Tensile Strength Analysis Of Simple Interrupted Suture And Double Sling Suture Technique With Non Absorbable Sutures

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Received 25 June 2026; Revision 1st 19 August 2026, Accepted 25 August 2026; Published online 25 August 2026

Keywords:

Tensile strength, suturing, simple interrupted suture, double sling suture, silk, nylon

ABSTRACT

Background: *Suturing is one of the important aspects in the success of periodontal flap surgery. The main purpose of suturing are for stability and immobilization of the wound. The success of suturing is influenced by the selection of appropriate suture techniques and materials. Simple interrupted suture techniques are often used in wounds with primary intention. However, this technique has several disadvantages so modification is made into a double sling suture technique. There are various kinds of sutures, such as non-absorbable sutures. The most important mechanical properties of sutures is tensile strength. The aim of this study is to compare the tensile strength of simple interrupted suture techniques and double sling sutures with non-absorbable sutures.*

Method: *24 samples were divided into 4 groups, simple interrupted suture group and double sling suture, each group using silk and nylon sutures. The suturing process was carried out on artificial gingival media, then carried out tensile tests and recorded the causes of failure that occurred in each sample.*

Result: *The mean tensile strength of the double sling suture technique was higher than the double sling technique in both the silk and nylon sutures groups. Based on the results of the ANOVA test showed a significant difference ($p \leq 0.05$) between groups. Failure in silk sutures was caused by rupture media, while nylon sutures was caused by knots slippage.*

Conclusion:

The tensile strength of the double sling suture technique is greater when compared to simple interrupted suture techniques so that it is better to use in suturing wounds with primary intention.

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DOI: http://dx.doi.org/10.30659/medali.8.2.107-113
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How to Cite: *Pratiwi et al*. Tensile Strength Analysis Of Simple Interrupted Suture And Double Sling Suture Technique With Non Absorbable Sutures. MEDALI Jurnal: Media Dental Intelektual, v.8, n.2, p.107-113, August 2026.

INTRODUCTION

A periodontal flap is a section of gingiva, mucosa, or both that is surgically separated from the underlying tissues to provide for the visibility of and access to the bone and root surface. The flap also allows the gingiva to be displaced to a different location in patients with mucogingival involvement. Suturing is one of the important aspects in the success of periodontal flap surgery.[1] Flap stability is, in particular positively influenced by an adequate suture technique, which therefore represents one important successful treatment outcomes and suture material. [2,3]

Suture is the most commonly used material. Various sutures are used clinically, and they are classified by several criteria: (1) spontaneous degradation-absorbable and non-absorbable; (2) composition-natural and synthetic; and (3) structure-monofilament and multifilament.[4,5] The ideal suture material for surgery should be biocompatible, easy to handle, form secure knots, produce minimal tissue drag, have long lasting tensile strength, and retain strength for sufficient time give support during fibrous tissue ingrowth into the mesh. The most important mechanical properties of suture material is tensile strength.[3,6,7]

During periodontal surgical therapy, suturing technique allows for the precise positioning of the flaps. Therefore, various suturing techniques are classified as simple interrupted suture, sling, continuous sling, double continuous sling, external and internal mattress, suspensory, anchor and laurel loop sutures. Selection of the techniques is primarily determined by surgical procedures, ease of placement, and the final position of the flap.Simple interrupted suture is a suturing technique that is often used in suturing wounds with primary intention.[8]

When adapting wound areas, traditional interrupted sutures are performed through the entire tissue thickness, including periosteum. Tissue adaptation is only successful when an identical bite size, defined as the distance between the incision line and the point where the needle is inserted into or exits the tissue is respected on each side of the incision. This is essential tension free and a perfect adaptation of the flap tissues. When accurate bite sizes cannot be established, in the interproximal spaces, overlapping and folding primarily at the palatal aspect of the flap results, leading to a compromised wound healing due to gap formation and colonization by microorganisms. The following modified microsurgical suture, the double sling suture, can overcome these disadvantages. The double sling suture combines two interrupted sutures, which are performed in different tissue layers and with different bite sizes.9 Suturing carried out in the oral cavity has a different phenomenon than when done on other body parts. The difference lies in the type of tissue involved, the role of saliva, more vascularity. The pull of the oral cavity muscles associated with the function of speech, chewing and swallowing causes sometimes sewing in the oral cavity easily released.[6,10]

The aim of this study is to compare the tensile strength of simple interrupted suture technique and double sling sutures with non-absorbable sutures.

RESEARCH METHOD

An “in vitro” study was performed to access the tensile strength of two suture techniques (simple interrupted suture and double sling suture) with two different non absorbable sutures, silk and nylon with 5-0 gauge. Twenty-four samples were divided into 4 groups, simple interrupted suture and double sling suture groups, each group using silk and nylon sutures.

Preparation of the Sample

Making templates or molds from zinc metal with the appropriate shape and size for artificial gingival media so that the size, width and location of the incisions are obtained and the location of the bite size is homogeneous. Cutting artificial gingival media according to the predetermined template. Making incisions on artificial gingival media in accordance with the template guidelines previously made. Perform sewing on artificial gingival media with simple interrupted techniques in group A samples and double sling suture techniques in group B samples with a bite size guide on the template (Fig. 1).

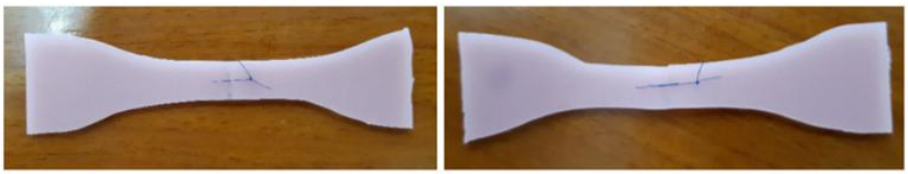

Figure 1. (A) Simple interrupted suture group sample; (B) Double sling suture group sample.

Performing the Sutures

One researcher (RP) independently performed 24 sutures under the same environmental conditions using silk and nylon (Ailee® Co. Ltd. South Korea). All the sutures were tied with surgeon's knot (2 clockwise-1 counter clockwise-1 clockwise) and were cut leaving 5 mm tails.

Tensile Strength Test

The samples were pulled in opposite directions using tensile test machine (ToyoseikiStrograph VG10-E; Japan). Traction was performed at a speed 5 mm/min. The event of failure that took place was registered (suture breakage, knot slippage or rupture media). The maximum load (in N) was registered when the suture failed due to one of the reasons: suture breakage, knot slippage or rupture media (**Fig 2**).

Figure 2. Tensile strength test

Statistical Analysis

The statistical analysis was performed with SPSS Statistic 16.0 software. Normality of the scale variable (tensile strength) was explored using Saphiro-Wilk test. Where distribution was compatible with normality, independent t-test were used. While, if normality was rejected, non-parametric tests were employed. ANOVA test and Post Hoc were used to see significant difference among groups. The statistical significance was set at $p \leq 0.05$.

RESULT

Means of tensile strength of simple interrupted suture technique with silk and nylon groups were 4.5 N and 1.5 N. While means of tensile strength of double sling suture with silk and nylon groups were 6.3 N and 3.0 N (**Table 1**).

Table 1. Means and standard deviation of simple interrupted suture and double sling suture technique groups.

TECHNIQUE	MATERIALS	TENSILE STRENGTH (N)	
		MEAN	SD
INTERRUPTED SUTURE	SILK (n= 6)	4.5	0.547
	NYLON (n= 6)	1.5	0.447
DOUBLE SLING SUTURE	SILK (n= 6)	6.3	1.290
	NYLON (n= 6)	3.0	0.707

Percentage of failure of both groups showed in **Table 2**. In the simple interrupted suture technique with silk group, all 6 samples 100% were damaged in the form of rupture media. While using nylon group, 100% were damaged of knot slippage.

In the double sling suture technique group using silk, there was 1 sample (16.7%) suture breakage and 5 samples (83.3%) having damage in the form of rupture media. While using nylon there was 1 sample (16.7%) also experiencing damage in the form of suture breakage, but 5 samples (83.3%) suffered damage in the form of a knot slippage.

Table 2. Percentage of failure of simple interrupted suture and double sling suture technique groups.

TECHNIQUE	MATERIALS	FAILURE (%)		
		SUTURE BREAKAGE	RUPTURE MEDIA	KNOT SLIPPAGE
INTERRUPTED SUTURE	SILK(n= 6)	0%	100%	0%
	NYLON(n= 6)	0%	0%	100%
DOUBLE SLING SUTURE	SILK(n= 6)	16.7%	83.3%	0%
	NYLON(n= 6)	16.7%	0%	83.3%

Normality test in the interrupted suture group using silk and nylon were ($p = 0.078 \geq 0.05$) and ($p = 0.167 \geq 0.05$) so that it can be concluded that the data was normally distributed. In the double sling suture technique group using silk and nylon were ($p= 0.463 \geq 0.05$) and ($p= 0.960 \geq 0.05$) so that it can be concluded that the data was normally distributed (Table 3).

Table 3. Statistical analysis of simple interrupted suture and double sling suture technique groups.

TECHNIQUE	MATERIAL	*Saphiro-Wilk*	*Independent t-test*	*ANOVA*
INTERRUPTED SUTURE	SILK	0.078	0.000*	0.000*
	NYLON	0.167		
DOUBLE SLING SUTURE	SILK	0.463	0.000*	
	NYLON	0.960		

*) p≤ 0.05 significant

Table 3 showed results of the analysis of different tests using independent t-test with a significance degree of 95% between silk and nylon in the interrupted suture technique groups was (p = 0.000≤ 0.05). It can be concluded that there was a significant difference between the tensile strength of interrupted sutures between groups of silk and nylon. While different tests using independent t-test between silk and nylon in the double sling suture technique groups was (p = 0.000≤ 0.05). It can be concluded that there was a significant difference between the tensile strength of the double sling suture between the silk and the nylon groups.

The ANOVA test results between groups showed values (p = 0.000≤ 0.05). It showed that there were significant differences between groups (**Table 3**).The results of the Post Hoc analysis showed that there were significant differences (p≤ 0.05) between the interrupted suture groups using silk and nylon thread with the double sling suture technique group using silk and nylon (**Table 4**).

Table 4. Post Hoc analysis of simple interrupted suture and double sling suture technique groups.

TECHNIQUE/ MATERIAL	*Interrupted Silk*	*Interrupted Nylon*	*Double sling Silk*	*Double sling Nylon*
Interrupted Silk		0.000*	0.005*	0.022*
Interrupted Nylon	0.000*		0.000*	0.022*
Double sling Silk	0.005*	0.000*		0.000*
Double sling Nylon	0.022*	0.022*	0.000*	

*) p≤ 0.05 significant

DISCUSSION

Reconstruction of dentofacial harmony has emerged as a major treatment goal in modern dentistry. Whereas in recent years much emphasis was placed on achieving a “white esthetic”, the main focus of modern treatment strategies is shifting towards the establishment of harmonious gingival architecture. Therefore, unfavorable wound healing

in the esthetic zone resulting fibrosis, scar tissue formation, and tissue necrosis can scarcely be tolerated and jeopardizes the esthetic outcome of any surgical intervention.[9]

The suturing technique is of certain importance in this context as it should meet the following two principal prerequisites needed for optimized healing: an intimate contact of the affected tissues and a proper wound stabilization.[2] Precise flap closure is one of the major determining factors in achieving wound healing by primary intention and obtaining the desired treatment result. This leads to fast bridging of the incision wound by fibrin, ingrowth of blood vessels, and epithelial wound closure over a period of up to 5 days. Accurate apposition of surgical flap is important for patient comfort, hemostasis, and minimize inflammation.[11]

In wound healing by primary intention, simple interrupted suture technique is often been used. In contrast, tissue adaptation is only successful when an identical bite size is respected on each size incision. The following modified microsurgical suture, the double sling suture technique can overcome these disadvantages. [9]

Based on the results, the tensile strength of double sling suture technique was higher than simple interrupted suture technique. The double sling suture is stronger and more stable because it combines two simple interrupted sutures, which are performed in different tissue layers and with different bite sizes. The first part of the suture ensures the closure of the deep wound areas, while the second is able to precisely adapt the outer tissue layers.

The suture materials plays important role. Two different non absorbable suture, silk and nylon were used in this research. Silk has multifilament structure, while nylon has monofilament structure. It might causes silk has higher tensile strength than nylon. The multifilament structure makes silk tends to accumulate more bacterial plaque than nylon. In order to minimize the risk of bacterial colonization, the knot must be kept away from the incision line because this area is more prone to plaque accumulation.[12]

Jin-Cheol et al (2007) in their research found that nylon has higher tensile strength than silk. Nylon showed the highest elongation rate, which might have induced the highest tensile load. Higher elongation rate of nylon can cause clinical failure. Moreover, elongation of suture material causes the decrease in diameter of material, which can act as a knife and can tear tissues.[4]

The study showed most failure in silk caused by rupture of the media, while in nylon caused by knot slippage. Silk had good knot's security than nylon. Knot slippage might result in a suboptimal physical environment for healing to occur: therefore, it is prudent to maximize every opportunity for a good repair, including the elimination of mechanical instability of repair suture.[4] There were one sample (16.7%) in each group suffered suture breakage. It might be caused by long duration of suture manipulation suture so that sutures became brittle and was easy to breakage.

CONCLUSION

It can be concluded that tensile strength varied by technique and suture materials. Double sling sutures technique was higher than simple interrupted suture so that double sling suture was recommended in wound closure with primary intention. Mode of failure in silk caused by rupture of the media, while in nylon caused by knot slippage. Further study with absorbable suture and diameter sutures variations should be performed.

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