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ORIGINAL ARTICLE

A SEVEN-YEAR LONGITUDINAL STUDY OF TECHNICAL COMPLICATIONS IN REMOVABLE DENTURES

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This study aimed to analyze the frequency and type of technical complications in different categories of removable dentures. We examined clinical health records of 637 denture wearers who presented for repair and collected information on fracture type (tooth, base, clasp), arch location (maxilla vs. mandible), and denture type. Tooth fractures were the most common complication in both arches. In the upper arch, complete dentures showed the highest incidence of base fractures (20.1%), while in the lower arch, the most common complication was acrylic partial denture clasp fractures (56,7%), followed by base fractures (48.4%). Because the prevalence and distribution of denture fractures vary significantly by denture type and arch location, our findings emphasize the critical role of material selection and reinforcement techniques in extending the service life of removable dentures.

Keywords: denture fracture, removable dentures, resins, dental materials

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INTRODUCTION

According to a WHO report from 2022, elderly people make up one-sixth of the total population, and 4.44% of the whole population, which is 0.35 billion people, were affected by edentulism (1,2). Removable complete and partial dentures are the most common solution for oral rehabilitation, especially among elderly patients, when there is a lack of anatomical and financial support for a higher-quality solution. Aging is associated with a progressive reduction in both the quantity and quality of alveolar bone available for dental implant placement, potentially limiting the feasibility and predictability of implant-supported prosthetic rehabilitation. These dentures, despite the shortcomings, improve mastication, phonetics, facial esthetics, and general quality of life. In spite of major advances in fabrication techniques and the development of polymer-based dental materials, fractures of removable dentures continue to occur at similar or even increasing rates (3). The most common causes of denture fractures include the absence of intimate contact between the denture base and the underlying mucosa, occlusal discrepancies, material fatigue, and patient-related factors such as inadequate hygiene or accidental dropping of the denture. Bone remodeling and resorption after extractions occur rapidly (within a few weeks). This can lead to destabilization of dentures made by poly (methyl methacrilate) (PMMA), and potentially to fractures. Bone resorption occurs much more slowly over several years with long-term dentures. Immediate removable dentures inserted on the day of extractions require a specific protocol to prevent fractures, such as relining (4). Removable Cr-Co-Mo prostheses are considered permanent prostheses. They are most often made following the replacement of an existing prosthesis (immediate, temporary, or permanent). Based on their morphology and location, fractures can be categorized into artificial tooth fractures (adhesive, cohesive, or combined), denture base fractures, and clasp fractures. The frequency and type of fracture depend on multiple parameters, including the prosthesis design (complete denture, acrylic removable partial dentures (RPDs) with wire clasps, or cast metal framework denture with cast clasps), material composition, duration of use, and patient-specific habits. PMMA remains the most commonly used denture base resin due to its ease of manipulation, biocompatibility, and esthetics (5,6). However, PMMA exhibits brittle behavior and low impact resistance, which may increase its susceptibility to fracture under functional and parafunctional loading conditions (6). Current research efforts are increasingly focused on modifying PMMA with reinforcing agents such as fibers, nanoparticles, or forming interpenetrating polymer networks (IPNs) to improve its mechanical performance. The present study was conducted at the Clinic of Prosthodontics, School of Dental Medicine, University of Belgrade, with the aim of collecting and analyzing clinical data on the frequency, location, and type of denture fractures. Additionally, we discuss fracture patterns in relation to prosthesis type and present perspectives on modern repair strategies and potential material innovations designed to improve the longevity and resilience of removable dental prostheses. The aim of this study was to analyze the frequency and type of technical complications in different categories of removable dentures.

The study was reviewed and approved by the Ethics Committee of the School of Dental Medicine, University of Belgrade (No. 36/28).

METHODS

This retrospective study was performed at the Clinic of Prosthodontics, Faculty of Dental Medicine, University of Belgrade.

The data were collected from the 637 denture wearers who attended our Clinic for repair. The study was conducted over seven years, between April 30, 2017 and June 20, 2024.

The age of the study participants ranged from 45 to 85 years. Exclusion criteria were: neuromuscular diseases (Parkinsonism, ALS, multiple sclerosis), epilepsy, oncological patients, parafunctional movement of the mandible (bruxism), and excessive upper and/or lower jaw defects.

The data were analyzed using IBM SPSS Statistics v22 software (SPSS Inc., Chicago, IL, USA). Descriptive statistics parameters were used to evaluate the distribution of participants' gender, denture type (complete dentures, acrylic RPDs and CoCrMo RPDs), and period of fracture occurrence. Frequencies of categorical variables were analyzed using the Chi-square (χ^2) test or Fisher´s exact test, as appropriate. A significance level was set at 0.05.

RESULTS

Frequencies of gender, denture type and period of fracture occurrence

The frequency of the study participants by gender is shown in Figure 1.

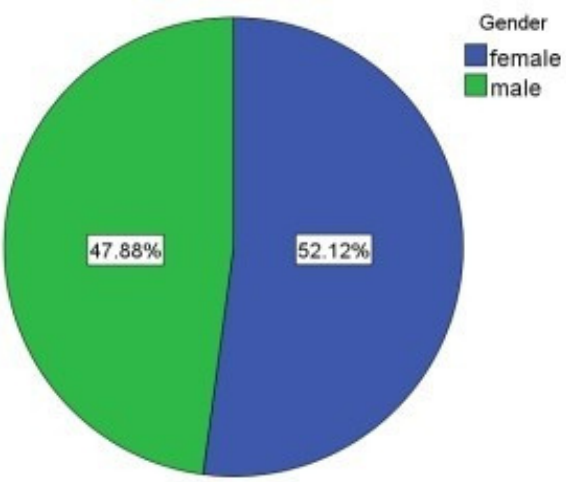

Figure 1. *Gender distribution of study participants*

Complete dentures were significantly more frequent in the upper jaw, while both acrylic and cast metal RPDs were more common in the mandible. The number of each denture type with some of the detected technical complications in the upper and lower jaw was 264 (60.3%) and 174 (39.7%), 129 (44%) and 164 (56%), and 111 (41%) and 160 (59%), respectively (Figure 2).

First-time fractures (63.7%) were more frequent than second or subsequent fractures. For acrylic dentures (complete and RPDs), nearly half of the registered fractures were detected in the first two years of denture delivery 285 (44.73%). For the CoCrMo RPDs, fractures occurred in only 9.2% of cases in the first two years.

Relation between fracture type and different dentures

Distribution of denture fractures according to denture type showed the highest incidence in complete dentures—174(27.3%), then acrylic removable partial dentures (RPDs)—164 (25.7%), and cobalt-chromium (CoCrMo) RPDs—160 (25.1%).

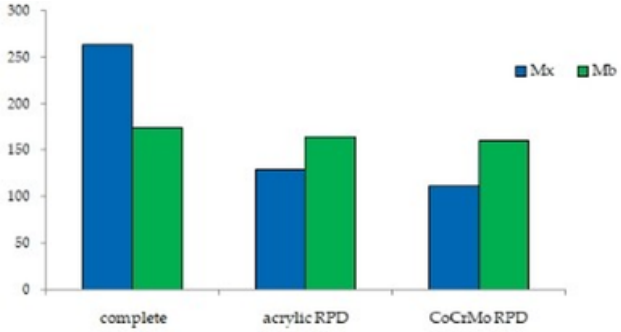

Figure 2. *Distribution of technical complications of each denture type for the upper (Mx) and lower (Mb) jaw*

Among maxillary (upper) dentures, artificial tooth fractures were the most prevalent—269 (42.2%) (Figure 3b), followed by denture base fractures—191 (30.0%) (Figure 3a), and clasp fractures—54 (8.5%). A similar behavior was observed in mandibular (lower) dentures, with tooth fractures accounting for 213 (33.4%) cases (Figure 4b), base fractures —154 (24.2%) (Figure 4a), and clasp fractures—67 (10.5%), respectively.

Analyzing the denture base fractures according to the denture type in the maxilla, the highest prevalence of fractures was noted in complete dentures —101 (20.1%), followed by acrylic RPDs—44 (8.7%), and CoCrMo RPDs— 9 (1.8%) cases, with a statistically significant association between base fracture and denture type ($p < 0.001$).

Oppositely, in the lower jaw, the highest incidence of base fractures was detected in acrylic RPDs—62 (48.4%). For complete dentures, that number decreased to 49 (38.3%), and for CoCrMo, RPDs it was 17 (13.3%). This association was also statistically significant ($p < 0.001$).

In the upper jaw, artificial tooth fractures were most commonly seen in complete dentures—113 (50.2%), whereas in CoCrMo RPDs, it was 58 (25.8%), and in acrylic RPDs 54 (24.0%). However, the association between artificial tooth fracture and denture type in the upper jaw was not statistically significant ($p = 0.192$).

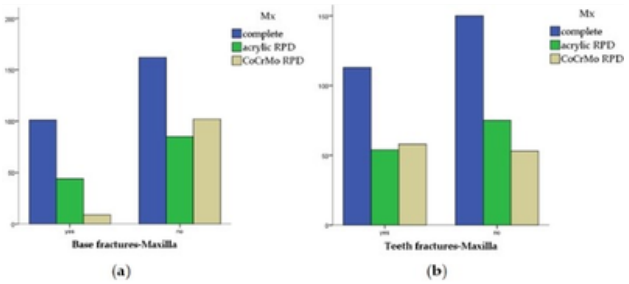

Figure 3. *Distribution of maxillary base and tooth fractures according to denture type*

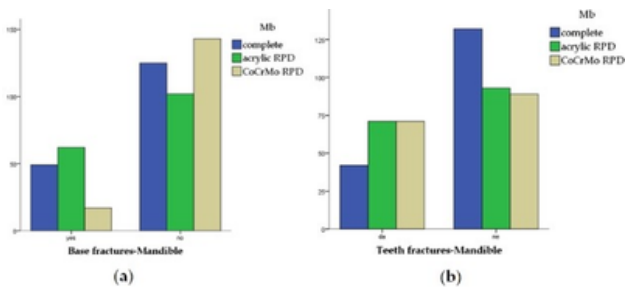

Figure 4. *Distribution of mandibular base and tooth fractures according to denture type*

In the lower jaw, artificial tooth fractures demonstrated comparable frequencies for acrylic and CoCrMo RPDs, 71 each (38.6%). Among complete denture wearers, half of them experienced tooth fracture complications, which was observed in 42 (22.8%) cases.

Among clasp fractures, the most frequent were in acrylic RPDs, involving 34 lower (56.67%) and 32 upper (65.3%) dentures. In Co-Cr-Mo RPDs, the incidence was 25 (42.4%) for lower and 17 (34.7%) for upper dentures.

Fracture type distribution by gender

Table 1 shows the frequency of different fracture types in mandibular dentures by gender. As seen, the type of mandibular denture fracture showed no statistically significant gender differences ($p > 0.05$).

Comparing similar results for maxillary dentures (Table 2), a statistically significant gender difference was observed only in tooth fractures, which were more prevalent in males (54.5%) than females (45.5%; $p = 0.019$), while differences in denture base and clasp fractures were not significant.

DISCUSSION

Fractures of removable dentures are among the most frequent secondary conditions, undermining both functional and esthetic outcomes. Despite improvements in prosthetic fabrication techniques, the present findings confirm that mechanical failure remains prevalent in both complete and partial dentures. This study is based on a clinical evaluation of fracture distribution and contributes to a better understanding of failure mechanisms and repair protocols, with a focus on material-based solutions. We processed the data only of complete, partial acrylic dentures and RPDs made after a long-term period of toothlessness, not immediately after tooth extraction. In the following text, we will describe other solutions for toothless patients.

Table 1. *Gender-based distribution of mandibular denture fracture types*

Gender	Female % (n)	Male % (n)	P value
Denture base	48.2% (92)	51.8% (99)	0.195
Tooth	53.2% (143)	46.8% (126)	0.688
Clasp	46.3% (25)	53.7% (29)	0.395

Table 2. *Gender-based distribution of maxillary denture fracture types*

Gender	Female % (n)	Male % (n)	P value
Denture base	53.9% (83)	46.1% (71)	0.644
Tooth	45.5% (97)	54.5% (116)	*0.019
Clasp	59.7% (40)	40.3% (27)	0.199

**Statistically significant difference.*

In order to better manage clinical complications, removable partial dentures with overlay represent an alternative to complete extraction (7), or if there are adequate anatomical structures, implant-supported dentures should be made (8).

Etiology and risks of denture fractures

The etiology of denture fractures is complex, including biomechanical, anatomical, material-related, and patient-specific factors. Accidental dropping of the denture remains the most frequently reported cause, particularly in complete dentures, aligning with previous reports that identify external trauma as the trigger in nearly one-third of cases (9). Additionally, poor adaptation of the denture base leading to uneven stress distribution was responsible for approximately 20% of fractures (10). Bone remodeling and resorption after extractions occur rapidly, which can destabilize dentures and, potentially, lead to fractures. Immediate removable dentures inserted on the day of extractions require a specific protocol to prevent fractures, relining to compensate for the lost tissue, stabilize the denture, and support healing after extractions (4), however, this is only a temporary solution. When bone resorption slows down, after a few months, a permanent removable denture should be made. Volumetric gaps between the denture base and the cast are considerably higher with conventional compression molding techniques compared to CAD-CAM milling, suggesting that poor adaptation significantly increases mechanical stress and a risk of fracture (11). Occlusal errors, deflective contacts, and unbalanced force vectors contribute to stress accumulation, particularly in non-stress-bearing zones such as the midline. From material perspective, defects introduced during processing (e.g., porosities, voids, residual stresses) significantly reduce fracture resistance. Patient behavior, including inadequate hygiene and cleaning practices, further contributes to the risk of damage (12). Evidence shows that among complete denture wearers, only approximately 40% achieved acceptable levels of prosthesis hygiene, with the majority demonstrating inadequate cleaning habits, behaviors known to contribute to denture deterioration and increased failure rates (13).

Accidental denture ingestion and aspiration are a recognized clinical emergency, particularly among the elderly, which may lead to serious gastrointestinal and pulmonary complications. It is often silent and may occur

due to poor prosthesis fit or fracture. Denture ingestion accounts for a small proportion of gastrointestinal foreign bodies but carries a higher risk of sigmoid and descending colon perforation, or duodenal obstruction due to sharp components. (14-17).

Fracture distribution and patterns

The current data from our study indicate that artificial tooth fractures were the most common, especially in the maxilla. Complete dentures predominantly exhibited midline base fractures, which were also reported in earlier studies that attribute with 50–70% of base failures to the biomechanically vulnerable midline zone (9,10). In contrast, base fractures in acrylic RPDs were more common in the mandibular arch, while clasp fractures were frequently associated with acrylic frameworks and wire clasps, which was already described by other researchers (18,19). These patterns highlight the impact of denture design, occlusal force distribution, and anatomical limitations on fracture distribution.

Treatment strategies and clinical protocols

Effective repair of fractured dentures implies proper surface preparation and appropriate material selection. The clinical workflow generally includes thorough cleaning, mechanical roughening (with carbide burs), and chemical conditioning using monomer or bonding agents to enhance bonding between two materials, both hot and cold polymerizing resins, which are the material of choice for chairside repairs due to their ease of use but limited mechanical properties. Improvements with nanofillers such us ZnO NPs have been shown to significantly increase flexural strength, bringing repaired dentures closer to their original performance levels (20). Additionally, nanoparticle incorporation (nano-ZrO_2, nano-SiO_2, TiO_2) has demonstrated improved stress distribution, fracture resistance, and interfacial adhesion in *in vitro* studies (8,12,21).

Advances in reinforced polymeric materials

Advanced polymeric systems provide potential for reducing fracture rates and improving repair outcomes. Interpenetrating polymer networks (IPNs), characterized by dual polymer matrices without covalent linkage, offer enhanced toughness and fatigue resistance due to superior energy dissipation properties. Nanoparticle-modified PMMA resins, incorporating materials such as silver (22), zirconia, or graphene (23), have demonstrated improvements in flexural strength, bond durability, and crack resistance (5). Nanoparticles implemented in PMMA matrix have also shown improved dispersion and mechanical integration (24,25), as well as antimicrobial efficacy (26). An increase in fracture toughness suggests enhanced resistance of PMMA against crack propagation and impact failure in reinforced PMMA. In clinical use, this may improve resistance to accidental impacts or high-load fractures. These modifications could extend the service life and improve the clinical durability of acrylic denture bases, despite a minor trade-off in flexural strength (27). Recent research also demonstrates self-healing polymers as an innovative direction (28). These systems rely on reversible covalent bonds or supramolecular interactions that enable autonomous structural repair, although their clinical application is still in early development. The use of these materials in everyday practice could drastically reduce the recurrence of fractures and improve long-term patient satisfaction. The results of this study reinforce the importance of aligning denture design and repair strategies with the evolving capabilities of polymer science. By incorporating fiber and nanoparticle reinforcements, and eventually adopting next-generation materials such as IPNs or self-healing systems, clinicians may significantly improve the longevity and biomechanical performance of removable dentures.

Additive manufacturing techniques in denture manufacturing offer advantages such as customization and rapid production but might exhibit weaknesses in mechanical strength and durability. Lee et al. evaluated and confirmed that incorporation of micro fillers demonstrated potential in enhancing the physicomechanical properties of the 3D printed denture base material (29). Studies have also shown that milled PMMA and dual-layer printing technique (compared to 3D-printed alternatives) improved the flexural and fracture resistance of denture base materials by eliminating interfacial weaknesses (30,31). A 3D-printed interim fixed dental prosthesis resin with different surface finishing procedures demonstrated favourable mechanical and biological properties, where glazing or mechanical polishing is recommended, but it should also be considered that the wear of the surface layer may be affected by the applied finishing procedure. Long-term wear resistance, staining, and intraoral aging should be evaluated in future research (32).

Based on the methodology applied in this study, we summarized the obtained results:

- Regarding the denture type, a statistically significant association was found between denture type and base fractures. Complete dentures were most commonly fractured in the upper jaw and acrylic RPDs in the lower jaw.
- Tooth fractures were more common in complete upper dentures.
- As far as gender-based distribution is concerned, mandibular denture fractures showed no significant differences between males and females. In the maxilla, tooth fractures were more common in males ($p = 0.019$), while base and clasp fractures were similar in both genders.
- Further investigations and implementation of nanoparticles or other fillers in the matrix of PMMA would improve stress distribution, fracture resistance, and lead to better quality of life for the denture wearers (19-21,33).

As the prevalence and distribution of denture fractures vary significantly by denture type and arch location, the findings of our results emphasize the critical role of material selection and reinforcement techniques in extending the service life of removable dentures.

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Author Contributions

Conceptualization: D.P.A. and M.M.L.; Investigation: D.P.A. and L.Z.; Data Curation: F.I. and M.L.; Formal analysis: S.D.; Writing- Original Draft Preparation: D.P.A.; M.M.L. and I.Dj. Writing- Review and editing: D.P.A, M.M.L, L.Z., M.L. and S.D. All authors have read and approved the published version of the manuscript.

Statement of Ethics

This study protocol was reviewed and approved by the Ethics Committee of the Faculty of Dentistry, Unversity of Belgrade, approval number 36/28 issued on 08.10.2025. Complete written informed consent was obtained from the patient for the publication of this study and the supporting datasets.

Statement of Competing Interest

The authors declare no relevant conflicts of interest.

Statement of Data Availability

The datasets generated and/or analyzed during this study are included within this article and are available from corresponding author upon reasonable request.

Statement of Generative AI Use

No generative AI was used.

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