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Reducing the effect of polymerization shrinkage of temporary fixed dental prostheses by using different materials and fabrication techniques

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ABSTRACT

Objective. The aim of this laboratory study was to evaluate the horizontal and vertical effects of the polymerization shrinkage of three-unit temporary fixed dental prostheses (FDPs) on the position of the prepared teeth. In addition, the reduction of these effects by using different fabrication techniques was evaluated.
Methods. A total of 192 temporary FDPs were fabricated using one methacrylate (MA) and two dimethacrylate (DMA) materials. Each material group (n = 64) was divided into two groups according to the fabrication methods (M1: curing on the prepared teeth, M2: curing in a silicone mold). Each fabrication group was divided into four subgroups (n = 8) according to the relining method used (B: no relining, S: spacer foil 300 μm, DG: grinding-out with 500 μm cutting depth, and FG: free grinding). The experimental apparatus consisted of two abutment teeth lowered at right angles into a silicone mold. One prepared tooth was embedded in silicone to simulate the periodontium and permit slight horizontal tooth movement. The dimensional changes were recorded with an optical microscope. The test images were superimposed and measured using image analysis software.
Results. The statistical analysis showed that there were significantly higher horizontal changes for the MA than the DMA resins in M1, while there was none in M2. Regarding the vertical changes, there were significant differences between the baseline group and all relining and fabrication groups in all materials.
Significance. Relining of directly fabricated temporary FDPs significantly reduces the effect of polymerization shrinkage and thus secures the position of the prepared teeth.

1. Introduction

An essential step of the prosthetic treatment is the direct fabrication of provisional restorations [1–6]. Teeth prepared for a fixed dental prosthesis (FDP) usually require a provisional restoration during the laboratory production of the final FDP. The main purpose of the provisional restoration is to protect the prepared teeth against thermal, mechanical and biological

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noxae, to stabilize the tooth position and to ensure masticatory function, phonetics and esthetics [6–10]. To meet these requirements, the provisional materials must possess specific properties [5,7,11–13]. Beside mechanical properties, a good marginal fit and dimensional stability are particularly important [6,9,14]. The dimensional stability is important to ensure a stabile position of the abutment teeth during FDP fabrication.

A variety of provisional materials are available on the market [13]. The majority of these materials can be divided into two main categories based on their compositions: unfilled methacrylate resins and filled dimethacrylate composite resins [11,13,15]. During the polymerization of monomers a reduction of the intermolecular distances occurs, which is known as polymerization shrinkage [16–18]. As a result of the lower molecular weight, higher polymerization shrinkage occurs with the use of monomethacrylates in comparison to dimethacrylate materials filled with inorganic fillers [19].

The polymerization shrinkage causes dimensional changes in the provisional materials [20], leading to internal stresses [16,21–23]. This might result in decreased accuracy of the restoration and deterioration of the marginal fit [6,19], and subsequently leading also to inaccuracies in the occlusal area [24,25]. Insertion of such poor fitting provisional restoration could result in migration of the abutment teeth causing subsequently a poor or misfitting final restoration. Therefore, to avoid the migration of abutment teeth after impression taking, the dimensions of temporary FDPs should be as accurate as that of final FDPs [6].

In one study report, it was found that the adaptation of the provisional crown improved significantly after the first and slightly after the second relining [25]. Zwetchkenbaum et al., likewise described that after relining provisional restorations and subjecting them to thermal cycling and occlusal loading, marginal gaps were significantly reduced [26]. Thus, relining can affect the accuracy of the provisional restorations positively.

It was also found that the marginal fit deteriorated with longer FDPs [25]. Therefore, it can be assumed, that by increasing the provisional material volume between the abutment teeth, the polymerization shrinkage also increases and thus results in a greater dimensional change.

Many studies have examined the effect of polymerization shrinkage of the provisional restorations [6,9,25–27]. However, the aforementioned studies investigated the shrinkage in regard to the marginal fit and occlusal interferences of the abutment teeth, but no studies investigating the correlation between polymerization shrinkage and tooth migration could be found in the dental literature.

Therefore, the aim of this laboratory study was to evaluate the effects of the horizontal and vertical polymerization shrinkage of temporary three-unit FDPs and to measure the position of the prepared teeth using optical methods. Additionally, it was examined whether these effects could be reduced by different fabrication techniques, which include different fabrication and relining methods.

The null-hypothesis of this study was, that there is no difference between the tested temporary resin materials and the fabrication techniques of the temporary three-unit FDPs regarding the positional stability of the abutment teeth.

2. Materials and methods

2.1. Study outline

All experiments were performed in laboratories under constant conditions (constant humidity of 40 ± 5% and an ambient temperature of 21 ± 1 °C).

Two prepared typodont teeth (KaVo Dental, Biberach/Riss, Germany) were slowly dropped at right angles into a mold made of silicone (Optosil Comfort Putty, Heraeus Kulzer, Hanau, Germany) with a weight of 1 kg secured by parallel

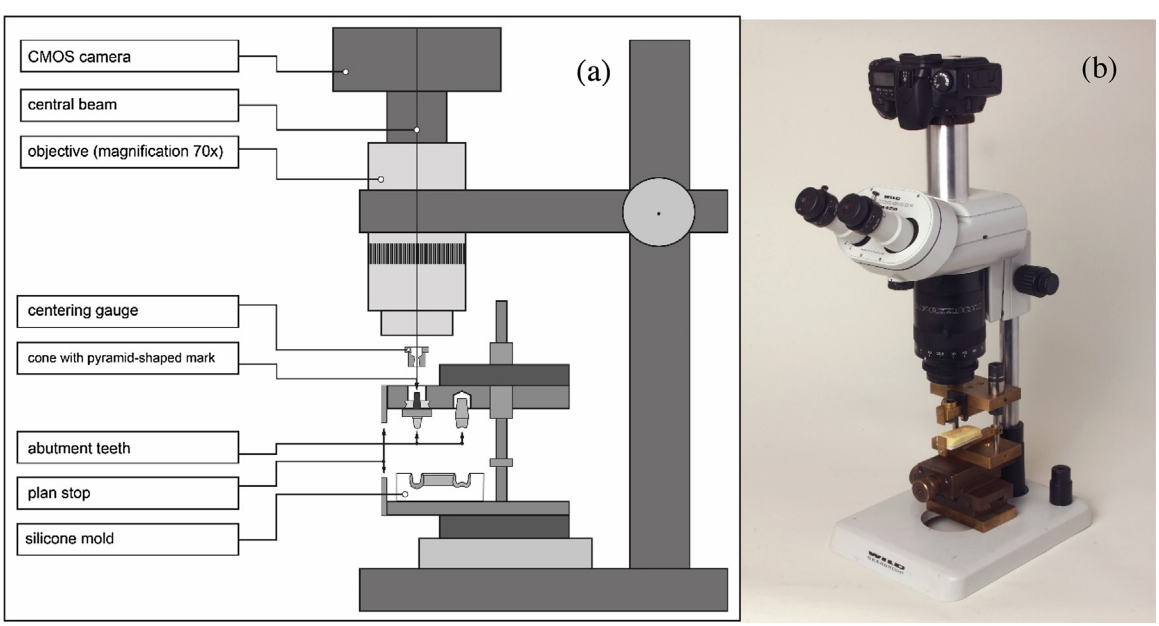

Fig. 1 – Schematic drawing (a) and photo (b) of light optical test set-up.