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COMPARATIVE EVALUATION OF MICROLEAKAGE OF 5TH, 7TH & 8TH GENERATION DBA'S: AN IN VITRO STUDY

Dentistry

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ABSTRACT

Aim: The purpose of the study was to evaluate microleakage of 5th, 7th & 8th generation DBA'S.

Methodology:
On 45 extracted premolars, Class V cavities were prepared and divided into 3 groups according to the generation of DBA used. Group I uses 5th generation, Group II uses 7th generation, and Group III uses 8th generation DBA's, followed by composite restoration, which were then thermocycled at 5 & 55 ± 2°C for 1000 cycles and submerged in methylene blue (2%) and observed under stereomicroscope.

Results: Microleakage was highest in 7th generation DBA followed by 5th and minimal in 8th generation DBA. The 8th generation DBA had statistically significant results in respect to minimal microleakage in comparison to other generation DBA's.

Conclusion: 8th generation DBA (Tetric N-Bond Universal) showed least microleakage compared to 5th and 7th generation DBA's.

KEYWORDS

DBA's (Dentin Bonding Agents), Prime & Bond-NT, Opti-Bond All-in-One, Tetric N Bond Universal.

INTRODUCTION:

In the dawn of restorative dentistry, retention and stabilization of restoration often needed stripping of healthy tooth structure to produce undercuts that act as auxiliary retention aids. This difficulty is resolved with the inception of newer adhesive systems in dentistry.[1] The goal of a bonded restorations is to attain an intimate adaptation of restoration with the cavity wall. The interface between restorative material and dental tissue is of clinical concern that may lead to secondary caries, discoloration of margins, and pulpitis.[2] Absolute adaptation is hard to achieve because of inconsistent physical properties between tooth and restorative materials. Microleakage, is defined as, clinically imperceptible passage of bacteria, fluids, molecules or ions between the cavity wall and the restoration.[3] Thus, modifications in adhesive systems and resin-based composites must be achieved to decrease the detrimental outcomes of polymerization shrinkage, gap formation & sequential leakage.[4]

Experimental section:

45 extracted teeth, were cleaned of debris, and autoclaved. Class-V cavities (dimensions 3×2×1.5 mm) were prepared on buccal/lingual surfaces of teeth, using high-speed airotor which were standardized with Vernier calliper, and were randomly grouped, based on DBA's used.

Group – I Prime & Bond-NT (Dentsply)
Group – II Opti Bond All-in-one (Kerr)
Group – III Tetric-N bond Universal (Ivoclar Vivadent)
DBA's were applied as of manufacturer's instructions.

Samples in Group-I, were bonded using Prime & Bond NT (5th generation), DBA. Etchant was applied for 10 sec, followed by rinsing and dried, then DBA is applied over the surface for 20 sec and cured for 10 sec.

Samples in Group II, were bonded using Opti Bond All-in-one (7th generation), DBA, where two coats of the bonding agent was applied, for about 20 sec, air dried for 5 sec, followed by curing for 20 sec.

Samples in Group III, were bonded using Tetric-N bond (8th generation), DBA, which was applied with a rubbing motion for 15 sec, and air dried for 5 sec, followed by curing for 20 sec. Filtek Z350-XT composite was incrementally placed, and polymerized for 20 sec with curing unit of 300mW/cm2 light intensity (3M Dental). Final finishing and polishing was done after curing.

Specimens were then subjugated to thermocycling for 1000 cycles between 5 ± 2° & 55 ± 2° with a immersion time of 30sec in each bath, with a transfer time of 30sec to replicate oral conditions. Thermocycling procedures represent a way to accelerate specimen aging and to challenge the marginal seal.[11] After the procedure root apices were closed with wax and were triple coated using nail varnish, leaving 0.5–1.0 mm space around the restoration. Then all the samples were submerged in methylene blue dye (2%) for two days after which they were washed with water and air dried. All the specimens were sectioned longitudinally in a bucco-lingual direction and assessed for microleakage under an stereomicroscope with magnification of 20×.

The scoring criteria assessment is followed according to Vinay and Shivanna:[12]

0 = no dye penetration
1 = Penetration of dye up to one-third cavity depth
2 = Penetration of dye up to two-third cavity depth
3 = Penetration upto full depth of cavity
4 = Penetration onto axial wall of cavity.

RESULTS:

The P < 0.05 is considered statistically significant and Kruskal-Wallis nonparametric analysis and Mann–Whitney U test were applied to compare the various groups.

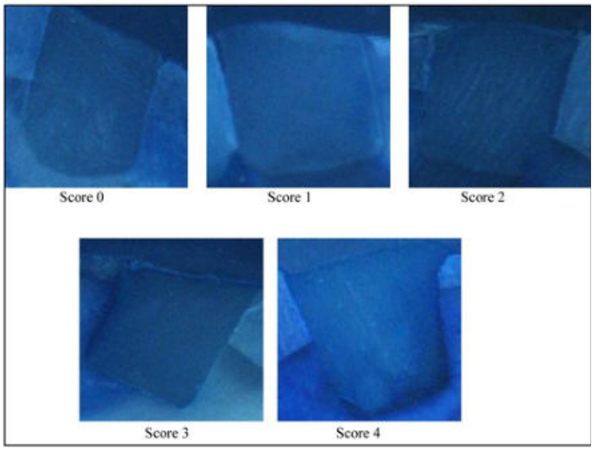


Figure:

Table 1: Mean values of microleakage in Group I, Group II, and Group III

Micro Leakage	N	MEAN	SD	MEDIAN	SEM
Group – I	15	1.93	0.799	2.0	0.2063
Group – II	15	2.40	1.502	3.0	0.3879
Group – III	15	0.87	0.639	1.0	0.1652
Total	45	1.73	1.214	2.0	0.1809

Group I - 5th generation DBA, Group II - 7th generation DBA, Group III - 8th generation DBA. SD = Standard deviation, SEM = Standard error of mean.

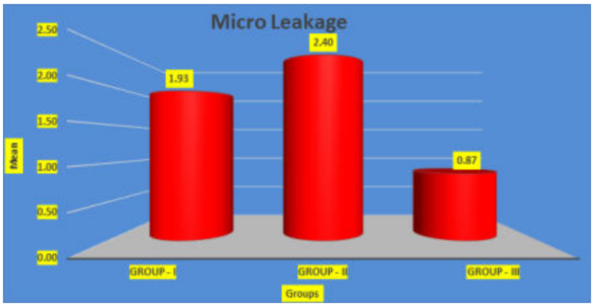
Table 1, shows the mean value of 1.93 for Group-1, 2.40 for Group-II, and 0.87 for Group-III. Based on the values obtained microleakage was highest in Group-II (7^{th} generation DBA) followed by Group-I (5^{th} generation DBA) and Group-III (8^{th} generation DBA). On inter-comparison, significant difference is seen between Group-I & Group-III and Group-II & Group-III with P value of 0.005 and 0.001, respectively and non-significant difference was seen between Group-I and Group-II with P value of 0.305 [Table 2 & Graph 1].

Table 2: Intergroup comparison of the mean rank of microleakage in Group I, Group II, and Group III

	Group	n	Mean Rank	Mann-Whitney U test	P Value
Pair 1	I	15	13.83	87.500	0.305
	II	15	17.17		
Pair 2	I	15	20.67	35.000	0.005
	III	15	10.33		
Pair 3	II	15	19.83	47.500	0.001
	III	15	11.17		

The mean difference is considered statistically significant at the $*P < 0.05$.

Graph 1: Graphical representation of mean of microleakage among all the groups.



Group I: 5th generation DBA, Group II: 7^{th} generation DBA, Group III: 8^{th} generation DBA

DISCUSSION:

Buonocore (1956) initiated the work on adhesion to dentin, since then different generations of DBA's are developed, to the recent 8th generation bonding agent.[11] Major factor of restoration is its marginal integrity, along tooth restorative border. An inadequate marginal integrity causes space between tooth and restoration inducing microleakage. Various improvements in the properties of bonding systems have done to decrease microleakage, by increasing the acid potential of the etchant, addition of nanofillers, and alterations in resin composition.

Prime & Bond-NT, a single-bottle system, showed comparatively greater marginal integrity than the self-etch All-in-one which could be, due to presence of various components like; Urethane dimethacrylate, a hydrophobic monomer for better polymerization and cross-linking to surface-bound hydroxyl groups through urethane. The presence of dipentaerythritol pentacrylate phosphoric acid ester (PENTA) help in penetration of monomers in the resin into dentin for micromechanical bonding[5]. Acetone in Prime & Bond-NT, is also found to be a better solvent than water which has ability to displace water from collagen network and promote saturation of conditioned dentin with primer components. Also has nanofillers apparently reinforcing adhesive layer interface. Dentin bonding is based on the formation of resin-dentin interface at the inter-diffusion zone.[21] Although the hybrid layer created by the total etch systems is thicker than that formed by the self-etch systems.[6] The resin tags formed with the etch and rinse adhesives are longer than those formed in self-etching adhesives[7] & also shows numerous small lateral extensions of microtags branching off at right angles from the main resin tags, which is a clear sign of proper adaptation and sealing.[8,9] So, the etch & rinse technique is still the most effectual approach in achieving efficient and stable bonding and requires only two steps, primarily diffusion based, and depends on hybridization or resin infiltration within the exposed collagen fibril scaffold, which should be as complete as possible.[10]

Optibond All-in-one which is the 7^{th} generation DBA showed highest microleakage. Optibond All-in-One contains not only HEMA (8% - 11%) but also water, acetone (35%-45%) and ethanol (4%-9%), ensue in stronger water assimilation by resin, which can act as a semi-permeable membrane causing water transport consequently affecting the properties (mechanical) of adhesive.[14,15] Another probable cause for the comparatively lower performance of Optibond All-in-One is water enmeshment in the hybrid layer [16] due to high hydrophilicity[13]; incomplete solvent removal from applied adhesive[17] can also show detrimental effect on Bis-GMA polymerization[18] and reduce the bond strength of Optibond-All-in-One. In present study, increased microleakage is seen in the self-etch adhesive than that of total-etch adhesive that is in agreement with Loguercio et al. study,[19] which may also be due to the inferior etching pattern of these systems[20].

8th generation DBA, Tetric-N-Bond Universal is used which contains polyfunctional acidic hydrophilic monomers which are phosphoric acid modified methacrylate esters, main advantage is that they can be easily applied to acidified enamel surface even if they are subsequently contaminated with saliva or moisture. These esters, when combine with water, induce favorable pH value of 1.4 which is compared to pH value of 1.8 and 2.4 of the 7th and 6th generation DBA's, respectively which favours dissolution (demineralization) of hydroxyapatite crystals, creating a deeper retentive pattern on the surface of tooth.[21] The mode of application may also have influenced the interfacial morphology of adhesives. As recommended by manufacturers, scrubbing or vigorous application of adhesives was performed for 20 sec, which improves infiltration of resin monomers into the dental substrates.[22,23,24] Probable explanation of the result can be that, eighth generation adhesives invade through the smear layer, not abolishing it completely, fixing smear plugs at the entrance of the tubules which contain residual hydroxyapatite in the resin-impregnated smear and hybrid layer providing additional chemical retention. Moreover, the 8th generation DBA is a nanofilled adhesive, with an average particle size of 12 nm which increase the thickness of the hybrid layer in turn helps in penetration of resin monomers and forms a more flexible interface that helps to counteract stresses resulting from polymerization shrinkage of composite.

CONCLUSION:

8th generation DBA (Tetric-N bond) proved to have least microleakage and better marginal integrity, followed by the 5^{th} generation (Prime & Bond-NT) and the 7^{th} generation (Opti Bond All-in-One) DBA.

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