Combination of short implants and a unilateral distal-extension implant-retained partial denture in case of severely reduced ridge height mandibular posterior region: 12-year follow-up

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This case report describes the treatment of a woman who lost mandibular posterior teeth. The bilateral alveolar ridges showed severe tissue defects. She complained of the discomfort of a partial denture connected by a lingual bar and wished for fixed prostheses. However, the height of the alveolar bone was insufficient to place standard-length implants. In addition, she rejected bone augmentation and the usage of biomaterials. Therefore, short implants were placed in both sides of atrophic alveolar ridges without tissue augmentation. Conventional crowns were placed on the right side on three short implants, and a unilateral distal-extension partial implant-retained partial denture (IRPD) using magnetic attachment was placed on the left side using the two available short implants. The patient was satisfied with the outcome of this treatment for 12 years even though a clasp was added to the removable partial denture at 11 years due to the wear of the magnet keepers. The combination of short implants and an IRPD using magnetic attachment is effective for patients with a severely atrophic posterior mandibular from the aspect of minimal intervention.


Introduction

For the Kennedy class II (unilateral free end) edentulous posterior mandible, distal extension removable partial dentures (RPDs) are employed for long-term use1). A bilateral design using lingual bars has been recommended for RPDs of the Kennedy class II edentulous mandible because it is difficult to stabilize the prosthesis unilaterally and to avoid swallowing and aspirating the prosthesis2). However, patients have are discomfort with lingual bars and esthetic problems due to the metal clasps3).

Recently, implant treatment has become an effective option for the edentulous posterior mandible4). However, when bone volume is not sufficient for a standard implant installation, severe loss of bone volume makes it difficult to place standard-length implants5). In addition, in the posterior region of the severely atrophic mandible6, 7), anatomical structures such as the inferior alveolar nerve may limit optimal implant placement.

Vertical bone augmentation is often necessary when the bone volume is insufficient for implant placement8). Several bone augmentation techniques have been employed successfully in posterior areas to increase bone height9). However, patients may suffer from surgical stress, long treatment period and high cost, and the outcomes of bone augmentation are not always satisfactory10). In addition, vertical augmentation is technique sensitive and there may be
some complications. As a result, when the bone volume is poor, implant treatment is often abandoned and the patient has to use RPDs. However, the lingual bar and flange may feel unpleasant and bother the patient, with the result that the patient might not use the RPDs, and occlusal collapse can occur.

Another alternative is using short implants (<10mm). Recently, the reliability of short implants has increased due to the improvement of their surface topography and design. However, there are still some concerns when we use short implants, which have less surface area than standard-length implants and we should select the indication carefully. In the case of an atrophic ridge, fixed prostheses using short implants without vertical bone augmentation provide a high crown-implant ratio and low hygiene, and this might result in instability of the short implants.

In the above situations, a partial unilateral distal-extension implant-retained partial denture (IRPD) might resolve the problems. A few clinical reports have described edentulous patients with missing mandibular premolars and molars who have undergone rehabilitation with IRPDs. An IRPD using short implants could solve the crown-implant ratio problem and relieve the discomfort of the patient due to lingual bars and clasps. However, there are few case reports using short implants for partial IRPDs. We used magnetic attachments to support an IRPD on the implants in the present case. Magnetic attachments have eternal retention force and are easy to apply to various cases. These attachments which have shorter height than other mechanical attachments, are useful for patients with restricted interocclusal space and can meet esthetic demands by omitting the clasp and bar. Furthermore, magnet-retained dentures are relatively easy to place and remove, and are useful for patients with physical disabilities such as those experienced by frail older adults. However, a long-term experience with a unilateral distal-extension IRPD using magnetic attachment has not been reported.

In this case, we used short implants for a patient who had bilaterally atrophic mandibular ridges to avoid large surgical burden. In addition, we selected a unilateral distal-extension partial IRPD with magnetic attachment on the right side and a conventional crown on the left side, and were able to attain a good clinical outcome for more than ten years by addressing certain problems.

Case report

A 65-year-old female patient with a complaint of mandibular toothache. Her mandibular right second premolar, left first molar, maxillary left lateral incisor, canine and first premolar showed mobility, and X-ray examination indicated localized severe bone defect in these regions (Fig 1). On the maxilla, she had for some years used a RPD that did not cover the palate to avoid the vomiting reflex. The alveolar ridge showed severe vertical tissue defects three months after extraction (Fig 2). She wore bilateral distal-extension RPDs connected by a lingual bar for the Kennedy class I situation in the posterior mandibular region. However, she complained of the discomfort of the lingual bar and of the aesthetic outcome due to clasping on a premolar. She is in good general health, with no local or systemic contraindication to oral surgery.

She wished to have a fixed prosthesis for the mandibular edentulous space using dental implants. However, X-ray examination and study model analysis demonstrated that the height of bone of this region was insufficient to place standard-length implants and the distance between the maxilla and mandibular ridge was extremely wide (Fig 3). In addition, panoramic radiograph examination and cone-beam computed tomographic analysis revealed that the distance between the ridge crest and mandibular inferior nerve was 6-10mm and it seemed to be extremely difficult to place even a short implant especially in the site of left

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Fig 1  An initial panoramic radiograph
The lower left first molar and right second premolar were extracted due to severe periodontitis.
first molar (Fig 4 A·B). These results indicated that vertical bone augmentation was necessary to place standard length implants. However, she rejected any surgical tissue augmentation and the usage of bone filling materials or a collagen membrane originating from an animal or cadaver.

Therefore, we suggested the following treatment plan to the patient.

1. Conventional crowns on three short implants (one implant 4.1mm in diameter and 8mm in length, two implants 4.1mm in diameter and 6mm in length) in the right posterior mandibular area.

2. A unilateral distal-extension IRPD using magnetic attachments on two short implants (3.3mm in diameter and 8mm in length, 4.1mm in diameter and 6mm in length) in the left posterior ridge area without bone augmentation. We considered that two implants were needed for left mandibular region to avoid the use of a lingual bar and clasp on the premolar and to prevent rotation and displacement.

3. A maxillary conventional RPD that did not cover the palate after extraction of the loose teeth. She accepted the RPD using a wire clasp and did not complain about any esthetic problem because of her low lip profile and a wire clasp was applied in the position as close to the tooth cervix as possible.

She agreed with these treatment plans. Implant position was planned by using computer simulation software (Simplant, Belgium) considering the acceptable angle for magnetic attachments. Then short implants (Straumann Japan, Tissue Level Implant) were placed in the right and left posterior mandibular areas using a one-stage method without any bone augmentation (Fig 5). The bone at this site was type three in the classification of Lekholm and Zarb and the insertion torque value was 35N/cm. After implant placement, the patient hardly complained of pain and swelling. Three months later, a conventional impression was taken to fabricate conventional crowns and an IRPD (Fig 6).
Fig 4  Computed tomography scan analysis and 3-dimensional reconstruction before surgery showing severe atrophy of the mandible demonstrated the difficulty of the placement of standard-length implants.

Fig 5  Short, narrow-diameter implants were placed without any surgical bone augmentation

A. Right side  B. Left side

Fig 6  A conventional impression was taken to fabricate conventional crowns and an IRPD.
A fixed prosthesis was placed on the right mandible. On the left side, magnet keepers were screwed into the two short implants. A unilateral IRPD was fabricated. A wing-type bracing arm without a sharp edge was provided on the lingual side to stabilize the denture. Magnetic capsules (MAGFIT, Aichi Steel Corporation, Aichi, Japan) were placed on the keepers and attached to the denture base intraorally with autopolymerizing methylmethacrylate (Provinice Shofu Japan) (Fig 7). The patient was satisfied with the clinical and esthetic outcomes and postoperative radiographs indicated no bone resorption around the short implants (Fig 8).

Follow-up was uneventful for ten years after completion of the definitive restoration and the bone resorption around the implants was acceptable as observed by X-ray analysis during the eleven years of follow-up (Fig 9). Careful attention was paid to her systemic condition. She had never been about to swallow or aspirate the IRPD.

The patient was instructed to use a tuft brush (One Tuft, Lion, Japan) to clean the whole circumference of the keeper in the maintenance phase (Fig 10). After eleven years, wear of the keepers was observed though the retention was not attenuated. Therefore a clasp was added on the premolar providing for the possible decline of retention in the future. Twelfth years of the follow-up was uneventful thereafter (Fig 11). She did not desire replacement of the units of the magnetic attachments though she accepted the esthetic problem by approproateness for her age. In addition, we explained the possibility of conversion to bilateral prostheses in the future for the prevention of swallowing as a result of a change in her systemic condition.

Discussion

In this case, we offered a treatment plan for a severely atrophic mandibular posterior region using short implants to minimize surgical stress10). Though bone augmentation has been proven successful, flap release and a lack of vascularization, together with a low supply of keratinized tissue, are obstacles that need to be overcome to achieve predictable results20, 21). In particular, vertical bone augmentation was reported to be extremely difficult and the formed bone might be unstable9). Moreover, the cost and long treat-

![Postoperative views of the patient](image1)

A fixed partial denture on the right side of the mandible and a distal extension IRPD supported by two short implants with magnetic attachment on the left side of the mandible.

![Postoperative radiographs of the patient](image2)
ment duration might be crucial problems for the patient. In this case, the patient wished for minimally invasive treatment.

The prognosis of short implants might be influenced by the bone volume and quality due to their small surface area though the success rate of mandibular short implants is comparable to that of standard implants. In addition, the survival rate of short implants might also be influenced by prosthetic factors and the crown/implant ratio. Moreover, the use of too few short implants might result in overload, though there is a lack of evidence to determine the optimal number and distribution of implants supporting fixed partial dentures (FPDs). On the other hand, it was reported that increasing the number of implants decreased the stress in the bone. Several studies using finite element analysis have indicated that the stress pattern on peri-implant bone is affected by the number of implants, and by the diameter, length of the implants as well as by the quality and quantity of surrounding bone. It was considered that short implants were suitable for this case due to the alveolar width and bone quality of her mandible.

However, it was expected that crown-implant ratio would be too high if we selected FPD for this case. In addition, finite element methods substantiate that a higher crown to implant ratio increases the risk of mechanical failure. A significant correlation between screw loosening, fracture of the prosthetic abutment, and crown height was reported. Moreover, we consider that a prosthesis with a
large crown/implant ratio may lead to insufficient hygiene. Especially in FPD, it is difficult for patients to clean around a long pontic.

Therefore, when the same number of implants as prosthetic teeth cannot be placed, a fixed prosthesis should be avoided and a removable prosthesis may be preferable. In this case, conventional crowns were selected for the right side, because the same number of short implants as replaced units could be used. Clinicians should minimize the load on short implants and provide a cleanable shape for the prosthesis. The combination of an IRPD and short implants could resolve these problems, and the point resisting the occlusal force exerted could be made lower, avoiding lateral force on the implants. Moreover, the IRPD can be emplaced without a lingual bar or clasp on a premolar with improved comfort.

In this case, we selected magnetic attachment to bind the IRPD and short implants. A magnetic attachment exerts force only when the magnet and the keeper are in contact and when they lose contact this force diminishes rapidly. Moreover, the magnetic unit offers little lateral resistance against displacement, which reduces the damage from lateral force directed by a denture onto teeth or implants. Magnets have a low height profile, and they reduce horizontal stress transmission to the implants and surrounding bone during overdenture dislodgement. Relief around the keeper and disclusion were provided to avoid lateral force on the implants in this case. Though splinting implants with a bar attachment has a reliable outcome, the cost is high and poor hygiene may result. Magnetic attachments can also accommodate a moderate divergence of alignment among implants since they do not depend on a particular path of insertion requiring minimal divergence for best function, and the usage of dome-type components allows a difference of direction for the implants. In this case, adequate retention could be achieved even though the mesial implant was tilted to avoid the mental foramen. The wing-shaped bracing arm contributed to denture stability.

Conclusion

In this case, we used short implants to reduce the surgical burden for a patient who had a severely atrophic alveolar ridge in the mandibular posterior region. In the right mandibular posterior region, a fixed prosthesis was installed and in the left region, a unilateral IRPD using magnetic attachment was employed. We obtained a desirable outcome without any surgical augmentation. The combination of short implants and a unilateral IRPD is useful in the severely atrophic posterior region. However, adaptability of the prosthesis design for future changes considering the properties of short implants and hygiene are important.

References


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下顎臼歯部の歯槽堤が著しく低下した症例における片側遊離端義歯の支持をインプラントに求めた症例：12年の経過観察

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キーワード：IRPD, 磁性アタッチメント, ミニマルインターベンション, ショートインプラント

この症例報告は下顎の臼歯を失った女性患者の治療について述べている。両側の歯槽堤は高度に組織が欠損していた。彼女はリンガルで連結された部分床義歯の不快感を訴え、固定性の補綴装置を希望していた。しかし、歯槽堤の高さは標準的な長さのインプラントを埋入するには不十分であった。加えて、彼女は骨形成や生物材料の使用を拒否した。そこでショートインプラントを組織増生することなしに両側の萎縮した歯槽堤に埋入した。右側には3本のショートインプラントに通常の冠を装着し、左側には2本の利用可能なショートインプラントと磁性アタッチメントを用いて、片側性遠心遊離端式の部分インプラント維持義歯(IRPD)を装着した。装着11年目にキーパーの摩耗により部分床義歯にクラスプの追加を行ったが、患者は12年間の治療結果に満足している。ショートインプラントと磁性アタッチメントを用いたIRPDのコンビネーションは臼歯部が高度に萎縮した下顎を有する患者に、ミニマムインターベンションの観点からも効果的であると考えられた。