Alternative Technologies for Dentures Manufacturing using Different Types of Resins

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In the idea of improving the performances of both full and removable partial dentures, new materials and technologies are coming on the market, promising a better quality. Thermoplastic materials are used more and more widely in the technology of complete or removable partial dentures due to their superior qualities. Thermoplastic resins are suitable for manufacturing a wide range of removable partial dentures without metallic structure, in optimal conditions of biocompatibility. By injection, we have manufactured several removable partial dentures without metallic structure. Full denture casting currently represents a technological alternative. The casting system we tested, usually uses reversible hydrocolloids for investing wax patterns. Besides the system's own advantages, the authors also noticed certain errors consecutive to casting, materialized in lack of substance and the development of porosities on the mucosal facets of the complete denture bases.

Keywords: removable partial dentures, thermoplastic materials, molding-injection devices, casting, full dentures, errors

The development of resins represented a great step forward in dental technique, the first thermopolymerisable acrylic resins being developed in 1936. Due to their disadvantages, such as the toxicity of the residual monomer (organic solvent, hepatotoxic), the awkward wrapping system, difficult processing, several alternative materials were introduced such as thermoplastic resins: polyamides (nylon), acetal resins, epoxy resins, polystyrene, polycarbonate resins etc. [1-3], which are manufactured by injection.

With the alteration of the chemical composition, the application field of thermoplastic materials diversified as well, so that at present they are suitable for the manufacturing of removable partial dentures which totally or partially eliminate the metallic component of skeletal dentures, resulting in the so-called "metal-free removable partial dentures" [2-4]. Indications for thermoplastic resins include: flexible partial dentures, full dentures, preformed clasps, flexible partial denture frameworks, temporary crowns and bridges, orthodontic appliances, anti-snoring devices, different types of mouthguards and splints [5].

The main characteristics of thermoplastic resins used are: they are monomer-free and consequently non-toxic and non-allergenic, they are injected by special devices, they are biocompatible, they have enhanced esthetics and are comfortable at wearing.

Full denture casting currently represents an alternative to the manufacturing of full dentures, used in parallel with the classical barothermopolymerization of acrylic resins or to various injection techniques. According to DIN EN ISO 1567 standard, autopolymerizable acrylic resins that are suitable for casting belong to type 2, group 2 of acrylic resins-table 1. Their common characteristic is that they are polymerized at temperatures below 65°C, after being poured in a casting flask. This means that they have already prepared in a texture suitable for casting [6,7]. Each resin developed by various companies has its own casting system.

Type	Class (manufacturing)	Group (presentation form)
Type 1	thermopolymerisable resins (> 65°C)	Groupe 1: bicomponent - powder and liquid Groupe 2: monocomponent
Type 2	autopolymerisable resins (< 65°C)	Groupe 1: bicomponent - powder and liquid Groupe 2: bicomponent - powder and casting liquid
Type 3	thermoplastic resins	Monocomponent system: grains in cartridges
Type 4	photopolymerisable resins	Monocomponent system
Type 5	microwave polymerisable resins	Bicomponent system

Table 1
CLASSIFICATION OF RESINS ACCORDING TO DIN EN ISO–1567

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The aim of the study was to test the injection technology for new types of resins: thermoplastic acetal resins and polyamide resins as well as the casting technology of full dentures, to establish the advantages and disadvantages of this relatively new methods, as well as to assess possible errors that may develop.

Experimental part

Thermoplastic materials can be polymerised or prepolymerised and they are in granular form, with low molecular weight, already wrapped in cartridges (fig. 1), which eliminates dosage errors. Their plasticization temperature is 200-250°C. After thermal plasticization in special devices, the material is injected under pressure of 6-8 barr into a mold, without any chemical reactions. Pressure, temperature and injecting time are automatically controlled by the injecting unit. This resultes in compact dentures with excellent esthetics and good compatibility [4].

Fig. 1. Grain-type thermoplastic resin, wrapped in a cartridge

We have experimentally solved different cases of partial edentations with removable partial dentures without metallic frame, using the thermoplastic acetal resin Bio Dentaplast and polyamide resins Flexiplast, Flexite Plus. The material has been selected according to the requirements of the clinical situation.

Thermoplastic Acetal is a poly-oxy-methylene-based material. Acetal resin is very strong, resists wear and fracturing, and is flexible, which makes it an ideal material for pre-formed clasps for partial dentures, partial denture frameworks, provisional bridges, occlusal splints. Acetal resins resist occlusal wear and are well suited for maintaining vertical dimension during provisional restorative therapy. Acetal does not have the natural translucency and esthetic appearance of thermoplastic acrylic and polycarbonate [8,9]. Bio Dentaplast is an acetal resin-type thermoplastic material, highly crystalline and with linear structure**,** mainly indicated for manufacturing frameworks of removable partial dentures, clasps and attachments matching the colour of the tooth. The material is opaque and can be found in the hues A1, A2, A3, B2 and B3 of the Vita colour range, being also used for making crowns and bridges.

Thermoplastic polyamidic resins derive from diamine and dibasic acid monomers. They are versatile materials, suitable for a broad range of applications, exhibiting high physical strength and chemical resistance and can be easily modified to increase stiffness and wear resistance. Due to their flexibility, they are primarily used for flexible partial dentures but can't maintain vertical dimension when used in direct occlusal forces. They are little more difficult to adjust and polish, but the resin can be semi-translucent and provides excellent esthetics.

Flexiplast is a polyamide-based flexible, unbreakable thermoplastic material. It is delivered in the following colours: transparent, B tooth colour, three shades of pink. Besides its main indications, i.e. removable partial dentures, the material can be used in manufacturing bruxism devices and sport mouthguards. The material is specially indicated for patients allergic to methyl metacrylate.

Flexite Plus, superflexible polyamide, is available in three tissue shades. This kind is extremely elastic, virtually unbreakable. The material is monomer-free, lightweight and impervious to oral fluids. Flexite Plus may also be combined with a metal framework.

The technical steps in the technology of manufacturing a removable partial denture with an acetal resin framework, the maintenance, support and stabilizing systems being metal-free, Ackers circular clasps, chosen according to the median line of the abutment teeth and the insertion axis of the denture are:

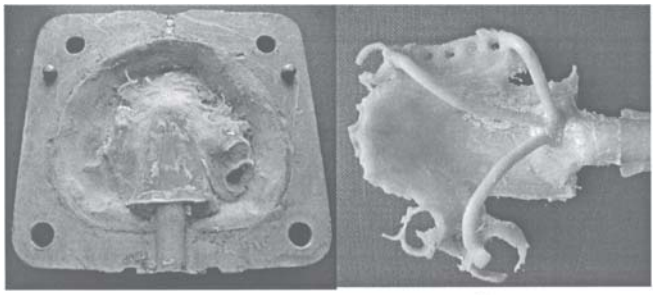
-manufacturing the frame from acetal resin, following the classic steps of casting of the working model, parallelograph analysis, drawing the future frame of the removable partial denture, foliation and deretentivisation of the model, duplication of the model, manufacturing the wax pattern of the removable partial denture frame, wrapping the detensioned wax pattern in the flask of the injection device. Then injection is carried out with the R-3C (Budapest, Hungary) injector (fig. 2), following the indicated procedure. The device has the following parameters: digital control, five preset programmes for Flexite materials and programmes that can be individually set by the user. The pressure developed is 6-8 barrs. Disassembling of the frame of the future removable partial denture (fig. 3) is followed by its matching to the model, processing and finishing this component of the framework denture;

- the artificial teeth were inserted over the thermoplastic material saddles by adding pink wax;

-the acrylic component of the denture is wrapped according to traditional methods. The denture is unwrapped after polymerization, and processed according to the existing norms.

Polyamide resin removable partial dentures are easier to make than those made of acetal resins as they do not require so many intermediary steps. The steps are similar to those followed for acrylic dentures, differences lying in the fact that with thermoplastic materials the injecting procedure is used, and the clasps are made of the same material as the denture base, when using superflexible polyamide Flexite Plus . With medium-low flexibility Flexite

Fig. 2. R-3C injector (Budapest, Hungary)



a. b.

Fig.3. Disassembling the framework of the acetal resin removable partial denture: a. the framework is still in the flask; b. disassembling is complete

Supreme we used ready-made Clasp-Eze clasps, in tooth colour, with a composition similar to that of Flexite Supreme and being adapted to the tooth by heating.

For testing the casting technology of full dentures, to establish the advantages and disadvantages of this relatively new method, as well as to assess possible errors that may develop various models of total edentation were chosen. Full dentures were manufactured for each model using the casting technique. The casting technique chosen was that of the Vertex company, the resin used being an autopolymerizable acrylate based on methyl polymethylacrylate. The resin is presented in a powder-liquid bicomponent system, intended for casting.

The method used was the traditional method of following all the technological steps in manufacturing full dentures, including the final pattern step [10](fig. 4). For the investment, the finite pattern is attached to the base of the flask with a special silicone. The liquefied hydrocolloid is thus cast in the already prepared flask.

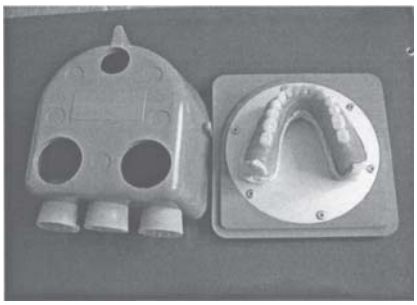


Fig. 4. Final pattern of the dentures, ready for investing

Turning the pattern into the finite denture is done according to the specifications of the full denture casting system. The finite pattern is invested in a special flask, using a reversible hydrocolloid. The indication of the system used is investing with a reversible hydrocolloid, but we also invested with silicones, the results being better, by gaining lower final porosity of the base acrylic material.

Once the impression materials have set, the flask is unwrapped, the model is removed together with the denture base pattern. The teeth are introduced in the Clean-Tray device, removing the wax remains. Subsequently, the teeth are repositioned in the investment impressions.

The acrylic resin is then prepared and poured through the specially created canal until the canal is completely filled. Afterwards, the acrylic resin is polymerized by immersing the flask for 30 minutes into a special polymerization pot which contains water at a temperature of 50+/-5°C, 2.5 bars. The polymerized denture is subsequently removed from the investment. The necessary adjustments are minimal.

The prosthetic solution of partial edentations with the help of metal-free removable partial dentures represents a modern alternative solution to classical framework dentures, having the advantage of being lightweight, flexible and much more comfortable for the patient. The effectiveness of the technique is given by the use of the same material in making the clasps or the use of ready-made clasps from the same material. Where the mechanical resistance of the structure came first, we chose an acetal resin for making the frame. Superflexible polyamide resin is especially indicated for retentive dental fields, which would normally create problems with the insertion and disinsertion of removable partial dentures [2-5]. The advantages of the injecting system lie in the fact that the resin is delivered in a cartridge which eliminates dosage errors, guaranteeing long-term stability of the shape, reduced contraction, as well as mechanical resistance with ageing. The disadvantages are mainly the consequence of the high cost of the injection device and of the materials to be used.

The casting system has the following advantages: the reversible hydrocolloid can be reused, reduced polymerization time, wide colour range of the material (10 colours), minimal adjustments required.

Disadvantages of the full denture casting system are: costly technology due to the necessity to acquire the casting system; in the case of retentive fields, problems may occur during the unwrapping stage; possible errors may occur during tooth positioning. Several dentures obtained by casting had a high level of porosity on the mucosal surfaces, which develops when the acrylic resin is being poured. This porosity is caused by the incorporation of air bubbles when the acrylic resin is poured in the mold. Dentures may also be incomplete, due to the fast setting of the resin which requires great skill when pouring it in the mold. The imperfections which develop on the mucosal surfaces may be a consequence of improper preparing acrylic resins or improper pouring.

Conclusions

Both denture injection and casting techniques represent alternatives to the classical barothermopolymerization technique, being part of the new methods offered by the producers, for improving the clinical performances of these prosthetic pieces.

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