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Manufacture of Different Types of Thermoplastic

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1. Introduction

The development of resins represented a great step forward in dental technique, the first thermopolymerisable acrylic resins being developed in 1936. Acrylic resins are better known as poly(methyl methacrylate) or PMMA. They are synthetically obtained materials that can be modelled, packed or injected into molds during an initial plastic phase which solidify through a chemical reaction-polymerisation (Phoenix et al., 2004). However, the disadvantages of thermopolymerisable acrylic resins, connected to increased porosity, high water retention, volume variations and irritating effect of the residual monomer (organic solvent, hepatotoxic), awkward wrapping system, difficult processing, together with the polymer development, have led to alternative materials such as polyamides (nylon), acetal resins, epoxy resins, polystyrene, polycarbonate resins etc. (Negrutiu et al., 2001).

Thermoplastic resins have been used in dental medicine for fifty years. In the meantime, their use has spread due to their superior characteristics. Their ongoing development has yielded new classes of more and more advanced materials and technologies, which make possible the manufacturing of dentures with better splinting properties then traditional dentures.

2. Thermoplastic resins used in dentistry

The classification of resins according to DIN EN ISO–1567 comprises:

From the point of view of their composition, as far as thermoplastic resins are concerned, we can distinguish among: acetal resins, polycarbonate resins (belonging to the group of polyester resins), acrylic resins, polyamides (nylons).

Usage of thermoplastic resins in dental medicine has significantly grown in the last decade. The technology is based on plasticising the material using only thermal processing in the absence of any chemical reaction. The possibility of injecting the plasticized resin into a mold has opened a new perspective to full denture and removable partial denture technology.

Successive alterations to the chemical composition led to the diversification of their range of application, so that at present thermoplastic materials are suitable for the manufacturing of removable partial dentures which totally or partially eliminate the metallic component, resulting in the so-called "metal-free removable partial dentures" (Bortun et al., 2006).

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. The classification of resins according to DIN EN ISO–1567

Indications for thermoplastic resins include: partial dentures, preformed clasps, partial denture frameworks, temporary or provisional crowns and bridges, full dentures, orthodontic appliances, myofunctional therapy devices, anti-snoring devices, different types of mouthguards and splints.

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 (Arikan et al., 2005).

Acetal resin is very strong, resists wear and fracturing, and it's 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 and implant abutments, partial denture frameworks, artificial teeth for removable dentures, orthodontic appliances.

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 (Ozkan et al., 2005).

2.2 Thermoplastic polyamide (nylon)

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 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.

They are used primarily for tissue supported removable dentures because their stiffness makes them unsuitable for usage as occlusal rests or denture parts that need to be rigid. 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 (Donovan & Cho, 2003).

Resin type	Main substance	Resistance	Durity	Flexibility	Esthetics	Biocompati-bility
Acetalic resin	Polioxime tylen	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

Table 2. Comparative aspects of acetalic and polyamidic thermoplastic resins

2.3 Thermoplastic polyester

Another group of thermoplastic materials used in dentistry are polyester resins. These resins melt between 230-290°C and the technology implies casting into molds.

Polycarbonate resins are particular polyester materials. They exhibit fracture strength and flexibility, but the wear resistance is lower when compared to acetal resins. However, polycarbonates have a natural translucency and finishes very well, which make them proper for producing temporary restorations. They are not suitable for partial denture frameworks (Negrutiu et al., 2005).

At present, there are several manufacturers that provide thermoplastic materials for dental use: The Flexite Company, Valplast Int. Corp., Girrbach Dental, Bredent, Dentsply, DR Dental Resource Inc., If Dental-Pressing Dental etc.

(a) (b)

(c)

Fig. 1. (a), (c) Cartridges of different thermoplastic resins, (b) The granular aspect of the material

2.4 Presentation form and injection

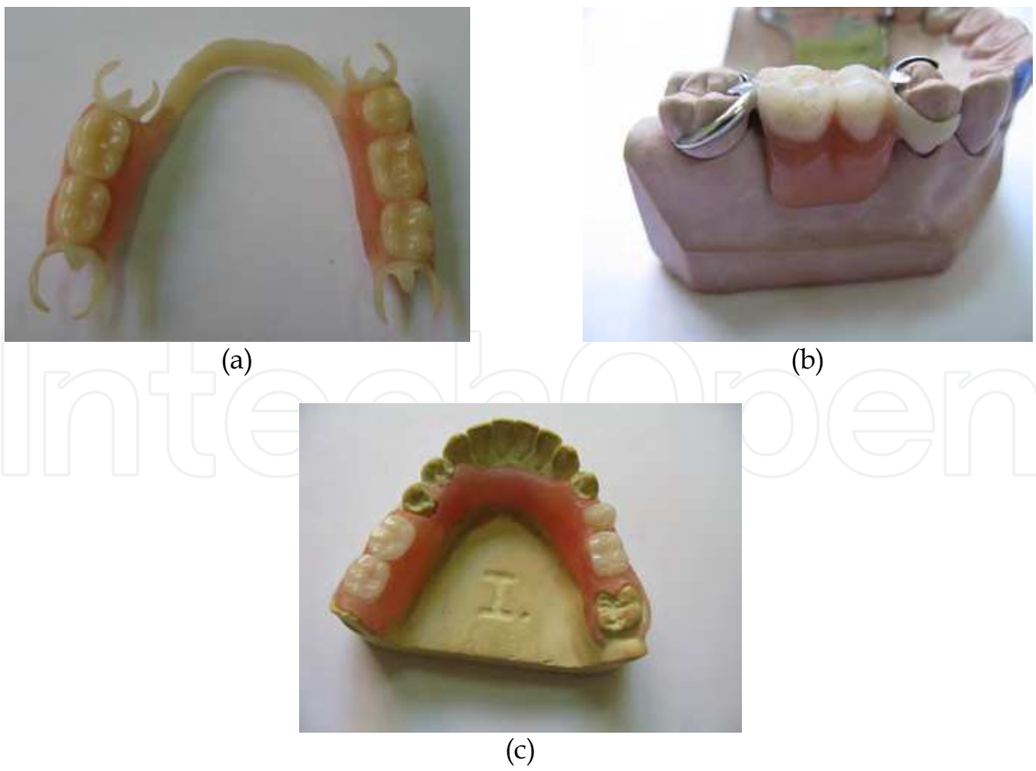
Thermoplastic materials can be polymerised or prepolymerised and they can be found in granular form, with low molecular weight, already wrapped in cartridges which eliminates dosage errors - Fig. 1.

They have a low plasticizing temperature and exhibit a high rigidity in spite of their low molecular weight. Their plasticizing temperature is 200-250°C.

After thermal plasticization in special devices, the material is injected under pressure into a mold, without any chemical reactions. The metallic cartridges containing thermoplastic grains are heated to plasticize the resin. The cartridges are set in place into the injecting unit and pressure of 6-8 barrs is used to force the plasticized resin to fill the mold. Pressure, temperature and injecting time are automatically controlled by the injecting unit. This results in compact dentures with excellent esthetics and good compatibility.

Injecting thermoplastic resins into molds is not a common technology in dental laboratories because the need of expensive equipment and this could be a disadvantage.

We will describe the manufacturing process of metal-free removable partial dentures made off several thermoplastic resins in different cases of partial edentations, with removable partial dentures without metallic frame, or combining the metallic frame with thermoplastic resin saddles, selected according to the requirements of the indications and manufacturing technology- Fig. 2.



(a) (b)

(c)

Fig. 2. Different combinations between thermoplastic resins. (a), (c) Without metal, (b) With metal

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

The special injection devices we use are Polyapress (Bredent) and R-3C (Flexite) injectors-Fig. 3.

(a) (b)

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

3. Manufacture technology for acetal-resin dentures

The acetal resin 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 in pink.

The denture acetal resin framework was combined with the use of acrylic resins at saddle level (Fig. 2). 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. Injection was carried out using the R-3 C digital control device that has five preset programmes, as well as programmes that can be individually set by the user.

The maintenance, support and stabilizing systems used are those with metal-free, Ackers circular clasps, chosen according to the median line of the abutment teeth and the insertion axis of the denture.

The significant aspects of the technical steps in the technology of removable partial dentures made of thermoplastic materials are described.

3.1 The working model

The working model is poured of class IV hard plaster, using a vibrating table, in two copies (Fig. 4), as one of the models gets deteriorated when the acetal component of the denture is dismantled.

Fig. 4. Casting the working model

3.2 Parallelograph analysis and framework design

The model is analyzed by parallelograph in order to assess its retentiveness and to determine the place where the active arms of the clasp are placed-Fig. 5.

The abutment teeth were selected and the position of the cast was chosen and recorded so that a favourable path of insertion was obtained.

Tripod marks were used to record the position of the cast. Carbon graphite rod was used to mark the heights of contour on the abutment teeth and the retentive muco-osseous tissues. Undercut gauges were used to measure the abutments undercuts. Engagement of the terminal third of the retentive arms of the clasps was established at 0.25 mm below the greatest convexities for each abutment.

After the parallelograph analysis was carried out, a soft tip black pencil was used to draw the future framework design on the model. The design included all extensions of saddles, major connector, retentive and bracing arms of the clasps, occlusal rests and minor connectors of Akers circumferential clasps on abutment teeth.

The design starts with the saddles, following the main connector, the retentive and opposing clasp arms, the spurs and secondary connectors of the Ackers circular clasps.

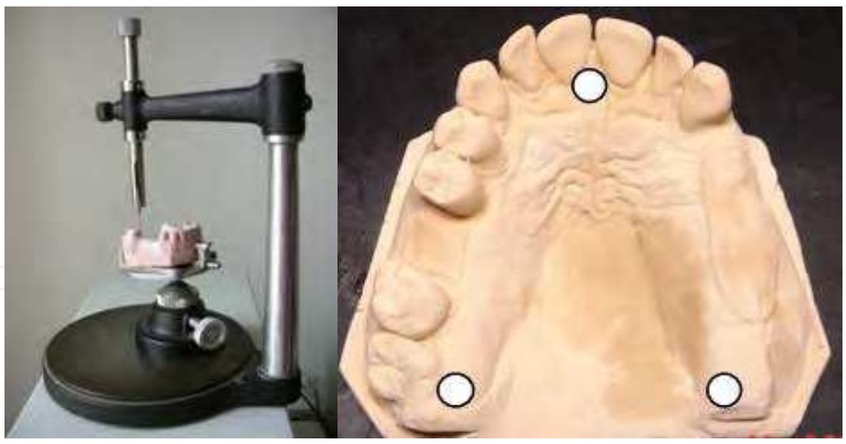


Fig. 5. Parallelograph analysis

3.3 Duplication of the master model

After designing the framework, the master model is prepared for duplication, including foliation and deretentivisation (Fig. 6). At the beginning, blue wax plates are used as spacers in regions where the framework has to be spaced from the gingival tissue. The residual ridges are covered with 1 mm thick wax along the 2/3 of the mesio-distal length and the 2/3 of the lingual slope height. The wax crosses the edge of the ridge and also covers a short portion of the buccal slope. The same thickness of the spacer is used along the mucosal region of the major connector where the wax is applied between the gingival margin and the bottom of the alveolo-lingual sulcus. A 0.3 mm wax spacer is placed along the place of minor connectors.

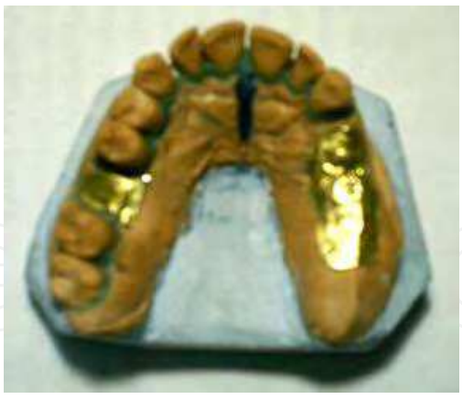


Fig. 6. Foliation and deretentivisation of the model

The next step is the block-out procedure. Block-out wax is applied between teeth cervices and gingival margin of the drawing representing the clasps arms. A smooth joint is made between block-out wax and spacing wax.

Duplication of the master cast is done in the usual manner, using a vinyl-polysiloxane silicone placed in a conformer. After the silicone bounds, the impression is taken and the duplicate model is cast (Fig. 7), using class IV hard plaster.

(a)

(b)

(c)

Fig. 7. Duplication of the model: (a) Conformer with the model placed inside, (b) Silicone impression, (c) Casting of the working model using class IV hard plaster

3.4 Wax pattern manufacturing

The wax pattern of the removable partial denture is manufactured following the profiles imprinted on the model (Fig. 8): the wax pattern of the main connector, made of red wax (so that it's thickness is twice as normal), the wax pattern of the saddles and the wax pattern of the Ackers circular clasps, made of blue wax.

Injection bars are required for the sensitive areas of the framework that are placed on the areas that are not visible in the finite piece.

A large central shaft is also 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 clasps, occlusal rests and lingual bar were made 50% thicker.

Because the wax pattern of the metal-free framework has to be 50% thicker than that of a metallic framework, pink wax is used for wax-up. In order to produce patterns of the saddles, wax plates were adapted on the cast according to the hallmarks and circular retentive holes were cut along them.

The lingual bar was made by the same wax, achieving a half-pear shape with an optimal dimension. Wax-up of the saddles and lingual bar was made using a special wax, easy to wash away, following the hallmarks. Preformed wax patterns were adapted to the hallmarks with an adhesive solution. Blue wax was used to drop wax-up the patterns of the circumferential clasps.

Once the pattern of the framework is ready, it is stabilized by sticking the margins to the cast.

3.5 Investing the wax pattern

Spruing the framework was performed using five minor sprues of 2.5 mm calibrated wax connected to one major sprue.

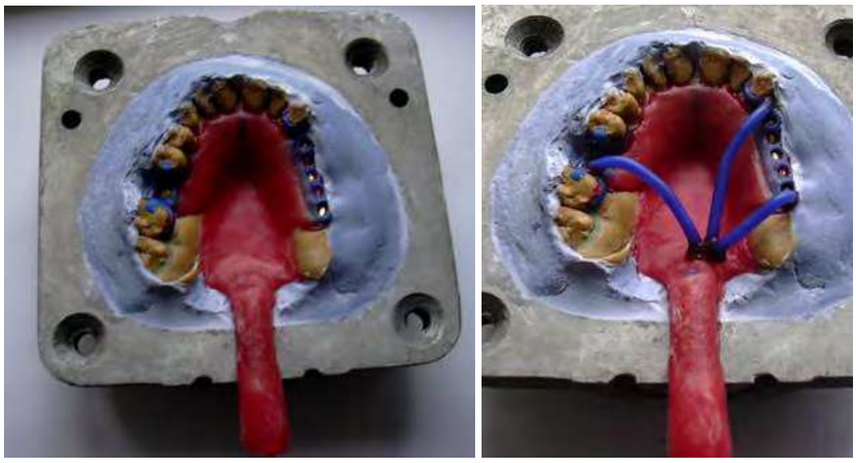


Fig. 8. Wrapping the wax pattern frame of the removable partial denture

After surface-tension reducing solution is applied to the wax pattern, it is invested in a vaseline insulated aluminum flask. Class III hard stone is used as investment. About 250 g gypsum paste is poured into one of the two halves of the flask and the duplicated cast containing the spruing of the framework pattern is centrally dipped base-face down-Fig. 9.

Fig. 9. Insulation of the investment

When the investment is set, the gypsum surface is insulated and the second half of the flask is assembled. About 400 g of the same hard stone is prepared and poured into the upper chamber of the flask, covering thoroughly the wax pattern and sprues.

After the gypsum sets the flask is submerged in warm water in a thermostatic container.

The two halves of the flask are than disassembled and the wax is boiled out using clean hot water.

The mold is then insulated using a special agent which is applied in a single layer on the gypsum surface. The surface of the mold is given a shining aspect by treating the gypsum surface with light curing transparent varnish.

3.6 Injection of the thermoplastic acetal resin framework

Injection is carried out with the R-3C (Flexite) injector-Fig. 10 a, 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 programmes for: Flexite Plus, Flexite Supreme and Flexite MP, Northerm, Proguard and programmes that can be individually set by the user. The pressure developed is 6-8 barrs.

(a) (b)

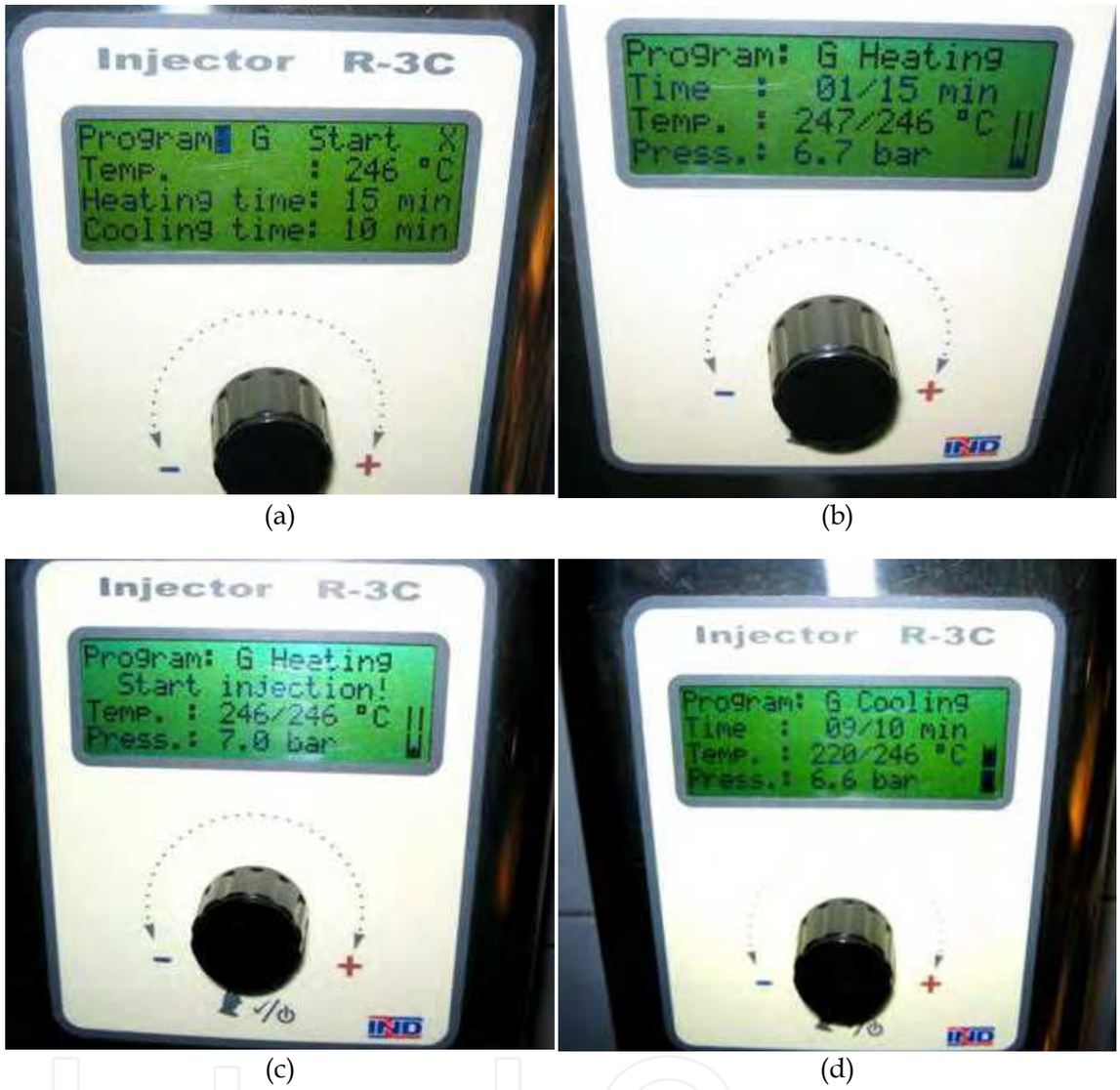
Fig. 10. (a) R-3C injector (Flexite), (b) The flask with grains of thermoplastic material and the lubricant used

Before the injection procedure, the valves of carbon dioxide tank are checked to make sure the injecting pressure was according to procedure demands (7.2-7.5 barrs). Preheating temperature and time are also checked (15 minutes at 220°C).

The corresponding cartridge of injecting material (quantity and color) is selected - Fig. 10 b. The cartridge is introduced into one of the two heating cylinders after a vaseline base lubricant has been applied at its closed end - Fig. 10 b. The cartridge membrane is pointed to the flask chamber.

The excess of silicone vaseline lubricant on the margin of the heating cylinder is wiped out using a highly absorbent paper.

Preheating process is then activated by pushing the key on the front control panel-Fig 11. When the programmed preheating time elapses, an audible signal is heard.



(a) (b)

(c) (d)

Fig. 11. Schedule of „G" program of injecting the thermoplastic material: (a) Start, (b) Heating, (c) Injecting, (d) Cooling

The two halves of the flask are assembled and fastened with screws. If the flask has been assembled earlier, water vapor condensation might have occurred inside the mold, which would have had a negative effect on the quality of the injected material.

The flask is inserted and secured in the corresponding place of the injecting unit. The opening of the flask is set in a straight line with the heating cylinder and cartridge.

The heating cylinder containing the material cartridge is brought near the flask and the injecting procedure is initiated by pressing the key on the control panel. The injection process takes 0.25 seconds. The pressure is automatically kept constant for one minute so that setting contraction is compensated. This stage is indicated with the sign "----" on the screen.

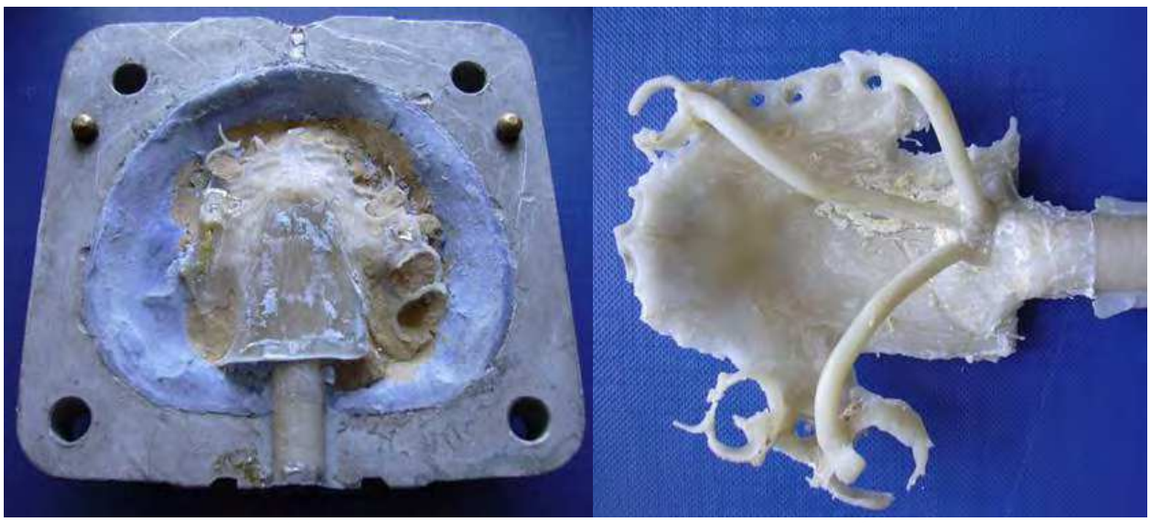
The cylinder is than moved about 3 mm away from the flask so that the cartridge could be separated using a trowel and a mallet. The flask is then released and pulled out. The used cartridge is automatically pushed out pressing the evacuation key.

In order to achieve optimal quality of the material, the flask is left to cool slowly for 8 hours.

3.7 Disassembling and finishing the acetal framework

Before investment removal, screws are loosened and the flask is gently disassembled.

The stone blocking the vents in the upper side of the flask are removed using a hook and a mallet- Fig. 12.



(a) (b)

Fig. 12. Disassembling the framework of the acetal resin removable partial denture. (a) The framework is still in the flask, (b) Disassembling is complete

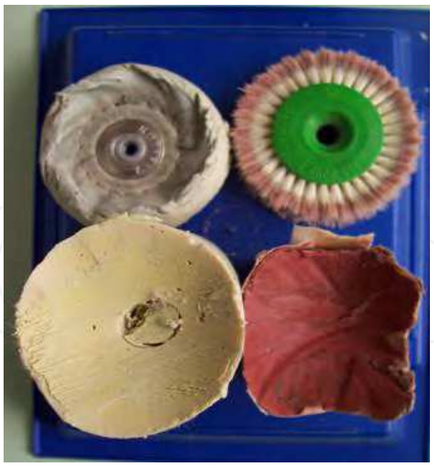
Any excess of vaseline in the injecting canal is removed so that the injected material wouldn't contain any such remains during subsequent usage.

The sprues are cut off using low-pressure carbide and diamond burs to avoid overheating the material.

Finishing and polishing was performed using soft brushes, ragwheel and polishing paste - Fig. 13.

Disassembling the frame of the future removable partial denture is followed by matching it to the model, processing and finishing this component of the framework denture - Fig. 14.

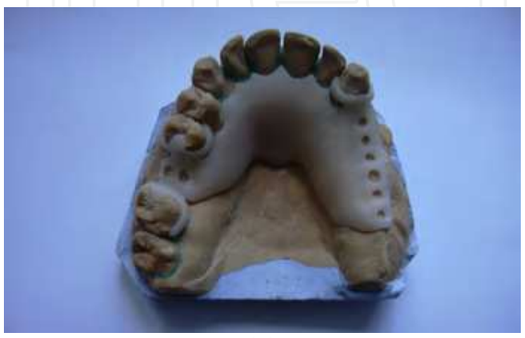
(a)



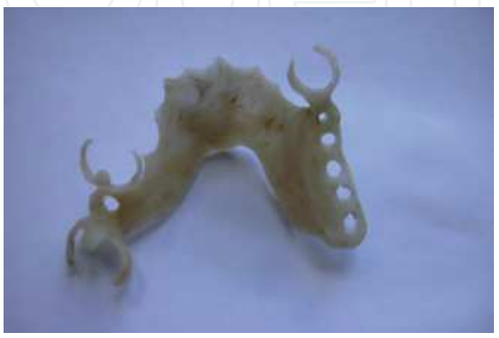
(b)

(c)

Fig. 13. (a) Tools used for processing the acetal framework, (b) Tools used for finishing and polishing the acetal framework, (c) Special polishing paste



(a)



(b)

Fig. 14. (a) Matching the acetal framework to the model, (b) The finished acetal framework

3.8 Saddle manufacturing and teeth mounting

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, set in place on the master model. The wax is extended to the bottom of the buccal and alveololingual sulci. Teeth set-up starts with the most mesial tooth, which is polished until it esthetically fits onto the arch.

When all the teeth are properly set, an investing procedure is used to turn the wax pattern into acrylic saddles. Putty condensation silicone is used to make an impression of the wax pattern placed on the master model. When silicone is set, impression is detached, wax removed, and 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. The master model is insulated. The framework is placed on the model and the impression set in its original place. The acrylic component of the denture is wrapped according to traditional methods, using rectangular flasks in which the wax pattern is embedded into class II plaster (Fig. 15 a).

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 barrs for 10 minutes to avoid bubble development. Once the resin is cured, the impression is removed. Burs, brushes, ragwheels and pumice are used to remove the excess, polish and finish the removable partial denture (Fig. 15 b).

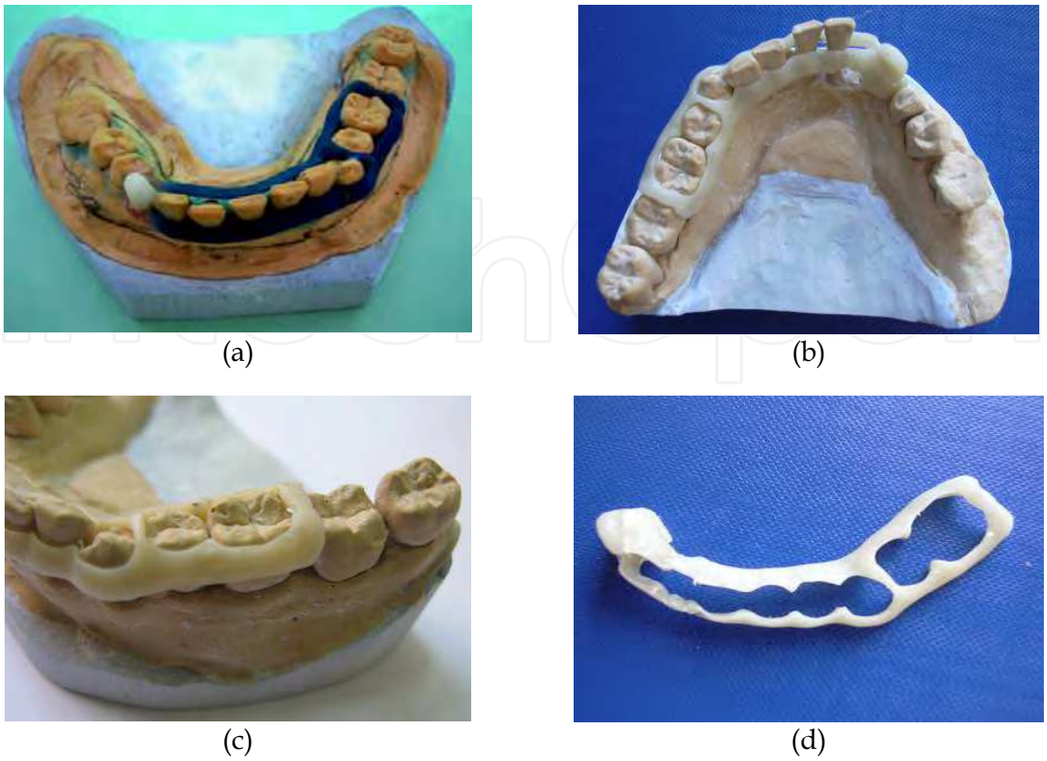
(a) (b)

Fig. 15. (a) Wrapped wax pattern with teeth, (b) Partial dentures made of acetal resin and acrylic resin

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.

4. Splints made of acetal resin

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 (Fig. 16), in order to immobilise parodonthotic teeth, after surgery, although this is not one of the main indications for the material. Due to the fact that it matches the colour of the teeth, the splint represents a temporary postoperative esthetic solution.



(a) (b)

(c) (d)

Fig. 16. The splint: (a) Wax pattern, (b) Thermoplastic acetal splint on the model, (c) Immobilisation splint made of acetal resin (d) Splint detached from the model

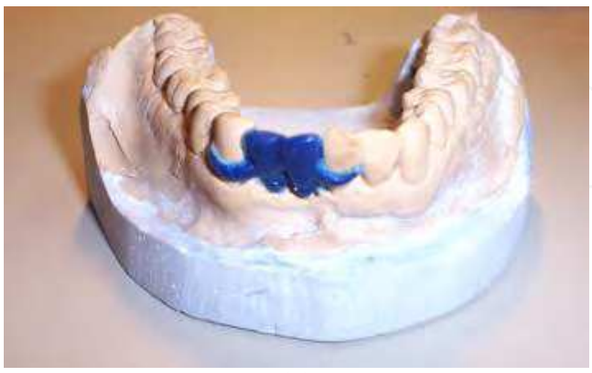
5. Acetal Kemeny-type dentures

As an experiment, in order to test the physiognomic aspect, we managed partial reduced edentations with Kemeny-type dentures (Fig. 17, 18), as an alternative to fixed partial dentures, having the advantage of a minimal loss of hard dental substance, located only at the level of the occlusal rims.

(a) (b)

Fig. 17. Kemeny dentures: (a) Unimolar denture wax pattern, (b) Denture made of acetal resin

Fig. 17 shows the way in which a molar unidental edentation can be managed, while Fig. 18 shows wax patterning aspects and manufacturing of a frontal bidental Kemeny denture made of acetal resin. The effectiveness of the technology is ensured by making artificial teeth of the same material.



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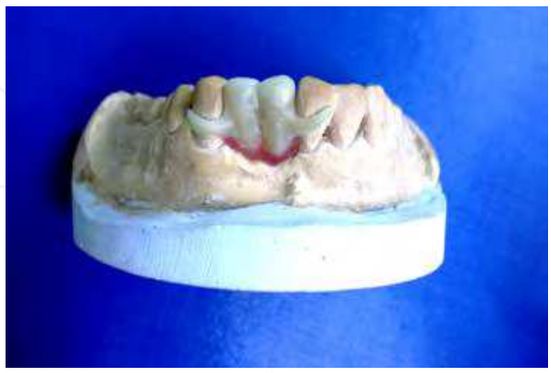

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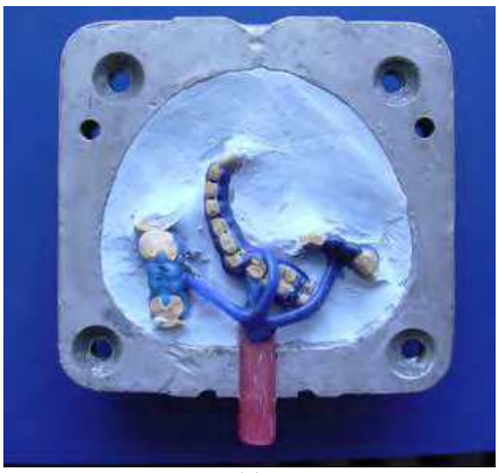


(c)

Fig. 18. (a) Frontal removable denture wax pattern, (b) Kemeny-type frontal denture, (c) Wax-patterns of the splint and Kemeny-type dentures investment system in special flask

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.

6. Manufacture technology for polyamide resins dentures

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 or we used ready-made clasps, in the case of using medium-low flexibility polyamide - Fig. 19.

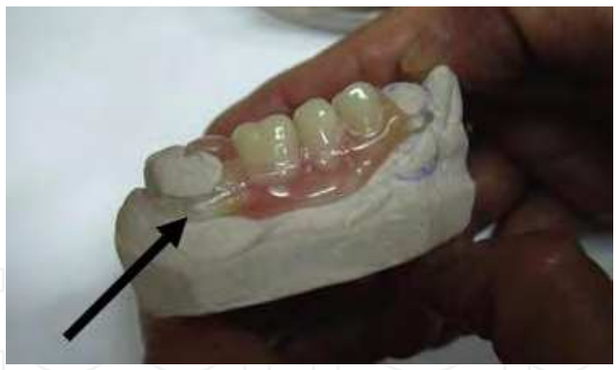
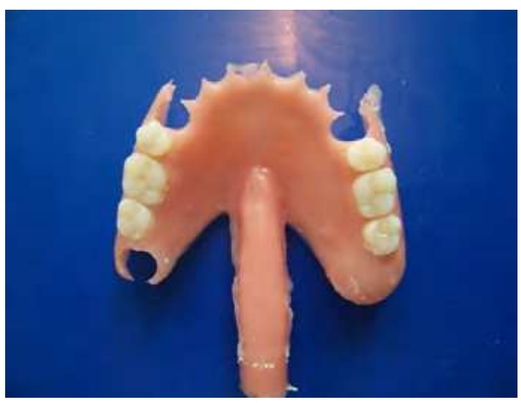


Fig. 19. Removable partial denture made of a medium-low flexibile polyamidic resin with pre-formed clasps

Using of flexible polyamide is extremely useful in cases of retentive dental fields- Fig. 20.

(a)



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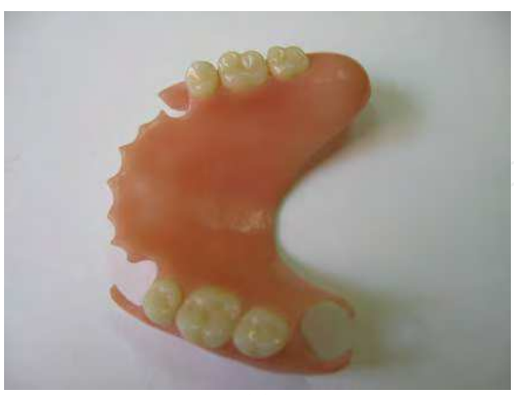

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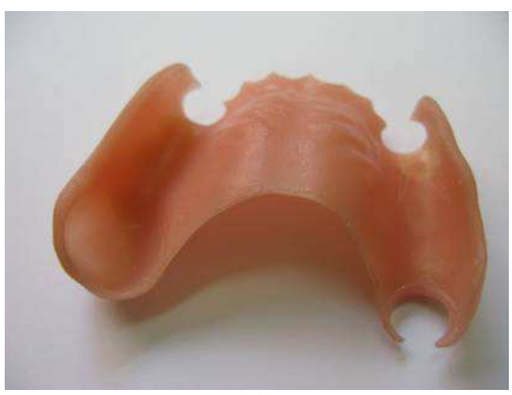


(d)

Fig. 20. 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

When manufacturing polyamidic dentures, the support elements blend in with the rest of the denture, as they are made of the same material (Szalina, 2005). - Fig. 21, 22.

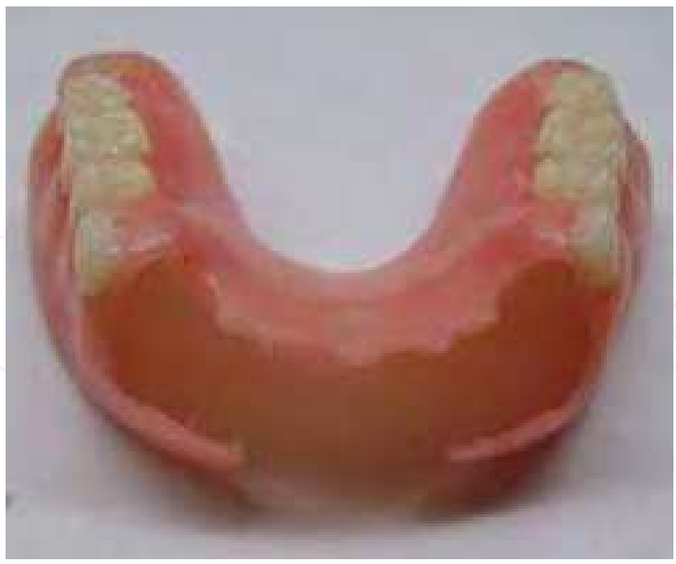


Fig. 21. Medium-low flexibility thermoplastic polyamide denture

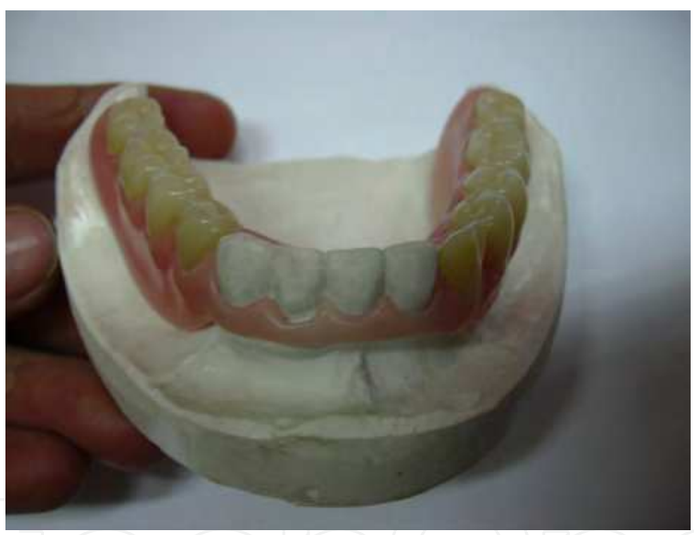


Fig. 22. Another medium-low flexibility thermoplastic polyamide denture

The superflexible polyamide resin is extremely elastic, virtually unbreakable, monomer-free, lightweight and impervious to oral fluids (Fig. 23, 24). 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 comfort, esthetics with no metallic taste (Fig. 21, 22). It is easy to polish and adjust, it can be added to or relined in office or laboratory. As previously shown, in certain cases we used pre-formed clasps, made of nylon, its composition being similar to that of the polyamidic resin used for denture manufacturing, which 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. In other cases we chose to make the clasps of the same thermoplastic resin as the saddles of from acetal resin.

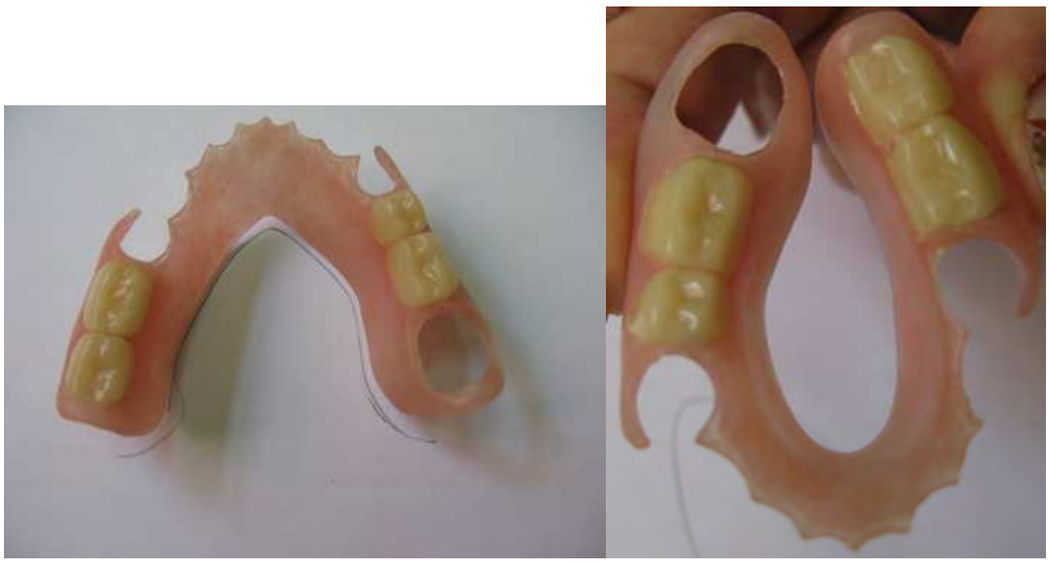
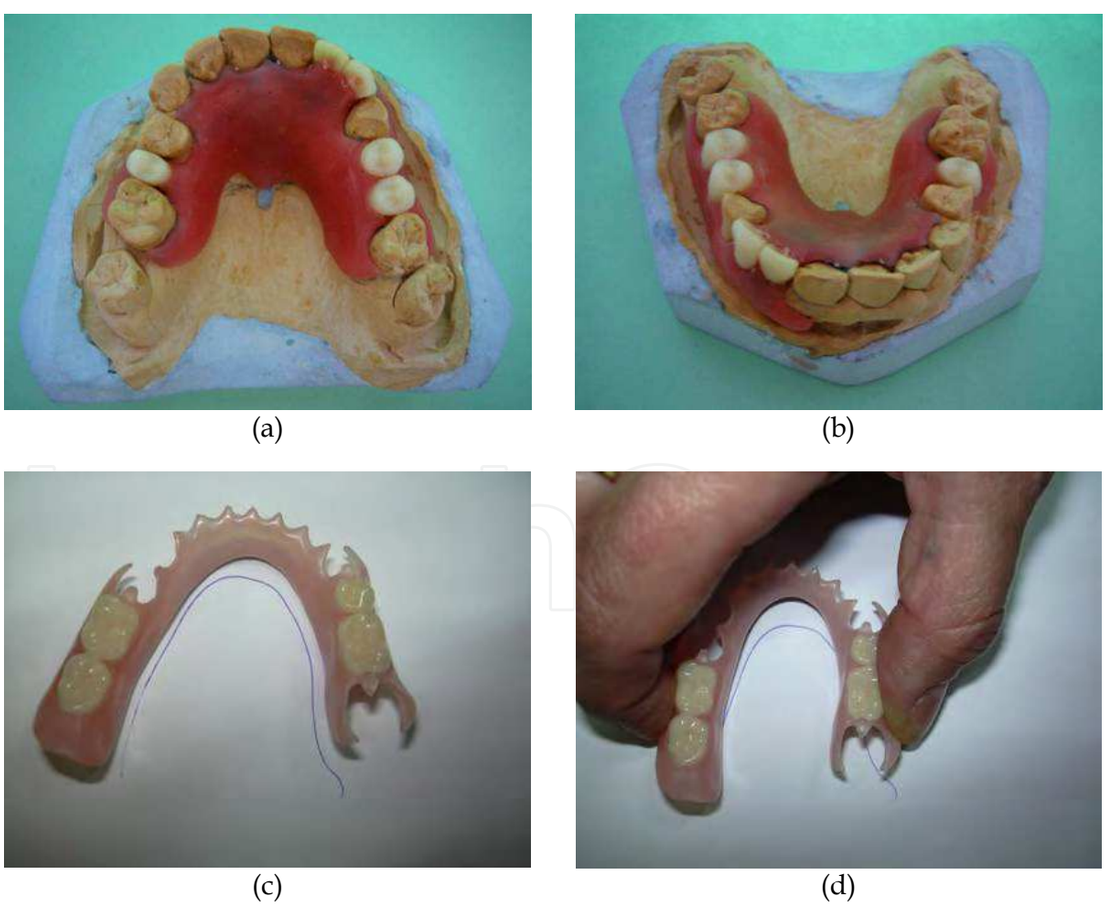


Fig. 23. Superflexible polyamidic partial dentures



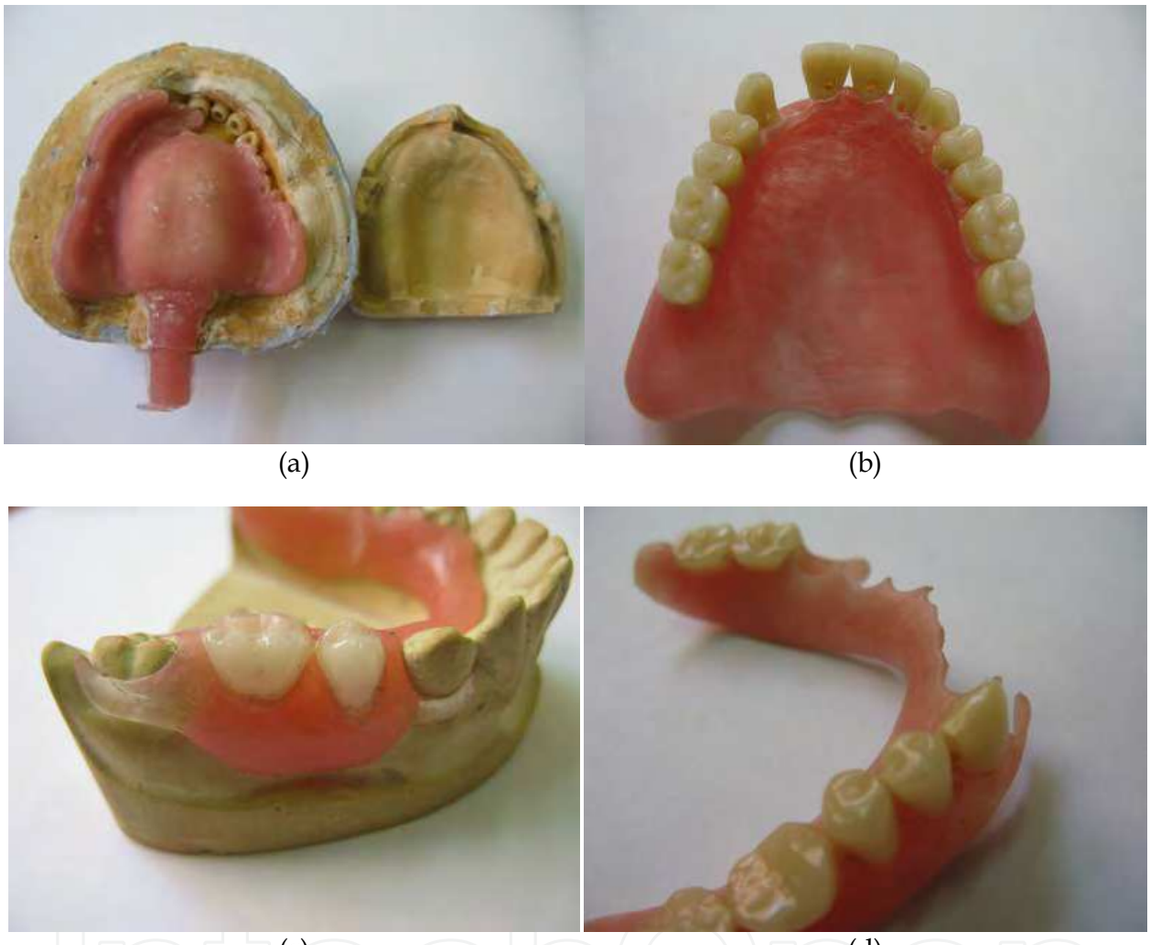
(a) (b)

(c) (d)

Fig. 24. (a), (b). Maxillary patterns, (c). The super-flexible polyamide denture , (d). The final flexibility test

7. 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 (Fig. 25).



(a) (b)

(c) (d)

Fig. 25. Errors which might occur when manufacturing dentures from thermoplastic resins; (a), (b) Lack of substance, (c), (d) Poor polishing

8. Myofunctional therapy devices

Recently much attention has been paid to the problem of controlling dento-facial growth interferences. The negative effects of mouth breathing, abnormal lip and tongue function and incorrect swallowing patterns on cranio-facial development in the mixed dentition period is well known. Correcting these myofunctional habits has been shown to improve cranio-facial growth and lessen the severity of malocclusion.

The purpose of myofunctional therapy is to retrain the muscles of swallowing, synchronize the movements of the swallow, and to obtain a normal resting posture of the tongue, lips,

and jaw. Treatment may be received before, during or following orthodontic treatment (Quadrelli et al, 2002). The age range can be from 4 through 50 years of age, with the most typical age between 8 and 16 years.

A lot of appliances were manufactured in order to treat this problem, the main objective of all these myofunctional appliances being to eliminate oral dysfunction and to establish muscular balance. There is a definite place for these appliances in orthodontics today because they are simple and economical, but the cases need to be carefully selected, and the operator needs to be well trained in their use.

Some products do not require manufacture in the laboratory and are made in a universal size for all children 6-11 years of age (mixed dentition stage), allowing orthodontic treatment to be implemented earlier and at lower cost.

Some of these are flexible appliances are made of a thermoplastic silicone polycarbonate-urethane which is a ground-breaking copolymer that combines the biocompatibility and biostability of conventional silicone elastomers with the processability and toughness of thermoplastic polycarbonate-urethanes.

The silicone soft segment works synergistically with polycarbonate-based polyurethanes to improve in vitro and in vivo stability. It's strength is comparable to traditional polycarbonate urethanes and the biostability is due to the silicone soft segment and end groups.

It's adaptable to various fabrication techniques to accommodate many different device shapes and capable of being extruded and injection or compression molded, as well as solvent bonded, dipped, coated and sprayed. Additional surface processing steps after the device component fabrication is not needed.

9. Conclusion

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 (Wostmann et al., 2005). 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 dento-maxillary structure. They offer quality static and dynamic stability.

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 (Ardelean et al., 2007). Where the mechanical resistance of the structure comes first, the choice is 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 the removable partial dentures. Of the thermoplastic materials used by us for manufacturing removable partial dentures, using acetal resin flexible thermoplastic frame, is the most laborious, requiring most working steps, due to the fact that first step involves manufacturing the acetal frame, afterwards the acrylic saddles and artificial teeth being manufactured (Ardelean et al., 2010). A removable partial denture with the framework made of acetal resin should be quickly integrated into the dento-maxillary system and accepted by the patient due to its reduced volume, esthetic and flexible clasps. Such a removable denture is a

comfortable solution for the partial edentulous patient, achieving the principles of static and dynamic maintenance and stability. The partial dentures made of acetal resin thermoplastic materials are not bulky, resin frameworks may be as thin as 0.3-0.5 mm, clasps are flexible and esthetic, being rapidly integrated in the DMA structure, thus representing the most comfortable solution for the patient.

In small dentures, it provides excellent support, static and dynamic stability. The material is opaque, thus avoiding the translucency of dark backgrounds and making possible the manufacturing of matching bases only 3 mm thick, being recommended for injected clasp partial dentures, sliding or telescopic dentures, lingual splints or sport mouthguards.

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 RPD to retain the bolus.

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 but it can be used temporarily, in the frontal area as well, in those clinical cases where short-term esthetic aspect is not important.

Unlike conventional acrylates, 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, lack of porosity, thus preventing the development of microorganisms and deposits, all of which, together with maintaining size and colour in time are very important characteristics for removable dentures, 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 splinterty quality; some of them can also be repaired or rebased (Szalina, 2006).

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 (Parvizi et al., 2004).

Thermoplastic resins have been used in dental medicine for fifty years. In the meantime, their use has spread due to their superior characteristics. Their ongoing development has yielded new classes of more and more advanced materials and technologies, which make possible the manufacturing of dentures with better splinting properties than traditional dentures.

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

As this class of materials, as well as the processing devices, have 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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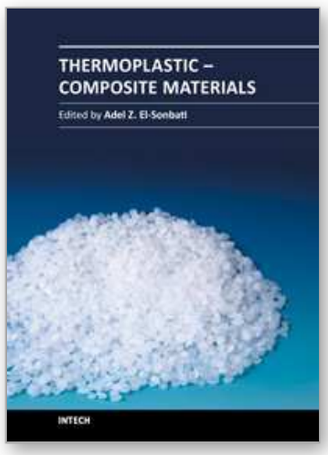

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Composite materials often demand a unique combination of properties, including high thermal and oxidative stability, toughness, solvent resistance and low dielectric constant. This book, "Thermoplastic - Composite Materials", is comprised of seven excellent chapters, written for all specialized scientists and engineers dealing with characterization, thermal, mechanical and technical properties, rheological, morphological and microstructure properties and processing design of composite materials.

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