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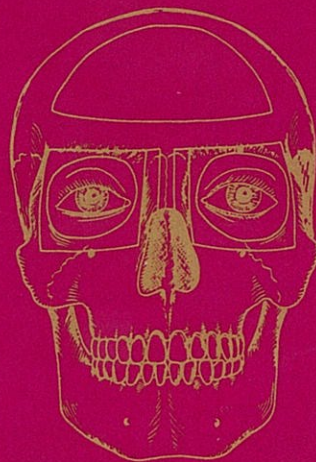
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Regenerative Treatment of Serious Periodontosis With Grafting of Cancellous Iliac Bone and Gingival Flaps and Replanting of Patients' Teeth

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The purpose of this study was to assess the ability of serious periodontosis patients to regain satisfactory biting function, using the patients' own teeth, by regeneration of the alveolar bone. Twelve serious periodontosis patients whose alveolar bone was markedly absorbed and whose teeth were quite unstable were treated with replanting of their teeth and grafting of cancellous iliac bone and gingival flaps by the clinical team, which consisted of plastic surgeons and dentists. No patients developed postoperative complications (e.g., infections), and grafted iliac bone took in all patients. The total number of replanted teeth was 65, and only 4 of them fell off (92% take rate). Three to 4 months after surgery, the replanted teeth received prosthetic treatment so that the patients could begin biting. Ten patients were monitored for 5 months or longer, and they started to eat normal food after the fifth month. Regained biting function and satisfaction of having food were almost the same as before the periodontosis became severe in these 10 patients. Regeneration of alveolar bone was confirmed in later radiographs. To date, the maximum follow-up period is 2 years and 8 months (average = 1 year and 6 months). All patients have good biting function, and there have been no findings of absorption of reconstructed alveolar bone or of the root of replanted teeth. This treatment method

would be quite useful for patients with serious periodontosis.

Key Words: Serious periodontosis, replanting teeth, gingival flap, cancellous iliac bone

Extraction of teeth and preparation of a full-mouth denture are the common treatment for serious periodontosis in which the entire alveolar bone is markedly absorbed, its border is lowered to the level of the root apex, and the teeth become unstable. Even after this treatment, satisfactory biting function is hard to regain, because the denture usually does not fit well as a result of ridge resorption. In addition, younger patients more frequently have discomfort and esthetic problems with a denture. To solve these problems, several treatment methods such as an intrabone implant using the maxillary sinus lift and subperiosteal implant were developed. Patients' financial, physical, and psychological burden cannot be underestimated, however, because these methods are associated with extensive surgical invasion, long treatment time, and high expenses. Conversely, some of the patients with serious periodontosis maintain healthy teeth, and these teeth are usually discarded after extraction.

The aim of this study was to assess the ability of serious periodontosis patients to regain satisfactory biting function using the patients' own teeth. For this purpose, reconstruction of the osseous defect on the alveolar bone and of retracted gingiva is essential. We have developed a surgical technique that uses grafting of autogenous cancellous iliac bone, interdental gingival flaps, and an advancement gingi-

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val flap. This article introduces this technique and reports clinical outcomes.

SURGICAL TECHNIQUE

Teeth Extraction and Root Canal Restoration

Two teams implement the surgery: one is the team that performs the oral surgery, and the other is the team that prepares the teeth for replantation. The oral surgery team extracts moving teeth, and the other team performs root canal restoration from the both sides of biting surface and root apex to completely remove dental pulp and to prevent postoperative infections such as an apical periodontal cyst (Figs 1A and 1B). Teeth remain unextracted when the apex and surrounding tissues do not have inflammation, adjacent alveolar bone is maintained relatively well, and the teeth do not move.

Opening the Operation Field and Preparation of Gingival Flaps

After the extraction, the operation field is developed. The gingiva is cut on the front line of the teeth starting from a point slightly shifted from the alveolar crest to the labial or buccal mucosa throughout the entire width of the jawbone and then ablated subperiosteally. This procedure allows the remaining interdental gingiva to be connected to the gingiva on the palate or lingual side. In patients with serious periodontitis whose alveolar ridge is markedly retracted, the height of the gingiva is shortened, but the distance between the teeth and the width of the alveolar crest are increased, and these parts can be used in the development of interdental gingival flaps. The gingiva is widely ablated to the point where the infraorbital nerve of the maxilla or the inferior edge of the mandible is confirmed. This wide ablation produces a wide operation field, and the gingiva in this area can be moved to the upper or lower side to be prepared for advancement into the gingival flap (see Fig 1B).

Curettage of the Lesion and Replanting of the Extracted Teeth

Inflammatory tissue, poor granulation, and scar tissue are completely curetted using a sharp spoon and a bar. After extracting a moving tooth, the cavity usually has inflammatory lesions reaching to the root apex, and this inflammatory connective tissue should be removed completely using a bar. It is also important to make this cavity 1 to 2 mm deeper. After root canal restoration, the tooth is replanted into this cavity by gently hitting the tooth with a

hammer or other appropriate equipment (see Fig 1C). If the tooth is already damaged or unable to be used, an intrabone implant is applied.

Collection of Cancellous Iliac Bone

A 10- to 15-cm skin incision is made approximately 1 cm medial from the iliac crest, and the internal surface of the iliac bone is ablated subperiosteally from the iliac crest. Approximately 10 × 5 cm of the inner plate of iliac bone is cut, and 5 cm × 10 cm³ of cancellous bone is collected. The collected bone volume could vary according to the size of the defect of the alveolar bone.

Reconstruction of the Lost Alveolar Ridge: Grafting of Cancellous Iliac Bone and Application of Gingival Flaps

The cancellous iliac bone is grafted around the replanted tooth to reconstruct the alveolar bone. The palate or lingual side of the grafted bone is completely covered with the interdental gingival flaps, and the side of the labial or buccal mucosa is completely covered with the advancement gingival flap. These flaps are sutured to each other, and reconstruction of the lost alveolar ridge is completed. If suturing of the flaps produces strong tension and the risk of sutural insufficiency is suspected, tension on the suture is relieved by using a bone anchor system on two or three points of the advancement gingival flap (see Figs 1B and 1C). If the replanted tooth is not stable enough, a line groove is made on the biting surface using a bar; a thread is hooked on this groove, and it is sutured on the gingiva for fixation (Fig 2).

Prosthetic Treatment of the Teeth and Implants

After replantation, each tooth has a different height (see Fig 2). To regain normal biting function, the biting surface must be adjusted 3 to 4 months after surgery when the teeth and implants are completely fixed with the bone.

CASES

Our technique was applied to 12 patients with serious periodontitis who had biting disorders as a result of moving teeth and whose radiographs depicted remarkable absorption of the entire alveolar bone. Their ages ranged between 28 and 74 years (mean = 51 years), and there were 6 men and 6 women.

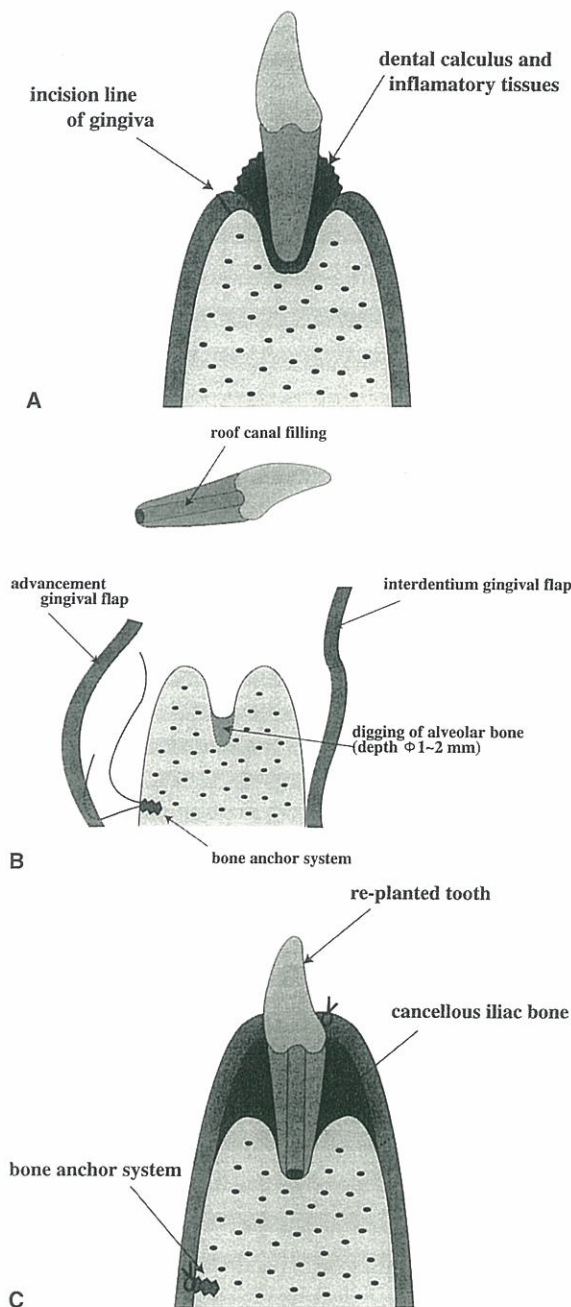


Fig 1 Surgical procedure. (A) Before surgery. The alveolar bone was absorbed and the lesion extended to the root apex. (B) During surgery. The extracted teeth received root canal restoration. After preparing an advancement gingival flap and interdental gingival flaps, inflammatory tissue on the lesion was curetted. If tension on the suture site was high, a bone anchor system was applied on the advancement gingival flap. (C) Immediately after surgery. The patients' teeth were replanted, cancellous iliac bone was grafted, and the interdental gingival flaps and advancement gingival flap were sutured to completely cover the grafted iliac bone.



Fig 2 Fixation of the replanted teeth using a thread.

Case 1: A 46-Year-Old Man

Periodontitis gradually progressed for 5 to 6 years, and the patient was unable to eat normal food because of moving teeth and pain for approximately 1 year. At the first examination, the gingiva and alveolar ridge were markedly recessed, the roots of the remaining teeth were widely exposed, and all the teeth were moving (Fig 3A). Radiographically, alveolar bone on the both maxilla and mandible was markedly absorbed (see Fig 3B). The patient received replanting of 10 teeth, three intrabone implants, and the grafting of cancellous iliac bone (see Figs 3C-E). To close the opening of the gingiva, tension on the suture site was reduced by using a bone anchor system on two points of the advancement gingival flap (see Figs 3F and 3G). There were no postoperative complications, and all the cancellous iliac bone grafts took. Two months later, one of the three intrabone implants fell off, but the 10 teeth and two remaining implants took.

Three months after surgery, the teeth and implants were prosthetically treated (see Fig 3H). Normal food consumption started the fifth month after surgery. The patient has been followed for 2 years and 3 months, and he has almost normal biting function and satisfaction of having food (see Fig 3I).

Radiographically, regeneration of a sufficient volume of alveolar bone around the replanted teeth was confirmed, and there was no root resorption (see Fig 3J). The donor site of the iliac bone has had no problems.

Case 2: A 40-Year-Old Woman

The patient first developed periodontitis when she delivered her first baby at the age of 30 years. Since

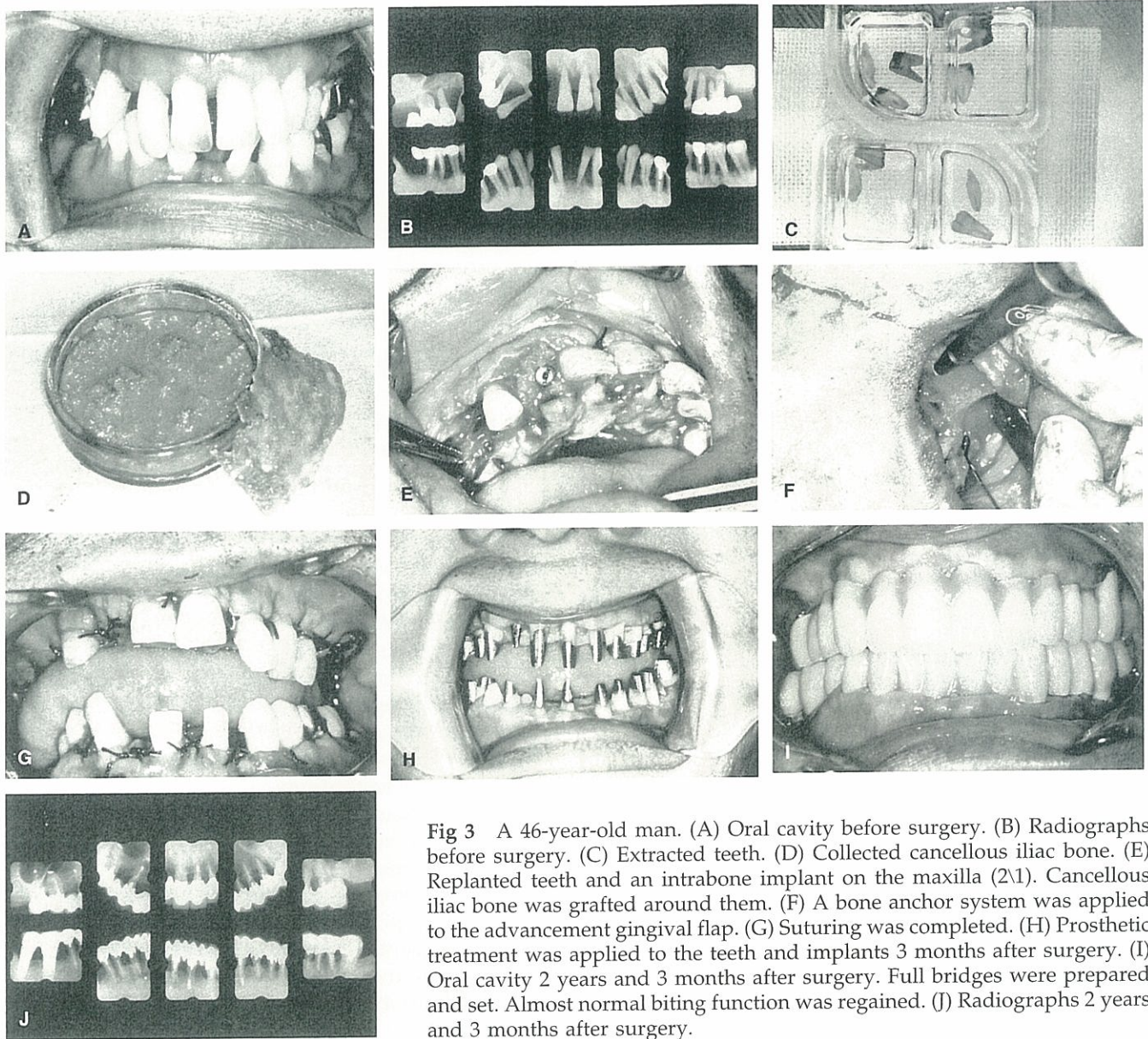


Fig 3 A 46-year-old man. (A) Oral cavity before surgery. (B) Radiographs before surgery. (C) Extracted teeth. (D) Collected cancellous iliac bone. (E) Replanted teeth and an intrabone implant on the maxilla (2/1). Cancellous iliac bone was grafted around them. (F) A bone anchor system was applied to the advancement gingival flap. (G) Suturing was completed. (H) Prosthetic treatment was applied to the teeth and implants 3 months after surgery. (I) Oral cavity 2 years and 3 months after surgery. Full bridges were prepared and set. Almost normal biting function was regained. (J) Radiographs 2 years and 3 months after surgery.

the age of 33 years, when she had a second baby, the periodontitis was gradually aggravated, and her bad breath and difficulty in eating food because of moving teeth became obvious during the last year. The patient had consulted with several specialists, but she was dissatisfied with their opinions to extract all her teeth and prepare a full-mouth denture. At her first examination in our office, the gingiva was markedly recessed, all teeth were moving, and pus draining from a part of the gingiva caused bad breath (Fig 4A). Radiographically, the alveolar bone on the maxilla and mandible was markedly absorbed (see Fig 4B). The patient received replanting of 18 teeth, one intrabone implant, and the grafting of can-

cellous iliac bone (see Fig 4C). Two months after surgery, 3 of the 18 teeth fell off. The cause was analyzed to be insufficient depth of the intrabone cavity at the time of replanting, with movement occurring again during the early postoperative period. The remaining 15 teeth and the one intrabone implant took. Four months after surgery, prosthetic treatment was given to the teeth and implant, and the spaces between the lost teeth were filled with bridges. Normal food consumption started the fifth month after surgery. One year after surgery, the patient has almost normal biting function (see Figs 4D and 4E). The patient is quite satisfied with the results. It is planned to fill the spaces between the lost teeth with implants in the future.

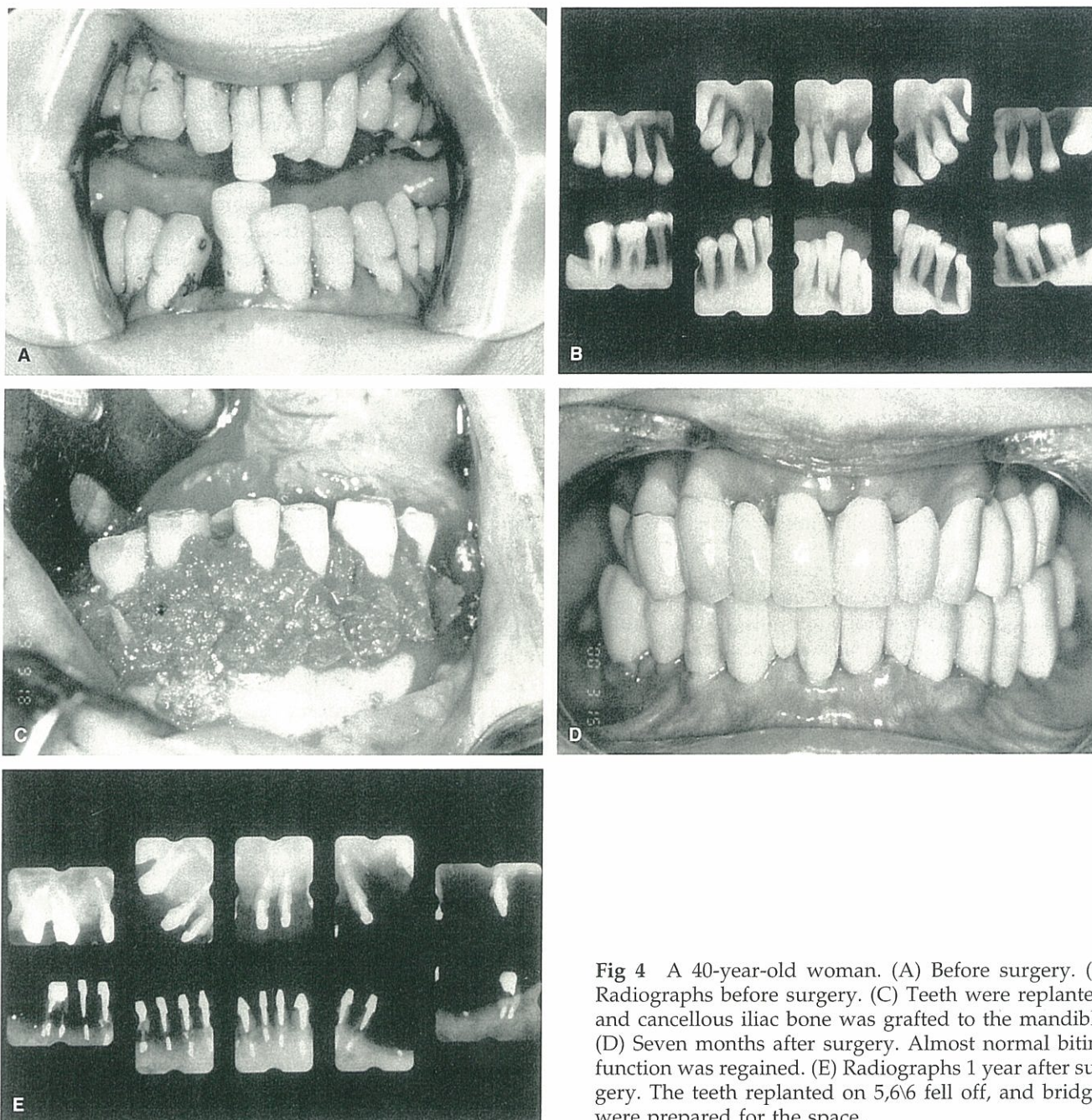


Fig 4 A 40-year-old woman. (A) Before surgery. (B) Radiographs before surgery. (C) Teeth were replanted, and cancellous iliac bone was grafted to the mandible. (D) Seven months after surgery. Almost normal biting function was regained. (E) Radiographs 1 year after surgery. The teeth replanted on 5,6/6 fell off, and bridges were prepared for the space.

RESULTS

No postoperative complications occurred in our 12 patients, and the cancellous iliac bone grafts all took. The total number of teeth replanted was 65, and 4 teeth of the above-mentioned 2 patients fell off (92% take rate). These 4 teeth were lost because the depth of the intrabone cavity was not sufficient for replanting, which resulted in weak stability during the early postoperative period and then caused

movement. Sixteen intrabone implants were used, and 3 of them fell off (81% take rate).

To date, the postoperative follow-up period has ranged between 3 months and 2 years and 8 months (mean = 1 year and 6 months). All patient received prosthetic treatment of the teeth and implants at the third to fourth month, started to eat soft food, and then started to eat normal food after the fifth month. Ten of the 12 patients have been monitored for 5 months or longer, and all 10 patients were able to eat

normal food. Interviews of these 10 patients revealed that they believe they have regained almost the same biting function and satisfaction of having food as before they developed periodontitis. Radiographs of the 10 patients also show regeneration of the alveolar bone (see Figs 3H and 4E). None of the patients have had any problems such as pain or deformation at the donor site of cancellous iliac bone (Table 1).

DISCUSSION

This surgical technique has excellent results with regard to the success rate, regained biting function, and patient satisfaction. All 10 patients who were monitored for 5 months or longer after surgery and who started to eat normal food were highly satisfied with the results. This technique solved not only the patients' difficulty in eating and having bad breath, which had continued for many years, but their discomfort and esthetic problems related to a denture. Normal biting function using their own teeth remarkably improved patients' quality of life.

Currently available treatments for osseous defects in periodontitis are autogenous iliac bone grafts,¹⁻¹¹ autogenous bone transplants from the maxilla or mandible,¹²⁻¹⁴ bone allografts,¹⁵⁻²⁶ and bioceramic implants.²⁷⁻²⁹ Other than the autogenous iliac bone grafts, these methods have limitations on collectable bone volume and variable success rates, and they were only applicable to treatment of a small area. Therefore, these methods were not applicable to severe periodontitis patients whose entire alveolar bone is markedly absorbed.

Iliac bone can provide a large volume of cancellous bone; the collected bone is not rejected because it is autogenous, and it has a high take rate. Cancellous iliac bone also contains quite a large number of stem cells (a bone marrow component) and a high level of cytokines.¹⁰ Because of this advantage, osteoinduction from the bone grafts can be expected in addition to osteoconduction from the remaining bone. We radiographically confirmed bone regenera-

tion in the 10 patients who were monitored for 5 months or longer after surgery. We also had a chance to surgically monitor inside the gingiva when 1 of these 10 patients had an intrabone implant the sixth month after surgery, and the regenerated bone of the patient was firm and possessed cortical bone. The present method is based on regenerative medicine.

Previous studies demonstrated good clinical outcomes of autogenous iliac bone grafts.¹⁻¹¹ In the current study, for the first time, a large volume of cancellous iliac bone was grafted in serious periodontitis patients whose lesion was expanded to the entire jaw. The major reason why these large-scale grafts were not applied in previous studies was the lack of a sufficient volume of gingiva to completely cover the reconstructed alveolar bone. In patients with serious periodontitis, the gingiva recesses together with the absorption of the alveolar bone, and it cannot cover the larger new bone after grafting. We solved this problem by preparing the advancement gingival flap and interdental gingival flaps (see Fig 1). In addition, a bone anchor system used on the advancement gingival flap helped us to advance the flap and made the low-tension suture possible (see Figs 1B, 1C, and 3F). The gingiva is easily torn, and suture with high tension could cause the exposure and necrosis of grafted iliac bone¹ as a result of sutural insufficiency. Compression caused by high suture tension could also accelerate postoperative absorption of the grafted bone.^{7,9,11} In the current study, the major factors resulting in the regeneration of alveolar bone with a sufficient height were the use of cancellous iliac bone as the graft and the two types of gingival flap that completely covered the reconstructed alveolar bone.

With regard to the replanting of patients' teeth, there are three possible problems. One is the teeth falling off early in the postoperative period or early stabilization period. With our technique, the osseous cavity was prepared 1 to 2 mm deeper after extraction, and the tooth for replanting was gently hit into the cavity. In addition, a line groove was made on the biting surface, and a thread was hooked on the groove and sutured to the gingiva for fixation (see Fig 2). With these treatments, the tooth was firmly fixed within the bone 3 to 4 months after surgery, and this then made the preparation of models and prosthetic treatments possible. Among the 65 teeth replanted, only 4 fell off, and the cause was insufficient depth of the osseous cavities and resultant movement. This shows that when fixation in the early postoperative period is completed successfully, a replanted tooth should be taken without any problem. Three of 16 (19%) intrabone implants that were

Table 1. Results

Follow-up period: 3 months through 2 years and 8 months (mean = 1 year and 6 months)		
Postoperative complications (e.g., infections)	0/12 patients	(0%)
Take of grafted cancellous iliac bone	12/12 patients	(100%)
Take of replanted teeth	61/65 teeth	(92%)
Take of intrabone implant	13/16 implants	(81%)
Regeneration of alveolar bone (by radiography)	10/10 patients*	(100%)
Complications at donor site of iliac bone	0/12 patients	(0%)

*Excluding 2 patients whose follow-up period did not extend to 5 months.

applied to the places where the patients' own teeth were unusable fell off, however. This indicates that the use of artificial material as an implant is difficult in comparison to the use of autogenous tooth. Another problem is a defect of the periodontal membrane, which is thought to act as a shock absorber. Nevertheless, all our patients regained good biting function as well as satisfaction of having food, although their periodontal membrane was damaged and lost. Absence of the periodontal membrane is the same as for commonly used intrabone implants. Therefore, absence of the periodontal membrane around the replanted teeth would not cause remarkable problems in biting. The other problem is root resorption after iliac bone grafting.^{7,8} At present, the longest follow-up of our patients is 2 years and 8 months, and no signs of root resorption have been observed. This is attributable to the complete root canal restoration done from both sides of the root apex and the biting surface on the extracted tooth and the complete removal of dental pulp, which could cause inflammatory diseases such as an apical periodontal cyst. Although longer follow-up is necessary, any root resorption that might be detected in the future indicates the replacement of root with bone. Therefore, if the replanted teeth fall off because of root resorption, an intrabone implant could be applied to the same place.

To date, serious periodontitis has been thought to have no treatment method other than teeth extraction and denture preparation. The present study introduced a new treatment technique that uses patients' own teeth, cancellous iliac bone grafts, advancement gingival flap, and interdental gingival flaps; as a result, patients can regain biting function as well as satisfaction of having food. This technique requires a clinical team consisting of professional plastic surgeons and dentists.

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