Case Report

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Dentistry Section

Management of Repeated Denture Fracture Through Direct Metal Laser Sintering Metal Reinforced Denture

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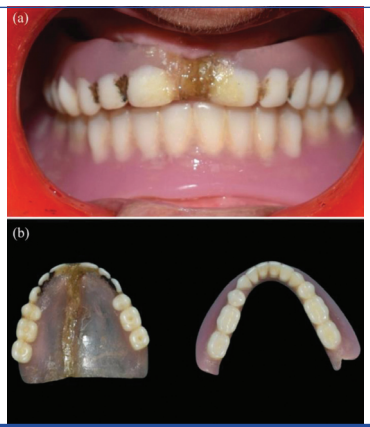
ABSTRACT

Direct Metal Laser Sintering (DMLS) is a type of additive metal production that is simpler, more precise, and healthier than traditional manufacturing, while being highly cost-effective. In this process, the metal powder which is free of binder or fluxing agent, is completely melted by the scanning of a high-power laser beam. The resulting part has properties like the original material. In removable prosthodontics, the fracture of heat cure acrylic resin dentures is an unsolved problem. The most common issue is a midline fracture of the maxillary denture. Among midline fractures, 71% were reported in maxillary complete dentures and 29% in mandibular dentures. Patients with heavy masticatory loads and those with parafunctional habits are more likely to experience this. In such circumstances, a metal framework base improves a prosthesis's fracture resistance, stability, and retention. A 45-year-old female patient reported with a chief complaint of repeated fracture of maxillary complete denture and gave the history of midline fracture of upper denture three times in last 2 years. Intraoral examination revealed v shaped deep hard palate and severely resorbed mandibular ridge. DMLS metal reinforced maxillary denture and metal mesh reinforced mandibular denture was planned to prevent fracture of the denture in future. Metal framework reinforcement of complete denture is a simple, quick, and cost-effective technique to decrease the chances of denture fracture in future, thus beneficial for both patient and the dentist. One year follow-up has been done and patient is comfortable with the denture.

Keywords: Complete denture, Metal framework, Resorbed ridges

CASE REPORT

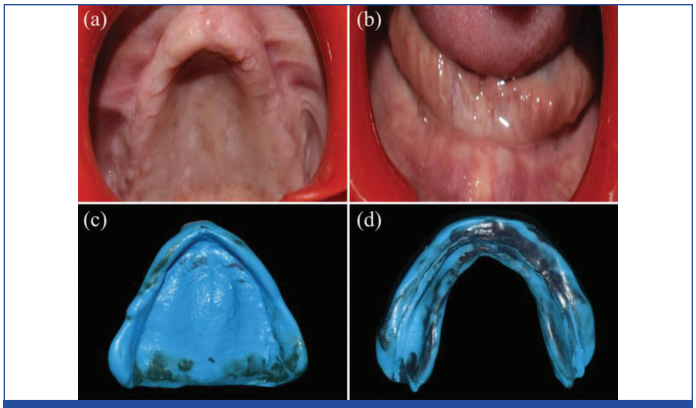
A 45-year-old female patient reported to the Department of Prosthodontics with a chief complaint of repeated fracture of maxillary complete denture [Table/Fig-1]. Patient gave the history of midline fracture of upper denture three times in last two years and loosening of lower denture. On intraoral examination, the patient had completely edentulous maxillary and mandibular arch with v shaped deep hard palate and severely resorbed mandibular ridge [Table/Fig-2a,b]. Keeping the patient's chief complaint in mind, fabrication of Direct Metal Laser Sintering (DMLS) metal reinforced maxillary denture with neutral zone technique for resorbed mandibular ridge and metal mesh reinforced mandibular denture was planned.



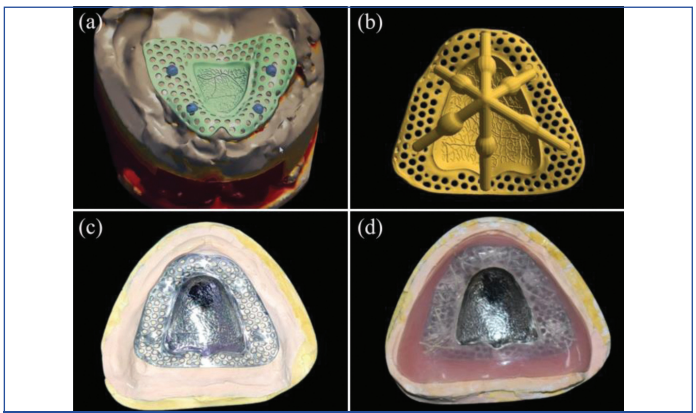
[Table/Fig-1]: Denture with midline fracture.

Border moulding and secondary impression of maxillary and mandibular arch was made using the existing denture [Table/Fig-2c,d]. The elastomeric impression was scanned by SMART desktop scanner (open technologies FARO Europe) and designing was done by EXOCAD software (exocad GmbH, Dermstadt, Germany).

Meshwork pattern on the crest of the maxillary arch and a plain sheet was designed over the palatal area [Table/Fig-3a,b]. The pattern was kept short of posterior palatal seal area to retain control over the adjustability of the posterior palatal seal [Table/Fig-3c,d]. The final design was imported and Standard Triangle Language (STL) file was generated.



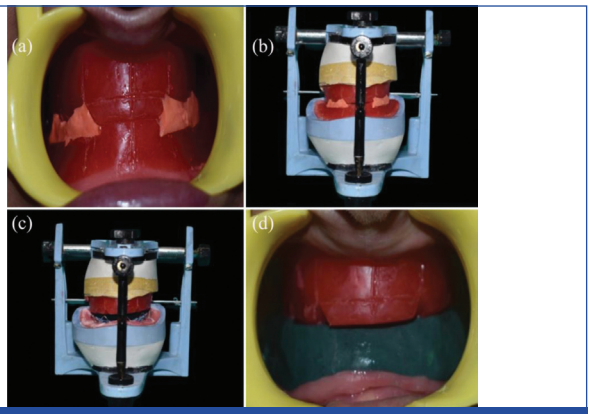
[Table/Fig-2]: (a,b) Intraoral maxillary view and mandibular view, (c, d) Secondary Impression.



[Table/Fig-3]: (a, b) Designing using direct metal laser-sintering technique, (c) Final processed metal framework, (d) Denture base fabrication.

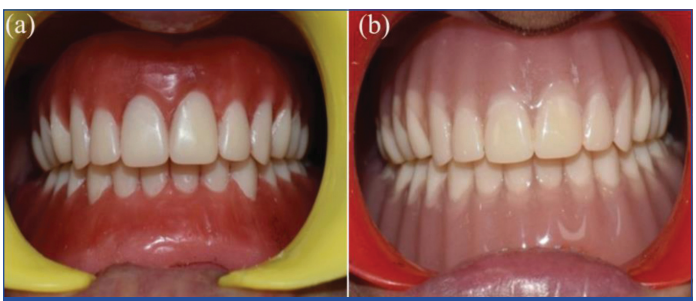
The STL file was feeded to the DMLS unit (Selective Laser Melting [SLM] 125; SLM Solutions, Lubeck, Germany), with 200 W of Fibre laser power and 1064 nm wavelength. The average particle size of the Co-Cr was 20 mm. After processing heat treatments was applied according to the manufacturers' instructions (45°C for 45 min and then cooled down). Framework was manually polished to produce a mirror-like surface.

Metal framework was tried in the patient's mouth to evaluate the fit with the underlining structures. A denture base was fabricated on the framework involving minor connector area (Table/Figure. 3 d). Maxillo-mandibular jaw relation was recorded [Table/Fig-4a] and mounted on the mean value articulator [Table/Fig-4b]. After removing the mandibular occlusal rim from the denture base, auto polymerizing resin was used to attach fins or spurs to the denture base posteriorly. These fins or spurs were made of a stainless-steel wire corresponding to the occlusal rim height [Table/Fig-4c]. The admixed material (3:7 parts of impression compound and green stick) was then placed on the mandibular base plate and the patient was then asked to perform various functional movements like talking, complete denture, swallowing, drinking water, licking the lips, sucking the post-rehabilitative frontal view of the patient. cheeks, etc. The set impression was removed from the mouth after 5-10 minutes [Table/Fig-4d].



[Table/Fig-4]: (a) Recording of maxillomandibular relationship (b) Articulation (c) Spurs made of a stainless-steel wire were adapted to the denture base, (d) Recording the neutral zone.

Monoplane teeth were used and teeth arrangement was done according to the recorded neutral zone. Try-in of the denture was carried out to check the fit, function, and aesthetics [Table/Fig-5a]. During processing a 0.4 mm thick stainless steel metal mesh was incorporated in mandibular denture while packing of heat cure acrylic. Denture was then finished, polished and final insertion was carried out [Table/Fig-5b,6a,6b]. Patient was instructed regarding denture hygiene maintenance and kept on a regular 3 monthly follow-up. One year follow-up has been done and patient is comfortable with the prosthesis with no complaint of fracture.



[Table/Fig-5]: (a) Try-in of the complete denture, (b) Post rehabilitative view.

DISCUSSION

Heat cured denture base resins are the most often utilised material for denture base fabrication because they provide appropriate physical, biologic, and aesthetic properties at a reasonable cost. However, denture base resins have been frequently found to fracture when subjected to excessive masticatory forces [1]. Midline fracture due to flexural fatigue is the most common problem. Among these midline fractures, 71% were reported in maxillary complete dentures and 29% in mandibular dentures [2].

[Table/Fig-6]: (a) Cameo surface, (b) Intaglio surface of the finished denture.

The breakage is usually mechanical or accidental. Faulty design and fabrication, as well as improper material use are the mechanical causes. Accidental denture fractures are most commonly caused by coughing and expelling the denture from the mouth, dropping the denture, or excessive biting force. Denture breakage is common in neuropsychiatric patients, particularly those with neuromuscular illnesses such hemiparalytic muscular dystrophy and Parkinson's disease [3,4].

Self-cure acrylic resin or heat-cure acrylic resin are used to repair broken dentures. When heat-cured resin is used for denture repair, it exhibits approximately 85% of its original strength, while only 55% to 65% of the original heat-cured denture strength is exhibited by the dentures repaired using autopolymerizing resin [5]. Metal reinforced denture bases, acrylic resin bases reinforced with metal mesh, carbon fibre, E glass fibre reinforced, lucitone 199, trevelon high, paladin ultra, and visible light polymerized resin are all used to reduce the risk of fracture. Out of all these methods metal reinforced dentures is still one of the most promising alternatives [6].

Acrylic resin is the most commonly used material to make complete dentures in clinical prosthodontic practice. However, the fracture of acrylic denture bases is an unavoidable complication. Despite its popularity in meeting aesthetic criteria, acrylic is still far from ideal in meeting the mechanical requirements of prosthesis. According to Jagger DC et al., there is a significant risk of fracture, especially if the denture thickness is thin [7]. Metal frameworks impart strength to the denture due to their high malleability and strength; metal scaffold acrylic materials allow them to survive flexural fatigue and stress concentration [8].

Metal denture base is used while giving single complete dentures with increased masticatory forces, in overdentures where the forces are concentrated over small part of the denture and shallow or flat palate as it would provide more area for the denture to flex under forces [8]. Metals such as gold, cobalt-chrome-molybdenum or cobalt-chrome alloy had been reported in the literature for the fabrication of metal denture bases. Retentive properties of all these materials were studied and cobalt-chromium was found to be most retentive, followed by aluminium, resin, and gold [9,10].

The casting (lost-wax) process, which has been used in dentistry for over a century, is traditionally used to fabricate metal frameworks. Casting is a time-consuming, expensive, and labour-intensive artisanal procedure that can result in low precision and ill-fitting frameworks [11]. Huang Z et al., compared the marginal and internal fit of SLM metal ceramic crowns with two lost-wax cast metal ceramic crowns and evaluated the influence of tooth type on the marginal and internal fit of these crowns. They concluded that the marginal fit of SLM Co-Cr metal ceramic crowns was similar to

that of the cast Au-Pt metal ceramic crowns and was better than that of the cast Co-Cr metal ceramic crowns. The SLM Co-Cr metal ceramic crowns were not significantly different from the two cast metal ceramic crowns in axial fit but were less accurate in occlusal fit. Tooth type did not influence the marginal and internal fit of the metal ceramic crowns [12]. In the present case, instead of casting, DMLS technique is used to fabricate maxillary framework. Laser-sintering metal frameworks improve casting quality in terms of high precision (20 mm), accuracy, durability, biocompatibility, greater fatigue resistance, good fitting, and stability, while also making treatment less expensive and less time consuming [13,14].

The fracture load and deflection of acrylic resin specimens with various types of metal inserts were studied by Polyzois GL. Round metal, braided wires, and mesh were used as inserts with a metal adhesive denture resin (Meta Dent) and a traditional denture resin (Meliodent). The findings showed that both denture resins' fracture resistance was improved by metal implants. There were no discernible differences between standard denture resin and the metal adhesive [15].

Yerliyurt K et al., investigated the potential use of polypropylene (PP) hernia mesh as a reinforcement of Polymethyl Methacrylate (PMMA) denture base resin in comparison with metal and glass fibre meshes, with the expectation of enhancing the mechanical stability of the PMMA dentures in oral conditions. They found that the mechanical properties were enhanced when PP hernia mesh was used on top [16]. In this case, for reinforcing mandibular denture, a ready-made metal mesh is used. It has holes for retention of the acrylic denture base which does not come in contact with the soft tissues and the small thickness of 0.4 mm of the mesh allows for easy manipulation and incorporation in the denture base without increasing its thickness.

Al-Magaleh WR et al., investigated patient satisfaction levels in edentulous patients after rehabilitation with dentures fabricated using the Neutral Zone (NZ) concept as compared with conventional dentures using a specific, question-oriented patient satisfaction questionnaire. The NZ dentures offered significantly higher levels of patient satisfaction than conventional dentures in all functional aspects (retention, stability, masticatory ability, and speech) as well as in comfort and appearance [17].

In the present case, the patient had severely resorbed mandibular ridge. So, to increase the stability of mandibular denture, neutral zone technique is utilised. NZ is recorded using admixed material (3:7) parts of impression compound and green stick, as it is a low viscosity substance which allow easier manipulation of the musculature of the mouth. Monoplane teeth were used. Advantages of using the monoplane teeth has less horizontal forces, freedom of movement and they can be easily adapted to situations prone to denture base dislodgement during the denture functioning [18].

CONCLUSION(S)

The present case report describes a composite treatment modality and an effective solution for the common problem of denture fracture in clinical prosthodontics. These methods of reinforcing complete denture are simple, cost effective, requires fewer patient visits and most importantly minimise the risk of denture fracture in future, thus beneficial for both patient and the dentist.

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