Tensile Strength Test of Retraction Cords Immersed in a Solution of Aluminum Chloride

Desislava Makakova[1], Svetlin Alexandrov[1], Elena Vasileva[1]*, Yoanna Georgieva[1], Mariya Hristozova[1], Pavel Stanchev[2]

1. Department of Prosthetic Dentistry, Faculty of Dental Medicine, Plovdiv Medical University, 15A Vasil Aprilov blvd. Plovdiv 4000, Bulgaria.
2. Department of Endocrinology, Medical Faculty, Medical University- Plovdiv.

Abstract

The article aims to present evaluate the tensile strength of different retraction cord.

In the research, we used 50 experimental units of each type of retraction cord (Ultrapak # 00; the two items created for the study – a thread with a core of monofilament and a thread without a core). The tensile strength test was performed in an LMT 100 micro-tensile apparatus after all test pieces of cords were immersed for 20 minutes in a 10% solution of Al2Cl3. The data was processed using the specialized statistical product SPSS (version 21). A critical significance level of $p<0.05$ is used.

The tensile strength test of retraction sutures immersed in a 10% solution of aluminum chloride shows a statistically significant difference in the comparison between the two treated cords and Ultrapak # 00 ($p <0.001$).

Impregnation with 10% Al2Cl3 increases the tensile strength of the samples with a monofilament core and the cotton braid without a monofilament and decreases the tensile strength of the samples of Ultrapak cord.

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Introduction

Displacement of the gingival tissues (retraction) is necessary because the impression of a fixed type of structures requires an accurate and detailed impression of the preparation margins, which in most cases are below the marginal gingiva[1,2]. The methods used for retraction of the gums can be divided into 3 categories or be a combination of them: mechanical, chemo-mechanical and surgical[3,4,5].

Retraction cords are considered to be the most popular method of gingival tissue displacement[6,7,8]. The cords available on the dental market are classified according to their composition (cotton, silk or yarn, wool), impregnation with the astringent or hemostatic solution and design (braiding technique)[1,6,9].

Corresponding author:
Elena Vasileva,
Chief assistant professor, Department of Prosthetic Dentistry, Faculty of Dental Medicine, Medical University of Plovdiv15A, Vassil Aprilov Str., 4002 Plovdiv, Bulgaria.
E-mail: elena.vasileva@mu-plovdiv.bg

Applying only dry cotton cords to the gingival sulcus can damage epithelial cells[10,11].

Therefore, in clinical practice, the most widely used method is the chemo-mechanical retraction with a retraction cord immersed in an astringent solution[12]. The purpose of mechanical-chemical displacement is to direct the pressure in the sulcus to soften the flow of crevicular fluid, achieve hemostasis and create a physical space for the entry of the impression material[13].

The use of materials with insufficient properties, as well as inappropriate technique in the withdrawal of the gingival pocket (retraction), can lead to irreversible changes in the gingival tissues[13]. Rupture of the retraction cord during its insertion or removal results in tearing of tissue in the gingival sulcus and trauma to the connective tissue. The reason for this may be the insufficient tensile strength; it is crucial for the retraction laces and their satisfactory physicochemical properties[14,15].

Retraction cords with hemostatic drug provide successful displacement of the gingival tissue and allow sufficient space for the impression material to enter the gingival sulcus to accurately mark the preparation margin, and also gives sufficient thickness of the impression material to be removed from the sulcus without possible ruptures[16,17].

Aim: To evaluate the tensile strength of different retraction cords.

Material and methods

In this study, we used a simple retraction cord Ultrapak # 00 (U) - Ultradent Products, South Jordan, Utah, USA (fig. 1), as well as two alternatives created by the authors (fig. 2):

1. 100% cotton braided cords without core (P),
2. 92% cotton and 8% polyamide braided cords with monofilament core (PP).

Figure 1. Braided cords (P and PP).

Figure 2. Ultrapak # 00 (U) cord.

From each type of cord P, PP and U were cut 50 pieces, a total of 150 samples with identical length - 50 mm.

Using the silicone matrix we made ((Silibest, BMS Italy), we produced 150 experimental units, fixing the cords at both ends of epoxy resin (Epovit, Vector) (Fig. 3).

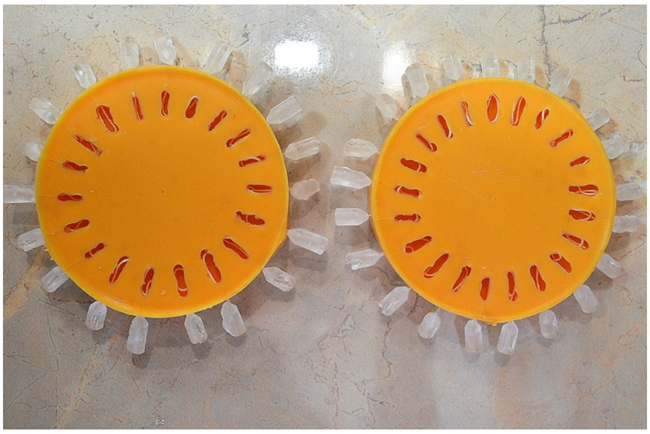


Figure 3. The final shape of the test specimens

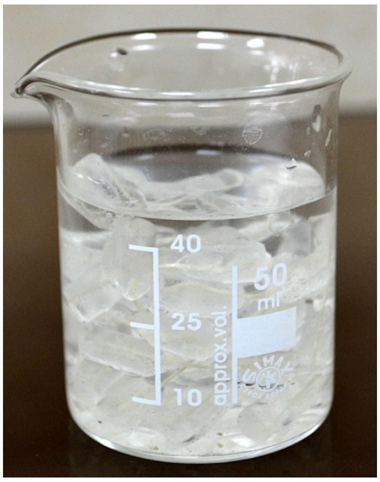


Figure 4. Test group soaked in a 10% solution of Al_2Cl_3.

The tensile strength test was performed in an LMT 100 micro-tension apparatus (Fig. 5).

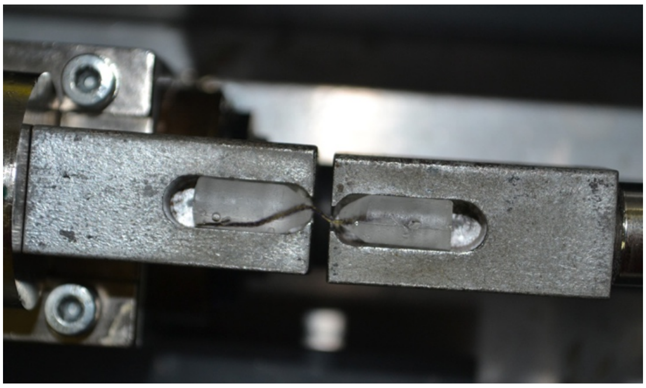


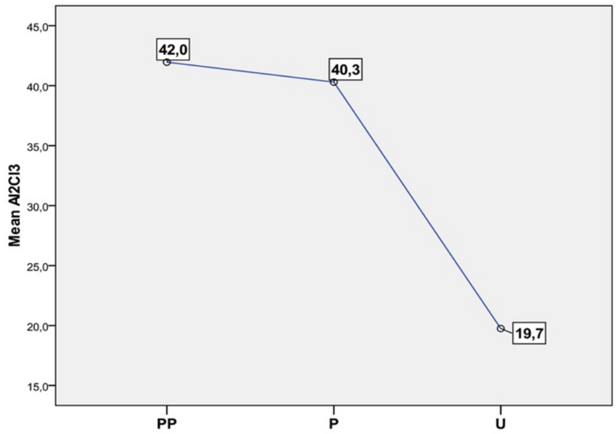
Figure 5. Prototype in the retaining elements of the LMT100.

We divided the experimental bodies units into 3 groups of 50 pieces according to the type of the retraction cord tested (Ultrapak # 00; the two created cords). Each group was then subjected to a tensile test after the cords were soaked for 20 minutes in a 10% solution of Roeko's Al_2Cl_3 (Fig. 4).

The data were processed using the specialized statistical product SPSS (version 21). The statistical methods used to process the information are descriptive analysis by means of two-dimensional frequency distribution tables (cross-tabulation) and analysis of variance (ANOVA One Way). A critical significance level of 0.05 is used.

Results

The comparison of the average strength of the three types of retraction cords tested in 10% solution of Al_2Cl_3 (Fig. 1) shows the highest tensile strength of 42 N/mm^2 in the cord with monofilament, followed closely in average result by the cord with the same cotton braid without monofilament 40.3 N/mm^2 and last, is Ultrapak I9.7 N/ mm^2.



Graph 1. Comparison between the type of retraction cord and the tensile strength (in 10% sol. of Al_2Cl_3).

Based on the multiple comparison, we establish a clear statistical difference between the compared groups by number. Diagram 1 proves that the distribution of the three groups, by analysis of variance (ANOVA One Way), does not confirm a statistically significant difference in PP and P tested with 10% $A1_2Cl_3$, where /> 0.05. The grouping of PP and U impregnated with 10% $A1_2C1_3$ confirmed a statistically significant difference, where P <0.001 (Graph 1).

It can be concluded that the distribution, by analysis of variance (ANOVA One Way), when comparing the values of P and U tested with 10% $A1_2C1_3$, confirms a statistically significant difference, where p <0.001 (Graph 1).

In conclusion, we will note that no statistically significant difference was found in the comparison of PP and P immersed in solution $A1_2C1_3$ at F = 396.021 (p <0.001) (Graph 1).

Discussion

Our results do not match the data obtained by Madhok et al., 2014 examining the effect of chemical impregnation and change in its concentration on the tensile strength of cords, as well as its effect on the ultrastructure of the cords using a scanning electron microscope (SEM). As hemostatic agents, they use aluminum and iron sulfates and conclude that they significantly reduce the tensile strength of the samples[16]. The tests performed by us do not support the results obtained in the study of Nietro-Martinez et al. establishing under experimental conditions the degree to which the tensile strength is affected by a change in the diameter of the cord; its impregnation and hydration with ferrous sulfate ($Fe_2(SO_4)_3$) or aluminum sulfate ($Al_2(SO_4)_3$). Their analyses show that cotton cords impregnated with $Fe_2(SO_4)_3$ have lower tensile strength than those impregnated with $Al_2(SO_4)_3$ and the effect is greater at higher concentrations of $Fe_2(SO_4)_3$. This study is one of the first evaluations of the physical properties of cords, highlighting characteristics that can minimize the risk of breakage[15].

Analysis from a study by Kimbuloglu et al. indicates that both the retraction medication used to impregnate the cord and the thickness (diameter) of the cords are important risk factors for gingival tissue health[18].

Kumbuloglu et al. found that proper hemostatic action depends on the amount of drug solution absorbed by the cord during soaking, which also depends on the length, thickness, structure, wetting properties of the cord, and duration of soaking time. The study generalizes to clinical practice that fluid absorption of cords is important for maintaining a dry field[18].

Wöstmann et al. found that the use of

nonimpregnated cotton cord caused an increase in crevicular fluid flow, although Kimbuloglu et al. found no bleeding after the use of untreated cord[18, 19].

Several studies have concluded that successful hemostasis and control of crevicular fluid flow can only be achieved by a combination of mechanical and chemical means[2,4,5].

A study by Pathel et al. designed to evaluate the optimal soak time and absorption of retraction fluid by retraction cords found that about 20 min was sufficient time to achieve maximum kinetic absorption. Based on the data, it is suggested that there is an inverse relationship between the rate of fluid absorption and the diameter of the sutures. Thus, smaller diameter cords exhibit faster absorption rates than thicker cords[20].

Similarly, our study found a relationship between incubation time and the amount of liquid absorbed. In this study, the researchers observed that air inclusions in the cords significantly interfered with the wetting of the cords. Consequently, the air inclusions were manually pinched prior to soaking so that this factor would not negatively affect absorption[21].

Maximal saturation of the retraction cords with hemostatic drug ensured successful displacement of the gingival tissue and allowed sufficient room for the impression material to enter the gingival sulcus to accurately record the preparation margin, and also imparted sufficient thickness for the impression material to be withdrawn from the sulcus without eventual tears.

Conclusions

The analysis of the results shows that the thread with monofilament has the highest tensile strength, followed by the braided cotton thread, and Ultrapak has the lowest values. The possible reasons for the higher values of the tensile strength of the two threads created and proposed by us, in comparison to Ultrapak thread, can be found in their composition (cotton or polyamide) and their braiding technology.

Declaration of Interest

The authors report no conflict of interest.

References

1. Alidema SH, Bundevska J , Maja S, Dimoski G, Halili R. Prosthodontic Management of Ridge Resorption: An Updated Review. J Int Dent Med Res 2022; 15(2): 867-872.
2. Singh AA, Rao BK, Gujjari AK. Evaluation of gingival displacement using foam cord and retraction cord: An in vivo study. J Int Oral Health. 2019; 11(1):8-14.
3. Phatale S, Marawar P, Byakod G, Lagdive SB, Kalburge JV. Effect of retraction materials on gingival health: A histopathological study. J Indian Soc Periodontol. 2010 Jan;14(1):35-9.
4. Vishnubhotla G, Basapogu S, Karnati RK, Dasari PP, Thommandru MV, Bethu MB. Evaluation of fluid absorbency of retraction cords after immersing in two retraction medicaments – An in-vitro study. J Clin Diagn Res. 2016 Nov;10(11):ZC19-ZC22.
5. Shrestha L, Pradhan D, Mehta VV, Dixit S. Gingival retraction methods: A descriptive survey among dentists in Nepal. Int J Contemp Med Res. 2017 Sep;4(9):1836-1839.
6. Jokstad A. Clinical trial of gingival retraction cords. J Prosthet Dent. 1999 Mar;81(3):258-61.
7. Prasad KD, Hegde C, Agrawal G, Shetty M. Gingival displacement in prosthodontics: A critical review of existing methods. J Interdiscip Dentistry. 2011; 1(2):80-86.
8. Kannan A, Venugopalan S. A systematic review on the effect of use of impregnated retraction cords on gingiva. Research J Pharm and Tech. 2018; 11(5):2121-2126.
9. S S, Ma VS, Mi VS, F HG, M H. Gingival retraction methods for fabrication of fixed partial denture: Literature Review. J Dent Biomater. 2016 Jun;3(2):205-213.
10. Riccitiello F, Amato M, Leone R, Spagnuolo G, Sorrentino R. In vitro evaluation of the marginal fit and internal sdaptation of zirconia and lithium disilicate single crowns: Micro-CT comparison between different manufacturing procedures. Open Dent J. 2018 Feb;12:160-172.
11. Rajambigai MA, Raja SR, Soundar SI, Kandasamy M. Quick, painless, and atraumatic gingival retraction: An overview of advanced materials. J Pharm Bioallied Sci. 2016 Oct;8(Suppl 1):S5-S7.
12. Rayyan MM, Hussien AN, Sayed NM, Abdallah R, Osman E, El Saad NA, et al. Comparison of four cordless gingival displacement systems: A clinical study. J Prosthet Dent. 2019 Feb;121(2):265-270.
13. Serra-Pastor B, Loi I, Fons-Font A, Solá-Ruíz MF, Agustín-Panadero R. Periodontal and prosthetic outcomes on teeth prepared with biologically oriented preparation technique: A 4-year follow-up prospective clinical study. J. Prosthodont. Res. 2019 Oct;63(4):415-420.
14. Del Rocío Nieto-Martínez M, Maupomé G, Barceló-Santana F. Effects of diameter, chemical impregnation and hydration on the tensile strength of gingival retraction cords. J Oral Rehabil. 2001 Dec;28(12):1094-100.
15. Madhok S, Kumaraswamy K, Madhok S. An Assessment of the Effect of Chemical Impregnation on the Tensile Strength of Gingival Retraction Cords Associated with Scanning Electron Microscopic Evaluation. Arch Cran Oro Fac Sci. 2014;1(6):87-92.
16. Abadzhiev M. Comparative research of the subgingival impression quality by fixed prosthesis using one and double cord retraction technique. J of IMAB. 2009; 15(2):52-54.
17. Sachdev PA, Arora A, Nanda S. A comparative evaluation of different gingival retraction methods-an in vivo study. Oral Health Case Rep. 2018; 4(1):1000142.
18. Kumbuloglu O, User A, Toksavul S et al. Clinical evaluation of different gingival retraction cords. Quintessence Int., 2007; 38:92–98.
19. Wöstmann B, P. Rehmann, M. Balkenhol. Influence of different retraction techniques on crevicular fluid flow., Int J Prosthodont., 2008; 21(3):215-6.
20. Patel P, K. Vaishnav, C. Ganatra. Evaluation of kinetic absorbency of 3 different medicaments by 5 different type of cords. J Int Oral Health, 2011; 3:15-21.
21. Csempesz F., J. Vág, A. Fazekas. In vitro kinetic study of absorbency of retraction cords. J Prosthet Dent., 2003; 89:45–49.