroup comparison of Tensile strength for chromic catgut (Group A) and monocryl (Group B) and at various time intervals (Day 1, Day 7 and Day 14) respectively.

GROUP A (CHROMIC CATGUT)	ARTIFICIAL SALIVA MEAN (SD)	CHLORHEXIDINE MEAN (SD)	LISTERINE MEAN (SD)
Day 1	205.4 (5.59)	172.8 (3.7)	148.2 (5.67)
Day 7	124.6 (13.81)	91.0 (17.07)	86.8 (4.71)
Day 14	27.8 (10.8)	19.8 (7.29)	15.2 (4.76)
p value	p<0.001**	p<0.001**	p<0.001**
GROUP B (MONOCRYL)	ARTIFICIAL SALIVA MEAN (SD)	CHLORHEXIDINE MEAN (SD)	LISTERINE MEAN (SD)
Day 1	1413.4 (14.06)	1303.2 (12.43)	1118.8 (11.77)
Day 7	826.2 (11.47)	773.8 (9.33)	622.6 (14.75)
Day 14	415.0 (14.17)	384.6 (9.91)	298.4 (17.72)
p value	p<0.001**	p<0.001**	p<0.001**

p >0.05 – not significant *p<0.05 – significant **p<0.001 – highly significant

DISCUSSION

Synthetic and natural absorbable sutures share a single indication, providing temporary and mechanical support until the natural tissue heals and regains strength. As the natural tissue heals, the degradable suture gradually weakens so that a gradual stress transfer occurs. Therefore, adjusting the rate of degradation of an absorbable suture to enable proper healing of the surrounding tissue is a major challenge in designing a temporary support.

The present study was aimed to evaluate the tensile strength between chromic catgut (4-0) and monocryl (4-0) in three different solutions at various time intervals. The selection of suture materials was based on their versatility and popularity for various oral and periodontal surgical procedures. In addition, selection of solutions were based upon frequently used solutions in the oral cavity such as artificial saliva, 0.2% chlorhexidine and Listerine.

The tying of knots is as important as any other aspect of surgery.[5] When using synthetic absorbable sutures, it is recommended that the surgeon's knot to be used to prevent knot untying.[6] Our study used the surgeon's knot for all of the samples for this reason.

The duration of our study and the selection of testing points were based on clinical relevance; the study was conducted for only 2 weeks because the sutures for most periodontal procedures are removed at that time. In our study, monocryl showed the highest tensile strength at each interval than chromic catgut.

On intragroup examination for both chromic catgut and monocryl, among three solutions, highest tensile strength was found in artificial saliva followed by chlorhexidine (0.2%) and listerine. Similar study was conducted by Mohammed et al[7] showed highest tensile strength for monocryl (5-0) in chlorhexidine mouthwash when compared with Listerine.

For future direction, large samples size are needed for evaluation. In our present study, we have evaluated tensile strength of suture material after emersion at 1st day, 7th day and 14th day. The pre-emersion tensile strength of suture material would be helpful for result.

CONCLUSION

In conclusion, our findings suggest that commercially available mouthwashes may influence the physical characteristics of the suture strength, stability and its impact during the healing period of surgical wounds. The current study suggests that Listerine mouthwash largely reduces the tensile strength of chromic catgut (4-0) & monocryl (4-0) than chlorhexidine and artificial saliva.

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