

Comparison of residual monomer leaching from orthodontic adhesives at different light curing tip distances

Muhammad Azeem^a, Arfan Ul Haq^b, Farzana Ambreen^c, Waheed Ul Hamid^d, Salman Ghauri^e

Abstract

Introduction: Improving the bond strength of orthodontic adhesives along with reduction in their deleterious effects has always been required. Present study was aimed at comparing the mean residual monomer (RM) leaching from adhesives cured at 0mm and 10mm curing light tip distances.

Material and Methods: In this in-vitro study, 60 extracted teeth were selected and 30 teeth were placed in group A and 30 teeth were placed in group B, by random process. Group A teeth brackets were cured at light tip distance of 0mm and Group B at 10mm distance. High performance liquid chromatography (HPLC) was utilized for measuring the RM. Independent t-test was used for comparison of mean release of RM.

Results: The mean value of RM was significantly higher in adhesives cured at 10mm distance (p-value = 0.000).

Conclusions: 0mm curing light tip distance is recommended in clinical orthodontic practice as the residual monomer leaching was significantly less as compared to the 10mm distance.

Keywords: Residual monomer; bisphenol A; curing light

Introduction

Various types of orthodontic adhesives are available in the market but composite resins are usually used for bonding orthodontic brackets.¹ Composite resin contains organic matrices consisting dimethacrylates like TEDGMA, UDMA and inorganic fillers like quartz.² Composite resins are of two types on the basis of method of polymerization. One is light cure composite and others are chemical cure composite, but light cure composites are usually preferred in clinical orthodontic practice, because of advantages of easy handling and controlled curing process.³

Various types of curing lights are used for

curing composite resins, such as conventional halogen light, lasers, plasma light, argon laser and LED.^{4,5} LED lights use junctions of doped semiconductors to generate blue light and got advantage of having long life, low cost and simplicity of handling.⁶

Polymerization of composite resins is not devoid of disadvantages. Some amount of residual monomer remains in unpolymerized form which on leaching in the oral cavity can lead to several negative biological effects such as skin hypersensitivity reactions, damage to cellular components, cellular necrosis, lethal effects on reproductive system of animals, high toxicity to pulp, estrogenic hormonal effects, mutagenic effects and tendency of causing color blindness.⁷⁻¹⁰

Residual monomer leaching can be quantified by various methods including, high performance liquid chromatography (HPLC), micro-hardness method and Fourier Transform Infrared Spectroscopy.¹¹ Results from previous literature¹² showed that mean release of residual monomer (RM) increase significantly with increase of curing distance,

^a Corresponding Author: BDS, FCPS; Assistant Professor, Orthodontics, Dental Section, Faisalabad Medical University, Pakistan. Email: dental.concepts@hotmail.com

^b BDS, MDS, FCPS (Orthodontics), MCPS (Oper.D); Dean of Dentistry, Professor & Head of Orthodontics, Dental Section, Faisalabad Medical University, Pakistan.

^c BDS; Postgraduate Resident, de'Montmorency College of Dentistry Lahore, Pakistan.

^d BDS, MCPS, M.Orth RCS Ed (UK), MS (Turkey). Dean & Professor, Head of Orthodontics, de'Montmorency College of Dentistry Lahore, Pakistan.

from 0 mm (RM release= 14.38 ± 0.010 ppm) to 10mm (63.69 ± 0.008 ppm) on day 1.

Minimizing the RM release by choosing the best curing light tip distance will prevent the hazardous biological effects of monomers. Therefore, rationale of current study was to measure the release of RM by various light curing tip distances. International data is publishing in this regard but present study was done to find out the effects of difference in composition of the composite material used, different models of LED light sources used and different evaluation methods.

The objective of present study was to compare the mean RM release from under the orthodontic bracket cured at different curing light tip distances of 0mm and 10mm, using HPLC technique on day 1. Our hypothesis was that, 10mm will cause a greater residual monomer release as compared to 0mm light curing tip distance.

Material and Methods

Present In-vitro, study was conceived at orthodontic department of de'Mont dental college, Lahore, Pakistan. Sample size of 60 extracted teeth was estimated.¹² Following teeth were selected: Maxillary first premolars extracted for orthodontic reasons, intact buccal surfaces, no restoration or buccal pathos and no previous history of orthodontic bonding.

Sixty extracted premolar teeth were preserved in 0.5 % thymol and 30 teeth were placed in group A and 30 teeth were placed in group B, by random process. Group A teeth brackets were cured at the light tip distance of 0mm and Group B brackets were cured at light tip distance of 10mm for the time recommended by manufacturer.

After cleansing process all the selected extracted teeth were embedded in acrylic jig. After initial cleansing, drying, conventional etching and priming process, premolar brackets (Discovery, Dentaurem, Germany) were bonded to the buccal surface using Transbond XT adhesive paste (Transbond XT,

3M, Monrovia, Calif) and light cured. The procedure used for measuring the amount of RM leaching was similar to that described by Eliades et al.¹³

Confounding variables were controlled by strictly following inclusion and exclusion criteria. Residual monomer was measured by expert orthodontist.

Quantitative data like mean measurement of residual monomer release was presented by mean \pm SD (in ppm). Independent t-test was applied for comparing the mean release of residual monomer in both the groups.

Results

Total 60 extracted premolars were included in this study. The mean value of residual monomer was noted as 30.83 ± 18.37 ppm (Table I).

The results showed that the value of residual monomer was less than 30ppm in 34(56.7%) teeth and it was above than 30ppm in 26(43.3%) teeth (Table II).

The mean residual monomer leaching in group A was 14.90 ± 3.35 ppm whereas in group B it was 46.76 ± 12.26 ppm (P-value=0.000) (Table III).

Table I: Descriptive statistics of Residual monomer (ppm)

Residual (ppm)	N	60
	Mean	30.83
	SD	18.37
	Minimum	10.00
	Maximum	64.00

Table II: Distribution of Residual monomer (ppm)

		Frequency	Percent
Residual Monomer (ppm)	< 30	34	56.7%
	\geq 30	26	43.3%
	Total	60	100.0%

Table III: Comparison of Residual monomer (ppm) in both the groups

		Study Groups	
		Group A	Group B
Residual Monomer (ppm)	n	30	30
	Mean	14.90	46.76
	SD	3.35	12.26

p-value = 0.000 (Significant)

Discussion

In order to achieve maximum composite polymerization to avoid leaching of residual monomers, various strategies have been utilized.¹⁴⁻¹⁵ Leaching of monomers can get influenced by various factors such as, the type of light curing, curing time, curing light tip distance and intensity of curing light.^{16,17}

This in-vitro comparative study was conducted to determine the mean residual monomer release, cured with different curing light tip distances i.e. 0mm and 10mm. According to results statistically significant differences were found between the two groups in leaching of residual monomer. This may be due to slow and incomplete polymerization at 10mm distance and decreased degree of conversion of the orthodontic resin.

Results are in agreement with findings of Murchison and Moore, who showed that hardness of resin liners was better at a distance of 3mm from the cavity floor than at 0mm or 6mm.¹⁸ Results from other previous literature are also in accordance with findings of present study,¹¹ but results are in contrast to findings of Asli Topaloglu Ak.¹⁹ Results from other previous studies by Amit Jain, Aguiar, and Sivazeroet et al., on shear bond strength in relation with curing light distance, are also in accordance with the findings of present study.²⁰⁻²³

One shortcoming of the current study was that it was in in-vivo conditions, which cannot reproduce the in-vitro oral conditions, furthermore RM leaching values in in-vivo conditions can lower than those found in-

vitro, because of biodegradation that occurs in the mouth cavity. Clinically, intraoral contamination, saliva, thermal changes, and other factors such as occlusal forces and orthodontic forces can influence release of RM. Following precautions are suggested to minimize leaching of residual monomers:²⁴

- Remove extra flesh of adhesive before curing
- Do excessive oral rinsing within 30 minutes following bonding
- Use recommended curing time
- Use 0mm curing light tip distance

Conclusions

Zero millimeters curing light tip distance is recommended to orthodontists for curing orthodontic adhesives in order to avoid leaching of residual monomer.

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