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Dental Sealants Part 4: Bisphenol A: What dentists should know

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ABSTRACT

Bisphenol A (BPA) is a synthetic chemical resin used worldwide to produce plastic products. It is also a component of the bisphenol A diglycidylether methacrylate (Bis-GMA), which is a monomer found in dental resin-based materials (including resin-based dental sealants, RBSs). The controversy about its possible toxicity begins around the early '30s. Even if the amount of BPA released by dental sealants is well below the limit proposed by the U.S. Environmental Protection Agency and the European Food Safety Authority, we can reduce the risk of exposure, particularly for children, following precautionary measures.

Keywords *Dental sealants; Glass ionomer sealant; Resin-based sealant.*

Introduction

Bisphenol A (BPA) is a synthetic chemical resin used worldwide to produce plastic products, notably polycarbonate plastic food-storage containers, some water bottles, bottle tops, and metal food cans' epoxy resin lacquer linings. Specifically, BPA was invented about 100 years ago and recognized to have estrogenic activity in the early '30s; nowadays, both national and international organisations unequivocally recognise this, acknowledging in official statements that BPA, at very low levels, has been detected in human blood and tissues. BPA can act as an endocrine disruptor by binding to estrogen receptors as well as blocking the estrogenic response by competing with endogenous E2 [Bailin et al., 2008; Viñas et al., 2012]. Furthermore, it can bind to thyroid receptors and influence thyroid functions thanks to its agonistic and antagonistic effects. It can also interact with the immune system and the developing central nervous system [Wetherill et al., 2007].

One of the current controversies about BPA is the possible violation of the Paracelsus principle "the dose makes the poison", stating that the higher the dose the greater the effect. Falling the BPA into the category of endocrine disrupting chemicals, this may elicit a non-monotonic dose response and the response may be greater at low doses [Vandenberg et al., 2012].

The hypothesis that the BPA could have a non-monotonic dose-response curve has raised even more concerns and, in 2012, it was decided to lower the tolerable daily intake (TDI) from 50 ug/kg bw/day, established in 2006 by the EFSA, to 5 ug/kg bw/day [Bakker et al., 2014]. Indeed, different studies have shown that perinatal and early life exposure to BPA can have harmful multisystemic effects [Hong et al., 2017; Rebuli et al., 2014]. The most vulnerable subjects are infants and children for whom the lowest observed-adverse-effect level dose is lower than 5 ug/kg bw/day, making them more predisposed to BPA health risks.

BPA and dental sealants

BPA is also a component of the bisphenol A diglycidylether methacrylate (Bis-GMA), which is a monomer used for production of dental resin-based materials (including resin-based dental sealants, RBSs). Although BPA is not present in a pure form in these materials, its derivatives, the Bis-GMA and the Bis-DMA are. Consequentially, trace molecules can be found due to degradation, incomplete polymerisation or impurity deriving from the manufacturing process. Moreover, BPA can also be released by resin-based materials because of the enzymatic salivary hydrolysis of BPA derivatives, such as the bis-GMA or the bis-DMA [Rathee et al., 2012]. In a study by McKinney et al. [2014], despite the fact that children who had dental sealants had a BPA concentration 20% to 25% higher than children with no dental sealants, there was no statistically significant association between the number of RBSs and urinary BPA concentrations. The ADA Science Institute tested the BPA release from 12 dental sealants used by dentists in the U.S.: The results indicated that BPA release from dental sealants is very low, about 0.09 nanograms per day. This amount is well below the limit proposed for a 6-year-old child (who weighs about 20 kilograms, or

44 pounds) by the US Environmental Protection Agency (1 million nanograms per day) and the European Food Safety Authority (80,000 nanograms per day).

Factors affecting the elution of BPA

- Temperature: Temperature increase and acid-base alterations increase the elution of BPA. A possible explanation may be the oxygen inhibition layer presence on the surface of RBSs [Braun et al., 2011];
- Degree of conversion: Adequate light energy density is required for free radical polymerisation.
- Polymerisation time: is more important than irradiation for a better degree of conversion. The ideal polymerisation time is about 20 seconds.
- Distance from curing light: Elution of BPA increases when the tip-to-RBS surface distance increases.
- Type of light curing unit: The best polymerisation lamps are LED-type;
- Storage medium: according to the American Dental Association, acetonitrile and methanol are strong solvents of organic compounds and are preferred over ethanol for maximizing the number of eluted monomers.

Recommendations for resin-based sealants application

To reduce BPA exposure during application of RBSs precautionary measures should be taken, and since the higher risk for potential exposure is the immediate post-RBS application, these measures are particularly relevant.

One technique entails removal of residual monomer by rubbing the monomer layer with pumice on a cotton roll or having the patient gargling for 30 seconds and spitting immediately after application of the dental sealant or composite. However, proper rinsing and spitting can be challenging for most children, hence rinsing with an air-water syringe may be a suitable substitute. As for all dental procedures, the use of a rubber dam to control the operative field would further limit potential exposure.

BPA and MIH

There is a number of reports on BPA exposure and adverse perinatal development. Molar Incisor Hypomineralisation is a recently reported condition which affects the first molars and the permanent incisors. Randomly scattered white opacities are present on the enamel and a variable prevalence of 2.4% to 40% is reported in children aged 6 to 8 years. Although there are different possible causes for this condition, an association with postnatal BPA exposure has been made and is possibly related to the fact that ameloblasts are susceptible to BPA exposure.

Conclusions

There is strong evidence that resin-based dental sealants improve children's oral health. Also, BPA exposure from dental materials seems transient and can potentially be controlled. Moreover, most studies report that BPA levels detected *in vitro* and *in vivo* are lower than the current recommended tolerable daily intake (TDI). The TDI value has been modified over the years and may be further reduced in the near future. Dentists must be aware of these possibilities and should take appropriate measures.

In conclusion, dental practitioners should be knowledgeable and give parents reliable and timely advices and answers about the topic. As professionals, we should try to reduce the risk of exposure to chemicals that are hazardous, particularly for our children.

References

› Fleisch AF, Sheffield PE, Chinn C, Edelstein BL, Landrigan PJ. Bisphenol A and related compounds in dental materials. Pediatrics 2010;126;760 originally published online September 6, 2010.
› Bailin PD, Byrne M, Lewis S, Liroff R. Public awareness drives market for safer alternatives: bisphenol A market analysis report. Investor Environ Health Network 2008; 15: 1-37.
› Bakker J, te Biesenbeek JD, Boon PE, Bos P, van Broekhuizen FA. Bisphenol A: Part 1. Facts and figures on human and environmental health issues and regulatory perspectives. 2014.
› Bevilacqua L, Cadenaro M, Sossi A, Biasotto M, Di Lenarda R. Influence of air abrasion and etching on enamel and adaptation of a dental sealant. Eur J Paediatr Dent 2007 Mar;8(1):25-30.
› Bevilacqua L, Sossi A, Cadenaro M, Di Lenarda R. Comparative evaluation of the microhardness of 4 dental sealants. Eur J Paediatr Dent 2007 Dec;8(4):179-82.
› Braun JM, Hauser R. Bisphenol A and children's health. Curr Opin Pediatr 2011; 23: 233-239.
› Colombo S, Beretta M. Dental Sealants Part 3: Which material? Efficiency and effectiveness. Eur J Paediatr Dent 2018 Sep;19(3):247-249. doi: 10.23804/ejpd.2018.19.03.15.
› Ferrazzano GF, Orlando S, Cantile T, Sangianantoni G, Alcidi B, Coda M, Caruso S, Ingenito A. An experimental in vivo procedure for the standardised assessment of sealants retention over time. Eur J Paediatr Dent 2016 Sep;17(3):176-180.
› Hong YP, Yang YJ. Low-Dose Exposure to Bisphenol A in Early Life. InBisphenol An Exposure and Health Risks 2017. InTech 2017.
› McKinney C, Rue T, Sathyanarayana S, Martin M, Seminario AL, et al. Dental sealants and restorations and urinary bisphenol A concentrations in children in the 2003-2004 National Health and Nutrition Examination Survey. J Am Dent Assoc 2014; 145: 745-750.
› Rathee M, Malik P, Singh J. Bisphenol A in dental sealants and its estrogen like effect. Indian J Endocrinol Metab 2012; 16: 339.
› Rebuli ME, Cao J, Sluzas E, Delclos KB, Camacho L, et al. Investigation of the effects of subchronic low dose oral exposure to bisphenol A (BPA) and ethinyl estradiol (EE) on estrogen receptor expression in the juvenile and adult female rat hypothalamus. Toxicol Sci 2014; 140: 190-203.
› Stellini E, De Francesco M, Avventi M, Gracco A, Berengo M, Simionato F, Mazzoleni S. In vitro comparison of the bond strength to the enamel of conventional and self-etching dental fissure sealants. Eur J Paediatr Dent 2013 Dec;14(4):319-22.
› Todirica D, Santini A, Curticapean A, Molnar Varlam C, Melinda S, Aldossary M. Bisphenol A – A possible health issue arising from dental restoratives. A Review May 2018 DOI: 10.31487/j.DOCR.2018.10.007
› Topaloglu Ak A, Riza Alpoz A. Effect of saliva contamination on microleakage of three different pit and fissure sealants. Eur J Paediatr Dent 2010 Jun;11(2):93-6.
› Vandenberg LN, Colborn T, Hayes TB, Heindel JJ, Jacobs DR Jr, et al. Hormones and endocrine-disrupting chemicals: low-dose effects and nonmonotonic dose responses. Endocr Rev 2012; 33: 378-455.
› Viñas R, Jeng YJ, Watson CS. Non-genomic effects of xenoestrogen mixtures. Int J Environ Res Public Health 2012; 9: 2694-2714.
› Welbury R, Raadal M, Lygidakis NA. European Academy of Paediatric Dentistry. EAPD guidelines for the use of pit and fissure sealants. Eur J Paediatr Dent 2004 Sep;5(3):179-84.
› Wetherill YB, Akingbemi BT, Kanno J, McLachlan JA, Nadal A, et al. In vitro molecular mechanisms of bisphenol A action. Reprod Toxicol 2007; 24: 178-198
› World Market, 2014. Bisphenol A (BPA): 2014 World Market Outlook and Forecast up to 2018. Market publisher.