Health, Sports & Rehabilitation Medicine
Vol. 25, no. 1, January-March 2024, 57–60

An overview of denture fractures

Cecilia Bacali[1], Mariana Constantiniuc[1], Anne-Marie Constantin[2], Antarinia Crăciun[1]
[1] *Prosthetic Dentistry and Dental Materials Department, "Iuliu Haţieganu" University of Medicine and Pharmacy, Cluj-Napoca, Romania*
[2] *Histology Department, "Iuliu Haţieganu" University of Medicine and Pharmacy, Cluj-Napoca, Romania*

Abstract
Background. Nowadays, acrylic dentures are commonly used in the treatment of various clinical situations. The preoccupations in improving physical and biological properties are therefore mandatory.
Aims. The aim of this study was to assess the most common causes that lead to fractures in different areas of both, mandibular and maxillary dentures, considering the materials, the polymerization techniques but also the possibility of enhancing the fracture resistance.
Methods. Literature research among the latest articles published on this topic was performed using related keywords.
Results. Several issues involved in denture fractures can be related to the dentist, technician, and patient.
Conclusions. The proper analysis and consideration of the causes, treatment steps and recommendations can reduce the risk of denture fractures.
Keywords: denture fractures, edentulism, complete dentures fabrication, acrylic resin, PMMA.

Introduction

The wear of partial or complete dentures is frequent among general population because of tooth loss caused by caries, periodontal diseases, traumatisms, tooth related tumors or inflammatory diseases. The absence of teeth determines different functional problems concerning mastication, phonation, dento-maxillary system self-maintenance function and also esthetics, being considered an important public health issue (Takamiya et al., 2012). While mid-aged individuals in general lose a relatively small number of teeth, in old individuals a higher number of missing teeth as well as complete edentulism are often found. The growing number of denture wearers is also attributed to the demographic changes due to the constant increasing longevity worldwide.

One of the most common problems associated with denture wear is denture fracture, which causes functions alterations in the dental maxillary system and discomfort for the patient in the absence of the prosthetic device.

Among the materials used for dentures since 1950, acrylic resins have been widely accepted and used due to their excellent properties regarding aesthetics, ease of manipulation and repair, but also for economic reasons. Ever since, it continues to be highly used in dental prosthetics (Jagger et al., 1999). Therefore, acrylic resin remains the material of choice for acrylic dentures, but special attention must be paid to possible fractures, that must be prevented or rectified (Darbar et al., 1994).

Material and methods

Literature research among the latest articles published on this topic was performed using related keywords (denture fractures, edentulism, complete dentures fabrication, acrylic resin, PMMA).

Results

Polymethyl methacrylate (PMMA) is still widely used as a material for the denture base. This unique material is considered the material of choice for making the denture base due to its low water solubility/sorption and cost, mechanical strength, and dimensional stability. Poor mechanical properties, such as impact strength, dimensional instability and residual monomer content can be considered the main disadvantages of acrylic resins. Poor mechanical properties usually lead to fracture of the denture base (Khan et al., 2017).

To improve the mechanical properties of the denture base materials, different approaches have been considered.

Received: 2024, January 17; *Accepted for publication:* 2024, January 25
Address for correspondence: Histology Department, Iuliu Haţieganu University of Medicine and Pharmacy, No. 6 Louis Pasteur Street, 400349 Cluj-Napoca, Romania
E-mail: annemarie_chindris@yahoo.com
Corresponding author: Anne-Marie Constantin; annemarie_chindris@yahoo.com
https://doi.org/10.26659/pm3.2024.25.1.57

Experiments have been carried out in the last two decades, such as the incorporation of filler particles and fibers of various orientations, sizes, and shapes (Khosravani, 2019; Galav et al., 2017). Also, the use of nanoparticles to improve the poor mechanical properties has increased (Aldegheishem et al., 2021). Since nanoparticles tend to agglomerate in a polymer matrix of the denture, the hardness of the resin polymer can increase (Gad et al., 2020). In contrast, tensile and bending strength, and other important mechanical properties are greatly affected due to the inhomogeneous dispersion of nanoparticles in the matrix system. Moreover, orientation, shape, form, surface treatment and interfacial adhesion of nanoparticles with polymer matrix are some of the crucial aspects to consider (Naji et al., 2018).

Chemical modification of the PMMA or altering the polymerization methods were conducted trying to fabricate a novel, experimental, more resilient, durable, and tough denture base material, with a high fracture resistance (Rached et al., 2001). In recent years, tunable properties in the new material have been achieved by executing chemical modifications. To accomplish the manufacturing of an acrylic material with increased mechanical properties, the blending of copolymers in different volumetric ratios and with different properties was performed (Arlen & Dadmun, 2003; Bacchi et al., 2015).

Nowadays, enhancing the mechanical properties can be achieved due to the advancements in technology and science (Goodacre et al., 2016). Pre-polymerized acrylic resin blocks are now available, with no polymerization shrinkage in the milling process, and also no technical error in the 3-D printed denture resin (Kawara et al., 1998). Promising materials like polyetheretherketone (PEEK), polyamide and polycarbonate, represent the newer thermoplastic resins with increased toughness (Takahashi et al., 2009). Favorable features in the manufacturing of the PMMA denture base can be offered also by using High-performance polymer (BioHPP) based on polyether ketone (AL-Rabab'ah, et al., 2019).

The polymer transformation of the monomers, using the traditional polymerization method, is due to the increasing heat that allow polymeric chains to grow (Anusavice et al., 2012). A deceleration in the growth and polymer formation is initiated by the temperature reduction with a major impact on a higher quantity of residual monomers in the polymerized resin (Urban et al., 2007). This phenomenon can affect in a negative manner the biological but also the mechanical and physical properties of the resin (Ayman, 2017). To overcome this inconvenience, over time, modifications of the curing procedures have been undertaken to enhance mechanical and physical properties of the materials used for denture base. Among these techniques the followings can be mentioned: injection moulding, autoclaving, microwave energy, heat polymerization under high pressure, 3-D printing and CAD-CAM milling.

Discussion

Denture fractures can occur as a consequence of different causes. One of the most common causes of denture fractures is the accidental dropping after removal or before insertion in the oral cavity, or during the cleaning procedures, especially in old people or in cases of patients with motility or cognitive problems (Bosanceanu et al., 2017). Forced insertions or dysinsertions or the bite on the dentures improperly inserted can induce cracks in the material (Bosanceanu et al., 2017). High forces during mastication, directed in a limited area or the interposition of hard aliments, can also be mentioned in denture fractures etiological factors because of the flexural fatigue (Wiskott et al., 1995). The placement of the artificial teeth outside the ridge can determine an incorrect transmission of the occlusal forces with possible consequences on denture integrity (Kumari & Bala, 2021). Imbalanced occlusion with the presence of teeth interferences and premature contacts may cause fissures or even fractures because of the high loadings in certain areas of the artificial teeth and denture base (Bosanceanu et al., 2017; Vallitu et al., 1993; Beyli & von Fraunhofer, 1981). The incongruence between the denture mucosal surface and the supporting tissues due to the bone atrophy and resorption processes can also favor undesired tensions inside the acrylic material (Morrow RM et al., 1986). Another cause of fractures in the base of the prothesis can be the presence of pores because of incomplete or incorrect polymerization (Vallitu et al., 1993); thin palatal or flanges areas, as well as high frenal attachments and presence of palatal or mandibular tori were also mentioned (Bosanceanu et al., 2017; Kumari & Bala, 2021). Diastema is not recommended in artificial teeth placement, as it represents a weak zone that can be associated to denture median fractures (Bosanceanu et al., 2017).

The fractures can be found in the artificial teeth or in the denture base. The teeth can be chipped, severely fractured or even detached from the base, while the base can be affected by fractures of different directions and localizations (Vallitu et al., 1993). A study done by Darbar et al. on the prevalence of the fractures in dentures showed the following distribution: 33% debonded/ detached teeth, 29% midline fractures (mostly in the upper denture) and 38% other fractures (Darbar et al., 1994). In another study, conducted by Bosanceanu et al. found the following distribution of the fractures in maxillary/ mandibular dentures: median 62%: 60%, canine area 26%: 10%, premolar region 0: 4%, molar zones 4%: 8%, other 4%: 4%: they appear mostly between 2-4 years of denture use (Bosanceanu et al., 2017).

Choudhary et al proposed a classification of the fracture lines (shown in Fig. 1 and Fig. 2) as follows:

Class I midline fracture with sagittal direction

Class II: paramedian fracture with oblique direction

Class III: Semicircular fracture of the buccal or lingual flange

Class IV: Detachment of two or more teeth with the corresponding denture base

Class V: Fracture or detachment of a single tooth

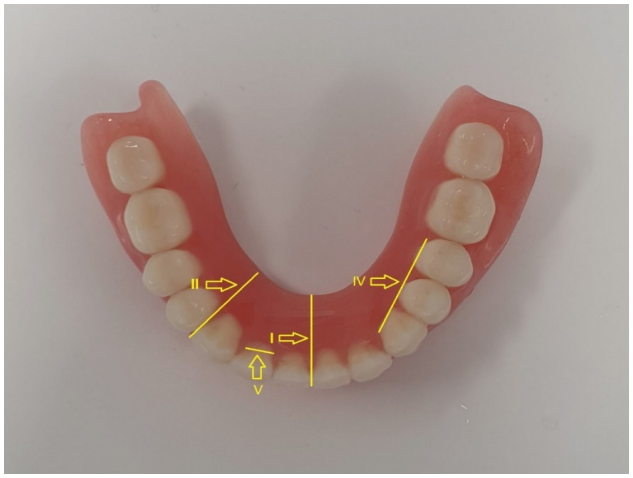

Fig. 1 – Mandibular fracture lines.

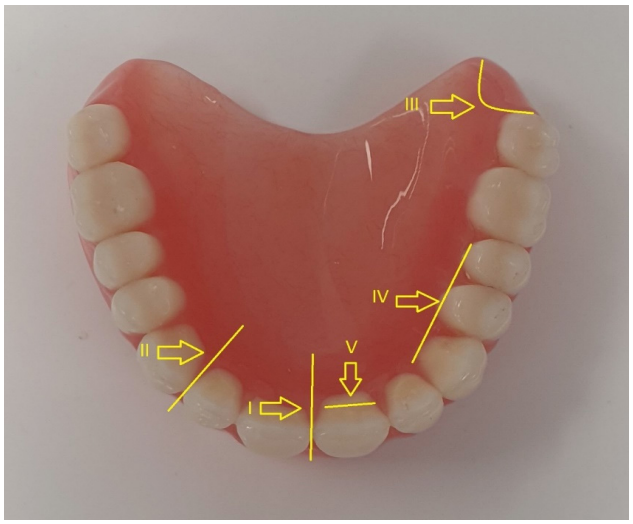

Fig. 2 – Maxillary fracture lines.

Midline fractures (class I) were the most common for both mandibular and maxillary dentures (61% of mandibular denture fractures, 46.87% of maxillary denture fractures) (Choudhary et al., 2019).

The most damaged denture is the upper one (Darbar et al., 1994; Vallitu et al., 1993). The fractures of the maxillary denture have certain characteristics, based on their localization. The midline fractures are found most frequently, followed by the fractures of the artificial teeth/ detachment of a single tooth, semicircular fractures on the labial or buccal flange and paramedian fractures; less frequent were the fractures in the fracture of the base with 2 or more teeth (Choudhary et al., 2019).

Class II, followed by class V was the second most common fracture found in the mandibular denture group (24% of mandibular denture fractures) (Choudhary et al., 2019).

A slight percentage of cases in the mandibular denture was found for class IV fractures (3,5% of mandibular denture fractures) and not a single Class III case (Choudhary et al., 2019).

The repair of the damaged denture is usually done by the dental technician in the laboratory, after the registration of denture basal seat (in denture base fractures) and of the occlusal relations (in fractures concerning the teeth).

The most frequently used material for repairs is the autopolymerizing acrylic resin due to low cost, easy handling, and quick repair (Fao et al., 2009). Heat polymerized acrylic resins, followed by microwave were found to be best in the category of heat-, microwave- or light- polymerized acrylic resins (Ng et al., 2004; Rached et al., 2004). Autopolymerized acrylic resin was found comparable to microwave-polymerized and conventional heat-cured acrylic resin in terms of repair strength (Agarwal et al., 2008). In regards of repairing acrylic tooth debonding, cyanoacrylate adhesive was found to be effective in combination with microwave polymerization (BinMahfooz & Qutub, 2018).

Conclusions

1. Denture fracture is one of the main complaints of denture wearers (due to the lack of comfort produced by denture absence) whenever repairs are considered.
2. There are several causes that favor denture damage and different localizations of the fracture lines.
3. The maxillary denture fractures are more often found than those of the mandibular ones; the midline is the area most involved.
4. The main clinical and technical procedures are highlighted to avoid the occurrence of the denture fractures:
   A. higher resistance materials and modern techniques should be used;
   B. accurate fabrication steps should be performed by the dental technician;
   C. a good denture fitting should be obtained;
   D. necessary improvements should be done by the dentist;
   E. a proper care of the prosthesis should be performed by the wearers;
5. A higher quality of life for denture wearers can be obtained by reducing the risks of denture fractures.

Conflict of interests

None

References

Agarwal M, Nayak A, Hallikerimath RB. A study to evaluate the transverse strength of repaired acrylic denture resins with conventional heat-cured, autopolymerizing and microwave-cured resins: An in vitro study. J Indian Prosthodont Soc 2008;8(1):36-41. DOI:10.4103/0972-4052.43252.

Aldegheishem A, AlDeeb M, Al-Ahdal K, Helmi M, Alsagob EI. Influence of reinforcing agents on the mechanical properties of denture base resin: a systematic review. Polymers 2021;13(18):3083. doi: 10.3390/polym13183083.

AL-Rabab'ah M, Hamadneh W, Alsalem I, Khraisat A, Abu Karaky A. Use of high performance polymers as dental implant abutments and frameworks: A case series report. J Prosthodont. 2019;28(4):365-372. doi: 10.1111/jopr.12639.

Arlen M, Dadmun M. The reinforcement of polystyrene and poly (methyl methacrylate) interfaces using alternating

copolymers. Polymer. 2003;44(22):6883-6889. doi:10.1016/j.polymer.2003.08.025.

Ayman A-D. The residual monomer content and mechanical properties of CAD/CAM resins used in the fabrication of complete dentures as compared to heat cured resins. Electron Physician. 2017;9(7):4766-4772. doi: 10.19082/4766.

Bacchi A, Consani RL, Martim GC, Pfeifer CS. Thio-urethane oligomers improve the properties of light-cured resin cements. Dent Mater. 2015;31(5):565-574. doi: 10.1016/j.dental.2015.02.008.

Beyli MS, von Fraunhofer JA. An analysis of causes of fracture of acrylic resin dentures. J Prosthet Dent. 1981;46(3):238-241. doi: 10.1016/0022-3913(81)90206-7.

BinMahfooz AM, Qutub OA. Effect of surface treatments and adhesive materials on the shear bond strength of artificial denture teeth to denture base resins. J Contemp Dent Pract. 2018;19(6):631-636. doi: 10.5005/jp-journals-10024-2310.

Bosanceanu DN, Beldiman A, Baciu RE, Bolat M, Bosanceanu DG, Forna NC. Complete dentures fractures- Causes and incidence. Ro J Oral Rehabil. 2017;9(1):54-59.

Choudhary S. Complete denture fracture - A proposed classification system and its incidence in National Capital Region population: A survey. J Indian Prosthodont Soc. 2019;19(4):307-312. doi: 10.4103/jips.jips_312_18.

Darbar UR, Huggett R, Harrison A. Denture fracture: A survey. Br Dent J. 1994;176(9):342-345. doi: 10.1038/sj.bdj.4808449.

Faot F, da Silva WJ, da Rosa RS, Del Bel Cury AA, Garcia RC. Strength of denture base resins repaired with auto-and visible light-polymerized materials. J Prosthodont. 2009;18 (6):496-502. doi: 10.1111/j.1532-849X.2009.00470.x.:496-502.

Gad MM, Abualsaud R, Al-Thobity AM, Baba NZ, Al-Harbi FA. Influence of addition of different nanoparticles on the surface properties of poly (methylmethacrylate) denture base material. J. Prosthodont. 2020;29(5):422-428. doi: 10.1111/jopr.13168.

Galav A, Deogade SC, Mantri S, Sumathi K, Galav S. Effect of water storage on the flexural strength of heat-cured denture base resin reinforced with stick(s) glass fibers. Contemp Clin Dent. 2017;8(2):264-271. doi: 10.4103/ccd.ccd_157_17.

Goodacre BJ, Goodacre CJ, Baba NZ, Kattadiyil MT. Comparison of denture base adaptation between CAD-CAM and conventional fabrication techniques. J Prosthet Dent. 2016;116(2):249-256. doi: 10.1016/j.prosdent.2016.02.017.

Jagger DC, Harrison A, Jandt KD. The reinforcement of dentures. J Oral Rehabil. 1999;26(3):185-194. doi: 10.1046/j.1365-2842.1999.00375.x.

Kawara M, Komiyama O, Kimoto S, Kobayashi N, Kobayashi K, Nemoto K. Distortion behavior of heat-activated acrylic denture-base resin in conventional and long, low-temperature processing methods. J Dent Res. 1998;77(6):1446-1453. doi: 10.1177/00220345980770060901.

Khan AA, Mirza EH, Syed J, Al-Khureif A, Mehmood A, Vallittu PK, Alfotawi R. Single and multi-walled carbon nanotube fillers in poly (methyl methacrylate)-based implant material. J. Biomater. Tissue Eng. 2017;7(9):798-806. DOI:10.1166/jbt.2017.1638.

Khosravani MR. Mechanical behavior of restorative dental composites under various loading conditions. J Mech Behav Biomed Mater. 2019;93:151-157. doi: 10.1016/j.jmbbm.2019.02.009.

Kumari R, Bala S. Assessment of cases of complete denture fracture. J Pharm Bioallied Sci. 2021;13(Suppl 2):S1558-S1560. doi: 10.4103/jpbs.jpbs_284_21.

Naji SA, Behroozibakhsh M, Kashi TSJ, Eslami H, Masaeli R, Mahgoli H, Tahriri M, Lahiji MG, Rakhshan V. Effects of incorporation of 2.5 and 5 wt% TiO2 nanotubes on fracture toughness, flexural strength, and microhardness of denture base polymethyl methacrylate (PMMA). J. Adv. Prosthodont. 2018;10(2):113-121. doi: 10.4047/jap.2018.10.2.113.

Ng ET, Tan LH, Chew BS, Thean HP. Shear bond strength of microwaveable acrylic resin for denture repair. J Oral Rehabil 2004;31(8):798-802. doi: 10.1111/j.1365-2842.2004.01295.x.

Anusavice KJ, Shen C, Rawls HR. Phillips' science of dental materials. Elsevier Health Sciences. 2012.

Rached R, Del-Bel Cury A. Heat-cured acrylic resin repaired with microwave-cured one: Bond strength and surface texture. J Oral Rehabil. 2001;28(4):370-375. doi: 10.1046/j.1365-2842.2001.00666.x.

Rached RN, Powers JM, Del Bel Cury AA. Efficacy of conventional and experimental techniques for denture repair. J Oral Rehabil 2004;31(11):1130-1138. doi: 10.1111/j.1365-2842.2004.01351.x.

Morrow RM, Rudd KD, Rhoads JE. Dental laboratory procedures: Complete Dentures. Pub Michigan Univ, 1986.

Takahashi H, Kawada E, Tamaki Y, Teraoka F, Hosoi T, Yoshida T. Basic properties of thermoplastic resins for denture base material referred to "non clasp denture". J Jpn Dent Mater. 2009;28(3):161-167. Material Number: G0583B

Takamiya AS, Monteiro DR, Marra J, Compagnoni MA, Barbosa DB. Complete denture wearing and fractures among edentulous patients treated in university clinics. Gerodontology. 2012;29(2):e728-734. doi: 10.1111/j.1741-2358.2011.00551.x.

Urban VM, Machado AL, Oliveira RV, Vergani CE, Pavarina AC, Cass QB. Residual monomer of reline acrylic resins: Effect of water-bath and microwave post-polymerization treatments. Dent Mater. 2007;23(3):363-368. doi: 10.1016/j.dental.2006.01.021.

Vallittu PK, Lassila VP, Lappalainen R. Evaluation of damage to removable dentures in two cities in Finland. Acta Odontol Scand. 1993;51(6):363-36 9. doi: 10.3109/00016359309040587.

Wiskott HW, Nicholls JI, Belser UC. Stress fatigue: Basic principles and prosthodontic implications. Int J Prosthodont. 1995;8(2):105-116.