Case Report

Full mouth rehabilitation of edentulous patient with implant assisted dentures - A case report

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Abstract

Implant overdentures emerge as a superior option for individuals lacking teeth, providing improved chewing function and enhanced quality of life compared to traditional complete dentures. The removable design also simplifies oral hygiene maintenance in contrast to fixed implant prostheses. A thorough evaluation of the patient's condition is imperative before commencing implant overdenture treatment. Meticulous planning, taking into account factors such as attachment type, number of implants, and precise implant locations, is essential for achieving successful outcomes. This case report outlines a prosthetic reconstruction process that combines a maxillary implant overdenture with a mandibular implant-assisted removable partial denture for a 62-year-old woman. The patient expressed satisfaction with the esthetics, function, and comfort of the dentures.

Key words: **Dental implants, implant overdentures, implant-assisted removable partial denture, interocclusal space, Locator attachment**

Introduction

Edentulous patients often face functional and psychosocial challenges due to ridge atrophy and difficulties adapting to removable dentures, leading to discomfort during chewing, inadequate stability, and poor denture retention. Implant overdentures provide an effective solution by offering improved masticatory function and overall improved quality of life compared to conventional complete dentures. However, prosthetic complications, such as denture base fractures, attachment loosening, and attachment wear, are inevitable in implant overdentures.[1] Their impact can be minimized through high-quality prostheses and vigilant follow-up protocols. Therefore, it is essential for clinicians to possess a thorough understanding of implant overdentures, including implant planning, prosthetic design considerations, occlusal concepts, and maintenance protocols.

For successful outcomes, thorough data collection and analysis, including assessment of interocclusal space, jaw relationship, and bone quantity, are crucial in planning implant overdenture treatment. Dentists must meticulously design the implant overdenture based on this analysis, considering attachment type, number of implants, and their distribution. Varying interocclusal space requirements call for different attachment systems.[2] Furthermore, different attachment systems and arches require different implant numbers and distributions to ensure optimal stress distribution and survival rates.[3–6] When considering prosthetic design, incorporation of metal reinforcement into the denture base is crucial to mitigate issues such as denture fracture and deformation. In addition, the technique for pick-up attachment and the choice of materials play significant roles in minimizing complications, such as attachment loosening and wear.[7]

This clinical report outlines a prosthetic rehabilitation involving a maxillary implant overdenture and a mandibular implant-assisted removable partial denture, both using stud-type attachments. The report emphasizes factors associated with potential complications in implant overdentures.

Case report

A 62-year-old woman sought evaluation at the Department of Prosthodontics at National Cheng-Kung Hospital due to difficulties in chewing, dissatisfaction with the aesthetics of her old denture, and mobility issues with her lower teeth (Figs. 1–3). Clinical examination revealed full edentulism in the maxilla and partial edentulism classified as Kennedy Class I in the mandible. The residual ridge of the maxilla was classified as Atwood Class III (posterior ridge, high and well-rounded) and Class V (anterior ridge, low and well-rounded), with no torus palatinus observed (Fig. 4A). In the mandible, the posterior teeth were missing and the patient had not worn a lower removable denture before. A periodontal examination revealed generalized horizontal bone loss affecting anterior teeth, characterized by deep probing depths and grade III mobility noted in teeth 43 and 42 (Fig. 5). Extraction of teeth 43 and 42 was recommended. The residual ridge of the mandible was classified as Atwood Class V, with no bony exostosis observed (Fig. 4B).

To confirm the diagnosis and devise an appropriate treatment plan, dental casts of both jaws were mounted on a semi-adjustable articulator (Artex CT, Amann Girrbach, Austria) in centric relation. The correct vertical dimension was established using wax rims. A comprehensive space analysis was performed to help determine the treatment plan. The interocclusal space was between 9 and 12 mm in both jaws (Fig. 6). The primary treatment objectives included restoration of vertical height, enhancement of masticatory function, and improvement of aesthetics. Following analysis of the study cast, three treatment plans were proposed: implant-fixed dental prostheses with extraction of lower teeth; maxillary implant overdenture with mandibular implant-assisted removable partial denture; and maxillary conventional complete denture with a mandibular conventional removable partial denture. The patient expressed a preference for the first treatment plan, which involved implant-fixed dental prostheses.

Before definitive treatment, interim dentures were fabricated to assess functional and occlusal stability (Fig. 7). After the patient had worn these interim dentures for three months, a cone-beam computed tomography scan was performed using maxillary and mandibular radiographic templates fabricated based on scan data from the interim dentures. Zirconia balls were embedded in the templates at every missing tooth position to indicate the planned implant positions in the measurement radiograph (Fig. 8). However, the radiographic examination revealed insufficient bone quantity for implant-fixed dental prostheses, leading to modification of the treatment plan to a maxillary implant overdenture with a mandibular implant-assisted removable partial denture, both employing stud-type attachments. Implant positions were planned at teeth 14, 16, 24, and 26 in the maxilla and teeth 43, 46, and 36 in the mandible (Fig. 9). A surgical guide was meticulously fabricated for the implant surgical plan (Fig. 10). The diameters and lengths of the implants (OsseoSpeed TX, Astra Tech, Dentsply Sirona, USA) were as follows: implants 14, 24, and 43 were 3.5 × 9 mm; implants 16 and 26 were 4.0 × 9 mm; implant 36 was 5.0 × 9 mm; and implant 46 was 4.0 × 6 mm. Ti mesh (Titanium Micro Mesh, ACE, USA) and FDBA bone graft (OraGraft, Lifenet Health, USA) were applied at implant 14 and 24 for bone augmentation (Fig. 11). After two weeks, sutures were removed and the patient was advised to return for follow-up.

During the follow-up phase, interim dentures were relined using a soft denture reline material (SOFT-LINER, GC, Japan) to preserve the patient's chewing function. After six months of implant placement, second-stage surgery was performed. Implants 14, 16, 24, 26, 36, 43, and 46 were surgically exposed, and healing collars were placed.

For the definitive prosthetic treatment, individual trays were fabricated by taking close-tray impressions for both jaws. The working cast underwent relief and blockage with paraffin wax (SIVUCH, LIANG LINN, Taiwan) for subsequent open-tray impressions, with the trays constructed using base plate material (Vertex Baseplate, Vertex Dental, Netherlands). The mandibular teeth were prepared for the guiding plane and cingulum

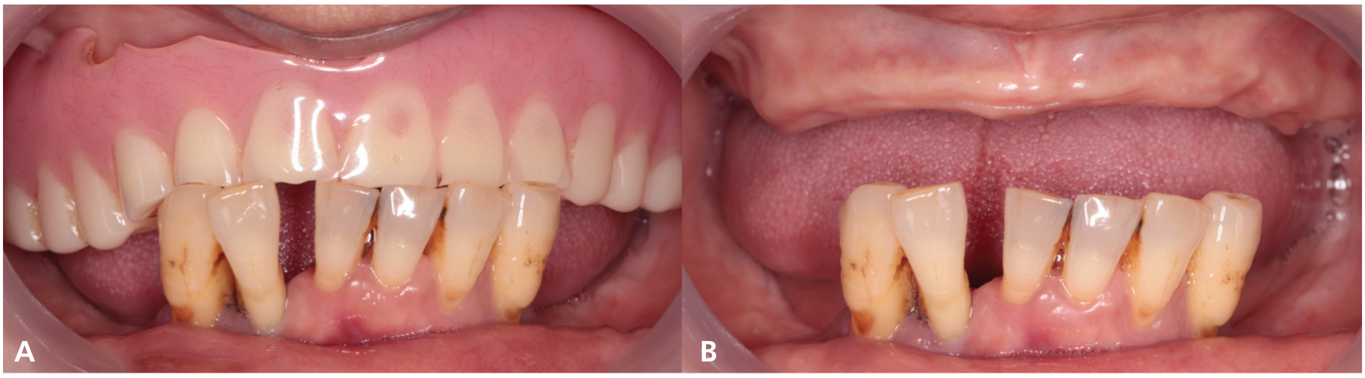

Figure 1. Pre-treatment intra-oral view. (A) With old denture; (B) without old denture.

Figure 2. Pre-treatment extra-oral view. (A) Frontal view; (B) lateral view.

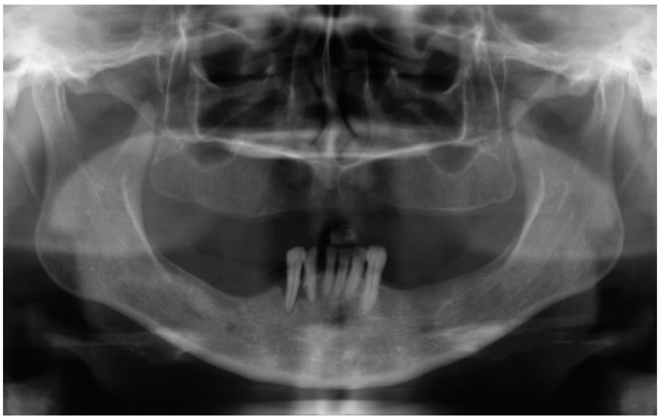

Figure 3. Pre-treatment panoramic film.

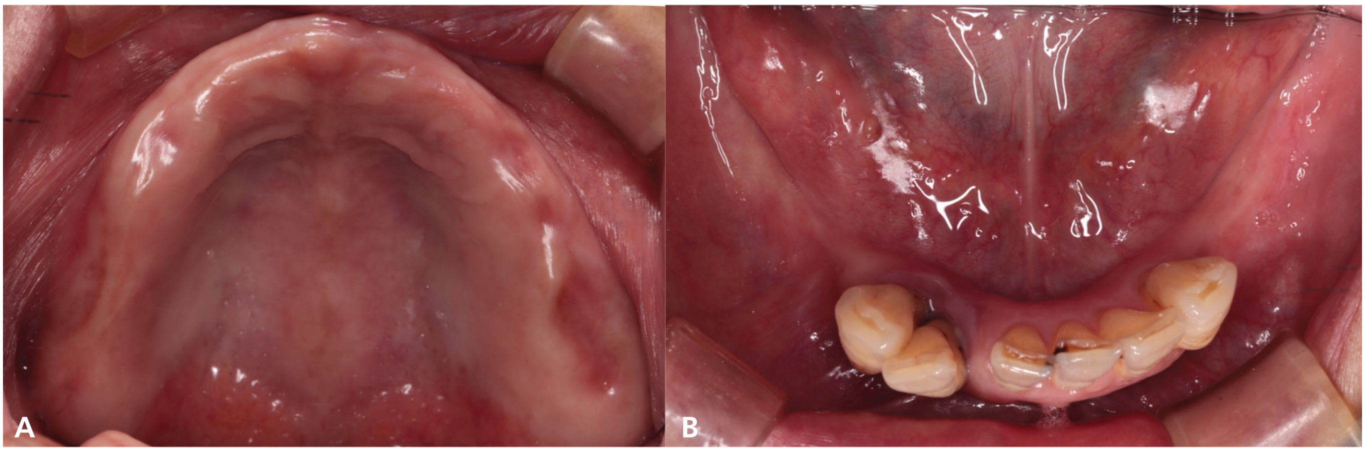

Figure 4. Pre-treatment intra-oral view. (A) Occlusal view of the maxillary arch; (B) occlusal view of the mandibular arch.

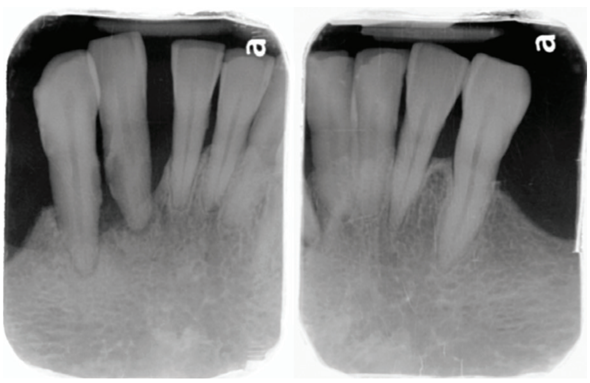

Figure 5. Pre-treatment periapical films.

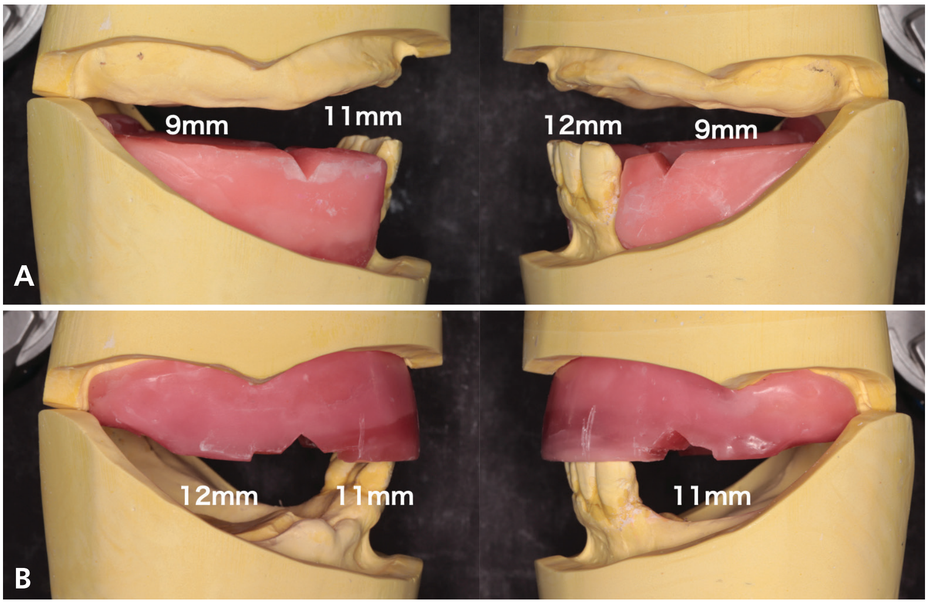

Figure 6. Space analysis of the semi-adjustable articulator. (A) Maxilla; (B) mandible

Figure 7. The interim dentures. (A) Occlusal view of the maxillary arch; (B) occlusal view of the mandibular arch; (C) right side; (D) facial aspect; (E) left side.

Figure 8. Radiographic stent with zirconium pearls. (A) Maxilla; (B) mandible.

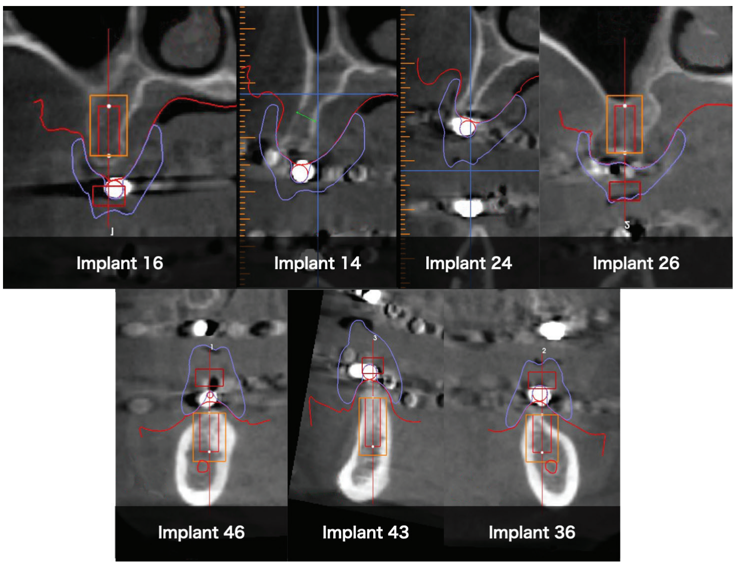

Figure 9. Cone-beam computed tomography images of implants 14, 16, 24, 26, 36, 43, and 46.

Figure 10. Implant surgical stent. (A) Maxilla; (B) mandible.

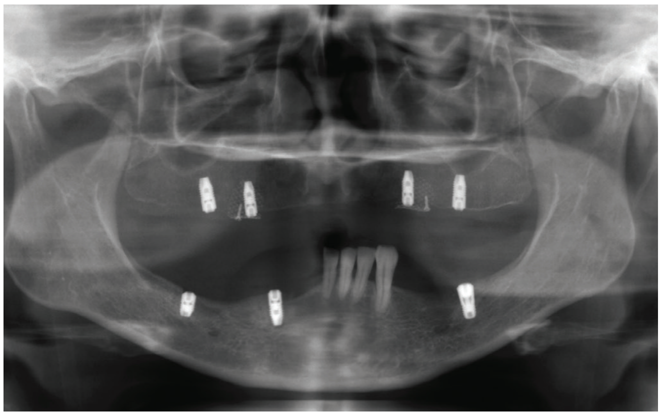

Figure 11. The panoramic film after implant placement.

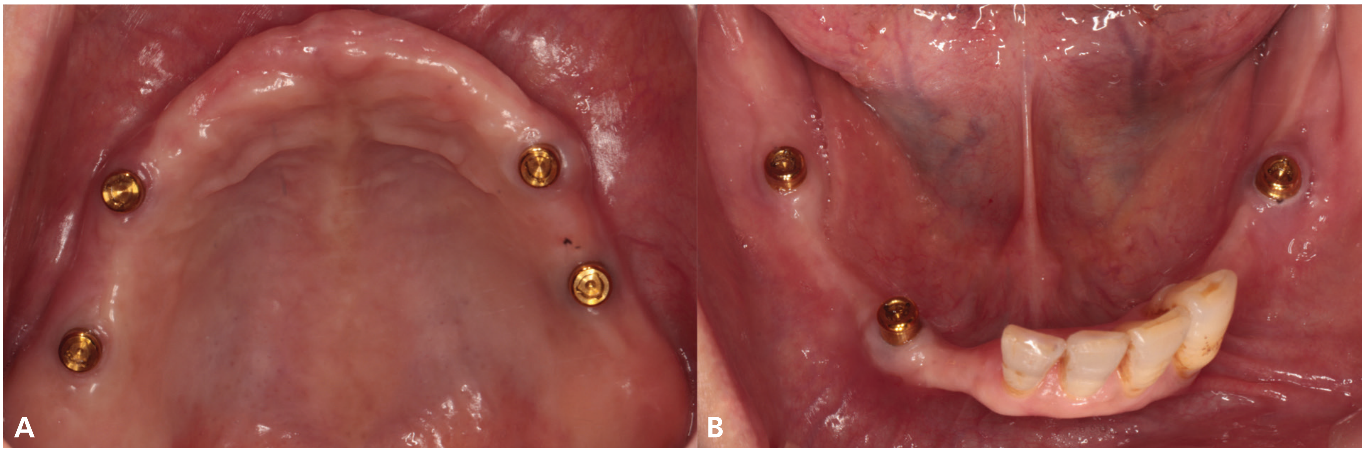

Figure 12. Locator abutment delivery. (A) Occlusal view of the maxillary arch; (B) occlusal view of the mandibular arch.

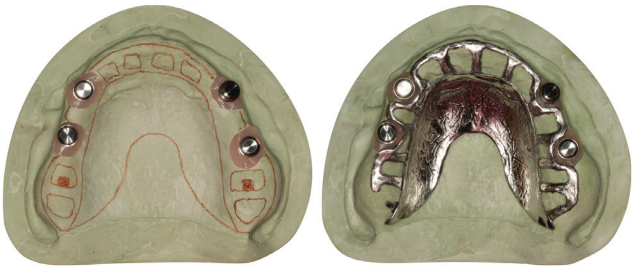

Figure 13. . The metal framework of maxillary implant overdenture. (A) Design; (B) metal framework.

Figure 14. The metal framework of mandibular implant-assisted removable partial denture. (A) Design; (B) metal framework.

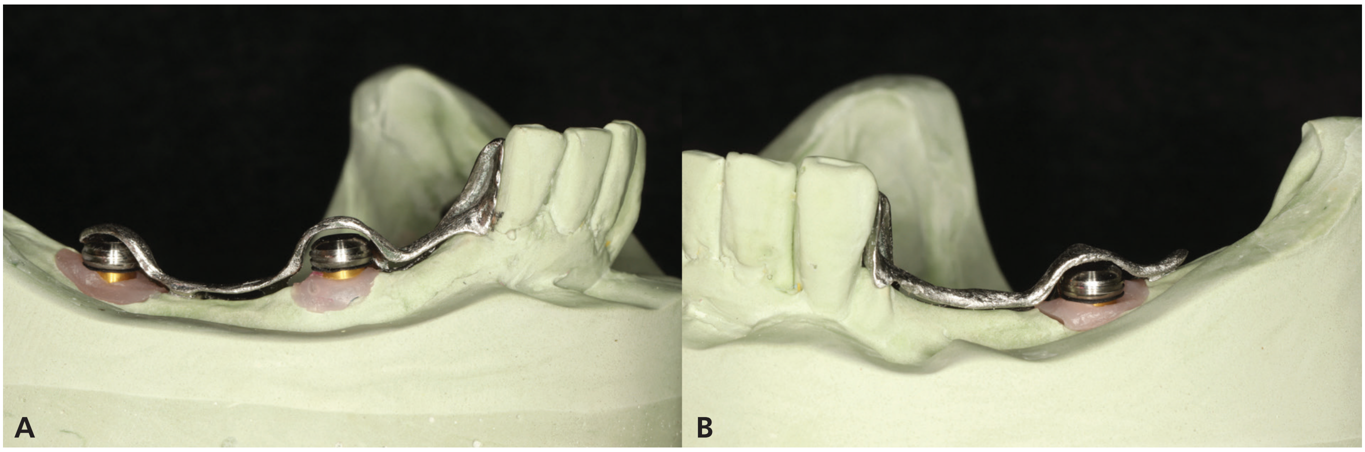

Figure 15. Checking the space between the framework and metal housing. (A) Right side; (B) left side.

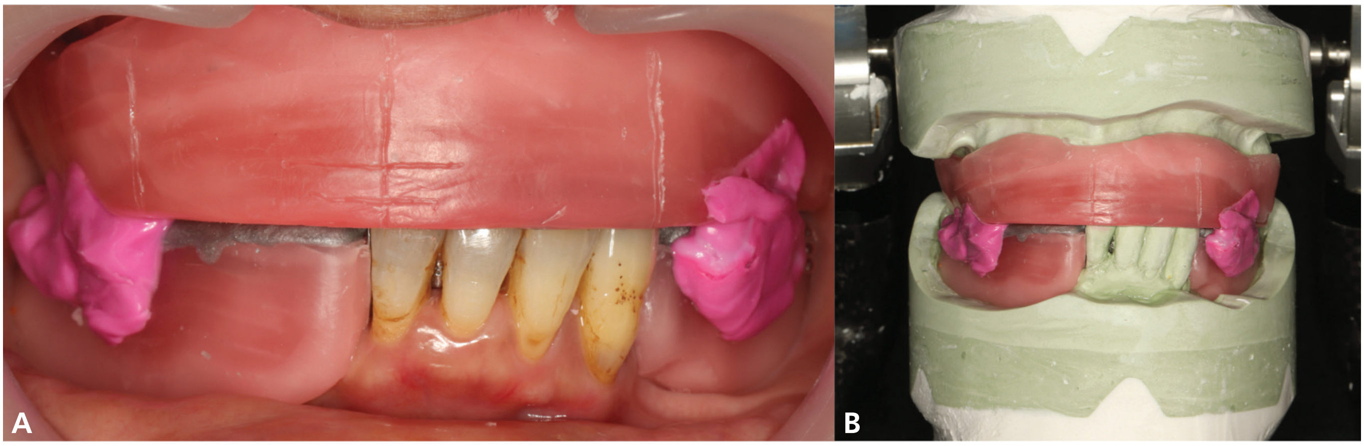

Figure 16. (A) Vertical dimension determination and bite record registration; (B) master cast mounted on a semi-adjustable articulator.

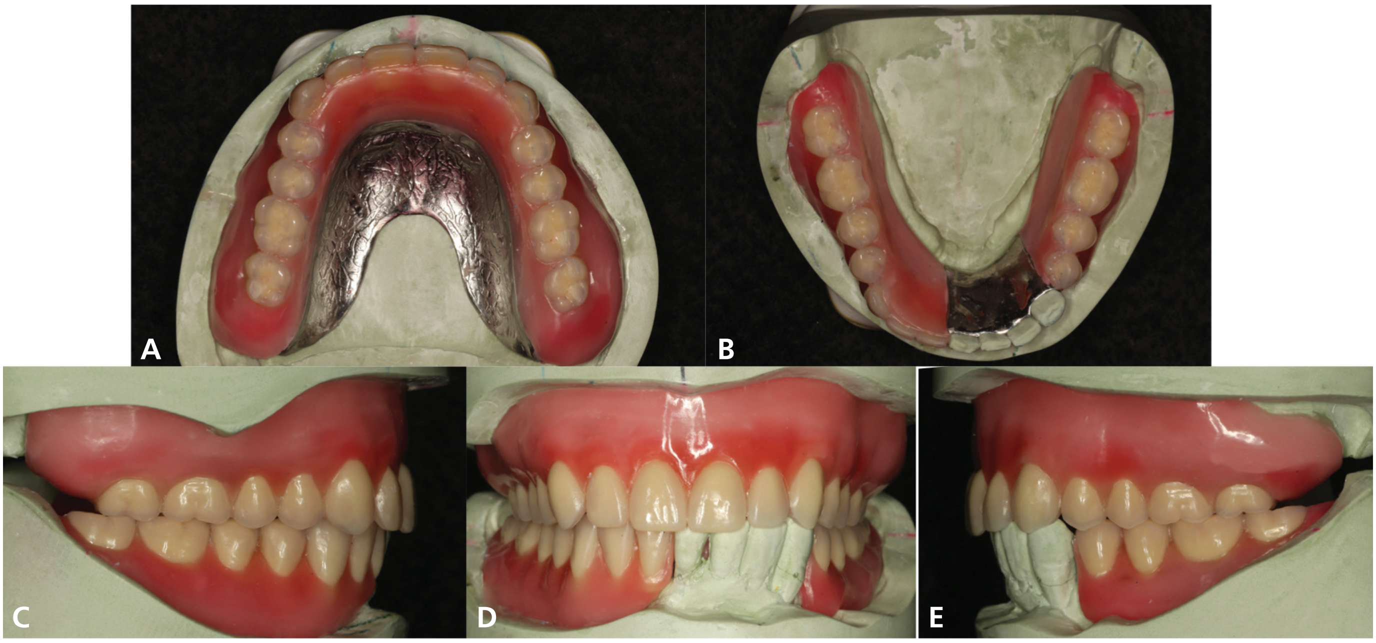

Figure 17. Teeth arrangement. (A) Occlusal view of the maxillary arch; (B) occlusal view of the mandibular arch; (C) right side; (D) facial aspect; (E) left side

Figure 18. Delivery of maxillary and mandibular dentures. (A) Occlusal view of the maxillary arch; (B) occlusal view of the mandibular arch; (C) right side; (D) facial aspect; (E) left side.

Figure 19. Postoperative extra-oral view. (A) Frontal view; (B) lateral view.

rest, guided by a preparation guide. In both jaws, open-tray impression copings were attached to the implants. Border molding was performed, and a final open-tray impression was taken.

The Locator attachment (LOCATOR, ZEST DENTAL SOLUTIONS, USA) was chosen based on gingival thickness and implant angulation (Fig. 12). The master casts obtained were examined and the cast framework was designed using a surveyor. The maxillary framework was designed with a U-shaped major connector because the patient did not want palatal coverage. In addition, a Ladder-type minor connector was incorporated without covering the metal housing of the attachment due to limited interocclusal space for tooth arrangement (Fig. 13). In the mandibular framework design, elements included a lingual plate, a Ladder-type minor connector covering the metal housing of the attachment for less strain on the denture, a cingulum rest on tooth 33, and proximal plates on teeth 41 and 33 (Figs. 14 and 15). Subsequent laboratory procedures were carried out based on the designed metal framework. The completed framework underwent clinical examination to confirm both acceptability and a passive fit.

The appropriate occlusal vertical dimension was established using a wax rim and confirmed through techniques such as phonetics, aesthetics, swallowing, physiological rest position, and assessment of interim dentures. The orientation of the upper occlusal plane was determined using the ala–tragus line and the interpupillary line as reference landmarks. Subsequently, master casts of both jaws were mounted on a semi-adjustable articulator with a facebow transfer (Fig. 16). Acrylic teeth (SR Vivodent S PE & SR Orthotyp, Ivoclar, Liechtenstein) were arranged on the wax rim in the maxillary and mandibular edentulous areas (Fig. 17). Full wax dentures were clinically tested to reassess the occlusal vertical dimension, occlusion, phonetics, and overall appearance.

The denture was processed, and laboratory remounting was performed to fine-tune the occlusion. The prosthesis was then delivered to the patient, accompanied by denture care instructions. After the patient wore the dentures for a week, a clinical remounting procedure was performed to enhance occlusal stability (Figs. 18 and 19). After the dentures were used for a month, the metal housing of the Locator attachment was picked up with denture reline material (Denture Liner, SHOFU, Japan). A minimum retention force of 2–3 kilograms per arch is essential. Therefore, for the maxillary implant overdenture, four blue nylon inserts, each providing 680 grams of retention, were employed, resulting in a total retention force of approximately 2.7 kilograms. In the case of the mandibular implant-assisted removable partial denture, a pink nylon insert, providing 1360 grams of retention, was applied to implant 36, while two blue nylon inserts were used for implants 43 and 46 (Fig. 20). The total retention force of the mandibular implant-assisted removable partial denture also amounted to approximately 2.7 kilograms. The patient reported satisfactory masticatory function with this level of retention force, and the dentures were easy to remove for maintenance purposes.

During follow-up visits, the patient expressed satisfaction with the aesthetics, function, and comfort of the dentures. Frontal and profile views demonstrated an enhanced appearance after the insertion of the new dentures. Postoperative periapical films indicated the stable periodontal and periapical status of the remaining teeth. At the 3-year follow-up visit, mild wear on the attachments in both jaws and slight retention loss were observed. To improve occlusal stability and denture retention, occlusal adjustments and changes to the nylon inserts were made.

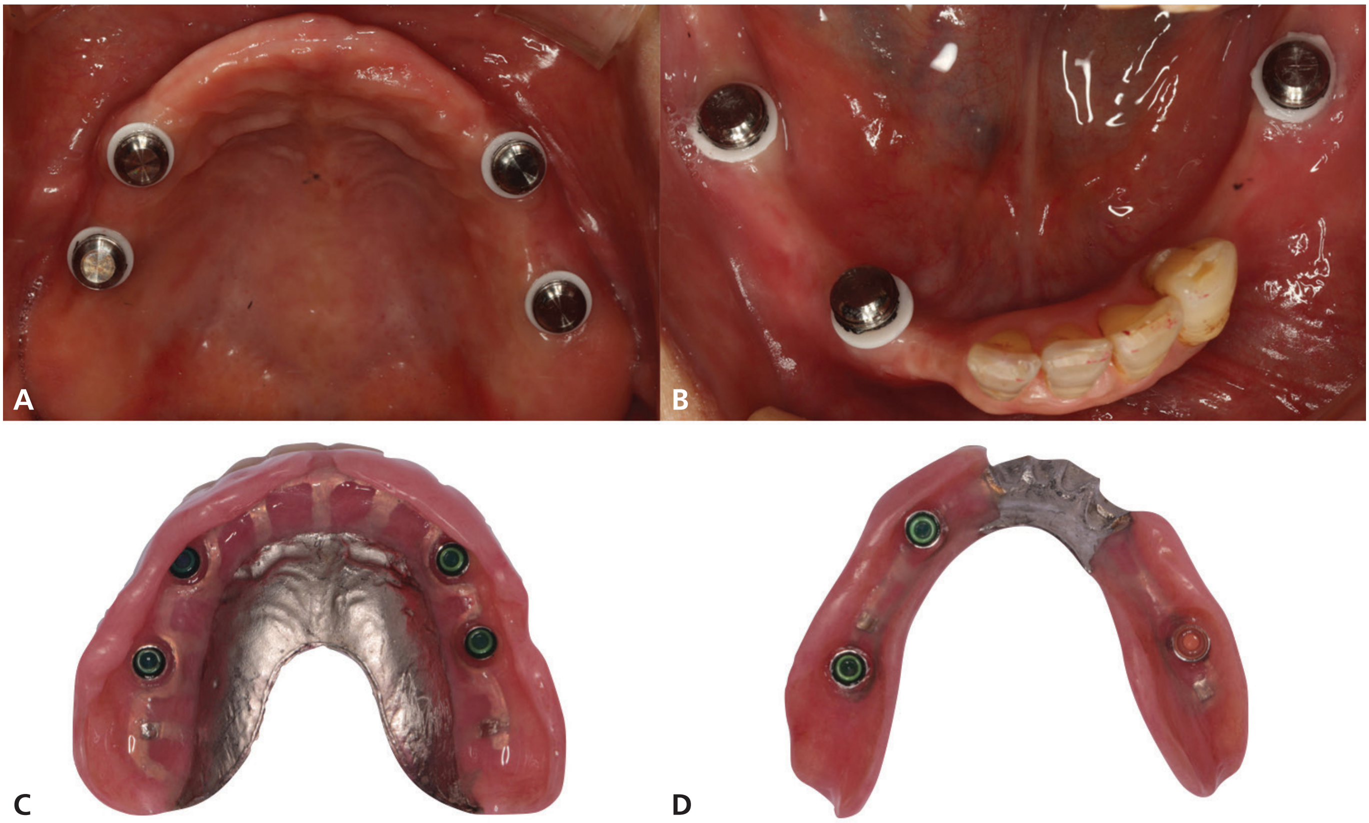

Figure 20. Locator attachment pick-up with chair-side technique. (A) Process kit insertion in the maxilla; (B) process kit insertion in the mandible; (C) maxillary implant overdenture after nylon insertion; (D) mandibular implant-assisted removable partial denture after nylon insertion.

Discussion

Implant overdentures are an excellent option for edentulous patients because they provide greater masticatory function and improved quality of life compared to conventional complete dentures. In addition, their removability allows for easier access for oral hygiene compared to fixed implant prostheses. Before starting implant overdenture treatment, the dentist must thoroughly assess the patient's condition and plan implant placement carefully, considering attachment type, implant number, and precise locations for successful outcomes.

The interocclusal space is pivotal in determining the attachment type for implant overdentures. Ahuja et al.[2] proposed a classification with four classes for restoring edentulous arches with implant overdentures. Class I denotes an interocclusal space larger than 15 mm, for which either bar-type or stud-type attachments are suitable. Caution is needed due to the increased space, which poses a higher risk of cantilevered occlusal loading. For Class II (12–14 mm), bar-type or stud-type attachments are applicable, with attention to space distribution to prevent denture fracture. For Class III (9–11 mm), stud-type attachments are suitable, with emphasis on assessment of attachment height and width. A metal framework may reinforce the overdenture. For Class IV (<9 mm), implant overdentures are unsuitable; interventions such as alveoloplasty, increase in vertical dimension, or alteration of the occlusal plane may be necessary to create the required space. In this case, the interocclusal space in both jaws measured 9–12 mm and was classified as Class III. Therefore, Locator attachments were selected to retain the implant dentures.

For mandibular implant overdentures, both the McGill consensus[3] and the York consensus[4] recommend a mandibular overdenture supporting two implants as the preferred minimum treatment for edentulous patients. In the case of maxillary implant overdentures, studies, including a systematic review by Raghoebar et al.,[5] highlighted that a maxillary overdenture supported by more than four splinted implants showed high implant and overdenture survival rates. Conversely, the use of fewer than four implants with non-splinted attachments increases the risk of implant loss. Di Francesco et al.[6] supported the use of an overdenture with a minimum of four implants for higher implant survival rates. Notably, the overdenture survival rate remained high irrespective of the number of implants. They suggested further studies to determine the advantages of splinting versus non-splinting.

The implant location is crucial for stress distribution and denture stability. In mandibular implant overdentures, the positioning of the implants over the canine or lateral incisor is crucial. The posterior part of the overdenture settles onto the soft tissue, providing superior support in stress-bearing areas like the buccal shelf. Placing implants too posteriorly may cause denture rocking around the fulcrum line. In addition, the anterior part, a non-stress bearing area, may contribute to bone resorption if not properly addressed.

For maxillary implant overdentures, implant location is influenced by factors such as residual bone, maxillary sinus extension, arch shape (V-shape or U-shape), and jaw relationship. Two regions, anterior and posterior, are considered for implant placement.[6] Dentists often prefer the anterior region due to a good stress-bearing area over the hard palate. In V-shaped arch forms, there is higher anterior cantilever force on implants. The jaw relationship influences occlusal force, with higher anterior cantilever force in Class III malocclusion. Hence, the anterior region is deemed more suitable. When four implants are chosen, they tend to be positioned between the canine and second premolar. Due to anatomical limitations, anterior implants are often not perpendicular to the occlusal plane, leading to increased stress concentration. Therefore, the placement of implants more anteriorly is generally not recommended.

This case report demonstrates the use of an implant-assisted removable partial denture to rehabilitate mandibular dentition in a Kennedy Class I edentulous scenario. Kennedy Class I, characterized by few remaining teeth for support and retention, often leads to increased instability of removable partial dentures (RPDs) and necessitates frequent adjustments, such as relining or fracture repair. The incorporation of additional implants in the posterior region of distal free-end RPDs has been suggested to improve function and stability. The requisite number of implants may vary depending on factors such as the length of the edentulous area, opposing dentition, and the presence of heavy bite forces, particularly common in patients with parafunctional habits. Increased implant numbers can help distribute stress more evenly around each implant and the surrounding bone, when enhanced prosthesis support is needed.[8] In the case of implant positioning, distally placed implants were observed to reduce stress at the edentulous area, transforming Kennedy Class I into a more favorable arch configuration resembling Kennedy Class III. Ortiz et al.[9] demonstrated that implant placement in the first molar area yields improved biomechanical outcomes, considering general displacements and maximum stress values, as well as their distribution in peri-implant bone, RPD metal framework, and implant. Moreover, when the clasps of existing RPD offer inadequate retention or their visibility is aesthetically unfavorable, implants can be positioned mesially adjacent to the abutment teeth. Placement of the implant next to the abutment tooth also aids in reducing occlusal forces on the abutment tooth.[8] Hence, in this case report, implants were placed in the areas of teeth 36, 43, and 46 to achieve broad stress distribution and improve aesthetics by eliminating the need for clasps.

Metal framework reinforcement of implant overdentures reduces denture strain, preventing fractures and minimizing residual ridge resorption. It also decreases strain on underlying implants by ensuring an even distribution of force across the implants. Studies by Takahashi et al.[10,11] have shown that framework design significantly influences strain on overdentures and implants. A full palatal coverage framework has a strain similar to that of a palateless framework with a palatal bar, while a palateless framework without a palatal bar tends to induce more strain. The highest strain on the denture is around the abutment, and denture fractures commonly occur in areas adjacent to the attachment. Thus, the design of the framework around the attachment is crucial, with metal reinforcement over the tops of the coping showing the least strain, followed by metal reinforcement over the sides of the coping.[12] In this case, the mandibular metal framework was designed to cover the metal housing to reduce strain on the denture. However, due to limited interocclusal space, the maxillary metal framework extended over the sides of the metal housing to facilitate easier tooth arrangement.

In stud-type implant overdentures, there are two techniques for pick-up attachment housing: laboratory pick-up and chair-side pick-up. The laboratory pick-up method incorporates metal housing during denture packing, while chair-side pick-up involves intra-oral incorporation with binding material. Laboratory pick-up offers reduced chair time, avoids mucosal contact with monomer, and provides a secure bond with the processing cap. However, disadvantages include potential binding errors and variations in settlement, leading to additional maintenance appointments. Chair-side pick-up addresses these issues but is technique-sensitive during intra-oral incorporation. Overall, the chair-side pick-up technique is considered a better choice. The incorporation of an attachment housing within the overdenture base significantly reduces the flexural strength of PMMA resin. Ozkir et al.[13] showed that PMMA-based acrylic resins, used as binding material for retaining the metal housing, exhibit superior flexural strength compared to composite resin-based retaining material and hard reline material. Domingo et al.[14] demonstrated that auto-polymerized acrylic resin has significantly higher flexural strength compared to light-polymerized acrylic resin. They also suggested that surface treatment of metal housing with silica-modified 30 μm aluminum oxide and silane produces higher flexural strength in denture blocks repaired with auto-polymerized acrylic resin. In addition, an issue frequently encountered in clinical practice with the locator attachment is the gradual detachment of its metal housing from the denture base resin over time. Nakhaei et al.[7] suggested using heat-polymerized acrylic resin for embedding the locator housing, which leads to a stronger bond between the metal housing and the denture base resin compared to auto-polymerized acrylic resin and auto-polymerized composite resin. The application of an alloy primer enhances the shear bond strength of the acrylic resin bond with titanium alloy.[15] However, Nakhaei et al.[7] found that the use of an alloy primer did not result in higher strength of the bond between the metal housing and denture base resin with auto-polymerized composite resin. Metal housings with undercuts on their axial wall provide mechanical retention for the retaining material. Consequently, the bond strength mainly relies on mechanical bonds, while the effect of chemical bonds is insignificant.

A systematic review by Assaf et al.[1] outlined a maintenance protocol for removable dentures, covering basic routines such as occlusion control and relining. Implant overdentures demand extra attention to assess attachment replacement needs. Success with overdentures means replacing the male part less than twice in the first year and up to five times in five years. Minimum retention of 2–3 kilograms per arch is required.[16] In a 4-implant maxillary overdenture with Locator attachment, a blue nylon insert is recommended, providing 680 grams of retention, extendable to 2.7 kilograms with four pieces. For a 2-implant mandibular overdenture, a pink nylon insert providing 1360 grams of retention, reaching 2.7 kilograms with two pieces, is suggested. However, starting with the smallest retention force is advisable, with adjustments made by the patient as needed.

Conclusion

An implant overdenture offers edentulous patients a stable removable option, resulting in increased patient satisfaction and improved quality of life. This case report outlines the fabrication of a maxillary implant overdenture supported by four implants and a mandibular implant-assisted removable partial denture supported by three implants. Both dentures used stud-type attachments due to limited interocclusal space, classified as Class III. Implant positioning was carefully planned based on bone volume and strategically distributed to enhance support and retention. In addition, the implant-assisted dentures were reinforced with metal frameworks to prevent denture fracture. Follow-up visits indicated stable periodontal status and only minor adjustments to ensure long-term comfort and functionality. Overall, the treatment provided significant benefits in terms of aesthetics, function, and patient well-being.

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