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CASE REPORT

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Fabrication of a mandibular implant-retained overdenture using an existing subperiosteal implant: A clinical report

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Key Clinical Message

A 64-year-old edentulous woman with a mandibular fracture received a subperiosteal implant for fracture fixation and dental rehabilitation. However, the ball abutments were submerged by the soft tissue because they were too short. Therefore, we designed a connector to lengthen the attachment and achieve adequate stability and retention for the overdenture.

KEYWORDS

alveolar bone loss, mandibular fracture, overdenture, subperiosteal dental implantation

1 | INTRODUCTION

A healthy dentition is essential for optimal quality of life and wellbeing. Complete or partial edentulism may eventually occur as the result of various dental conditions. Considering the increased life expectancy in today's world, dental clinicians face a growing demand for dental rehabilitation.[1] Poor dentition directly affects the nutritional intake and therefore, may increase the risk of many diseases, such as gastrointestinal and digestive problems, stroke, cardiac, pulmonary and respiratory diseases, rheumatoid arthritis, and even cancer.[2,3]

At present, the available treatment options for edentulism include complete removable dentures, implant-supported overdentures, and fixed implant-supported dentures.[4] Although many systematic reviews have indicated that dental implants have a higher success rate and overall oral health related quality of life, removable dentures may be preferred for many cases due to financial or physiological constraints.[5] Complete removable dentures were the most common treatment option for edentulous patients in the past century.[4,5] However, despite their high popularity, complete removable dentures have several shortcomings, such as difficulty in mastication and adverse psychological effects. Even well-fitted removable dentures decrease the masticatory efficiency by approximately 30%, which commonly leads to substitution of high-fiber, healthy, and nutritious foods with easy-to-chew soft foods rich in carbohydrates and fat.[6] Some authors suggest two-implant-supported overdentures as the first-line treatment option for an edentulous mandible.[7]

Tooth loss initiates a cascade of gradual resorption of the supporting bone. Management of an atrophic alveolar ridge presents a challenge for any subsequent treatment, whether

it be removable or implant-supported dentures. Evidence shows that bone resorption is most pronounced within the initial 6 months following tooth loss, primarily affecting the horizontal dimension of alveolar bone. This ongoing resorption renders the mandible susceptible to fractures.[8]

Implant placement may be impossible in cases with chronic and severe alveolar ridge resorption. A variety of bone grafting techniques have been proposed to overcome this problem. However, bone grafting may be associated with complications, and has drawbacks such as unknown prognosis and unpredictable outcome, the need for a second surgical site in autogenous bone grafting, and prolonged treatment course.[9] Resultantly, the search is ongoing for a superior alternative.[9] Subperiosteal implants (SPIs) were introduced as an alternative treatment for patients with severely resorbed ridges. SPIs were first introduced in 1943 and have undergone significant modifications ever since.[10] Currently, with the introduction of modern techniques such as the additive manufacturing technique along with improved implant materials and using three-dimensional computed-tomography imaging, the success rate of SPIs has greatly increased, and SPIs are currently considered as a safe and preferred treatment option for patients with a compromised alveolar ridge.[10]

Management of mandibular fractures is challenge due to mobility of the mandible and its prominent role in mastication and speech. In management of mandibular fractures, it is necessary to ensure undisturbed healing of bone to resume optimal function and esthetics. Open reduction is among the most common approaches adopted to manage mandibular fractures, which can be performed by using a variety of devices, such as the lag screws, micro- and mini-plates, and mini-locking plates.[11,12]

In this report, the authors describe management of a mandibular fracture in an edentulous patient. The fracture was initially managed by placement of a SPI, which effectively stabilized the fracture. However, during the healing phase, the SPI ball abutments were submerged by the keratinized mucosa. Thus, a connector was designed to serve as a link between the SPI and the overdenture. The five-year follow-up examination revealed an excellent outcome. This case exemplifies the adaptability and effectiveness of SPIs in complex clinical scenarios.

2 | CASE HISTORY

A 64-year-old woman was referred to the Oral and Maxillofacial Department of Tehran University of Medical Sciences. She had a complete removable denture for about 30 years, which had resulted in a significant alveolar bone loss. She had experienced a fall 3 months earlier, for which she had sought medical attention. About 1 month after the fall, she was referred to an oral and maxillofacial surgeon complaining of an ill-fitted mandibular complete denture, mouth opening limitation, and jaw deviation.

3 | METHODS

A panoramic radiograph was requested, which revealed extensive mandibular bone resorption causing a traumatic fracture in the left side of the mandible probably during her fall 3 months earlier (Figure 1). Remarkably, she was not aware of this fracture. Furthermore, her mandible had healed in a misaligned manner, resulting in a malunion.

Considering the inadequate quality and quantity of the alveolar bone, endosseous implant placement was ruled out as a viable option. Resultantly, her treatment plan included placement of a SPI and realignment of the mandibular fracture, followed by its stabilization with the SPI through an extraoral surgical approach. Four months later, her follow-up imaging revealed strong fixation and successful healing, which was further confirmed by clinical examination. Subsequently, the patient was referred to the Prosthodontics Department for prosthetic rehabilitation (Figure 2). However, the surgeon failed to consult

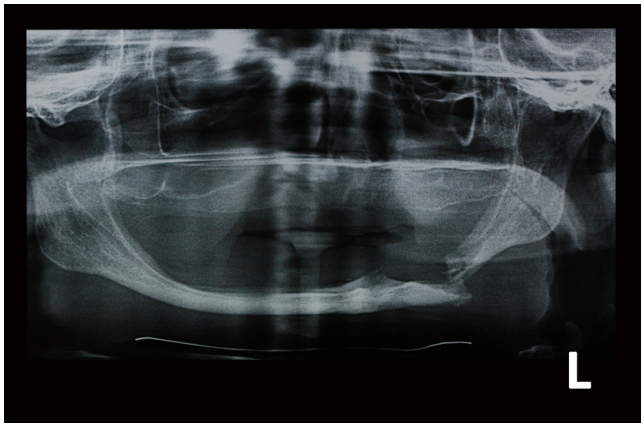

FIGURE 1 Radiographic view showing a mandibular body fracture.

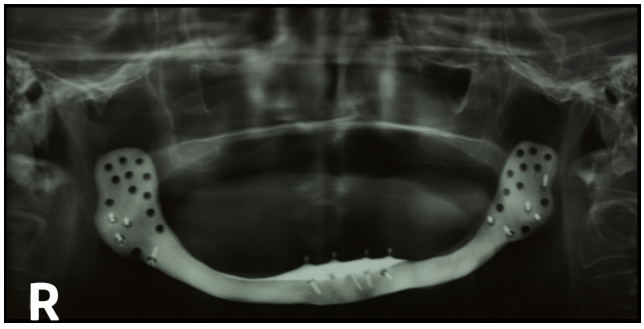

FIGURE 2 Fracture was properly fixed.

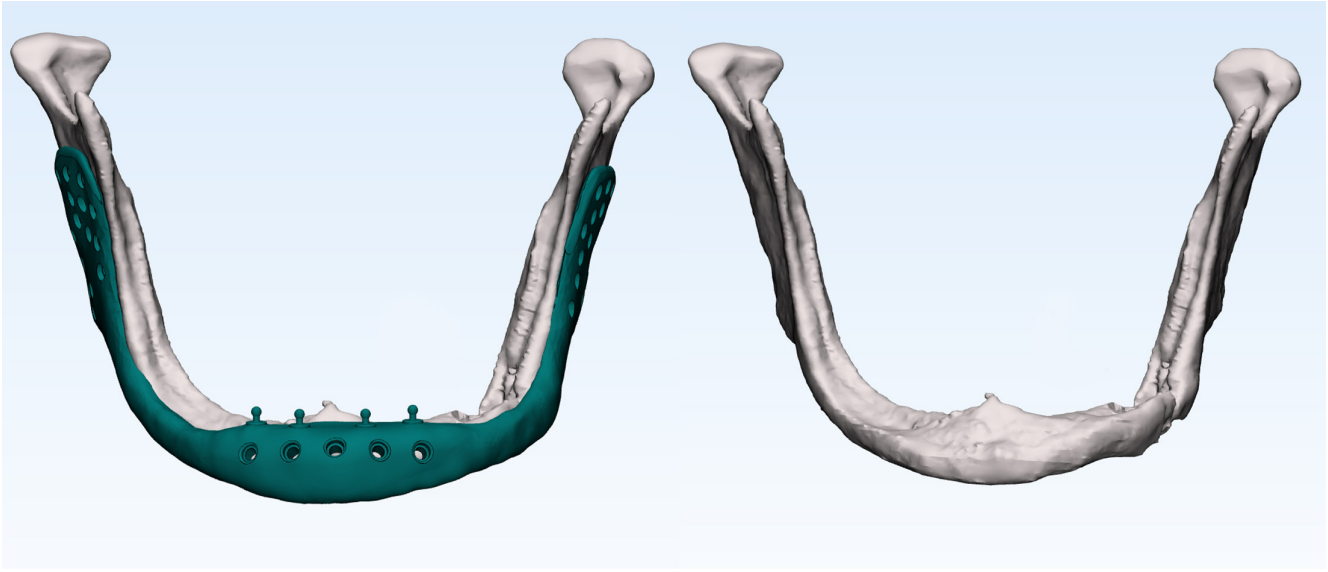

FIGURE 3 Frontal view of the 3D design of the SPI in Materialize Software.

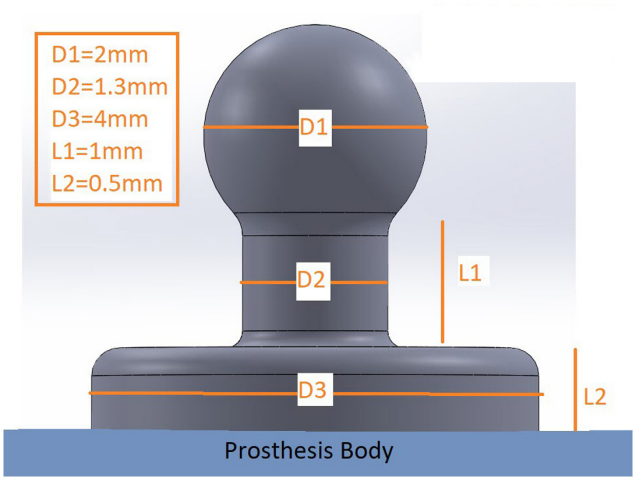

FIGURE 4 Ball attachment design.

FIGURE 5 Ball abutments were too short to emerge through the soft tissue.

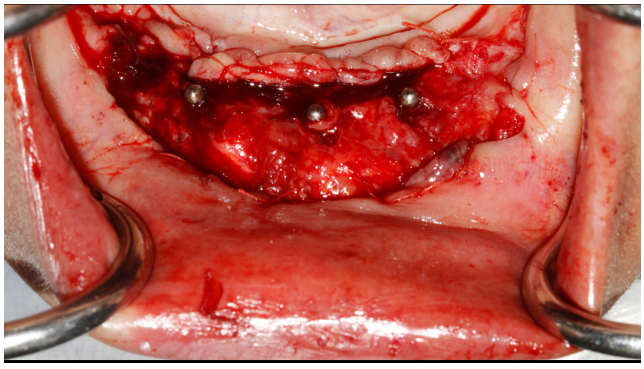

FIGURE 6 A periodontal surgery was performed.

a prosthodontist to verify the customized SPI design (Figures 3 and 4). The surgical procedure was carried out without the benefit of a preoperative dental analysis and a radiographic stent. A radiographic stent is essential for accurate treatment planning and framework design. As the result of absence of these tools, the ball abutments of the SPI were undersized and too short. Resultantly, the abutments were submerged by the surrounding soft tissue during the healing period (Figure 5). Following completion of the healing period, the patient was referred to the Prosthodontics Department to receive a mandibular overdenture and a maxillary denture. Upon examination of the situation, it became evident (as depicted in Figure 3) that the neck-like structures designed to support the ball abutments were inadequately sized, leading to submergence of the abutments by the surrounding keratinized tissue.

To address this problem, the soft tissue was surgically removed to uncover the abutments (Figure 6), but shortly after the uncovering surgery, the soft tissue covered the abutments again (Figure 7). Considering the close proximity of the

FIGURE 7 Ball abutments after gingivoplasty.

FIGURE 8 A customized tray was used to make the final impression.

abutment balls to the SPI body, extensive surgical removal of the keratinized tissue deemed impractical due to the risk of dehiscence. Despite the soft tissue removal, the abutment balls were still partially embedded in the soft tissue rather than being completely exposed. Consequently, the authors came up with a solution to design a connector to elongate the abutment neck, and thereby elevate the attachment balls to a position higher than the soft tissue level.

In order to fabricate the connector, primary impressions were made from the mandible by a prefabricated tray and irreversible hydrocolloid material (Alginate, Zhermack, Badia Polesine [R.O.], Italy). Based on these impressions, a special tray was fabricated by auto-polymerizing acrylic resin (GC, Japan), and border molded by using green modeling plastic impression compound (Kerr Corp., Bioggio, Switzerland) to achieve a more accurate final impression (Figure 8). The SPI ball attachments were surgically uncovered and multiple gingival retraction cords (Ultradent, South Jordan) were placed along with a hemostatic agent (ViscoStat; Ultradent, South Jordan). The 3D printing process and subsequent polishing of the SPI changed the size of the abutment balls, compared with their standard dimensions. Thus, impression

FIGURE 9 Laboratory black plastic caps helped achieving higher accuracy.

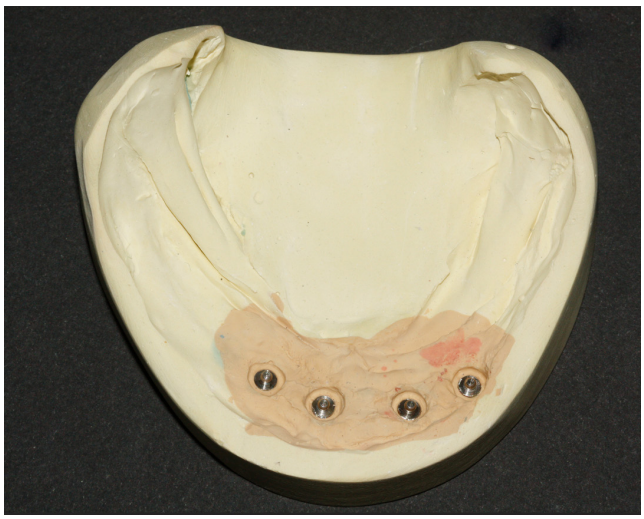

FIGURE 10 Master cast.

caps could not be used for an abutment-level impression. In light of this, laboratory black caps (Rheine 83 system, Bologna, Italy) were used instead to cover the abutment balls and were fixed with Duralay acrylic resin (GC, Japan) and burs (Prima, England) (Figure 9).

The final impression was obtained by using light body polyvinyl siloxane impression material (Panasil, Kettenbach, USA) via the direct technique. The Rheine ball abutment analogs were tightened, and the master cast was poured with improved stone (Moldano, Kulzer, Hanau, Germany) (Figure 10). The intermaxillary relationship was registered with a record base and wax rims. Following the

FIGURE 11 Connector framework.

FIGURE 12 Tooth setup on the suprastructure.

diagnostic tooth setup and trial, a putty index was obtained from the teeth on the cast for a space analysis, taking into account the position of the balls and the available vertical space. The wax-up of the suprastructure bar and ball design framework was completed, and invested with chromium cobalt alloy (VeraBond, CA, USA). After try in, the undercuts on the master cast were blocked out, the cast was duplicated, and the framework was fabricated in the form of a support holder (Figure 11). Tooth setup was performed again in presence of the framework and attachment and tried in (Figure 12). It was then waxed-up and processed using heat-polymerizing acrylic resin (Meliodent; Heraeus Kulzer). The suprastructure ball and bar framework was cemented with dual-cure resin cement (Panavia F2, kuraray, Japan), and the ball attachment mandibular overdenture was delivered (Figure 13).

4 | CONCLUSION AND RESULTS

The overdenture notably enhanced patient appearance and speech. Initial follow-up appointments were scheduled at

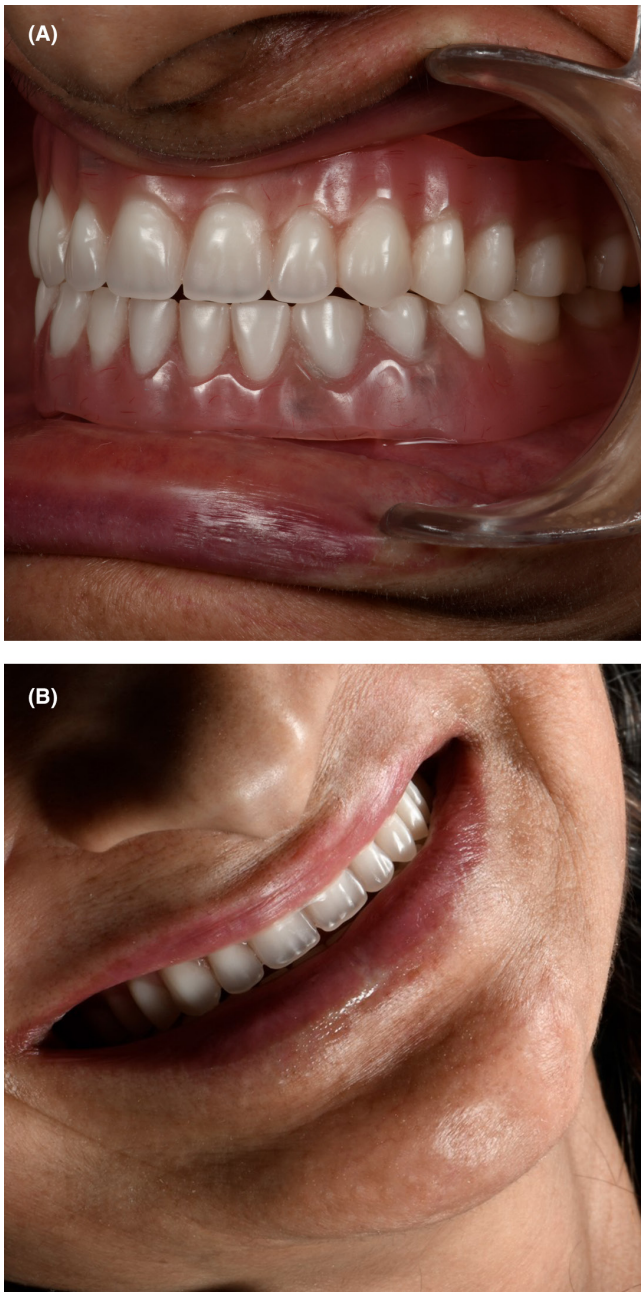

FIGURE 13 Final prosthesis. (A) Intraoral view, (B) extraoral view.

1 day, 1 week, and 1 month after delivery, followed by annual checkups. It has now been 5 years, and no complications have been detected so far during the annual follow-ups.

5 | DISCUSSION

Management of severely resorbed edentulous alveolar ridges has always been challenging.[13] Bone grafting is one of the most common solutions for such patients.[13] However, it offers limited advantages and a variety of disadvantages such as unpredictable outcome, prolonged healing period, the need for a second surgery in autografting, increased risk of infection, and limitations in restoring the vertical dimension of occlusion.[9,13] SPIs were introduced in 1943 as an alternative to bone grafting but were soon abandoned due to difficulties in fabrication and high rate of failure mostly due to peri-implantitis.[10] The art of prosthetics has come a long way since the 1940s in terms of manufacturing and materials.[10] The modern manufacturing techniques such as the additive manufacturing have improved the success rate of SPIs, and they are now considered as a preferred treatment option for management of patients with severely resorbed alveolar ridges.[9,14]

In the present case, the mandibular fracture was managed by closed reduction using a SPI, resulting in satisfactory fixation and proper fracture healing, as confirmed by both clinical examination and radiographic assessment. However, the surgical team did not anticipate the future prosthetic needs. As a result, the implant's ball abutments were found to be too short and were resultantly submerged by the soft tissue. Consequently, a connector had to be custom-designed and affixed to extend the abutments to accommodate the overdenture. This complication and the subsequent need for a second surgical procedure and additional prosthetic work could have been avoided with proper treatment planning, including the use of a radiographic stent to predict the surgical outcome accurately and design the implants with consideration of the future denture requirements. To the best of the authors' knowledge, no similar case of managing such complications has been reported in the literature. Such issues may arise due to poor or lack of preoperative consultation with prosthodontists to strategize the future steps. Although achieving mandibular reduction and ensuring effective fixation are immediate objectives in addressing a fractured mandible, it is crucial to have a long-term treatment perspective, considering the patient's future prosthodontic rehabilitation needs, which encompass not only functional mastication but also esthetic considerations.

At present, considering the risk of nerve repositioning and iliac bone graft complications, application of SPIs in severely resorbed ridges is a suggested treatment option for edentulous patients, who are not candidates for conventional endosseous dental implants; nevertheless, proper treatment planning based on patient's profile and clinical condition is essential to accomplish a successful rehabilitation.

AUTHOR CONTRIBUTIONS

Mahnaz Arshad: Conceptualization; methodology; project administration; writing – review and editing. **Nourin Khoramshahi:** Data curation; investigation; resources; writing – original draft. **Gholamreza Shirani:** Conceptualization; project administration; supervision; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest relevant to the current case report. The materials used in this case report are mentioned for clinical research purposes only. The authors do not have any financial interest in the companies mentioned in this article.

DATA AVAILABILITY STATEMENT

All the data is available upon request.

CONSENT

Written informed consent was obtained from the patient to publish this report following the journal's patient consent policy.

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