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Comparación de la resistencia compresiva de tres cementos resinosos en la reconstrucción de muñones dentales

Comparison of the compressive strength of three resinous cements in the reconstruction of dental studies

[1] Evelyn Esther Naula Lema https://orcid.org/0009-0001-7392-7080
Dentist, National University of Chimborazo, Riobamba, Ecuador.
evelynnaula1@gmail.com
[2] Yarima Selene Morales Chicaiza https://orcid.org/0009-0002-3343-9952
Dentist, National University of Chimborazo, Riobamba, Ecuador.
yarimam8@gmail.com
[3] Silvia Marisol Millingalle Vega https://orcid.org/0009-0006-8436-6166
Dentist, National University of Chimborazo, Riobamba, Ecuador.
silviammv@outlook.es
[4] Jeicy Isamar Gaibor Castro https://orcid.org/0009-0004-0803-0906
Dentist, National University of Chimborazo, Riobamba, Ecuador.
jeysigaybor1997@gmail.com

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Palabras claves: Resistencia compresiva, cementos resinosos, Rebilda, Paracore, Allcem – core, esfuerzo, fuerza

Resumen

Introducción. La presente investigación se refiere a la comparación de la resistencia compresiva de tres cementos resinosos en la reconstrucción de muñones dentales. Asimismo, a las investigadoras les interesa aportar información actualizada y de alto impacto sobre la resistencia compresiva de tres cementos resinosos en la reconstrucción de muñones dentales en la rehabilitación oral. **Objetivo**. El objetivo de la presente investigación fue analizar la resistencia compresiva de tres cementos resinosos a través de máquina de estudios universales (Tinius Olsen) para conocer el cemento resinoso más resistente en la reconstrucción de muñones dentales, determinado la resistencia de los cementos resinosos Allcem Core, Paracore y Rebilda ante una fuerza de compresión externa e identificando los cementos resinosos más utilizados para la reconstrucción de muñones dentro de rehabilitación oral. **Metodología.** Se realizó una investigación de tipo experimental, observacional con enfoque cuantitativo. El instrumento para utilizar es una ficha de recolección de datos, confeccionada por el investigador, elaborando un cuadro en donde se indica el tipo de material a usar cementos resinosos la fuerza usada medida en Newtons (N) y la resistencia medida en Mega Pascales (MPa) con la máquina de compresión de la Escuela Superior Politécnica Nacional, en el Departamento de Ingeniería Mecánica. **Resultados.** Según los datos obtenidos con respecto a la fuerza se determina que el Grupo C Paracore con una media de 1561,40 [N] fue superior al grupo A, B y control; en donde el grupo con menor cantidad de fuerza antes de fracturarse fue el grupo B Allcem Core con una media de 1032 [N]. El esfuerzo máximo del Paracore es superior al grupo control, Allcem core y Rebilda. La mayor cantidad de esfuerzo mínimo posee el grupo Allcem core. **Conclusión.** La fuerza máxima que soporto el cemento Paracore antes de su ruptura fue de 1561,40 [N], Rebilda fue de 1223,95[N], Allcem core de 1032[N] y el grupo control de Resina Z350 Filtek de la 3M 1075,15[N], por tal motivo se reflejan resultados favorables hacia el grupo C Paracore. **Área de estudio general:** Odontología. **Área de estudio específica:** Rehabilitación Oral. **Tipo de estudio:** Artículos originales

Keywords: Compressive strength,

Abstract

Introduction. The present investigation refers to the comparison of the compressive strength of three resin cements in the

resinous cements, Rebilda, Paracore, Allcem – core, effort, strength

reconstruction of dental stumps. Likewise, the researchers are interested in providing updated and high-impact information on the compressive strength of three resin cements in the reconstruction of dental stumps in oral rehabilitation. objective. The objective of the present investigation was to analyze the compressive strength of three resin cements through a universal study machine (Tinius Olsen) to know the most resistant resin cement in the reconstruction of dental stumps, determining the resistance of the Allcem Core resin cements. Paracore and Rebilda before an external compression force and identifying the most used resin cements for the reconstruction of stumps within oral rehabilitation. Methodology. An experimental, observational type of research was conducted with a quantitative approach. The instrument to be used is a data collection sheet, prepared by the researcher, preparing a table indicating the type of material to be used, resinous cements, the force used measured in Newtons (N) and the resistance measured in Mega Pascals (MPa) . with the compression machine of the National Polytechnic Higher School, in the Department of Mechanical Engineering. Results.According to the data obtained regarding strength, it is determined that Group C Paracore with an average of 1561.40 [N] was superior to group A, B and control, where the group with the lowest amount of force before fracturing was group B Allcem Core with an average of 1032 [N]. The maximum effort of Paracore is higher than the control group, Allcem core and Rebilda. The Allcem core group has the greatest amount of minimum effort. Conclusion. The maximum strength that the Paracore cement withstood before breaking was 1561.40 [N], Rebilda was 1223.95 [N], Allcem core was 1032 [N] and the control group of Z350 Filtek Resin from 3M 1075 .15[N], for this reason , favorable results are reflected towards group C Paracore.

Introduction

Prosthetic rehabilitation is a clinical procedure that has the function of reconstructing missing teeth using different materials. In fractured teeth, it is possible to place intraradicular cores, which are fixed with a resinous cementing agent using an adhesive technique. It can be defined as one of the main problems when carrying out the rehabilitation of a tooth that has lost a lot of dental structure. In recent decades, resinous

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cements have become a very important dental material in oral rehabilitation for cementation and reconstruction of stumps (1).

The degree of tooth destruction, affected piece, root canal, occlusion and other clinical variables are factors to be taken into account when carrying out prosthetic rehabilitation. In most clinical research, composites are used to reconstruct the stumps because they have mechanical resistance, ease of use and adhesion to the dental structure (2, 3).

Some resin cements can be used for post and core build-up cementation in a single step, allowing clinicians to work with a single material. The use of self-etching resin cements helps to optimize clinical time as they are used to cement the post and build the dental core. This prevents the formation of interfaces between various materials, technical sensitivity, and increased time spent performing the different procedures. It should also be noted that a tooth may be more susceptible to fracture when it does not have dental pulp or has more than 50% loss of tooth structure (4).

A tooth that has lost a large amount of its dental tissue at the coronal level, either due to carious lesions or dental trauma, must in most cases undergo several procedures. One of them is endodontic treatment, which causes the tooth to lose several of its physical-mechanical characteristics, which makes it a more susceptible pillar to fractures. For this reason, prosthetic rehabilitation must be carried out with materials resistant to shearing forces after functional loads and masticatory cycles (5).

The selection of the biomaterial to be used for the core reconstruction technique will represent a large part of the lost dental structure, so it must resist multidirectional masticatory forces in order to be successful in the long term. The main problem that the dental professional faces in the consultation is to know which biomaterial has the ideal characteristics for the reconstruction of dental cores, which can withstand the different types of forces and maintain good physical and mechanical properties over time (6, 7).

In ancient times, stump reconstruction was performed with amalgam because it has excellent mechanical properties and good clinical performance. However, this material has been progressively decreasing in use because it does not have aesthetic or environmental considerations and does not adhere to dental tissue. Another option for reconstruction is the custom cast metal stump and post, which has lost its use due to the high cost because it requires more clinical and laboratory time. For this reason, dual resin cements, thanks to their adhesive technology, help to reconstruct a stump in a more effective way and at a lower cost (8).

Resin cements are materials used for cementation since they have a composition similar to composite resins, presenting an organic matrix with BisGMA and UDMA monomers that helps it to be a material resistant to bending and rigidity. These composites are used to perform core reconstruction thanks to their mechanical resistance, ease of use and good adhesion to the tooth. The cements have less filler and particle size, which allows them to have fluid viscosity, adapting better to the crown or post in a solid interface (9, 10).

Traditionally, dental stumps have been reconstructed using highly inorganically loaded materials such as microparticle and nanoparticle composites. For this reason, dual-polymerization cements with a highly inorganically loaded component have appeared on the market, which give greater strength to the dental stump and present properties similar to composites without the need to perform two separate processes for post cementation and core reconstruction (11).

According to Lacerda et al. (11), it has been shown that the pin-stub system with resin cementation is resistant to compressive forces, which are defined as the maximum compressive stress that a body can withstand before fracturing. This property is highly relevant during mastication, especially in the posterior sector, since it is at the time of grinding food that the greatest compressive loads occur (3, 11).

Although the characteristics of resin cements have improved, they still suffer alterations when subjected to different multidirectional forces that affect the weakened tooth. For this reason, the dentist must know which resin cement suffers less fracture when applying compressive forces and therefore determine which resin cement has greater compressive strength when performing dental core reconstruction. Based on the above, the following research question arises: What type of biomaterial for core reconstruction provides greater compressive strength in teeth with little remaining tooth structure?

The aim of this research is to compare the compressive strength of three resin cements in the reconstruction of dental cores. The researchers are also interested in providing updated and high-impact information on the compressive strength of three resin cements in the reconstruction of dental cores in oral rehabilitation.

Methodology

An experimental type of research was carried out since there is manipulation of the study variables, observational with a quantitative approach. The instrument used was a data collection form, which was prepared by the researcher, creating a table where the type of material to be used (resinous cements), the force used measured in Newtons (N) and the resistance measured in Mega Pascals (MPa) with the compression machine of the National Polytechnic School, in the Department of Mechanical Engineering, were indicated.

The study population of the research consisted of a total of 80 resin cement discs of 6 mm height and 3 mm diameter. These were distributed in 20 cylinders of 3M universal resin Filtek Z350, 20 cylinders of ParaCore from Coltene, 20 cylinders of Allcem Core cement and 20 cylinders of Rebilda cement from Vocco. Due to the type of research presented, the calculation and extraction of a sample is not required, since being totally experimental, the entire universe of cases will be worked with.

The inclusion criteria for the research included:Cylinders made with resinous cements from Allcem Core, Parecore and Rebilda, resinous cement cylinders that meet the exact measurements for the study, dimensions of 6 mm high and 3 mm in diameter and polished resinous cement cylinders with smooth surfaces.

Exclusion criteria included:Resin cement cylinders with defects or cracks, resin cement cylinders that do not meet the exact measurements for the study and discs made with another type of resin cement.

Results

According to the data obtained with respect to the force, it is determined that Group C Paracore with an average of 1561.40 [N] was superior to Group A, B and control; where the group with the lowest amount of force before fracturing was Group B Allcem Core with an average of 1032 [N].

Table 1:*Descriptive statistics of Strength [N]*

	Force[N]				
	Number of samples	Minimum	Maximum	Average	Standard deviation
Control_Group_Resin	20	395	2189	1075.15	512,445
Group_A_Rebilda	20	794	1675	1223.95	242,503
Group_B_Allcem_Core	20	360	1714	1032.00	377,085
Group_C_Paracore	20	806	2435	1561.40	445,296

When analyzing table 1 regarding the mean compression stress, it is evident that group C was superior to group A, B and control with a mean compression of 216.43 MPa. While group A obtained a value of145.99MPa, making it the resinous cement with the lowest compressive strength.

Table 2:*Descriptive statistics of MPa stress*

	STRESS MPa				
	Number of samples	Minimum	Maximum	Average	Standard deviation
Control_Group_Resin	20	55.88	309.68	152,1026	72,49610
Group_A_Rebilda	20	112.33	236.96	173,1535	34,30710

Group_B_Allcem_Core	20	50.93	242.48	145,9981	53,34669
Group_C_Paracore	20	114.03	344.48	216,4366	64,63594

Table 2 shows that the mean compression stress shows that group C was superior to group A, B and control with a mean compression of 216.43 MPa. While group A obtained a value of145.99MPa, making it the resinous cement with the lowest compressive strength.

Table 3.*ANOVA statistical test*

		F	Significance
Between groups		6,040	< 0.001

In Table 3, it is known that the significance level of $P < 0.05$ reflects that there is a significant statistical difference. It is observed that the highest compressive strength through the difference in means gives a favorable value to the Paracore resin cement – Group C.

Discussion

In the present investigation, the compressive strength of three types of resinous cements was compared: Paracore, Allcem core and Rebilda, through a bibliographic review with high impact articles where the Gold Standard cements were chosen and with the test of samples it was determined that the maximum force that the Paracore cement can withstand is 2435 [N] with an average of 1561.40 [N] and its maximum compressive stress is 344.48 MPa, with an average of 216.44 MPa. These data are related to those obtained according to Sharma et al. (12), which described a compressive strength of the Paracore cement of 314.94 MPa.

Bialy et al. (13), in their article mentions an average compressive strength of Rebilda cement of 1119 [N] which is similar to the data obtained in the present investigation which are an average strength of 1223.95 [N], the maximum strength of 1675 [N] and a maximum compressive stress of 236.96 MPa. On the other hand, according to Praça et al. (14) mentions that the maximum compressive strength of Allcem core cement is 235.27 MPa which is similar to the data obtained in the study being the maximum stress of 242.48 MPa with an average of 145.99 MPa.

According to Tejada et al. (15), in his research he obtained a compressive strength of the Filtex Z350 XT 3M resin of 148.47 MPa, like Peñafiel et al. (16) determined a strength of 177.5 MPa; also Mauricio et al. (17) in his study stated a compressive strength of 222.33 MPa, while Da Silva et al. (18) demonstrated a strength of 255.5 MPa. These data are similar to those obtained from a maximum compressive strength of 309.68 MPa with deviation of 72.49 and a maximum force of 2189 [N].

According to Walcher et al. (19) in their study where they compare the compressive strength of Allcem core and Rebilda cement where their compressive strength is 103.48 MPa and 116.77 MPa respectively, it is similar to the data obtained in the present investigation, obtaining a favorable result for Rebilda cement compared to Allcem core, on the contrary, Säilynoja et al. (20) in their research obtains 60.23 MPa for Rebilda cement, which differs from the data obtained in our study because the area of the test piece is larger.

In the present investigation it is evident that there is a significant difference at a level of $P < 0.05$ ($P = 0.001$) with respect to the compressive strength giving a favorable result to the Paracore cement since it showed the highest value of compressive strength which was 216.43 MPa and a maximum force of 2435 [N] coinciding with the result obtained from Rajkumar (21) who mentions that its high degree of rigidity is due to the fact that it has a higher filler load. Agrawal & Mala (22) ratifies this information mentioning that this cement is reinforced with dual-curing glass fibers which allows its photopolymerization to be complete improving its resistance strength.

Based on the results obtained in this study, it is recommended to use Paracore resin cement since several investigations have shown that this cement has greater resistance to compression. However, the inconsistency in the development of in vitro studies highlights the importance of developing clinical studies where the results can be endorsed and verified.

Conclusions

- It is established through the application of force from the Stress and Vibration Analysis Laboratory of the National Polytechnic School, that the maximum force that the Paracore cement supported before breaking was 1561.40 [N], Rebilda was 1223.95 [N], Allcem core was 1032 [N] and the control group of Filtek Z350 Resin from 3M was 1075.15 [N], for this reason favorable results are reflected towards the Paracore C group.
- The compressive strengths of the three resinous cements were compared by applying force on the cylindrical test pieces with the help of the Universal Machine Tinius Olsen super L 120 with a capacity of 500 kilo Newton (kN) at a speed of 1 millimeter per minute (mm / min). Once the descriptive data was collected, the ANOVA test was applied where it was obtained that statistically there is a significant difference of $P <0.05$ ($P = 0.001$), where the Paracore had a higher compressive strength with a value of 216.44 MPa and a standard deviation of 64.64; while the Rebilda cement with a value of 173.15 MPa accompanied by a standard deviation of 34.30 and the Allcem core cement with a value of 145.99 MPa with a standard deviation of 53.34.

- A bibliographic search was conducted in Pubmed to support and justify the present study.

Conflict of interest

The authors declare no conflict of interest in relation to the submitted article.

Authors' contribution statement

All authors contributed to writing, reviewing and editing the article. Author

principal and who developed the systematic review. EENL, collaboration and verification

of YSMC, SMMV and JIGC results

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