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Full Length Research Paper

A comparative study of the fracture strength of dental porcelains: Vita VMK 95 versus Noritake

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One fundamental dimension of long-lasting dental treatments which has attracted many researchers is the fracture strength of dental porcelains. To contribute to this aspect of research, we have compared the fracture strength of two types of porcelains in metal-ceramic restorations: Vita VMK 95 and Noritake. To carry out this research, a standard die made of stainless steel was prepared. Then molds were prepared from the metal and chalk die. In order to create metal foundations with equal thickness, Adapta Krupp sheets were used. After shaping the models with cheap metal, the frames were randomly divided into two groups of eleven. For one group Vita VMK 95 and for the other group Noritake porcelains were used for powdering. To measure the fracture strength of the samples, Hounsfield Test Equipment was utilized. Statistical analysis of the findings shows that Vita is significantly stronger than Noritake.

Key words: Vita VMK 95, Noritake, Adapta sheet, porcelain, frame.

INTRODUCTION

Nowadays, dental treatments are based upon rigorous scientific foundations. There are lots of patients who need fixed prosthetics, and dentists are trying to provide them with effective and long-lasting treatments. They aim at providing stable, durable and beautiful treatments. The key to achieve this lies in dentists' awareness of the science of dental materials. One dimension of this issue which has attracted the attention of many researchers is the fracture strength of dental porcelains.

In a study, Yu et al. (2002) observed the effect of the ion-exchange technique on the surface strengthening of the dental ceramics. The findings of the study showed that the flexure strength of the experiment group was higher than the control group ($P < 0.05$). EMPA showed that the depth of Na(+)→K(+) ion-exchange was more than 100 µm. Therefore, it was concluded that HX-I ion-exchange cataplasm can significantly improve the flexure strength of dental ceramics and get an evident Na(+)→K(+) ion-exchange.

In another study, Ku et al. (2002) compared the fracture strengths of metal-ceramic crowns and 3 types of ceromer crowns in a simulated anterior tooth preparation. No significant difference was found among the fracture values of Artglass, Sculpture and Targis crowns. Chitmongkolsuk et al. (2002) compared the fracture resistance of all-ceramic 3-unit bridges for the replacement of first molars to conventional porcelain-fused-to-metal bridges. Porcelain-fused-to-metal bridges showed significantly higher fracture strengths than all-ceramic bridges. However, the fracture strength of the all-ceramic bridges was higher than peak physiological chewing forces.

In a similar study, Zarbakhsh (2002) evaluated the fracture strength of Vita 95 and Vision dental porcelain in porcelain-fused-to-metal restorations containing non-precious alloy. The study reported no significant difference between the two and concluded with highlighting nearly equal fracture strength when the two porcelains were applied to non-precious metal substructures.

Jalali et al. (2005) evaluated the effect of polishing on flexural strength of feldspathic porcelain and compared it with autoglazing and over glazing. A significant difference was observed among the studied groups ($P < 0.0001$). According to post-hoc test, flexural strength in overglaze and fine polish group were significantly stronger than clinic polish and autoglaze group ($P < 0.001$). Although, the mean value for overglazed group was higher than fine polish group, this was not statistically significant (P = 0.9). Also, no statistical difference was seen between autoglazed and coarse polish group (P = 0.2). Based on the findings of this study, flexural strength achieved by fine polish (used in this study) can compete with overglazing the feldspathic porcelains. It also can be concluded that a final finishing procedure that involves fine polishing may be preferred to simple staining followed by self-glazing.

In another study, Sinmazişik and Oveçoğlu (2006) attempted to microstructurally characterize and to make comparisons of the physical properties of sintered dental porcelains prepared by mixing with distilled water and with their modeling liquid. The study clearly shows that mixing the porcelain powders with distilled water or modeling liquid prior to sintering has no effect on the resultant sintered crystalline microstructure. On the other hand, significant differences exist between the physical properties of some porcelain.

Moreover, in a study of this type, Susana et al. (2007) evaluated the shear bond strength of Co-Cr and Ni-Cr metal alloys and a specific ceramic, submitted to different thermocycling immersion times. The results did not show significant statistic differences between the metal-porcelain combinations. Nevertheless, both metal-ceramic systems submitted to 60 s of immersion time showed lower values as compared to specimens without thermocycling. It was concluded that the thermocycling immersion time of 1 min affect the shear bond strength values for the Ni-Cr/porcelain and Cr-Co/porcelain systems.

In another study, Shokry et al. (2010) tried to determine the effect that metal selection and the porcelain firing procedure have on the marginal accuracy of metal ceramic prostheses. Student-Newman-Keuls multiple comparison tests showed that there were significant differences between any 2 metals compared, at each stage of measurement. Paired t tests showed that significant changes in marginal discrepancy occurred with opaque firing on milled CP Ti (P = 0.017) and cast Ti-6Al-7Nb alloy (P = 0.003). It was concluded that titanium copings fabricated by CAD/CAM demonstrated the least marginal discrepancy among all groups, while the base metal (Ni-Cr) groups exhibited the most discrepancy of all groups tested.

In another study, Kukiattrakoon et al. (2010) evaluated the ion leaching of porcelains immersed in acidic agents. This study revealed that each type of porcelain had significantly leached the various ions to varying degrees after being immersed in acidic agents (P < 0.001 for all comparisons). Scanning electron microscope (SEM) photomicrographs showed the surface destruction of all porcelains. It was also concluded that acidic agents used in this study affected elemental dissolution of the 4 types of porcelains evaluated.

Sarikaya and Guler (2010) evaluated the effects of different polishing techniques on the surface roughness of dental porcelains. When comparing the 4 different porcelain materials, the machinable feldspathic porcelain block group (Mark II) demonstrated statistically significantly less Ra values than the other porcelain materials tested (P < 0.05). No significant difference was observed between the VMK 95 and Ceramco III porcelain groups (P = 0.919), also these groups demonstrated the highest Ra values. Therefore, it was concluded that when subjected to surface roughness, the surfaces obtained with polishing and/or cleaning-prophy paste materials used alone were rougher as compared to the surfaces finished using Sof-lex, Dialite, and NTI polishing kit. Polishing kits and discs were found more effective than the polishing pastes used alone or combined use with Sof-lex discs, thus improving surface smoothness.

Although, as we have reviewed earlier, the fracture strengths of different porcelains (even maybe the ones we have included in our investigation) have been investigated, we can justify the necessity of further research on the assumption that different findings can emerge in different technological and clinical contexts. Thus, to contribute to our understanding of how such differences can influence our findings, we have compared the fracture strength of two types of porcelains in metal-ceramic restorations: Vita 95 VMK and Noritake. It is believed that the findings of this research can help the dentists working in contexts similar to the present research to utilize the most economical and durable dental porcelains.

MATERIALS AND METHODS

To carry out this research, a standard die made of stainless steel was prepared. Regarding the size of a premolar upper jaw tooth, the height of occlusal and cervical was considered to be 7 mm, and the diameter of buccolingual was considered to be 7.5 mm. Consequently, considering a 1.5 mm decrease of the surface occlusal and 2.5 mm of 90 shoulder scratches, pivotal walls of die were prepared in a semi pyramid shape of 6 mm (height) and 5.2 mm (diameter). The approximation angle of the peripheral walls of die was 10, and a 45, 1 mm wide bevel was created on the die. In order to prevent the movement of restorations on the die, a ditch of 1 mm width and depth was created on the peripheral wall of the die which emerged from the surface to a 2 mm distance. Then molds were prepared from the metal die, and chalk die was made. In order to create metal foundations with equal thickness, Adapta Krupp sheets were used. This system has a 0.5 mm-thick sheet in which a space-constructing rouge of 0.1 mm thickness plays the role of die spacer. These sheets are placed on the surface of Adapta dough in a way that the 0.1 mm sheet is placed outwards and at this moment die is placed on the sheets by the performing person and inserted inside the dough towards the place of ditch and under the end of scratch line. In order to decrease the possibility of error, all this procedure is carried out by a single person. Then, the extra parts of sheets are cut up to 1 mm above the scratch line. After extracting the 0.1 mm sheet forming the pattern, the marginal zone was waxed up on the chalk die by inlay. The height of collar was formed 1 mm for all samples using thickness adjusting device.

Cylinders were installed on the samples produced by Investment Material (Degovest, Germany), and after Burn Out phase, they were molded with Verabond V alloy. The molded frames were extracted from the cylinders, and after sandblast, they were measured by gage in order to maintain equal thickness.

The stages of the powdering of frames

After preparation and homogenization of frames, all the samples were degased by using Veraband metal. After oxidation phase, the frames were divided into two groups of eleven, and each group was exposed to special opaque. Then, they were exposed to the second opaque. After preparation and exposure to the opaques, the powdering stage started and each group received its own powder. The first group received Vita with color B2 and the second group received Noritake with color A3. After phase one baking of each group, the second phase of baking was applied on each group in order to homogenize all the samples. The baking procedure was carried out within the instructions provided by the producing factory. In this stage, the baked powders were prepared. After baking, the homogenization and polishing of samples started. In the final stage, all samples were glazed by the glaze of the same factory. The samples were coded by two different colors (A3 and B2) in order to be easily distinguished and also to prevent any possible mistakes. In order to impose pressure, Hounsfield Test Equipment Model H5K-3 (made in England) was used. The designated angle was 10° on a point within ۱/۳ central and ۱/۳ environmental distance so that we can place the metal die inside the metal holder (which had been specifically designed for holding the die. In order to create more adaptability with the environment of the mouth, the samples were kept in distilled water for 24 h and then they were placed in the holder and imposed to pressure till the fracture. The criterion for deciding whether fracture had occurred or not was the sudden decline of sustenance which was recorded by the equipment itself. The fractures were in either complete forms or partial forms. The speed of the equipment was 10 min^{-1}. After trials, the graphs for each group of samples were independently recorded (Appendix). The tested samples were investigated and confirmed by specialized prosthesis laboratory of the Dental Department of Tabriz.

In the present study, the intervening factors were neutralized by adopting the following measures:

1) The influence of the design of shaping was neutralized by using a single die with a Shoulder Bevel finish line.
2) The thickness of the foundation metal was equalized by using Adapta sheets. Foundations with different thicknesses were omitted.
3) The thickness of die spacer was equalized by using 0.1 mm Adapta.
4) The same type of alloy was used for both samples and therefore the impact of core material and its elasticity on fracture strength was neutralized.
5) The thickness of collar was considered to be 1 mm for all samples and it was equalized.
6) Opaque porcelain was scattered by airbrush and the thicknesses were controlled after baking.
7) The impact of the thickness of porcelain was neutralized by a device specifically constructed for this purpose.
8) The samples were kept in liquid environment to simulate wet mouth condition.
9) Luting agent was not used for any of the samples.
10). The fracture strength of the samples was measured by Hounsfield Test Equipment (Model H5K-S, Surray, UK).

RESULTS AND DISCUSSION

The data obtained was fed into the software package SPSS 16. The estimated force to create fracture in two groups was studied by one-sample Kolmogorov Smirnov test and since normal distribution was used to show the correspondence, the variances of two groups was measured by Leven's test and the means were compared by t-test. In all cases, the first type of error was considered 1% and P ≤ 1 was considered as meaningful.

On the basis of the findings of the present study, the average fracture strength of Vita VMK95 porcelain was 1131.6 ± 271.0 N (standard deviation ±), 0.95% of the estimated security domain in this case was 947/0 to 1316.2 N and its variation range was 837 to 1664 N. In the case of Noritake, the average fracture strength of the porcelain was 197.9 ± 769.1 (standard deviation±). 95% of the estimated security domain in this case was 634.2 to 904.0 N and its variation range was 445 to 1138 N. The median of the fracture strength in case of Vita VMK95 porcelain was 1104.0 N and in the case of Noritake it was 771 N.

The statistical analysis of the aforementioned averages revealed a significant difference (Leven's test was used to measure the variance: F = 0.663, P = 0.425; and T-Test was used to measure the averages: t = 3.582, P = 0.002). The statistical comparison of the fracture strength of Vita VMK95 and Noritake showed a significant difference: Vita VMK95 had higher fracture strength than Noritake.

The findings of this study can be discussed in the light of the following conditions: the shaping manner, the type of material used, the condition of cementing and imposing pressure which influences the fracture strength of the crown. Furthermore, the design of shaping can influence the distribution of pressure. Other influential factors were thickness, possessing or not possessing space and elasticity of metal foundation can influence the fracture strength of the crown.

The findings of the study conducted in the condition discussed under materials and methods showed that the fracture strength of Vita WMK95 porcelain was 1131.6, and the fracture strength of Noritake was 769.1. Statistical analysis of the findings shows a significant difference (P = 0.002). This means that Vita is significantly stronger than Noritake in the aforementioned conditions.

A short glimpse at different aspects of the present research reveals that there were different findings ranging from 170 to 4500 N. There were various reasons that influence such diversity of findings: the design of scratch, the use standard die or natural teeth, the use of different moldings, the type of alloy utilized, the thickness and th design of metal substructure, the application or non-application of opaque porcelain, the type of porcelain used, the porosity in porcelain, the thickness of porcelain used, the way of homogenizing the porcelain thickness, the way of baking porcelain, the baking time, whether the samples were glazed or not, whether using die was used or not when pressure was imposed, whether cement was used or not, the type of cement used, the way pressure was distributed and the speed of imposing pressure were some factors that have main role in such findings.

We suggest that other researchers should compare the fracture strength of the two porcelains we have used in other conditions, especially in practical and clinical contexts. Of course, we also believe that a better understanding of the issue will emerge only when other researchers carry out this investigation in different clinical conditions to test whether any difference in clinical conditions may influence the outcomes of the research or not.

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