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Flexural-strength and E-modulus of hypo-allergic denture base materials

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Introduction

Many ingredients of acrylic resins denture base materials are suspicious to cause allergic reactions [1]. Except the complete polymerized PMMA all ingredients in methacrylate based denture resins such as residual monomer or BPO have allergic properties with different potentials. So, alternative products with no or only minor quantities of allergic components were developed. To fabricate these "hypo-allergic" denture base materials different technical and chemical processing's are applied. To serve as a clinically substitute conventional PMMA denture base resins hypo-allergic denture base materials should meet the standards for mechanical-physical properties of conventional denture base resins. Fundamental material properties are flexural strength (σfM) and flexural/elastic modulus (Ef). Flexural strength is equivalent to the maximum flexural stress during a bend test [2]. Flexural or E-modulus represents the relation between flexural stress and flexural strain in the elastic and visco-elastic region. So, it indicates the material's resistance against elastic deformation. High flexural strength and flexural modulus contribute to the preservation of edentulous jaw areas [3]. Flexural strength is an indicator of the load level and clinical work capability of denture materials finally. A high flexural modulus specifies rigidity as well as stiffness and represents denture base material's resistance to elastic as well as visco-elastic deformation.

The aim of this in-vitro study was to evaluate mechanical-physical properties of hypo-allergic denture base materials Additionally the results should be compared to the material properties of established PMMA denture base resins.

Material and Methods

Seven hypo-allergic denture base resins (Tab.1) different in configuration, chemical composition and processing procedure were tested for mechanical-physical properties. According to manufacturers the tested products were free from toxic or potential allergic substances. To evaluate the materials' properties three conventional PMMA denture base resins with different polymerization cycles and processing parameters represented the control group and provided the standard for comparison. To guarantee optimal processing and material quality specimens (Fig 1) were produced by the manufactures or an authorized laboratory.

To prevent the influence of preparation specimens were cut under water cooling (60x10x4mm). Six specimens from each product were tested in the three point bending test according to ISO178:2006 [Center for Engineering Sciences (Director: Prof. Dr. W. Grellmann)].

The distance between the supports was 50 mm. In an universal testing machine (Zwick, Germany, Fig 2) bending force and deflection were measured until break at a constant cross head speed of v=5 mm/min. The data were automatically recorded (software TestXpert 8.1, Zwick). σfM and Ef were calculated, analyzed and compared to the control level (T-test, < 0.05).

Hypo-allergic resins	Basis	Processing procedure	Manufacturer
Acetal	polyoxymethylene	Injection	Pressing Dental S.r.l., Dogana, San Marino
Erkocryl	polymethyl methacrylate, partial of buthyl acrylate	Injection-casting	Erkodent Erich Kopp GmbH, Pfalzgrafenweiler, Germany
Luxene	polyvinyl copolymer	Injection	TopDent GmbH, Mühlgraben Germany
Microbase	diurethan diamethcrylate	Injection	DENTSPLY De Trey GmbH, Konstanz, Germany
Polyan	modified methyl methacrylate	Injection-casting	Polyapress GmbH, Altkirchen, Germany
Sinomer	polymethyl methacrylate, polyfunctional oligomers (acrylate/urethane based)	Injection	ALLDENT AG, Ruggell, Liechtenstein

Versio.com	dimethacrylate, polyfunctional methacrylates	Casting	Heraeus Kulzer GmbH & Co. KG, Hanau, Germany

Conventional Resins	**Basis**	**Processing procedure**	**Manufacturer**
Paladon 65	polyfunctional methacrylates	Injection	Heraeus Kulzer GmbH & Co. KG, Hanau, Germany
PalaXpress	polyfunctional methacrylates and copolymer	Plug & press	Heraeus Kulzer GmbH & Co. KG, Hanau, Germany
SR-Ivocap	polyfunctional methacrylates	Injection	Ivoclar Vivadent GmbH, Ellwagen, Germany

Tab 1: Tested hypoallergenic denture base materials and PMMA based denture base resins

Fig 1: Specimens

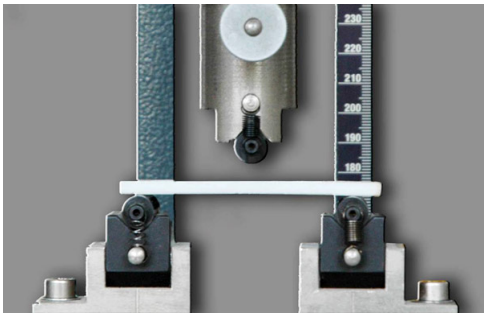

Fig 2: Three point bending test

Results

All tested hypo-allergic materials fulfilled the basic requirements according to DIN ISO 1567:2000. ofM standard of the conventional control group was in the range of 92.8 - 120.2 MPa (Fig 3). The average flexural strength of three tested products was within (100.5 - 116.0 MPa), two products were above (123.9 - 136.1 MPa) and two materials below (65.3 u. 71.4 MPa) the standardized control level.
Flexural modulus gained from the three point bending test characterizes material's stiffness. Ef standard level was between 2431 - 3180 MPa (Fig 4). The average flexural modulus of three products was within (2522 - 3020 MPa), two above (3234 - 3853 MPa) and one material below (2208 MPa) the respective control level.

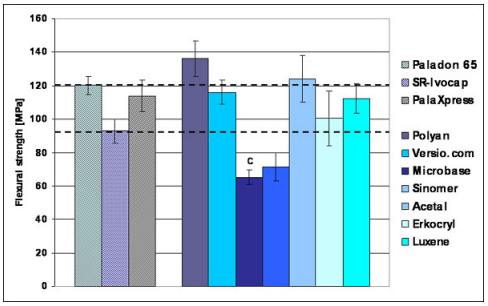

Fig 3: Flexural strength

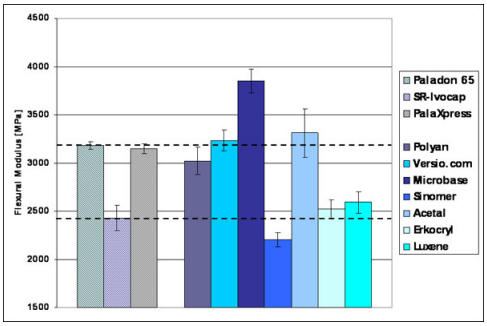

Fig 4: Flexural modulus /elastic modulus

Conclusions

Flexural strength is an indicator of the load capacity and the resistance against stress cracking. Therefore it also indicates clinical work capability of resin dentures. A high flexural modulus value specifies rigidity as well as stiffness and represents denture base material\'s resistance to elastic and visco-elastic deformation. All tested products fulfilled the requirements of ISO 1567:2000. The flexural strength and flexural modulus of five tested hypo-allergic denture base materials were within or superior to the control levels established by the tested conventional PMMA denture base resins. Microbase exhibited insufficient flexural strength combined with high flexural modulus which indicates brittle material properties. Sinomer showed deficient values for flexural strength and flexural modulus.

Literature

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2. Grellmann W, Seidler S (Eds): Polymer Testing. Hanser, Munich, Wien, 2007
3. Finger W: Mechanical and dynamic properties of denture base resins. Dtsch Zahnaerzt Z 30, (1975) 665-671

This Poster was submitted by Dr. Sonia Mansour.

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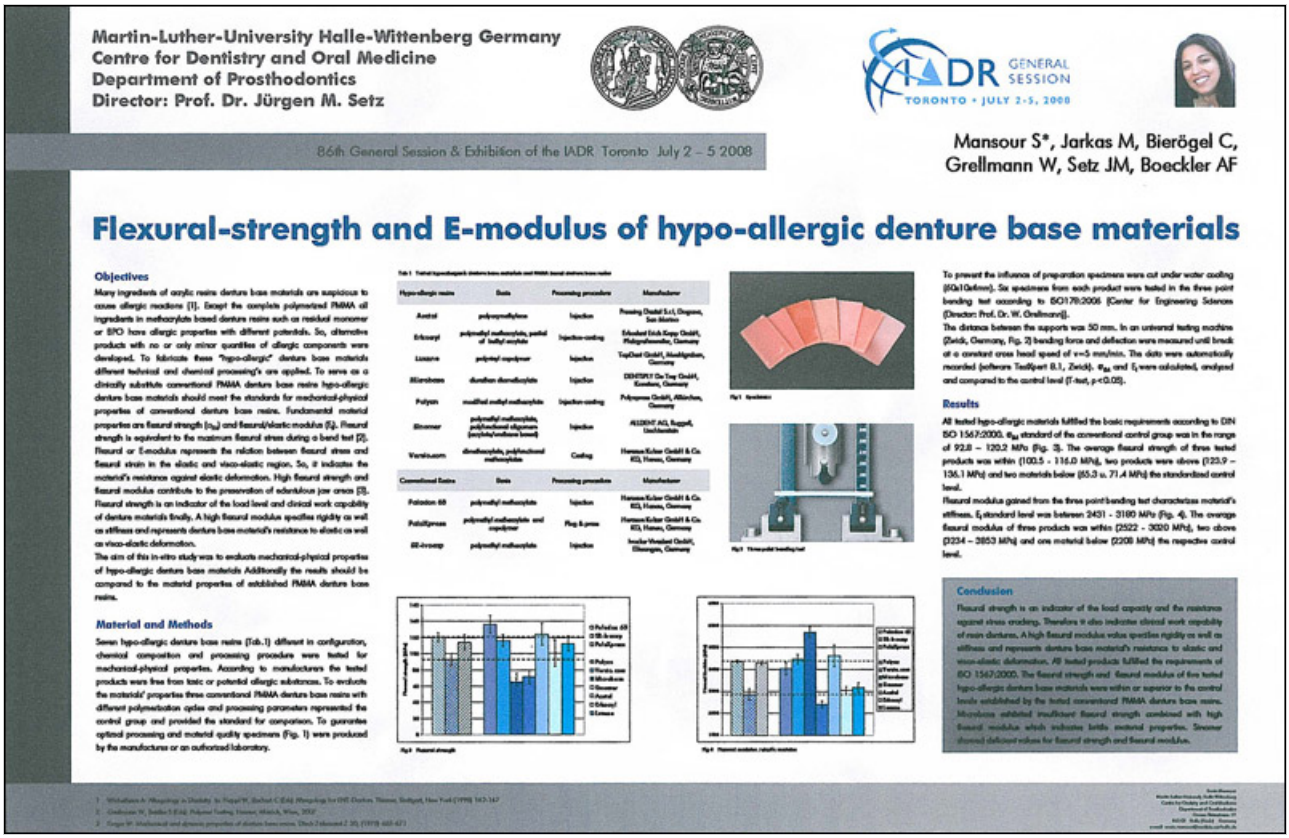

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IADR GENERAL SESSION TORONTO • JULY 2-5, 2008

Mansour S*, Jarkas M, Bierögel C, Grellmann W, Setz JM, Boeckler AF

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Objectives

Many ingredients of acrylic resins denture base materials are suspicious to cause allergic reactions [1]. Except the complete polymerized PMMA all ingredients in methacrylate based denture resins such as residual monomer or BPO have allergic properties with different potentials. So, alternative products with no or only minor quantities of allergic components were developed. To fabricate these "hypo-allergic" denture base materials different technical and chemical processing's are applied. To serve as a clinically substitute conventional PMMA denture base resins hypo-allergic denture base materials should meet the standards for mechanical-physical properties of conventional denture base resins. Fundamental material properties are flexural strength (σ_{fM}) and flexural/elastic modulus (E_f). Flexural strength is equivalent to the maximum flexural stress during a bend test [2]. Flexural or E-modulus represents the relation between flexural stress and flexural strain in the elastic and visco-elastic region. So, it indicates the material's resistance against elastic deformation. High flexural strength and flexural modulus contribute to the preservation of edentulous jaw areas [3]. Flexural strength is an indicator of the load level and clinical work capability of denture materials finally. A high flexural modulus specifies rigidity as well as stiffness and represents denture base material's resistance to elastic as well as visco-elastic deformation.
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Hypo-allergic resins	Basis	Processing procedure	Manufacturer
Acrostal	polyacrylethylene	Injection	Pressing Dentist S.r.l, Cinisello, San Marino
Eclusyst	polymethyl methacrylate, partial of butyl acrylate	Injection-casting	Eduard Erich Kopp GmbH, Philippinenweiler, Germany
Lucano	polymer copolymer	Injection	TopChoice GmbH, Mönchgladbach, Germany
Microbase	dicarbon dimethacrylate	Injection	DENTSPLY De Trey GmbH, Konstanz, Germany
Polyan	modified methyl methacrylate	Injection-casting	Polyquenoss GmbH, München, Germany
Sinomer	polymethyl methacrylate, polyfunctional oligomers (acrylate/urethane based)	Injection	ASUDENT AG, Rupperswil, Switzerland
Vertex.com	dimethacrylate, polyfunctional methacrylate	Casting	Heraeus Kulzer GmbH & Co. KG, Hanau, Germany
Conventional Resins	**Basis**	**Processing procedure**	**Manufacturer**
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SR-Ivocap	polymethyl methacrylate	Injection	Ivoclar Vivadent GmbH, Ellwangen, Germany

To prevent the influence of preparation specimens were cut under water cooling (65x12x4mm). Six specimens from each product were tested in the three point bending test according to ISO178:2006 (Center for Engineering Sciences (Director: Prof. Dr. W. Grellmann)).
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Results

All tested hypo-allergic materials fulfilled the basic requirements according to DIN ISO 1567:2000. σ_{fM} standard of the conventional control group was in the range of 92.8 – 120.2 MPa (Fig. 3). The average flexural strength of three tested products was within (100.5 - 116.0 MPa), two products were above (123.9 – 136.1 MPa) and two materials below (65.3 u. 71.4 MPa) the standardized control level.
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Conclusion

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