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Evaluation And Comparison of the Effect Of Grooving And Sandblasting on the Retentive Strength Of Stainless Steel Crowns (SSCs)

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Abstract

Purpose: This in vitro study was conducted to evaluate and compare the effect of grooving and sandblasting on the retentive strength of stainless steel Crowns (SSCs).

Materials And Methods: Sixty extracted human primary molars (maxillary/mandibular) were mounted in acrylic blocks. These specimens were divided into 4 groups: Group 1(with vertical grooves on both buccal as well as lingual surface of prepared teeth), Group II (Sandblasting of crowns), Group III(Vertical grooves and sandblasting of crowns), Group IV(control group). After cementation of SSCs with RMGIC, the specimens were incubated t 37^0c for 24 hrs. Then the retentive strength of each sample was evaluated by means of an Universal testing machine. The obtained data was analysed using ANOVA for statistical analysis of data and 't'-test for pairwise comparison.

Results: Mean value of retentive strength was maximum for group III i.e. grooves with sandblasting (1150.2±74) and minimum for control group IV(639±43.1). The mean retentive strength of stainless steel crowns in KPa ,which were not sandblasted i.e. Group IV was 639.35 and which were sandblasted i.e. Group II was 865.65 with a mean difference of 226.30. the results were statistically significant. ANOVA-Analysis depicts that a significant difference in retentive strength values exist among the groups (p=0.000) which is below 0.05.

Conclusion: Vertical grooving along with sandblasting of crown increases the retentive strength of stainless steel crowns. Vertical grooves on the buccal as well as on lingual surfaces of prepared tooth increases the retentive strength of stainless steel crowns and Stainless steel Crowns which were sandblasted offered better retention than the crowns which were not sandblasted.

Keywords: Primary teeth, retentive strength, stainless steel crowns, sandblasting

Introduction

The restoration of primary and permanent teeth with advanced carious lesions has been a constant and difficult problem for the clinician, to prevent their premature loss and to maintain normal occlusion[1]. In primary dentition, carious lesions often develop early in the first molars because of their relatively early eruption and not restoring them in time can cause a possible reduction in mesiodistal dimensions and consequently, loss of space[2], and if caries progress to multiple surfaces then restoring these primary molars with conventional restorative materials poses a challenge for Pediatric dentist[3]. Thus the introduction of stainless steel crowns was a major breakthrough in the field of Pediatric restorative dentistry. Its use has provided an effective and practical method of restoring teeth that otherwise could not have been retained[4].

Ever since the introduction of stainless steel crown by Engel and later by Humphery in 1950, the premature loss of teeth due to rapidly progressing caries has been decreased[5] and improved the restoration to form and function[3] . These crowns are superior to amalgam restorations in multisurface caries and their failure rate is much lower than that of other restorations. SSCs are efficient and easy to use for restoring primary and permanent teeth with extensive caries and congenital or hypoplastic defects and pulp treated teeth[2]. Hence for children who are presented with large, multisurface carious lesions of primary teeth, the American Academy of Pediatric Dentistry(AAPD) recommends the full coverage of crowns using SSC's[6].

The designs of these crowns has changed over time. The changes have led to better adaptation,improved morphological properties and greater similarity to tooth anatomy[2].Also various methods have been tried in the past to increase the retention of stainless steel crowns[3].

The prevailing opinion on the retention of stainless steel crown appears to be that the cervical adaptation of the crown to the tooth is most important aspect as refuted by **Mathewson and Savide[7].**Various other factors affecting retention includes magnitude of the dislodging forces, geometry of the tooth preparation, roughness of the fitting surface of the restoration, materials used for cementation and the film thickness of the luting agent[8]. Hence the cervical adaptation and crown fit are the most important criteria for crown retention , the role of cement, the surface treatment of crowns using sandblasting,and grooving of tooth surface to increase retention can not be overlooked[9].

Crown displacement often occurs because the features of the tooth preparation do not counteract the forces directed against the restorations. Retention prevents removal of cast restoration along the path of insertion or long axis of tooth preparation whereas resistance prevents dislodgement of the restoration by forces directed in an apical or oblique direction and prevent any movement of the restoration under occlussal forces[10].Grooves have been the principal feature used for retention and resistance lost by leaving the facial surface intact[11].There are reports in literature where vertical grooves also enhances the crown retention by providing resistance against any rotational forces during mastication[3].

Finally,Cementation is a vital step in the process of retention, marginal seal and durability of indirect restoration[10]. A wide range of luting cements have been used for cementing the stainless steel crowns in the past which includes zinc phosphate, zinc polycarboxylate and glass ionomer cements.In recent years newer classes of cements such as resin modified glass ionomers and resins have been formulated with adhesive properties[4]. Several studies quoted that RMGIC exhibits higher mechanical strength, strong adhesion, lower solubility,when compared to conventional GIC, zinc phosphates and polycarboxylates and at the Same time does not loose out the advantage of fluoride release[12] .

There is very less data regarding the effect of giving retentive grooves on the tooth surface on the retentive strength of stainless steel crown. Also there is very little information of effect of sandblasting of inner surface of stainless steel crowns on the retention of SSCs.

Hence the purpose of this study is to evaluate and compare the effect of adding grooves on the buccal and lingual surface of the prepared tooth and sandblasting on inner surface of SSCs on crown retention using latest resin modified GIC luting cement.

Methods: The present in vitro study was conducted in the department of Pedodontics and Preventive dentistry , Himachal dental college, Sundernagar with the approval from college review board.

The study was conducted on 60 extracted primary molars, which were indicated only for orthodontic extractions and were collected from Department of Pediatric dentistry, Department of Orthodontics, HDC Sundernagar, Civil hospital, Sundernagar . Any remaining tissue from the extracted tooth was mechanically removed using a curette. All the teeth were stored in thymol solution till they were used. Teeth were then mounted in cold cure acrylic resin blocks, exposing the crowns upto the cementoenamel junction.

Specimens were divided into 4 groups as: (15 specimens each)

1. Group I - With grooves on the prepared tooth surface
2. Group II - With sandblasting on the inner surface of stainless steel crowns. Group III - With grooves and sandblasting
3. Group IV - Control group (without grooves and sandblasting)

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Conventional tooth preparation for SSCs was performed by a single operator. The occlusal surfaces of all teeth were reduced 1mm uniformly by using a pear shaped diamond bur(330 no.). The proximal surfaces were prepared with a tapered fissure bur (no.169L) by removing all mesial and distal undercuts without leaving any ledges. All sharp line angles were rounded.

For teeth assigned for groove placement i.e.Group I and Group III, 3 grooves were prepared on the middle third of the buccal and lingual surfaces each with depth of 1mm and a length of 4mm, with a no. 56 carbide bur.

Pretrimmed,precontoured SSCs were selected and tried on the prepared tooth. Gingival third of crowns were uniformly contoured with no.114 plier and the crown margins were crimped with crown crimping plier and then again checked the margins for adaptation. Buccal tubes were welded in middle one third of buccal and lingual surfaces of all crowns to facilitate an attachment for the Universal Testing Machine(Tinus Olsen 50KN).

For the stainless steel crowns assigned for sandblasting of inner surfaces(GROUP II & GROUP III), sandblasting was done with a mixture of aluminium oxide and silicon dioxide particles with a particle size of 250 µm.

All teeth were cleaned with pumice and water and dried before cementation.The crowns were luted with RelyX^{TM} Luting2(3M ESPE) and cement was mixed according to the manufacturer's instructions at room temperature.The cement was loaded into the crown and each crown was seated with finger pressure.After initial set, excess cement was removed from the crown tooth interface using an explorer. The teeth were then stored in artificial saliva and incubated at 37degrees Celsius for 24 hrs.

Retentive strength was tested using an instron Universal Testing Machine.After stabilization of the specimen on the machine, load was applied and gradually increased from a zero reading to a point until the cemented crowns showed first dislodgement and the corresponding value was noted from the graphical representation present in the testing machine computer monitor.The same procedure was followed for all the specimens.The applied load was directly parallel to long axis of tooth during crown removal with a machine crosshead speed of 0.05 inches per minute.The retentive strength values were recorded and calculated using following formula:

Retentive strength= load/area in KPa

The load from the testing machine was in Newtons so we converted it to kgs by using formula:

1N=1/9.8066Kgs

The surface area of each crown was determined by flattening the crown and marking the outer boundary of the crown's inner surface on a graph sheet and then adding the surface areas of squares formed with in that boundary and it was calculated in cm2.

Retentive strength we have now is in kg/cm2. We have converted it to KPa by using formula: 1Kg/cm2=98.07 KPa

Results: Descriptive statistics obtained for four groups is summarised in table-1. Mean value of retentive strength was maximum for group III i.e. grooves with sandblasting (1150.2±74) and minimum for control group IV(639±43.1). Second highest RS value was obtained for sandblast group II i.e.(865±171.8). A wide variation of RS value was obtained for groove and sandblast group.

Table 1. Descriptive statistics for retentive strength

Groups	Mean	S.D.	Minimum	Maximum

Group 1	769.79	180.28	583.90	1081.19
Group 2	865.65	171.81	564.23	1092.01
Group 3	1150.23	74.02	1011.20	1284.13
Group 4	639.35	43.08	575.41	700.84

The table no.2 (ANOVA-Analysis), depicts that a significant difference in RS values exist among the groups (p=0.000) which is below 0.05.

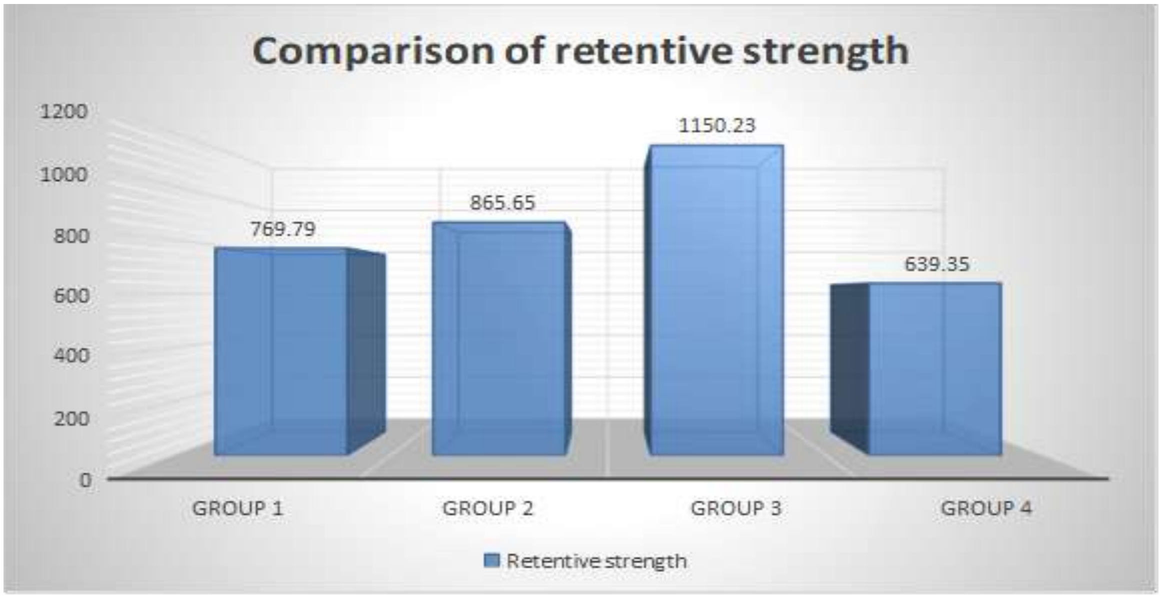
Table 2- ANOVA RESULTS'

	Sum of squares	df	Mean of Squares	F	p-value
Between groups	2115526.68	3	705175.56	40.67	0.000
Within groups	970991.04	56	17339.13		
Total3086517.72		59			

The mean retentive strength of stainless steel crowns in KPa ,which were not sandblasted i.e. Group IV was 639.35 and which were sandblasted i.e. Group II was 865.65 with a mean difference of 226.30. the results were statistically significant.

A post-hoc Tukey test was performed for creating homogenous subgroups. Among the different treatment groups, groove and sandblast group differ significantly (1150±74,p<0.05) from sandblasting or groove group. However no significant difference in mean value of retentive strength was observed between the groove(mean=769.8) and sandblasting group (mean=865.7) and therefore these two groups appeared to be homogenous.

Comparison Of Retentive Strength



Discussion:

Over the last 50 years, SSCs have proved to be an excellent restoration treatment for primary teeth severely affected by caries, developmental defects and extensive, multisurface carious lesions[13]. Advantages of SSCs include their easy application in a relatively short time, preserving the remaining tooth structure, resuming the function of damaged tooth, restoring the lost contour of the tooth and subsequently, maintaining the length of the dental arch[14,15,16].

Retention of a SSC to tooth structure is critical for the success of a restoration. The main retentive feature is the close marginal adaptation of a metal crown to the tooth surface in the undercut areas of the prepared tooth[17,18]. Marginal adaptation of SSC depends on several factors including the proper size of the crown, trimming of the crown to achieve adequate length, crimping of the crown margins for approximation to the prepared tooth surfaces[19].

There are number of other factors that increases the retention of crowns on to the prepared tooth. Cements used for luting of stainless steel crowns are also one of these contributory factors for crown retention[20].The cement provides mechanical resistance to the displacement of restoration and also resists fracture when a load is applied to the restoration[21]. Therefore choice of cementation material has an important effect on SSC retention[22,23,24]. The development of Resin modified glass ionomer cement offers the benefit of both resins and conventional glass ionomer i.e. adhesion and fluoride release[25]. A number of previous studies have shown that compared to conventional GIC , RMGIC exhibit higher mechanical strength, strong adhesion, low solubility while at Same time ,the advantage of fluoride release[26-31].

The results of the study done **by Mitchell et al (1994)[32]**,when they compared the maximum loads and modes of failure of four glass ionomers , found that Resin modified glass ionomer cement offered a higher retention when compared to the conventional Glass ionomer cements. The probable reason for increase in retentive strengths of crowns luted with RMGIC can be attributed to the modified compositon, low solubility and high compressive & tensile strength[5]. So in present study we have used RMGIC as a standard luting cement.

Pretrimmed and precontoured stainless steel crowns were used in this study to standardize the surface area of crowns as in case of other type of crowns trimming is necessary which gives an intra clinicians variations in surface area. Universal Testing Machine was used in this to measure the retentive strength because of its easy availability. The specimens were stored in prepared artificial saliva because it simulates human saliva.Primary molars were selected for this study as stainless steel crowns are more widely used in primary molars to prevent premature tooth loss and development of further malocclusion[4].

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The use of grooves for increasing the retention of SSC have been reported in literature by many authors. **Croll(1995)[33]** in his clinical technique has placed vertical striations on the buccal surface of the tooth. Groove placement has varied in preparation design. Some have placed grooves in the facial aspect of the proximal surfaces while others have placed on buccal surfaces or midway between the facial and lingual surfaces[34-39]. A study done by **Saad AA et al (1995)[40]** who placed grooves proximally and found that addition of grooves produced a significant increase in retention of complete cast crowns. In other study done by **Kishimoto M et al (1983)[11]** found that lingual placement of proximal grooves enhanced the retention of three quarter crowns.

In our study, we placed the grooves vertically on both buccal as well as lingual surfaces and not on proximal surfaces because very often caries destroys proximal surfaces in primary molars.

Our results showed that placement of grooves during tooth preparation, significant increases the retentive strength($p<0.05$ b/w Group I &Group IV) of Stainless steel crowns. Our study is in accordance with the study done by **Croll (1995)[33]** who found that cutting vertical grooves around the prepared tooth crown's periphery increased the surface area and enhanced crown retention by providing resistance against any rotational forces during mastication. On the other hand, study done by **Potts et al (1980)[10]** found that addition of grooves did not significantly augment retention. **Veerabhadran MM(2012)[5]** in his study, placed grooves horizontally on the middle third of the buccal surface of the tooth and found that presence of grooves did not influence the retentive strength of SSCs.

In another study done by **Rosensteil et al (2001)[41]**, it was found that adding grooves or boxes to a preparation with a limited path of withdrawal does not markedly affect retention because the surface area is not increased significantly. However where the addition of a groove limits the paths of withdrawal, retention is increased.

The other statistically significant factor that affects the retentive strength of stainless steel crowns is the sandblasting of the crowns[5]. Sandblasting has been regarded as a form of microetching that clean and roughen the surface. This procedure involves spraying a stream of aluminium oxide particles under high pressure against the metal surface intended for bonding[32]. The idea of roughening the interior surface of the crown came from clinical study done by **Garcia-Godoy (1984)[22],** where they roughened the interior of the crown with a high speed bur to create a more retentive surface. However, the authors failed to report the significance of this, on the retention of stainless steel crowns.

In current study, crowns were sandblasted with a mixture of aluminium oxide and silicon dioxide particles of 250μm size. The high speed bur was avoided for the lack of uniformity and fear of perforating the crown. While studying the effect of sandblasting on retention on SSCs, Our study found that sandblasting significantly increases the retentive strength($p<0.05$ b/w Group II & Group IV). This is in accordance with the study done **by Pathak S et al(2015)**[3] who observed that the sandblasting done on the inner surface of SSCs increased their retentive strength. In other studies done by **Nergiz I et al(1997)[42] and O'Connor RP et al(1990)[43],** who reported that sandblasting increased the retentive strength of cast crowns or posts or orthodontic bands. This is due to the abrasion of the inner surface of SSC by the airborne mixture of alumina and silicon dioxide particles which makes the surface rougher, improved the mechanical interlocking for luting cements, thereby increasing the retention. Contrary to this, **WorleY et al(1982)[44] and Veerabadhran et al(2012)[5]** concluded that sandblasting had no significant effect on crown retention.

While comparing the sandblasting group with grooving group, our study found that there was no significant difference between sandblasting and grooving($p>0.05$ b/w Group I &Group II). Although both the groups were significantly high in retentive strength when compared to control group with conventional SSC preparation.

While studying the synergistic effect of grooving with sandblasting ,our study found the highest retentive strength in this group which was statistically significant when compared to either sandblasting and grooving alone ($p<0.05$ b/w Group I &Group III and b/w Group II &Group III).

These results are in accordance with the studies done by **Nergiz et al(1997)[42]** and **Pathak S(2015)[3]** who all have found that grooves with sandblasting provide maximal synergistic effects for SSC retention, where as **Veerabadhran et al(2012)[5]** reported no effect on the retentive strength of SSCs,which might be due to their small sample size.

Conclusion:

It can be concluded from our study that grooving and sandblasting alone significantly increases the stainless steel crown retention but is not significant when compared to themselves i.e. sandblasting when done alone is not significantly higher than grooving alone.

Bibliography

1. Reddy MHR, Reddy VVS, Basappa N. A comparative study of retentive strength of zinc phosphate,polycarboxylate and glass ionomer cements with stainless steel crowns- An in vitro study. Journal of Indian Society of Pedodontics and Preventive Dentistry, Vol.28,No. 4, October-December,2010,pp. 245-250.
2. Ramajani N, Ranjbar M. Effect of tooth preparation on microleakage of stainless steel crowns placed on primary mandibular with reduced mesiodistal dimensions. Journal of Dentistry. tums.January 2015: Vol.12,No. 1.
3. Pathak S, Shasibhushan KK, Bharath KP, Poornima P, Subba Reddy V. In vitro retentive effect of groove, sandblasting and cement type on stainless steel crowns in primary molars. Pediatric dentistry.2015; Vol. 37 No. 4. .
4. Munjal S, Sood A, Samadi F, Bembi S. A comparative study of retentive strengths of zinc phosphate, resin modified GIC and adhesive resin cement with stainless steel crowns. An in-vitro study. Indian Journal Of Dental Sciences Oct2013:5(4).
5. Veerabadhran MM, Reddy V, Nayak UA et al. The effect of retentive groove, sandblasting and cement type on the retentive strength of stainless steel crowns in primary second molars: An in vitro comparative study. J Indian Soc Pedo Prev Dent 2012;30;19-26.
6. Hattan MA, Pani SC, Alomari M. Composite bonding to stainless steel crowns using a new universal bonding and single bottle system. International Journal of Dentistry Vol. 2013/607405.
7. Stewart RE. Pediatric Dentistry Scientific Foundations And Clinical Practice. Vol.2.
8. Tomar SS, Battacharyya J et al. Comparative evaluation of bond strength of all metal crowns with different luting agents after undergoing various modes of surface treatments: An in-vitro study. The Journal of Indian Prosthodontic Society|Oct-Dec 2015|Vol 15|Issue 4.
9. Kumari RV, Poluri RK, Nagaraj H, Siddaruju. Comparative evaluation of bond strength of dual-cured resin cements: An in-vitro study. Journal of International Oral Health 2015;1:43-47.
10. Potts RG, Shillingburg HT Jr, Duncanson MG Jr. Retention and resistance of preparation for cast restorstions. J Prosthet Dent 1980;43(3):303-8.
11. Kishimoto M, Shillingburg HT Jr, Duncanson MG Jr. Influence of preparation features on retention and resistance. Part II: Three- quarter crowns. J Prosthet Dent 1983;49(2):188.
12. Li Y, Lin H, Zheng G, Zhang X, Xu YO. A comparative study on the flexural strength and compressive strength of four resin modified luting glass ionomer cements. Biomedical Materials And Engineering 2015.
13. Baeza-Robelto SJ et al. Effects of ultraviolet irradiation on the bond strength of a composite resin adhered to stainless steel crowns. Pediatric Dentistry V 35/No.1 Jan/Feb 13.
14. Mortens LC, Dermaut LR. The marginal polishing of Ni-Chro crown: a preliminary report. ASDC J Dent Child. 1983 Nov-Dec;50(6):417-21.
15. Catala Pizarro M, Ferrer Tuset I, Estrela-Sanchus F. Preformed crowns in pedodontics. A classic and valid option. Av Odontoestomatol. 1990 Apr;6(4):295-303.
16. Savide NL, Caputo AA, Luke LS. The effect of tooth preparation on the retention of stainless steel crowns. J Dent Child 1979:46(5):385-9.
17. Murray J. Prevalence of dental caries: retrospect and prospect; Dent Update,25:374- 378,1998.
18. Roberts JF, Attari N, Sherriff M. The survival of resin modified glass ionomer and stainless steel crown restorations in primary molars,placed in a specialist paediatric dental practice. British Dental Journal Volume 198 No.7 April 9 2005.
19. Bin Alshaibah WM, EL-Shehaby FA, EL-Dokky NA, Reda AR. Comparative study on the microbial adhesion tp preveneered and stainless steel crowns. J Indian Soc Pedod Prev Dent. 2012 Jul-Sep;30(3):206-11.
20. Rezk-Laga F, Ogaard B, Rolla B. Tensile bond force of glass ionomer cements in direct bonding

of orthodontic brackets: An in vitro comparative study. Am J Orthod Dentofac Orthop,100: 357-361,1991.

21. Fayle SA. UK National Clinical Guidelines in Pediatric Dentistry.Int J Paediatr Dent, 9(4):311-314,1999.
22. Garcia-Godoy F. Clinical evaluation of the retention of preformed crowns using two dental cements . J Pedod 1984;8:278-281.
23. Garcia-Godoy F, Bugg JL. Clinical evaluation of glass cementation on stainless steel crown retention. J Pedod 1987;11:339-344.
24. Shiflett K, White SN. Microleakage of cements for stainless steel crowns. Pediatr Dent 1997;19:262-266.
25. Rosenstiel SF, Land MF, Crispin BJ. Dental luting agents: A review of the current literature. J Prosthet Dent,80:280-301,1998.
26. Prosser HJ, et al. The characterization of glass ionomer cement. Journal of Dentistry, 1984;12:231.
27. Chadwick RG , Woolford M. A comparison of the shear bond strengths to a resin composite of two conventional and two resin modified glass polyalkenoate cements. Journal of Dentistry,1993;21:111-116.
28. Kandaswamy D et al. Shear bond strength evaluation of resin composite bonded to glass ionomer cement using self etching bonding agents with different ph,in vitro study. Journal of Conservative Dentistry,2012;15:27-31.
29. Andersson-Wenckert IE, Dijken JWVV, Horstedt P. Modified class II open sandwich restorations:evaluation of interfacial adaptation and influence of different restorative techniques, European Journal of Oral Sciences ,2002;110:270-275.
30. Kerby RE, Knobloch L. The relative shear bond strength of visible light curing and chemically curing glass ionomer cements to composite resin. Quintessence International,1992;23:641-644.
31. Arora V et al. Comparison of the shear bond strength to RMGIC to a resin composite using different adhesive syatems. An in vitro study. Journal of Conservative Dentistry,2010;13:80-83.
32. Mitchell CA et al. Comparative study of four glass ionomer luting cements during post pull-out tests. Dent Mater 1994;10:88-91.
33. Croll TP. Restorative dentistry for oreschool children. Dent Clin N Am 1995;39:737-770.
34. Carmichael JP. Attachment for inlay and bridgework. Dent Rev,1901;15:82.
35. Tinker ET. Fixed bridgework. J Natl Dent Assoc,1920;7:579.
36. Krause OG. Cast attachments for bridgework with special reference to vital teeth. J Am Dent Assoc,1934;21:2104.
37. Smith DE. Abutment preparation. J Am Dent Assoc, 1931;18:2063.
38. Ingraham R, Bassett RW, Koser JR. An atlas of cast gold procedures, 1969.Uni-Tro college press,p 161.
39. Shillingburg HT and Fisher DW. The partial veneer restoration. Aust Dent J 17:411,1972.
40. Saad AA, Claffey N, Byrne D, Hussey D. Effects of groove placement onretention/resistance of maxillary anterior resin bonded retainers. J Prosthet Dent 1995;74:133-9.
41. Rosenstiel SF, Land MF, Fujimoto J. Comtemporary Fixed Prosthodontics. 3rd ed. St.
42. Nergiz I, Schmage P, Platzer U, et al. Effect of different surface textures on retentive strength of tapered posts. J Prosthet Dent 1997;78(5):451-7.
43. O'Connor RP, Nayyar A, Kovarik RE. Effect of internal microblastingon retention of cementedcast crowns. J Prosthet Dent 1990;64(4):557-62.
44. Worley JL, Hamm RC, Von Fraunhofer JA. Effects of cement on crown retention. J Prostho Dent 1982:48(3):289-91.