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Factors in polymerization influencing the accuracy of PMMA denture bases

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Introduction

Different technologies are available for the manufacturing of denture-base-resins with different types of polymerization. Although there have been permanent advancements in the range of denture-base-resins(1) polymerization shrinkage is still an important problem which leads to dorsal and lateral gaps and therefore decreasing functional fit. Comparing the different types of polymerization, especially heat-polymerized resins suffer under considerably larger dorsal gaps (2).
A further problem is the allergic property of different ingredients in PMMA denture bases such as residual monomer or BPO (3). Although there are some disadvantages regarding the dimensional accuracy, heat-polymerized PMMA resins are considered to have advantages in terms of allergic potential as there was less residual monomer left after denture processing (4). Recently, special hypo-allergic denture base resins were developed. According to the respective manufacturers these hypo-allergic resins have a significantly reduced allergic potential.
To meet clinical requirements, polymerization shrinkage of PMMA denture bases should be reduced to a minimum. Different processing technologies such as several types of injection-moulding or conventional flasking were developed in respect of reducing polymerization shrinkage (5).

Objectives

The aim of this in-vitro study was to investigate the dimensional accuracy of conventional and modern denture-base-resins after polymerization depending on the type of polymerization and the manufacturing technology.

Material and Methods

Ten standardized denture bases from 7 PMMA resins (Tab. 1) were fabricated on identical casts. All 70 casts were made from stone as a duplicate of a brass-master-model. Depending on product and manufacturers instructions 4 different manufacturing technologies were applied (Tab. 1). The dorsal gap between resin base and master cast represents a measure of fit and accuracy of a polymerized denture. The dorsal gap was measured at 5 points (palatal centre, bilateral vertical/horizontal border) engraved on the brass-master-model. To investigate the dimensional behaviour over a certain period, measurements took place at 4 particular times: immediately after embedding, after one hour, after one day and after one week. Between the measurements specimens were stored under constant humidity and temperature (22°C) in a hygrophore. A light-microscope with automatic video measuring technology (x 560, VMZM, TV-tubus 1,6x - objective 2,0x - screenlevel 4,0 x, Metrona Software, 4H JENA engineering, Jena, Germany) was used for the measurements.
The data were recorded and analyzed (Metrona- 4H Version 4.0, 4H JENA engineering). At different times for each product the average dorsal gap was calculated and analyzed for statistical differences and correlations (ANOVA, Bonferroni $P<0,05$).

Type of Polymerization	Product	Process	Manufacturer
Heat-polymerizing	Fururacryl 2000	Manual injection	Schütz Dental, Rosbach, Germany
Heat-polymerizing	Paladon 65	Conventional-flask-technique	Heraeus Kulzer, Hanau, Germany
Heat-polymerizing	SR-Ivocap	Pneumatic injection	Ivoclar Vivadent, Ellwangen, Germany
Auto-polymerizing	Futura Gen	Manual injection	Schütz Dental, Rosbach, Germany
Auto-polymerizing	PalaXpress	Pneumatic injection	Heraeus Kulzer, Hanau, Germany
Auto-polymerizing	Probase	Conventional-flask-technique	Ivoclar Vivadent, Ellwangen, Germany
Melting	Polyan	Injection-moulding	Polyapress, Altkirchen, Germany

Tab 1: Tested PMMA denture base resins

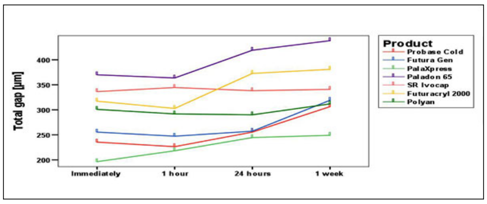

Fig. 1: Overview of Total gaps

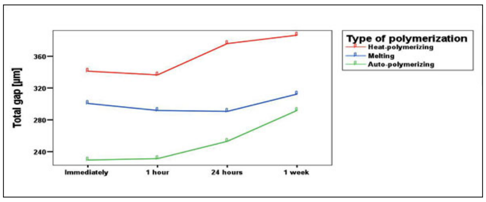

Fig. 2: Total gap in subject to type of polymerization

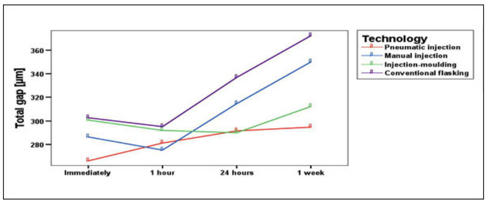

Fig. 3: Total gap in subject to type of technology

Fig. 4: Conventional-flask-technique

Fig. 5: Manual injection (Unipress)

Fig. 6: Pneumatic injection (SR-Ivocap)

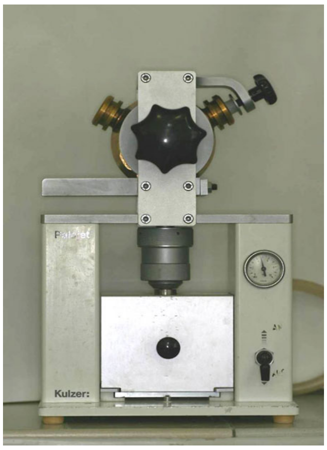

Fig. 7: Pneumatic injection (Palajet)

Fig. 8: Injection-moulding (Polyapress)

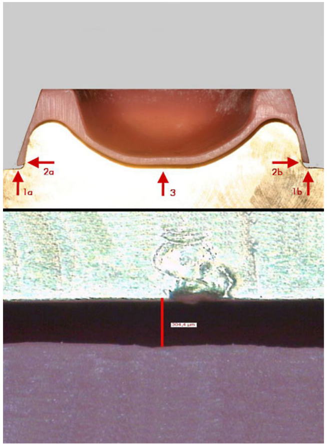

Fig. 9: Measuring points and dorsal gap measurement at point 3

Results

After embedding all products showed different dorsal gaps (Fig. 2). The tested auto-polymerizing PMMAs showed the smallest average dorsal gaps (196(±46µm) to 256(±83)µm), the heat-polymerizing PMMAs the highest measured values (317(±57) to 369(±88)µm). The industrially pre-polymerized hypo-allergic PMMA presented a dorsal gap in between (301(±116)µm). After one week the dorsal gap of both auto-polymerizing and heat-polymerizing PMMAs except SR-Ivocap increased significantly about 53(±75) to 71(±57)µm. There was no significant change detectable in dorsal gap for the industrially pre-polymerized PMMA Polyan. 71% of the products had a significant increase of dorsal gaps after one week. In this respect, PalaXpress showed the best, Paladon65 the worst results. Considering all measuring times, statistical analysis (descriptive statistics/cross-chart) revealed a significantly higher correlation of dorsal gap to the type of polymerization (eta=0.513) than to the applied manufacturing technology (eta=0.145).

Conclusions

Dimensional behaviour of PMMA during and after polymerization is decisively responsible for the quality of dentures in terms of clinical fit.
At different measuring times dorsal gaps of the auto-polymerizing denture base resin were smaller than the dorsal gaps of industrially pre-polymerized denture base resin which were followed by the significantly larger dorsal gaps of heat-polymerizing denture base resins.
Compared to the manufacturing process the type of polymerization had a greater effect on the dimensional accuracy of the tested denture-base-resins.

Literature

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This Poster was submitted by Andreas Peters.

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