



Comparison and Evaluation of Marginal Accuracy of Provisional Restoration by 3 Different Materials *In vitro* Study

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ABSTRACT

Overview: Provisional Restoration plays a vital role in the long term Success of fixed partial restorations. A provisional restoration is a transitional restoration that provides protection, stabilization and function before Fabrication of the definitive prosthesis. A poorly adapted provisional restoration encourages plaque accumulation which can lead to periodontal conditions ranging from gingival Inflammation to periodontal support breakdown, this being especially true in cases where finish line margins are placed equigingivally or subgingivally. Aim of this *in vitro* study to compare the vertical marginal discrepancy of provisional restorations fabricated using light polymerized composite resin by direct technique. **Materials and methods:** Ivorine teeth (mandibular right and left 1st molar) were attached to the Typodont. Putty index was prepared Putty for each Ivorine tooth and prepared for a full crown restoration with a 1mm shoulder finish line and a uniform height of 6 mm of all the axial surfaces. After tooth preparation, impression was made with heavy body and light body using putty wash technique. Impression was immediately poured with die stone. Altogether sample size was 48. Provisional crowns fabricated using direct technique and cemented using Freegenol luting cement. They were divided into 3 groups, i.e. sixteen for each material. Die hardener was applied to the remaining part of the stone dies to prevent distortion of the die stone during aging process of the specimen. Each group was further divided into 8 depending on the type of aging process the specimens were subjected to: Pepsi, Tea and Arabian coffee and soaked for 54 hours. After immersion, the specimens were washed in distilled water, dried with filter paper, and subjected to marginal accuracy by Stereo microscope. Data obtained in the present study was subjected to statistical analysis using one-way ANOVA and inter group comparison was done with Post-Hoc Bonferroni's correction SPSS Version 21. **Results:** Comparison of the buccal marginal discrepancies in the 3 materials used for temporary crowns using ANOVA showed significant changes when dipped in the 3 beverages. Significant buccal and lingual marginal discrepancy of all 3 temporary crowns was observed when immersed in tea compared to coffee and Pepsi as well as coffee with Pepsi by Post-Hoc Bonferroni's correlation. **Conclusion:** Within the limitations of this study, it was concluded that, all the three temporary crowns fabricated from different materials showed significant marginal discrepancy when dipped in three different beverages.

Keywords: Fixed dental prosthesis, Provisional restoration, Marginal accuracy

INTRODUCTION

Fixed partial dentures have become a wide spread treatment option for many partially edentulous patients because these prostheses are indirectly fabricated in a dental laboratory. It usually takes several days or weeks for their completion. It is a crucial step in fixed prosthodontics. The word provisional means 'established for the time being'. Provisional restoration is designed to enhance esthetics, stabilization and function for a limited period of time, after which it is to be replaced by a definitive prosthesis [1]. During the prosthetic replacement of missing teeth with fixed partial denture, provisional restorations are commonly used to furnish both pulpal and periodontal protection in expectation of the final prosthesis. Such temporary provisional restorations must have good marginal integrity, esthetics and sufficient endurance to withstand the forces of mastication [2]. When selecting materials for provisional restorations, it should have more strength to withstand masticatory forces.

Provisional restorations are an important part of prosthetic therapy procedures with fixed prostheses (i.e., crowns and bridges). Provisional restorations serve important roles during tooth preparation and until fitting, luting the final fixed restoration [3-5].

Provisional restorative materials are an important accessory for a variety of indirect dental Restorative Procedures, such as inlays, onlays, crowns, bridges, and implant temporization [6]. Provisional restorations are usually indicated for a short duration. Seldom, interim restorations have to function for extended time and provide tooth protection and stability for longer time, if the patient is travelling and unavailable for cementation of the final prosthesis [7]. There are three methods for fabricating fixed provisional restorations: Direct intraoral technique which will be fabricated in the patient's mouth, Hybrid technique involving the laboratory and the intraoral phases and indirect technique which will be fabricated on the stone cast and usually made in the laboratory [7]. The direct technique has significant advantages and disadvantages. Advantages are quick, easy and no laboratory work needed. Disadvantages are potential tissue trauma from the polymerizing resin and marginal inaccuracy [8]. Advantages of indirect techniques are easy on tissues and efficient. Disadvantages of indirect techniques are time consuming. Materials which are used for fabricating provisional restorations should have certain mechanical properties, such as flexural strength, hardness, and wear resistance to withstand the complex environment of oral cavity [9]. Provisional restorative materials are classified as methyl methacrylate, ethyl methacrylate, bis-acryl resin composites, and light-cured composites. Provisional restorations are also seldom used as diagnostic tool for checking the altered occlusion and pulpal response [10].

Polymethyl methacrylate (PMMA) resins and composite-based resins (CBR) are the most common materials used to fabricate provisional fixed dental prosthesis [10]. Their chemical natures differ; methacrylate resins use liquid/powder and are hand-mixed, and composite-based resins use paste/paste and are usually auto-mixed. The polymerization reaction of methacrylate resins initiates chemically (self-curing), while composite-based materials are available as both self-curing and dual-curing systems.

Many factors contribute for the success of fixed Dental prosthesis such as preparation design, maintenance of oral hygiene, masticatory forces, type of restorative materials being used and type of luting cement used for luting. However, the key to success is the selection of luting cement and cementation procedure. The primary function of luting cement is to provide a seal, preventing marginal leakage and hence pulp irritation and withstands occlusal forces and should be easy to remove from the prosthesis from the patient's mouth. Luting cement provides some form of attachment, which may be mechanical, micro-mechanical, chemical or combination [11]. Provisional crowns cemented with temporary cements are, however, susceptible to cement washout, marginal leakage, bacterial infiltration and caries, especially when placed for prolonged periods. The earliest provisional cements were made from zinc-oxide powder and eugenol liquid. Eugenol has an obtundent effect on the pulp but inhibits the setting reaction of acrylic resins and thereby reduces the surface hardness. Therefore, a number of manufacturers introduced provisional luting cements that are eugenol-free. Furthermore, polyorganic acid and polycarboxylate formulations are used to make them eugenol-free and to improve their strength, also provides an excellent marginal seal and allowing the material to be easily removed from the prepared tooth when required [12].

Provisional (temporary) crowns serve important roles during the treatment after the preparation of the teeth and until final cementation of the permanent crown or bridge [13]. Marginal accuracy of provisional restorations is of paramount importance because an acceptable marginal fit maintains the gingival health and protects the tooth from physical, chemical, bacterial, and thermal injuries. Poor marginal adaptation of provisional restorations increases plaque retention and changes the distribution of the micro flora, which can induce the onset of gingival disease, leading to the complications during the subsequent treatment steps of fixed prostheses. The presence of marginal gaps in the provisional restorations exposes the temporary luting cement to the saliva and brushing intraorally. If the gap is large, the dissolution of cement in the oral fluids will also be fast [12,14].

The strength of Polymethyl methacrylate resin is only about one-twentieth that of porcelain fused to metal alloys, fracture more likely to happen with provisional restorations. Fracture is more often with long-span provisional restorations, heavy occlusion, patient with bruxism, or used. Mechanical failures of provisional fixed prostheses causes inconvenience, loss of time, and awkwardness for both patient and clinician [14].

The marginal accuracy of provisional crowns is due to a combination of factors that include: Material properties, fabrication techniques and dynamic loading factors. Any marginal gap combined with inherently weak provisional cement

will provide an ideal site for micro leakage to occur [15]. Clinicians must be familiar with the commercially available provisional restorative materials and their mechanical properties so that they can select the best material depending on the clinical situations. Hence, with this background, the present *in vitro* study was conducted with an aim to evaluate and compare the marginal accuracy of three commercially available provisional restorative materials [16].

MATERIALS AND METHODS

This *in vitro* study was conducted at Ibn Sina National College for medical studies, Jeddah. Ethical approval was taken from ethical committee of the institute and Ethical approval number is H-22-11072019.

Materials and equipment's used for this study as follows: Typodont, ivory teeth: mandibular right and left first molars, Aerator hand piece, Bur kit, polyvinyl siloxane putty (Aquasil, DENTSPLY Germany), Light body addition silicone Impression material (Reprosil, DENTSPLY Germany), Dentulous impression tray, spacer, Die stone, Provisional restorative material used for this *in vitro* study were as follows: Charm temp temporary crown and bridge material by Dent Kist, Harvard temp C and B PRO and Structur 2SC, VOCO temp crown and bridges, Cast hardener, Freegenol (GC corporation, Japan), Pepsi, Arabic Coffee powder, Tea powder and Stereomicroscope (EMZ-5, Meji, Japan).

Ivory teeth (mandibular right and left 1st molar) were attached to the Typodont. Putty index was prepared Putty for each Ivory tooth and prepared for a full crown restoration with a 1 mm shoulder finish line and a uniform height of 6 mm of all the axial surfaces. After tooth preparation, impression was made with heavy body and light body using putty wash technique. Impression was immediately poured with die stone. Altogether sample size was 48. Each tooth of the cast was thoroughly lubricated with petroleum jelly and Provisional crowns were fabricated. Direct technique was used for fabricating provisional for Charm temp, Harvard temp C&B PRO and VOCO temp. All the Provisional crowns were cemented using Freegenol luting cement. They were divided into 3 groups, i.e. sixteen for each material. Die hardener was applied to the remaining part of the stone dies to prevent distortion of the die stone during aging process of the specimen.

In this present *in vitro* study 3 types of beverages were used such as tea, Arabic coffee and Pepsi. All the samples were immersed in the above-mentioned beverages to simulate the oral condition. Beverages used for aging process were Pepsi (PepsiCo), Tea (Lipton Tea: Unilever) and Coffee (Nescafe). Coffee and Tea were prepared according to the manufacturer's instructions (15 g in 300 mL of boiled distilled water). Staining liquids were prepared once using the same solution for each specimen. Specimens were immersed individually and remained soaking inside up to 54 hours. Each group was further divided into 8 depending on the type of aging process the specimens were subjected to: Pepsi, Tea and Arabian coffee (Coffee and Tea were prepared according to the manufacturer's instructions, 15 g in 300 ml of boiled distilled water) and soaked for 54 hours. After immersion, the specimens were washed in distilled water, dried with filter paper, and subjected to marginal accuracy by Stereo microscope.

Data obtained in the present study was subjected to statistical analysis using one-way ANOVA ($p < 0.00$) and inter group comparison was done with Post-Hoc Bonferroni's correction SPSS Version 21. (Significance level was 0.001).

RESULTS

The present study was conducted with the purpose of analyzing the marginal accuracy of three commercially available provisional restorative materials. The vertical marginal discrepancy of temporary crowns fabricated from the three commercially available provisional materials ranged from 71 μ to 106 μ by dipping in 3 types of beverages.

Comparison of the buccal marginal discrepancies in the 3 materials used for temporary crowns using ANOVA showed significant changes when dipped in the 3 beverages ($p < 0.001$) (Table 1 and Figure 1). Comparison of the lingual marginal discrepancies in the 3 materials used for temporary crowns using ANOVA showed significant changes when dipped in the 3 beverages ($p < 0.001$) (Table 2 and Figure 2).

Post-Hoc Bonferroni's correction applied showed significant buccal marginal discrepancy of all 3 temporary crowns when immersed in tea compared to coffee and Pepsi as well as in coffee compared to Pepsi ($p < 0.001$); except in the Harvard temporary group between tea and Pepsi ($p > 0.05$). Similarly, significant lingual marginal discrepancy of all 3 temporary crowns was observed when immersed in tea compared to coffee and Pepsi as well as coffee with Pepsi ($p < 0.001$) except with charm temporary group between coffee and Pepsi ($p > 0.05$) (Tables 3 and 4). ANOVA showed

that there was significant buccal marginal discrepancy observed in all 3 types of temporary crowns when immersed in all the 3 beverages (p<0.001) (Table 5 and Figure 3).

ANOVA showed that there was significant lingual marginal discrepancy observed in all 3 types of temporary crowns when immersed in all the 3 beverages (p<0.001) (Table 6 and Figure 4).

Table 1 Comparison among the groups using anova (buccal)

Buccal		N	Minimum	Maximum	Mean	SD	F value	p-value
Charm temp	Tea	16	253.45	259.67	257.11	2.02	1279.47	0.00*
	Coffee	16	240	249.43	246.17	2.97		
	Pepsi	16	283.45	289.56	285.51	1.58		
Harward temp	Tea	16	260.32	268.34	264.47	2.18	1556.17	0.00*
	Coffee	16	223.01	228.9	226	2.12		
	Pepsi	16	260.34	269.89	266.15	2.57		
2SC	Tea	16	242.43	249.65	246.11	2.53	1448.2	0.00*
	Coffee	16	234.05	238.95	236.65	1.58		
	Pepsi	16	273.09	280.49	275.82	2.21		

*significant

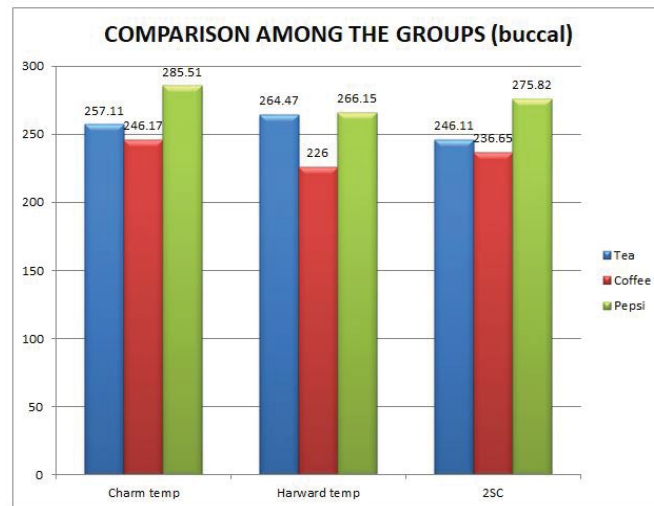


Figure 1 Comparison among the groups buccal

Table 2 Comparison among the groups using anova (lingual)

Lingual		N	Minimum	Maximum	Mean	SD	F value	p-value
Charm temp	Tea	16	240.43	247.56	244.32	2.38	386.73	0.00*
	Coffee	16	260.34	270.01	265.11	2.77		
	Pepsi	16	262.12	269.23	265.62	2.24		
Harward temp	Tea	16	271.34	277.98	274.88	1.85	1824.76	0.00*
	Coffee	16	232.56	239.67	235.81	1.77		
	Pepsi	16	240.48	247.45	244.52	2.12		
2SC	Tea	16	239.05	246.24	243.06	2.26	83.23	0.00*
	Coffee	16	224.45	230.56	227.11	1.88		
	Pepsi	16	232.05	247.23	238.03	5.45		

*significant

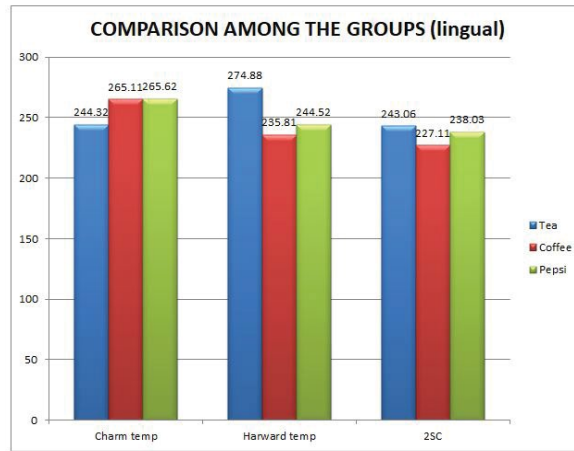


Figure 2 Comparison among the groups lingual

Table 3 Post-hoc bonferroni

		Tea v/s coffee		Tea v/s 2SC		Coffee v/s 2SC	
		Mean diff	p-value	Mean diff	p-value	Mean diff	p-value
Buccal	Charm temp	10.93	0.00*	-28.39	0.00*	-39.33	0.00*
	Harward temp	38.47	0.00*	-1.6	0.135	-40.15	0.00*
	2SC	9.46	0.00*	-29.71	0.00*	-39.17	0.00*
Lingual	Charm temp	-20.78	0.00*	-21.29	0.00*	-0.51	1
	Harward temp	39.07	0.00*	30.36	0.00*	-8.7	0.00*
	2SC	15.95	0.00*	5.02	0.001*	-10.9	0.00*

*significant

Table 4 Post-hoc bonferroni

	Tea v/s coffee		Tea v/s 2SC		Coffee v/s 2SC	
	Mean diff	p-value	Mean diff	p-value	Mean diff	p-value
Charm temp	-7.36	0.00*	10.99	0.00*	18.36	0.00*
Harward temp	20.17	0.00*	9.52	0.00*	-10.65	0.00*
2SC	19.35	0.00*	9.68	0.00*	-9.67	0.00*
Charm temp	-30.55	0.00*	1.26	0.32	31.82	0.00*
Harward temp	29.3	0.00*	38	0.00*	8.7	0.00*
2SC	21.1	0.00*	27.59	0.00*	6.48	0.00*

*significant

Table 5 Comparison among the groups using anova (buccal)

	Buccal	N	Minimum	Maximum	Mean	SD	F value	p-value
Tea	Charm temp	16	253.45	259.67	257.12	2.02	267.86	0.00*
	Harward temp	16	260.32	268.34	264.48	2.18		
	2SC	16	242.43	249.65	246.12	2.54		
Coffee	Charm temp	16	240	249.43	246.18	2.97	308.11	0.00*
	Harward temp	16	223.01	228.9	226	2.12		
	2SC	16	234.05	238.95	236.65	1.58		
Pepsi	Charm temp	16	283.45	289.56	285.51	1.59	319.8	0.00*
	Harward temp	16	260.34	269.89	266.16	2.58		
	2SC	16	273.09	280.49	275.83	2.21		

*significant

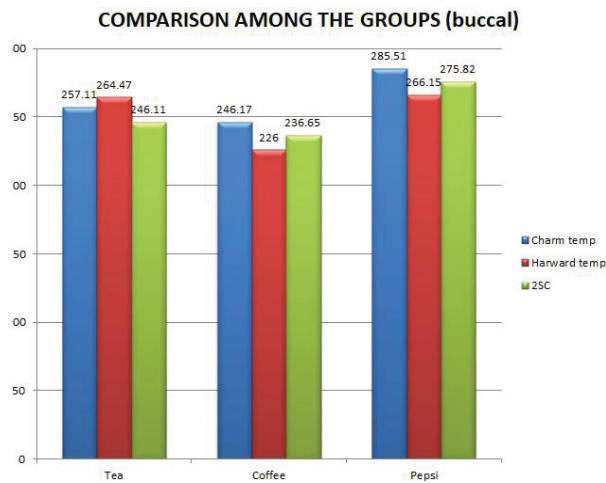


Figure 3 Comparison among the groups buccal

Table 6 Comparison among the groups using anova (lingual)

	Lingual	N	Minimum	Maximum	Mean	SD	F value	p-value
Tea	Charm temp	16	240.43	247.56	244.32	2.38	1097.53	0.00*
	Harward temp	16	271.34	277.98	274.88	1.85		
	2SC	16	239.05	246.24	243.06	2.26		
Coffee	Charm temp	16	260.34	270.01	265.11	2.77	1326.89	0.00*
	Harward temp	16	232.56	239.67	235.81	1.77		
	2SC	16	224.45	230.56	227.11	1.88		
Pepsi	Charm temp	16	262.12	269.23	265.62	2.24	254.68	0.00*
	Harward temp	16	240.48	247.45	244.52	2.12		
	2SC	16	232.05	247.23	238.03	5.45		

*significant

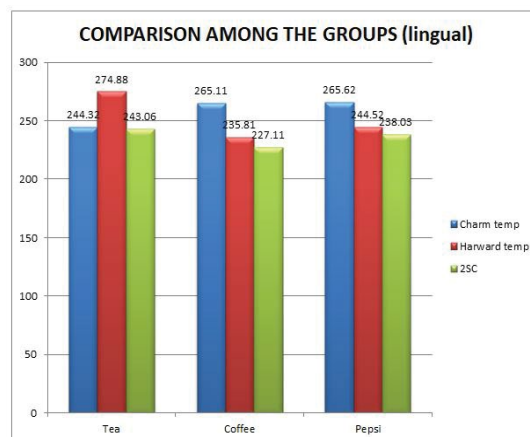


Figure 4 Comparison among the groups lingual

DISCUSSION

Provisional restorations serve to enhance aesthetics, stabilization and function for a short period of time for fixed Dental prosthesis [17]. Provisional restorations should have good marginal adaptation, adequate retention and resistance to withstand masticatory forces. It should be durable, not irritating to pulp and gingival tissues.

The present study was an attempt to test the vertical marginal gap values of the different provisional materials using same standardized dies and also following the manufacturer’s instructions. Like any *in vitro* study, there were some

limitations, which may have affected the marginal gap, like finishing of the Provisional after the complete curing, vertical force applied to keep the provisional intact over the respective die and the measurements under the digital microscope. However, an attempt was made to address to each of the individual issues. The provisional crown margin was marked with a lead pencil and during the finishing it was kept as a reference to make sure it was not touched by the finishing bur [18].

In the present study, the marginal accuracy of three temporary crown materials was evaluated. While this *in vitro* study may not reflect the oral conditions, could be a useful predictor of clinical performance and helpful for comparing provisional materials tested in a controlled situation.

The provisional crowns in the present study were constructed using a direct technique. Each crown was fabricated directly over an ivorine abutment tooth and was slightly elevated and depressed in a repeated manner until cured, simulating the direct technique that is used clinically to avoid iatrogenic damage to a vital tooth from the exothermic reaction of the material, as well as to prevent the crown from locking onto the tooth [19].

Our decision to fabricate the Provisional using this technique was based primarily on the belief that this is the method most commonly employed in practice. Potential errors were minimized through the following methods: (1) each crown was fabricated on its own abutment tooth, and (2) a pilot group of temporary crowns was fabricated before the actual experimental crowns to maximize experience in the handling of each type of material. These crowns were not included in the final pool of samples. All Provisionals were fabricated over their own respective replica, and were fabricated in a similar environment according to the manufacturer's specifications. Also, all Provisionals of the same brand were fabricated on the same day. This was done to achieve standardization of experimental conditions. For each provisional crown to be accepted into the final pool of samples, the following inclusion criteria were applied: (1) Crowns that did not exhibit internal or external voids; (2) No visible cracks; (3) Adaptation to the replica on all surfaces; and (4) Acceptable quality to both evaluators. As expected, all four materials used in the study exhibited.

Some degree of marginal discrepancy Luxatemp Solar, the dual cure bis-acryl material, exhibited the greatest discrepancy. Using an indirect technique to fabricate provisional crowns in their study, Koumjian and Holmes found similar results with Triad, a dual-cured bis-acryl material [20].

Auto polymerizing resins have been used to fabricate provisional restoration by various methods with the introduction of composite based materials which may be chemically; light or dual cured acrylic resin which has lost their popularity. Composites are used over acrylic because of chemical irritation and allergic reactions to acrylics caused by methyl methacrylate monomer over the amine accelerator, causing the composites to gain popularity over the acrylics.

For this study, direct technique was used for fabricating provisional restorations which has lot of advantages: eliminating all the intermediate laboratory procedures and which is convenient when assistant training and office laboratory facilities are inadequate. This method in accordance with the study by Muralidhar Reddy, Isil Karaokuta [21,22].

Several studies have used coloring solutions as diverse as water, coffee, tea, cola, oral rinse, red wine and food dyes for evaluating the color stability of provisional restorations. In this present *in vitro* study 3types of beverages were used such as tea, Arabic coffee and Pepsi. All the samples were immersed in the above-mentioned beverages to simulate the oral condition. Beverages used for aging process were Pepsi (PepsiCo), Tea (Lipton Tea: Unilever) and Coffee (Nes-cafe). Coffee and Tea were prepared according to the manufacturer's instructions (15 g in 300 mL of boiled distilled water). Staining liquids were prepared once using the same solution for each specimen. Specimens were immersed individually and remained soaking inside for up to 54 hours. This method of ageing process was in accordance with study by Elleni-Sotiria Pall [23] and Sakineh Nikzad [24].

All the specimens were checked for marginal fit using Stereomicroscope. Crowns were tested for marginal adaptation using (Stereomicroscope EMZ-5, Meji, Japan) at 7×405 magnification. The specimens were placed under the microscope and photographed using a camera that was connected to the microscope (Figure 3). The images were then transferred to image analysis software program that measured the vertical marginal gap from the two reference points (buccal and lingual) at the edge of the shoulder finish line of the dies to the inferior edge of the provisional crowns. The results from each reference point were calculated separately for each specimen. Finally, an overall average of the marginal gap was calculated for each test group. This was done accordance with the study by Ishita Dureja, Bhupender [25] and Munir Tolga [26].

Limitations of the Study

In this *in vitro* study,

- Although the study was designed in an attempt to simulate *in-vivo* conditions, this experimental design still had limitations in replicating clinical conditions accurately
- The effect of oral fluids on the polymerization of the provisional materials was not considered
- In addition, the specimens were not thermo cycled and only experimentally aged with 3 types of beverages
- The results obtained in this *in vitro* study are applicable to single temporary crowns and the data report may vary for multiple units
- It is suggested that in future studies, these factors to be taken into account

CONCLUSION

- Within the limitations of the study by analyzing the results, it was concluded that:
- The vertical marginal discrepancy of temporary crowns fabricated from the four commercially available provisional materials ranged from 71 μ to 106 μ
- All the three temporary crowns fabricated from different materials showed significant marginal discrepancy when dipped in three different beverages
- Further studies are required to confirm which provisional restorative material is suitable for fabricating temporary crowns by direct method

DECLARATIONS

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Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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