EDITOR's OPINION

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Extraction socket preservation

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Abstract (J Korean Assoc Oral Maxillofac Surg 2020;46:435-439)

Extraction socket preservation (ESP) is widely performed after tooth extraction for future implant placement. For successful outcome of implants after extractions, clinicians should be acquainted with the principles and indications of ESP. It is recommended that ESP be actively implemented in cases of esthetic areas, severe bone defects, and delayed implant placement. Dental implant placement is recommended at least 4 months after ESP.

Key words: Dental implant, Tooth extraction, Socket graft

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I. Introduction

Tooth extraction triggers disuse atrophy of the surrounding alveolar bone. Within 1 year of extraction, an average of 50% of the ridge width is reduced. The average amount of loss was between 5-7 mm, and 2/3 of this reduction occurred within the first 3 months and showed similar patterns in all areas of the oral cavity[1]. Since maxillary buccal cortical bone resorption occurs after extraction, the center of maxillary ridge is moved toward the palatal side. Maxillary buccal resorption is more pronounced in molars compared to anterior and premolar areas, and mandibular buccal resorption occurs more frequently than that of the lingual bone[2]. In 2009, a systemic review demonstrated bone resorption of approximately 3.87 mm and 1.67 mm horizontally and vertically, respectively, during the first three months after extraction[3]. In 2012, another randomized controlled trial revealed that more than 60% of the total resorption occurred during the first six months after tooth loss[4].

Since disuse atrophy persists if not restored, many issues with vertical and horizontal bone loss can occur. Additional bone graft surgeries are inevitable for dental implant treatment in areas of bone loss. To minimize bone loss, extraction socket preservation (ESP) has been introduced, where bone graft is performed at the time of extraction. However, the efficacy of ESP has been controversial, and the procedure might be unnecessary in some cases. At the time of extraction, the clinician should make a decision based on the condition of the extraction socket and surrounding tissues[5]. Extraction sockets can be classified into four types according to degree of bone loss, on which need for ESP can depend.(Table 1) Alveolar ridge preservation and post-extraction preservation of the socket are used synonymously with ESP[6,7].

II. Controversy regarding ESP

1. Positive view

Since ESP is performed to minimize ridge atrophy after tooth extraction, several advantages have been suggested, including that ESP reduces the need for additional bone graft, facilitates the implant procedure, and improves marginal bone loss and survival/success rate of implants[8]. Avila-Ortiz et al.[9] reported that the ESP group had statistically significantly less bone resorption of 1.89 mm horizontally, 2.07 mm

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Table 1. Classification of extraction sockets[6,7]

Class	Description
I	4-wall defect, intact bony housing, no wall involvement
II	3-wall defect, 3 intact walls, 1 wall with dehiscence or fenestration
III	Type 1: adequate height, inadequate width Type 2: 2 intact walls, 2 walls with dehiscence or fenestration
IV	1-wall defect, inadequate vertical height, inadequate horiz ontal width

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at labial side and 1.18 mm at lingual side vertically compared to the simple extraction group. In particular, the result of ESP was excellent in the maxilla. When ESP is performed in the maxillary posterior region, sinus elevation surgery can be minimized or avoided, enabling flapless implant surgery[10].

Natural bone healing is insufficient in extraction sockets with periodontal or inflammatory disease because soft tissue invasion into the socket impedes bone healing even long after the procedure. To maintain the volume of the extraction socket, thickness of the buccal bone wall is the most important factor. ESP is generally recommended for sockets with thin buccal bone wall (≤1 mm) to compensate for bone resorption with suggested non-absorbable bone substitutes such as deproteinized bovine bone and alloplastic bone[11-13].

2. Negative view

Some researchers have argued a negative view of ESP[8,14,15]. ESP can reduce the bone resorption, but not completely prevent. Rather, bone substitutes could contribute to impaired natural bone healing. No differences has been reported in feasibility, success/survival rates, and marginal bone loss between implants with and without ESP[8,14,15]. Simon et al.[16] questioned the usefulness of performing bone graft before implant placement (guided bone regeneration [GBR], ESP) and observed that bone height loss occurred more than bone width even after bone graft. Therefore, it was argued that filling the graft material not only inside the extraction socket but also outside the extraction socket and covering it with a barrier membrane could prevent bone loss as much as possible.

III. Surgical Technique of ESP

Complete removal of inflammatory tissue and pathologic lesions should be performed with minimally invasive procedures after tooth extraction. All soft tissues along the socket wall are removed, and spontaneous bleeding is induced to release healing factors from the bone marrow. Suturing is performed with a collagen plug, barrier membrane, or autogenous gingival tissue after application of bone substitute. Primary wound closure is not essential if proper suturing is achieved to prevent dislodgement of the membrane or collagen plug above the substitutes. It was said that using a osteoconductive bone substitutes such as deproteinized bovine bone material (DBBM) (Bio-Oss; Geistlich Pharma AG, Wolhusen, Switzerland) or other synthetic materials with slow resorption and covering the upper part with a resorbable barrier membrane or connective tissue (CT) graft, or selecting the BioCol procedure maintains the volume of the extraction socket well and facilitates implant placement in the future[5]. Implants were placed with no complications at 4-6 months after grafting.

IV. Bone Graft Materials

1. Autogenous bone

In 2005, an ESP case with autogenous bone was reported using the buccal bone of the maxillary canine and raising a rotated palatal flap[17]. However, autogenous bone has not been widely used due to its high risk of resorption.

2. Xenogeneic bone

Currently, xenografts are generally used in implant dentistry including anorganic bovine bone and porcine bone. Artzi et al.[18] reported 82.3% extraction socket filling with new bone at 9 months after ESP using porous bovine bone mineral (PBBM). PBBM is a biocompatible and acceptable bone substitute for ESP that shows no resorption for 9 months[19]. In 2018, deproteinized porcine bone mineral (DPBM) exhibited comparable ESP outcomes with DBBM[20].

3. Synthetic bone

Several synthetic bone products have been reported to have effective outcomes on ESP, including Bioplant HTR[9,21], hydroxyapatite (HA)[22], biphasic calcium phosphate (BCP)[23,24], bioactive glass[25], and calcium sulfate[25].

4. Allogeneic bone

Allogeneic bone, such as freeze-dried bone allograft, has been widely used in implant dentistry[26]. To improve the bone healing potential and reduce the mobility of bone graft, allo-

geneic bone can be manufactured as putty or gel type and can be mixed with particulate xenogeneic or synthetic bone[27].

5. Growth factors

Ridge preservation and bony healing can be enhanced with growth factors including recombinant human bone morphogenetic protein-2 (rhBMP-2), platelet concentrate (platelet-rich plasma [PRP], platelet-rich fibrin [PRF]), synthetic cell-binding peptide P-15 (Putty P15), and vascular endothelial growth factor (VEGF)[28-36].

V. Socket Sealing

After packing the socket with bone substitute, it is recommended to cover it with a membrane. To perform minimally invasive surgery, flap release such as vertical releasing incisions and submucosal undermining should be avoided as much as possible.

1. Autogenous tissue

Since 1997, socket sealing surgery has been used to cover the graft with free gingival tissue or CT from the palate or maxillary tuberosity[36-40].

2. Acellular dermal matrix

Luczyszyn et al.[41] introduced a technique using an acellular dermal matrix to cover the socket graft with resorbable HA. The HA affected the ESP outcome, and the matrix contributed to thickening of the soft tissue around the socket.

3. Resorbable barrier membrane

Although many researchers have demonstrated significant ESP outcomes using only a resorbable membrane to cover the socket, without bone grafting, the outcome could be maximized with bone grafting[41-43]. In cases of BCP grafting with a cross-linked collagen membrane, sufficient ridge preservation occurred with prolonged barrier function even with early membrane exposure[44,45]. Acceptable ESP outcomes were reported with polylactide and polyglycolide sponges and native bilayer collagen membranes[46,47].

4. Non-resorbable barrier membrane

Faciola Pessôa de Oliveira et al.[48] reported successful ESP outcomes after covering with a polytetrafluoroethelne (dPTFE) membrane after minimally traumatic extraction.

5. Collagen sponge

The Bio-Col method was suggested as an effective ESP technique to pack a collagen sponge above the xenogeneic bone graft into 1/2 to 2/3 of the extraction socket[49,50].

VI. Timing of Implant Placement after ESP

Several histologic studies have been conducted on ESP with bone graft[51,52]. Although ESP contributed to prevention of bone resorption, some cases exhibited insufficient bone healing quantity and quality. Larger defects required longer healing time[53]. New bone grew at the contact with recipient bone up to the lower 1/3 of the defect. Bone regeneration to the upper aspect required a long healing period[54,55]. Therefore, implant placement was recommended after a sufficient healing period of approximately 4 months[51,52,56]. Primary stability of the implant should be obtained at the basal bone rather than in the bone graft area.

VII. Summary

1. ESP is not required in all extraction cases, but should be considered in the following cases:
   1) Aesthetic concern
   2) Severe destruction of residual bone walls after tooth extraction
   3) Delayed implant treatment
2. With ESP, the necessity for additional bone grafting is reduced at implant placement.
3. ESP does not affect the success rate or marginal bone loss of implants.
4. No consensus has been made on the standard protocol among ESP techniques.
5. Socket sealing can protect bone substitutes and contribute to soft tissue healing through autogenous gingival tissues, barrier membranes, collagen sponges, etc.
6. During ESP, primary closure is not essential, but minimally traumatic procedures are very important.
7. Dental implants are recommended to be placed 4 months after ESP.

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Authors' Contributions

Y.K.K. participated in the literature review and wrote the primary manuscript. J.K.K. participated in the literature review and wrote the final manuscript.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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