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Assessment of retention in cement retained implant supported crowns on surface modified abutments using circumferential grooves and airborne particle abrasion- An In-Vitro study

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Abstract:

Background: *Implant restorations can be either screw-retained, cement retained, or a combination of both. Use of Provisional cement result high risk for loss of retention and de-cementation leads to accidental swallowing or worse, the aspiration of dental prosthesis.*

Aim: *Evaluate the effect of circumferential grooves and Airborne Particle Abrasion on the retention of cemented cast copings on implant abutments.*

Settings and Design; *Hospital based observational study*

Methods and materials: *Fifty similarly-shaped implant abutments were divided into 5 groups as: without surface treatment, with 1 groove, 2 grooves, 3 grooves and Airborne Particle Abrasion. Fifty identical NiCr cast copings were prepared to fit all abutments. The castings were cemented to each group of abutments with Glass ionomer cement (GC Gold labed 1). After thermal cycling and storage for 6 days in a water bath, retention tests were conducted with a tensile testing machine (Instron) (5 mm/min) and retentive forces were recorded. Data analysis were done using SPSS ver,17*

Results and Conclusion: *The mean retentive force of control group was 405.1880N and with one circumferential groove was 532.5620N(P <.001).The mean retentive force of two circumferential groove was 609.41N is approximately 50% greater than control group(P<.000), with three circumferential groove was 888.38N, which is more than 2 times than the retention force of the control group(P<.000). The Mean value of retentive force for the abutment surface treated with Air borne particle abrasion was 623.7120N. The retention increased substantially with increase in number of circumferential grooves. Surface modification by airborne-particle abrasion also increased the retention of implant cement-retained castings substantially.*

Key words:-*Abutment, Analog, Circumferential Grooves, Airborne Particle Abrasion, Retentive*

Force.

.INTRODUCTION

Implant restorations can be either screw-retained, cement retained, or a combination of both. With cement-retained prostheses, the restorative screw is eliminated for many reasons cited by different authors; esthetics, occlusal stability, screw loosening, and fabrication of passively fitting restorations[1-3]. Use of Provisonal cement result high risk for loss of retention and de-cementation leads to accidental swallowing or worse, the aspiration of dental prosthesis[4-6].The issue of retrievability has become less critical and use of high strength cements have become more popular[2]. The purpose of this study was to introduce the use of circumferential grooves and surface roughness on implant abutments as retentive promoters and to evaluate the effect of the circumferential grooves and surface roughness on the retention of castings cemented to implant abutments with permanent cements.

METHODS

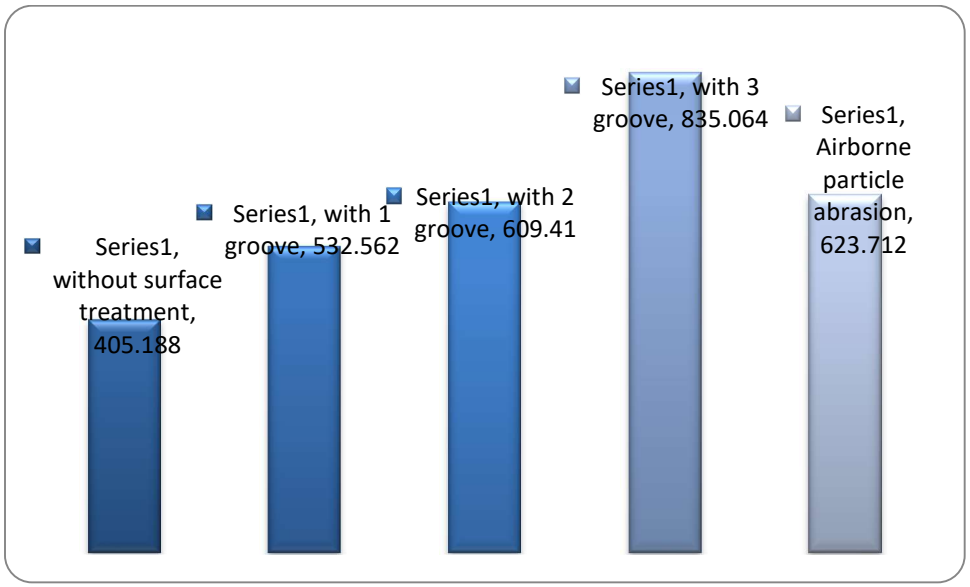
Fifty wider diameter titanium abutments(Fig-1) were connected with abutment screws to corresponding stainless steel laboratory implant analogs with a screwdriver and a torque control device to a torque of 20Ncm(ADIN Implant Technologies Ltd, Israel)Laboratory implant analogs were connected to computer aided machining equipment (HASS 01-USA)and implant abutments were milled to a length of 6.0 mm and 6-degree taper with 0.5mm shoulder width(Fig-2). Then in 30 abutments circumferential grooves were made. Each groove was milled to 0.5 mm wide and 0.4 mm deep with an inter wall angle of 60 degrees(Fig-3). Then 10 abutments Abraded with Airborne-particle (Aluminium oxide 50µm) for 20 seconds at a pressure of 2.5lb to 3lb. The 50 abutments with respective laboratory analogs were divided into five groups, 10 abutments each: without surface treatment, Abraded with Airborne-particle (Aluminium oxide50µm), with 1 circumferential groove, with 2 circumferential grooves, with 3 circumferential grooves.(Fig-4)The Implat abutments were duplicated using Elastomeric impression material (DENTSPLY). Impression were cast with Type IV Dental stone, Die hardner and Die spacer (Yeti) were applied to the cast. Wax patterns were made on the cast with a wax ring attached to the occlusal portion. The wax patterns were sprued, invested, and casted with NiCr alloy (GOROBOND). The copings were numbered 1 to 10 for identification. Finally, the intaglio surface of all copings were airborne-particle abraded for 20 seconds with 110µm aluminium oxide particles at a pressure of 2.5lb to 3lb in sand blaster (DELTA), then washed with water and dried with compressed air and inspected for accuracy and fit using Stereoscopic Microscope 10 X magnification. A metal ring filled with acrylic resin was fabricated with a vertical hole prepared in the centre(Fig-5) act as a base to cement the copings onto the abutments in a repeatable manner. The analog with its abutment was placed in the hole. Glass ionomer cement (GC Gold Lable 1) were mixed according to the manufacturer's instructions and applied into the inner surface of copings.

Each coping was seated on the abutments and held in place with finger pressure for 10 seconds and 2 minutes under a static load of 5N pressure[7] and excess cements were removed and stored under 100% humidity at 37°C for 1 hour, thermocycled 500 times between 5º C and 55º C with a dwell time of 10 seconds and then stored in 100% humidity at 37°C for 6 days in water bath[8].The specimens were assembled in the universal testing machine (Instron 3382) and subjected to a pullout test (retention) at a crosshead speed of 5.0 mm/min(Fig-6). The forces required to remove the copings were recorded in Newton's. After the retention test, the copings and abutments were evaluated for failure mode according to the location of the residual cement

with 10X magnification (Stereoscopic Microscope; Lawrence & Mayo). Full thickness residues on the abutment or casting were denoted as adhesive failure. Cohesive failure was denoted when the failure was within the cement and partial thickness residues were seen on the abutment and the opposing surface of the casting. A combination of adhesive and cohesive failure was considered a mixed failure. Ethical committee clearance was obtained from balaji dental college hospital. SPSS ver 17 was used for analysis. Chi square and ANNOVA was used to see the difference between groups

RESULTS:

The mean retentive force of control group (abutment without surface treatment) was 405.1880N and the mean retentive force of group 2 samples with one circumferential groove was 532.5620N, shows that substantial increase in the retention occur after incorporation of single groove(P<.001). The mean retentive force of group 3 samples with two circumferential groove was 609.41N is approximately 50% greater than the retention force of control group (P<.000) Table:1. The mean retentive force of group 4 samples with three circumferential groove was 888.38N is more than 2 times greater than the retention force of control group (P<.000). The Mean value of retentive force for the abutment surface treated with Air borne particle abrasion was 623.7120N. Comparison of the retention value for sandblasted assembly with those for the untreated control group confirms that mechanical surface treatment dramatically increases the retention of metal copings (P<.000) (Graph-1,Table-2)



Graph:1 Mean value of retentive force for the abutment surface treated with Air borne particle abrasion

	Group1	Group2	Group3	Group4	Group5
Mean	405.188	532.5620	609.4100	835.0640	623.7120
Std. Error of	16.6214	18.75476	14.05544	24.34217	15.25871

Mean					
Median	397.300	523.2400	612.1300	861.9400	632.0700
Std. Deviation	37.1666	41.93691	31.42891	54.43074	34.11950
Minimum	370.0	473.64	567.96	750.81	571.65
Maximum	457.4	579.41	644.93	884.38	664.56
p-value	<0.000	<0.000	<0.000	<0.000	<0.000

Table-1 Comparison Between Abutments Without Surface Treatment And Abutments With Circumferential Grooves of retentive force

ANOVA				
		Sum of Squares	Mean Square	Sig.
group2	Between Groups	7034.818	1758.705	.0.22
	Within Groups	.000		
	Total	7034.818		
group3	Between Groups	3951.105	987.776	0.22
	Within Groups	.000		
	Total	3951.105		
group4	Between Groups	11850.823	2962.706	.0.22
	Within Groups	.000		
	Total	11850.823		
group5	Between Groups	4656.562	1164.140	.0.22
	Within Groups	.000		
	Total	4656.562		

Table:2 Comparison of four groups with control

In stereoscopic microscope it was found that Castings cemented on plain abutments also

exhibited adhesive type failure. For these specimens, the cement remnants were found primarily (more than 50%) over the inner-surface of the castings. With grooved and sand blasted abutments, the mixed type (adhesive/cohesive) failure was evident, while the remnants were found primarily on the abutments.

DISCUSSION:

Cement-retained restorations in many situations are the method of choice for implant-supported prostheses. The null hypothesis was that there will be no improvement in retention with circumferential grooves and sandblasting in the abutment surface. From the above said values of retention between control group and abutment with surface treatment shows that the null hypothesis was rejected.Israel Lewinstein et al[8], Hwa-Yeon Lee et al[9], in their studies concluded that the addition of circumferential grooves to implant abutment surface increased the retention of cement-retained castings.And also Airborne particle abrasion increase the retention are being reflected in Yongsik Kim et al[10], Hwa-Yeon Lee et al[9], G.Rappelli et al[11], Jalil Ganbarzadeh et al[12] study.

Factors that may affect the retention of the provisional restoration are the geometry of abutment preparation, abutment taper, abutment height, surface roughness, surface area, and the luting agent[13-15]. Surface roughness and luting agents are factors that can be controlled by the clinician. Surface roughness increases the retention due to resulting micro-retentive ridge and groove patterns[16-20], surface roughness enhances crown retention as much as 31%[13]. Retention can be increased by modifying surface topography, which can be achieved on natural teeth using coarse burs[18], while on metal structures it can be achieved through air-borne particle abrasion[21] and grooves. Air abrasion conditioning with aluminum oxide particles was ease to use, also in the oral environment, without requiring sophisticated processing and specific equipment. The cross sectional shape and depth of the grooves in the present study was selected based on previous study[8].It was observed that most of the clinicians who actively involving implant practice, uses glass ionomer cement for cementing the implant prosthesis. This regular use of glass ionomer cement in implant practice, made us to use glass ionomer cement for this study. But zinc phosphate cement can also be used because there is no risk of caries at the abutment surface. since many studies are support for zinc phosphate cement. Die spacer with film thickness of 24µm was use for Glass ionomer cement to eliminate the variations in retentive bond strength due to the cement film thickness, based on ADA Specification Number - 66 [22]. Implant abutment with 6 degree was selected for this study because Implant restorative abutments need to be designed with a taper of 6 to 8 degrees for optimum retentive force. An abutment with 6 degrees of taper has a retentive force measured at 80gm/mm and found as taper increases, retention decreases[23]. In Stereoscopic Microscope it was found that the cement failure mode was generally adhesive in nature, although some cohesive and mixed failure was observed. Cement remnants were found mostly on the metal coping on abutments without surface treatment. In grooved and sand blasted abutments remnants were found mostly on abutments. This pattern of failure may indicate that the circumferential grooves and sand blasting create a local lock, which affects the failure mode and the location of the remnants in the abutment surface. However a separate study based on failure of adhesion, cohesion or mixed should be carried out to substantiate this statement. The mechanism by which the glass ionomer bonds to tooth structure is primarily involves chelation of carboxyl groups of the polyacids with the calcium in the apatite of the enamel and dentin[24].From Stereoscopic Microscope view it was found that the cement failure mode was generally adhesive in nature indicate that glass ionomer cement won't bond with metal. Clinically, the circumferential grooves and sand blasting can be effective for increasing the retention of fixed dental

prostheses in situations where short abutments are used due to limited interocclusal distance.The limitation of this study is only one type of cement was used based on the usage. The pullout test of the cemented castings was performed after limited aging without cyclic loading. This protocol did not simulate long term oral conditions. Therefore, additional studies are needed to quantify the effect of grooves, grooving method on the retention of other cements under long-term simulation, which may assist clinicians in cement selection.

CONCLUSION

The addition of circumferential grooves to implant abutments increased the retention of implant cement-retained castings. The retention increased substantially with increase in number of circumferential grooves. Surface modification by airborne-particle abrasion also increased the retention of implant cement-retained castings substantially.

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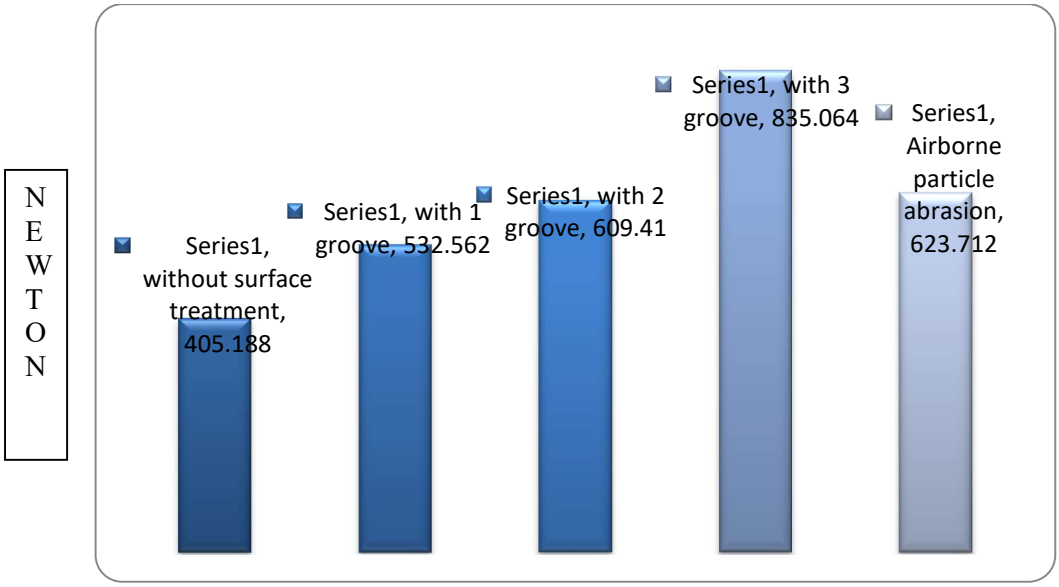

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