

Comparative Study of Bisphenol A Release from Various Orthodontic Adhesive and Myofunctional Appliances - An In-Vitro Study

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ABSTRACT

BACKGROUND

We wanted to compare & evaluate, regularly used orthodontic materials including adhesives & myofunctional appliances for release of Bisphenol A.

METHODS

Bisphenol - A release was assessed from two materials - orthodontic adhesive resin and heat cure acrylic resin [twin block]. Based on materials used, a total of 40 samples was assigned into two groups; Group A and Group B, each containing 20 samples. For Group A [orthodontic adhesive resin], metal brackets were bonded to 20 bicuspid teeth using adhesive resin and cured with LED light. For group B, 20 twin block appliances made from heat cured acrylic resin were used. Then, samples from both the groups were immersed in artificial saliva and then subjected to thermal treatment from hot (60 °C) to cold (4 °C) temperatures, followed by shaking for 5 minutes. The samples were again shaken at (37 °C) and 1.0-mL aliquots were removed at 24 hours and 7 days after insertion. Gas chromatography / mass spectroscopy was used for the evaluation of leaching of bisphenol A from artificial saliva.

RESULTS

Significant results were found after 24 hours of analysis in both groups where 70 % samples from group A had bisphenol A release, whereas 80 % samples from group B had bisphenol A release. However, a non-significant result was obtained after 7 days where 20 % samples from group A had bisphenol A release whereas 60% samples from group B had bisphenol A release. The Heat cure acrylic group showed higher Bisphenol - A than that of orthodontic adhesive resin group. It was seen that the levels were lower than the reference dose which were calculated for daily consumption but were statistically significant.

CONCLUSIONS

Bisphenol A is considered as an endocrine disruptor. Degradation of orthodontic materials results in leaching of Bisphenol-A into oral cavity which is a clinical concern.

KEY WORDS

Bisphenol-A, Adhesive Resin, Acrylic Resin, Orthodontics

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BACKGROUND

Bisphenol-A (BPA) is a synthetic chemical with disruptive endocrine and weak estrogenic properties. BPA is one of the components in polycarbonate and epoxy polymers, which have enormous applications which ranges from paints, coatings, and adhesives to electrical components, and data storage. Over recent decades, there has been extreme growth in the unease about the release of chemicals from various appliances. In 2011, amongst the endocrine disruptive chemicals listed by the World Health Organization, bisphenol A (BPA) was one of them and was considered to be a synthetic compound that has gained medical attention.¹

BPA release was emphasized by many authors as it was seen that it affects various organs and is known to have teratogenic effects even at a low dose. It results in early onset of puberty, causing feminization in males, and also in association with carcinogenic effects. There were many studies carried out in animals which eventually deduced the BPA presence in body fluids including urine, adult and fetal blood, amniotic fluid, placental tissues, breast milk, and saliva.^{2,3} Epoxy resin and polycarbonate plastic are produced from a synthetic chemical substance called BPA which is highly used for the manufacturing of products such as toys, materials for packaging food, used as resinous material in dentistry for example the pit and fissure sealants and composites, detergents, pesticides and many more. There are many products in the market which are based on epoxy resins and polycarbonate plastics, in turn exposing the BPA to humans. Due to the competitive binding of oestrogen like polymer molecules to natural hormone receptors, the BPA has gained its estrogenic potential, and authors have considered BPA for its endocrine disruptions. There are many routes of exposure to this BPA, like from the environment itself water, air and soil but amongst them the primary source being the foodstuffs.^{2,3}

For better treatment outcomes, it is necessary to bond orthodontic brackets with composite materials based on bisphenol A glycidyl methacrylate in patients undergoing orthodontic treatment with fixed appliances.^{4,5} Bisphenol A (2, 2'- bis [4 - hydroxyphenyl] propane; BPA) is considered to be the main component used in resins and orthodontic adhesives.⁶ Composites releases BPA in 2 phases: first phase is during or just after resin placement which is because of deficiency in polymerization of monomer, and the second phase is because of material degradation.⁶ BPA release in the intraoral environment, may be due to the exposure of these materials to extreme thermal changes, mechanical erosion, pH alterations, and enzymatic degradation from bacterial and salivary enzymes. There are also few facts which suggest the release of BPA as a result of incomplete polymerization of adhesive systems.⁶

The precursors of bisphenol A glycidyl methacrylate (Bis - GMA), bisphenol A dimethacrylate (Bis - DMA), and bisphenol A ethoxylated dimethacrylate (Bis - EMA) monomers found in dental sealants, adhesive resins, and composite resins is considered to be BPA in the clinical dentistry. There is a degradation of these materials which takes place in the intra oral environment which in turn leaches BPA, which is of concern and could be affected by temperature changes,

mechanical wear, changes in pH, and bacterial or salivary enzymatic action. So, this study was done to compare & evaluate regularly used orthodontic materials including adhesive & myofunctional appliances for release of Bisphenol A.

METHODS

This study was carried out in the Department of Orthodontics and Dentofacial Orthopaedics, KIMSDU, Karad, Maharashtra, India, after obtaining ethical clearance from the university. This in vitro study analysed the presence of Bisphenol-A from various orthodontic materials for different time intervals. This study was conducted on 10 samples in each group. Group A consisted of 10 bicuspid teeth without any fluorosis, caries or fractures. Group B consisted of twin block appliance made of heat cure acrylic resin.

Group	Material
Group A	Transbond XT resin adhesive
Group B	Twin block appliance (heat cure acrylic resin)

Table 1. Groups in the Study

Procedure for Evaluation of Bisphenol A Release from Orthodontic Adhesive

The Extracted Bicuspid samples were cleaned and the enamel surface were subjected to etching using 37 % Phosphoric acid. On the buccal surface of the bicuspid, Transbond XT primer was applied which was further photo activated for 20 seconds. The bracket base was applied with Transbond XT resin, and were bonded to the teeth, followed by and photo activation for 20 seconds with a LED light-curing unit at 1200 mW / cm² light intensity. After that a medium of 10.0 mL of Artificial Saliva in glass was used for the sample immersion. Samples from the twin block groups were immersed in artificial saliva and then subjecting them to thermal treatment from temperature hot (60 °C) to cold (4 °C) followed by shaking for 5 minutes, the samples were again shaken at (37 °C) and 1.0-mL aliquots were removed at 24 hours and 7 days after insertion. Following this, Gas chromatography/Mass spectroscopy was used for evaluation of leaching of bisphenol A from artificial saliva.⁷

Procedure for Evaluation of Bisphenol A Release from Twin Block

Samples from the twin block groups were immersed in artificial saliva and then subjecting them to thermal treatment from temperature hot (60 °C) to cold (4 °C) followed by shaking for 5 minutes, the samples were again shaken at (37 °C) and 1.0 - mL aliquots were removed at 24 hours and 7 days after insertion. This procedure was repeated for a total of 10 cycles.

Time	Phase of treatment
T1	24 hours after immersion
T2	1 week after immersion

Table 2. Sample Evaluation Schedule

Statistical Analysis

Tabulation of data was done followed by statistical analysis after the data was collected. SPSS Software Version 20 was used to perform Statistical analysis. Summary statistics was done using frequency & percentage. Chi - square test was used to evaluate association among inter-group & intra - group study variables with demographic variables. Statistical values are significant when $p < 0.05$.

RESULTS

Qualitative analysis of Group A (Transbond XT) showed that Bisphenol A was present in 70 % samples while absent in 30 % samples at T1 (24 hrs.). While qualitative analysis of Group A (Transbond XT) at T2 (7 days) showed that Bisphenol A was present in 20 % samples while absent in 80 % samples.

	Group A (Trans Bond XT)		Chi - Square	P - Value
	24 hrs. (T1)	7 days (T2)		
Present	7 (70 %)	2 (20 %)	3.232	0.0722
Absent	3 (30 %)	8 (80 %)		
Total	10 (100 %)	10 (100 %)		

Table 3. Association of BPA Release from Transbond XT at Different Time Intervals

*significant when $p < 0.05$

Qualitative analysis of Group B (Twin Block) showed that Bisphenol A was present in 80 % samples while absent in 20 % samples at T1 (24 hrs.) While qualitative analysis of Group B (Twin Block) at T2 (7 days) showed that Bisphenol A was present in 60 % samples while absent in 40 % samples.

Comparison of Group A and Group B at T1 (24 hrs.) showed significant results of Bisphenol A release. Comparison of Group A and Group B at T2 (7 days) showed non-significant results of Bisphenol A release.

	Group B (Twin Block)		Chi - Square	P - Value
	24 hrs. (T1)	7 days (T2)		
Present	8 (80 %)	6 (60 %)	3.232	0.0722
Absent	2 (20 %)	4 (40 %)		
Total	10 (100 %)	10 (100 %)		

Table 4. Association of BPA Release from Twin Block Group at Different Time Intervals

*significant when $p < 0.05$

Comparison	After 24 Hrs.		Chi-Square	P-Value
	Transbond XT	Twin Block		
	Present	7 (70 %)		
Absent	3 (30 %)	2 (20 %)		

Table 5. Comparison between the Two Materials after 24 hrs.

*significant when $p < 0.05$

Comparison	After 7 days.		Chi-Square	P-Value
	Transbond XT	Twin Block		
	Present	2 (20 %)		
Absent	8 (80 %)	4 (40 %)		

Table 6. Comparison between the Two Materials after 7 Days

*significant when $p < 0.05$

DISCUSSION

This study explored BPA leaching from routinely employed orthodontic materials which are used from weeks to years. Elevated human BPA levels can cause cancer cell proliferation, peripheral arterial disease, cardiovascular disease, diabetes,

abnormal liver enzyme levels, and obesity in children and adolescents.

Composites releases BPA in 2 phases: first phase is during or just after resin placement which is because of deficiency in polymerization of monomer, and the second phase is because of material degradation.

In our study, the Bisphenol-A release from Transbond XT adhesive group was seen in 70 % of the samples after 24 hours and 20 % after 7 days. A similar study was conducted by Marilia Rodrigues Moreira et al where they evaluated Bisphenol A release from orthodontic adhesives for 30 days with gas chromatography.⁸ They concluded that BPA levels at 30 minutes & 24 hours were significant while at the end of 30 days values were negligible.

The results achieved in the current study depicted significant Bisphenol A release after 24 hours and at the end of 1 week. This was concordant to the results achieved by Matthew W. Kotyk; William A. Wiltshire, where they had evaluated BPA levels from Transbond XT discs immersed in artificial saliva for 1, 3, 7, and 14 days and observed Bisphenol-A leaching only within the first 3 days.⁹ In this study, the Bisphenol-A release from heat cure acrylic was 80% after 24 hours and 60 % after 7 days respectively. They also said that the Complex polymerization is of utmost importance when it comes to the prevention of BPA leakage from resin-based materials. In the case of the chemically polymerized resin, where oxygen prevents the polymerization over the surface, it is important to wait for hardening of the material and to grind the surface.

Since the visible light has the potential of reaching only a distance of 2mm into the material, the usage of optical polymerization-type resin in deep cavities has gained interest of many dentist. Furthermore, there could be a leakage of the bonding agent having an increased levels of monomer as well in turn causing a delayed-type allergic reaction in the tissues. Therefore, the manipulation of the dental materials which contains BPA must be done with extreme care and wherever possible GIC should be the choice of cement.⁹

An in vivo study was conducted on patients wearing vacuum-formed and Hawley retainers by Akila Srinivasan Raghavan.¹⁰ They concluded that, there was an ascending growth in the salivary BPA levels in Hawley retainers processed by heat cure followed by chemically cured Hawley's retainer and greatest value in the VFRs. They have also mentioned that the exposure of BPA to the developing and growing bodies of the teenagers can be more dangerous and harmful than the exposure to the adults, as maximum of patients undergoing orthodontic treatment comprises of teenagers. The conclusion derived from their study was that the BPA leach was observed in thermoformed Biocryl retainers and fully cured Tran's bond XT orthodontic adhesive.¹⁰

Our study was in agreement with other authors evaluating leaching of Bisphenol-A from restorative resins and, although these materials are used under different situations.^{11,12} After the placement of resin-based composites there was an reported increase in BPA levels in saliva which was assessed by enzyme-linked immunosorbent assay methods. When the patients gargled with water after the placement of composite, it has observed that the BPA levels in saliva returned to its pre-treatment levels within 24 hours. Resin-based composites

were considered the most widely used restorative material. There was increase in the usage of composite restorations than the amalgam restorations by 2006.¹²

There are some methods to reduce leaching of Bisphenol-A from adhesive includes removal of excess adhesive before curing, use of Bisphenol-A free adhesive and ensuring complete curing of resin.

CONCLUSIONS

After 24 hrs of exposure, adhesive & twin block group showed significant Bisphenol-A release while twin block group showed Bisphenol-A release after 7 days exposure. So, it can be concluded from this study that BPA had leached from both heat cured acrylic resin and Transbond XT orthodontic adhesive in significant levels after 24 hrs. of exposure, while heat cure acrylic group showed BPA release till 7 days.

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