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Laboratory Evaluation of the Retention of an Innovative Pin Placement Compared with the Conventional Method in Human Mandibular Molars

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Abstract

Objective: The retention of restorative materials in severely decayed teethhas been a significant matter in dentistry. Different methods of pin placement in the dentin have been introducedbut perforation of the pulp chamber and the external tooth surface have remained to be the associated risks. Introduction of different bonding and composite resin systems have eliminated the need for mechanical retention. Considering the bonding potential of composite resins to the tooth structure, it seems that applying a layer of composite prior to treatment with amalgam restorations and placement of the pin in both the composite and dentinal layers may reduce the complications associated with pin application. The purpose of the current investigation was to evaluate the retention provided by an innovative pin placement in teeth via composite resins compared with the conventional method.

Methods: This experimental study was conducted in 3 groups of A to C. Groups A and B possessed 15 mandibular molars each and group C included 15 composite samples. The crowns of the teeth in groups A and B were reduced 3 mm coronal to the CEJ. Group A received T.M.S minim pin at 2mm depth of the dentin. Group B was treated with a 1mm composite layer after crown reduction and received a T.M.S minim pin that was located 1mm in the dentin and 1mm in the composite material. For group C, 15 cylindrical composite samples which were 5mm in height and 8mm in diameter were provided and the T.M.S minim pin was placed at a 2mm depth inside them. Samples then underwent a tensile force using the universal testing machine. Test Xpert.10-11 software was used to draw the graphs for each sample. Data were analyzed by ANOVA testing via SPSS software and L.S.D statistical tests.

Results: Findings of the analysis of variance revealed significant statistical differences amongst the study groups ($P \leq 0.05$). The results obtained by the L.S.D test showed no statistical differences between groups A and B ($P > 0.05$). Group C was found to show significant statistical differences with groups A and B ($P < 0.05$).

Conclusion: The results of the present study demonstrated that the highest tensile force for pin removal was administered in group A. Placement of the pin at a 1mm depth in the dentin and 1mm in the composite resin will give an equivalent amount of retention compared with the conventional method of pin placement in the dentin. Moreover, the lowest tensile force required for pin removal was found in group C.

Key words: dental pin, composite, retention

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Introduction:

Pin-retained amalgam restorations have long been used to repair the severely destructed teeth structures. They are used as direct restorative materials on the high stress bearing occlusal surfaces of posterior teeth (1-4). High mechanical properties, easy application and lower cost rates compared with composite resins are amongst the advantages of amalgam

restorations that lead to their extensive application in large posterior cavities (5, 6). The conventional cavity preparation is designed to provide the retention required for amalgam restorations. Pins that are screwed into the tooth structure may provide the appropriate retention but are associated with potential risks and complications. In a study that was carried out in Lidez dental school, pin application in teeth had a failure rate of 19% with the most common types of failures being pin mobility and inadequate pin penetration in the cavity. Serious complications such as pulp involvement, perforation of the external tooth surface and tooth fractures were observed in 10% of the cases studied (7).

A significant number of in vitro studies have demonstrated that pin application may result in complications such as dentinal cracks and pulpal sensitivity (7, 8). In one study carried on animal teeth, severe pulp inflammation was observed with pin placement 0.5mm spaced from the pulp (7, 9). It seems that treating small cavities with a composite base after caries removal and placing the pin in both dentinal and composite layers may provide the retention required for amalgam restorations and reduce the complications associated with pin application. The present study aimed at comparing the innovative method described for pin placement with the conventional method (2mm penetration through the dentin). Such comparison has not been performed in previous studies.

Methods:

This experimental study was conducted using 30 mandibular molars of 20-25 year old participants. The teeth were intact and did not reveal any signs of caries or previous restorations. They resembled the same anatomical features and the tests were carried out within 8 months following their extraction. The teeth were preserved in water at room temperature throughout the study. They became free of calculus and stains by scaling and root planning procedures. Their occlusal surfaces were reduced 3mm coronal to the CEJ leaving a smooth surface perpendicular to the vertical tooth axis. They were placed in a case that was3cm in diameter and 2cm in height so that their occlusal surfaces would be parallel to the horizontal plane. The roots of the examined teeth were mounted by transparent acrylic resins (Transparent acrylic resin, acropars monomer, Iran) 1mm below the CEJ. There were 3 study groups of A to C (n=15). Groups A and B included the teeth and group C possessed the composite samples. The teeth were randomly assigned to each group.

Group A (n=15): The pin hole was prepared starting at a line angle spaced 1mm from the DEJ, perpendicular to the occlusal surface and parallel to the tooth vertical axis using a low speed hand piece with a 0.021 inch drillat a depth of 2.2mm. Tri-jet pin (EDENTA GmbH A-6890, Switzerland) with a diameter of 0.024 inch was then located in the prepared hole using a hand piece at low speed.

Group B (n=15): Surface preparation of the sectioned teeth was conducted using 37% phosphoric acid (Kimia factory, Iran) etching the enamel for 30 seconds and the dentinal surface for 20 seconds. After rinsing and drying, keeping the dentin moisturized by a wet cotton wool, a thin layer of bonding (Prime & Bond N.T, Dentsply Caulk-Germany) was applied on the prepared surface.Five seconds of air drying at a 2cm distance was applied according to the manufacturer's instructions so that the solvent would be evaporated. A light curing machine (Coltolux 75, Coltene- Whaledent, USA) was used for 20 seconds to complete the polymerization process. A composite layer of 1mm thickness (DentsplyDetrey-spectrum submicron hybrid, Germany) was applied on the surface and the light curing machine was used according to the manufacturer's instructions at 1cm distance to polymerize the composite for 20 seconds.

The pin hole was prepared starting at a line angle spaced 3mm from the tooth circumference, perpendicular to the occlusal surface and parallel to the vertical axis of the tooth using a hand piece at low speed with a 0.021 inch drill. The depth of the hole was 2.2mm and a Tri-jet pin with a diameter of 0.024 inch was inserted inside using a low speed hand piece in a way that the

pin covered 1mm of the dentin and 1mm of the composite resin.

Group C (n=15): A transparent plastic cylinder 8mm in diameter and 5mm in height was used to place the spectrum composite in 5 layers each having a diameter of 1mm. Each layer was cured for 20 seconds according to the manufacturer's instructions using a light curing machine. The samples were then taken out from the cylinders and were cured at two 40 second intervals at the lateral sides. The composite samples were fixed in a case that was 3cm in diameter and 2cm in height using transparent acrylic resins. This resin did not
cover the top 3mm portion of the composite resins. At a 3mm distance from the lateral sides, the pin hole preparation was administered perpendicular to the surface at a depth of 2.2mm using a hand piece at low speed with a 0.021 inch drill. The Tri-jet pin with a diameter of 0.024 inch was then placed into the hole using a low speed hand piece. In order to measure the penetration depth of the pin a caliper was used to mark 2mm of the distal end of the pin. If the mark was above the cavity surface, the pin got replaced by another. A dental surveyor was also used to ensure the perpendicularity of the samples. If the pin was not in line with the perpendicular arm of the surveyor, the sample got replaced. All samples then underwent a tensile force using a universal testing machine (Zwick/Roell Zo20) (10). The force was applied through the vertical axis of the pin and the teeth and removed the pins out from the samples. The machine worked at a speed rate of 1mm/min. Test Xpert v 10-11 software was used to draw the related stress-strain graphs and the maximum tensile force at Newton/Mm2 was obtained for each sample. Data were analyzed using one way ANOVA by SPSS software and L.S.D tests.

Results:

Test findings were analyzed using one way ANOVA whichshowed significant statistical differences amongst the study groups ($P \leq 0.05$). The L.S.D test was used to perform the comparison between the groups. The mean force values required for pin removal, the standard deviations and the minimum and maximum degree of force in each group is demonstrated in Table 1.

Table 1- Representation of the mean tensile force, SD, minimum and maximum amount of force required in each group.

Group type	Sample frequency	Mean tensile force N/Mm2	Maximum force N/Mm^2	Minimum force N/Mm^2	SD
A	15	1113.75	1374.54	819.08	308.21
B	15	1055.71	1485.46	547.09	262.76
C	15	244.79	266.38	198.46	19.55

Based on the findings of the L.S.D test, the outcomes of the groups A and B did not show significant statistical differences ($P > 0.05$) whereas group C revealed different results that were statistically significant compared with the other two groups ($P < 0.05$).
Group A (pin placed in the dentin) required the highest mean tensile force for pin removal (1113/75 N/mm2). The next high values were reported in group B with the mean force of 1055/71 N/mm2 and group C with the mean force of 244/79 N/mm2. The retention provided by pin placement in the dentin compared withwhen the pin is located at both the composite and dentinal surfaces does not therefore vary significantly and the results would be comparable.

Discussion:

When the tooth structure is severely damaged, cavity preparation will require administration of additional slots and grooves to establish the

adequate retention needed for restorative materials. A useful way of providing the appropriate retention for amalgam restorations is to apply intradentinal pins in vital teeth (11-14). Thread mate system pins (TMS pins) are the most common type of self-threading pins used. In the Thread mate system the minim and minikin pins are the selected choices used in highly decayed posterior teeth (15-17).

In a study by Arlong, it was demonstrated that the retention provided by TMS minim pins when embedded in composite resins with large and small particle sizes is significantly higher than minikin and minuta pins. It was suggested that the higher surface contact of theminim pins with the composite resin due to the increased pin diameter and length will lead to elevated retention levels of this pin (18). Minim pins and spectrum composite resins from the hybrid composite group were therefore selected to be used in the present study.Same findings have been reported by Duncason and colleagues regarding the retention provided by minim pins in comparison with the retention of minikin and minuta pins (19).

The maximum pin penetration into the dentin (2mm) is associated with risks of entering the pulp or external tooth surface perforations and pin insertion is usually applied at lower depth levels to prevent such incidences (20, 21). Studies have shown a decline in the pin retention in the dentin and restorative materials when there is a reduction in its diameter and insertion depth (18, 19, 22). Introducing a method that would allow less penetration of different pin types in the dentin and yet provide equivalent retention levels as the conventional technique would be highly advantageous.

As found by the innovative method in our study, the retention provided by pins that were embedded 1mm in the dentin and 1mm in compositeresins was equivalent to 2mm pin penetration in the dentin.

Although there is a difference in the elasticity of the dentin and composite resins, only 1mm pin insertion in the dentin and 1mm in the composite resin would give similar results as 2mm pin penetration in the dentin. All previous studies have demonstrated that 1mm pin penetration in the dentin will not provide the adequate retention required (23, 24). However, our findings suggest that composite application with regard to their potential bonding ability to the tooth structure will provide adequate retention levels even at 1mm pin penetration in the dentin. Such benefit is also applied to the composite ability of restoring the impaired tooth structure i.e. replacing 1mm of the dentin. According to the results for group A (2mm pin penetration in the dentin) and the findings of group C (pin placement in composite units) in our study, the difference in the retention levels was statistically significant between these groups. Appropriate retention levels would not therefore be achieved if the pin is only embedded in a composite base. This could be due to differences in the elasticity of the dentin compared with the tooth structure. The pins in group C were removed by 1/5 of the tensile force applied in group A.

The findings of the present study of equal retention levels by coverage of dental pins by 1mm of the dentinal structure and 1mm of the composite resin compared with the conventional method would be a major clinical advantage. Smaller cavities could be restored with a composite base and 1mm pin penetration in the dentin thus reducing the risks of pin entrance to the pulp, pulpal inflammation and perforation of the tooth external surface.

Conclusion:

The results of the current investigation revealed that the highest tensile force required for pin removal was found in group A and the lowest was found in group C. Pin administration in 1mm of the dentinal structure and 1mm in the

composite resin will result in an equivalent retention as the conventional method of pin insertion in the dentin.

References:

1. Alptekin T, Ozer F, Unlu N, Cobanoglu N, Blatz MB. In vivo and in vitro evaluations of microleakage around class I amalgam and composite restorations. Oper Dent 2010; 35: 614-648.
2. Gupta M, Pandit Ik, Srivastave N, Gugnani N. Comparative evaluation of 2% sodium fluoride iontophoresis and other cavity liners beneath silver amalgam restorations. J Indian Soc pedod Prev Dent 2010; 28: 68-72.
3. Al-Omari WM, Al-Omari QD, Omar R. Effect of cavity disinfection on post operative sensitivity associated with amalgam restorations. Oper Dent 2006; 31: 165-170.
4. Gallato A, Angnes G, Reis A, Loguercio A. Long term monitoring of microleakage of different amalgam with different liners. J Prosthet Dent 2005; 93: 571-576.
5. Osborne JW. In defense of amalgam. Oper Dent 1991; 16: 157-159.
6. Stampalia LL, Nicholls JI, Brudvik JS, Jones DW. Fracture resistance of teeth with resin-bonded restorations. J Prosthet Dent 1986; 55: 694-697.
7. Wassell RW, Smart ER, St George G. Crowns and other extra-coronal restorations: cores for teeth with vital pulps. Br Dent J 2002; 192: 499-509.
8. Irvin AW, Webb EL, Holland GA, White JT. Photo elastic analysis of stress induced from insertion of self threading retentive pins. J Prosthet Dent 1985; 53:311-316.
9. Felton DA, Webb EL, Kanoy BE, Cox CF. Pulpal response to threaded pin and retentive slot techniques: a pilot investigation. J Prosthet Dent 1991; 66:597-602.
10. Burke FJT, Shaglouf AG, Combe EC, Wilson NH. Fracture resistance of five pin-retained core build-up materials on teeth with and without extracoronal preparation. Oper Dent 2000; 25: 388-394.
11. Summitt JB, Burgess JO, Berry TG, Robbins JW, Osborne JW, Haveman CW. The performance of bonded vs. pin-retained complex amalgam restorations: a five-year clinical evaluation. J Am Dent Assoc 2001; 132: 923-931.
12. Brackett WW, Bailey JH. The retention of amalgam and composite resin by a smooth reverse-tapered pin. Oper Dent 1992; 17: 152-155.
13. Harris RK. Dental amalgam: success or failure? Oper Dent 1992; 17: 243-250.
14. Summitt JB, Burgess JO, Berry TG, Robbins JW, Osborne JW, Haveman CW. Six-year clinical evaluation of bonded and pin-retained complex amalgam restorations. Oper Dent 2004; 29: 261-268.
15. Summitt JB, Robbins W, Hilton TJ, Schwartz R. Fundamentals of operative dentistry. 3rd Ed. Hanove Park, Quintessence 2006; Chap 11: 340-393.
16. Roberson TM, Heymann HO, Swift EJ. Art and science of operative dentistry. 5th Ed. USA. St.Louis: The C.V. Mosby Co. 2006; Chap 19: 807-842.
17. Caputo AA, Standlee J. Pins and posts- why, when and how. Dent Clin North Am 1976 ;20: 299-311.
18. Podshadley AG. The retention of threaded pins in composite resin. J Prosthet Dent 1989; 61:169-173.
19. Dilts WE , Duncason MG Jr, Collard EW, Parmley LE. Retention of self -threading pins. J Can Dent Assoc 1981; 2: 119-120.

20. Burgess JO, Summitt JB. Retention and resistance provided by Nine self-threading pins. Oper Dent 1991; 16: 55-60.
21. Davis SP, Summitt JB, Mayhew RB, Hawley RJ. Self -threading pins and amalgapins compared in resistance form for complex amalgam restorations. Oper Dent 1983; 8: 88-93.
22. Bione HM, Wilson PR. The effect of the mismatch between the core diameter of self-threading dentine pins and the pinhole diameter. Aust Dent J 1998; 43:181-187.
23. Imbery TA, Burgess JO, Batzer RC. Comparing the resistance of dentine bonding agents and pins in amalgam restorations. J Am Dent Assoc 1995; 126: 753-756.
24. Butchart DG, Grieve AR, Kamel JH. Retention of composite restorations. A comparison between a threaded pins and a dentine bonding agent. Br Dent J 1988; 165:217-220.