ISSN: 2959 – 3298
Received date: 07/07/2023
Acceptance date: 07/10/2023
LDN: 260/2017
JOURNAL OF SCIENCES AND TECHNOLOGIES, VOL.(7), No.(2) Dec., 2023

DIMENSIONAL CHANGES IN ACRYLIC RESIN DENTURE BASE MATERIALS: A review article

Fadila Youns Ezabi
College of Medical Sciences and Technologies
Tripoli, Libya
amrwanalzaby@gmail.com

ABSTRACT

Although acrylic resins are one of the most commonly used polymers in dentistry, heat-cured acrylic denture bases undergo dimensional changes during and after processing which may clinically affect retention, stability and patient comfort negatively

Aims: *The purpose of this review is to verify factors related to the dimensional changes of denture based acrylic resin materials, to clarify methods used in detection of dimensional changes of acrylic resin material from previous studies*

Methodology: *The data for this review was collected through an electronic search of English dental literature was performed through Google Scholar to obtain all the relevant studies and reviews as well as case reports pertaining to dimensional changes in acrylic resin .The review focused on the fact of dimensional changes that are seen throughout the processed of acrylic resin and factors contributing to measuring the dimensional precision as well, and its began with the search of relevant key words linked with the dimensional accuracy and stability of various denture base (DB) acrylic resins processed by different techniques .*

المستخلص

على الرغم من أن راتنجات الأكريليك هي واحدة من أكثر البوليمرات شيوعًا واستعمالًا في طب الأسنان ، إلا أن أطقم الأسنان المصنوعة من الأكريليك المعالج بالحرارة تخضع لتغييرات في الأبعاد أثناء وبعد المعالجة مما قد يؤثر سريريًا على الاحتفاظ والاستقرار وراحة المريض بشكل سلبي.

الأهداف: الغرض من هذه المراجعة هو التحقق من العوامل المتعلقة بتغيرات الأبعاد لمواد راتنج الأكريليك المستعملة في قواعد ا طقم الأسنان، وايضا لتوضيح الطرق المستخدمة في الكشف عن التغيرات في أبعاد مادة راتنج الأكريليك من الدراسات السابقة.

المنهجية: تم جمع البيانات الخاصة بهذه المراجعة من خلال بحث إلكتروني لمقالات علمية ودراسات سابقة مختلفة المنهجية البحتية في طب الأسنان باللغة الإنجليزية تم إجراؤه من خلال شبكة المعلومات الدولية للحصول على جميع الدراسات والمراجعات ذات الصلة بالإضافة إلى تقارير الحالة المتعلقة بالتغييرات في الأبعاد في راتنج الأكريليك ، وركزت المراجعة على حقيقة التغيرات في الأبعاد التي يتم ملاحظتها خلال معالجة راتنج الأكريليك والعوامل المتعلقة بها التقنيات التي تساهم في قياس دقة الأبعاد أيضًا ، وبدأت بالبحث عن الكلمات الرئيسية ذات الصلة ومنها: راتنج الاكريليك - قواعد الاطقم -البوليمر

Keywords: *acrylic, resin, denture, PMMA, polymers.*

1. INTRODUCTION

Since 1930, Polymethyl methacrylate (PMMA) has been the most popular denture base material in the field of dentistry. It is used for repairs, tooths, orthodontic appliances, and maxillofacial prosthesis, in addition to its use in crown and bridge work as a temporary coverage of prepared tooth and a denture base material. In comparison of PMMA with other resin materials, the material meets necessary characteristics such as sufficient strength to withstand mastication forces, maintain dimensional stability, and is easy to manipulate. Furthermore, it's less irritant to the oral mucosa, is nontoxic with better aesthetics as well

ISSN: 2959 – 3298
Received date: 07/07/2023
Acceptance date: 07/10/2023
LDN: 260/2017

[1]. Although acrylic resin is the most commonly used material in dental construction, it is subjected to dimensional changes before, during, and after processing [2].

The dimensional instability of acrylic resin denture base results from both polymerization shrinkage and stresses released during flask cooling and incomplete polymerization [3]. which affects the retention and stability of the denture and patient comfort as well. The greatest effect of linear shrinkage would be seen on the post dam area of the upper denture causing a space between the supporting region and the denture base. By using traditional flasking technique, the residual internal tension would be released before PPMA polymerization occurs and that could lead to movement of upper and lower members of the flask up on removal from press unite and placement in to the clamp [4]. It has been reported that the degree of polymerization shrinkage occurred in the range of 6~20% after curing (in various commercialized resins). This will affect the quality of complete denture and result in inaccurate adaptation of the denture to the tissue, reduction in denture stability and retention and changes in the positions of the artificial teeth [5,6].

The changes in the dimension of denture base acrylic resin material are influenced by many variables such as the ratio of polymer to monomer, as well as processing temperatures (heating and cooling) of denture bases, which will affect the amount of denture distortion. Heating during processing of acrylic denture base leads to polymerization shrinkage which is not uniform throughout the denture base [7]. Therefore, a lot of literature has conventionally recommended long second cures at low temperatures. The polymerization process is activated by water bathing in a packed flask and increasing the temperature. It is an exothermic reaction that could be related to greater denture base distortion. A study conducted by Yeung et al (1995) on the effect of cooling rate on linear dimensional changes associated with dual cure methods. They reported that there was no statistical significance in overall linear dimensional changes of -0.44% and -0.51% for the slow cooling and rapid cooling methods. A lot of processing technology has been introduced to overcome dimensional instability related to conventional processing methods of PPMA denture base. Pryor, in 1942 introduced the injection- molding technique which has reported no significant advantages over the conventional method. While the injection-molding system, which was introduced by Ivoclar in 1970, claimed to produce a dimensionally stable denture. The Ivoclar system depends on injection of a pre-measured mixing of methyl methacrylate liquid and powder under continuous pressure with temperature and pressure of about 100c and the curing process lasts for 55 minutes [8-9].

The findings of a study conducted by Bouattour et al. (2022) to assess the relation between over- night denture storage conditions in a dry vs wet environment and changes in dimensional stability of removable prostheses. Reported no significant differences was found [11].

2. HISTORY

In the past few years, researchers have been focused on improvement of present acrylic denture base material chemically and mechanically or introducing new ones to

ISSN: 2959 – 3298
Received date: 07/07/2023
Acceptance date: 07/10/2023
LDN: 260/2017

overcome the disadvantages of conventional poly- methylmeth-acrylate denture materials. In the 1950s, new developments in the field of polymerizable dental resins resulted in the production of alternative thermoplastic resin materials such as epoxy resins, polyamides (nylon). Polystyrene was developed in the 1948s, followed by acetal resins in the 1971s, and polycarbonate resins. The most important characteristics of thermoplastic resins are, they are monomer free, non-allergic biocompatible, nontoxic, highly esthetic and also can be injected using special devices [5]. Thermoplastic resin materials are considered as good alternatives to conventional PMMA [9]. They showed a lower percentage of water sorption and dimensional stability. Meanwhile, the conventional resin exhibits a high-water sorption degree that causes dimensional changes [10].

In order to maintain the oral health of denture wearers and prevent denture stomatitis, patients are advised to use daily chemical denture cleaners besides mechanical cleaning methods[11] .Many studies have been done evaluating the effect of denture cleansers on the linear dimensional change of acrylic resin materials. Pongkornkumpon et al., 2021 tested the effects of 180 days soaking in different chemical cleaners on many specimens of heat-polymerized acrylic resin with compression technique and IvoBase hybrid with injection molding technique as well [12].The results showed that denture cleansers did not significantly affect the linear dimension changes of both the heat polymerized acrylic resin and the IvoBase hybrid after 180 days of being immersed in denture cleansers and supported other studies finding on the injection molding procedure which had the advantages over conventional processing methods in terms of dimensional stability [12]. The differences in monomer-polymer ratio are another factor that can cause dimensional change in the acrylic resin [13]. A study by (Cristina M, et, al) to evaluate whether differences in monomer content in the monomer-polymer ratio could influence the linear displacement of teeth in dentures processed by conventional and microwave energy techniques. Based on the obtained results, there was no statistically significant difference in dimensional changes between (control) and the experimental groups (25% excess or 25% less monomer) for conventional and micro-waved resins.

3. PROGRESSIVE DEVELOPMENTS

Progressive developments have been done to improve the mechanical and physical properties of resin polymer denture base material, resulting in introducing new alternative fabrication methods. Recently, complete dentures have been fabricated using CAD-CAM technology. The digitally fabricated complete denture has good retention, better fitness and improved dimensional stability than that of a conventional complete denture [14, 15]. For many years, there was continuous improvement in dental bio-materials used in the field of polymer .Theses attempts were done to improve the properties of acrylic resin polymer and resulted in the appearance of re-inforced polymers with high module natural or synthetic fibers such as glass fiber,carbon fiber and nano-particles reinforcement which provides higher compressive, tensile, impact and flexural strengths of PPMA. Ratwita et al 2007 concluded that acrylic resin shows minimum dimensional change after reinforcement with

ISSN: 2959 – 3298
Received date: 07/07/2023
Acceptance date: 07/10/2023
LDN: 260/2017

glass fibre. [19, 20] . Safi N,2016 reported a decrease in the thermal expansion coefficient and contraction after adding tita-nium dioxide (TiO_2) with PPMA [21].

Table (1):
Flexural strength of hot curing resins repaired with polyethylene

Material	Flexural Strength
Polyethylene fibers wet with MMA 24 h	110.4± 4.5MPa
Polyethylene fibers wet with MMA 28 days	108.2 ± 3.7MPa
Polyethylene fibers wet with Construct resin 24 h	129.2 ± 3.1MPa
Polyethylene fibers wet with Construct resin 28 days	124.5 ± 4.1MPa
Polyethylene fibers wet with Villacryl ULS 24 h	113.5 ± 2.9MPa
Polyethylene fibers with Villacryl ULS 28 days	115.6 ± 3.8MPa
REF: Zbigniew Raszewski et al.2013 International Journal of Biomedical Materials Research 2013; 1(1) [9-13]	

Table (2):
Flexural strength of hot curing resins repaired with glass fibers

Material	Flexural Strength
Glass fibers wet with MMA 24 h	112.4± 4.3MPa
Glass fibers wet with MMA 28 days	105.2 ± 4.4MPa
Glass fibers wet with Construct resin 24 h	135.3 ± 5.1MPa
Glass fibers wet with Construct resin 28 days	123.1 ± 4.1MPa
Glass fibers wet with Villacryl ULS 24 h	136.9 ± 3.7MPa
REF: Zbigniew Raszewski et al.2013 International Journal of Biomedical Materials Research 2013; 1(1):[9-13]	

Different methods have been introduced for measuring dimensional accuracy of acrylic resin, such as, the use of Vernier calipers, gauges, comparators, micrometers, and radiography [16]. Keenan PL et al 2003 compared the dimensional changes of simulated maxillary complete den-tures during polymerization by the use of an internal micrometer. [17]. Mosharraf R.et al 2009 compared the linear dimensional changes of two heat-acrylic resins using a digital caliper. Gharechahi et al, for determination of the overall gap formation and dimensional changes of denture bases, they scanned dentures placed on the working casts of computerized tomography (CT) to Optical laser scanner used by Lee s et al 2016 while boelroos E,et al 2016 used a universal measuring microscope with an accuracy of 0.001mm to detect presence of gap between the resin base processed by different methods and different curing cycles and stone cast was measured at posterior palatal area at many points However, these methods may not be sensitive enough to detect changes that occur in 3D space. It is expected by digital technologies such as the use of 3-D scanning devices that provide a better understanding of acrylic resin behavior.

ISSN: 2959 – 3298
Received date: 07/07/2023
Acceptance date: 07/10/2023
LDN: 260/2017

4. RESULTS AND DISCUSSION

Based on previous reviewed studies, Despite the agreement on that heat cured acrylic resin denture base material undergoes different dimensional changes because of shrinkage during the polymerization process as well as thermal contraction and releasing of internal stress, as well as many studies reported on the negative impacts of changes in the dimensions of denture base material on the stability and retention of complete denture as well as on patient comfort and satisfaction with removable dental prosthesis. There were different results and statistical significance regarding factors related to dimensional changes of PPMA denture base materials .Theses differences in findings could be attributed to many reasons such as differences in the study methodology, tools used for measurements, properties of PPMA used as well as processing methods and others factors

5. CONCLUSION

Although (PMMA) is one of the most popular materials used in prosthetic dentistry. It is commonly used for fabrication of removable complete denture, relining and re-basing procedures as well. The material meets necessary characteristics such as sufficient strength to withstand mastication forces, maintain dimensional stability, and it's easy to manipulate 1 . Furthermore, it's less irritant to the oral mucosa, non-toxic with better aesthetic as well and, however, this material undergoes dimensional changes during processing and after cooling, which could have effects on stability, accuracy and patient comfort as well. The most applicable method for curing acrylic resin due to its simplicity and relatively good accuracy is the conventional processing method. Therefore, in various studies, this method has been considered the gold standard for comparison with other techniques. Among denture processing methods, injection molding has always been interesting for researchers because of compensation of polymerization shrinkage due to the pressure exerted by injection of the acrylic resin [16]. Differences in acrylic resin brands may be considered another variable in addition to molding technique, affecting the mechanical properties. Different factors could be responsible for the dimensional change of the acrylic resin denture base effect on the accuracy of denture in the oral . Many successful studies reported the use of reinforcement added to heat polymerized acrylic bases could improve the mechanical properties of these denture bases,

REFRENCES

1. Jaelee CH.. Bem bok S. young BAE. Lee young H. comparative adaptation accuracy of acrylic denture bases evaluated by two methods. Dent. Mat J.2010; 29(4); 411-417.
2. Salim S, Sadamori S, Hamada T. The dimensional accuracy of rectangular acrylic resin specimens cured by three denture base processing methods. J Prosthet Dent 1992; 67: 879-881.
3. Anusavice KJ. Philips science of dental materials. 11 th ed., st. louis: Sounders Co; 2003;721-757.
4. Arafa KAO. Effect of different denture base materials and changed mouth temperature on dimensional stability of complete dentures. Int J Dent. 2016; 2016:7085063. Doi:

ISSN: 2959 – 3298
Received date: 07/07/2023
Acceptance date: 07/10/2023
LDN: 260/2017

10.1155/2016/7085063.
5. Woefel JB. Processing complete dentures. Dent Clin North Am 1977,21:329-338.
6. Rueggeberg FA. "From vulcanite to vinyl, a history of resins in restorative dentistry". Journal of Prosthetic Dentistry 87.4(2002)- 364-379
7. Darvell BW. Acrylics. In: BW Darvel, editor. Materials Science for Dentistry 9 th Ed. Woodhead publishing, United Kingdom, 2009; 108-127
8. Jafar Gharechahi Nafiseh Asadzadeh, Foad Shahabian, Maryam Gharechahi Conventional Versus Injection-Molding Technique. Journal of Dentistry, Tehran University of Medical Sciences.July 2014; Vol. 11, No. 4
9. Saleh Abdullah Al-Ghamdi1, O. A. (2018). Dimensional Changes and Water Sorption of Vertex Thermosense Versus a. Acta Scientific Dental Sciences.
10. MayHamza, MazenAlsolam, Musaad Oudah A Alanazi Abduljalil Bader Alhadi and Alwaleed Alarjan: Appraise the different types of polymer used in denture base Through their physical property (water sorption): EIM Journal : 6-2020
11. Yasmine Bouattour, Nicole Kalberer, Najla Chebib, Philippe Mojon,Albert Mehl,Murali Srinivasan, Frauke Müller: Effects of Overnight Storage Conditions on Conventional Complete Removable Prostheses: The International Journal of Prosthodontics: Volume 35, Number 6, 2022
12. Somchai Pongkornkumpon, Chaivut Prunkngarmpun, Subin Puasiri : Linear Dimensional Changes of Acrylic Resin Denture Bases After Using Denture Cleansers: Conventional and Injection-molding Techniques: J DENT ASSOC THAI VOL.71 NO.2 April - June 2021.
13. Anusavice KJ. Phillips' science of dental materials. 11th. ed. Elsevier, Chicago;2003.Mosharraf R, Farzan A., Hatamzadeh E: Comparison of Linear Dimensional Changes of two Heat– cure Acrylic Resins: Shiraz Univ Dent J 2009; 10(1): 38-43
14. Ibrahim M Hamouda * and Alaa Makki : History and Development of Polymeric Denture Base Reinforcement: Acta Scientific Dental Sciences 6.6 (2022): 111-12
15. Erna R. Einarsdottir, Alessandro Geminiani, Konstantinos Chochlidaki, Changyong Feng, Alexandra Tsigarida, and Carlo Ercoli, Dimensional stability of double-processed complete denture bases fabricated with compression molding, injection molding, and CAD-CAM subtraction milling :THE JOURNAL OF PROSTHETIC DENTISTRY .July 2020 Volume 124 Issue 1
16. Yunus N, Rashid AA, Azmi LL, Abu-Hassan MI. Some flexural properties of a nylon denture base polymer. *J Oral Rehabil.* 2005; 32:65–71. [PubMed] [Google Scholar]
17. Keenan PLT, Radford DR, and Clark RKF. Dimensional change in complete denture fabricated by injection molding and microwave processing. J. Prosthet Dent 2003; 89: 37-44.
18. Seo-Ryeon Lim, Joon-Seok Lee: Three-dimensional deformation of dry-stored complete denture base at room temperature: J Adv Prosthodont 2016;8:296-303

ISSN: 2959 – 3298
Received date: 07/07/2023
Acceptance date: 07/10/2023
LDN: 260/2017

19. Dwiyanti Feriana Ratwita and Rinda Mahalistiyani: Dimensional change of acrylic resin plate after the reinforcement of glass fibre: Dent. J. (Maj. Ked. Gigi), Vol. 40. No. 2 April–June 2007: 61–64
20. Ehab M. Aboelroos and Amr A. Rady: The Effect Of Two Packing Techniques on Adaptation of Resin Denture Base Materials. EGYPTIAN DENTAL JOURNAL. Vol. 62, 1169:1176, January, 2016
21. Safi IN. Evaluation the effect of nano-fillers (TiO 2, AL 2 O 3, SiO 2) addition on glass transition temperature, E-Moudulus and coefficient of thermal expansion of acrylic denture base material. J Bagh Coll Dent. 2014; 26:37**–41.**