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Potential efficacy of GTR and autogenous bone graft for autotransplantation to recipient sites with osseous defects: evaluation by re-entry procedure

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Abstract – This clinical study aimed to evaluate the effectiveness of guided tissue regeneration (GTR) or autogenous bone graft for autotransplantation to recipient sites with an osseous defect, based on a substantial assessment of bone regeneration using a re-entry procedure. Three cases of autotransplantation of a wisdom tooth to the position of first molar, in which moderate to extensive bone loss at the buccal alveolar plate was observed, were studied. Each tooth was transplanted with no additional treatment, or in conjunction with GTR or autogenous bone graft. Four to 20 months after surgery, a re-entry procedure was performed to visually examine healing. When GTR membrane coverage or bone graft was used, previously absent alveolar bony plates regenerated and the initially exposed roots were covered with newly formed bone, while no bone formation was observed in the case without any additional procedure. These results demonstrate that both GTR and autogenous bone graft are beneficial for obtaining bone regeneration in autotransplantation to defective recipient sites, contributing to retaining space and excluding the contact of gingival connective tissue with periodontal ligaments.

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Key words: autotransplantation; guided tissue regeneration; bone graft; re-entry; osseous defect

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The biological principles of autotransplantation of teeth have been established from a number of basic and clinical studies, and the predictability of the results of this treatment has been improved (1–4). The prerequisites for obtaining optimal healing after autotransplantation are the transfer of a donor tooth with a viable periodontal ligament (5, 6) to a recipient socket, which has a sufficient amount of the alveolar supporting plates to house the donor tooth, and the tight repositioning of the flap in the cervical area. Additionally, it is important to transplant the tooth so that the upper margin of the root surface with the periodontal ligament is located 1–2 mm above the alveolar bone ridge (7).

Although successful autotransplantation is expected when the recipient sites fulfil the requirements noted above, the clinical situations of sockets vary and are not always ideal. We often encounter cases in which the width of the root of the transplanted tooth is greater than the dimension of the recipient sites. In such situations, rotation or resection of the root of the donor tooth is performed to fit into the sockets. However, autotransplantation to recipient sites with buccal or lingual alveolar bone loss is even more problematic, and often contraindicated, as healing with the formation of long attachments of connective tissue frequently occurs. An effective treatment method for obtaining better results for transplantation to recipient sites with an extensive osseous defect has not yet been fully developed.

In the present case report, healing, aided by guided tissue regeneration (GTR) or autogenous bone graft after autotransplantation to recipient sites with buccal alveolar bone loss, was evaluated. In particular, a re-entry procedure was utilized, and the effectiveness of each method to obtain bone regeneration was visually examined.

Case report

Case 1 – control

A 23-year-old female presented with spontaneous and occlusal pain in tooth 46 because of fracture. A treatment plan was formulated to extract the fractured tooth and to transplant the lower right incisor tooth.

When the mucoperiosteal flap was reflected 1 month after extraction of the fractured lower right first molar, an osseous defect on the buccal alveolar wall was noted. Surgical preparation of the socket made bone loss more severe, and a large area of the buccal root surface including the furcation area showed an absence of bone support when tooth 48 was placed in the socket (Fig. 1a). The lingual alveolar wall had sufficient height to cover the donor tooth. With no additional procedures, the transplanted tooth was fixed to the approximate teeth and the flap was repositioned.

After 2 weeks, an intentional root canal filling was performed with calcium hydroxide paste (Vitapex®; Neo Dental Chemical Products, Tokyo, Japan) to reduce the risk of inflammatory root resorption. Approximately 3 months later, the splint was removed and the root canal was filled with gutta-percha and root canal sealer (Canals N®; Showa Yakuhin Kako, Tokyo, Japan). Four months after surgery, a re-entry procedure was performed. The dehisced site was filled with granulation tissue, but no regeneration of bone-like tissue was observed (Fig. 1b).

(a)

(b)

Fig. 1. (a) Clinical appearance of autotransplanted molar after socket placement in case 1. An absence of bone support on the buccal area is noted. (b) Clinical appearance at the time of re-entry (4 months after autotransplantation). No regeneration of bone-like tissue at the defective site is observed.

Case 2 – utilization of GTR

A 55-year-old female presented with occlusal pain in the upper left first molar. Radiographic examination revealed protrusion of a metal post core at the furcation area. When the post core was removed, furcal perforation and an extensive carious lesion were observed. To re-establish posterior function, the transplantation of tooth 48 after extraction of the upper left first molar was planned.

Moderate loss at the buccal bony plate was noted when the upper left first molar was extracted. The donor tooth was transplanted with a 90° rotation to avoid positioning furcation to the dehisced site (Fig. 2a). The horizontal space between the buccal alveolar bone and root surface was less than 1 mm. Drilling with a sterile round bur was used to promote bleeding, and the denuded root surface was confirmed as covered with clots. A polytetrafluoroethylene barrier (Gore-Tex®; WL Gore, Flagstaff, Arizona) membrane was then placed to completely lap the defective site, and was tightly adapted to the tooth (Fig. 2b). The flap was repositioned to cover the membrane, and the tooth was thus stabilized.

The root canal was cleaned and filled with calcium hydroxide paste (Vitapex®; Neo Dental Chemical Products, Tokyo, Japan) 2 weeks after surgery. After 4 months, the barrier membrane was surgically removed as a part of the membrane was exposed. At this stage, the initially exposed root was covered with newly formed hard tissue resembling the bone (Fig. 2c). The flap was repositioned, and prosthodontic treatment was performed after filling the root canal with gutta-percha and root canal sealer (Canals N®; Showa Yakuhin Kako, Tokyo, Japan). When a re-entry procedure was performed at 20 months after autotransplantation, the previously absent buccal alveolar bony plate regenerated, and the exposed root was covered with newly formed bone (Fig. 2d).

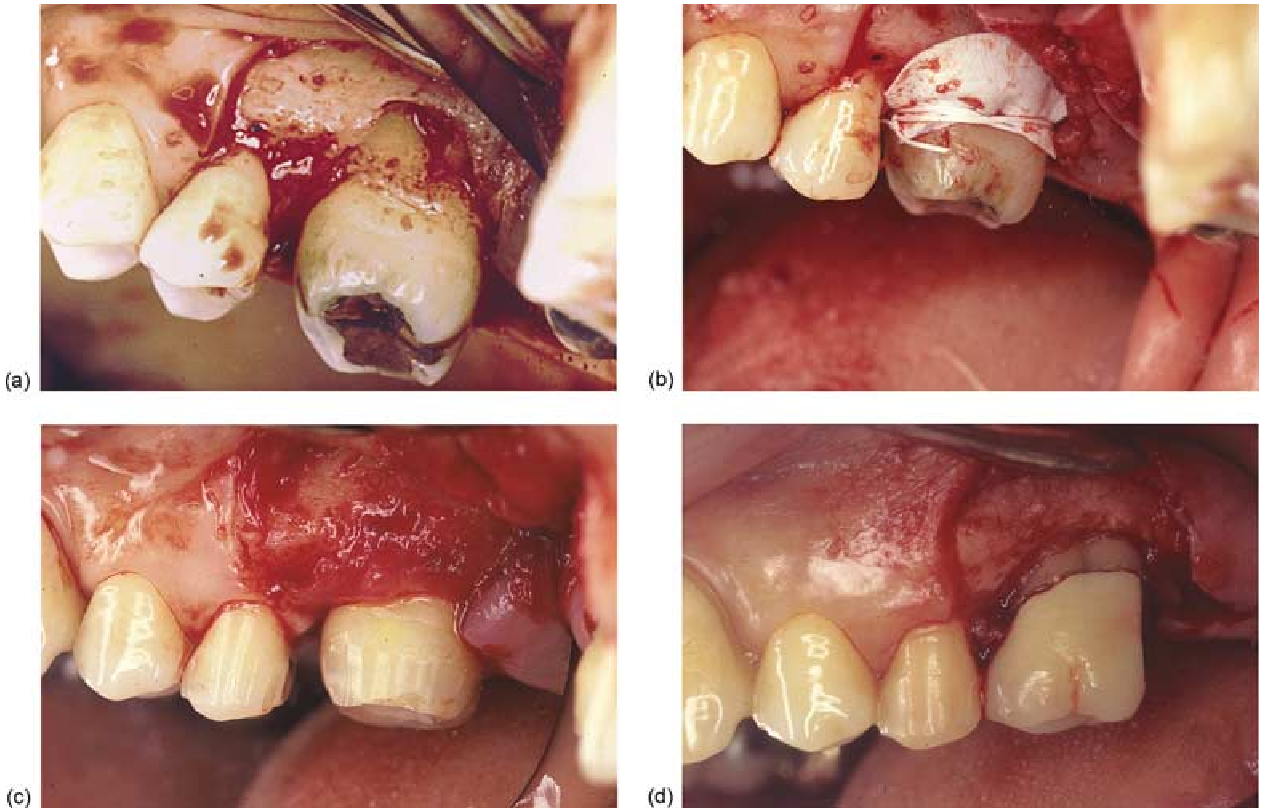


Fig. 2. (a) Clinical appearance of autotransplanted molar in case 2 in which the donor tooth was transplanted with a 90° rotation. Moderate loss at buccal bony plate is noted. (b) Buccal view showing the adaptation of GTR membrane. (c) Four months after surgery. The barrier membrane has been removed; the initially exposed root is covered with newly formed hard tissue resembling the bone. (d) Clinical appearance at the time of re-entry (20 months after autotransplantation). Regeneration of the previously absent buccal alveolar bony plate is observed.

Case 3 – utilization of bone graft

A 45-year-old male presented with swelling of the buccal area of the lower right first molar and complained of spontaneous and occlusal pain (Fig. 3a). Radiographic examination revealed a fracture of the mesial root, and decision was made to extract the impaired tooth 46 and transplant the partially impacted upper right wisdom tooth.

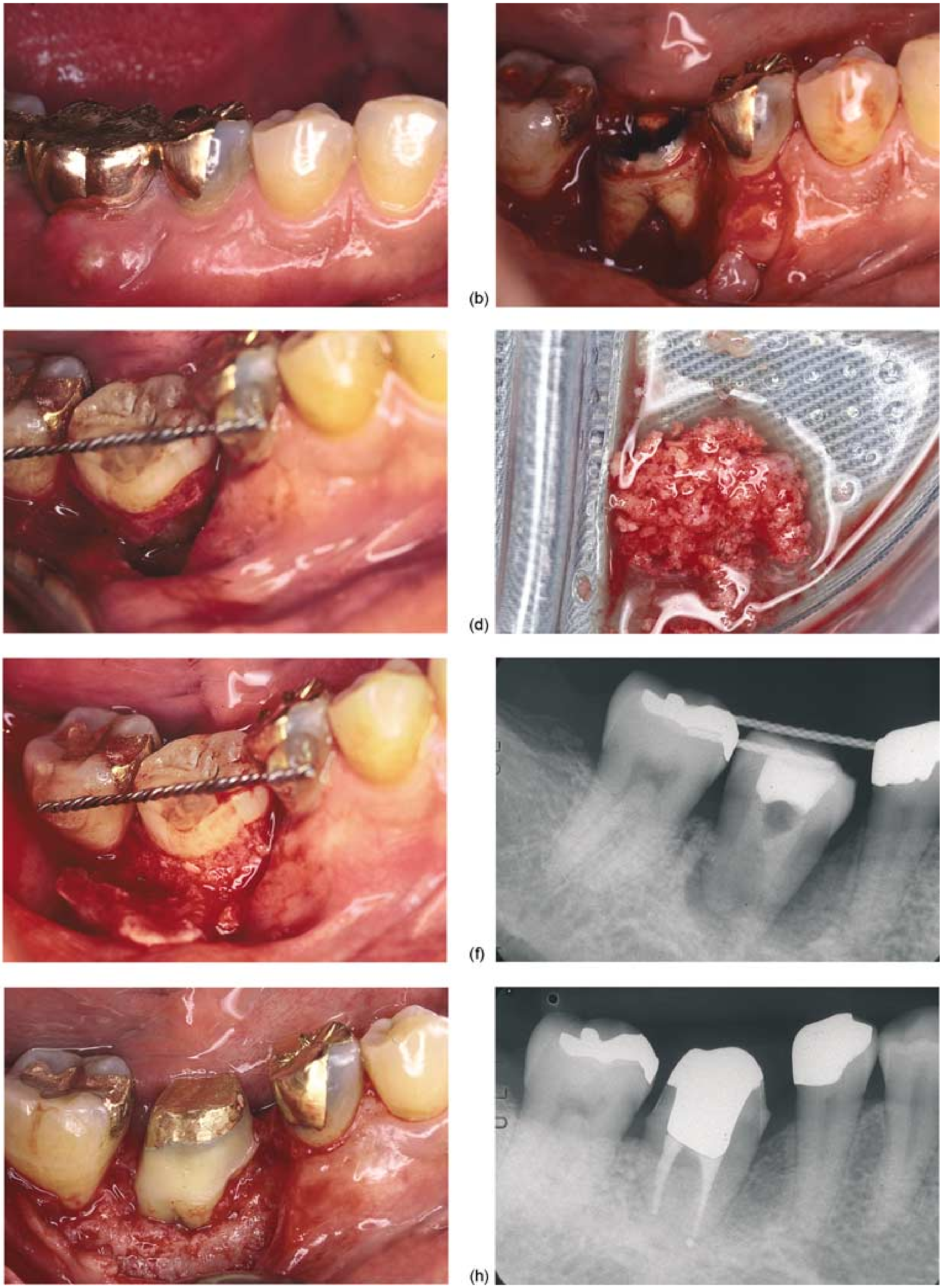
When the flap was reflected, a marked osseous defect was observed at the buccal alveolar wall (Fig. 3b). The lower right first molar was extracted carefully to avoid exacerbating bone loss. The upper right wisdom tooth was extracted and transferred to the recipient socket 2 months after extraction of the lower right first molar. An absence of bone support on the extensive buccal root surface of the donor tooth was noted (Fig. 3c). Autogenous powdered bone was taken from the patient's retromolar pad (Fig. 3d) and grafted into the dehisced area (Fig. 3e). The transplanted tooth was stabilized to the approximate teeth, and the flap was repositioned and sutured (Fig. 3f).

A root canal filling was performed with calcium hydroxide paste (Vitapex®; Neo Dental Chemical Products, Tokyo, Japan) after 2 weeks. After 3 months, the splint was removed and the root canal was filled with gutta-percha and root canal sealer (Canals N®; Showa Yakuhin Kako, Tokyo, Japan). Eight months after surgery, a re-entry procedure was performed and new bone formation, which completely covered the initially exposed root, was observed (Fig. 3g,h).

Discussion

The effectiveness of two options, GTR and autogenous bone graft, for autotransplantation to the

Fig. 3. (a) Clinical appearance of tooth 46 before surgery in case 3. (b) Clinical appearance of buccal area of tooth 46. Marked osseous defect is observed. (c) Clinical appearance of autotransplanted molar. An absence of bone support on the extensive buccal root surface is noted. (d) Autogenous powdered bone taken from the patient's retromolar pad. (e) Autogenous powdered bone grafted to the dehisced area. (f) Radiograph showing transplanted tooth. (g) Clinical appearance at the time of re-entry (8 months after autotransplantation). New bone formation, which completely covers the initially exposed root, is observed. (h) Radiograph showing transplanted tooth at the time of re-entry.



(a) (b) (c) (d) (e) (f) (g) (h)

recipient sites with buccal osseous defects were investigated. Radiographic examination is routinely used for evaluation of periodontal healing after autotransplantation (3, 8, 9). However, the bone level at buccal or lingual sites cannot be precisely estimated by radiography, and this procedure is not useful for assessing bone regeneration at areas that have previously exhibited osseous defects. Re-entry is the most efficacious method to evaluate such tissue healing, although only limited studies have employed this interventive procedure (10). Therefore, we present, in this study, three cases of autotransplantation of a wisdom tooth to recipient sites with buccal bone loss to replace a missing first molar, and show the results that were evaluated by visual estimation utilizing a re-entry procedure, with informed consent of the patients.

It is well understood that maintaining an intact and viable periodontal ligament on the root surface is an important factor for successful autotransplantation (5, 6), and this also holds true for cases with bone defects. Andreasen (11) compared the results of autotransplantation of teeth with intact or dead periodontal ligaments to experimental sockets in primates with severe bone loss on the buccal surface and concluded that a viable periodontal ligament is indispensable for obtaining new bone formation. Polson (12) evaluated healing after two patterns of autotransplantation in primates: transplantation of teeth with intact periodontal ligaments to sockets with bone loss and transplantation of periodontally involved teeth with limited amounts of viable ligaments to sockets surrounded by sound alveolar bone, and reported that periodontal tissue healing, including bone regeneration, occurred in the former, while periodontal destruction advanced and bone loss was marked in the latter. These experimental results indicate that a viable periodontal ligament is a prerequisite for healing dehisced sites after transplantation. However, case 1, as a control in this study, showed that regeneration of new bone at defective sites does not necessarily occur clinically, even if the transplanted tooth had a viable periodontal ligament. The healing process for periodontal tissue after autotransplantation is based on (i) migration of mesenchymal cells dedifferentiated from periodontal ligament cells to the bone defect; (ii) differentiation of migrated cells to osteoblasts as well as direct differentiation of periodontal ligament cells to osteoblastic cells by contact with existing bony tissue; and (iii) subsequent regeneration of bone (13). In case 1, the space between the root surface of the transplanted tooth and the buccal alveolar ridge was small, and the root surface was in contact with gingival connective tissue when the flap was repositioned. If reattachment of periodontal ligament and gingival connective tissue is established first, the differentiation of cells from the periodontal ligament to osteoblastic cells is inhibited and new bone formation is disturbed (14). Therefore, it is considered that healing with long attachments of connective tissue rather than bone formation occurred in case 1. The bone regeneration observed by experiments using animals reported by Andreasen (11) or Polson (12) is possibly because the transplanted tooth was located completely inside the alveolar plates, and the space between the flap and root surface was maintained in an ideal situation. Thus, when transplantation is performed without any additional procedures as in case 1, the clinical result is likely to fail to obtain bone formation at the defective site.

In case 2, bone-like tissue was formed 4 months after autotransplantation, and regeneration of buccal alveolar bone was confirmed after 20 months. This result was in accordance with that of a previous report, which described regeneration of alveolar bony plate 10 weeks after autotransplantation of a third molar aided by GTR (10). These findings indicate the effectiveness of using GTR membrane together with transplantation to gain periodontal support. The width of the root of the donor tooth in case 2 was smaller than the dimension of the buccolingual ridge, but the space between the buccal alveolar bone and the root surface was less than 1 mm. It was therefore probable that the gingival connective tissue was in contact with the root surface when the flap was tightly sutured. The membrane placement was effective to retain the space and to act as a barrier so that osteoblastic cells were predominantly induced to the retained space and repopulation by epithelial or gingival connective tissue cells was excluded. However, special attention is required when using GTR. Coverage by the membrane may impair the blood supply from gingival connective tissue, and it is unclear how long the periodontal ligament cells on the root surface of transplanted tooth would survive. Additionally, autotransplantation is likely to result in failure if the membrane is infected with bacteria. Indeed, exposure of part of the membrane occurred 4 months after surgery in our case, and the vulnerability of GTR membrane use was demonstrated.

Several reports have described the usefulness of autogenous bone grafts for treating periodontal defect (15–17). Although the mechanism of autogenous bone graft to stimulate regeneration has not been fully elucidated, bone morphogenetic protein from the grafted bone is considered to promote osseous formation (18). In case 3, in which autogenous bone was grafted, regeneration of alveolar bone at the previously defective site was observed, even though the horizontal location of the transplanted tooth and the buccal alveolar bony plate was close. Bone graft, therefore, proved to be an effective method to retain space and induce regeneration. Recently, the utilization of membrane coverage in combination with the application of bony components have been tried for the treatment of periodontitis with severe bone loss (15, 17, 19). The present results indicate that bone graft *per se* is effective for autotransplantation to the recipient site with bone loss at one surface. As stated above, the use of GTR provides an opportunity for the surgical area to be infected, and so, a bone graft is considered to be advantageous for obtaining a better prognosis. In addition, space retaining can be easily achieved with a bone graft, and this method may enable the induction of new bone formation even when the root surface of the transplanted tooth is located beyond the alveolar bony plates.

In conclusion, the cases reported here demonstrate the potential use of GTR or autogenous bone graft for tooth transplantation to recipient sites suffering from bone loss. Their effects appear to be mainly based on excluding any contact of gingival connective tissue with periodontal ligaments and in maintaining a space for the proliferation of osteoblastic cells. Further clinical research to determine success rates for these procedures is important to expand the indication for autotransplantation.

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