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Original Research

Distinctive Analysis of Retention between Conventional Retainers and Modified Retainers in Fixed Partial Denture: An In Vitro Study

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ABSTRACT:
Objectives: Resin-bonded bridges offer many advantages over conventional full coverage fixed partial dentures, including reduced cost, high patient satisfaction and minimal loss of tooth structure during tooth preparation resulting in less trauma and superior prognosis. Little or no preparation to the abutments means relying heavily upon adhesive technology with minimal mechanical assistance. The present study had evaluated the bond strength of full metal crowns with the Glass Ionomer Cements and compared with variance in regard to adhesive resin cement by using two different methods like minimally invasive inlay and conventional full coverage tooth preparations. **Materials and methods:** A total of 40 freshly extracted non-carious human premolar and molar teeth were collected. The samples were grouped into Control group consisted of full metal FPDs cemented using GIC and Experimental group consisted modified inlay-retained FPDs luted using self-adhesive resin. **Statistical analysis:** The data was analysed by employing t-test and ANOVA using SPSS software (IBM version 21). **Results:** Maximum Force, Break Force and Maximum Stress of conventional group were statistically significant. **Conclusion:** The full coverage FPDs luted with GIC recorded higher retentive strengths than modified inlay retained FPDs designs luted with self-adhesive resin.
Key words: Adhesive resin cement; Full Coverage FPDs; Glass-ionomer cement; Inlay Retained FPD’s; Retentive strength.

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INTRODUCTION

The essence of medical ethics lies in the Latin phrase "Primum nil nocere" – first, do no harm. This principle reverberates in dentistry, where practitioners must balance restoring function and aesthetics while minimizing harm to dental tissues. Fixed prosthodontics, involving restorations attached to natural teeth or implants, traces its roots back centuries, evolving from basic crowns to sophisticated multiunit restorations [1,2].

However, challenges persist. Long-term retention issues and aesthetic concerns, like abutment teeth darkening and composite resin degradation, plague conventional treatments. Modern dentistry increasingly values minimally invasive approaches, preserving natural tooth structure. Resin-retained fixed partial dentures (FPDs) champion this ethos, sparing more tooth tissue compared to traditional methods [3-6].

The traditional approach necessitates sacrificing healthy tooth structure for abutment preparations, raising patient concerns about unnecessary damage. Alternative strategies, like cantilever FPDs or unilateral removable partial dentures, attempt to minimize this issue but often fall short in stability or retention. Acid etching emerged as a less destructive means of attaching fixed partial dentures, initiating a shift toward more conservative practices [2,4,5].

The choice of restorative options for a missing tooth involves multiple considerations—economic factors, occlusal disturbances, or the extent of healthy tooth removal. Inlay-retained FPDs (IRFPDs) and resin-bonded FPDs offer promising alternatives. IRFPDs demonstrate moderate failure rates but remain favorable for their biological and economic benefits. Resin-bonded FPDs, evolving over three decades, have become more predictable due to advancements in materials and bonding techniques, emphasizing minimal abutment preparation [6-8].

Each restoration aims to restore function, aesthetics, and comfort. Conventional FPDs and implant-supported crowns have long been heralded for reliability but demand invasive procedures. Resin-bonded FPDs emerge as minimally invasive options, preserving more of the natural tooth structure and posing fewer risks to pulp vitality.Decision-making in replacing missing posterior teeth involves evaluating various designs. Full veneer FPDs necessitate substantial healthy tooth removal, while implant-supported options might not align with patient preferences or constraints. Inlay-retained FPDs gain traction due to their conservative nature and satisfactory short-term survival rates [8-10].

These IRFPDs bond easily to minimally prepared abutment teeth, offering a conservative alternative. The design typically involves pontics with inlay wings as retainers, constructed from diverse materials. However, the success of such restorations hinges on retention, which can be augmented by adhesive luting cements.

In essence, the evolution of fixed prosthodontics seeks a delicate balance between restoration and preservation. As dentistry progresses, the emphasis on minimal invasiveness continues, promoting techniques that preserve tooth structure while effectively restoring function and aesthetics.

MATERIALS AND METHODS

The in-vitro study was conducted at the Department of Prosthodontics, Panineeya Mahavidyalaya Institute of Dental Sciences and Research Centre, Hyderabad, Telangana, India. Ethical approval was secured from the Institutional Review Board (Protocol number: 0225-18) before the commencement of the study. Using G*Power software (version 3.0.10) and considering effect size, power, alpha error probability, and confidence level, a sample size of 10 in each group was determined.

Forty non-carious human premolar and molar teeth were collected, cleansed in a 1% hydrogen peroxide solution for 24 hours to remove debris, and individually mounted on small boxes made of cold cure acrylic resin.

Sample Grouping and FPD Fabrication:

1. Control Group (Group 1): Consisted of full metal FPDs with full metal coverage preparations intended for luting using GIC.
2. Experimental Group (Group 2): Comprised modified inlay-retained FPDs with full metal coverage preparations on premolars and box-shaped inlays on molars intended for luting using self-adhesive resin.

Tooth Preparation: Using a high-speed, high-torque airotor handpiece (NSK), tooth preparations were conducted for both groups. Control group teeth were prepared for conventional full metal FPDs with specific axial and occlusal depths and a 6-degree convergence angle in the finish line margins. In the Experimental group, modified inlay-retained FPDs were prepared with specific dimensions and divergence achieved using a parallelometer bur attached to the surveyor.

Fabrication of All Metal-FPDs: Impressions of prepared teeth were taken using polyvinyl siloxane putty and light body, followed by die stone manipulation for casts. Wax patterns were fabricated, treated with die hardener, die spacer, and die lubricant. Inlay casting wax was used to create wax patterns, invested, and cast with a base metal alloy.

Cementation: Castings were cemented using two different luting agents: Glass ionomer cement for conventional full metal FPDs and self-adhesive resin for modified inlay-retained FPDs. Excess cement was removed, and samples were stored in distilled water for 24 hours before subjecting them to tensile strength testing using a universal testing machine (Instron) to record dislodgment forces in Newtons.

Statistical analysis of the recorded data in Microsoft Excel sheet was done using IBM SPSS Statistics Version 21.0.

RESULTS

Table 1 presents the descriptive statistics of various variables measured in the Control and Inlay groups. For the Maximum Force, Break Force, Max Displacement, Max Stress, and Max Strain, both groups (Control and Inlay) exhibited differences in means. The Control group generally showcased higher means for Maximum Force and Break Force compared to the Inlay group. However, for Max Displacement, Max Stress, and Max Strain, the Inlay group exhibited higher means.

Table 2 outlines the comparison of means of the study variables between the Control and Inlay groups using Student’s t-test. The results indicate statistically significant differences between the two groups across all variables. The Control group demonstrated notably higher mean values for Maximum Force, Break Force, Max Displacement, Max Stress, and Max Strain compared to the Inlay group, signifying substantial variations in these parameters between the two groups.

Table 3, depicts the comparison of means of study variables between the two groups using One-way ANOVA Test. The findings showcase significant differences in Maximum Force, Break Force, Max Stress, and Max Strain between the Control and Inlay groups, as indicated by the statistically significant p-values. However, there were no significant differences observed in Max Displacement, suggesting similarity in this parameter across both groups.

Table 1: Descriptive Statistics

Group	Variable	N	Mean	SD	Median	Range	Minimum	Maximum
Control	Max Force	10	500.76	54.08	502.78	125.56	432.23	557.79
	Break Force	10	473.65	55.97	469.79	147.72	408.84	556.56
	Max Displacement	10	4.489	1.417	4.314	3.475	3.061	6.536
	Max Stress	10	3.3	1.56	2.687	4.04	1.816	5.856
	Max Strain	10	4.49	1.418	4.314	3.475	3.061	6.536
Inlay	Max Force	10	268.80	27.11	263.10	77.75	242.68	320.43
	Break Force	10	255.62	23.91	250.04	82.95	215.41	298.36
	Max Displacement	10	5.665	2.576	4.766	8.898	2.872	11.77
	Max Stress	10	1.612	0.464	1.660	1.515	1.052	2.567
	Max Strain	10	5.665	2.576	4.766	8.898	2.872	11.77

Table 2: Comparison of Means between Control and Inlay Groups (Student's t-test)

Variable	T Value	P Value	Mean Difference	95% CI Lower Bound	95% CI Upper Bound
Maximum Force	Control	29.282	500.76	462.074	539.445
	Inlay	31.349	268.796	249.399	288.192
Break Force	Control	26.761	473.646	433.608	513.684
	Inlay	33.811	255.62	238.517	272.722
Max Displacement	Control	10.013	4.49	3.475	5.504
	Inlay	6.953	5.665	3.822	7.51
Max Stress	Control	6.690	3.3	2.183	4.415
	Inlay	10.981	1.612	1.28	1.944
Max Strain	Control	10.011	4.5	3.475	5.505
	Inlay	6.953	5.665	3.822	7.509

Table 3: Comparison of Means between Control and Inlay Groups (One-way ANOVA Test)

Variable	F Value	P Value
Maximum Force	147.028	0.004*
Break Force	128.332	0.002*
Max Displacement	1.6	0.222
Max Stress	10.752	0.004*
Max Strain	1.596	0.223

(*Significant at 0.1% level of significance)

DISCUSSION

The study aimed to assess and compare the retentive strength of two different types of retainers in fixed partial dentures (FPDs) using distinct luting agents and their impact on tensile strength. Specifically, it sought to discern the retentive strength between modified inlay-retained FPDs and conventional FPDs, considering the former's minimal invasive approach.

Numerous studies have explored the retention potential of resin cements and glass ionomer cement (GIC) in various crown applications. Anto and Kumar GV [8], Pattanaik and Nagda [9], Pathak [10], Sreeramulu.B [11], Orsi et al [12], Tomar SS [12], among others, investigated different luting agents' effectiveness on crown retentive strength. While these studies predominantly focused on single crowns and varied luting agents, the present study diverged by evaluating the retentive strength in FPDs using self-adhesive resin cement and GIC. Surprisingly, it found that GIC exhibited superior retentive strength compared to self-adhesive resin cement when used as a luting agent for FPDs.

Other literature, such as studies by Augusti [14], Mohsen [15], Ohlmann et al [16], Xie et al [17], and Gohring [18], explored diverse aspects of FPDs, including different designs, materials, and clinical outcomes. However, they predominantly employed FPDs with exclusively prepared inlay designs. In contrast, the present study utilized modified inlay-retained FPDs, incorporating full metal coverage on one tooth and a box-shaped inlay luted with resin cement on another. Interestingly, this unique combination showcased decreased retentive strength, even with the use of resin cement, albeit proving to be more effective than GIC.

Despite upholding rigorous research methodologies, the study holds limitations, notably the small sample size and the inherent constraints of an in vitro design, lacking complete simulation of actual oral forces. Therefore, future investigations should consider larger sample sizes and more robust research designs to augment the study's evidence level beyond an in-vitro setup.

CONCLUSION

GIC-luted full coverage FPDs exhibited higher retentive strengths compared to modified inlay-retained FPDs employing self-adhesive resin. The study emphasizes that when planning minimally invasive restorations, the longevity of retention predominantly relies on the adhesive agents used. Hence, the selection of the combination of tooth preparation and cementing agent should be thoughtfully considered for optimal outcomes.

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