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발치와경화증에서 보이는 백악질성 골화

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〈Abstract〉

Cementoid Ossification in Socket Sclerosis

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Socket sclerosis can be an obstacle for orthodontic space closure, however, the precise histomorphogenetic mechanism has not been elucidated up to date. A 73 years old female complained of dull pain on palpation in the extraction site of the left maxillary first molar, and uncomfortable to use her complete denture. In panoramic X-ray view the socket sclerosis was clearly demarcated as a radiopaque outline of extracted root. In histological examination the socket sclerosis showed the basophilic deposition of cementum-like materials in the peripheral rim of trabecular bones instead of eosinophilic osteoid materials for intramembranous ossification. In the immunohistochemical staining for osteogenetic proteins, BMP-2 was strongly positive in the peripheral rim of trabecular bone, in which RANKL and osteoprotegerin were also consistently positive. Particularly, versican, a marker of cementum was also positive in the peripheral rim of the trabecular bone. Therefore, it is presumed that the trabecular bones of socket sclerosis were hypermineralized by cementoid ossification, producing cementum-like materials by osteoblasts/cementoblasts derived from the previous periodontium.

Key words : Immunohistochemistry, Periodontium-derived Osteoblasts/Cementoblasts

Ⅰ. INTRODUCTION

Socket sclerosis is a rare reaction to tooth extraction, resulting in high-density bone in the area of extraction socket[1,2]. Socket sclerosis can be an obstacle for orthodontic space closure, if traditional orthodontic mechanics are employed. Rather mini-implant-reinforced anchorage is necessary to perform successful space closure in orthodontic tooth movement[3]. The hypercalcified lesion in the edentulous alveolar ridge may produce the ill-fitting and painful site for denture wearing in older people[4,5]. On the other hands, the abnormal bone repair in jaws, socket sclerosis may indicate a sign of systemic diseases, i.e., hyperparathyroidism, systemic osteopetrosis and idiopathic sclerosis of jaw[2,6-8]. The uncommon lesion of socket sclerosis is usually resemble to the retained root in X-ray view, and should be differentially diagnosed from the localized osteosclerosis and osteopetrosis[1,2]. The present socket sclerosis showed unique features of radiopaque image similar to its root architecture, and had no evidence of systemic abnormality. Nevertheless, with the tumor fovea and mild dull pain in the extraction site the socket sclerosis was removed surgically and abandoned as a simple benign osseous lesion[2]. However, only a few

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reports have been known, and the precise histomorphogenetic mechanism of socket sclerosis had not been elucidated so far. The present study is aimed to clarify the abnormal calcification processes of socket sclerosis by histochemical and immunohistochemical methods, and demonstrates that the socket sclerosis is the result of cementoid ossification by the osteoblasts/cementoblasts derived from the previous periodontium.

II. MATERIALS AND METHODS

The radiopaque lesion diagnosed as socket sclerosis was surgically removed, and fixed in 10% neutral formalin and decalcified with 0.5M EDTA solution (pH 8.0), embedded in paraffin, and sectioned in 4 μm thickness. The microsections were stained with hematoxylin and eosin, von Gieson, Masson trichrome, periodic acid Schiff (PAS) reaction, and followed by immunohistochemical staining using antibodies of bone morphogenetic protein 2 (BMP-2), receptor activator of nuclear factor kappa-B ligand (RANKL), osteoprotegerin, versican (Santa Cruz Bio- technology, USA). All the immunostainings were simultaneously performed with indirect triple sandwich method as previously described[9]. Background cross reaction was minimized by the negative control staining using no primary antibody in the same immunohistochemical procedures. The histological images of representative immunohistochemical reactions were captured by digital camera (DP-70, Olympus, Japan). The usage of the biopsy specimens filed in the Department of Oral Pathology, Gangneung-Wonju National University Dental Hospital was approved by Life Ethic Committee (IRB 2009-1-3).

III. RESULTS

Panoramic radiography showed edentulous jaws, particularly disclosing the retained root-like image at left maxillary first molar area with the impression of socket sclerosis (Fig. 1A, C). And standard radiography showed the outline of socket sclerosis which is different from the

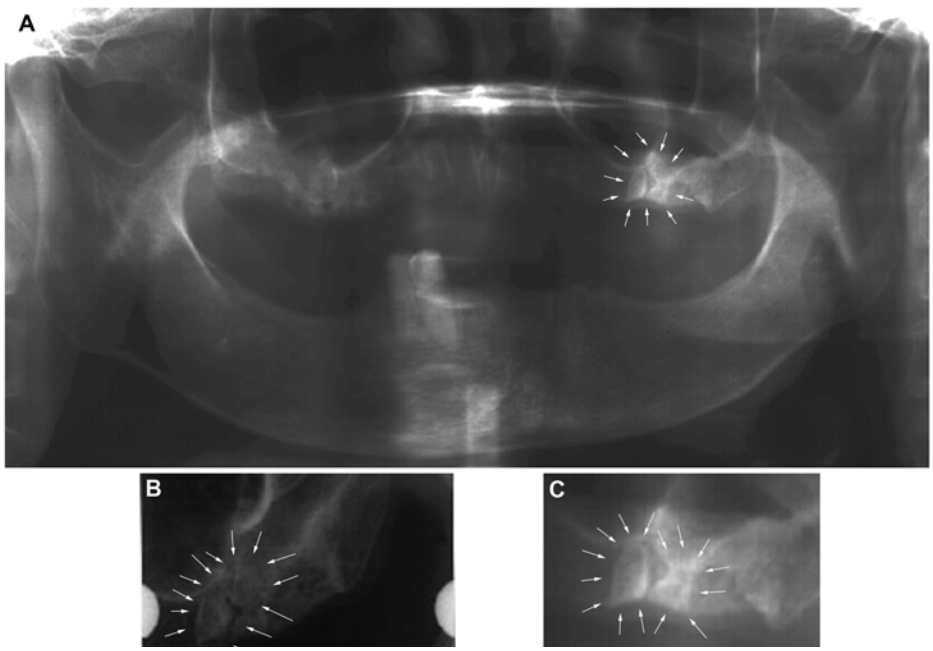

Fig. 1. A. Panoramic radiography showed edentulous jaws, particularly disclosing the retained root-like image at left maxillary first molar (arrows) with the impression of socket sclerosis. B. Standard radiography showed the outline of socket sclerosis which is different from the feature of retained root in radiopaque density. C. High magnification of panel A, conspicuously disclosing the socket sclerosis in the previous extraction site.

features of retained root in radiopaque density (Fig. 1B). In the histological observation, the extraction socket wall, alveolar bone, was composed of thick compact bone, while the extraction socket was replaced by cancellous trabecular bones (Fig. 2A1). The marrow space of the socket bone was filled with loose connective tissue containing a few collagen fibers, and showed rare osteoclastic reaction (Fig. 2A2). And the ossification of the socket trabecular bone was characterized by the basophilic cementum-like deposition in its periphery instead of the typical eosinophilic osteoid rim of intramembranous ossification (Fig. 2A3, A5, A7). In the polarizing microscope observation the trabecular bones of socket sclerosis showed the refringence of woven bone pattern, and especially the basophilic cementum-like deposition in the periphery of the trabecular bone was almost absent of refringence, contrast to the palisading refringence in its inside bone (Fig. 2A4, A6, A8).

Masson trichrome stain disclosed the trabecular bones of socket sclerosis hypermineralized by cementum-like deposition in their periphery (Fig. 2B1). The marrow connective tissue of socket sclerosis contained relatively small amount of collagenous matrix stained in blue compared to that of alveolar bone (Fig. 2B3). In von Gieson stain, the matrix of the socket trabecular bone appeared in pink, and the marrow connective tissue contained primitive collagen fibers instead of the osteoblasts-rich osteoid rim in the periphery of the trabecular bone (Fig. 2C1, C2). In PAS stain, the cementum-like deposition in the periphery of the socket trabecular bone was weakly positive, and the inside woven bone matrix of some trabecular bone also showed slight positive reaction of pink (Fig. 2D1, D2).

In the immunohistochemistry BMP-2 was strongly positive in the periphery of trabecular bone (Fig. 2E), and both of RANKL and osteoprotegerin were consistently localized at the periphery of trabecular bone, although the immunoreactions of RANKL and osteo- protegerin were weaker than that of BMP-2 (Fig. 2F, G). Particularly, the immunostain of versican was positive both in the periphery of trabecular bone and inside matrix of trabecular bone (Fig. 2H).

Ⅳ. DISCUSSION

The radiological image of socket sclerosis was similar to the retained root, but only a condensed bony mass was found during extraction[1,3]. Histologically, the extraction socket was completely replaced by cancellous bone, and then the orifice margin of extraction socket was slightly elevated. The elevated margin might produce the mechanical irritation on touch during mastication. The socket sclerosis lesion can be an obstacle for orthodontic tooth movement and denture construction in edentulous ridge[3]. In the present study a 73 years old female patient complained of mild pain in the area of previous extraction site, and was almost unable to use her denture. However, the whole histological examination of the socket sclerosis lesion showed marrow spaces filled with loose connective tissue, gradually producing cementoid ossification on the cancellous trabecular bones in the similar manner to the cementogenesis in the previous periodontal ligament tissue. Therefore, we presume that the mild bone pain may be originated from the previous nerve endings in periodontal ligament, still embedded in the socket sclerosis.

In Masson trichrome stain, which stained the osteoid matrix in red and the collagen bundles in blue, the trabecular bone as well as the socket wall alveolar bone was hypermineralized. Whereas the former was woven bone pattern, the latter was compact bone pattern in the refringence of polarizing light. However, the cementum-like deposition in the periphery of trabecular bone showed

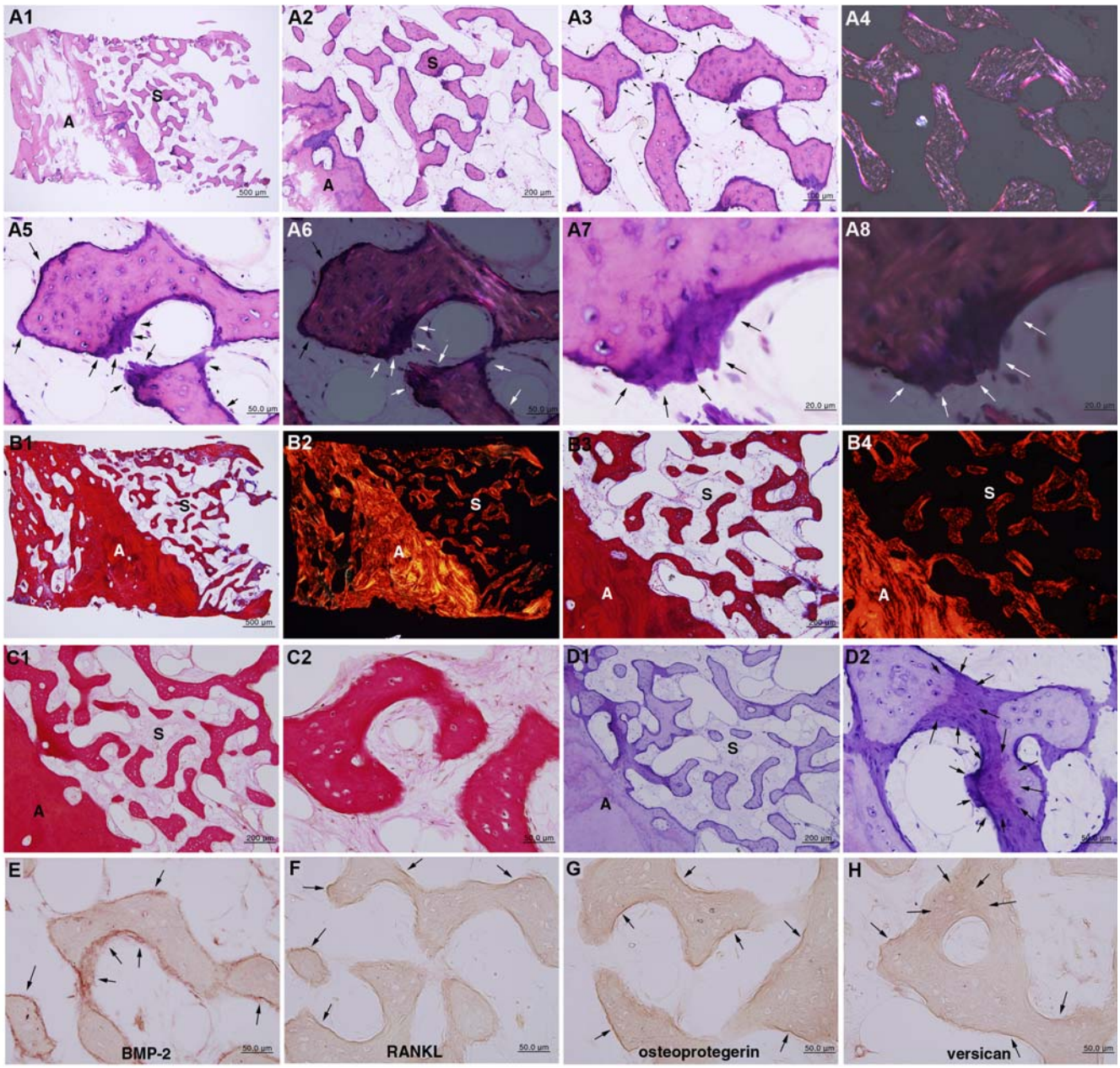

Fig. 2. Photomicrographs of socket sclerosis. A. Hematoxylin and eosin stain, A1. low magnification of extraction socket wall, noted the thick compact alveolar bone (arrows, A) and cancellous socket bone (S). A2. The socket bone (S) was distinguishable from the alveolar bone (A) and contained loose connective tissue. A3. The socket trabecular bone showed basophilic deposition (arrows) in its periphery instead of the eosinophilic osteoid rim, and the marrow connective tissue showed a few collagen fibers and rare osteoclastic activity. A4. Polarizing microscope showed the refringence of woven bone pattern in the trabecular bones of socket sclerosis. A5. High magnification view showed the typical basophilic cementum-like deposition (arrows) in the periphery of the trabecular bone. A6. Polarizing microscope view of panel A5 showed no refringence light in the peripheral cementum-like deposition, while conspicuous palisading refringence in the inside bone. A7. Higher magnification of panel A5 showed the features of cellular cementum which was continuous to the inside bone without the osteoid matrix layer. A8. Polarizing microscopic view of panel A7, noted the absence of refringence in the cementum-like materials. B. Masson trichrome stain, B1. Low magnification, noted the hypermineralized alveolar bone (A, arrows) and relatively loose cancellous bone in the socket sclerosis area (S). B2. Polarizing microscopic view of panel B1 showed

no refringence of polarizing light contrast to the conspicuous refringence in the nearby alveolar bone. The marrow tissue of socket sclerosis showed relatively small amount of collagen fibers in Masson trichrome and von Gieson stains, which were much different from the abundant collagen fibers in the marrow tissue of nearby alveolar bone. And more, the present socket sclerosis showed slight PAS reaction in the cementum-like deposition in the periphery of trabecular bone and in the woven bone matrix of the trabecular bone. Therefore, it is suggested that the ossification of socket sclerosis resembles to the cementogenesis of periodontium, which becomes hypermineralized enough to be radiopaque in X-ray view and to be an obstacle for orthodontic tooth movement.

In the immunohistochemistry the major osteogenic marker of BMP-2 was strongly positive in the periphery of trabecular bone in socket sclerosis, where was the same site with the deposition of basophilic cementum-like materials. And RANKL and osteoprotegerin, osteogenic markers for bone modification[10-14], were also consistently positive in the similar area to the positive reaction of BMP-2, although the immunoreactions of RANKL and osteoprotegerin were weaker than that of BMP-2. Therefore, we presume that the basophilic deposition in the periphery of trabecular bone in socket sclerosis is in the processes of ossification which is somehow different from ordinary intramembranous ossification. However, the ordinary osteoblast layer, eosinophilic osteoid rim in the periphery of trabecular bone, as well as the osteoclastic activity were not observed in the whole sections of socket sclerosis, which were the hallmarks of intramembranous ossification. The histological patterns of calcifying cells and the basophilic deposition of cementum-like materials were much similar to the cementogenesis. And more, the immunostain of versican, a chondroitin sulfate proteoglycan used as a marker of cementum[15-18], was diffusely positive in the periphery of trabecular bone and in the matrix of inside bone, thus it can be said that the trabecular bones of socket sclerosis contain the cementum-like materials. Therefore, it is presumed that the socket sclerosis belongs to a cementoid-osseous tissue produced by the mesenchymal cells originated from the previous periodontium, which have potential to be differentiated into osteoblasts or cementoblasts.

V. CONCLUSIONS

Socket sclerosis is the result of hypermineralization by the cementum-like deposition in the periphery of trabecular bones during the wound healing of extraction socket, which is similar to the cementoid ossification produced by periodontium-derived osteoblasts/cementoblasts.

the strong refringence in the alveolar bone, but weak refringence in the socket trabecular bone. B3. Higher magnification of panel B1, the marrow connective tissue was lack of collagenous matrix stained in blue. B4. Polarizing microscopic view of panel B3 showed the sparse refringence of woven bone pattern in the trabecular bones of socket sclerosis (S), while the strong refringence in the alveolar bone (A). C1. von Gieson stain showed pinkish bone matrix both in the alveolar bone and socket trabecular bones. C2. High magnification of panel C1 showed a few pinkish fibrous materials in the marrow connective tissue, indicating the existence of primitive collagen fibers. D1. PAS stain, noted the well distinguishable cementum-like deposition in the periphery of the socket trabecular bone. D2. High magnification of D1, noted the slight pinkish color in the cementum-like materials (arrows) in the periphery of bone. E. Immunostain of BMP-2 showed the strong positive reaction (arrows) in the periphery of trabecular bone. F. Immunostain of RANKL showed the slight positive reaction in the periphery of trabecular bone, G. Immunostain of osteoprotegerin was localized at the periphery of trabecular bone. H. Immunostain of versican was positive both in the periphery of trabecular bone and inside matrix of trabecular bone.

Ⅵ. References

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