Some Alternatives for Classic Thermopolymerisable Acrylic Dentures

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The use of the acrylic resins in the dental technique was a very important gain for the manufacturing and treatment of dentures and during the years new materials and technologies have appeared on the market, promising a better quality. Full-denture casting currently represents a technological alternative. The casting system we tested usually uses reversible hydrocolloids for investing wax patterns, and has certain advantages. 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. Our aim is to compare thermopolimerysable acrylic resins, manufactured using the classic technology with cast full dentures and injected thermoplastic resins.

Keywords: thermopolimerisable acrylic resin, thermoplastic resin, molding-injection devices, casting, full dentures.

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. which are manufactured by injection [1-3].

Full-denture casting currently represents an alternative to the manufacturing of full dentures, used in parallel with the classical barothermopolymerisation of acrylic resins or to various injection techniques. According to DIN EN ISO 1567 standard, autopolymerisable 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 been prepared in a texture suitable for casting [5-8]. Each resin developed by various companies has its own casting system.

With the alteration of the chemical composition, the application field of thermoplastic resins (Type 3) 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 ("metal-free removable partial dentures") [2-4], flexible partial dentures, full dentures, preformed clasps, temporary crowns and bridges, orthodontic appliances, anti-snoring devices, different types of mouthguards and splints [7].

The main characteristics of thermoplastic resins used are the following:

- they are monomer-free and consequently non-toxic and non-allergenic;
- are injected by special devices;
- are biocompatible;
- have enhanced esthetics and are comfortable at wearing.

Experimental part

Acrylic thermopoyimerisable resins (Type 1) have poor mechanical resistance and satisfying physiognomic properties. The plasticizing temperature is above 65°C, with

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

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

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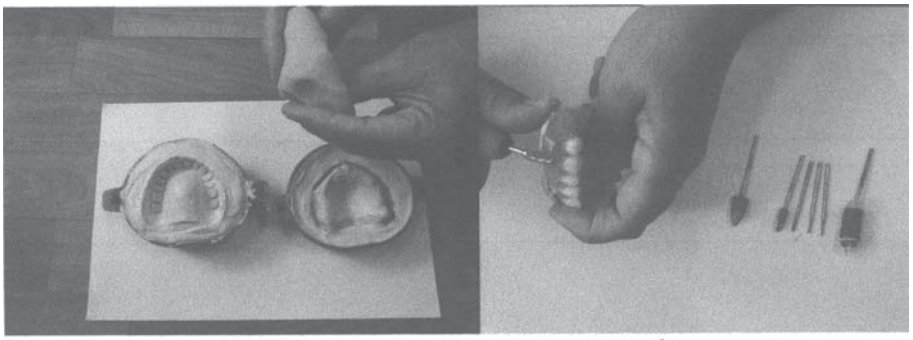

a. b.

Fig. 1a. Introducing the thermopolimerisable acrylate in the mould
Fig. 1b. Unwrapping, adjusting and finishing

an average of approx. 105°C, depending on the product. For denture basis, if they are thick enough, the rigidity and resistance are considered to be adequate. They have poor abrasion resistance and slowly absorb water. A number of patients are considered to be allergic to acrylate, especially to residual monomer, and in these cases alternative materials should be used. Even for non-allergic patients, high residual monomer quantities may lead to irritation.

Most thermopolimerisable acrylates are bicomponent - powder and liquid, the powder consisting mainly of metyl polymetacrylate and the liquid of monomer: metyl metacrylate. The technique of making full thermopolymerisable acrylic dentures is a classic one.

The mixture of these components results in a paste which is polymerized by increased heat . The acrylic paste is introduced in the mould, the pressurized mould is then introduced in a water bath, the polymerization being induced by continuous heating of this bath (fig. 1a). The thermal protocol must be accurate, the pressure assuring the material penetration in all the mould areas, preventing polymerisation shrinkage and occlusion rise, due to a thicker base. The cooling has to be slow, unwrapping, adjusting and finishing must be thorough (fig 1b) [1].

As consequence of dosage, manipulation or adjustment errors, air bubbles may occur, which are easy to determine.

For the casting technique we used autopolymerisable acrylate (Type 2, group 2) 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 [12] (fig. 2). 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.

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 or silicones. When invested in silicones the results were 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 cleaning 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 polymerised by immersing the flask for 30 min into a special polymerisation pot which contains water at a temperature of 50+/-5°C, 2.5 barrs. The polymerised denture is subsequently removed from the investment. The necessary adjustments are minimal (fig. 3).

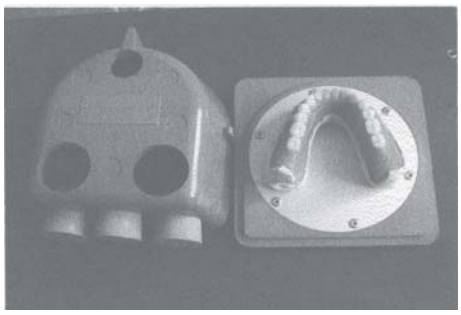

Fig. 2. Final pattern of the dentures, ready for investing

Thermoplastic materials can be polymerised or prepolymerised and they are in granular form, with low molecular weight, already wrapped in cartridges (fig. 4), which eliminates dosage errors. Their plasticization

Fig. 3. The denture removed from the elastic investment

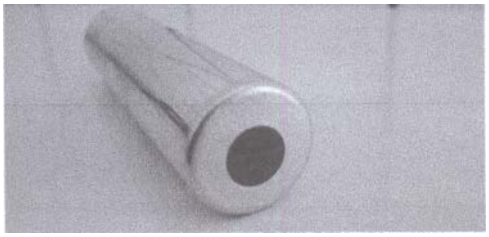

Fig. 4. Grain-type thermoplastic resin, wrapped in a cartridge

temperature is 200-250°C. After thermal plasticization in special devices, the material is injected under pressure of 6-8 barr into a mould, without any chemical reactions. Pressure, temperature and injecting time are automatically controlled by the injecting unit. This results in compact dentures with excellent esthetics and good compatibility [4].

Thermoplastic resins suitable for full or partial dentures, are thermoplastic acrylics, acetal resins and polyamide resins, the material being selected according to the requirements of the clinical situation.

Thermoplastic acrylate consists of fully polimerised acrylate, its base component being methyl-metacrylate, the special blend of polymers giving it the highest impact rating of any acrylic. This material was developed for making full dentures, it is not elastic, but its flexibility makes it practically unbreakable. The material has long-term stability, its surface structure being dense and smooth. The absence of the residual monomer gives it a very good biocompatibility. Water retention is limited, giving the denture a very good long-term adaptability. You can bounce such denture off the floor without cracking the base.

Thermoplastic Acetal is a poly-oxy-methylene-based material. Acetal resin is very strong, resists to 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 has not the natural translucency and esthetic appearance of thermoplastic acrylic and polycarbonate resins [10,11].

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. They can be easily modified to increase stiffness and wear resistance. Because of their flexibility, they are used primarily for flexible partial dentures. Their flexibility varies from one material to another, so we can choose from low flexible to superflexible polyamide. They can not maintain vertical dimension when used in direct occlusal forces. They are a little more difficult to adjust and polish, but the resin can be semi-translucent and provides excellent esthetics. The material is specially indicated for patients allergic to methyl metacrylate, being monomer-free, lightweight and impervious to oral fluids. Some 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 are the following:

-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 may be carried out with different injectors, following the indicated procedure. The devices usually have digital control, preset programmes for certain 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 is followed by its matching to the model, processing and finishing this component of the framework denture;

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

- the acrylic component of the denture is wrapped using traditional methods. The denture is unwrapped after polymerisation, and processed according to the existing norms (fig. 5).

Acrylic thermoplastic full dentures and 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 classic acrylic dentures, differences lying in the fact that with thermoplastic materials the injecting procedure is used. For partial polyamidic dentures the clasps are made of the same material as the denture base, when using superflexible polyamide (fig. 6), or ready-made clasps, in tooth colour, with a composition similar to that of the low-medium polyamide may be adapted to the tooth by heating.

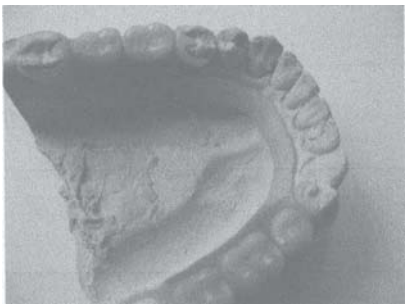

Fig. 5. Metal-free acetal - acrylic partial denture

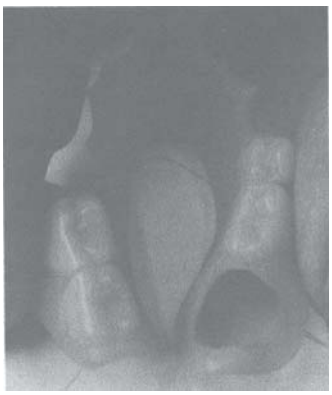

Fig. 6. Superflexible polyamide dentures

Results and discussions

The numerous disadvantages of classic thermo-polymerisable acrylic dentures are well known: poor resistance to deformation and wear, poor long-term performance and stability, poor tolerance, usual presence of residual monomer which induces allergies in a high percentage of the patients, porosity which helps the development of microorganisms and deposits. The dentures need thorough adjustments. The thermo-polymerisation process is time consuming but its main advantage is the accessibility for all the laboratories and patients. Errors might easily occur, like high porosity or bubbles and high occlusion.

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.

For biocompatible full dentures one may choose monomer-free thermoplastic acrylic resin. 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].

Unlike conventional acrylates, thermoplastic resins have numerous advantages: long-term performance, stability, resistance to deformation and wear, excellent tolerance, resistance to solvents, absence or reduced quantity of residual monomer which induces allergies in a high percentage of the patients, lack of porosity which prevents the development of microorganisms and deposits, as well as maintaining their size and colour in time [1].

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.

Conclusions

Both denture injection and casting techniques represent alternatives to the classical thermopolymerisation technique, being part of the new methods offered by the producers, for improving the clinical performances of full and partial dentures.

As this class of materials and their processing devices are being permanently improved, their future applicability in dental medicine will keep growing.

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