Vol 1 No 5 2024 || E-ISSN 2997-7258

The Journal of Academic Science

journal homepage:
https://thejoas.com/index.php/

Effect of Tooth Element Retention and Acrylic Resin Brand on the Tensile Bond Strength with Denture Base

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KEY W O R D S

Retention Of Dental Elements, Tensile Bond Strength, Acrylic Resin

A B S T R A C T

Teeth have a role that is very much needed for humans. Without teeth, some functions of teeth can be disrupted. Disorders that occur due to tooth loss can be prevented by making dentures to replace missing teeth. In dentures, adequate bonding between the acrylic tooth elements and the denture base is necessary to increase the strength and durability of the denture. Purpose: This aim of this study was to understand the effect of the shape of the retained tooth elements and type of acrylic brand on bond strength tensile denture base acrylic resin. Methods: This was an experimental laboratory study research. There were 36 specimens in this study from two brands of acrylic resin. Specimens were divided into three groups, namely the group without retention, slope retention, and groove retention respectively. Specimen testing was carried out using a universal testing machine brand Shimadzu AG-X plus. The data obtained was analyzed using bivariate Two Way ANOVA test. Results: The research indicates a significant difference ($p<0.05$) in tensile bond strength for the Vertex brand acrylic resin (0.001). Within the Vertex brand, the slope retention group showed a significant difference ($p<0.05$) of 0.017, and the groove group showed a significant difference of 0.003 in the denture elements. Conclusion. It conclusion, there is a significant impact of the vertex brand acrylic resin material compared to the twin cure base acrylic material on the tensile bond strength of dental elements with a denture base while the form of retention has no significant influence.

1. INTRODUCTION

Polymethylmethacrylate (PMMA) is the most commonly used material for dentures. This is due to aesthetic factors, physical and also relatively more economical. (1,2) Acrylic resin can be divided into three types: heat-polymerized acrylic resin, light-polymerized acrylic resin, and auto-polymerized acrylic resin. (3-7) Based on ADA specification number 12 (ISO 1567). Hot polymerized acrylic resin is most often used in denture manufacture compared to other types of resin. (4-8) Hot polymerized acrylic resin has been the most common for over 60 years. (5-9) Hot polymerized acrylic resin is a mixture of methyl methacrylate monomer and poly methyl methacrylate polymer, which achieves polymerization after being heated. (6-10) This heat polymerized acrylic resin has the advantages of being easy to process and polish, elastic, affordable cost, and low toxicity. One of the properties of heat polymerized acrylic resin materials is their high permeability, quickly absorbing water. (3-7)

The union between the denture teeth elements

and base is an important factor in the integrity of the denture. According to The Health Service of Britain, the number of repair cases of existing teeth is more than 60% of the number of dentures produced annually. The repair referred to can be in the form of factors on the base or denture elements that are separated from the denture base. Some of the causes are errors in the manufacturing process, from the material or excessive strength when used. (7-9,12-14)

The denture base is the part of the denture that rests on the soft tissue surface of the oral cavity and is where the denture is attached. The base of the embankment denture obtains support from the oral mucosa in edentulous areas. The denture base serves as a place for the attachment of dentures, restoring the function of mastication and gaining support from the temporomandibular joint. (10,15) Therefore further research is to improve patient satisfaction and obtain better bonding quality of denture teeth elements with denture base by comparing several forms of repair on denture elements.

Adequate bonding between the acrylic tooth elements and the denture base material is necessary because it increases the strength and durability of the denture because the tooth elements are an essential part of the denture. (11,16) Bond failure between tooth elements and acrylic denture base is a problem in dentures manufactured by the National Health Services of Britain and Northern Ireland. (12,17)

Detachment of the tooth elements from the denture base is one of the problems that attempt to prevent or at least reduce, this may be to the less surface ridge lap to bond and the direction of stress during use. Inadequate thickness of the artificial teeth can lead to denture fracture and detachment of the tight elements from the denture base. (13-16,18,19). The number of cases of repair of existing teeth is more than 60% of the number of dentures produced each year. Other factors that also affect the bond strength are the differences in the mechanical properties of the denture base materials used, dewaxing procedures, and inadvertent application of separation materials may lead to contamination of the ridge lap. Some of the causes are errors in the manufacturing process where there is a waxy material attached to the tooth element, the cohesion properties of the material or excessive force when wearing. (12)

Several researchers studied the physical and chemical bonds in the ridge area of the acrylic tooth cloth with repair techniques at the dough stage of the acrylic resin material, there was a significant difference. (16,20) Other studies have also established a protocol to reduce bond failure between tooth elements and denture base. Treatment on the denture surface must be carried out both chemically and mechanically. Various studies have been conducted to improve the bond between the tooth elements and the denture base. (TICHA 2016). (20) According to Zidan et al.'s research, there is a significant relationship between making retention of a prominent ridge lap with a vertical groove on the canine tooth compared to a small and thin ridge lap shape.

Adelina Elena Stoia and colleagues conducted chemical research by adding a sandblasting process to the tooth element repair area with a less significant level. Meanwhile, Ticha Thongrakardi and colleagues conducted chemical research by adding methyl formate and methyl acetate solutions to the tooth element repair area at a significant level. (17,20) in contrast to this study, there is no significant relationship in the form of retention, while the brand of acrylic resin has a significant

relationship. From the description above, the author is interested in researching to the extent of impact of the form of retention of dental elements and the brand of acrylic resin on the tensile bond strength of dental elements with a denture base.

2. METHOD

This type of research is experimental laboratory research. The acrylic resin material with the brand Vertex is manufactured in the Netherlands, while the resin material with the brand Twin Cure Base is manufactured in Japan. The manufacturing process and the number of specimens for testing the tensile bond strength of tooth elements with denture base acrylic resin were made according to ISO 22112 of 1917, 6 specimens were taken from the left and right maxillary first incisors, and the specimens consisted of three groups, without retention, sloping retention, and groove – shaped retention using an acrylic freezer, mechanical retention was made with a depth of 1,5 mm at the bottom of element tooth with a length of 75 mm x 35 mm wide x 7 mm thick according to ISO 22112.

3. RESULT AND DISCUSSION

After testing the tensile strength of the acrylic resin in the form of retention: without retention, retention in the form of slopes, and retention in the form of grooves, the results obtained can be seen in Table 1. these results were obtained from the results of statistical tests using SPSS Windows version 25, the average tensile bond strength results were obtained in the table.

Table 1. Mean and standard deviation of the number of samples.

		Mean Tensile Bond Strength (Standard Deviation)	
Form of Retention	**n**	**Twin Cure Basis**	**Vertex**
Without retention	12	4.526 (1.034)	4.143 (0.979)
Slope retention	12	2.332 (2.086)	5.797 (2.103)
Groove retention	12	3.795 (0.996)	5.804 (0.828)

The table above shows that the average tensile strength of acrylic resin heat curing without retention, slope retention, and groove retention shows different values. The average tensile strength data were tested for normality using the Shapiro-Wilk. The results of the normality test showed the average tensile bond strength without retention, slope retention, and groove retention with a result of 0.585, these results exceeded (p> 0.05), indicating that it was normally distributed. Furthermore, the homogeneity test of Levene's Test was carried out with a significance of p> 0.05, and a value of 0.563 was obtained so that this data was homogeneous because p> 0.05 so that it could meet the requirements to continue the two-way ANOVA test. As a homogeneity test in this study can be seen in Table 2.

Table 2. Homogeneity test result.

F	df1	df2	Sig.
793	5	30	.563

The two-way ANOVA test showed that from the retention type group of tooth elements between without retention, slope retention, and groove retention had no significant difference. Meanwhile, when viewed from the type of acrylic

heat curing resin brands, Basis Twin Cure and Vertex brands, there was significance with the results of p = 0.001 (p <0.05), which showed that there were significant differences between the two groups of brands. For the type of acrylic heat curing material Twin Cure Basis and the Vertex brand with the type of retention, the results showed p = 0.010 (p <0.05), which means there was a difference between the brand groups and the type of retention. Therefore, a T-test was carried out to see which group showed a significant difference.

Table 3. T-test result of tensile strength of tooth elements with acrylic resin dentur basis based on acryclic brand.

Form of Retention	Significance
Without retention	0,525
Slope retention	0,017
Groove retention	0,003

The T-test showed that the two brands were in the non-retention group with result of 0.525 showing no significant difference. The Vertex brand material with a sig in the slope and groove retention group. result of 0.017 and result of 0.003, there is a significant difference.

The tensile bond strength between the tooth element and the denture base is very important. In this study for the type of retention of ramps and grooves in the Twin Cure Base brand resin, the strength decrease was higher than the possibility because this material contained more molecular weight and polymer chains that entered the tooth element, while the retention of ramps was lower than those without retention. Possibly due to the fact that these materials contain more molecular weight and polymer chains that enter the tooth elements, while the retention ramps are lower than those without retention, this is due to possible material, molecular weight and chain factors shorter and the ridge area becomes thin due to grinding so that the incoming chain is slightly different from the shape of the groove retention is higher than the retention of the ramps this is due to the incoming material and the molecular weight is higher and grinding opens the pores, and the presence of dovetailed retention adds a solid bond to the tooth elements.(22)

As for the Vertex brand's retention of slopes and grooves is higher than without retention. This is probably due to molecular weight, good abrasion of the ridge lap surface, and sharpening acrylic teeth opening pores, thus allowing more polymer chains to enter. (22) This is based on the specifications of the ingredients contained in the brand This is also seen. That the Vertex brand material contains a crosslinker. (23) of these various forms of retention, all are statistically meaningless. According to previous research, using retention in the form of vertical grooves with a large surface area of the ridge lap produces a stronger tensile bond. In contrast to the relatively smaller contact area in the ridge lap area, the tensile bond strength is lower. (24) In line with the research by Anne Palitsch, Matthias Hanning, Paul Ferger, 2012 the tensile bond strength values available in the reported studies cannot be directly compared with this study due to differences in materials or mechanical properties of dentures, denture bases, polymerization methods used and types of dentures. In contrast to this study, which used only one brand of denture base, there was no significant relationship found between the 13 retention shapes and the tensile bond strength of tooth elements with denture bases. However, a significant relationship was observed with the brand of acrylic resin. Vertex acrylic resin demonstrated a stronger tensile bond compared to the Twin Cure Base. This is likely due to Vertex having higher polymer chain density, longer chains, and containing more cross-linking agents.

For the fracture surface on the Twin Cure Base material, there is visible adhesion where all the separate tooth elements are not attached, or only a few tooth elements are attached to the acrylic base. Failure of material cohesion may not provide proper bond strength to the denture. Whereas on Vertex brand materials, the surface is visible strong fracture cohesion occurs where all the tooth elements are still attached to the

acrylic base because the Vertex brand material contains a crosslinker. (24)

In the type of acrylic resin material, it was shown that between the two acrylic heat curing materials, there was a significant difference in the tensile bond strength of the dental elements and the denture acrylic base. The Vertex brand material is stronger than the Twin Cure Base brand, this is probably because the Vertex brand material has higher polymer chains, is denser, the chains are longer, and it appears to contain more crosslinkers where the chains and molecular weight are the longer the polymer chain, the greater the number of windings that can form between the chains.(25) Therefore, the longer the chains, the more difficult it is to distort the polymeric material, and thus properties such as stiffness, strength, and melting temperature increase with increasing chain length. Consider the analogy between the behavior of a polymer molecule chain and a plate of spaghetti, the longer the strands or chains, the more difficult it is to separate them. On the other hand, reducing the chain length makes it easier to separate. (26) The Twin Cure Base brand is less strong, this is probably due to the shorter chain and lower molecular weight, and shorter crosslinker so that the binding strength is reduced compared to the Vertex brand material.

4. CONCLUSION

Based on the research findings, it can be concluded that the shape of retention has no significant influence on the tensile bond strength of tooth elements with denture bases. However, the acrylic resin brand Vertex has a significant impact compared to acrylic resin Twin Cure Base. Vertex demonstrates a stronger tensile bond, possibly due to its higher polymer chain density, longer chains, and more cross-linking agents. The researchers recommend further studies involving various brands of acrylic resin and additional strengthening treatments for Vertex resin. This could provide insights into enhancing the bond strength of tooth elements with acrylic resin materials.

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