Metal-free Removable Partial Dentures made of a Thermoplastic Acetal Resin and Two Polyamide Resins

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Thermoplastic materials are used more and more in the technology of complete or removable partial dentures due to their superior qualities. We have tested an acetal resin, two polyamide resins and polyamide prefabricated clasps. By injection, we have manufactured several removable partial dentures without metallic structure. Thermoplastic resins are suitable for manufacturing a wide range of removable partial dentures without metallic structure, in optimal conditions of biocompatibility.

Key words: removable partial dentures, thermoplastic materials, molding-injection devices

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 polyamides (nylon), acetal resins, epoxy resins, polystyrene, polycarbonate resins etc. [1-3].

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].

Thermoplastic Acetal is a poly-oxy-methylene-based material, which as a homo-polymer has good short-term mechanical properties, but as a co-polymer has better long-term stability. 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, single pressed unilateral 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 [5,6].

Thermoplastic Nylon is a polyamidic resin derived from diamine and dibasic acid monomers. Nylon is a versatile material, suitable for a broad range of applications. Nylon exhibits high physical strength and chemical resistance. It can be easily modified to increase stiffness and wear resistance. Because of its excellent balance of strength, ductility and heat resistance, nylon is an outstanding candidate for metal replacement applications. Because of its flexibility, it can't maintain vertical dimension when used in direct occlusal forces. Nylon is a little more difficult to adjust and polish, but the resin can be semi-translucent and provides excellent esthetics [7].

Table 1
THE 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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Thermoplastic materials can be polymerised or prepolymerised and they are in granular form, with low molecular weight, already wrapped in cartridges which eliminates dosage errors. After thermal plasticization in special devices, the material is injected under pressure into a mold, without any chemical reactions. Pressure, temperature and injecting time are automatically controlled by the injecting unit [8]. This results in compact dentures with excellent esthetics and good compatibility [5-7].

Indications for thermoplastic resins include: flexible tooth born partial dentures, preformed clasps, flexible tooth born partial denture framework, temporary or provisional crowns and bridges, full dentures, orthodontic appliances, anti-snoring devices, different types of mouthguards and splints [9].

The objective of the study is to test a thermoplastic acetal resin and two polyamide resins in manufacturing metal-free removable partial dentures.

Experimental part

We have experimentally solved different cases of partial edentations, with removable partial dentures without metallic frame, using one thermoplastic acetal resin and two polyamide resins, selected according to the requirements of the indications and manufacturing technology.

The main characteristics of thermoplastic resins used are: 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.

The acetal resin used has optimal physical and chemical properties and it is indicated in making frames and clasps for removable partial dentures, being available in tooth colour and pink.

Experimentally, the denture acetal framework was combined with the use of acrylic resins at the saddles level. As a particularity of the manufacturing we mention the fact that it is necessary to oversize the main connector, clasps and spurs, because the resistance values characteristic for the acetal resin do not reach those of a metal framework.

The main aspect in the technology of removable partial dentures made of thermoplastic materials is to make the working model of hard plaster class IV, in two copies, because one will be deteriorated when the acetalic framework will be dismanteled.The model was analyzed by parallelograph in order to asess its retentiveness and to determine the place where the active arms of the clasp is placed. The maintenance, support and stabilizing systems were those used with metal-free, Ackers circular clasps, made of the same acetalic resin as the framework, chosen according to the median line of the abutment teeth and the insertion axis of the denture. The future frame of the removable partial denture is drawn, starting with the saddles, following the main connector, the retentive and opposing clasp arms, the spurs and secondary connectors of the Ackers circular clasps. The model was duplicated by foliation and deretentivisation. The working model was duplicated using a vinyl-polysiloxanic silicon placed in a conformer. After the silicon is bound, the impression is taken and the duplicate model is cast, from class IV hard plaster. The wax pattern of the removable partial denture was manufactured following the profiles imprinted on the model: the wax pattern of the main connector (so that it's twice as thick as it normally would), the wax pattern of the saddles and the wax pattern of the Ackers circular clasps. The detensioned wax pattern is wrapped in the flask of the injection device, using class III hard plaster, and lined with vaseline.

Injection was carried out with a digital control device that has five preset programmes and programmes that can be individually set by the user. Before the injection procedure, the injecting pressure is checked according to procedure demands (7.2-7.5 barr), preheating temperature and time were also checked (15 minutes at 220°C). The selected corresponding cartridge of injecting material (quantity and color) was introduced into one of the two heating cylinders. Preheating process was then activated. After preheating time elapsed, the flask was inserted and secured in the corresponding place of the injecting unit. The injection process took 0.25 seconds. The pressure is automatically maintained for one minute, in order to compensate the contraction. In order to achieve optimal quality of the material, the flask was left to slowly cool for 8 hours.

The disassembling of the frame of the future removable partial denture was 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, starting with the insertion of the most mesial tooth. The acrylic component of the denture is wrapped according to traditional methods (fig. 1), the denture being unwrapped after polymerization, and was processed following existing norms.

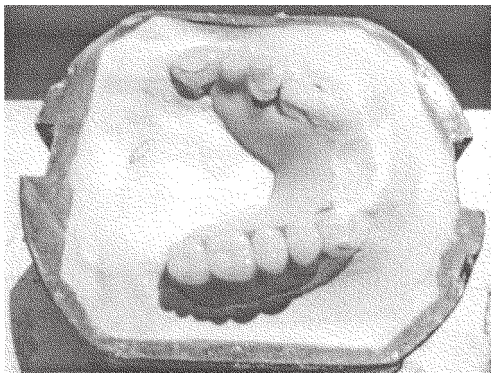

Fig. 1. Wrapped acetalic resin frame, and the pattern with teeth

Due to the fact that among the indications of thermoplastic resins are anti-snoring devices, different types of mouthguards and splints, we experimentally manufactured acetalic resin splints, in order to imobilise parodonthotic teeth, after surgery (fig. 2).

Experimentally, in order to especially test the physiognomic aspect, we resolved partially reduced edentations with Kemeny-type dentures- fig. 3, as an alternative to fixed partial dentures, having the advantage of a minimal loss of hard dental substance, located only at the level of occlusal rims.

The two polyamidic resins used are: a medium-low flexibility polyamide and a superflexible polyamide, extremely useful in cases of retentive dental fields.When manufacturing polyamidic dentures, the support elements blend in with the rest of the denture, as they are made of the same material. The superflexible polyamide resin is available in three tissue shades, is extremely elastic, virtually unbreakable, monomer-free, lightweight and impervious to oral fluids. The medium-low flexibility polyamide is a half-soft material which has much wider range of use, being the ultimate cast thermoplastic for removable partials and offering the patient superior

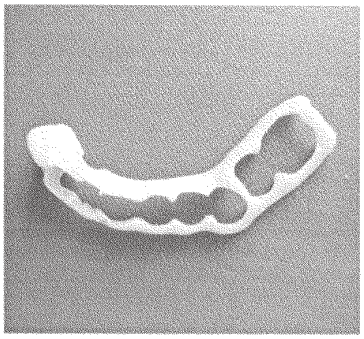

Fig. 2. Imobilisation splint made of acetal resin

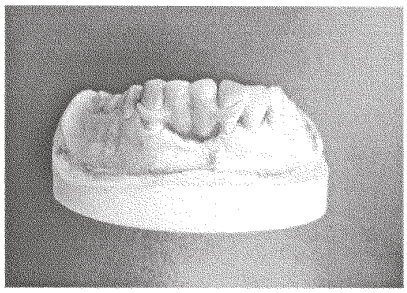

Fig. 3. Kemeny - type frontal denture

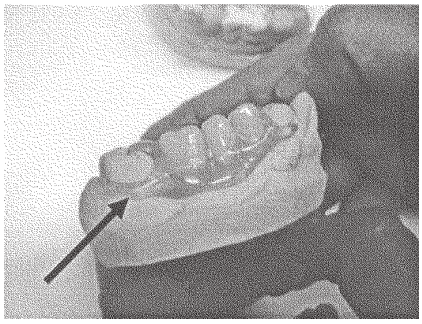

Fig. 4. Medium - low flexibility polyamide resin denture, with pre-formed clasps

polyamide or we used ready-made clasps, in the case of using medium-low flexibility polyamide (fig. 4).

Results and discussions

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 [2,3,4,9]. Of the three materials used by us for manufacturing removable partial dentures, using acetal resin flexible thermoplastic frame, was the most laborious, requiring the more working steps, due to the fact that first step involves manufacturing the acetal frame, afterwards being manufactured the acrylic saddles and artificial teeth.

In the case of Kemeny-type acetalic dentures, the effectiveness of the technology is given by making artificial teeth of the same material, in the same step as the rest of the denture. As the material is not translucent, it is mainly suitable for dealing with lateral edentations. It can, however, be used temporarily, in the frontal area as well, in those clinical cases where short-term esthetic aspect is irrelevant.

Table 2
COMPARATIVE ASPECTS OF ACETALIC AND POLYAMIDE THERMOPLASTIC RESINS

Resin type	Main substance	Resistance	Durity	Flexibility	Esthetics	Biocompatibility
Acetalic resin	polioximetylen	very good	very high	medium	good	very good
Polyamidic resin	diamin	good	high	medium or very high, depending on the material	very good	very good

comfort, esthetics with no metallic taste is easy to polish and adjust, it can be added to or relined in office or laboratory. The pre-formed clasp, is made of nylon, its composition being similar to that of the polyamidic resin used for denture manufacturing, is available in shades of pink, tooth colour and translucent, and is adapted to the tooth by heating. It can be used for classical dentures, with metal framework, or it can be associated with injected thermoplastic resins.

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

Conclusions

Metal-free removable partial dentures made of thermoplastic materials are biocompatible, nonirritant, sure, nontoxic, comfortable, biologically inert, with superior esthetics, which make them rapidly integrate in dento-maxilar structure, being the most comfortable solution for the patient. They offer quality static and dynamic stability [2,3,8].

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. They also have a high degree of flexibility and resistance; they permit the addition of elastomers in order to increase their flexibility or can be reinforced with fiberglass to improve their physical properties; they can also be lined and repaired using various methods [10, 11,12].

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. Having superior physical properties, thermoplastic materials processed by injection represent esthetic alternatives to metal frames, being at the same time comfortable for the patient [7, 11,12].

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