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Assessment of Flexible and Conventional Resins as Denture Bases

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Abstract: *Flexible and acrylic resins are used as denture bases. Acrylic resins derived from polymethyl methacrylate are the conventional approach. Flexible thermoplastic resins are the alternative, and of these, polyamides with low flexibility and ethylene propylene resins are often used in current practice. The biocompatibility, flexibility, non-allergenic properties, and ease of denture insertion all highlight the suitability of these materials. This study aims to evaluate the behavior of low flexibility polyamide, ethylene propylene resin, and polymethyl methacrylate resin, used as partial denture bases, by monitoring the specific parameters obtained. The evaluation of the behavior of the materials was carried out by clinical examination. Additionally, a questionnaire was used. The results with both flexible resins are almost similar and superior to conventional resins, in partially edentulous patients, in difficult clinical situations, on undercut prosthetic areas, and in extended edentulous, tilted teeth, or when the patient has a limited mouth opening. The prognosis over time with polyamides with low flexibility and ethylene propylene resins is more advantageous than with classic acrylic resins.*

Keywords: *Flexible resins, polyamides, ethylene propylene, polymethyl methacrylate, dentures*

1. Introduction

Flexible thermoplastic or acrylic resins are used as denture base materials. The resins used for the denture bases must meet the requirements: biocompatibility, strength, durability, dimensional stability, high insolubility, aesthetics, chemical stability, acceptable thermal properties, low sorption in oral fluids, ease of production, and cleaning. In addition, it must be easy to repair [1].

Thermoplastic resins are used for flexible dentures. Flexible thermoplastic resins have been used as bases for partial dentures due to their properties and the advantages they confer. The thermoplastic resins used as denture bases are materials (copolymers) that have the characteristic of flexibility. Flexible thermoplastic resins soften when heated and solidify when cooled. These are high-molecular compounds and come from different chemical elements, with different properties [2].

Flexible thermoplastic resins are monomer-free, biocompatible and nonallergenic. The thermoplastic resins ensure a comfortable fit, are durable, flexible, and can be repaired. Because there is a low risk of denture fracture, the base of the denture is thinner. This makes them lighter and thinner than partial dentures using an acrylic resin. These are used for complete and partial dentures, immediate dentures, post-resection dentures, and temporary dentures after implantation [3].

Flexible materials have viscoelastic properties that lead to improved masticatory function in flexible dentures and patient comfort compared to acrylate dentures. Flexible partial dentures can adapt to the ridge's shape and are much more comfortable to wear [4].

Flexible partial dentures are an alternative to conventional dentures. Flexible partial dentures are indicated in cases where there are bilateral undercuts, tilted teeth, a patient allergic to acrylic resin denture bases, or alloy components. Other clinical indications include exostoses with deep undercuts, syndromes associated with microstomia, conditions such as scleroderma, and oral submucosal fibrosis with limited mouth opening [5].

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Flexible thermoplastic resins are polyamides, acetal resins, polyesters, polycarbonate, and polypropylene. Polyamides are crystalline polymers. Polyamides are generated by the condensation reaction between a diamine and a dibasic acid. This copolymer has the characteristics: lack of solubility in solvents, high heat resistance and strength, ductility, higher elasticity than common heat polymerizing resins, and toxicological safety for patients with resin monomer allergies. This material can have problems such as water sorption, surface roughness, warpage, color deterioration, and difficulty in polishing [6].

Polypropylene resin is used due to its aesthetic appearance and mechanical properties. This polymer is non-toxic, odorless, flavorless, and has mechanical stability. Their mechanical stability depends on their molecular weight. The most used member of this group is ethylene propylene, a semi-crystalline transparent polymer with stable color, which does not absorb liquid [7].

Acrylic resins are polymethyl methacrylate (PMMA). It is an amorphous polymer. In current practice, heat-cured or injectable acrylic resins are used. Polymethyl methacrylate is used as a biomaterial due to biocompatibility, reliability, dimensional stability, absence of taste, odor, tissue irritation and toxicity, teeth adhesion, color stability and good aesthetics. The advantages of acrylic resins are: aesthetics, low water sorption and solubility, adequate strength, low toxicity, easy to repair, easy to process, and affordable. The disadvantages of acrylic resins are: they can cause allergies, increased porosity, increased water retention, high risk of fractures, polymerization shrinkage, discomfort, weak flexural, lower impact strength, and low fatigue resistance [8].

Studies compared patient satisfaction with flexible and acrylic dentures in terms of aesthetics, speech, and comfort, with a mean value of 90% for flexible dentures.

Flexible thermoplastic resins, polyamides, and ethylene propylene, offer advantages, compared to acrylic resins, so that the long-term performance of thermoplastic resins is usually predictable [9].

The aim of this study is the comparative evaluation of three different resins, used as partial denture bases, polyamide with low flexibility, ethylene propylene material, and polymethyl methacrylate. The resin's behavior was evaluated, by following certain characteristics specific to the material.

2. Materials and methods

The following resins were used for this study: polyamide with low flexibility (Flexiultra), ethylene propylene material (Duraflex), and polymethyl methacrylate (BSM). The study was carried out over a period of four years on a group of 38 partially edentulous patients. They were divided into three groups. Group 1 patients were treated with Flexiultra flexible dentures (n1 = 10 patients), group 2 patients were treated with Duraflex flexible dentures (n2 = 12 patients), and group 3 were treated with BSM acrylic dentures (n3 = 16 patients). Definitive dentures were planned for restoration Kennedy classification class I, II, III, IV edentulous. Eligible patients for this study were aged 45–76 years. Patient inclusion criteria were: smokers, pacients with occlusal dysfunctions, periodontal disease, allergy to acrylate, and osteoporosis. Patient exclusion criteria were: patients with psychological disability and physical disability.

Flexiultra (developed by Sabilex) is a thermoplastic flexible resin for injectable prostheses, from the polyamide group. It has low flexibility. Its low flexibility allows for a balance between flexibility and stiffness. This is a high molecular weight polyamide. It has the following characteristics: flexibility, resistance, stability in the oral cavity, without monomers, hypoallergenic, translucency, and dense surface. It is also easy to process. Dentures with occlusal rests can also be made. It is indicated for partial dentures.

Duraflex (developed by Myerson) is the thermoplastic flexible resin for injectable prostheses, which derives from the polypropylene group. This is ethylene propylene copolymer. It has a high molecular weight (approximate weight 99.9750%). This resin is recognized for its flexibility, strength, durability, and secure fit. It allows easy adaptation in the oral cavity, reducing the probability of irritation and painful lesions. It has the following characteristics: translucency, resistance to staining, monomer-free,

low moisture absorption, easy to process, and repair. DuraFlex absorbs almost no water when placed in water compared to other flexible materials. It is indicated for partial and total prostheses.

BSM (developed by BSM Dental) is a heat-curing denture base acrylic resin for complete and partial dentures. It is polymethyl methacrylate (PMMA). It has a low molecular weight. It has the following characteristics: high bending strength, tear resistance, color stability, has residual monomer, biocompatibility, easy to process and repair. (chemical adhesion to artificial teeth). After polymerization, the amount of residual monomer is smaller.

The flexible resin base dentures are made by the injection technique. The acrylic base dentures are made by the classical technique with heat-cured acrylic resin. After making the prostheses, the behavior of the resins was evaluated by following the specific parameters.

During the study, specific parameters that reflect certain properties of the materials used were monitored. The method of obtaining the data was achieved through two methods, clinical examination and a questionnaire.

During the clinical examination, the specific parameters were highlighted and monitored: the way of insertion/disinsertion of the dentures, adaptability in areas with undercuts, mucosal irritation, abutments loading, denture repair, fracture lines, relining, aesthetics, halitosis, patient comfort, denture impregnation (Table 1).

Table 1. Evaluation parameters

Group	N	Treated by	Parameters	Evaluation score
Group 1	10	Flexiultra dentures	Insertion/removal Adaptability in areas with undercuts Mucosal irritation Abutments loading Comfort Denture impregnation Halitosis Repair/fracture Relining	Score for severity of the clinical symptoms: 0—none 1—minimal 2—moderate 3—severe
Group 2	12	Duraflex dentures		
Group 3	16	BSM dentures	Aesthetics Patient satisfaction	Score for satisfaction degree: 0—not satisfactory 1—satisfactory 2—highly satisfactory

Note: N = number of patients.

The clinical examination followed both insertion and disinsertion of dentures in terms of ease of maneuvering. Similar to adaptation on ridges with areas with undercuts. Both flexible dentures from polyamide and ethylene propylene resin flex during insertion and disinsertion and are easy to maneuver. Monitoring the degree of difficulty in assessing clinical parameters is done on a value scale.

The abutment teeth loading is verified by clinical and radiological examination. Clinical signs of overload were followed. Radiologically, the periodontal space is checked, namely the widening of the periodontal space.

In addition, a questionnaire was used regarding the following aspects: aesthetics of the denture, patient comfort, ease of speech, accommodation with the denture, mastication, halitosis, and patient satisfaction.

The questionnaire validation was done by comparing the obtained results with those from specialized studies. The minimum requirements for the small sample size of 10 patients per group were respected.

The Visual Analog Scale (VAS) was used to measure the characteristics of clinical symptoms in patients, to monitor the evolution of some clinical symptoms, and to evaluate the effectiveness of therapy. The Visual Analog Scale (VAS) contributes to the classification of the severity of symptoms. Visual Analog Scale (VAS) is a measurement tool, including the Verbal Rating Scale (VRS) and Numeric Rating Scale (NRS).

The specific parameters were monitored, using the Visual Analog Scale (VAS) and highlighting the problems that appeared on a 4-point scale, among which: score 0—none, score 1—minimal, score 2—moderate (medium), score 3—severe (extensive, maximum). The 4-point scale represents the Verbal Rating Scale (VRS).

For the evaluation of the patient's aesthetics and satisfaction through the clinical examination and the questionnaire, the following score was used: 0—not satisfactory, 1—satisfactory, 2—highly satisfactory. The patient's satisfaction was evaluated through a questionnaire and included assessments related to comfort, speech, functioning with the denture, and denture integration in the oral cavity.

Patients were evaluated one week, one month, six months after the application of the dentures, and annually. Follow-up of patients was for a period of four years.

3. Results and discussions

No important differences were found between the flexible resins behavior, polyamide with low flexibility, and the ethylene propylene resin. The main differences arise from the behavior of the two flexible resins compared to the behavior of polymethyl methacrylate.

Both flexible resins are preferred by patients due to the elimination of the risks of fractures and allergic reactions. To these are added the other benefits of flexible thermoplastic resins, namely easier adaptation in the prosthetic area, less mucosal irritation, and greater comfort for the patient.

Also, due to the reduced volume of dentures and thinner edges, patients adapt to dentures, speak, and function faster. Flexible thermoplastic resins, polyamides with low flexibility, and ethylene propylene have a better prognosis over time than polymethyl methacrylate resins as partial denture base materials.

Flexible resins, polyamides with low flexibility, and ethylene propylene, are used for partial denture bases with a predilection for areas with accentuated undercuts, where acrylic denture insertion causes problems. Another situation in which these flexible thermoplastic resins are useful is given by the tilting of abutment teeth or remaining teeth, a situation in which acrylic dentures are more difficult to insert.

Due to the fact that the ethylene propylene used absorbs water in an insignificant percentage compared to polyamides, the initial adaptation of the prosthesis in the oral cavity with ethylene propylene is easier. In complex clinical situations, polyamide dentures may still require an adaptation appointment in the prosthetic area.

Ease of insertion, the mean value and standard deviation for group 1 (treated by polyamide low flexibility dentures) is 1.1 ± 0.31, for group 2 (treated by ethylene propylene dentures) it is 1 ± 0.28, and for group 3 (treated by polymethyl methacrylate dentures) it is 2.5 ± 0.51.

In prosthetic areas with accentuated undercuts, flexible new generation polyamide and ethylene propylene resins are suitable. In the presence of areas with undercuts, for example, bilateral buccal undercut tuberosities, optimal results are conferred by polyamides, ethylene propylene in an almost similar percentage.

In areas with accentuated undercuts, polyamide is more suitable than ethylene propylene. In areas with longer edentulous space, the best results are obtained with ethylene propylene. Under the same conditions, the results with polyamides are almost similar, due to the fact that it has low flexibility.

In atrophied areas, ethylene propylene is more indicated than polyamide. The results with both flexible resins are superior to those with acrylic resins. Adaptability in areas with undercuts, the main value and standard deviation for group 1 is 1.3 ± 0.48, for group 2 it is 1.4 ± 0.51, and for group 3 it is 2.4 ± 0.51.

In terms of mucosal irritation, the results over time with the two flexible materials as partial denture bases are almost similar and are significantly reduced compared to acrylate dentures. The presence of mucosal irritation, the mean value and standard deviation for group 1 is 0.7 ± 0.48, for group 2 it is 0.4 ± 0.51, and for group 3 it is 2.3 ± 0.5.

From the point of view of abutment teeth loading, flexible resins, low flexibility polyamides, and ethylene propylene, act less on them, distributing the occlusal forces. For this reason, they have behaviors like attachments that are stress breakers. The abutment teeth loading, the mean value and standard deviation for group 1 is 0.9 ± 0.31, for group 2 it is 0.8 ± 0.38, and for group 3 it is 2 ± 0.25.

In terms of patient comfort, polyamide dentures have a similar score to those with ethylene propylene dentures. Patient comfort, the mean value and standard deviation for group 1 is 0.2 ± 0.42, for group 2 is 0.2 ± 0.45, and for group 3 is 2.12 ± 0.34.

Among the materials used, flexible resins have a minimal percentage of impregnation compared to acrylic ones and have not changed their color. Denture impregnation, the mean value and standard deviation for group 1 is 1.2 ± 0.42, for group 2 it is 1.1 ± 0.38, and for group 3 it is 1.9 ± 0.25.

Oral halitosis is reduced with polyamides and ethylene propylene compared to acrylate. Halitosis mean value and standard deviation for group 1 is 0.3 ± 0.48, for group 2 it is 0.3 ± 0.49, and for group 3 it is 2.3 ± 0.47.

An insignificant percentage of repair or fractures were found in flexible dentures, compared to acrylic dentures. Due to laboratory processing as finished parts, polyamide and ethylene propylene dentures behave almost similarly. Ethylene propylene is easier to process than polyamide.

Repairs/fractures, the mean value and standard deviation for group 1 is 0.8 ± 0.42, for group 2 it is 0.7 ± 0.45, and for group 3 it is 2.1 ± 0.40.

Relining the mean value and standard deviation for group 1 is 0.6 ± 0.51, for group 2 it is 0.5 ± 0.52, and for group 3 it is 2.2 ± 0.44.

From an aesthetic point of view, flexible thermoplastic resins are superior to those with polymethyl methacrylate, the maximum aesthetics being conferred in similar percentages of the latest generation polyamides and ethylene propylene. Aesthetics, the mean value and standard deviation for group 1 is 1.5 ± 0.52, for group 2 it is 1.4 ± 0.51, and for group 3 it is 1.1 ± 0.40.

Patient satisfaction, the mean value and standard deviation for group 1 is 1.4 ± 0.51, for group 2 it is 1.5 ± 0.51, and for group 3 it is 1.1 ± 0.34.

The parameters obtained according to a scale from 0–3, which reflect the severity of the clinical symptoms that appeared, are shown for the three groups (Table 2).

Table 2. Parameters after denture treatment for group 1, group 2, and group 3

N	Parameter (Mean ± SD)	Group 1	Group 2	Group 3
38	Insertion/removal	1.1 ± 0.31	1 ± 0.28	2.5 ± 0.51
	Adaptability in areas with undercuts	1.3 ± 0.48	1.4 ± 0.51	2.4 ± 0.51
	Mucosal irritation	0.7 ± 0.48	0.4 ± 0.51	2.3 ± 0.5
	Abutments loading	0.9 ± 0.31	0.8 ± 0.38	2 ± 0.25
	Comfort	0.2 ± 0.42	0.2 ± 0.45	2.12 ± 0.34
	Denture impregnation	1.2 ± 0.42	1.1 ± 0.38	1.9 ± 0.25.
	Halitosis	0.3 ± 0.48	0.3 ± 0.49	2.3 ± 0.47
	Repair/fracture	0.8 ± 0.42	0.7 ± 0.45	2.1 ± 0.40
	Relining	0.6 ± 0.51	0.5 ± 0.52	2.2 ± 0.44

Note: SD = standard deviations, N = number of patients.

The parameters obtained according to a scale from 0–2, which reflect the satisfaction degree, are shown for the three groups (Table 3).

Table 3. Parameters after denture treatment for group 1, group 2, and group 3

N	Parameter (Mean ± SD)	Group 1	Group 2	Group 3
38	Aesthetics	1.5 ± 0.52	1.4 ± 0.51	1.1 ± 0.40
	Patient satisfaction	1.4 ± 0.51	1.5 ± 0.51	1.1 ± 0.34

Note: SD = standard deviations, N = number of patients

Mean values of denture insertion between group 1, group 2, and group 3 show the ease of insertion of flexible resins compared to acrylic ones (Figure 1).

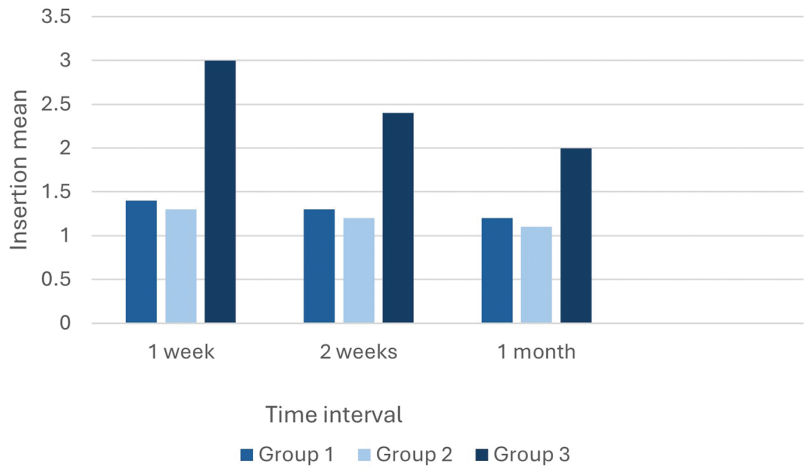

Figure 1. Insertion denture mean values and standard deviation for group 1, group 2, group 3

Both flexible resins used have a positive score compared to the acrylic ones in difficult clinical situations.

Ethylene propylene resin has optimal results on undercut areas as on atrophied areas and in extended edentulous spaces. Polyamide with low flexibility has optimal results on accentuated undercuts.

The comparison of mean values when adapting the denture on undercuts between group 1, group 2, and group 3 indicates the preference for flexible resins over acrylic ones (Figure 2).

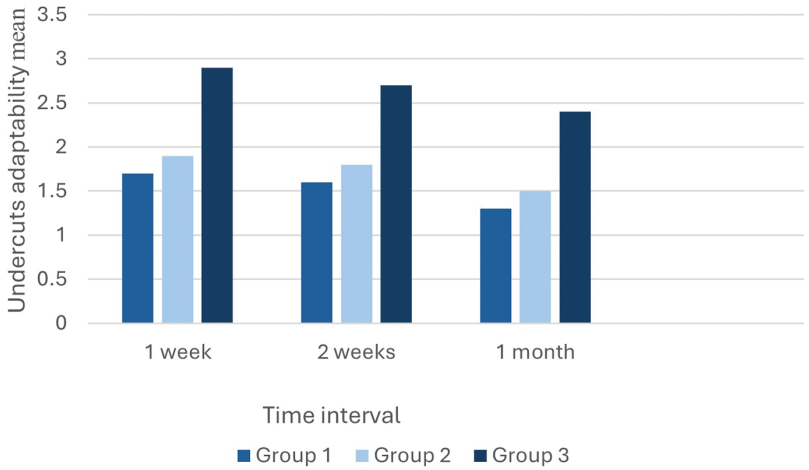

Figure 2. Undercuts adaptability mean values and standard deviation for group 1, group 2, and group 3

From the point of view of tilted teeth, the results with the two flexible resins are almost similar. Polymethyl methacrylate resins are deficient from these points of view.

Mucosal irritation mean value is lower with both flexible resins used compared to the acrylic resin (Figure 3).

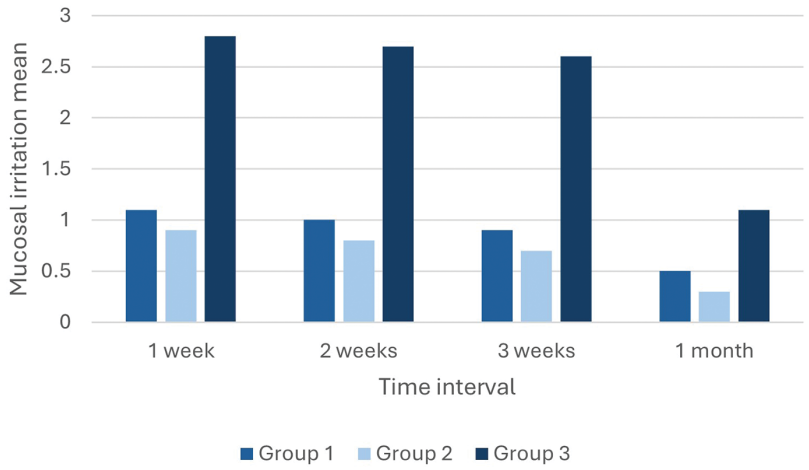

Figure 3. Mucosal irritation mean values and standard deviation for group 1, group 2, group 3

Mean values of abutment loading between group 1, group 2, and group 3 reveal the effect of flexible and acrylic resins on abutment teeth (Figure 4).

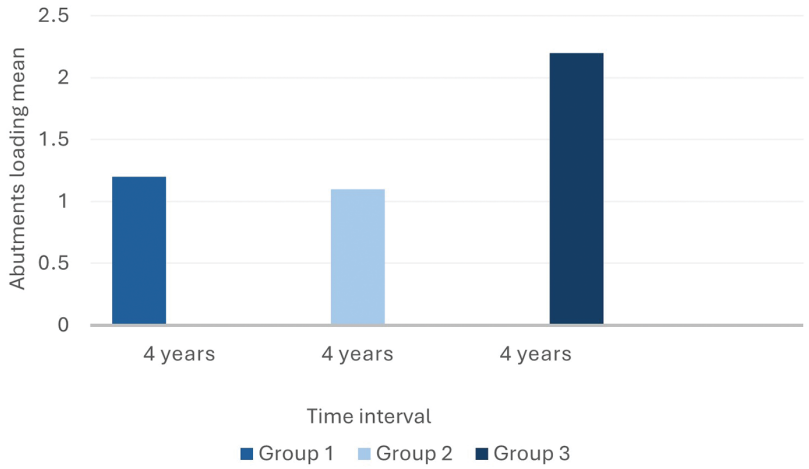

Figure 4. Abutments loading mean values and standard deviation for group 1, group 2, group 3

The comparison of the mean values of patient satisfaction between group 1 (treated by polyamide dentures), group 2 (treated by ethylene propylene dentures), and group 3 (polymethyl methacrylate dentures) shows the favorable treatment results (Figure 5).

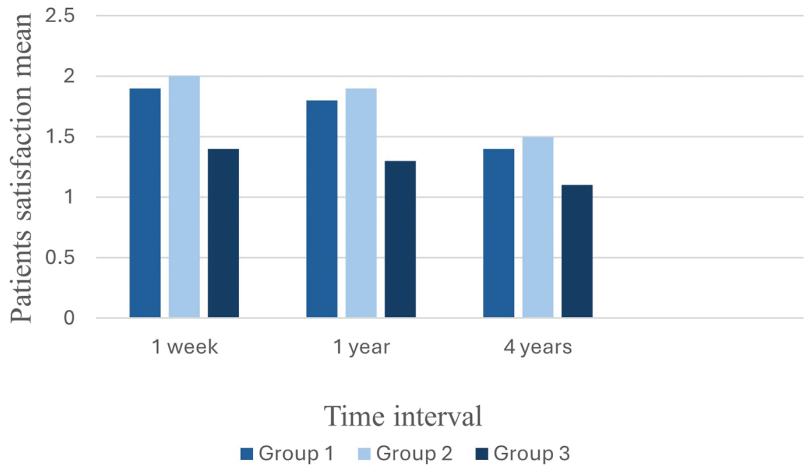

Figure 5. Patients' satisfaction mean values and standard deviation for group 1, group 2, group 3

In the partially edentulous, the reliability of the dentures after 4 years of study is almost similar for both flexible materials used and superior to acrylic material.

In smokers, the percentage of denture impregnation was slightly higher than in non-smokers. In patients with osteoporosis, the need for denture relining was faster than in healthy patients, with half a year earlier. There were no cases of incompatibility with the flexible and acrylic dentures.

The parameters that evaluate the clinical behavior of flexible resins in this study are close to those mentioned in other studies performed on a group of 15 patients, like adaptability in areas with undercuts, mean value and standard deviation 0.73 ± 0.488 and oral soft tissue tolerance, mean value and standard deviation 0.27 ± 0.488 [10].

A clinical study of flexible dentures indicated the following parameters: aesthetics, mean value and standard deviation 1.67 ± 0.488, and patient satisfaction mean value and standard deviation 2.07 ± 0.488 [11].

Another study reflects for flexible dentures a frequency of fracture, mean value, and standard deviation 0.67 ± 0.488 [12].

A study conducted in a group of 54 cases of patients treated with flexible dentures shows that 3 cases presented mucosal irritation, 6 cases reported halitosis, and 0 cases related to difficulties in inserting and removing the denture [13].

Flexible thermoplastic resins, polyamides, and ethylene propylene offer advantages such as better stability, resistance to solvents, high fatigue resistance, and good wear properties. These materials provide safe therapy for patients who have an allergy to free monomers.

The long-term prognosis of thermoplastic resins is usually favorable. Thermoplastic materials have low porosity, reducing the build-up of biological material, odors, and stains. It shows superior dimensional and color stability [14]. For this reason, they are used as temporary long-term dentures for difficult cases on teeth or implants or permanent, removable dentures.

Flexible resins are indicated when there are buccal undercut tuberosities associated with a narrow buccal vestibule. For patients with systemic sclerosis and those with oral and facial scars due to disease, trauma, or burns, comfort is provided by flexible prostheses.

A study shows that almost all patients (96.7%) were satisfied with the appearance of the flexible partial denture because of its aesthetic superiority over conventional dentures. The aesthetic aspect is provided by the higher translucency of the dentures which can reflect the shade of the underlying tissue [15].

A study shows that mucosal changes and the adaptability of the denture were compromised in patients with acrylic dentures, and no changes were found in those with flexible dentures. Movement is

allowed by the flexibility of the material, which bends and returns to its original shape and position [16]. Flexible resins adapt.

Flexible resins, polyamides, and ethylene propylene, have a lower modulus of elasticity and a softer surface compared to acrylic resin, which also determines patient comfort [17]. The modulus of elasticity of flexible dentures is lower than that of polymethyl methacrylate (PMMA) dentures.

A study shows that flexible dentures fail to maintain the vertical dimension under occlusal forces due to flexibility. It is not a good thermal conductor, it does not give the patient natural sensations of hot and cold [18].

Flexible thermoplastic resins are high molecular weight macromolecular polymers. The flexibility degree and high mechanical stability of flexible resins are given by the long molecules. The linear molecular type establishes the high density of the material [19].

The mechanical properties of these biomaterials are given by their bulk properties. The interactions of these materials with tissues are the consequence of their surface properties, which can be easily adapted to specific requirements. Thus, polymer coatings can be used to increase the biocompatibility of a bulk material [20].

Polyamides are heterochain polymers with an amide group. Polyamides used as denture bases have an aliphatic structure. Aliphatic polyamides have high strength, wear resistance, resistance to degradation, and bacterial influence. They are used for the manufacture of complete or partial removable dentures. Polyamides have water sorption between the molecular chains due to the hydrophilicity of the amide bonds that form the main chains of the resins [21].

Polyethylene and polypropylene belong to the group of polyolefins. They have good mechanical and aesthetic qualities. Ethylene polypropylene used is a semi-crystalline transparent polymer with a stable color that does not absorb liquid. Ethylene polypropylene has high wear resistance. It has a molecular weight between 75,000 and 200,000. The mechanical stability depends on their molecular weight. It is indicated for partial dentures, temporary dentures, and implant-supported dentures [22].

The properties of ethylene propylene polymers are influenced by the type of catalytic system. It affects microstructure, crystallinity, transition temperature, molecular weight characteristics, thermal, and quality [23].

Acrylic resins are polymeric esters of methacrylic acid. By adding elastomeric resins, the flexibility and strength of thermoplastic acrylic resins can be increased. Polymethyl methacrylate is a material soluble in its monomers and compounds. It has high resistance to wear, mechanical strength, aesthetics, and shade variation [24].

Polyamide dentures have a significant flexibility that also determines a high resistance against fracture and flexural fatigue. Polyamides are useful in clinical situations that do not indicate hard materials as denture bases [25].

Polyamides can also be used in patients allergic to polymethyl methacrylate (PMMA). Polyamides are more difficult to process and repair. They show high water absorption, solubility, and staining potential [26]. Polyamides present high heat resistance, flexibility, and insolubility in various solvents.

Ethylene propylene used is an advanced thermoplastic resin. It is denser than acrylic resin dentures and unlike nylon-based materials, it does not discolor and is highly resistant to stains and odors. Ethylene propylene dentures combine flexibility with strength. Ethylene propylene partial dentures can be repaired. Ethylene propylene is unusually resistant to water absorption, making it less prone than nylon to absorbing stains or odors [27].

Polymethyl methacrylate (PMMA) is used as a biomedical material for making complete and partial dentures. PMMA is a tough, lightweight material with good impact resistance compared to glass and polystyrene. PMMA also has the disadvantage that it dissolves in many organic solvents and chemicals due to its easily hydrolysable ester groups [28].

Processing of the denture base materials produced unequal deformations. The amount of this dimensional change depends on the (casting conditions) conditions of moulding, the shape of the mold.

A study evaluated dimensional changes during the fabrication of flexible polyamide and polymethyl methacrylate (PMMA) dentures. The result found is that polyamides have a higher degree of distortion than PMMA [29].

Another study compared the flexural strength of heat-cured polymethyl methacrylate (PMMA) and polyamides (flexible resins) and found that PMMA had the highest flexural strength, followed by polyamides [30].

A study that compared the flexural strength of polymethyl methacrylate (a heat-cured denture base resin) with polyamides of different generations found that polyamides of the first generation have the highest flexural strength, followed by PMMA and polyamides of the last generation. Dentures must have strong impact strength to prevent fractures [31].

Denture bases must have a flexural strength to withstand masticatory forces. Study shows the flexural strength of cold-cured, hot-cured, and microwave-cured PMMA is good (84.40 ± 1.68, 92.84 ± 4.73, and Polymers (flexible resin) 109.63 ± 5.31 MPa, respectively) [32].

Studies have reported that rougher surfaces can encourage microbial colonization. Polyamide and ethylene propylene as denture bases produced higher surface roughness compared to polymethyl methacrylate (PMMA) [33].

Some studies have shown that the impact strength of polyamide prosthesis was significantly higher than that of conventional PMMA. In addition, the polyamide denture showed higher flexural strength than the PMMA denture due to its improved flexibility. The flexural strength of the polyamide denture base was more significant reported to that of acrylic resin, while the flexural modulus of polyamide was lower than that of PMMA [34].

Ethylene propylene has an impact strength better than PMMA. Improvement in impact strength was also obtained through surface treatment. Also, the modulus of elasticity of ethylene propylene is higher than that of acrylic resins, PMMA. Ethylene propylene as a material for the denture base provides an improvement in transverse, tensile, and impact strength. The results obtained are superior to those conferred by acrylic resins, PMMA [35].

The surface hardness causes the wear resistance of the material. One study compared the surface hardness of two types of PMMA with that of polyamide and ethylene propylene flexible resins. The results showed that the hardness of PMMA with values of 82.5 ± 3.779 (VHN) and 76.9 ± 4.771 (VHN), respectively, are higher than that of polyamides 66.0 ± 2.78 (VHN) and ethylene propylene 67.4 ± 1.955 (VHN) [36].

The wear resistance of polymethyl methacrylate (PMMA) is significantly low. The surface hardness of hot-cured PMMA is higher than that of cold-cured PMMA. Heat-cured PMMA has lower solubility and sorption than cold polymerized PMMA. PMMA has poor color stability due to multiple factors. Low color stability is determined by a large amount of residual monomer and a poor degree of conversion [37].

The fracture toughness of hot-cured PMMA (2.06 ± 0.17 MN/m^3/2) is higher than that of cold-cured PMMA (1.63 ± 0.1 MN/m^3/2). Denture fracture is more common with acrylic dentures compared to flexible dentures. A study reported that the impact strength of polymethyl methacrylate (PMMA) was reduced in the presence of surface defects as small as 16 μm [38].

This study has several limitations. First of all, small samples of patients were used, n1 = 10, n2 = 12, n3 = 16, specific to the prosthetic treatment with each resin. In the second place, only certain parameters were evaluated, which indicate the clinical behavior of the resins. Future studies will appreciate the behavior of the resins on larger groups of patients.

4. Conclusions

Polymethyl methacrylate resins are the classic approach to achieving dentures. Flexible resins are the usual alternative for the base of partial dentures. Their advantages, as they indicate. Thermoplastic flexible resins are biocompatible materials with physical and mechanical properties. Flexible resins

improved denture adaptability and retention due to their lightweight nature and ability to accommodate more undercuts. These materials have good aesthetics. From the point of view of using low flexibility polyamide and ethylene propylene material in difficult clinical situations, the results are almost similar. From the point of view of accentuated undercuts, low flexibility polyamide and ethylene propylene have an almost similar prognosis. Polymethyl methacrylate resins are deficient from these points of view. Due to the physical and mechanical characteristics, the low flexibility polyamide and ethylene propylene used as denture base materials have a favorable prognosis over time, superior to polymethyl methacrylate.

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