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CLINICAL USE AND SUCCESS OF FLEXIBLE DENTURE MATERIALS: A NARRATIVE REVIEW

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Abstract

The current narrative review aims at describing these flexible denture materials used in prosthodontics applications including their historical development, efficiency, and potential development. Unlike the conventional acrylic dentures that have dominated the market of dental prosthetics for decades, thermo-plasticized dentures prepared from the third-generation thermoplastic polymers and nylon-based resins are emphatic innovations. These modern materials have the following advantages – better adaptation to the configuration of the mouth's tissues and decreased pressure on some areas of the mouth that makes the patient more comfortable and satisfied. Thus, the flexed type of dentures possesses certain disadvantages, including higher costs and adaptation problems; however, ongoing scientific endeavors are to enhance the effectiveness of flexible dentures. An extensive search of the literature was done involved using the information available from journal articles, library of the faculty of dentistry –University of Malaya, with aids from databases like Science Direct and Pub-Med. The new flexible denture base materials and digital dentures fabrication technologies provide huge possibilities for clinical application, and contain numerous advantages compared with the traditional material and techniques. Nonetheless, a deeper reflection on the indications and contraindications of such drugs is needed for the best results from treatment plans.

Keywords: Soft Liner Material for Flexible Denture, Efficacy, Patient Preferential Attachment, Masticatory Efficiency, Computer-Aided Design and Manufacturing, Three-Dimensional Printing.

Introduction

The recent innovations in the flexible denture material are considered as a great step in the field of prosthodontics since it offers options to patients who are allergic to the normal form of material or perhaps patients who desire better esthetics and superior comfort. These materials include polyamide (nylon), polycarbonate, and polyethylene terephthalate; most of these materials have various characteristics that affect their clinical functions. In addition, recent advancement in computer technology has brought innovation in the manufacture of dentures with the inclusion of

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CAD/CAM and 3D printers which hold prospects of accuracy, individualization, and speed [4]. Note that dentures serve an important function of restoring the masticatory function and facial aesthetics of patients with missing teeth, improving their quality of life. Dentures have in the past been fabricated out of inflexible materials like acrylic resin and metal matrix. Although these materials have been proved to offer a good solution for many years now, they are by no way perfect; they are bulky, uncomfortable, and brittle and can easily crack [1]. Thus, the above disadvantages may result in patient dissatisfaction as well as limited functionality and constant repairs or adjustments. New generation materials for flexible denture has indeed brought about a new positive change to the practice of dental prosthetic appliances a great appeal over the conventional type of dentures. Flexible dentures are made from the best advanced thermoplastic polymers, nylon-based resins that make the denture as comfortable, aesthetic and durable as possible. These materials have certain characteristics that enable dentures to conform to the shape of the mouth and alleviate pain and looseness [7]. This flexibility also enhances the comfort of the set in addition to eradicating the problematic skin bruising that comes with most dentures. The benefits of flexible dentures include compatibility with the natural tissues, the dentures' capability not to break when used, and since the material is not allergenic. Compliments of these advantages made flexible dentures to be adorable to both the clients as well as the practitioners. However, shifting to the flexible materials also has some drawbacks and this are highlighted below. These are challenges because higher costs are incurred, it becomes difficult for patients to adjust to changes and there are always challenges relating to patients' retention in some of the speciality clinics [9].

As such, the purpose of this review is to bring together and evaluate the current literature regarding flexible denture materials and their evolution. Firstly, it will unravel the historical evolution of denture materials with focus on today's flexible type and secondly, the advantages rolled by these materials [9]. Also, the review will explore some of the difficulties and limitations encountered when using flexible dentures and will review innovations and trends concerning this field of study which appears to be expanding very fast. In this regard, the present review aims to draw attention to the use of flexible denture materials in contemporary prosthetic dentistry [18].

Historical Background

Denture materials have changed remarkably over the past century, and the following sections shall present an overview of these materials and how they have evolved over the years. The journey started in the mid nineteenth century when vulcanite, more famously known as vulcanized rubber, was invented in the year 1855 [20]. Although this material suffers from limited esthetics and processibility, it ranks as one of the first major steps in the evolution of denture base materials. Before the early twentieth century vulcanite was the usual material for manufacturing dentures [16]. In 1937, a material known as polymethyl methacrylate also known as PMMA, an acrylic resin, was developed by Dr. Walter Wright. The applications of PMMA in dentistry expanded rapidly and by the 1980s denture bases were predominantly made from PMMA. This material could hardly undergo movements within the mouth as well as could be easily fixed in case it was damaged, which considered as innovation in the denture making. However, PMMA had its

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disadvantages like the comparatively low F El, which contributed to the fact that dentures were fragile and could easily fracture; as well, some patients could have allergic reactions to PMMA [12]. Consequently, to overcome the shortcomings of PMMA, cobalt-chromium (Co-Cr) alloys were incorporated to fabricate partial denture frameworks in the later part of the 1920s [13]. Compared to PMMA, Co-Cr provided a higher degree of modulus of elasticity and strength, which would make dentures longer lasting of higher durability. Nevertheless, these performances as far as aesthetic properties were concerned were not optimal, and infrastructures constructed out of Co-Cr presented inconveniences to patients with metal-related allergies. The search for a better material went on and in the fifties, polyamide, better known as nylon, was suggested to be used as denture base material. Presently, nylon is considered as the first flexible denture material ever invented [11]. Following it the famous brands Valplast which was launched in 1953 and FlexSite which was launched in 1962 offered the flexible dentures based on polyamide. These were advances in light weight and toughening, where the material became almost to a degree, and proved to be much tougher than originally used materials. Later in the 1980's there were progressive improvements with the incorporation of light-polymerized denture base resins like the urethane acrylate oligomers [14]. These materials marketed under names like Eclipse, used visible light as the curing light source and this provide brand new opportunities in denture making. The advancement in these materials stemmed by a variety of problems seen in lower PMMA and Co-Cr implants cubes for example in relation to aesthetics and patients comfort [17].

Types of Flexible Denture Materials

Flexible dentures are predominantly made from two main types of materials: as the thermoplastic polymers and nylon based resins. These materials have several favorable features over typical acrylics and metals, which is why they are widely used in the contemporary prosthetic dentistry.

Thermoplastic Polymers

Thermosetting polymers are widely used in dentistry today mainly in the construction of flexible dentures. Some of the syntactic foams include polyamide (nylon), polycarbonate plastic and poly ethylene terephthalate (PET) plastics these are flexible strong and have excellent looks [18]. Polyamide, which has become famous due to its transparency and non-irritation of the skin as shown inside the Figure 1, allows the patients with specific sensitivity to choose a more suitable type of dentures. The properties of polycarbonate are high impact strength for durability but which has relatively low wear resistance, restricting the material's long-term application. CLEAR ORTHODONTIC ALIGNERS AND RETAINERS: With the excellent fitting accuracy and flexibility, PET is widely used [12]. The workability of thermoplastic polymers provides the advantage of wising and readjustments in dental applications. Thus, the problems associated with them, such as surface roughness and scratch sensitivity, are counterbalanced by such benefits as biocompatibility and the patient's comfort of using these materials in prosthodontics [17].

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Fig: 01 Thermoplastic polymer

Nylon-Based Resins

Nylon based resins namely the polyamide resins show good flexibility and chemical resistance owing to the highly stable C-N bonds in the material [16]. To some extent polyamide dentures are very useful especially to those patients who have reactions to acrylic monomers. Wear resistance is better, and there is less distortion of structures when bent than that of other dental materials; therefore, polyamide resins are preferred for use with delicate oral tissues or patients with allergies to other forms of dentures. The desirable characteristics of polyamide resins include wear resistance, and good biocompatibility, which makes the material appropriate for application in construction of flexible dentures [11]. They are most suitable for patients with risk of allergic reactions or those who have an irritated mucosa of the oral cavity, as they do not contain the acrylic and are hypoallergenic, as shown in the figure 2. Flexible dentures are dentures, which are more flexible and less rigid compared to conventional ones Fixed flexible dentures offer the following benefits, In general, flexible dentures are used as following The flexible dentures are contraindicated in the following cases. [15]

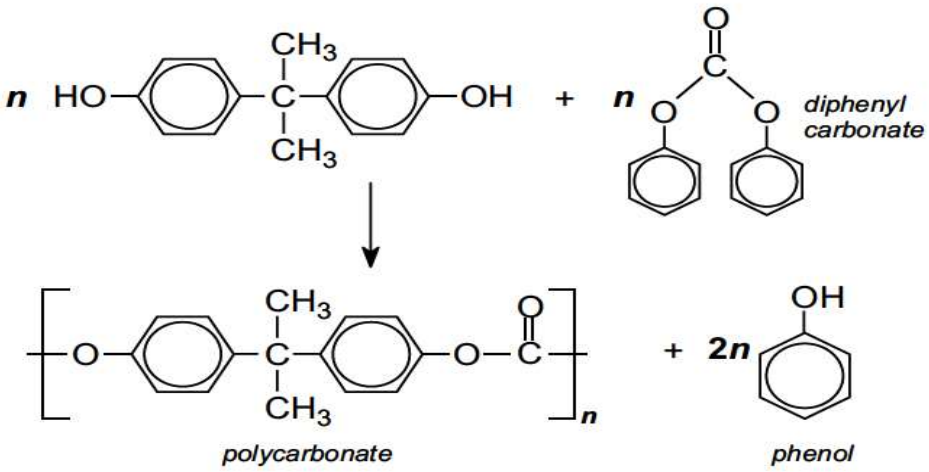

Fig: 02 polycarbonate Resins

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Indications and Contraindications of Flexible Dentures

Indications

- Severe Undercuts: Pre-prosthetic surgical conditions are rather contraindicated if the flexible dentures are intended to be used in severe undercut situations, thereby making them highly suitable apparels. The characteristic of the material is that it is easily shaped to the contours of the mouth, which excludes the formation of tissue lesions, and there is no need to wear models that shift throughout the day [13].
- Allergic Patients: Temporary or flexible dentures are recommendable to patients with allergies to materials used in making hemorrhagic dentures like the polymethyl methacrylate (PMMA) or metal part. Such materials included minimize chances of allergic reactions within the patients and at the same time make the patients agents more comfortable [14].
- Long-Term Interim Dentures: In cases of implant placement or any other dental surgeries flexible dentures prove to be as good temporary dentures which are comfortable and long-lasting. They can change as the oral tissues reshape themselves during the healing process to maintain the functionality as well as comfort [19].
- Aesthetic Demands: This is especially because flexible dentures are natural looking as compared to the conventional ones hence patients who consider looks will benefit from the above flexible dentures. Transparent materials merge with the natural gum color, described previously, thus creating little or no visual use of metal clasps, which are essential in the design styles of these kinds of bags [6].
- Comfort Issues: This is because unlike the conventional hard dentures that most patients consider uncomfortable to wear, flexible dentures are available. This is attributed to the fact that the materials used in making the dentures are flexible and can easily move along with the motions of the mouth hence; they do not exert pressure on hard surfaces [11].
- Hereditary Ectodermal Dysplasia: People suffering from hereditary ectodermal dysplasia which involves the irregularities in the formation of teeth besides developing other body structures should also consider the flexible dentures due to its flexibility to be customized to match various oral structures for the patient [10].
- Frequent Adjustments: Orthodontic treatment or ageing therefore are some of the specific circumstances that would require one to make changes in the dentures frequently and this can only be regulated by flexible dentures [7].

Contraindications

- Deep Overbites: Moreover flexible dentures are unsuitable for patients with deep overbite since the stability and functioning of the dentures are affected. The small gap between the arches seems to be an issue when it comes to support and retainer of the flexible materials [8].

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- Knife-Edge Ridges: Flexible dentures are not as effective for the patients who have sharp residual ridges left in place. Comfort is also a problem when they thin and sharp, just like wedges, the knife-edge will keep the users in discomfort because the material will be too flexible to give requisite support [3].
- Displaceable Tissue: Flexible dentures may be required to be stabilized for those patients who may have what may be otherwise described as flabby or displaceable tissues. Absence of firm support will cause dentures to move from place to another and also cause irritation thus making the dentures to be less appropriate [6].

Advantages of Flexible Dentures

There are many benefits to using flexible dentures as opposed to the conventional hard denture materials, these are, comfort, esthetic, lasting and biocompatibility.

Comfort

Flexible dentures are made from materials which can conform to the context of the oral cavity thus no pressure points and therefore no discomfort. It also contributes to general wearing satisfaction of the dentures, and for this reason, patients opt for them. Portable dentures are going to be shaped adequately to fit inside the oral cavity with ease while on the other hand eliminating problems like soreness that comes with the use of rigid dentures [14]. Flexible dentures are more comfortable compared to its rigid counterparts as they can hug the shape of the gums well and thus; patients are more satisfied. A number of patient testimonials also focus on the increase in the comfort level of new flexible dentures than the conventional acrylic counterparts. According to clinical trials and case reports made available elective dentures especially those made from superior materials are less likely to cause gum sores and uncomfortable sensations [11]. The soft characteristics of flexible dentures do not bring about any discomfort, and this is a major plus for many patients who need to have their dentures for rather a long time [5].

Esthetics

Flexible dentures are much more appealing than the conventional dentures because they sit at the gums' line and are almost unnoticeable. These flexible dentures are usually are made of materials that are close to colorless or semi clear so that they blend with the gum color effectively [1]. This natural appearance is quite beneficial to the general outlook of the denture and makes the patient have a better perception of the denture [13]. The materials that they use such as Valplast have a gum friendly shade that gives a better appearance to the smile of the patient. Clinical pictures and surveys of the patients prove the enhanced esthetics of the flexible dentures which results in natural and self-confident smile [3].

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Fig: 03 Flexible Denture

Durability

It was found that thermoplastic and nylon type of material for flexible dentures put it in a better position than the traditional acrylic used in making the dentures. None of them is breakable or chip off like the ordinary ones which will be an added advantage especially to the denture users. Extensive research conducted with flexible denture materials, for example, materials which were tested in Japan, showed that they possess excellent parameter of impact as well as stress durability [15]. In the long run, considering the fact that they may be slightly cheaper to make than the RPD flexible dentures have a longer life span and therefore are cheaper in the long run since they hardly break, crack or need to be repaired or fixed [12].

The benefits associated with flexible dentures, for instance as regards to duration and robustness, are also summarized in case reports and comparative examinations. The practical use of flexible dentures as demonstrated by this case study highlights the fact that they are strong structures that can be used durably in a patient's mouth while going through daily activities [19].

Biocompatibility

For the most part, soft line denture materials are tolerated well by patients especially when they have some reaction to PVS. Thus, flexible dentures are preferable to individuals developing allergic reactions to acrylic monomers because the materials applied are non-irritative [14]. In this literature review, allergy–testing results and patients' case–records prove that the denture materials could be highly biocompatible, especially the nylon–based resins. These materials do not contain any elements that cause allergies like styrene; therefore, skin reactions are minimalized [16]. Conduct on biocompatibility also strengthens the necessity of employing flexible dentures especially to patients with certain sensitiveness or allergies. The application of biocompatible materials in flexible dentures in the dental clinic has been helpful in reducing the probability of

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causing irritation to the patients and thus improving patient comfort [20].

Fig: 04 Polishing Kits

Challenges and Limitations

Despite their numerous advantages, flexible dentures face several challenges and limitations. These issues can impact their overall effectiveness and patient acceptance.

Adjustment Difficulty

As for the disadvantages – flexible dentures are rather flexible and this is one of the issues connected with the adjustment and repair of the appliances. Usually flexible dentures are remolded or repaired which may be a complicated process and more time consuming, than with the conventional ones requiring specialized instruments or procedures, which can also contributes to the higher price for the flexible dentures and more difficulties for the practitioners [9]. Thus, specific tools and training also involve more time and costs on the adjustment side since proper commensuration cannot be achieved. Because of this property of flexibility of the material, the patient may make multiple visits for adjustments, this may be irritating. Technical training and professional feedback stress the importance of addressing employment of specialized tools in working with flexible denture materials. It is noted that the process of using flexible dentures can be more prone to certain problems than the traditional ones, and thus might require more tools and steps to be taken for its adjustment [1].

Cost

Flexible points and materials prove more costly and the processes followed during fabrication of flexible denture material are slightly costly than the regular acrylic dentures. The initial cost is a bit high; this can pose as a challenge for some patients especially those who have insufficient amount of money to pay for the treatment [10]. This section also demonstrates legal

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aspects as well as how the financial cost and insurance of the new distributed flexible dentures are assessed. It does have the drawback of being more expensive at the beginning, but flexible dentures are usually more durable benefits in the long-run. A number of economical surveys of the patients as well as studies prove that the flexible dentures prove to be more economical in the long run because of their longer life span and relatively fewer chances of needing replacements. But the initial cost is high, and this always plays a vital role in consumers' choice or decision-making process [18].

Retention Issues

Some of the issues that may occur include; retention may be difficult especially when the patient has severe alveolar ridge resorption. Adaptability of the material may not necessarily bring the rigidity required for a tight grip and hence there is need for other means to increase holding power. Several difficulties are associated with the process of denture stabilization and is rather significant for patients with extensive bone loss or the presence of any abnormalities within the mouth area. This may mean having to add other fittings, or redesign to accommodate the fitting so that they are well fitted. Self-perceived data of the patients and clinical observations show the demand for extra methods and aids to enhance the holding possibilities of dentures. Solutions to retention problems might have to be innovative and include modifications which will guarantee stability and comfort for patients with different extents of ridge restoration [7].

Surface Roughness

Another drawback of flexible dentures is that they are even rougher on the surface than the hard ones. Polyamide is a material that is easily damaged and exemplified in this case by scratches and wears which detract the looks of the dentures while the same scratches may also lead to the accumulation of bacteria. Also, the mechanical hold of acrylic teeth to flexible denture base offers various difficulties. It may have more rates of the teeth being displaced from the base than other denture materials, thus possibly causing functional problems. It may also be a problem when color fastness is an issue for the fabric being used in the clothing. Flexible dentures may also change color with time and this is because of brush, foods, drinks, and other oral hygiene materials and products. Some of this may alter the color of the dentures which makes the dentures not look natural [6]. In addition, the efficient removal of stains on the flexible dentures is not easy with the normal polishing procedures leading to a poor surface finish which is not glossy enough to the appearance of the dentures. Flexible dentures could prove more expensive than traditional types of dentures. This can be attributed to the fact that they are produced using specialized materials and equipment hence limiting their availability to some patients. Also, it must understand that flexible dentures are generally not applicable in some clinical cases, for example, in patients with deep overbite or in cases with limited inter-arch space where the stability and function of flexible dentures can be significantly unsuitable [11]. Patients who are prone to develop flexible dentures are those with bilateral free-end distal extensions with knife-edge ridges or lingual tori [15].

Recent Advances and Future Directions

The general category of flexible dentures remains a hot topic now, given that the strides are being made in the material science and technology aspect. All these developments have been

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deemed to endeavor at dealing with some of the prevalent problems and enhance on the general efficiency of the flexi dentures [17].

Material Improvements

New and promising flexible denture bases materials have recently come out due to advanced research in the field of polymer science. New developments are such as fabrication of antimicrobial materials for use in dentures that would minimize predisposition to infection among denture users. Recently published articles show that incorporating antimicrobial agents into the denture base materials can be useful in controlling microorganisms and reducing the onset of oral infections [10]. New and improved forms of denture base materials through extensive research and innovation have facilitated development of flexible denture materials that are stronger, longer lasting and health friendly. These innovations are meant to solve problems regarding durability of prosthesis, offering both long-lasting and efficient types of prostheses. The continuum of the antimicrobial characteristics demonstrates a progressive step in diminishing the probability of oral health hazards [5].

Digital Fabrication

CAD/CAM productions and three-dimensional printing technologies that have occurred with advancement in digital technologies has positively impacted the fabrication of flexible dentures. These technologies allow for great control in the design and fabrication, and thus there is less need for modifications that would benefit the patient. It also makes the customization exact and quicker as compared to the traditional methods, thus, making dentures an efficient product. Such sources as articles and works concerning the application of digital fabrication techniques pinpoint the benefits which are associated with the usage of the mentioned technology in the framework of accurate and individual approach. CAD/CAM systems and 3D printing help in making precision dentures that can better adapt to the patient's oral tissues because of high individualization [12].

Hybrid Dentures

There are flexible and rigid types of dentures; however, the modern development of dentures that include the use of hybrid regime that comprises both the flexible and rigid components. These dentures' design is intended to take the best of both the flexible and rigid classifications of denture materials to arrive at an optimum in various clinical situations. Perhaps that is why hybrid designs are somewhat more effective in retaining patients and comfortable since they seek to meet some of an individual's requirements [13]. A literature review of the current published works and clinical trials conducted on hybrid dentures helps to conclude that this design can offer a moderate and balanced approach in the process of denture construction. The approach entails a mix of both rigid and flexible components so as to offer better form of matching to both flexible and rigid denture materials [17].

Conclusion

Flexible denture materials are the one of the revolutionizing technologies in dental prosthetics as the possibility of to use flexible denture materials can eliminate many of the associated issues connected with today's rigid ones. A new creation in dentistry is indicated by

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thermoplastic polymers and nylon-based resins that enhanced patient comfort and esthetics and enhanced functionality of a denture. Due to the flexibility of the flexible denture material, lesser chances of patients complaining of discomfort and irritation, improving on patient satisfaction. These materials harmonize with the natural gum color; it also helps to obtain a relatively more natural look than a cavity with the visible metal clasp of conventional dentures. In addition to this aesthetic value, it enhances the comfort of patients who have skin sensitivity to use the conventional materials since polyamide is hypoallergenic. Since the flexible dentures can be remodeled quickly and with minimal muss, it means that they are always effective as the patient's oral situation changes. The communication technologies like CAD CAM and 3D printing have also expanded the possibilities of flexible denture material. These technologies offer accurate, individualized, and effective solutions satisfying the objectives of fabricating work and enhancing the prognosis of patients' treatment. Due to the prospects of digitalization in the dental field notes that the usage of flexible dentures takes an improved position implying greater benefits to both patients and practitioners. To sum up, the materials used for flexible dentures are convenient, resistant, and comfortable for the patient. Due to the variety of benefits that have been described, these technologies are considered as useful additions to the contemporary prosthodontics practice and enhancing the quality of life in patients who require prostheses. Thus, given the current development of new technologies and research activities, the application of flexible denture materials will undoubtedly increase, which will help improve the quality of treatment for patients.

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