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Chapter 7

Thermoplastic Resins used in Dentistry

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Additional information is available at the end of the chapter

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Abstract

Thermoplastic materials such as polyamides (nylon), acetal resins, epoxy resins, polystyrene, polycarbonate resins, polyurethane and acrylic thermoplastic resins were introduced in dentistry as an alternative to classic resins, which have major disadvantages such as the toxicity of the residual monomer, awkward wrapping system and difficult processing.

Indications for thermoplastic resins include partial dentures, preformed clasps, partial denture frameworks, temporary or provisional crowns and bridges, full dentures, orthodontic appliances, anti-snoring devices, different types of mouth guards and splints. Some flexible myofunctional therapy devices, used for orthodontic purposes, may also be made of thermoplastic silicone polycarbonate-urethane.

The main characteristics of thermoplastic resins used in dentistry are as follows: they are monomer free and consequently nontoxic and nonallergenic, they are injected by using special devices, they are biocompatible, they have enhanced esthetics and they are comfortable to wear.

Keywords: Thermoplastic resins, injection devices, metal-free removable partial dentures

1. Introduction

Continuous development and progress of polymer's industry with applications in general and dental medicine was of great importance for the health domain. Using various types of resins for restorations in the oral cavity is beneficial from childhood till geriatric period [1-4].

Thermopolymerizable acrylic resins were first used in dental technique in 1936, this being a great step forward. Acrylic resins are also known as polymethylmethacrylate or PMMA. These synthetically obtained materials can be modeled, packed or injected into molds during the plastic phase and become solid after chemical polymerization [5, 6]. Thermopolymerisable acrylic resins have many disadvantages as increased porosity, high water retention, volume variations and irritating effect due to the residual monomer, awkward wrapping system and difficult processing. Because of these, once polymers developed, alternative materials such as polyamides (nylon), acetal resins, epoxy resins, polystyrene, polycarbonate resins etc. [7-9] came on the market.

The main characteristics of the thermoplastic resins used in dentistry are as follows: they are monomer-free and consequently nontoxic and nonallergenic, they are injected by using special devices, they are biocompatible, they have enhanced esthetics and they are comfortable to wear [10].

2. Types of thermoplastic resins used in dentistry

The classification of resins according to DIN EN ISO 1567 is presented in Table 1:

Type	Class (manufacturing)	Group (presentation form)
Type 1	Thermopolymerizable resins (>65°C)	Group 1: bicomponent powder and liquid Group 2: monocomponent
Type 2	Autopolymerizable resins (<65°C)	Group 1: bicomponent powder and liquid Group 2: bicomponent powder and casting liquid
Type 3	Thermoplastic resins	Monocomponent system grains in cartridges
Type 4	Light-cured resins	Monocomponent system
Type 5	Microwave cured resins	Bicomponent system

Table 1. The classification of resins according to DIN EN ISO 1567

Among the technologies for manufacturing removable complete and partial dentures we distinguish: heat-curing, self-curing, injection, light-curing, casting and microwave use [11].

Thermoplastic resins may be classified by their composition, as acetal resins, polycarbonate resins (belonging to the group of polyester resins), acrylic resins and polyamides (nylons).

The use of thermoplastic resins in dental medicine is continuously growing. The material is thermally plasticized and no chemical reaction takes place. The injection of plasticized resins into a mold represents a new technology in manufacturing complete and removable partial dentures [12].

At present, due to successive alterations in the chemical composition, thermoplastic materials are suitable for manufacturing removable partial dentures with no metallic components, resulting in the so-called "metal-free removable partial dentures" [13].

Indications for thermoplastic resins include removable partial dentures, preformed clasps [14], partial denture frameworks, temporary or provisional crowns and bridges, complete dentures, orthodontic appliances, anti-snoring devices, different types of mouth guards and splints. Some flexible myofunctional therapy devices, used for orthodontic purposes, may also be made of thermoplastic silicone polycarbonate-urethane.

2.1. Thermoplastic acetal

Thermoplastic acetal is a poly(oxy-methylene)-based material, which as a homopolymer has good short-term mechanical properties but as a copolymer has better long-term stability [15]. Due to its resistance to wear and fracture, combined with a certain amount of flexibility, acetal resin is an ideal material for preformed clasps for partial dentures, single-pressed unilateral partial dentures, partial denture frameworks (Figure 1), provisional bridges, occlusal splints and implant abutments, artificial teeth for removable dentures and orthodontic appliances [16].

Because of their resistance to occlusal wear, acetal resins are also well suited for maintaining vertical dimension during provisional restorative therapy. Acetal is not translucent and does not match the esthetic appearance of thermoplastic acrylic and polycarbonate [17].

Figure 1. Removable partial denture with acetal frame and clasps

2.2. Thermoplastic polyamide (nylon)

Thermoplastic polyamide (nylon) is a resin derived from diamine and dibasic acid monomers. Versatililty is one of its characteristics and makes it suitable for various applications. Nylon exhibits high flexibility, physical strength, heat 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 [18]. Nylon is mainly used for tissue supported removable dentures. Its stiffness makes it unsuitable for usage as occlusal rests or denture elements that need to be rigid [7, 13]. Because it is flexible, it cannot maintain vertical dimension when used in direct occlusal forces. Adjustment and polishing is difficult but provides excellent esthetics due to its semitranslucency [19, 20].

Nylon is specially indicated for patients allergic to methyl metacrylate, being monomer-free, lightweight and impervious to oral fluids [21]. Some may also be combined with a metal framework (Figure 2).

Figure 2. Removable partial denture of polyamide combined with metal

Comparative properties of thermoplastic acetal and polyamide, the two types of resins suitable for manufacturing removable partial dentures, are shown in Table 2.

Resin type	Main substance	Resistance	Durity	Flexibility	Esthetics	Biocompatibility
Acetalic resin	polioximetylen	very good	very high	medium	good	very good
Polyamidic resin	diamine	good	high	medium or very high	very good	very good

Table 2. Comparative aspects of acetalic and polyamidic thermoplastic resins

2.3. Thermoplastic polyester

Thermoplastic polyester resins are also used in dentistry. They melt between 230°C and 290°C and the technology implies casting into molds. Polycarbonate resins are particularly polyester materials. They have good fracture strength and flexibility, but the wear resistance is lower than acetal resins. Polycarbonates have a natural translucency and finishes very well, which recommends them for temporary restorations, but they are not suitable for partial denture frameworks [22].

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2.4. Thermoplastic acrylate

Thermoplastic acrylate consists of fully polymerized 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 manufacturing complete 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. Due to the absence of residual monomer its biocompatibility is very good. The denture has very good long-term adaptability because water retention is limited. You can bounce such denture off the floor without cracking the base [7, 21, 23].

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2.5. Presentation form and injection

Thermoplastic materials can be polymerized or prepolymerized and they can be found in granular form, with low molecular weight, already wrapped in cartridges that eliminate dosage errors (Figure 3).

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a. b. c.

Figure 3. (a, b) Cartridges of different thermoplastic resins (c) The granular aspect of the material

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They exhibit a high rigidity despite their low molecular weight. Their plasticizing temperature is low (200°C-250°C). Thermal plasticization takes place in special devices afterward the material is injected under pressure into a mold, without any chemical reactions. After heating, the metallic cartridges containing thermoplastic grains are set in place into the injecting unit and the plasticized resin is forced into the mold at a pressure of 6-8 bars. Pressure, temperature and injecting time are automatically controlled by the injecting unit. Dentures obtained using this technology have excellent esthetics and good compatibility [7, 12, 13, 22].

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Figure 4. (a) The Polyapress injection-molding device (Bredent) (b) The R-3C injector (Flexite)

3. Prosthetic devices made of thermoplastic resins

The main characteristics of thermoplastic resins used in dentistry are as follows: they are monomer-free and consequently nontoxic and nonallergenic, they are injected by using special devices, they are biocompatible, they have enhanced esthetics and they are comfortable to wear.

Our experience with thermoplastic resins for dental use involves solving several different cases of partial edentations, with removable partial dentures without metallic framework, or combining the metallic framework with thermoplastic resin saddles, using different thermoplastic resins, selected according to their indications and manufacturing technology (Figure 5).

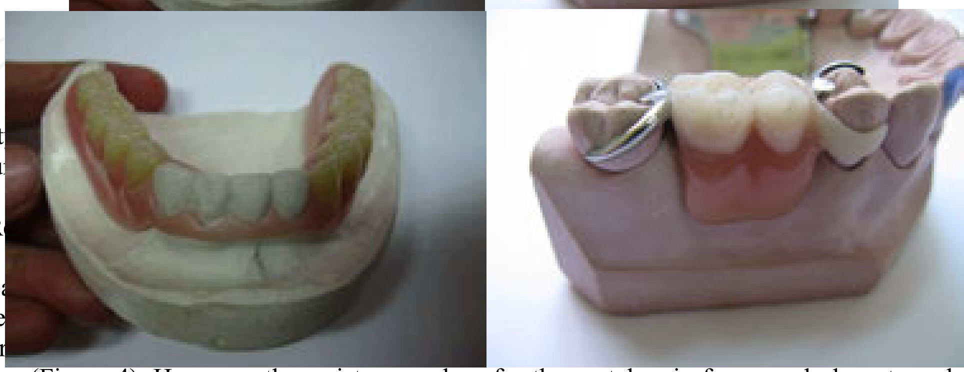

Figure 5. Different combinations between thermoplastic resins, with or without metal

The types of thermoplastic resins we used for manufacturing different types of removable partial dentures are acetal resins and polyamides of different flexibilities.

3.1 Removable partial dentures with acetal framework

The acetal resin has optimal physical and chemical properties and it is indicated in making frameworks and clasps for removable partial dentures, being available in tooth color and pink [12]. Experimentally, in some cases, we combined an acetal resin frames with classic acrylic resins for the saddles (Figure 4). However, the resistance values for the acetal resin framework do not reach those of a metal one [16], consequently the main connector, the clasps and the spurs need to be oversized

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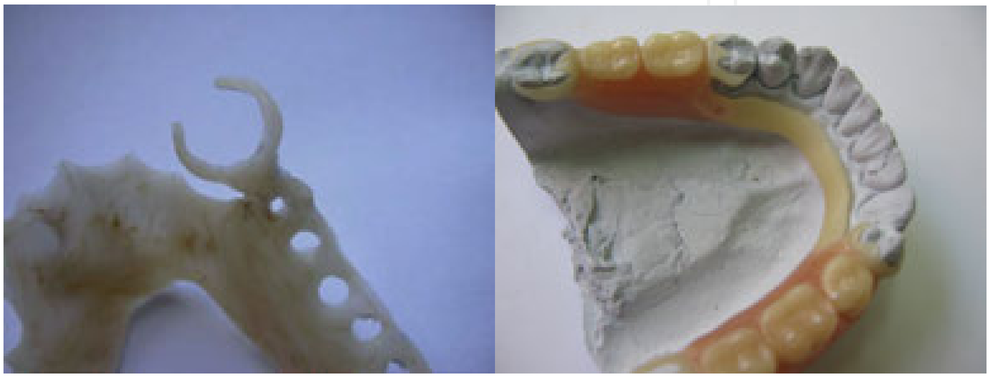

Figure 6. Acetal framework and clasp and removable partial dentures with acetal framework and clasps

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Figure 7. Casting the master model

In order to assess its ... arms of the clasp are placed a parallelograph analysis is made (Figure 8). The abutment teeth are selected and the position of the cast is chosen and recorded so that a favorable path of insertion is obtained. To record the position of the cast tripod marks are used. The contour heights on the abutment teeth and the retentive muco-osseous tissues are marked. The abutments undercuts are measured and the engagement of the terminal third of the retentive arms of the clasps is established.

After the parallelograph analysis is carried out, the future frame design is drawn, including all extensions of saddles, major connector, retentive and bracing arms of the clasps, occlusal rests and minor connectors of Ackers circumferential clasps on abutment teeth. The design starts with the saddles, following the main connector, the retentive and opposing clasp arms, the spurs and the secondary connectors of the Ackers circular clasps [12, 13].

In order to assess its retentiveness and to determine the place where the active arms of the clasp are placed a parallelograph analysis is made (Figure 8). The abutment teeth are selected and the position of the cast is chosen and recorded so that a favorable path of insertion is obtained. To record the position of the cast tripod marks are used. The contour heights on the abutment teeth and the retentive muco-osseous tissues are marked. The abutments undercuts are measured and the engagement of the terminal third of the retentive arms of the clasps is established.

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After designing the framework, the master model is prepared for duplication, including foliation and deretentivisation (Figure 9). At the beginning, blue wax plates are used as spacers in regions where the framework has to be spaced from the gingival tissue [12].

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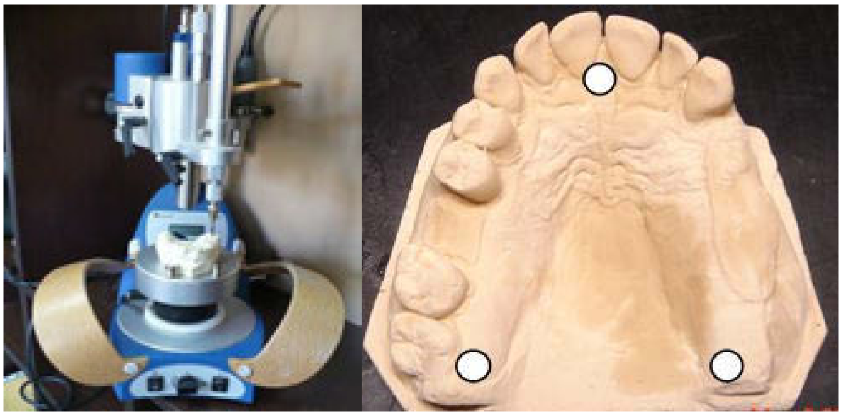

Figure 8. Parallelograph analysis

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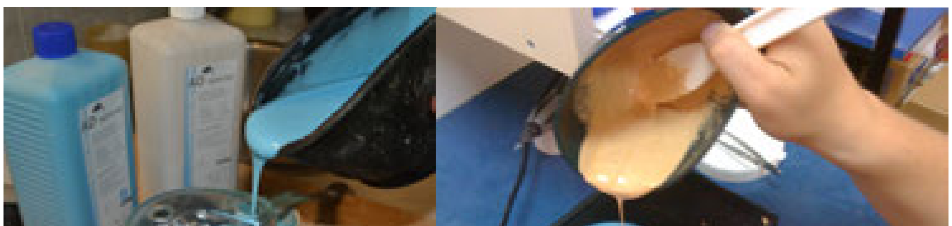
Block-out wax is applied between teeth cervices and gingival margin of the drawing representing the clasps arms. The block-out wax meets the spacing wax in a smooth joint.

Figure 9. Deretentivisation of the model

In order to duplicate the master model, a vinyl-polysiloxane silicone placed in a flask is used. After its setting, the duplicate model is poured (Figure 10), using class IV hard plaster.



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a. b.

Figure 10. (a) Duplication of the model (b) Casting of the duplicate model using class IV hard plaster

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The elements of removable partial denture's wax pattern are as follows (Figure 11a): the main connector, made of red wax (so that its thickness is twice as normal), the saddles and the Ackers circular clasps, made of blue wax. Injection bars are also required for those areas of the framework that are not visible in the finite piece. A large central shaft is necessary in order to connect with the main connector, through which the initial injection takes place. Unlike the pattern of a metallic framework, the patterns of the metal-free framework have to be 50% thicker (clasps, occlusal rests and main connector) [12, 13].

Spruing the framework is performed using minor sprues of 2.5 mm calibrated wax connected to one major sprue (Figure 11a).

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Figure 11. (a) Wrapping the wax pattern frame of the removable partial denture (b) Insulation of the investment

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Surface tension reducing solution is applied and the wax pattern is then invested in a vaseline insulated aluminum flask (Figure 11b). Class III hard stone is used as an investment. The gypsum paste is poured into one of the two halves of the flask and the duplicated model containing the framework pattern with sprues attached is centrally dipped base-face down. After setting, the gypsum surface is insulated and the second half of the flask is assembled. Class III hard stone is once more prepared and the flask is submerged in warm water in a thermostatic container. The two halves of the

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Injection is carried out with the R-3C (Flexite) injector (Figure 4b), which does not take up much space as it can be mounted on a wall as well. The device has the following parameters: digital control, preset programs for different types of thermoplastic resins and programs that can be individually set by the user. The pressure developed is 6-8 Bar [23].

Figure 12. Schedule of "G" program of injecting the thermoplastic material (a) Start (b) Heating (c) Injecting (d) Cooling

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Before investment removal, screws are loosened and the flask is gently disassembled (Figure 13).

Before starting injection, the valves of carbon dioxide tank are checked to make sure the injecting pressure is according to procedure demands (7.2-7.5 Bar). Preheating temperature and time are also checked (15 minutes at 220°C). The selected cartridge (quantity and color) is

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introduced ... n activated (Figure 12) ... d fastened. Early asser ... might occur inside the ... he flask is inserted ar...

The injecti ... key on the control pa ... hat setting contractior ... creen. The cartridge is separated and the flask is then released and pulled out. In order to achieve optimal quality of the material, the flask is left to cool slowly for 8 hours [12, 13].

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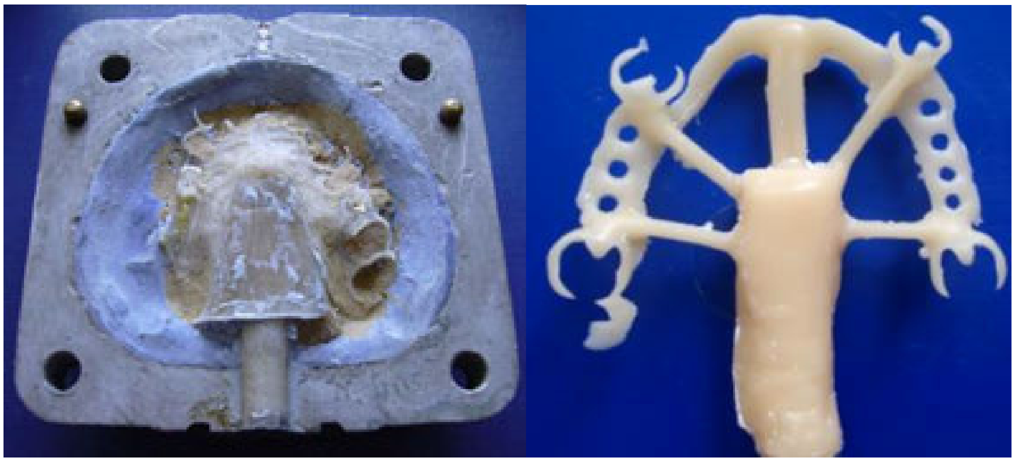

a. b.

Figure 13. Disassembling the framework of the acetal resin removable partial denture (a) The framework is still in the flask (b) Disassembling is complete

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The sprues are cut off using low-pressure carbide and diamond burs to avoid overheating the material. Finishing and polishing is performed using soft brushes, ragwheel and polishing paste (Figure 14).

Disassembling the framework of the future removable partial denture is followed by matching it to the model, processing and finishing this component of the removable partial denture (Figure 15).

Once the framework is ready, the artificial teeth are set up. Wax patterns of the saddles are constructed by dropping pink wax over the framework. Teeth set up starts with the most mesial tooth, which is polished until it esthetically fits onto the arch [24].

After properly setting of all the teeth are the wax pattern is invested in order to obtain the acrylic saddles. An impression of the wax pattern placed on the master model is made by using a putty condensation silicone.

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a. b. c.

Figure 14. (a) Tools used for processing the acetal framework (b) Tools used for finishing and polishing the acetal framework (c) Special polishing paste

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a. b.

Figure 15. (a) Matching the acetal framework to the model (b) The finished acetal framework

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After properly setting of all the teeth are the wax pattern is invested in order to obtain the acrylic saddles. An impression of the wax pattern placed on the master model is made by using a putty condensation silicone.

After setting, the impression is detached, wax is removed, and the teeth, framework and the master model are thoroughly cleaned. Openings are being cut on the lateral sides of the impression and the teeth are set in the corresponding places inside the impression [13]. After insulating the master model, the framework is placed and the impression set in its original place. The acrylic component of the denture is wrapped as usual, using rectangular flasks and a class II plaster (Figure 16a).

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Self-curing acrylic resin is prepared and poured inside the impression through the lateral openings. The cast is introduced into a heat-pressure curing unit setting a temperature of 50°C and a pressure of 6 bars for 10 minutes to avoid bubble development. Once the resin is cured, the impression is removed [12, 13]. Burs, brushes, ragwheels and pumice are used to remove the excess, to polish and finish the removable partial denture (Figure 16b).

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a. b.

Figure 16. (a) Wrapped wax pattern with teeth (b) Partial dentures made of acetal resin and acrylic resin

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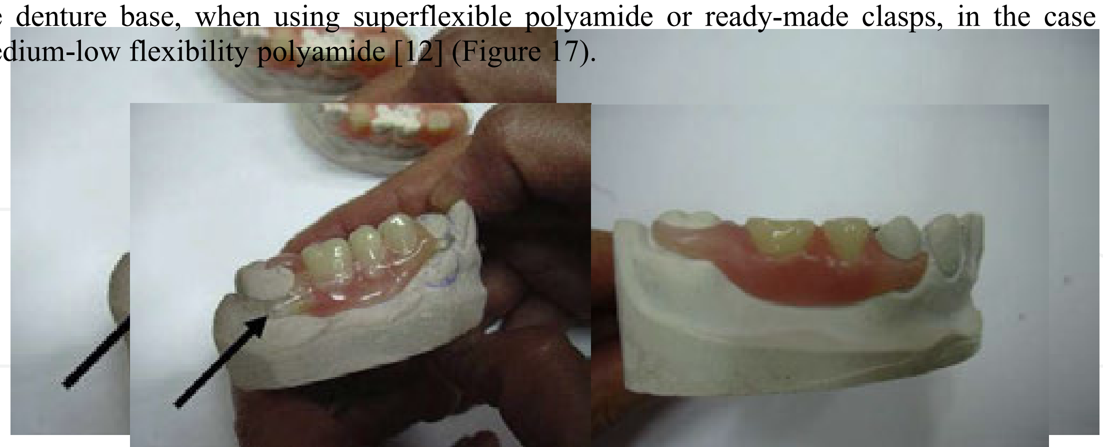
The result is a consistent removable partial denture with no macroscopic deficiency even in the thinnest 0.3-0.5 mm areas of clasps, which means the technology is effective.

3.2 Removable partial dentures made of different types of polyamides

Making polyamide resin removable partial dentures does not require so many intermediary steps as those made of acetal resins. The steps are similar to those followed for acrylic dentures, but with thermoplastic materials the injecting procedure is used. The clasps are made of the same material as the denture base, when using superflexible polyamide or ready-made clasps, in the case of using medium-low flexibility polyamide [12] (Figure 17).



a. b.

Figure 17. Polyamide removable partial denture with (a) pre-formed clasps (b) clasps made of the same material as the denture base

Using flexible polyamide is indicated in cases of retentive dental fields (Figure 18).

When manufacturing polyamidic dentures, the support elements blend in with the rest of the denture, as they are made of the same material [25, 26].

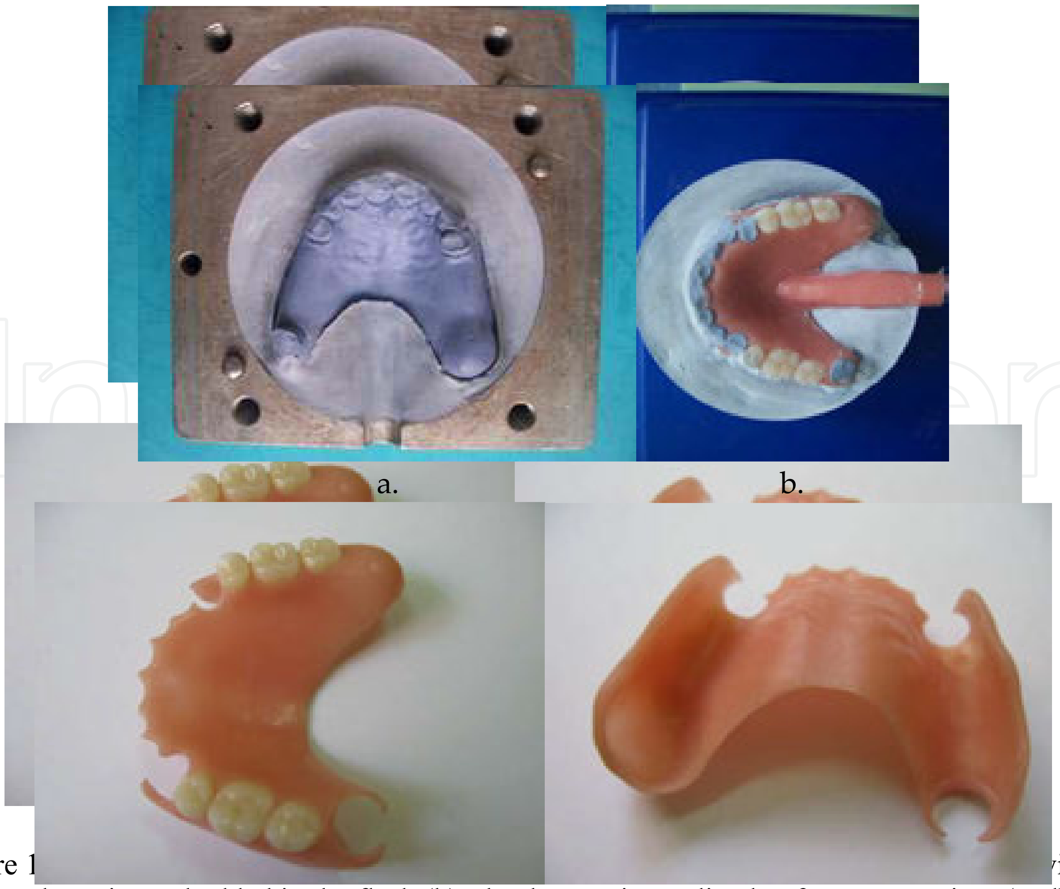


Figure 18. Removable partial dentures made of a super-flexible polyamide (a) The model with retentive tuberosity embedded in the flask (b) The denture immediately after unwrapping (c, d) The flexible removable partial denture

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Figure 19. Medium-low flexibility thermoplastic polyamide denture

The superflexible polyamide resin is extremely elastic, virtually unbreakable, monomer-free, lightweight and impervious to oral fluids (Figures 18, 20, 21). The medium-low flexibility polyamide is a half-soft material mainly indicated for removable partial dentures. It offers superior comfort, good esthetics and no metallic taste (Figures 19 and 20). Polishing and adjusting is easy, it can be added to or relined in both dental practice and laboratory. In certain cases we used preformed clasps made of nylon. These clasps have the same composition as the polyamidic resin used for denture

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a. b.

a. b.

Figure 20. (a) Medium-low flexibility polyamide partial dentures (b) Superflexible polyamide partial dentures

Figure 20. (a) Medium-low flexibility polyamide partial dentures (b) Superflexible polyamide partial dentures

a. b.

Figure 20. (a) Medium-low flexibility polyamide partial dentures (b) Superflexible polyamide partial dentures

Figure 21. (a) The superflexible polyamide denture (b) The final flexibility test

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3.3 Kemeny-type removable partial dentures made of acetal

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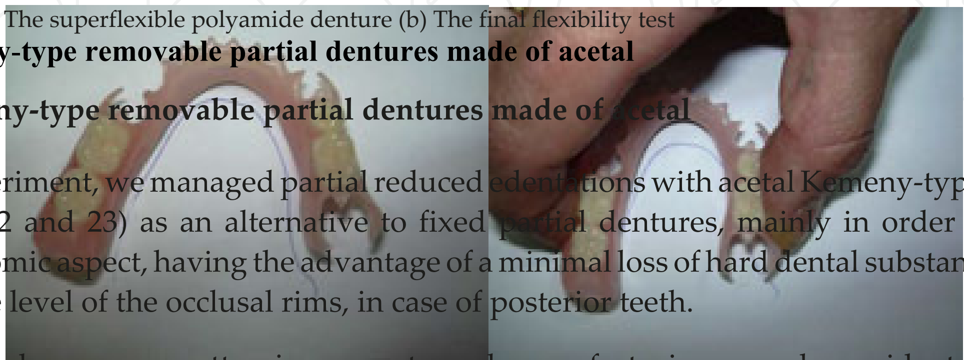

a. b.

As an experiment, we managed partial reduced edentations with acetal Kemeny-type dentures (Figures 22 and 23) as an alternative to fixed partial dentures, mainly in order to test the physiognomic aspect, having the advantage of a minimal loss of hard dental substance, located only at the level of the occlusal rims, in case of posterior teeth.

Figure 22 shows wax patterning aspects and manufacturing a molar unidental Kemeny denture of acetal resin, while Figure 23 shows the way in which a frontal bidental edentation can be managed. The effectiveness of the technology is ensured by making artificial teeth of the same material.

Figure 21. (a) The superflexible polyamide denture (b) The final flexibility test

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Figure 22 shows wax patterning aspects and manufacturing a molar unidental Kemeny denture of acetal resin, while Figure 23 shows the way in which a frontal bidental edentation can be managed.

The effectiveness of the technology is ensured by making artificial teeth of the same material.

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 [12,23,27].

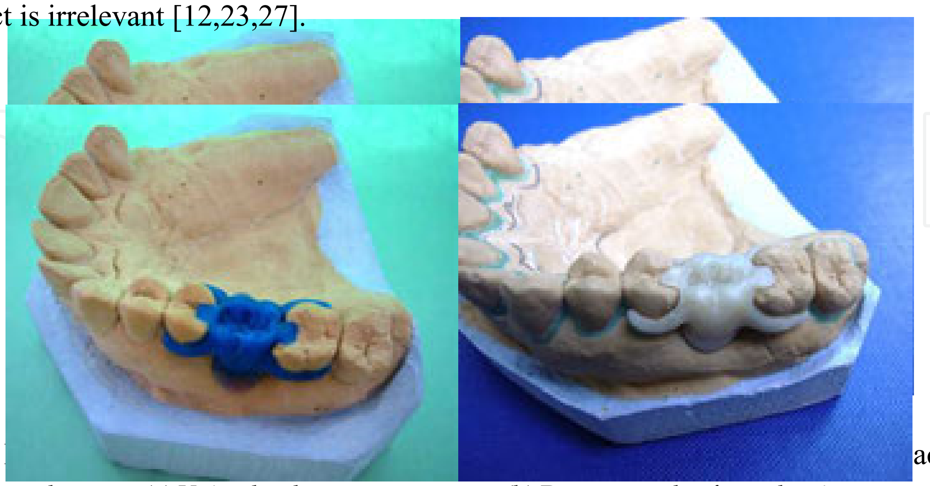

Figure 22. Kemeny dentures: (a) Unimolar denture wax pattern (b) Denture made of acetal resin

Figure 22. Kemeny dentures: (a) Unimolar denture wax pattern (b) Denture made of acetal resin

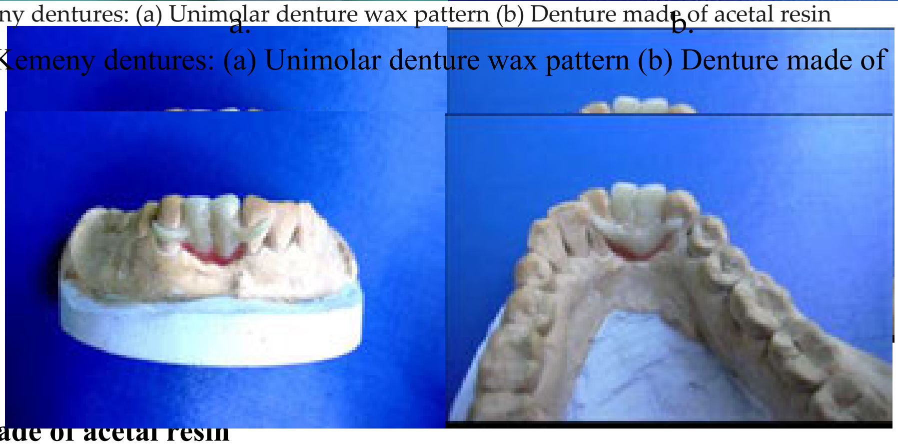

Figure 23. Kemeny-type frontal denture

Figure 23. Kemeny-type frontal denture

3.4. Splints made of acetal resin

3.4 Splints made of acetal resin

Thermoplastic resins are also indicated for manufacturing antisnoring devices, different types of mouthguards and splints. Parodonthotic teeth after surgery need immobilization. We experimentally manufactured acetalic resin splints (Figure 24) which turned out to be a viable solution because it matches the color of the teeth and thereby represents a temporary postoperative esthetic choice [18, 23].

3.5. Mouth guards

Mouth guards are dental appliances that can be manufactured using thermoplastic resins. The most satisfactory mouth protectors are custom-made mouth guards. This type of mouth guards is designed by the dentist. They adapt well and provide good retention and comfort. Being custom-made they interfere the least with speaking and have virtually no effect on breathing

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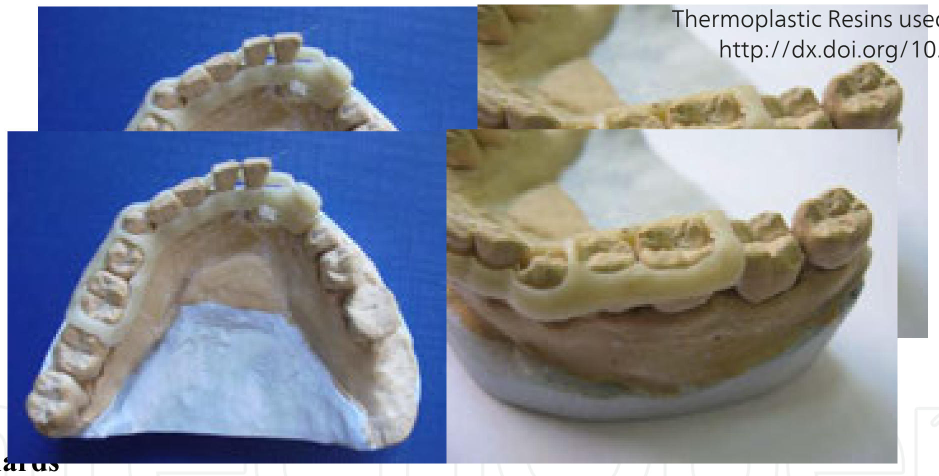

Figure 24. Thermoplastic acetal splint

3.5 Mouth guards

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The most satisfactory mouth protectors are custom-made mouth guards. This type of mouth guards is designed by the dentist. They adapt well and provide good retention and comfort. Being custom-made they interfere the least with speaking and have virtually no effect on breathing [28]. Custom-made mouth guards may be classified into two types: the vacuum mouth guard and the pressure-laminated mouth guard.

The vacuum mouth guard is manufactured using a model of the upper arch. The model is casted using an impression. The thermoplastic mouth guard material, usually a polyethylene vinyl acetate (EVA) copolymer, is adapted over the model with a special vacuum machine. The vacuum mouth guard is then trimmed and polished to allow for proper tooth and gum adaptation. All posterior teeth should be covered and muscle attachments should be unimpinged. Using a vacuum machine single-layer mouth guards are manufactured. More and more, multi- ple-layer mouth guards (laboratory pressure-laminated) are preferred to the single-layer vacuum ones. The laboratory pressure-laminated mouth guard, also made from a stone cast, is a custom-made multiple-layered mouth guard that is considered the state-of-the-art mouth guard in for years. It can be made by laminating two or three layers of material to achieve the necessary thickness. Lamination is defined as the layering of mouth guard material using high heat and pressure machines. The mouth guard material should be biocompatible, have good physical properties, and last for at least 2 years [29].

We manufactured laminated custom-made mouth guards for 3 layers, with the inner layer made of a thermoplastic polyurethane which increases discoloration resistance and creates a soft inner surface feel (Figure 25).

Figure 25. Laminating the custom-made mouth guard. Custom made mouth guard

3.6 Myofunctional therapy devices

3.6. Myofunctional therapy devices

Controlling dentofacial growth interferences is an important issue. The negative effects of mouth breathing, abnormal lip and tongue function and incorrect swallowing patterns on craniofacial development in the mixed dentition period is well known. Correcting these myofunctional habits improves craniofacial growth and decreases the severity of malocclusion [12].

Myofunctional therapy retrains the muscles of swallowing, synchronizes the swallowing movements obtaining a normal resting posture of the tongue, lips, and jaw. Myofunctional therapy may be rescheduled before, during or after orthodontic treatment [30]. The most typical age range for this type of therapy is between 8 and 16 years.

The main objective of the myofunctional appliances is to eliminate oral dysfunction and to establish muscular balance. These appliances play a certain role in orthodontics because they are simple and economical. The selection of the cases needs to be thorough and the specialist needs to be well trained in their use.

The universal size products, suitable for children between 6 and 11 years old (mixed dentition stage), allow implementing the orthodontic treatment earlier and at lower cost. These are made of a flexible thermoplastic silicone polycarbonate-urethane, a ground-breaking copolymer that combines the biocompatibility and biostability of conventional silicone elastomers with the processability and toughness of thermoplastic polycarbonate-urethanes. This type of appliances has good in vitro and in vivo stability. Its strength is comparable to traditional polycarbonate-urethanes, and the biostability is due to the silicone soft segment and end groups. Various fabrication techniques may be used in order to obtain to different. Additional surface processing after fabrication is not needed [12].

4. Errors in manufacturing thermoplastic resins dentures

Errors might occur when manufacturing thermoplastic resins dentures: the insufficient pressure at injection, which leads to lack of substance, poor polishing, or too thick saddles being some of the causes (Figure 26). These errors lead to deficiencies of the denture, which might be unusable because of esthetic deficiencies, occlusal dysmorphia, exaggerated elasticity, and decubitus areas [31].

5. Conclusions

Thermoplastics used in dentistry have known a great diversification in the last years. Processing principles are similar to the injecting technology of chemoplastics, the main difference consisting in their chemical composition, liquefying temperature of grains, injecting pressure and the fact that thermoplastic resins are monocomponent.

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a. b.

Figure 26. Errors that might occur when manufacturing dentures from thermoplastic resins (a) Lack of substance (b) Poor polishing

Figure 26. Errors that might occur when manufacturing dentures from thermoplastic resins (a) Lack of substance (b) Poor polishing

5. Conclusions

Thermoplastics used in dentistry have known a great diversification in the last years. Processing principles are similar to the injecting technology of chemoplastics, the main difference consisting in their chemical composition, liquefying temperature of grains, injecting pressure and the fact that thermoplastic resins are monocomponent.

Processing technology is based on the thermal plasticization of the material, in the absence of any chemical reaction. The technology of injection molding is not widely used in dental technique labs, yet, as it requires special devices, but has opened new perspectives in the technology of total and partial removable dentures.

Solving partial edentations with metal-free removable partial dentures represents a modern alternative solution to classical metal framework dentures, having the advantage of being lightweight, flexible and much more comfortable for the patient. Metal-free removable partial dentures made of thermoplastic materials are biocompatible, nonirritant, sure, nontoxic, biologically inert, with superior esthetics, which make them rapidly integrate in dentomaxillary structure. They offer quality static and dynamic stability.

The clasps are made of the same material as the denture base or ready-made clasps from the same material may be used. Where the mechanical resistance of the structure comes first, the choice is an acetal resin for making the framework. Superflexible polyamide resin is especially indicated for retentive dental fields, which would normally create problems with the insertion and disinsertion of the removable partial dentures. The removable partial dentures with acetal resin frame are the most laborious to manufacture, requiring most working steps. Manufacturing the acetal framework is first, followed by the acrylic saddles and artificial teeth. A removable partial denture with an acetal resin frame is rapidly integrated into the dentomaxillary system and accepted by the patient. Such a removable denture is a comfortable solution for the partial edentulous patient, achieving the principles of static and dynamic maintenance and stability. These types of partial dentures are not bulky, the frameworks being 0.3-0.5 mm thin, and clasps are flexible and esthetic.

A particular advantage of a removable partial denture made of acetal resin applies to patients with large oral defects as a result of a maxillectomy procedure, who are due to have postoperative radiotherapy and need to have the density of the defect restored to ensure standardized radiation distribution. Different types of boluses may be used for restoration but a stent is usually needed as a support. Traditional metal-clasp retained stents are discarded in such cases as the clasps cause backscatter of the radiation beams. Acetal resin is a radiolucent material suitable for making a stent with clasps or even a removable partial denture to retain the bolus.

In the case of Kemeny-type acetalic dentures, the artificial teeth are made of the same material and in the same step as the rest of the denture. Because it is not translucent, its first indication is lateral edentations but it can be used for short periods, in the frontal area as well, if short-term esthetic aspect is not important.

Thermoplastic resins have several advantages: long-term performance, stability, resistance to deformation, resistance to wear, excellent tolerance, resistance to solvents, absence or low quantity of allergy-inducing residual monomer, and lack of porosity, thus preventing the development of microorganisms and deposits, all of which, together with maintaining size and color in time are very important characteristics, presenting a high degree of flexibility and resistance, permitting the addition of elastomers for increased elasticity or reinforcement with fiberglass, in order to increase their physical splinter quality; some of them can also be repaired or rebased.

The advantages of using the molding-injection system lay in the fact that the resin is delivered in a cartridge, thus excluding mixture errors with long-term shape stability, reduces contraction, and gives mechanical resistance to ageing.

As this class of materials, as well as the processing devices, has been continuously perfected, their future applicability in dental medicine will keep spreading.

Most probably, further chemical development of elastomeric and polymeric materials will enlarge the domain of clinical applications of thermoplastics in dentistry.

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