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Case Report

Immediate Implants with Early Loading Accompanying Autogenous Bone Grafting in a Maxilla with Periodontal Destruction: A Case Report

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Abstract: In the case of multiple hopeless teeth and severe bone loss, a conventional healing protocol of 3–4 months has been recommended to prevent the possibility of infection or unpredictable resorption of grafted bone during consolidation of the extraction socket. The use of a provisional denture is inevitable in the case of delayed implant placement, which is a common risk factor for wound dehiscence after a bone graft. Although autogenous bone is still the gold standard for bone grafting because of its excellent biocompatibility and osteogenic potential, there has been controversy in the unpredictable resorption of autogenous bone grafting. We present a case of successful maxillary rehabilitation without the use of provisional dentures by immediate implant placement, with early loading accompanying an extensive autogenous bone graft.

Keywords: autogenous bone; bone graft; dental implant; dental implant loading; extraction

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1. Introduction

Autogenous bone is still the gold standard for bone grafting because of its excellent biocompatibility, osteogenic potential owing to the living osteoblasts, osteoinductivity, and osteoconductivity [1]. Autogenous bone grafts can provide support and stability to dental implants and maintain a proper volume with the surrounding bone, which can accelerate bone healing. However, limitations of autografts, such as possible harvesting morbidity and unpredictable resorption, have been reported in cases of intraoral bone grafts. Cordaro et al. [2] reported that up to 42% of patients presented vertically resorbed bone at 6 months after transplantation. Bone grafting with autogenous bone alone has been controversial because of its volumetric instability.

Among autogenous bone grafts, intramembranous bone has been known to show minimal resorption and more rapid integration compared with that shown by endochondral bone [3]. In addition, when compared with the symphysis, the mandibular ascending ramus can allow a larger volume of graft material, resulting in a lower possibility of harvesting complications [4]. Harvesting complications, such as nerve damage, hemorrhage, hematoma, or severe pain, can be prevented if the surgeon can harvest the cortical ramus without marrow invasion.

Considering tooth extraction, immediate implant placement with guided bone regeneration (GBR) can shorten the healing period and reduce the duration of the surgical procedure. However, in the case of multiple teeth with severe bone loss due to periodontitis or sinusitis, a conventional delayed protocol has been recommended to prevent the possibility of infection and unpredictable resorption of the grafted bone [5]. The conventional protocol requires a healing period of 3–6 months for the consolidation of the extraction socket [6]. Delayed implant placement is inevitable when provisional dentures are used. Provisional partial dentures apply a retentive force on the remaining teeth; there-

fore, strategic extraction of teeth in poor condition is needed before the application of a provisional denture.

However, a common complication after bone grafting in patients with dentures is wound dehiscence [7]. If a patient requires a bone graft even after the consolidation of the extraction socket, immediate implant placement with early loading could reduce the overall rehabilitation time, increase patient satisfaction and function, and have a psychological benefit. The aim of this case report was to introduce a case of successful maxillary rehabilitation without the use of provisional partial dentures by immediate implant placement with extensive autogenous bone graft and early loading after 4 weeks of surgery for soft tissue healing.

2. Case Report

This study was approved by the institutional review board of the Armed Forces Capital Hospital (AFCH-21-IRB-004) and conducted in accordance with the tenets of the Declaration of Helsinki for research involving humans.

A 55-year-old male patient with a smoking habit (10 cigarettes/day over 20 years) and a history of sinus surgery for chronic sinusitis 20 years ago visited our hospital for dental implant treatment. Clinical examination revealed severe periodontitis and mobility of all maxillary teeth, except the left central incisor (#21) and left premolars (#24 and #25: mild chronic periodontitis and mobility). Radiography showed severe bony defects in the anterior and molar regions and sinus haziness (Figure 1A,B). Considering the possibility of an oroantral fistula formation, extraction of the hopeless teeth (severity grade IV; complexity grade IV; tooth mobility degree ≥ 2 [8]) with simultaneous reconstruction surgery using an autogenous bone graft was performed. To prevent overpressure and wound dehiscence due to the provisional dentures, the authors attempted to simultaneously place the implants with early loading on the premolars and anterior tooth.

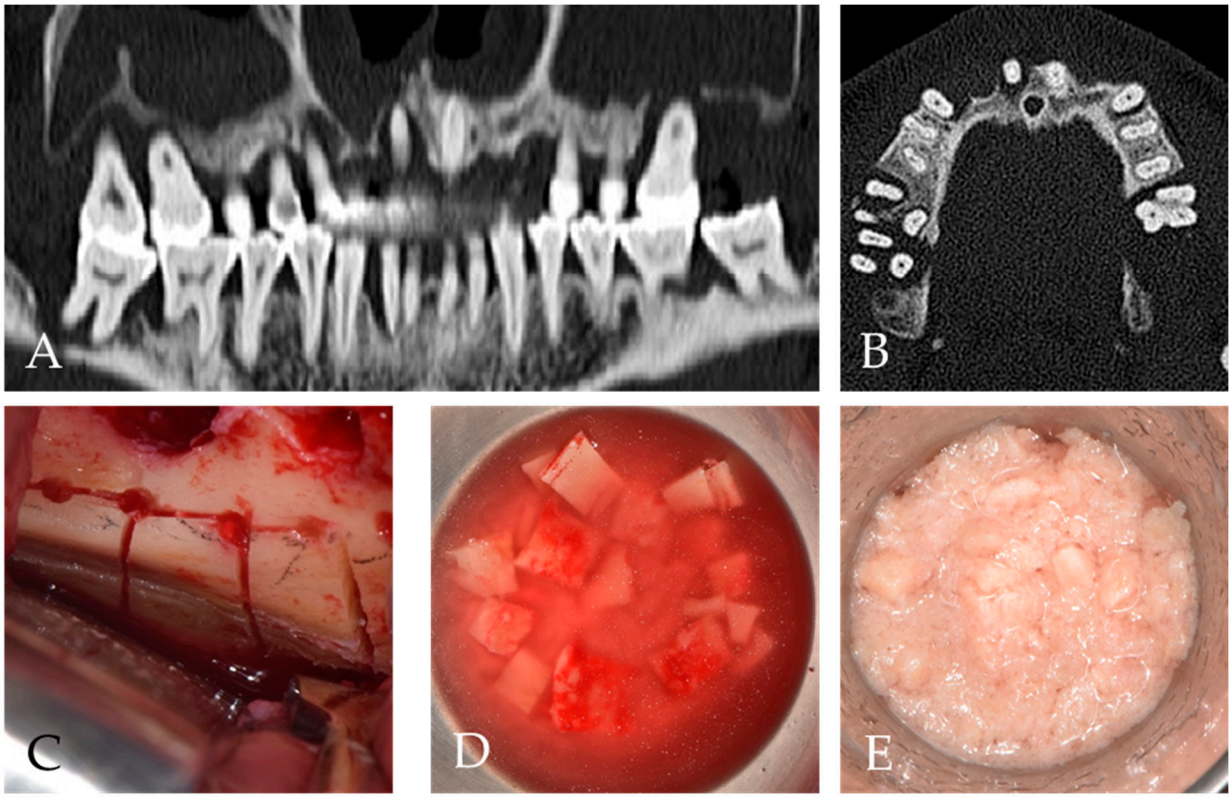

Figure 1. (**A**,**B**) Pre-operative radiographs showing generalized severe periodontitis and residual bone loss in the maxilla, with both sinusitis and oroantral fistulae. (**C**,**D**) Simultaneous surgery with the extraction of hopeless teeth; the autogenous bone was harvested from the lateral ramus. (**E**) The autogenous graft was crushed.

After extraction of the teeth and preparation of both sinus floors, the implants (ø 4.5 × 10.0 mm on #11, #14, and #15; ø 4.0 × 10.0 mm on #13, #22, and #23, Osstem TS III SA, Osstem, Seoul, Korea) were placed in the desired position for prosthetic rehabilitation. The lateral cortical bone of the mandibular ramus was harvested without bone marrow invasion (Figure 1C). The harvesting involved sagittal, coronal, and axial osteotomies using a micro-saw within the cortical bone. The thickness was confirmed by the ditching holes made with a round burr. The cortical bone was harvested from the occlusal part using a chisel and crushed to a particle size of 300–800 μm using a bone mill in order to increase the contact area (Figure 1D,E). The autogenous bone was grafted around the implants and both posterior oroantral fistulae. Titanium meshes (Retro Ti-matrix, Seum medi, Bucheon, Korea; thickness 0.3 mm, hole size ø 1.7 and 3.4 mm) were used to fix the grafts. Concerning primary stability for early loading, the values of the stable implants (≥40 N initial torque and ≥65 implant stability quotient (ISQ)) were determined by an Osstell mentor (Integration Diagnostic AB, Göteborg, Sweden) using a non-submerged protocol with a healing abutment connection. Tension-free sutures were achieved after adequate flap management, including incision release.

Post-operation care was delivered via antibiotics (Mesexin, 500 mg tid, Hanlim Pharm., Yongin, Korea) and naproxen (Naxen F, 500 mg bid, Chong Kun Dang Pharm., Seoul, Korea) as anti-inflammatory analgesics for 1 week and 0.2% chlorhexidine gluconate (Alpha-hexidine, 100 mL twice per day, Firson, Cheonan, Korea) for 2 weeks. With verified soft tissue healing at 2 weeks after the surgery, the submerged implants were considered for a provisional prosthesis with the confirmation of soft tissue healing (Figure 2A). The provisional prostheses were fabricated with polymethyl methacrylate (PMMA) resin and delivered with ≥30 N of torque at 4 weeks postoperatively (Figure 2B–D).

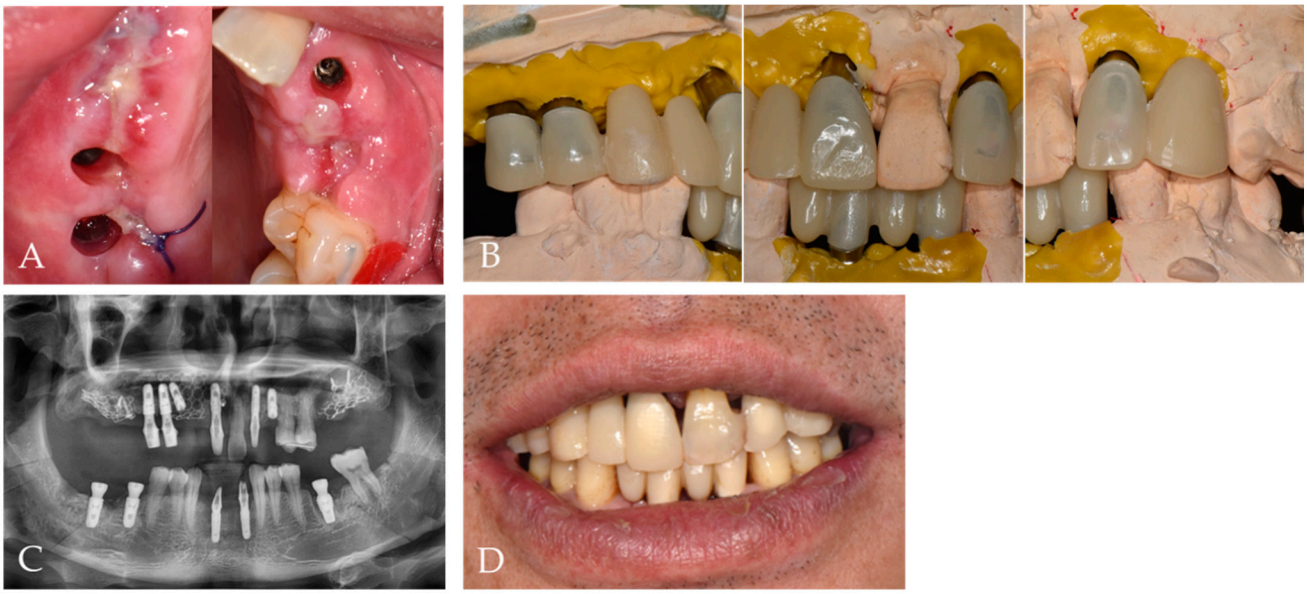

Figure 2. Early loading to avoid provisional partial dentures. (**A**) At 2 weeks after the surgery, we confirmed the soft tissue healing, and an impression was taken for provisional fixed protheses. (**B**) At 4 weeks after the surgery, the provisional prostheses were fabricated and delivered. (**C**,**D**) Post-operative radiographs and photographs at the provisional prosthetic delivery.

Five months postoperatively, the provisional prostheses were changed to final prostheses. After five months with the final prostheses, we planned to place one of each implant on the maxillary molar areas. However, the patient wanted the implants to be placed in the same spaces as his natural teeth before their loss. Both maxillary posterior areas were placed on the implants (ø 5.0 × 10.0 mm on #16, #17, and #27; ø 4.5 × 10.0 mm on #24 and #25, Osstem TS III SA) with the extraction of the left premolars at 10 months after

the surgery. The final prostheses were delivered 14 months postoperatively (Figure 3A). The early loaded implants (#11i, #14i, #15i, and #21i) were supported by well-developed corticocancellous bone. When comparing the pre-operative radiography (Figure 3B), the grafted bone and dental implants were well-integrated, with functional loading during the regular check-up (Figure 3C). In addition, the patient with a low smile line was satisfied with the esthetic outcomes of the dental implants (Figure 3D).

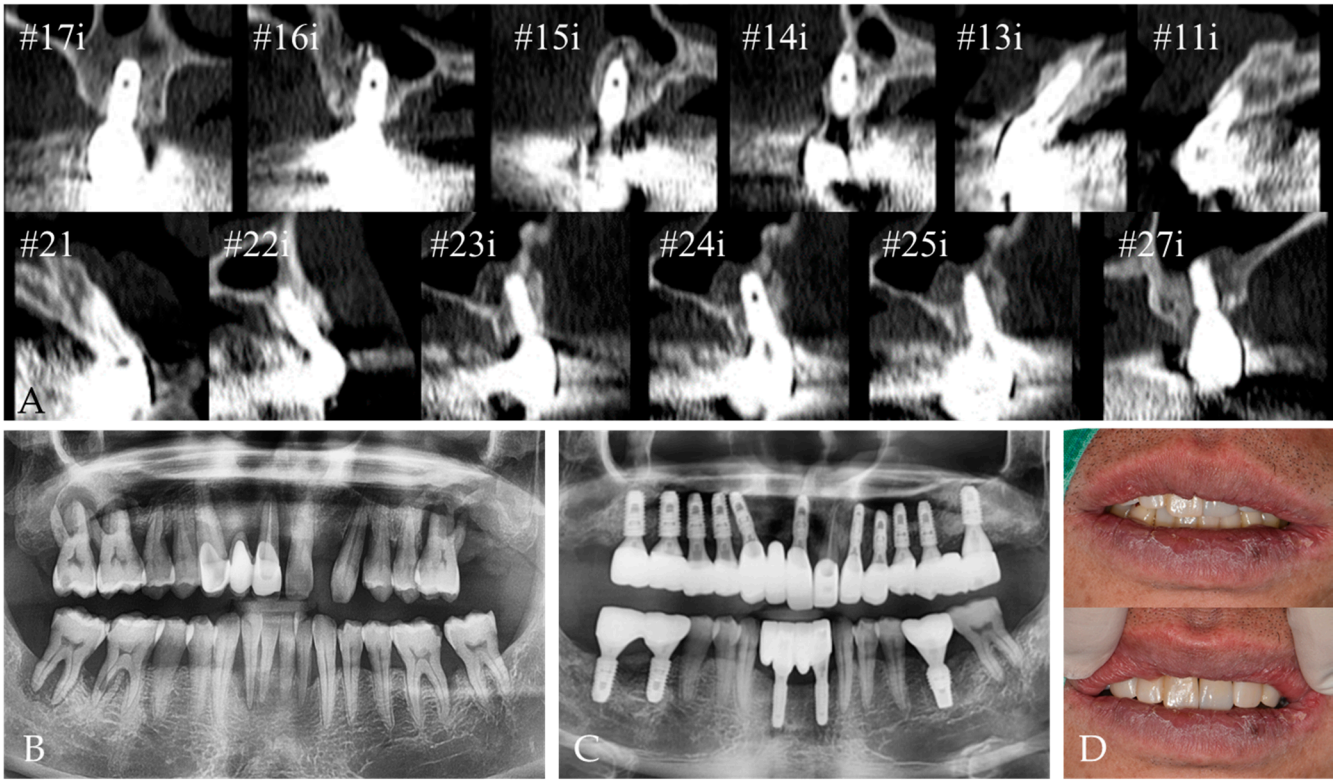

Figure 3. Postoperative radiographs. (**A**) Post-operative radiographs at 14 months after the surgery. All implants were functioning well with no complications, such as graft or implant failure or marginal bone loss. (**B**) Pre-operative radiograph. (**C**,**D**) At 16 months after the surgery, the implants and grafted bone were well-maintained, with masticatoric and esthetic functions.

3. Discussion

The authors thought that the autogenous bone graft could resist infection and wound dehiscence with non-submerged implant placement and heal rapidly with osseous integration around the implant, even after early loading. To prevent graft infection and achieve soft tissue healing, an impression was made at 2 weeks, and the implants were loaded with provisional prostheses at 4 weeks. This resulted in a successful outcome without graft loss or implant failure.

Quantitative evaluation of implant stability using resonance frequency analysis is reliable for the assessment of implant success using ISQ values. Less susceptibility to implant failure has been reported with ISQ values higher than 65 after immediate or early prosthetic loading [9]. However, due to the remodeling process, the ISQ value is known to decrease 3–4 weeks after placement, during which the transition period from primary to secondary stability occurs. Furthermore, maxillary implants show lower stability and ISQ values than mandibular implants [9]. Since ISQ values are directly related to the extent of osseointegration, the timing of the loading at four weeks was undesired in this case. Despite several unfavorable conditions, such as severe bone loss, chronic periodontitis, a smoking habit, the timing of prosthetic loading, and poor bone quality of the maxilla, all implants functioned well without failure and were supported by a well-developed corticocancellous

bone with no marginal bone loss. We can speculate that high initial stability (≥65 ISQ value) and autogenous bone grafting could achieve effective reconstruction of severe bone defects with early implant rehabilitation [7,9]. In addition, we easily verified the vertical dimension using the remaining three teeth (#21, #24, and #25) during the healing period, and the left premolars were extracted before the final prosthetics. Since provisional partial dentures can be avoided through early loading, the patient could easily adapt to the implant prosthesis and showed significantly improved satisfaction and quality of life.

With considering the early loading of this patient, a mechanobiological effect might also contribute positively to the grafted autogenous bone. In 2018, Li et al. highlighted that mechanical stimulation was able to augment implant osseointegration and the peri-implant bone mass in both healthy and diseased bone [10]. The mechanical loading seems to be effective, especially in the vicinity of the implant and the response of the implanted bones in the first 2 weeks after implantation. Some in vivo studies showed that mechanical stimuli have positive effects, such as enhanced bone formation and inhibited bone resorption [11–13]. Leucht et al. reported that an enhanced osteoblastic differentiation was observed in the early loaded group in the peri-implant tissue [14]. Implantation surgery, as well as the presence of prosthetic loading, might alter the mechanobiology of the peri-implant bone, causing a different reaction to the loading than the bone without an implant [10,15].

Wound dehiscence, which could be contributed to by using provisional dentures, is the most frequent complication after extensive bone augmentation [7]. In 2021, Ku et al. suggested an effective conservative technique for wound dehiscence by using attachable dressing material [16]. Although the conservative technique could achieve secondary healing with osteoinductive autogenous bone substitutes, some bone volume loss was inevitable in the wound dehiscence area. By avoiding the use of provisional partial dentures, we could reduce the risk of wound dehiscence even with extensive bone grafting and acheive soft tissue healing without excessive compression.

The factors that facilitate the healing of autogenous bone grafts are similar to those that facilitate the healing of fractures, such as the embryonic origin of the graft, graft orientation, rate and extent of revascularization, contact surface, and rigid fixation of the graft to the recipient site [17]. Among the various sites of intramembranous bone, which has better characteristics for bone grafting than endochondral bone [3], the mandibular ramus has several advantages, including accessibility of the donor site, a short operation time, the patient's preference, and low complication rates [4]. Considering these factors, we harvested the ramus cortical bone, crushed it to increase the contact surface for vascularization, and affixed it using titanium mesh and mini-screws. The rigidly fixed autogenous bone graft is accepted by invading progenitor cells to differentiate into bone-producing cells (osteoblasts) or soft tissue-forming cells (fibroblasts) [18]. The transformed fibroblasts could affect not only the rapid vascularization of the graft but also accelerate soft tissue healing above the graft. To enhance the bone healing capacity, recombinant human BMP-2 (rhBMP-2) and several carriers have been developed [19]. Demineralized dentin matrices have been suggested as promising candidates for rhBMP-2 carriers with the sequential and slow release [20]. However, there is little clinical evidence of a large defect of the jaw, which has a high risk of infection and poor stability of the grafts [7].

Success rates of 88–95% have been achieved for implants with GBR by autogenous bone for severely resorbed jaws [21]. In 2021, Libertucci et al. reported the optimal outcomes of both mechanical stability and maintaining volume, with autogenous bone grafts for the implants after an 18-year follow-up [22]. Although the follow-up period was 14 months in this patient, the final radiography showed that the early loaded implant showed no marginal bone resorption and was supported by cancellous bone, and the grafted bone was remodeled with corticocancellous bone. In accordance with a previous study on particulate autogenous bone grafts for implants [23], this marginal bone result could assure the long-term success of the implants. For long-term success, however, clinicians should treat the patient with proper therapy and prevention of periodontal diseases and maintenance of

the dental implants [24]. This case report had several limitations, including an unevenly controlled size of the particulate autogenous bone, no edentulous state, no prosthesis before the early loading, and a lack of patients. Further research should be conducted for full-mouth rehabilitation with no available residual bone to ensure the initial stability of the implant.

4. Conclusions

The application of autogenous bone from the mandibular ramus can allow the early loading of simultaneous non-submerged implant placement after tooth extraction, avoid the use of a provisional partial denture, and achieve successful osteointegration around the implant, even after early loading.

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Informed Consent Statement: Patient consent was waived due to the retrospective study design.

Data Availability Statement: Data are contained within the article.

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