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Original Article

Dentistry Section

The Influence of Implant Abutment Surface Roughness and the Type of Cement on Retention of Implant Supported Crowns

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ABSTRACT

Objectives: To provide relative data on the retentive characters of the commonly used cements on different implant abutment surfaces.

Materials and Methods: A total of 20 implant abutments were divided into 2 groups. Ten implants were unaltered and ten were air borne particle abraded with 50μ aluminium oxide. Three luting agents (Tempbond, IRM and ImProv) were used to secure the crowns to abutments. All the crowns were removed from the abutment with an Instron machine at 0.5mm per minute and tensile bond strengths were recorded. Statistical analysis was performed using Anova, Paired t-test and Post-Hoc tests.

Results: IRM showed the highest mean tensile strength among the three cements when used with treated and untreated implant abutment surfaces. Change in the abutment surface roughness had no effect on the mean tensile bond strength of TempBond and IRM cements, whereas ImProv cement showed reduced tensile strength with sandblasted surface.

Conclusion: When increased retention is required IRM cement with either sandblasted or milled surface could be used and when retrievability is required cements of choice could be either TempBond or ImProv.

Keywords: Aluminum oxide, Dental Cements, Eugenol, Methymethacrylates, Tensile strength

INTRODUCTION

Implants have revolutionized the dental practice in the last few decades. They are being considered as a better alternative to conventional fixed or removable prosthesis as they have overcome many of the limitations encountered with these conventional approaches. Implant supported prostheses are considered as highly esthetic, functional restorations with long-term predictability [1]. One of the most important decisions in implant prosthodontics is to choose between screw-retained and cement retained restorations [2]. The choice between screw-retained and cement retained restorations has always been a controversy in the literature. It has been documented that screw retained restorations were successful in edentulous arches. However, they do have disadvantages such as, screw loosening and screw fracture [3]. Cement retained prostheses have superior esthetics, easier control of occlusion, and are economical when compared to screw retained restorations but are not retrievable [4].The abutment preparation design and the cementation technique are similar to the conventional fixed procedures for natural teeth. So, all the factors that influence the retention in the restorations over natural teeth also affect the retention in implant supported crowns [1]. The factors that can affect the retention are abutment taper, surface area, height, surface finish and roughness. By increasing the surface roughness of the implant abutment the retention of the cement retained restoration can be improved [4]. The type of cement used is also an important factor in determining the retention of the restoration [1]. Retention of the luted provisional implant restoration can be a challenge, especially as the provisional implant restoration should minimize micro movement that may interfere with implant osseointegration [5,6].

Improvement of the implant surfaces such as airborne-particle abrasion and acid etching make early or immediate loading more successful. The values for the retentive strength for the different classes of luting cements are reported in the literature [7-14]. The choice of cement for an implant supported restoration should be based on the need or desire for retrievability, the anticipated amount of retention needed, removal and cost [12-17].The aim of this study is to provide relative data on the retentive characters of the commonly used cements on different implant surfaces.

MATERIALS AND METHODS

Impressions of the implant abutments were made and casts were poured [Table/Fig-1]. Wax patterns were fabricated by dipping technique (waxpot) to provide 0.5 mm thick standard wax patterns [17,18] and a sprue of uniform length of 3mm was attached to the wax pattern.

Wax patterns were then invested in a phosphate bonded investment and casting was done using nickel chromium alloy. Burnout casting procedure was followed according to the manufacturer's instructions and the castings were divested. The remnants of investment on the surface of the abutment were removed by the use of sandblaster with the use of 50 microns aluminium oxide. After sand blasting, the samples were ultrasonically cleaned for 3 min in a distilled waterbath.

Finally 60 specimens were divided into 2 groups of 30 each. Each group was sub divided into 3 subgroups of 10 samples each.

Group I: Control group.

Group II: Sandblasting group

An abrasive tool with 50 micron aluminium oxide particles with a pressure of 5 kg/cm^2 at a distance of 5 mm away from the surface with a circulating motion at 6 mm in diameter for 20 seconds was used to abrade the abutment surface. After sandblasting, the specimens were ultrasonically cleaned for 15 mins in distilled water.

Autopolymerising acrylic resin blocks were fabricated, allowing the implant analogs to be placed in the blocks perpendicular to the face of the resin block. The abutments were connected to the implant analogs and torqued to 35 N-cm. After fabrication of 3 cast crowns for each abutment the luting agent Tempbond, ImProv and IRM cements were used to secure the crowns to respective abutments [Table/Fig-2]. All specimens were stored in 100% humidity for one day at 37°C prior to testing. Each crown was removed from the abutment with an Instron mechanical testing machine at 0.5mm/min [19] and the tensile strength was recorded.

[Table/Fig-1]: Study samples **[Table/Fig-2]:** Cements used in the study

RESULTS

When Group I (control) specimens were luted with type A (IRM), typeB (TempBond cement) and type C (ImProv cement), the mean tensile bond strengths were 258.28N, 138.41N and 184.86N respectively.When Group II (sandblasted) specimens were luted with type A (IRM), type B (TempBond cement) and type C (ImProv cement), the mean tensile bond strengths were 260.68N, 138.28N and 152.13N respectively [Table/Fig-3-5]. Both type A and B did not show any significant differences in tensile strength between the control and sandblasted surfaces whereas type C showed an increase in the tensile bond strength with the Group I samples (control) when compared to Group II samples.

	N	Mean	Std. Deviation	Std. Error Mean
Control Irm	10	258.280	39.6837	12.5491
Sandblasted Irm	10	260.680	42.8893	13.5628

[Table/Fig-3]: Mean tensile bond strength of Type A cement with Group I and II-Paired Samples Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Control Temp Bond	10	138.410	11.6730	3.6913
Sandblasted Temp Bond	10	138.280	12.4334	3.9318

[Table/Fig-4]: Mean tensile bond strength of Type B cement with Group I and II-Paired Samples Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Control Improv	10	184.860	52.0776	16.4684
Sandblasted Improv	10	152.130	45.7934	14.4811

[Table/Fig-5]: Mean tensile bond strength of Type C cement with Group I and II-Paired Samples Statistics

STATISTICAL ANALYSIS

Paired t-test was used to compare the mean tensile bond strength values between the three luting agents among the two groups. The mean tensile strength values of Group I and Group II did not show any statistically significant differences when tested with type A and type B cements(p>0.5). However, there was a decrease in the mean tensile bond strength value with Type C cement in the sandblasted group by 17%, which was statistically significant (p<0.5).

DISCUSSION

Since the surface condition of the abutment and the type of the provisional luting agents are the factors that can be controlled by the clinician, modifications of the surface of the solid abutment and the different provisional luting agents were used to evaluate retention. Surface roughness increases the retention due to resulting micro retentive ridge and groove patterns. Increase in retention resists, or opposes the movement of the abutment under occlusal loads and prevents removal of the restoration by the forces applied in an apical or oblique direction. If the cement is more retentive the clinical retrievability without damage to the restorations, implant or peri implant tissue may be difficult [20].

In sub-group A the mean value of the tensile strength of the Group I (control) was 258.20N and in Group II (sandblasted group) was around 260.68N. The difference between the values of the mean tensile strength was not statistically significant (p-value >0.5). In sub-group B also the mean tensile strength of group I (control) was 138.41N and Group II (sandblasted) was 138.20N. The differences between the mean tensile strength were also not statistically significant (p-value>0.5). Few other studies indicate that the effect of interaction between the surface characteristics and luting agent affect the tensile bond strength. This surface alteration could be done either with the use of rotary instruments or sand blasting. In a study done by Yongsik Kim [21], there were no differences in the tensile strength of TempBond and other provisional luting agents when used with all different surface conditions. In another study done by Wolfart M [22] retention of the castings cemented with eugenol free zinc oxide cements was not affected by abutment surface conditioning by air abrasion. According to DJ Witwer [23], rough finished surfaces showed a significantly (p<.05) greater retention than the smooth finished surfaces with grooved crowns. According to Niwat Juntavee [24], the retention values of cements increased with increasing surface roughness of the restorations or abutments. However, the present study indicated that the higher surface roughness did not influence the retention values of eugenol free zinc oxide or TempBond cements. This could be due to the limitive cohesive strength of the cement [25]. Hence, when Type A or Type B cements are used as luting agents, surface treatment either with rotary instruments or air abrasion would be equally effective in increasing the retention.

In sub-group C the mean tensile strength values of Group I samples were 184.86N, while that of Group II samples were 152.13N. From the values it is evident that the tensile strength of abutments which were sandblasted were less than that of the control group which were also statistically significant (p-value<0.5). According to another study by Shane N White [26] several factors influence the film thickness of the luting material. These include the substrate the material is tested against, the size or shape of filler particles, the viscosity of the unset materials, and its rate of set. According to another study by Mona Wolfart [22] air abrasion of the castings and abutments may have also decreased the inner fit of the castings, which may have caused different film thickness leading to differences in tensile bond strength. In another study by Y Taira et al., minimal decrease in the bond strength was obtained with alumina blasting [27].

The maximum retention force required to retrieve a cemented restoration without damage to the adjacent structures, is not known. As there are no criteria for minimum amount of force required to prevent easy dislodgement of crowns, the choice of cements and abutment surface modifications is based on the clinician's choice [4].

CONCLUSION

The results of this study showed that Type A (IRM) cement exhibited the highest tensile strength among the cements tested, followed by type C (ImProv) and type B cement (TempBond). Both Type A and Type B cements did not exhibit any significant differences in the tensile bond strength among the control (milled) and sandblasted group. Type C (ImProv) exhibited statistically significant increase in the tensile bond strength values with Group I (Control) when compared to Group II (Sand blasted). By evaluating the above results it can be suggested that when increased retention is required (260N) Type A (IRM) cement with either sandblasted or milled surface could be used and when retrievability is considered, cements of choice could be either Type B (TempBond) or Type C (ImProv).

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