Original Article

Comparison of Tensile Strength of Suture Materials used in Periodontal Surgeries: An *In vitro* Study

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Abstract

Aim: The aim of the present study was to compare the *in vitro* tensile strength of suture materials used in periodontal surgeries. **Materials and Methods:** Four suture materials (silk, polyglactin 910, polyglecaprone, and polytetrafluoroethylene [PTFE]) were included in this study. A total of 120 suture samples (30 of each suture material) were included in the present study. The *in vitro* tensile strength (tested on Instron® universal testing machine) of each suture sample was evaluated pre-immersion and post-immersion at 1 h-day 0, 3rd, 7th, and 14th day. **Results:** Each suture sample demonstrated an obvious breaking point during mechanical testing on the Instron® universal testing machine. Analysis of variance was used to determine the significance of difference from pre-immersion in dried state to day 14 post-immersion for both intergroup and intragroup comparisons. **Conclusion:** Among four materials evaluated, at day 14, a decrease in tensile strength was seen in polyglecaprone, silk, and polyglactin. However, there was increase in mean tensile strength seen in PTFE.

Keywords: Periodontal surgery, Polyglactin 910, Polyglecaprone, Polytetrafluoroethylene, Silk, Tensile strength.

Introduction

A suture is a biomaterial device, either natural or synthetic, used to ligate blood vessels and approximate tissues together.[1] Primary closure of tissues, which were separated by surgical procedure or accidental trauma, promotes a healing process and controls inactive bleeding.[2] Proper positioning and stabilization of the surgical flap are important to achieve healing by primary intention. Improper positioning of the flaps can lead to delayed or compromised healing.

Suitable sutures require precise physical characteristics and properties. One of the most important mechanical properties is the tensile strength of the suture material. Tensile strength is a characteristic that is required to be upheld due to the fact that suture material tends to lose between 70% and 80% of its original strength. Consequently, the necessary original tensile strength must be guaranteed to avoid breaking the suture material.[3,4]

In the oral cavity, different suture materials show different behaviors.[5,6]Among the several available suture materials, silk, polyglactin, polyglecaprone, and polytetrafluoroethylene (PTFE) are commonly used in periodontal procedures. Therefore, the aim of the present study was to evaluate and compare the tensile strength of silk, polyglactin 910, polyglecaprone, and PTFE suture material in artificial salivary substitute and a pre-immersed dry condition during a period of 14 days.

Access this article online

Website: www.jrad.co.in

DOI: https://doi.org/10.53064/jrad.2022.13.3.147

Objective

The purpose of the present study was to compare the *in vitro* tensile strength of suture materials used in periodontal surgeries.

Materials and Methods

The proposed study was conducted at the Department of Periodontology, AMC Dental College and Hospital and Ahmedabad Textile Industry's Research Association. The study was designed with four groups of suture materials silk, polyglactin 910, polyglecaprone, and PTFE with 30 materials of equal length of 10 cm in each group.

Materials/equipment used in the study (Figures 1 and 2)

Methodology

Suture materials studied were silk, polyglactin 910, polyglecaprone, and PTFE. All the suture samples were measured to a uniform length of 10 cm. Artificial salivary substitute was used.

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Received: Jan. 12, 2022; **Accepted:** Feb. 15, 2022; **Published:** Feb. 26, 2022

How to cite this article: Narsinghani H, Dave B, Thakker V, Jadeja K, Shah K, Raj K. Comparison of Tensile Strength of Suture Materials used in Periodontal Surgeries: An *In vitro* Study. J Res Adv Dent 2022;13(3):9-12.

Figure 1: Suture materials, artificial salivary substitute, Petri dishes

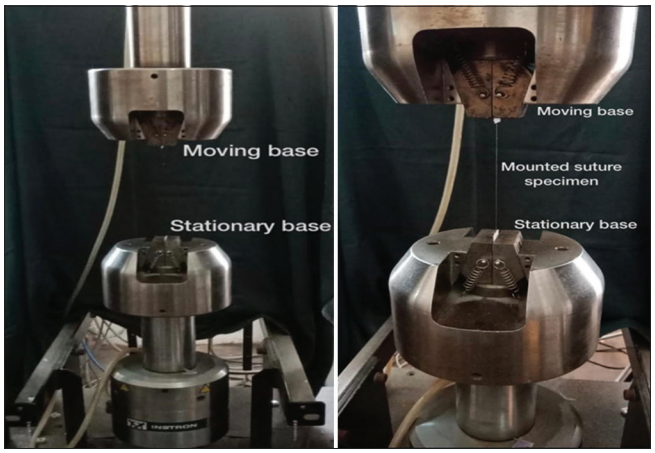


Figure 2: Universal testing machine

Figure 3: Suture material in (a) non-tensioned state and (b) while tensile loading

Figure 4: Breakage of suture specimen

Mechanical properties of the suture samples were evaluated using universal testing machine coupled to a computer for digital productivity. The tensile strengths of the suture samples were tested at specified time points: Pre-immersion, immediate post-immersion, and 1, 3, 7, 10, and 14 days post-immersion. Artificial salivary substitute was maintained at a pH of 7.4–8.1 in an incubator at 37°C. All 120 suture samples were placed in separate labeled Petri dishes containing the artificial salivary substitute and maintained for a specified time in a non-tensioned state (The salivary substitute solution was replenished every 2 days).

Tensile strength assessment of the suture samples was done at a speed of 1 mm/min. Each specimen was stretched to failure and the maximum load was recorded in Newton (N) and tabulated for analysis (Figures 3 and 4).

Results

A total of 120 suture samples (30 of each suture material) were included in the present study. Each suture demonstrated an obvious breaking point during mechanical testing on the Instron® universal testing machine. Analysis of variance was used to determine the significance of difference from pre-immersion in dried state to day 14 post-immersion for both intergroup and intragroup comparisons (Figure 5).

The comparison of mean tensile strength for each suture group at different time intervals intended for the study is shown in Table 1 and presented in Graph 1.

Intergroup comparison of tensile strength of silk, polyglactin, polyglecaprone, PTFE is shown in Table 2.

Discussion

For the surgeon, the challenge is to choose a suture material that provides an optimum balance between the advantages of monofilament and multifilament sutures. At baseline (both pre-immersion and post-immersion), tensile strength was highest for polyglecaprone (Mean ± SD= 45.82 ± 0.53, 51.98 ± 0.67) pre-immersion and post-immersion, respectively, followed by polyglactin 910 (Mean ± SD = 36.25 ± 0.53, 34.85 ± 0.53)

Table 1: Comparison of mean tensile strength of different suture material groups at different time

Time	Silk		Polyglactin		Polyglecaprone		PTFE		*P*-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Pre	20.57	0.24	36.25	0.53	45.82	0.53	25.09	0.76	0.000
0 day	20.02	0.02	34.85	0.53	51.98	0.67	25.30	0.69	0.000
3 days	18.80	0.36	38.03	0.24	48.18	0.26	26.81	0.50	0.000
7 days	21.44	1.14	43.41	1.59	42.98	0.62	25.79	0.39	0.000
14 days	17.35	1.00	18.53	0.84	43.94	0.63	29.17	0.63	0.000

P>0.05: Not significant, *P*<0.05: Significant, *P*<0.001: Highly significant

Table 2: Intergroup comparison of tensile strength pre- and post-immersion in artificial salivary substitute

Time	S versus PGL	S versus PGCL	S versus PTFE	PGL versus PGCL	PGL versus PTFE	PGCL versus PTFE
Pre	0.000	0.000	0.000	0.000	0.000	0.000
0 day	0.000	0.000	0.000	0.000	0.000	0.000
3 days	0.000	0.000	0.000	0.000	0.000	0.000
7 days	0.000	0.000	0.000	>0.05	0.000	0.000
14 days	>0.05	0.000	0.000	0.000	0.000	0.000

PTFE: Polytetrafluoroethylene

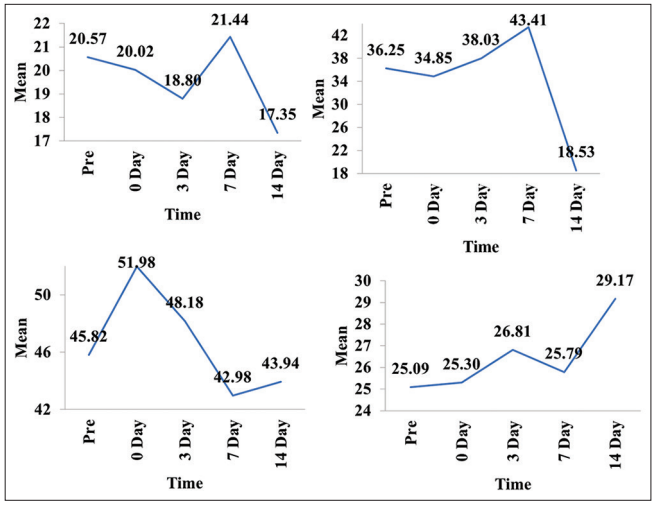
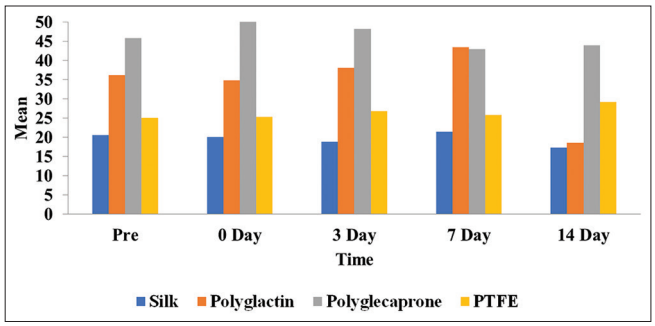


Figure 5: Mean tensile strength of silk, polyglactin, poliglecaprone, and PTFE, respectively



Graph 1: Comparison of mean tensile strength of suture materials

pre-immersion and post-immersion, respectively, PTFE (Mean ± SD = 25.09 ± 0.76, 25.30 ± 0.69) pre-immersion and post-immersion, respectively, and silk (Mean ± SD = 20.57 ± 0.24, 20.02 ± 0.02) pre-immersion and post-immersion, respectively.

Silk had the lowest tensile strength at baseline. This is in accordance to the studies done by Naleway *et al.* (2014)[7] and Arce *et al.* (2019).[3]

Silk is the most commonly used suture material in the surgical field even though it carries suboptimal mechanical properties. Although silk is classified as a nonresorbable suture, but is recognized to be subject to proteolytic degradation over a period of time.[8] Studies have shown that silk is one of the most susceptible to mechanical property changes in case of variation in pH conditions.[9] In the present study, it was reported that tensile strength of silk suture gradually reduced from day 0 (20.02 ± 0.02) to day 14 (17.35 ± 1.00). This is in accordance to the studies done by Arce *et al.* (2019) and Alamer *et al.* (2019).[10]

Polyglactin 910, a synthetic, multifilament, absorbable suture, had tensile strength at baseline (34.85 ± 0.53) which was significantly greater than silk and PTFE. This tensile strength was maintained till day 7. However, between days 7 and 14, a significant reduction in tensile strength was seen. These results are in accordance with results obtained by Vasanthan *et al.*[11] and Khiste *et al.*[12]

Polyglecaprone, a synthetic, monofilament, absorbable suture, had highest tensile strength at baseline (51.98 ± 0.67). This is in accordance to the studies done by Naleway *et al.* (2014),[7] Alsarhan *et al.* (2018).[6] The tensile strength in our study showed significant reduction from day 0 (51.98 ± 0.67) to day 14 (43.94 ± 0.63) though, even after reduction, the strength was highest compared to silk, polyglactin, and PTFE. However, in the study done by Alsarhan *et al.* (2018) concluded that unlike monocryl, tensile strength of Vicryl sutures significantly increased in CHX and Listerine solutions, which may be due to difference in emerging solution. Furthermore, in the study done by Varma *et al.* (2019),[13] they compared tensile strength of polyglactin,

polyglecaprone, and catgut and concluded that when immersed in herbal solutions, polyglactin was superior to polyglecaprone and catgut as there emerging solution was herbal.

Tensile strength of PTFE showed significant difference in mean tensile strength from day 0 (25.30 ± 0.69) to day 14 (29.17 ± 0.63). This is in accordance to the study done by Arce *et al.* 2019.[3] Intergroup comparisons between four suture materials showed that the materials differed significantly at baseline with polyglecaprone having the greatest tensile strength, followed by polyglactin, PTFE, and silk. These results were maintained till day 3. At day 7, there was increase in mean tensile strength of polyglactin (43.41 ± 1.59) and silk (21.44 ± 1.14). At day 14, polyglecaprone in spite of significant decrease in tensile strength had higher mean tensile strength (43.94 ± 0.63) as compared to PTFE (29.17 ± 0.63), polyglactin (18.53 ± 0.84), and silk (17.35 ± 1.00).

Conclusion

Within the scope and limitations of the study, the following conclusions were made:

- Polyglecaprone has the highest tensile strength at baseline both pre-immersion and post-immersion, followed by polyglactin, PTFE, and silk in that descending order
- At day 3, post-immersion highest mean tensile strength was seen in polyglecaprone, followed by polyglactin, PTFE, and silk in descending order
- At day 7, post-immersion highest mean tensile strength was seen in polyglactin, followed by polyglecaprone, PTFE, and silk in descending order
- At day 14, post-immersion highest mean tensile strength was seen in polyglecaprone, followed by PTFE, polyglactin, and silk in descending order
- Among four materials evaluated, at day 14, a decrease in tensile strength was seen in polyglecaprone, silk, and polyglactin. However, there was increase in mean tensile strength seen in PTFE.

Future Scope of the Study

- Future study may be done comparing the material showing highest mean tensile strength at day 14 in our study with other widely used suture materials such as polypropylene and ePTFE.
- Further study may be done using 1:1 mixture of artificial saliva with serum as environment.

Financial Support and Sponsorship

Nil.

Conflicts of Interest

There are no conflicts of interest.

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