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Original research

COMPARISON TENSILE STRENGTH OF DIFFERENT SUTUR MATERIALS

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ABSTRACT

Objectives: The purpose of this study is to compare the tensile strength of different types of surgical suture materials.

Materials and Methods: Current study, the tensile strengths of 4 different suture materials was compared. [(1-4/0 silk suture 2-4/0 propylene suture 3-4/0 Polyamide suture 4-4/0 Poly[Glycolide-Co-L-Lactide] (90%:10%) (PGLA) suture)] The tensile strength of a total of 40 samples was calculated, with 10 samples in each group. In the study, the tensile strength of the sutures was calculated using a universal tester, the sutures were tightened to both poles of the test device and fixed with a distance of 15 mm between the poles, tensile force was applied so that both poles of the test device moved away from each other at a speed of 25cm/min until the sutures broke, and the force value of the sutures at the moment of brake was recorded in Newton units (N) as the tensile strength of suture. Statistical analysis of the data was evaluated by One-Way ANOVA and Tukey HSD tests.

Results: In the statistical analysis of the tensile strength of the suture materials, the difference between the tension resistance of the PGLA and Polyamide suture was not statistically significant, but the difference between all other suture materials was statistically significant ($p<0.05$). Tensile strength of suture materials were determined as propylene, polyamide, PGLA and silk suture, respectively.

Conclusions: Within the limits of the current study, the tensile strength of the propylene suture was higher than that of PGLA, silk, and polyamide sutures.

Keywords: Sutures, Tensile, Break.

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INTRODUCTION

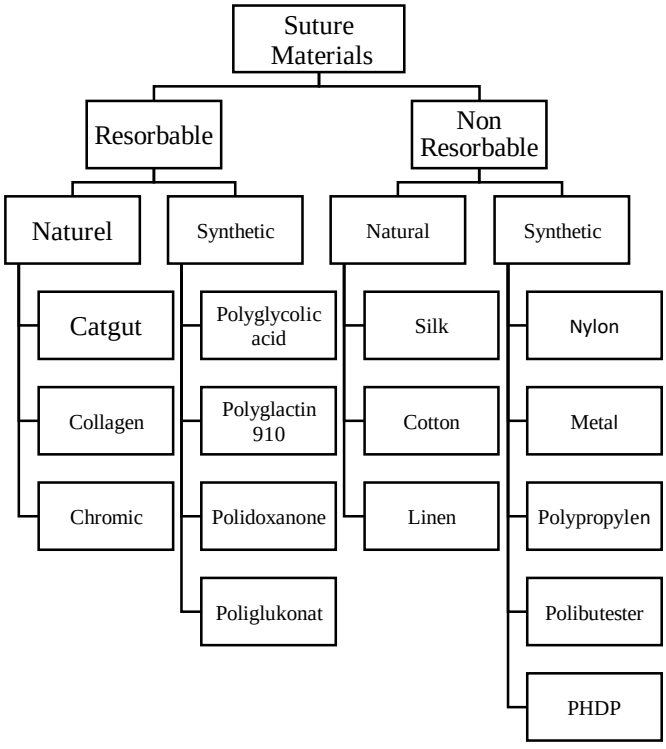
Suturing is performed in dentistry, implant treatment, impacted tooth extractions, minor surgical procedures or in cases where tissue integrity is disrupted due to trauma and similar reasons. Suturing are used sutures, tissue adhesives and staples in the clinic. Suture is the most frequently used material among them.[1] Which suture will be selected in the clinic; The suture's tensile strength, knot reliability, elasticity, capillarity, and tissue reaction should be evaluated.[2]

Tensile resistance; It is the condition that the suture material resists the tension on the wound edges enough to maintain the current position of during the wound healing process. Knot reliability; It is the condition of maintaining the stability of the knot against tissue tension, and this feature varies according to the capillarity feature of the suture, whether it is monofilament or multifilament. Capillarity in sutures is defined as the flow of absorbed fluids through the suture. This feature causes infection in the tissues around the suture by microorganisms in the mouth. Capillarity is higher in multifilament sutures than in monofilament sutures. The elasticity of an object is defined as the object's deformation with force and its ability to return to its original shape after the force is removed. Elasticity in sutures is defined as the return of the original dimensions after the pressure is removed, although the suture shows stretching at varying pressures in the tissue during healing. Flexibility in sutures varies according to the suture material. Foreign body reaction is that the suture causes inflammation in the tissue. When sutures are evaluated in terms of Foreign body reaction, multifilament sutures cause higher tissue reaction than monofilaments, and natural ones cause higher tissue reaction than synthetic sutures.[3]

The ideal suture material should provide the following properties; 1-It should have enough tensile strength to protect the primary closure during the healing process, 2-It should have sufficient knot reliability, 3-It should be easy to use clinically, 4-It should have low capillarity and it should cause minimal foreign body reaction in the tissues. Each suture material has some advantages and disadvantages.[4,5]

Suture materials are classified according to the material from which they are obtained (Table 1).

Table 1: Classificiation of suture materials



Our aim in this study is to investigate the tensile strength of different suture materials. The use of different suture materials provides clinical advantages. In this study, our aim is to compare the tensile strengths of different suture materials.

MATERIALS AND METHODS

Our study was conducted with the approval of Nuh Naci Yazgan University non-interventional clinical research ethics committee dated 31.03.2021 and numbered 2021/1491.In our study, 4 different sutures were used. [(1-4/0 3/8 sharp black silk suture 16 mm Dogsan TURKEY, 2- 4/0, 3/8 sharp propylene suture 20 mm Dogsan TURKEY, 3- 4/0 3/8 sharp Polyamide, suture 20 mm Doğsan TURKEY, 4-Pegelak 4/0 1/2 round 20 mm poly (glycolide-co-lactide) (PGLA) suture, Doğsan TURKEY)]. This study, all sutures were used in 4/0 thickness for standardization and the type of suture to be used in the study was decided according to the frequency of use in the dentistry clinic.

The experimental stage of the study was carried out in Erciyes University Technology Research Application Center (TAUM). The number of samples in each group was determined as 10 (n=10). The tensile strength of all samples was calculated using a universal tensile-compression test device *(Shimadzu ag-xd 50kN Japan)* (Figure 1).

Figure 1: Tensile strenght measurement device (Shimadzu Ag-Xd 50kn Japan)

The sutures were fixed to the poles with a distance of 15 mm between then the poles moved away from each other at 25 cm/min and the tension force was provided on the sutures, the force was recorded at the moment break of the sutures as the tension resistance of that suture in Newtons (N) (Figure 2).

Figure 2: Fixing the suture on both poles of the tension resistance device

Statistical analysis of the obtained data was performed using SPSS 20 (SPSS Inc., Chicago, U.S.A) program. Variance homogeneity was examined using the Levene test. In evaluating the tensile strength analysis of variance (ANOVA) and Tukey's post hoc test were used to determine the differences between groups.

RESULTS

Statistical results are as shown in Table 2 ,Table3 and Figure 3 The mean values of each group were found as follows, Propylene suture 19.252 N, Polyamide suture 17.446 N, PGLA 16.907 N, Silk suture 14.250 N. The difference between polyamide and PGLA sutures was not statistically significant ($p>0.05$), while the differences between all other groups were statistically significant ($p<0.05$).

Table 2: Statistical comparison of the study grops

	Sum of squares	df	Mean of squares	F	Significant
Between groups	128.038	3	42.679	24.989	.000
Within groups	61.485	36	1.708		
Total	189.523	39			

**The mean different is significant at the 0.05 level (One –Way ANOVA)*

Table 3: Statistical evaluation of the mean values of the all groups

	n	Mean tensile strenght (Min-Max)	St. Dev.	p
Silk	10	14.250 (12.25-15.92)	1.54 [a]	p<0.05
PGLA	10	16.907 (13.85-19.85)	1.77[b]	p>0.05
Polyamid	10	17.446 (16.8-19.16)	0.772[b]	p>0.05
Propylene	10	19.252 (18.4-20.5)	0.85[c]	p<0.05

*There is significant difference between the averages shown with the different letter. (Tukey HSD).*The mean different is significant at the 0.05 level*

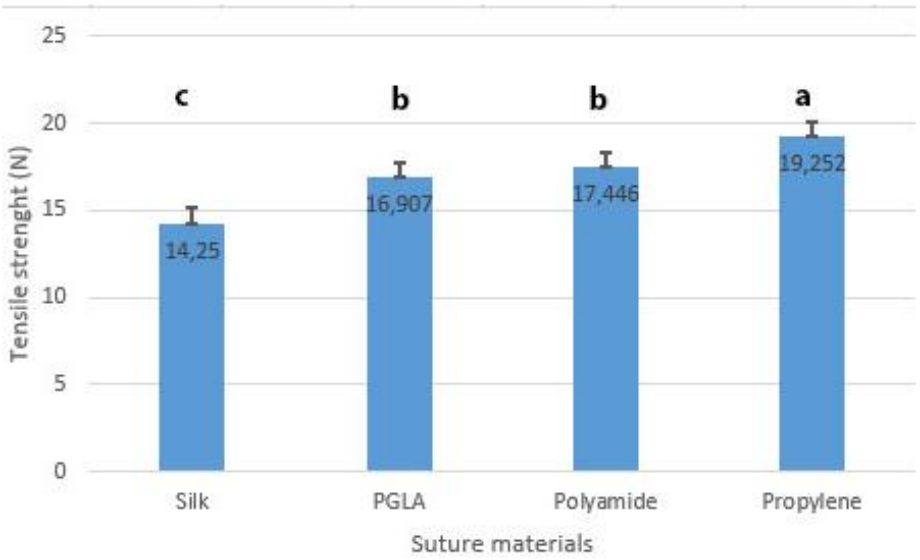


Figure 3: Graphical representation of the tensile strength averages of 4 different sutures. Different letters just above the columns in the graph indicate statistically significant difference.

DISCUSSON

Today, in dentistry, especially in surgical operations suture selection and suturing methods are important parameters to consider for adequate healing and maintaining the integrity and continuity of soft tissues.[6] The tensile strength of suture materials is affected not only by the material from which the sutures are obtained, but it's being monofilament or multifilament, suture thickness, and the duration of use in oral tissues.[7] Monofilament sutures have strong shape memory but poor knot reliability. Multifilament suture materials are resistant to abrasion and have higher tensile strength, flexibility, elasticity and knot reliability than monofilament sutures.[8]

In our study, contrary to the current literature, it was observed that the silk suture less tension resistance than other sutures.[9,10]

In the current study, the tension resistance of the propylene suture was found to be higher than the silk suture, while Joshi *et al.* and Gemci R. *et al.*[1,10,11] the tension resistance of silk suture was found to be higher than that of porpylene sutures and other sutures.

Suture materials are classified according to their thickness. Two main standards are used in the classification made according to the suture thicknesses. These standards are USP (United States Pharmacopoeia) and EP (European Pharmacopoeia) standards and USP is more commonly used in suture classification than EP classification. In the USP classification, sutures are numbered with the metric system, such as 7/0, 6/0, 5/0, 4/0, 3/0, and as the number increases, the suture gets thinner and the tension resistance decreases.[12]

According to this classification, 7/0 and more thinner sutures are used in microsurgery and ophthalmology procedures, 6/0 and 5/0 sutures are used in aesthetic suturing and vascular surgery, 4/0 sutures are used in mucosa, extremity and tendon suturing, and 3/0 sutures are used in general surgery.[13] In our study, we chose 4/0 thickness because it is a commonly used suture thickness in dentistry clinical routine.

Arce *et al.*[14] compared the tension resistance of PGLA and silk sutures in their study and according to the result of the study, the tension resistance of PGLA Suture was found to be higher than silk suture. In our study, Arce *et al.* Similar to the results of the study, the tensile strength of the PGLA suture was found to be higher than the silk suture.

The rat study in which tissue tension was measured during the healing process soft tissue defects were created experimentally, then the tension resistance of the tissue was measured on different days during the healing process. The results of this study showed that the tissues resisted tension up to 8 Newtons in the 1st week, 11 Newtons in the 2nd week, and up to 15 Newtons in the 6th week during the healing process.[15]

When we compared that previous sentences study and our study. We can conclude that all the sutures used in our study can be used safely for up to 2 weeks, but the resistance of the silk suture is insufficient in procedures that require a longer healing period.

Chu *et al.*[16] reported that resorbable sutures lost 30% of their tensile strength during the resorption process. The results of Chu *et al.'s* study are consistent with the current literature, and resorbed sutures lose some of their tensile strength over time.

Another factor affecting the suture tension is the knot, knotting the suture causes a loss of approximately 1/3 of the tensile strength, especially in the knot area.[17] Polyamide sutures are produced in 2 different structures as monofilament and multifilament, the tensile strength of the monofilament is higher than the multifilament.[18] In our study, we preferred a monofilament polyamide suture. Results of the study, the second highest tensile strength was found in this suture, which is partially compatible with the literature.

In the present study, it was determined that there are 2 important limitations. The first limitation is that monofilament and multifilament sutures were used in the same study. The second limitation is that a single measurement value cannot be a clear result since the tension resistance of resorbable sutures decreases as long as they remain in the mouth.

CONCLUSION

According to the results of the current study, propylene suture may be preferred in cases where primary closure of soft tissue is important, such as bone augmentation or mucogingival surgical procedures, since it is a suture with high tension resistance. However, the clinician should consider factors such as knot reliability, capillarity, and patient tolerance after the procedure when choosing sutures.

CONFLICTS OF INTEREST STATEMENT

The authors declare no potential conflicts of interest with respect to the authorship and/or publication of this article.

ÖZ

***Amaç**: Bu çalışmanın amacı elde edildikleri maddelere göre değişik yapıdaki sütür materyallerinin laboratuvar ortamında gerilime dirençlerinin karşılaştırılmasıdır.* ***Gereç ve Yöntem**: Çalışmamızda değişik materyalden üretilmiş 4 sütür materyalinin gerilim dirençleri karşılaştırılmıştır. [(1-4/0 siyah ipek sütür 2-4/0 propilen sütür, 3-4/0 Poliamid, sütür,4-4/0(PGLA)] her bir grupta*

10 örnek olmak üzere toplamda 40 örneğin gerilim direnci hesaplandı. Çalışmada sütürlerin gerilim direnci üniversal bir test cihazı kullanılarak hesaplandı, sütürler test cihazının her iki kutbuna gergin ve kutuplar arası 15 mm mesafe olacak şekilde sabitlendi, gerilim kuvveti sütürler kopuncaya kadar test cihazının her iki kutbunun 25cm/dk hızla birbirinden uzaklaşması şeklinde uygulandı ve sütürlerin kopma anındaki kuvvet değeri o sütürün kopma direnci olarak Newton biriminde (N) kaydedildi. Verilerin istatistiksel analizi One –Way ANOVA ve Tukey HSD testleriyle değerlendirildi. ***Bulgular:*** *Sütür materyallerinin gerilim dirençleri istatistiksel olarak analiz edildiğinde PGLA ve Poliamid sütürün gerilim dirençleri arasındaki fark istatistiksel olarak anlamlı değil iken, diğer tüm sütür materyalleri arasındaki fark istatistiksel olarak anlamlı bulunmuştur (p<0,05). Sütür materyallerinin gerilim direnci yüksekten düşüğe doğru sırasıyla propilen, poliamid, PGLA ve ipek sütür olarak belirlenmiştir.* ***Sonuçlar:*** *Bu çalışma sınırları dahilinde gerilim direncinin önemli olduğu durumlarda propilen sütürün PGLA, ipek veya poliamid sütüre göre daha avantajlı olabileceği belirtilmiştir. Bununla beraber, sütür seçiminde düğüm güvenilirliği, yabancı cisim reaksiyonu gibi faktörler de göz önünde bulundurulmalıdır.* ***Anahtar kelimeler****: Sütür, gerilim, kopma.*

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