Comparative clinical evaluation of slot versus dovetail Class III composite restorations in primary anterior teeth

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This study compares the clinical characteristic evaluations of slot against dovetail class III composite restorations. Focusing on the primary anterior teeth of children aged 2 years 6 months to 5 years 3 months with the mean age of 4 years, thirty-six matched pairs of class III of slot and dovetail preparations were made by one investigator. These preparations were evaluated for marginal adaptation, anatomic form, secondary caries and marginal discoloration after 6, 12, and 24 months by another investigator with the intra-examiner reliability of 0.95 – 1 (Kappa Statistic). The results revealed no statistical significance in the difference of clinical characteristics between the two designs ($p > 0.05$).
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INTRODUCTION

Present day improved adhesives exhibit a highly predictable level of clinical success, especially in the aspect of retention. Traditional mechanical methods of retaining restorative materials have been replaced to a large extent by the tooth conserving adhesive technique.[1] In most situations, bonding agents demonstrated less shear bond strength in primary than permanent tooth dentin, however, many dentin bonding agents had the potential to equal or exceed the bond strength to enamel in primary teeth.[2-3] In other studies, shear bond strength in primary dentin was found comparable to permanent dentin.[4-5] Dovetail has been advocated to aid in additional mechanical retention of small to moderate size of class III cavity design from the past to present.[6-7]

Notwithstanding the fact that more tooth structure is lost, it may not be necessary to add dovetail to cavity design with present day bonding agents since by exhibiting higher shear bond strength, they ensure better adhesion to primary teeth.

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The success in restoring primary teeth, depends on far more than the restoration material, especially extending to the degree of patient cooperation, the difference in primary tooth anatomy, and the life span of the tooth.

Though restoration in children is characterized by the need to be durable, yet the technique needs to be simple and less time consuming owing to diminished cooperation and small tooth size, excessive longevity is not necessary due to the finite life span of the tooth. Many *in vitro* studies were conducted on the physical, mechanical properties of material used to restore primary teeth. Nevertheless, clinical trials remain the ultimate proof of clinical effectiveness of material or technique used, due to the actual function in the oral cavity. This research compares the clinical characteristics of slot and dovetail class III restorations with the composite resin in present use. These findings may help in conserving primary tooth structure while maintaining good retention of the restoration.

METHODS AND MATERIALS

Thirty-six patients aged 2 years 6 months to 5 years 3 months, with the mean age of 4 years, who had at least one pair of similar size class III lesion on the middle third of the same proximal surface of contralateral anterior teeth comprised the subject group. Dentino-enamel junction was the limit of the lesion depth. The sample consisted of 22, 4, 4, and 6 pairs of upper central incisors, upper lateral incisors, cuspids, and lower incisors, respectively. One tooth in each pair was randomly assigned to dovetail, and the other to slot preparation by simple random sampling without replacement. The procedure, possible discomforts, risks and benefits were fully explained to the parents or

Table 1. Rating system and criteria for evaluating of clinical characteristics adapted from Ryge's[10].

Clinical characteristics	Category of rating	Evaluation criteria	Overall quality
Marginal adaptation	A	No catch or visible evidence of a crevice along the margin	O
	B	A small catch, crevice or ditch but dentin or cement base is not exposed	a
	C	Dentin or cement base is exposed	a
	D	Mobile restoration, fractured or missing in part or total	U
Anatomic form	A	Restoration contour is continuous with existing anatomical form	O
	B	Restoration is undercontoured, restorative material discontinuous with existing anatomic form but loss of material not sufficient to expose the dentin or base	a
	C	Loss of material to the extent that dentin or base is exposed	U
Secondary caries	A	No evidence of caries contiguous with the margin of the restoration	O
	B	Evidence of caries contiguous with the margin of the restoration. An explorer catches or resists removal after insertion with moderate to firm presence	U
Margin discoloration	A	No discoloration penetrated along the margin of the material in a pulpal direction	O
	B	Discoloration penetrated along the margin of the material in a pulpal direction	U

A = ideal
B = acceptable but exhibits one or more features which deviate from ideal conditions
C = not acceptable. Future damage to tooth and/or it surrounding tissues is likely to occur
D = not acceptable. Damage to tooth and/or its surrounding tissues is now occurring.
O = optimal, expected to protect the tooth and surrounding tissues
a = acceptable, no need for replacement
U = unacceptable, need replacement to avoid damage or to repair damage already began

guardians. Their informed consents were obtained prior to the investigation.

CAVITY PREPARATION

The first investigator prepared all of the teeth under local anesthesia and using a rubber dam. A No. 330 carbide bur was used to prepare the cavity into slot[8] or dovetail[9] design and caries was removed by a No. 2 or No. 3 round bur or spoon excavator. A tapered diamond bur was used to make a short bevel on the cavosurface margin, followed by polishing with pumice and water. The tooth was rinsed and dried with a triple syringe. A celluloid matrix and wedge were placed on the proximal surface. The tooth was etched with a phosphoric acid gel (37% by volume) for 20 seconds, washed with air-water spray for 15 seconds and finally gently dried with compressed air from an air syringe for 5-6 seconds. Optibond Fl primer (Kerr Manufacturing Co., Romulus, MI) was applied to the tooth with a brush in a gentle back and forth motion for 30 seconds. A thin layer of Optibond bonding resin (Kerr Manufacturing Co., Romulus, MI)) was applied over the primed preparation with a brush and was light cured for 20 seconds with a visible light source, XL 3000 (3M, St. Paul, MN). This light source was used throughout the study and its effectiveness was confirmed daily with a curing radiometer, model 100 (Demetron Research Corp., Danbury, CT). A small portion of composite resin, Herculite XRV (Kerr Manufacturing Co., Romulus, MI), was placed on the cavity and cured for 40 seconds. Each restoration was finished with white stone (Shofu Mellowpark, CA) and Pop-on discs, Soflex (3M St. Paul, MN), and the proximal margin planed with a No. 12 blade and sandpaper strips.

CLINICAL EVALUATION

The second investigator examined and recorded the condition of the restoration at 6, 12, and 24 months. In establishing the intra-examiner reliability, practice exams were given to patients who had had class III composite restoration, and follow-up exams of 20 random samples coinciding with the 6, 12, and 24 month timetable of the principle investigation. The results were analyzed using Kappa statistical techniques. The examination was done visually with an explorer and a mouth mirror, using the criteria modified from Ryge's[10] in Table 1.

Whenever the restoration was rated as unacceptable the tooth was excluded from the study and retreated. The results from each examination were recorded into a form containing basic information including the assigned code for the patient, the tooth number, the surface restored, and slot or dovetail design. The clinical evaluations at each follow up were marginal adaptation, anatomic form, secondary caries and margin discoloration. In evaluating these four characteristics, letter ratings were assigned, such as those described in Table 1 and the locations of failures would be identified and recorded.

STATISTIC ANALYSIS

The data was analyzed by using version 9.0 of SPSS (Statistic Package for the Social Science). Differences in the clinical characteristics between the two groups were tested using the non-parametric Marginal Homogeneity Test. P values < 0.05 were considered to indicate statistically significant differences.

RESULTS

Thirty-six pairs of primary anterior teeth formed the subject group at the beginning of this study. At both

Table 2. Number and percentage of clinical characteristics evaluation at 6, 12, 24 months.

Clinical Characteristics	Category of rating	6 months				12 months				24 months			
		Slot		Dovetail		Slot		Dovetail		Slot		Dovetail	
		N=31	%	N=31	%	N=31	%	N=31	%	N=22	%	N=22	%
Marginal adaptation	A	30	96.8	27	87.1	29	93.5	27	87.1	20	91.0	19	86.4
	B	1	3.2	4	12.9	2	6.5	4	12.9	1	4.5	2	9.1
	C	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	D	0	0.0	0	0.0	0	0.0	0	0.0	1	4.5	1	4.5
Anatomic Form	A	31	100.0	31	100.0	30	96.8	28	90.3	20	91.0	19	86.4
	B	0	0.0	0	0.0	1	3.2	3	9.7	1	4.5	2	9.1
	C	0	0.0	0	0.0	0	0.0	0	0.0	1	4.5	1	4.5
Secondary Caries	A	31	100.0	31	100.0	31	100.0	31	100.0	22	100.0	22	100.0
	B	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Margin Discoloration	A	31	100.0	31	100.0	30	96.8	30	96.8	22	100.0	20	91.0
	B	0	0.0	0	0.0	1	3.2	1	3.2	0	0.0	2	9.0

six and twelve month marks, five pairs were excluded, three from patients unable to come for follow up, one due to a fractured incisor edge from accident, and one due to early exfoliation. At the end of the study (twenty four months) only twenty-two pairs remained for analysis, fourteen pairs having been eliminated from the study. Six pairs from patients who did not come for follow up. Two pairs acquired fracture at incisal edge from accident and 6 pairs exfoliated. The intra-examiner reliability analyzed using Kappa statistical techniques showed the degree of agreement (K) at the interval of 0.95 – 1. Table 2 shows the evaluation of different characteristics of slot and dovetail preparations.

From Table 2, at six months, the only finding was one and four B ratings in the marginal adaptation of slot and dovetail designs. At twelve months, no restoration failed requiring any replacement, however there was a small crevice at the margin of each of two slot and four dovetail restorations. This resulted in discontinuity with the existing anatomic form, but without penetrating dentin and was clinically acceptable. There was a shallow air bubble at the surface of one dovetail restoration, though replacement was not necessary. One discoloration in each group was observed. No secondary caries was found at the margin of any restoration.

At six, twelve, and twenty-four months a higher percentage of B ratings were found in marginal adaptation of dovetail than in slot restorations. The defects most commonly noticed were small crevices along the margin into which the explorer could penetrate, however dentin was not exposed and these defects were rated clinically acceptable. When analyzed with the Median test and the Marginal homogeneity test, there was no statistical difference between slot and dovetail restorations in marginal adaptation.

The anatomic form at twelve and twenty-four months that demonstrated more A ratings in the slot groups and more B ratings in the dovetail counterparts were still judged clinically acceptable. Only one unacceptable rating was found in both groups after twenty-four months at the study conclusion. The differences in the anatomic forms of slot versus dovetail restorations were not statistically significant. When considering secondary caries, there were none found in either group.

Marginal discoloration was not found at six months. At twelve months each group exhibited one discolored margin. At twenty-four months, dovetail exhibited two B ratings, though the slot group exhibited none. This was not statistically significant.

At twenty-four months, evaluation of overall quality revealed four unacceptable restorations. Of this group, one exhibited total dislodging of composite from a slot restoration, the remaining three in the dovetail group. Of these the following occurred: one fracture at isthmus and proximal composite missing, and the remainder, two small crevices together with discoloration toward pulp at the margin. All four restorations required replacement. A small crevice at the margin and the restorative material discontinuous with existing anatomic form but not penetrating dentin was rated as acceptable in a slot restoration. The majority of defects were found at the gingival margin of the restorations. When the data was analyzed, it was found that the differences in clinical characteristics of slot and dovetail restorations were not statistically significant in any aspect of evaluations at six, twelve, and twenty-four months ($P > 0.05$).

Table 3. Overall clinical quality of slot and dovetail restorations at 6, 12, 24 months.

Overall evaluation	Number and percentage of restorations											
	6 months				12 months				24 months			
	Slot		Dovetail		Slot		Dovetail		Slot		Dovetail	
	N=31	%	N=31	%	N=31	%	N=31	%	N=22	%	N=22	%
Optimal	30	96.8	27	87.1	28	90.3	26	83.9	20	91.0	19	86.4
Acceptable	1	3.2	4	12.9	2	6.5	4	12.9	1	4.5	0	0.0
Unacceptable	0	0.0	0	0.0	1	3.2	1	3.2	1	4.5	3	13.6

From Table 3, when considering the overall quality at the end of the study, it was found that over 85% of the restorations were rated as optimal, decreasing as time increased. In every evaluation, the percentage of optimal dovetail restorations was less than that found in the slot counterparts. In considering unacceptable restorations, or those requiring replacement, the twelve month mark revealed one in each group; at twenty-four months more were found in the dovetail group. However, under analysis, differences in overall quality between slot and dovetail restorations were not statistically significant ($P > 0.05$).

DISCUSSION

One of the important aims in restorative dentistry is to conserve tooth structure in the removal of caries and cavity preparation. Many studies have been conducted to compare different designs that attempt to meet these objectives. Clinical studies have many limitations such as the short life span of the primary teeth, and the chance of exfoliating in the follow up examination. The age of patients at the time of treatment should not be too old, that long-term follow up be possible. Cooperation of the parents and behavior of child patients make the study complicated. In addition to all the aforementioned limitations, our samples were also restricted to our selection criteria. They were: the patient must be cooperative, with small to medium size class III caries in the middle 1/3 of incisocervical length, and the depth be confined to dentinoenamel junction. Thus the samples selected were limited in numbers and some were missing in the follow up.

The results of this study revealed that the difference in the success rate of slot and dovetail class III preparation was not statistically significant. After twenty-four months, over 85% of both types of restoration were in optimal condition. In the first twelve months, no restoration was judged unacceptable. Restoration failure, first observed at twenty-four months, was fractured restoration and material dislodging or discoloration of margin in the pulpal direction. The majority of failures in marginal discoloration and of the crevice at the margin of restoration, or discontinuity with the anatomic form, but not penetrating the dentin were found at the gingival margin. Gingival fluid contamination despite the use of rubber dam is a possible cause. Incomplete sealing may have occurred and given rise to the marginal leakage and discoloration.[1] Furthermore, this may have progressed to the fracture or the dislodging of the restoration.

Despite expected added retention in dovetail preparations, if moisture contamination could not be controlled, marginal adaptation may have deteriorated and thereby led to fracture or the missing of restoration. Although no statistically significant differences were found between the two types of cavity designs, dovetail restoration had a greater tendency of marginal fracture than slot restoration, owing to the more marginal area of the restoration. The discontinuity of restoration with anatomic form was partly caused by the air bubble at the surface of restoration, arising from the process of insertion of composite resin into the preparation. Nevertheless, these restorations were considered acceptable clinically. Though considered one of the most frequent causes of failure in restoring primary teeth with composite resin,[10] no recurrent caries at the margin of restoration was observed.

Qvist *et. al.*[11] reported that the most common reasons for replacement of composite resin restoration in primary teeth were missing of restorations, followed by recurrent caries and marginal discrepancies, similar to the findings of Friedl *et. al.*[12] Nevertheless, we did not find any recurrent caries on the margin. Because our study only lasted twenty-four months, it might not be long term enough to observe recurrent caries clinically.

Atkins *et. al.*[13] studied the rate of failure in class III slot preparation in two to four-and-one-half year old children with the dentinal bonding agent, Scotchbond™ (Dental Products, St. Paul, MN), and filled with composite resin, Silux™ (Dental Products, St. Paul, MN). After six months, they reported a ten percent failure rate described as marginal leakage, recurrent caries, and fractured and missing restorations. The rate was higher than our study (4.5% in twenty-four months). In their study, the cooperation of the patients was not considered as part of the selection criteria. Many different dentists restored the teeth and rubber dams were not used. Additionally, Scotchbond was a

second generation bonding agent with very low bonding strength with dentin[14-16] compared to the higher strength bonding agent used in this study. Each of these aspects served as contributing factors to the results observed. The reason for fracture or missing composite in this study is probably due more to the restorative procedure than the insufficient bonding strength of the bonding agent. Knight *et. al.*[17] concluded that the use of rubber dam resulted in less microleakage at the enamel resin interface significantly when compared to that with cotton roll. In our study, local anesthesia, rubber dam, and fourth generation bonding agents with greater shear bond strength[4] were used, and only cooperative patients were included in the subject group. All of these aspects contributed to the lesser failure rate of our restorations.

Our findings revealed that the additional dovetail preparation did not result in better clinical characteristics, nor more durability than the slot preparation. Additionally, slot preparations provided sufficient retention and conserved tooth structure, tendency toward less pulp exposure risk, reduced marginal leakage, easy to polish and less time consuming. Especially in young children, restoration technique needs to be simple and quick to decrease chair time, minimize moisture contamination and provide sufficient strength and durability suitable to the life span of primary anterior teeth.

Nevertheless our study of twenty-four months may not have detected other clinical failures, which might take more time to observe; longer study would be beneficial. This study does not extrapolate to other composite and bonding agents and applies only to lesions restricted to the middle third of incisor-cervical width and depth not exceeding dentinoenamel junction.

CONCLUSION

No statistically significant differences were found in clinical characteristics between dovetail and slot class III preparations of primary anterior teeth in the aspects of marginal integrity, recurrent caries, discoloration and anatomic form at six, twelve and twenty-four months.

- Class III slot composite restoration showed a tendency toward better clinical characteristics with less failure or defect.
- No recurrent marginal caries were found in either cavity designs.
- Greater failure rates were found in dovetail restorations than slot restoration (13.6% and 4.5%). This arose from fractured and missing restorations and discoloration.
- The majority of failure in both designs occurred more on the gingival margin than other areas.
- After twenty-four months, slot preparations exhibited a 90.9% optimal rating, while a rating of 86.4% was derived for dovetail counterparts.

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