Evaluation of the wear rates of eight different brands of artificial resin teeth
Avaliação do grau de desgaste de oito diferentes marcas de dentes artificiais de resina

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Abstract

The wear of artificial resin teeth used in prosthetic rehabilitation treatment is of great concern to the dentist, since wear changes the occlusal vertical dimension (OVD) and may provoke cranio-mandibular disturbance, decrease masticatory efficiency, increase the discomfort for the patient and alter esthetics. Thus, one of the most important physical properties of artificial teeth is their abrasion resistance and the ability to maintain the occlusal relation of the patient stable. To evaluate the rates of wear of eight commercially available brands of artificial resin teeth, forty-eight samples were prepared from 8 different brands, totaling 8 groups each with six elements. The samples were evaluated by a gravimetric method, and analyzed by measuring the difference between the initial and final weights following the experiment. Obtained values were submitted to variance analysis and Tukey's test ($p<0.05$). Statistic analysis revealed a difference between Artplus, Biolux, Duratone, Trilux, Trubyte Biotone and Vipi Dent Plus brands and the SR Orthosit teeth. Teeth of Myerson brand did not show any significant difference for any of the brands tested, presenting results with intermediate values ($p<0.05$). Artplus, Biolux, Duratone, Trilux, Trubyte Biotone and Vipi Dent Plus teeth brands presented higher wear values, while the SR Orthosit teeth brand demonstrated lower wear values and was, therefore, the best brand of tooth among those evaluated.

Uniterms

Tooth, artificial teeth; dental restoration wear; toth abrasion, resistance; dental materials, comparative study, analysis of variance

Introduction

Factors affecting the success of prosthetic rehabilitation treatments include the choice and correct recommendation of adequate materials for the performance of clinical-laboratory procedures. Whilst a number of different orthodontic materials have been used for the fabrication of prosthetic devices, special attention has been paid to the resin used, the major component of dentures and its effects on function (teeth) and esthetics (base). Characteristics such as easy manipulation, possible color alterations, smooth surface after polishing, easy adjustment and good esthetic are reasons for the wide use of this material. Depending on the resin material utilized, the artificial teeth may affect the functional aspect of the prosthesis, particularly in regard to resistance to wear. Abrasion of artificial teeth is of concern since this may change the Occlusion Vertical Dimension, decrease the masticatory efficiency, prejudice esthetic and increase the

patient discomfort associated with possible ATM disorders (OGLE & DAVIS[8], 1998). Another worry is that posterior teeth demonstrate functional wear at a faster rate than anterior teeth, causing occlusal prematurities and a loss of vertical dimension of occlusion. As a result, more stress is placed on the anterior ridges, which may cause a loss of alveolar ridge height in the anterior segments (WHITMAN et al.[12], 1987).

Thus, one of the most important physical properties of artificial teeth used in the restoration of edentulous patients is wear resistance and the ability of these teeth to maintain a stable occlusal relationship over time (HIRANO et al.[3], 1998), increasing the favorable prognostic of the prosthetic treatment.

Acrylic resin teeth are more easily adjusted, may produce less trauma in slight malocclusions, have better adhesivity to the denture base (VERGANI et al.[10], 1997) and have a higher shock absorbability than porcelain teeth (KAWANO et al.[4], 2002). Porcelain teeth are more stable against wear and have a better color stability than artificial resin teeth, however they are more prone to fractures (HIRANO, et al.[3], 1998; GRAIG[2], 1993), can abrade enamel, gold and acrylic resin present in antagonist teeth, may cause a clicking sound when in function and since there is no chemical bond with the denture base resin, mechanical retention is required to hold then together (WHITMAN et al.[12], 1987).

At the end of the 1980's, in an attempt to combine the qualities of acrylic resin and porcelain teeth, new materials for artificial resin teeth have been introduced commercially: interpenetrating-polymer-network (IPN) are structures formed when a polymer is cross-linked into a three-dimensional network occupied by a second cross-linked polymer. The cross-linked network coexist in the same volume of space, physically trapped one within the other, and cannot be disassociated without rupture of chemical bonds (Trubyte Bioform IPN, Dentsply International, York, PA), and microfilled silic composite, that is a compound of fumed silica filler particles, about 70nm in size, fused to a Bowen-formula matrix system (Isosit – SR Orthosit-PE, Ivoclar, Schaan, Liechtenstein). According to manufacturers' literature, these materials present a better wear resistance than conventional acrylic resin, without the disadvantages of porcelain artificial teeth (WHITMANet al.[12], 1987), being classified according to Satoh et al.[9] (1992) as modified resin teeth. As a result, currently the majority of dentists have opted for the use of resin teeth in rehabilitation treatment with partial or complete removable prostheses, since the advantages of these materials are well described; however their resistance to abrasion is still being questioned (VERGANI et al.[10], 1997; HIRANO et al.[3], 1998).

According to Hirano et al.[3] (1998), many studies have been carried out to investigate artificial tooth properties, but few comparative studies have reported on the available models in the market. The objective of this study was to evaluate, using the gravimetric method, the abrasion resistance of eight different brands of artificial resin teeth: Artiplus, Biolux, Duratone, Myerson, SR Orthosit, Trilux, Trubyte Biotone and Vipi Dent Plus.

Material and Method

For the performance of this study, six mandibular first molar teeth of each brand were used; these are listed in the Picture 1.

For the standardization of the samples, the teeth were built-in an acrylic resin base, with the assistance of a metallic ring, through a metalographic in-built device (Arotec PRE 30S, Arotec S.A. Ind. e Com., Cotia, SP, Brazil). The teeth were positioned and fixed in the middle of the metallic ring with condensation silicone (Zetalabor, Zhemarck S.p.A., Rovigo, Italy). The use of the metallic ring allowed the standardization of the exposure height of the teeth to the base, as well as the parallelism of the occlusal surface to the solo. For the procedure 5.0g of autocuring acrylic resin was used (Jet, Artigos Odontológicos Clássico, São Paulo, SP, Brazil), weighed on an electronic precision balance (Adventurer Balances – Ohaus Corporation, Pine Brook, NJ, USA), and these were used as the sample bases. After loading the metallographic in-built device with the metallic ring and the autocuring acrylic resin, both were maintained under a constant pressure of 150 Kgf/cm² for eight minutes of warm up and eight minutes of cooling, totaling sixteen minutes for resin curing. The piece was separated and the replica was ready (Figure 1).

Forty-eight samples were made and divided in eight groups, according to brands. After weighing on an electronic precision balance, the wear resistance tests were performed in a metallographic polishing device (APL Arotec, Arotec S.A. Ind. and Com., Cotia, SP, Brazil), where each group was submitted to abrasion polishing with sandpaper (360, 211Q, 3M do Brasil Ltda., São Paulo, SP, Brazil), during a period of ten minutes under constant velocity, pressure and irrigation (Figure 2). For each test, the

Picture 1 – Box with artificial teeth used and their characteristics

Brand	**Manufacturer**	**Origin**	Composition	**Model**
Artplus	Dentsply Ind. e Com. Ltda.	Petrópolis – RJ, Brazil	IPN Acrylic Polymer	U36
Biolux	Dental Vipi Ltda. Ind., Com, Imp. e Exp. de Produtos Odontológicos	Pirassununga – SP, Brazil	Matrix Cross-Linked	P4
Duratone	Imperial Trading	Flushing – NY, USA	Cross-Linked Acrylic	N5
Myerson	Austenal, Inc.	Chicago – Ill, USA	Composite	34
SR Orthosit	Ivoclar Vivadent, Inc	Amherst – NY, USA	Isosit Composite	N6
Trilux	RuthiBras Imp., Exp. e Com. Ltda.	Pirassununga – SP, Brazil	Polymethyl-metacrylate	M5
Trubyte Biotone	Dentsply Ind. e Com. Ltda.	Petrópolis – RJ, Brazil	Cross-Linked acrylic	34L
Vipi Dent Plus	Dental Vipi Ltda. Ind. Com. Imp. e Exp. de Produtos Odontológicos	Pirassununga – SP, Brazil	Cross-Linked acrylic	34L

sandpaper was changed and afterwards the samples were washed in an ultrasonic wash machine (Branson 2210, Branson Ultrasonics Corp., Danbury, CT, USA) with distilled water for 3 minutes. The samples were weighed again, with the purpose of evaluating the quantity of structure lost during the test (Figure 3). The data was analysed by ANOVA and for its results for Tukey's Test ($p<0.05$) to establish the difference in wear resistance between the eight tested the brands.

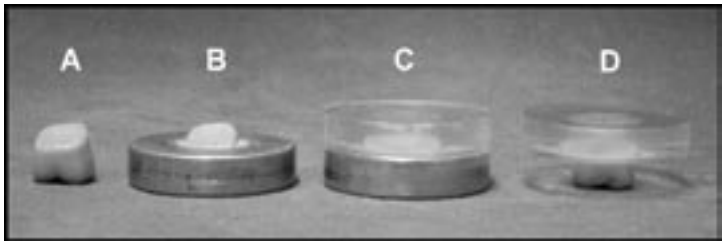

FIGURE 2 – Illustration of the sequence procedure to obtain the samples: A – artificial tooth; B – artificial tooth positioned and fixed in the middle of the

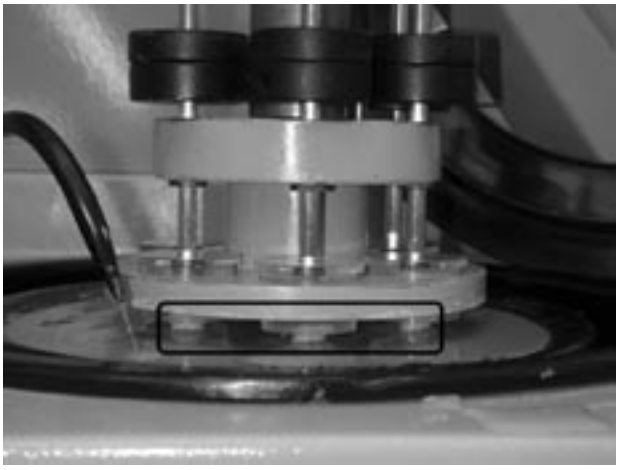

FIGURE 3 – IIlustration of the samples positioned inside the metallographic polishing device.

FIGURE 4 – IIlustration of the samples before and after abrasion test.

Results

The reading of the replicas was made using the gravimetric method, employing an electronic precision balance, by calculating the difference in their masses before and after the test. The difference between the obtained values was converted into percentage using the Excel computer Program (Microsoft Excel 2002, Microsoft Corporation, Redmond – USA). Data were analyzed by ANOVA, indicating a statistical difference between the analyzed groups. Tukey's Test was applied to establish the difference between the groups.

Table 1 – ANOVA table.

C.Variation	D.F.	S.S.	M.Q.	F
Treatments	7.	23.5709	3.3673	4.06
Error	40.	33.1837	.8296	
Total	47.	56.7546		

Standard deviation= 0.9108
Mean= 2.9163
Standard Mean Error= 0.3718
Coefficient of variation= 31.23

Table 2 – Tukey Test demonstrating the differences between the eight groups analyzed.

BRANDS	MEAN	
Duratone	13.2450 (7.0465)	A
Trilux	11.8150 (5.9645)	A
Biolux	11.1717 (4.3600)	A
Artplus	11.8967 (9.3586)	A
Vipi Dent Plus	11.2650 (10.0566)	A
Trubyte Biotone	8.8667 (2.0083)	A
Myerson	7.8217 (4.3205)	AB
SR Orthosit	1.4167 (0.5468)	B

Means are significantly different when followed by different letters ($p<0.05$)
( ) standard deviation

According to the results, a statistical difference was observed between the teeth of the brands; Duratone, Trilux, Biolux, Artplus, Vipi Dent Plus Trubyte Biotone and the teeth of the SR Orthosit brand ($p<0.05$). The Myerson teeth did not demonstrate any statistical difference when compared to SR Orthosit or the teeth of the other brands, presenting intermediate values.

Discussion

This study excludes clinical variables such as neuromuscular forces and movements, lubricants associated with both salivary flow and pH, foreign objects, exposure to an abrasive or corrosive atmosphere, patient habits, diet, poor or excessive hygiene, and type of material used, that according to Lindquist et al.[7] (1995), are difficult to control.

Khan et al.[5] (1984), determined and described the factors involved in wear, such as pressure between the abranding surfaces, the relative speed of the movement between the surfaces, the characteristics of the surfaces and the composition of the materials in contact, analyzed by Abe et al.[1] (1997) that evaluated abrasion resistance of high-strength modified resin against different materials. Thus, wear is a combination of abrasion, adhesion, chemical disintegration and surface fatigue according to Lindquist et al.[7] (1995). In another study, Khan et al.[6] (1985) evaluated the abrasion of anatomic acrylic resin denture teeth produced by three different manufacturers and concluded that the selection of the teeth for dentures should therefore be based on personal preference and esthetic considerations rather than on assumed differences in wear rates, once no statistically significant different was found between the tested samples. We agree with the conclusion of this paper parcially, in relation to six of the eight brands evaluated in our study, that did not presented statistically significant difference among them.

Winkler et al.[13] (1992) also did not find difference when compared three new formulation teeth compositions and two conventional teeth brands, finding similar results to those of Khan et al.[5] (1985), concluding that none of the tested brands or formulations demonstrated superiority over another, differently from what ours findings results demonstrated. Clinically study of Ogle & Davis[8] (1998) suggested that the new modified resin teeth display clinically acceptable wear resistance for most patients, although no statistically significant difference in total wear material at 36 months of analysis was observed, like the results obtained by Kahn et al.[5] (1985) and Winkler et al.[13] (1992). Furthermore, chewing side preference and cuspal anatomy did not affect wear.

Conversely, Whitman et al.[12] (1987), evaluated conventional acrylic resin teeth (Trubyte Bioform), interpenetrating polymer network teeth (Trubyte Bioform IPN) and microfilled composite (Isosit) and concluded that IPN and Isosit teeth are chemically more stable and wear resistant than acrylic conventional resin teeth.

Similarly, Von Fraunhofen et al.[11] (1988) evaluated two commercial brands of reinforced acrylic resin, already evaluated by Whitman et al.[12] (1987) and demonstrated that SR Isosit teeth showed a higher abrasion resistance than Bioform IPN teeth. These results are in agreement with our findings in present study, demonstrating that microfilled composite (Isosit), is more resistant to wear than the other brands of acrylic cross-linked resin and modified IPN resin teeth evaluated.

Oposing to the findings of Khan et al.[6] (1985) and Winkler et al.[13] (1992) and Ogle & Davis[8] (1998), Satoh et al.[7] (1990) analyzed the wear resistance of high-strength artificial anterior teeth and conventional plastic teeth by superficial roughness analysis, Knoop hardness and electronic scanning microscope readings were made. The results showed that plastic teeth presented decreased hardness and a superficial roughness five times higher than that of high-strength teeth, indicating that a difference exist between the commerciable brands of artificial resin teeth, fact also observed in our study.

The literature suggests that artificial teeth are very important for the success of rehabilitation prosthetic treatment, not only for esthetics but also for function. Highly wear resistant artificial resin teeth may have a significant clinical advantage for patients subject to excessive denture tooth wear Von Fraunhofer et al.[11] (1988). Patients with implants prosthodontics treatment are one of this indication, because of the high wear observed clinically by authors during follow-up. This excessive wear may be due to the rigid fixation Hirano et al.[3] (1998), as well as the increase of retention of the prosthesis that allow confidence to the patient. It is necessary that the dentist have an understanding of the characteristics of the artificial teeth that he recommend and the functional and anatomic characteristics of the patient, as well as his diet habits, to provide a favorable prognostic to the treatment. The rehabilitation treatment with a prosthesis is an add of

correct procedures, thus, objectives such as comfort, function and esthetic can be achieved and the choice of the right artificial teeth should not be based only on esthetical aspects, as Khan et al.[6] (1985) suggest.

Conclusion

For the eight brands evaluated, there was a statistically significant difference ($p<0,05$) between the Artiplus, Biolux, Trubyte Biotone, Duratone, Trilux and Vipi Dent Plus groups and the SR Orthosit brand group, that presented lower values of wear, being therefore the most wear resistant.

Artiplus, Biolux, Trubyte Biotone, Duratone, Trilux and Vipi Dent Plus brand teeth showed no statistically significant difference amongst them and Myerson brand teeth presented no statistically significant difference compared to the other evaluated brands of teeth, showing intermediate wear values.

Resumo

A abrasão dos dentes artificiais utilizados nos tratamentos reabilitadores protéticos é de grande preocupação para o CD, uma vez que altera a DVO podendo desencadear distúrbios crânio-mandibulares, diminui a eficiência mastigatória, aumenta o desconforto do paciente e prejudica a estética. Por isso umas das mais importantes propriedades físicas dos dentes artificiais é a resistência ao desgaste e a capacidade de manter estável a relação oclusal do paciente. Para avaliar o grau de desgaste de oito diferentes marcas de dentes artificiais de resina disponíveis comercialmente, foram preparados 48 corpos-de-prova de oito marcas disponíveis no mercado, totalizando oito grupos com seis elementos cada. As amostras foram avaliadas através do método gravimétrico, analisadas segundo a diferença dos pesos inicial e final após o ensaio dos corpos-de-prova. Os valores obtidos foram submetidos à análise de variância e teste de Tukey ($p<0,05$). A análise estatística revelou diferença entre os dentes das marcas Artplus, Biolux, Duratone, Trilux, Trubyte Biotone e Vipi Dent Plus e os dentes SR Orthosit. Os dentes da marca Myerson não apresentaram diferença estatisticamente significante com nenhuma das outras marcas testadas ($p<0,05$). Os dentes das marcas Artplus, Biolux, Duratone, Trilux, Trubyte Biotone e Vipi Dent Plus apresentaram os maiores valores de desgaste, enquanto que os dentes da marca Ivoclar apresentaram os menores valores. Os dentes Myerson apresentaram resultados com valores intermediários.

Unitermos

Dente artificial; desgaste de restauração dentária; abrasão dentária, resistência; material dentário, estudo comparativo, análise de variância.

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REFERENCES

1. Abe Y, Sato Y, Akagawa Y, Ohkawa S. Na in vitro study of high-strengh resin posterior denture tooth wear. Int J Prosthodont. 1997; 10(1):28-34.
2. Graig RG. Restorative dental materials. 9th ed. St.Louis: Mosby; 1993. p.535-8.
3. Hirano S, May KB, Wagner WC, Hacker CH. In vitro wear of resin denture teeth. J Prosthet Dent 1998; 79(2):152-3.
4. Kawano F, Ohguri T, Ichikawa T, Mizuno I, Hasegawa A. Shock absorbability and hardness of commercialy available denture teeth. Int J Prosthodont 2002; 15(3):243-7.
5. Khan Z, Morris JC, Von Fraunhofer JA. Wear of nonanatomic (monoplane) acrylic resin denture teeth. J Prosthet Dent. St. 1984; 52(2):172-4.
6. Khan Z, Morris JC, Von Fraunhofer JA. Wear of anatomic acrylic resin denture teeth. J Prosthet Dent. St. 1985; 53(4):550-1.

7. Lindquist TJ, Ogle RE, Davis EL. Twelve-month results of a clinic wear study of three artificial tooth materials. J Prosthet Dent. 1995; 74(2):156-61.
8. Ogle RE, Davis EL. Clinical wear results of three commercialy available artificial tooth materials: Thirty-six month results. J Prosthet Dent. 1998; 79(2):145-51.
9. Satoh Y, Ohtani K, Maejima K, Morikawa M, Matsuzu M, Nagai Eet al. Wear of artificial denture teeth by use of toothbrushes. Part 1: Abrasive wear of anterior teeth. J Nihon Univ Sch Dent. Tokyo 1990; 32(4):247-58.
10. Vergani CE, Giampaolo ET, Cucci AL. Composite occlusal surfaces for acrylic resin denture teeth. J Prosthet Dent. 1997; 77(3): 328-31.
11. Von Fraunhofer JA, Razavi R, Khan Z. Wear characteristics of high-strengh denture teeth. J Prosthet Dent. 1992; 67(6):812-4.
12. Whitman DJ, McKinney JE, Hinman RW, Hesby RA, Pelleu GB Jr. In vitro wear rates of three types of commercial denture tooth materials. J Prosthet Dent. St. 1987; 57(2):243-6.
13. Winkler S, Monansky GE, Kwok J. Laboratory uinvestigation of resin posterior denture teeth. J Prosthet Dent. 1992; 67(6):812-4.

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