

Clinical evaluation of transcrestal sinus floor elevation using HA-coated short implants without bone graft

Yukiyasu Kishimoto

1. Introduction

In the posterior maxilla, bone resorption after tooth extraction and pneumatization of maxillary sinus often cause atrophy of the alveolar ridge¹⁾. As the result, the implant treatment becomes difficult. Recently, the implant treatment has become possible using Sinus Floor Elevation (SE), Transcrestal Sinus Floor Elevation (TCSE), tilted installation, and use of short implant. Especially, the TCSE procedure is less surgical invasion, but is a blind surgery. Thus, a perforated maxillary sinus membrane may be unnoticed and maxillary sinusitis may take place due to migration of a graft material or infection. It is also disadvantageous that elevating the maxillary sinus membrane large amount is difficult.

For the purpose of reducing the risk of perforation of sinus membrane applying the small amount of sinus membrane elevation, and reducing the possibility of sinusitis by using graftless procedure even if membrane perforation takes place, we investigated cases of TCSE procedure using HA-coated short implants without bone graft.

2. Method

Using TCSE procedures without bone graft, 27 implants were placed in the atrophic posterior maxilla of 16 cases in whom prosthetic steps were

completed between March 2004 and May 2011. All implants were one-piece type made of plasma-spray method (AQB implant[®], ADVANCE Co.Japan) and their HA-coated implant fixtures were 6-mm long. The 27 implants in the 16 cases were investigated for the following items.

- 1) Sex and age distribution
 - 2) Location of implants inserted
 - 3) Diameter of implants used
 - 4) Duration of healing period from the implant placement up to addition of occlusal force.
 - 5) Creation style of the prosthetic structure
- The survey was carried through May 2012.

Inclusion criteria

- 1) The distance to the maxillary sinus is less than 6mm and it is necessary to elevate the sinus membrane for implant placement.
- 2) Vertical stop is maintained at the other side of implantation.
- 3) No lesion of the maxillary sinus is shown clinically and radiographically.

3. Results

- 1) The subjects were 6 males and 10 females (a total of 16 persons) aged 29 to 73 (Table 1).
- 2) The first molars were 14 out of 27(51.9%) as for sites of implant placement, it was the most (Table 2).
- 3) The diameters of implants used were 4mm in

25(92.6%) and 5mm in 2(7.4%).

- 4) The period from the implant placement up to addition of occlusal force by the prosthetic structure was 4 months or less in 10(37.0%) and 5 months or less in 11(40.7%) (Table 3).
- 5) The prosthetic structures included those made single in 4(14.8%) and those made with splinting in 23(85.2%).

Bio-integration was gained in all the 27 implants of 16 cases. Post-operative complications such as sinusitis, nasal bleeding and rhinorrhea didn't appear. Two implants in one case failed after 2-years loading (Fig 1~10).

Table 1 : Sex and age distribution

Age	Male	Female	Total
20-30	1		1
30-40		2	2
40-50	3	3	6
50-60	2		2
60-70		3	3
70-80		2	2
Total	6	10	16

Table 2 : Location of implants

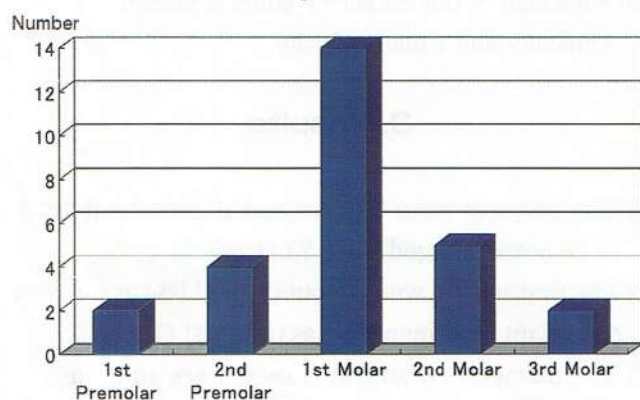


Table 3 : Duration of healing period

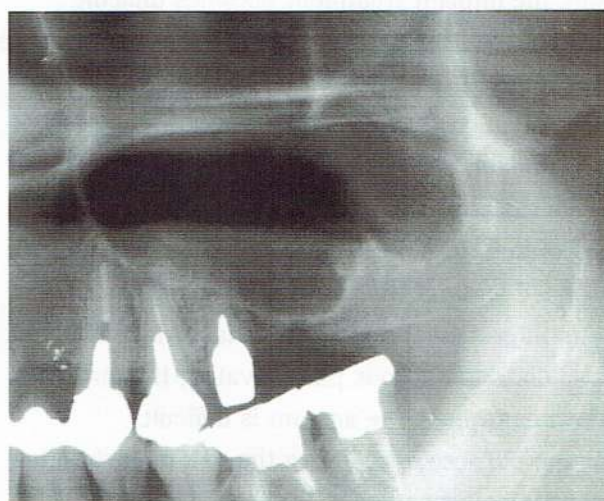
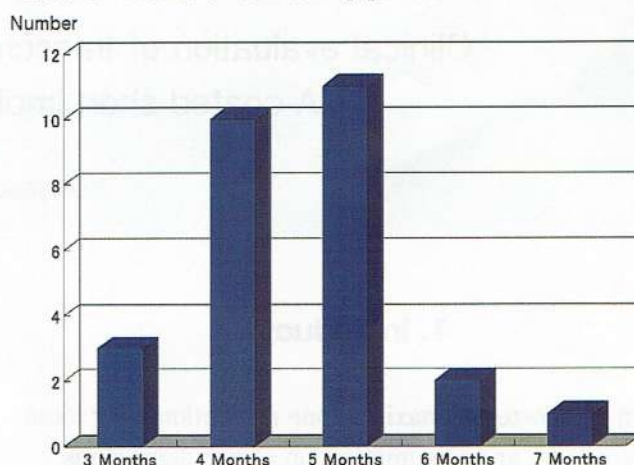


Fig 1 : Preoperative radiograph (Case 1) showing the pneumatization of maxillary sinus and atrophy of the alveolar ridge

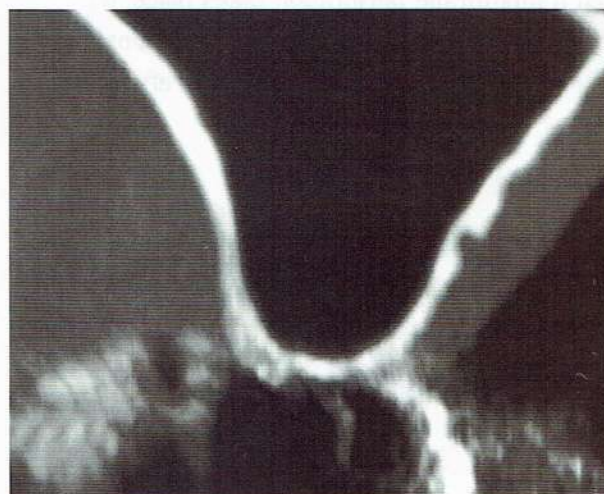


Fig 2 : Preoperative CT image of left first molar

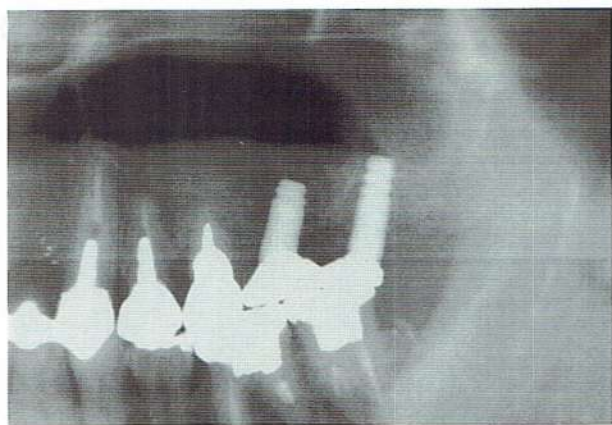


Fig 3 : Radiograph at prosthetic structure placement showing no new bone formation on left first molar

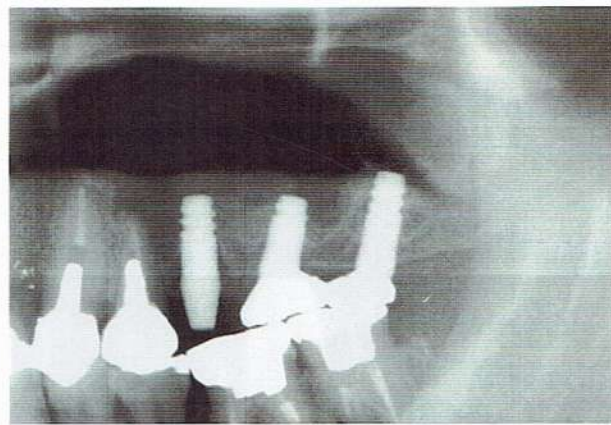


Fig 4 : Radiograph at 1-year follow up showing new bone formation on left first molar

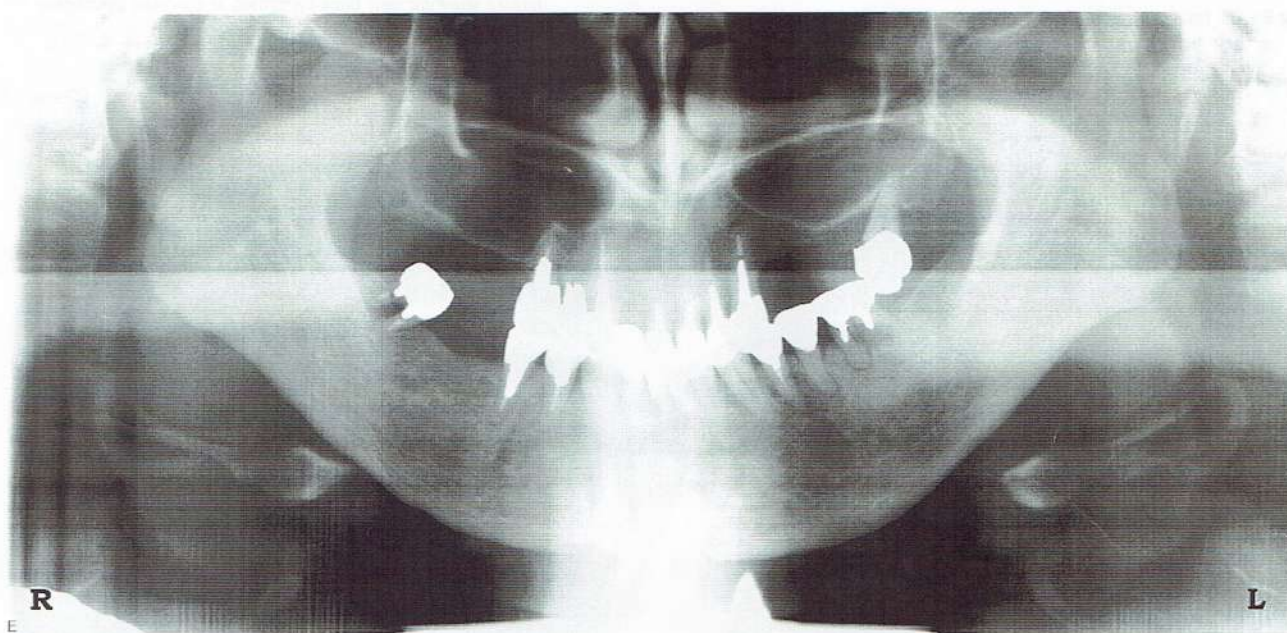


Fig 5 : Preoperative radiograph (Case 2) showing the pneumatization of maxillary sinus and atrophy of the alveolar ridge

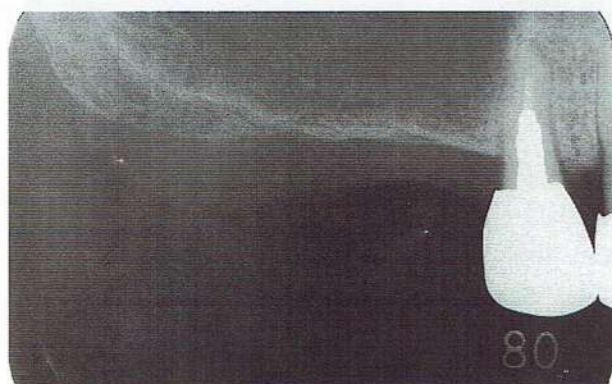


Fig 6 : Preoperative radiograph of right first and second molars

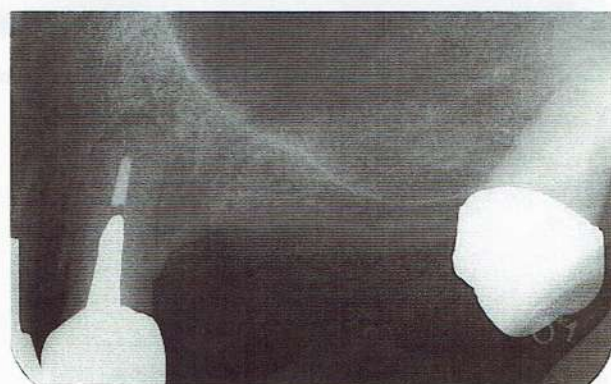


Fig 7 : Preoperative radiograph of left first molar

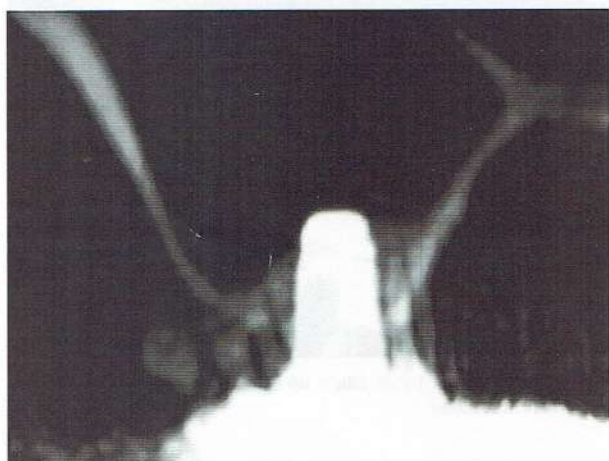


Fig 8 : CT image of right first molar after 4-months loading showing new bone formation around implant

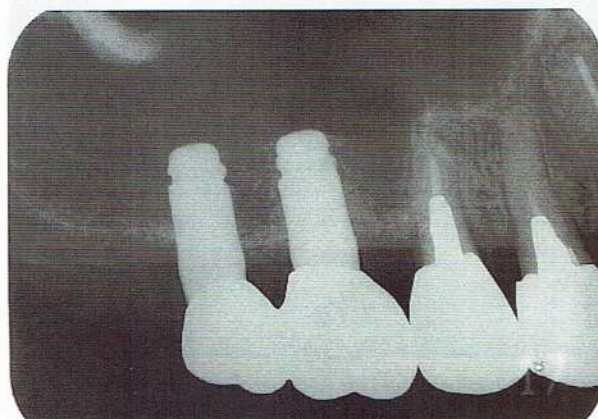


Fig 9 : Radiograph after 3-years loading for first and second right molars showing new bone formation at elevated membrane

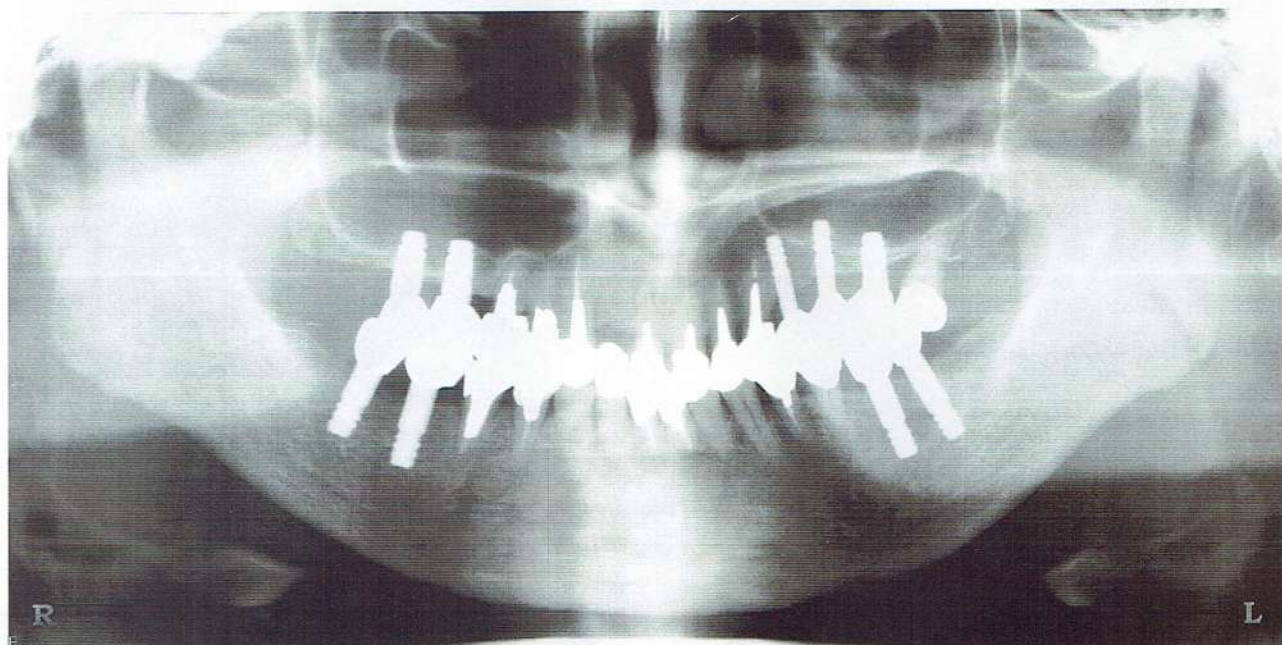


Fig 10 : Radiograph after 4-years loading for first and second right molars, 3-years loading for first left molar showing new bone formation

4. Discussion

Sinus Floor Elevation (SE) with bone graft or bone substitute materials is used for implant placement on the atrophic alveolar ridge of the maxilla. However, the procedure is so surgically invasive that if the graft material used migrates,

maxillary sinusitis may take place. On the other hand, Transcrestal Sinus Floor Elevation (TCSE) is less invasive, but a blind surgery that when elevated maxillary sinus membrane is perforated, it may be unnoticed. The purposes of this study were to reduce surgical invasion by applying TCSE procedure, to reduce the risk for the perforation of the maxillary sinus membrane by use of short

implants, to reduce the occurrence of maxillary sinusitis by using graftless surgery, and to apply one piece of HA-coated implants to TCSE procedures.

In 1986, Tatum²⁾ reported TCSE procedure with bone graft. In 1980, Boyne et al.³⁾ reported SE procedure with bone graft using blade implants in 11 cases. In the paper, it was stated that the mere elevation of the sinus membrane also resulted in a certain amount of bone formation in rhesus monkeys and dogs.

It appears to be Shimizu et al.⁴⁾ who reported first about SE procedure without bone graft. The mucoperiosteal flap was reflected to expose the lateral aspect of the maxilla and a bone window was opened to elevate the sinus membrane from the original skeletal sinus floor. Then, two implants were placed. The mucoperiosteal flap was sutured without replacing the bone window. It was stated that the intraoral x-ray on postoperative week 23 showed the border between the new bone and the original sinus skeletal floor was unclear. Seven months after the surgery, a secondary surgery was performed to tighten an abutment. At that time, it was reported that the bone window on the lateral aspect of the maxilla disappeared.

On the other hand, Brånemark et al.⁵⁾ formed a implant bed immediately down to the sinus membrane, elevated the sinus membrane by a small raspatory, and then placed an implant. Although it appears to be the first report on TCSE procedure without bone graft, the new bone formation at the elevated site was not described actively. A paper by Li⁶⁾ is the first one stating the bone formation at the elevated site in TCSE procedure without bone graft. It was stated that blood clot is important for the bone formation at the elevated site.

Tan et al.⁷⁾ reported in a systematic review that 3-year survival rate was 92.8% in cases with the maxillary sinus membrane elevated by TCSE procedure, and the rate was similar to those in non-augmented sites. According to a report by Pjetursson et al.⁸⁾ of the same group, the 3-year

survival rate in a systematic review of SE procedure was 90.1%. However, both the reports showed the results of cases with and without bone graft.

Nedir et al.⁹⁾ reported 100% of 5-year survival rate in cases without bone graft.

Bruschi et al.¹⁰⁾ reported 95.45% for 16-year cumulative survival rate in cases that the maxillary sinus membrane was elevated at a site of 2.11mm in mean height of the alveolar crest bone, a collagen sheet was applied, and 3 months later, implants were placed without bone graft.

Lai et al.¹¹⁾ stated that there was no statistical significant difference in the 5-year survival rate of TCSE procedure between presence and absence of bone graft. However, the group with bone graft had the healing period up to addition of occlusal force for 6 to 8 months, whereas the group without bone graft had the healing period for 3 or 4 months. The healing period was shorter in cases without bone graft.

Brägger et al.¹²⁾ performed secondary surgery after 6-month healing period in cases that using ITI implants. Bio-Oss particles were mixed with autogenous bone and inserted to the area between the elevated maxillary sinus membrane and original skeletal sinus floor. On the other hand, Nedir et al.⁹⁾ conducted secondary surgery after 3 or 4-month healing period in which ITI implants were used without bone graft at the sites maxillary sinus membrane elevated alone. The treatment period may be shorter in cases without bone graft.

Palma et al.¹³⁾ reported that in an animal study, bone formation started earlier in case without bone graft than in those with bone graft. Sohn et al.¹⁴⁾ compared SE procedures without bone graft to those using Bio-Oss and stated that new bone formation was faster and denser in cases without bone graft than those in with graft materials.

Moreover, Sohn et al.¹⁵⁾ conducted histologic research of SE procedure in human without bone graft, and confirmed the new bone formation without any inflammatory reaction.

Bruschi et al.¹⁰⁾ stated that because in TCSE procedures without bone graft, the healing process proceeded more rapidly than in those with autogenous grafts, allografts or xenografts, graft materials were not recommended. Moreover, it was reported that bone height gained after TCSE procedures without bone graft did not shrink over 16 years as reported with graft materials.

As for complications of SE and TCSE procedures, infections of the maxillary sinus are problems. In systematic reviews, Tan et al.⁷⁾ and Pjetursson et al.⁸⁾ stated that it was 0.8% in TCSE procedure and 2.9% in SE procedure. Recently, SE and TCSE procedures without bone graft have been used so frequently that even if the maxillary sinus membrane is perforated, the incidence of maxillary sinusitis has become smaller¹⁶⁾. However, once it takes place, the treatment period and the number of hospital visits increase¹⁷⁾. It means that TCSE procedure without bone graft is significant.

Ferrigno et al.¹⁸⁾ stated that the predictable use of 8mm-long implants in conjunction with TCSE procedure may reduce the indication for complex invasive procedures like SE and bone graft procedure.

Reiser et al.¹⁹⁾ stated that in a study using formalin-fixed human cadavers, elevating the maxillary sinus membrane by 6-8mm might cause to perforate the sinus membrane widely. Nkenke et al.²⁰⁾ stated that in a study using an endoscope, when the elevating amount of the maxillary sinus membrane was small, the possibility of the perforation decreased. Sung et al.²¹⁾ reported that without bone graft, even if the maxillary sinus membrane was elevated greatly, bone formation didn't take place greatly. In case without bone graft, it is considered that even if the elevating amount of the maxillary sinus membrane is increased, bone formation doesn't increase, but the possibility for perforating the sinus membrane increases. Thus, it becomes important to obtain treatment results when short implants are used and the elevating amount of the sinus membrane is

reduced without bone graft. But there has been no such report.

Lai et al.¹¹⁾ reported that when TCSE procedure using 6mm implant was applied, one of 12 implants failed and the 5-year survival rate was 95.49%, and stated that there would be no difference in the survival rate among the different lengths of implants. Pietursson et al.²²⁾ reported 47.6% of 3-year survival rate in 7 implants of 6mm in length, which was significantly low. Both the reports showed small sample sizes and didn't state about whether or not bone graft was performed. In this study, 27 implants in 16 cases were investigated. The findings were that 2 implants in one case failed after 2-years loading, and the remaining 25 implants functioned well, which were relatively favorable results.

As for the surface texture of the implants placed using TCSE procedures without bone graft, there are some reports about Straumann^{9) 11) 22)}. Reports on use of HA-coated implants have been presented by Summers²³⁾ and Kishimoto et al.²⁴⁾ Summers used 123 HA-coated implants and stated that the success rate for 18 months of both HA-coated and TPS coated implants was 96%, but did not state the success rate for the use of HA-coated implants only. In addition, it is a paper focusing on osteotome technique and how many implants among the 123 implants were used for elevating the maxillary sinus membrane was unknown. Kishimoto et al. used 68 HA-coated implants and stated that there was one failed during observation period for 3 months to 6 years.

As for reason why new bone formation takes place in the space between elevated sinus membrane and the original skeletal sinus floor, Kim et al.²⁵⁾ reported about histological specimen that ossification started from the original skeletal sinus floor. On the other hand, Kim et al.²⁶⁾ reported that the maxillary sinus membrane has a possibility to produce stem cells differentiating to osteoblasts. Sohn et al.¹⁴⁾ reported that ossification started from elevated maxillary

sinus membrane. Aoki²⁷⁾ stated that hydroxyapatite is in oversaturation condition in blood, which facilitated to start calcification around HA-coated implant. In case that a HA-coated implant is placed at the maxillary sinus without bone graft, new bone formation may start from the original skeletal sinus floor, elevated maxillary sinus membrane and implant side.

In this study, because one-piece implant was used, the healing progresses in the condition that the implant penetrates the gingiva. While the integration is acquired, the occlusal force should not be added. Thus, in this study, cases that a vertical stop is maintained at the other side of implantation were made for the subjects. In two-piece implant, it is difficult to surely evaluate the acquisition of the integration before the secondary surgery. Thus, there will be some cases that despite not acquiring the integration, the secondary surgery is performed and the implant migrates to the maxillary sinus. On the other hand, in one-piece implant, because the abutment part penetrates the oral cavity, it is easy to evaluate the acquisition of the integration. It is advantageous that when the primary stability of the implant is uncertain, the healing can be waited as fixation of adjacent implant or tooth is required. In the future, in case that a vertical stop is maintained at the other side of implantation, the use of one-piece implants appears to increase.

In this study, the results should be interpreted with caution due to the limited sample size and short observation period. It will be necessary to evaluate the followings: if it is possible to place a short implant having the predictability at the atrophic posterior maxilla; if HA-coated implant is effective; and if one-piece implant is effective. For those including RCT, a long-term observation is necessary.

5. Conclusion

Six mm-long HA-coated short implants were placed at atrophic posterior maxilla without bone graft and

obtained favorable clinical results. The evaluation results are from a short-term observation and a long-term observation will be thus necessary.

References

- 1) Sharan A and Madjar D: Maxillary sinus pneumatization following extractions: a radiographic study. *Int J Oral Maxillofac Implants* 23: 48-56, 2008.
- 2) Tatum H Jr: Maxillary and sinus implant reconstructions. *Dent Clin North Am* 30: 207-229, 1986.
- 3) Boyne PJ and James RA: Grafting of the maxillary sinus floor with autogenous marrow and bone. *J Oral Surg* 38: 613-616, 1980.
- 4) Shimizu H, Hidaka T, *et al*: A case treated with subantral augmentation without grafting material. *J Jpn Soc Oral Implantology* 7: 32-38, 1994.
- 5) Brånemark PI, Adell R, *et al*: An experimental and clinical study of osseointegrated implants penetrating the nasal cavity and maxillary sinus. *J Oral Maxillofac Surg* 42: 497-505, 1984.
- 6) Li TF: Sinus floor elevation: a revised osteotome technique and its biological concept. *Compend Contin Educ Dent* 26: 619-626, 2005.
- 7) Tan WC, Lang NP, *et al*: A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation. Part II: transalveolar technique. *J Clin Periodontol* 35(8 Suppl): 241-254, 2008.
- 8) Pjetursson BE, Tan WC, *et al*: A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation. Part I: lateral approach. *J Clin Periodontol* 35(8 Suppl): 216-240, 2008.
- 9) Nedir R, Nurdin N, *et al*: Osteotome sinus floor elevation technique without grafting: a 5-year prospective study. *J Clin Periodontol* 37: 1023-1028, 2010.
- 10) Bruschi GB, Crespi R, *et al*: Transcrestal sinus floor elevation: a retrospective study of 46 patients up to 16 years. *Clin Implant Dent Relat Res*, Oct 26. doi: 10.1111/j.1708-8208.2010.00313.x., 2010.
- 11) Lai HC, Zhuang LF, *et al*: Osteotome sinus floor elevation with or without grafting: a preliminary clinical trial. *Clin Oral Implants Res* 21: 520-526, 2010.
- 12) Brägger U, Gerber C, *et al*: Patterns of tissue remodeling after placement of ITI dental implants using an osteotome technique: a longitudinal radiographic case cohort study. *Clin Oral Implants Res* 15: 158-166, 2004.
- 13) Palma VC, Magro-Filho O, *et al*: Bone reformation and implant integration following maxillary sinus membrane

- elevation: an experimental study in primates. Clin Implant Dent Relat Res 8: 11-24, 2006.
- 14) Sohn DS, Moon JW, *et al.*: Comparison of new bone formation in the maxillary sinus with and without bone grafts: immunochemical rabbit study. Int J Oral Maxillofac Implants 26: 1033-1042, 2011.
- 15) Sohn DS, Lee JS, *et al.*: New bone formation in the maxillary sinus without bone grafts. Implant Dent; 17: 321-331, 2008.
- 16) Jung JH, Choi BH, *et al.*: The effects of exposing dental implants to the maxillary sinus cavity on sinus complications. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 102: 602-605, 2006.
- 17) Urban IA, Nagursky H, *et al.*: Incidence, diagnosis, and treatment of sinus graft infection after sinus floor elevation: a clinical study. Int J Oral Maxillofac Implant 27: 449-457, 2012.
- 18) Ferrigno N, Laureti M, *et al.*: Dental implants placement in conjunction with osteotome sinus floor elevation: a 12-year life-table analysis from a prospective study on 588 ITI implants. Clin Oral Implants Res 17: 194-205, 2006.
- 19) Reiser GM, Rabinovitz Z, *et al.*: Evaluation of maxillary sinus membrane response following elevation with the crestal osteotome technique in human cadavers. Int J Oral Maxillofac Implants 16: 833-840, 2001.
- 20) Nkenke E, Schlegel A, *et al.*: The endoscopically controlled osteotome sinus floor elevation: a preliminary prospective study. Int J Oral Maxillofac Implants 17: 557-566, 2002.
- 21) Sul SH, Choi BH, *et al.*: Effects of sinus membrane elevation on bone formation around implants placed in the maxillary sinus cavity: an experimental study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 105: 684-687, 2008.
- 22) Pjetursson BE, Rast C, *et al.*: Maxillary sinus floor elevation using the (transalveolar) osteotome technique with or without grafting material. Part I: implant survival and patients' perception. Clin Oral Implants Res 20: 667-676, 2009.
- 23) Summers RB: A new concept in maxillary implant surgery: the osteotome technique. Compendium. 15: 152-162, 1994.
- 24) Kishimoto Y, Matsumoto Y, *et al.*: Forty-five cases of osteotome sinus floor elevation in atrophic maxilla using HA-coated implants without bone graft. J Australian Ceramic Soc 46: 34-37, 2010.
- 25) Kim DM, Nevins ML, *et al.*: The efficacy of demineralized bone matrix and cancellous bone chips for maxillary sinus augmentation. Int J Periodontics Restorative Dent 29: 415-423, 2009.
- 26) Kim SW, Lee IK, *et al.*: Adult stem cells derived from human maxillary sinus membrane and their osteogenic

differentiation. Int J Oral Maxillofac Implants 24: 991-998, 2009.

- 27) Aoki H, Yajima T, *et al.*: Calcification on pure titanium or HA coated on titanium in mediums. The 4th International Symposium on Apatites and Correlative Biomaterials (ISACB 08) Manila Philippines. 159-161, 2008.

抄 録

目的: 萎縮した上顎臼歯部に対し、骨移植を伴わない Transcrestal Sinus Floor Elevation (TCSE) 法を応用して HA をコートされたショートインプラントを埋入した症例を検討する。

研究方法: 2004年3月から2011年5月までの間、上顎臼歯部に骨移植を伴わずに TCSE 法を応用してインプラント埋入を行った症例で、上部構造の装着が完了した 16 症例 27 本を評価対象とした。使用したインプラントは Plasma-Spray 法で HA をコーティングされた 1 ピースタイプのインプラント (AQB インプラント® アドバンス社製) で HA コーティング部の長さ 6mm を用いた。2012年5月まで調査した。

結果: 16 症例 27 本すべてのインプラントがバイオインテグレーションを獲得した。上顎洞炎、出血、鼻漏などの合併症は発生しなかった。機能開始 2 年後、同一症例 2 本に脱落が発生した。

結論: 上顎臼歯部の萎縮した歯槽骨に、TCSE 法を用いて骨移植を行わずに短い HA コーティングインプラントを埋入した結果、良好な臨床成績が得られた。

Abstract

The purpose of this study was to evaluate the clinical cases of 6mm-long Hydroxyapatite (HA)-coated implants placed into the atrophic posterior maxilla using Transcrestal Sinus Floor Elevation (TCSE) without bone graft.

Using TCSE procedure without bone graft, 27 implants were placed in the posterior maxilla of 16 cases in whom prosthetic steps were completed between March 2004 and May 2011. All implants were one piece type (AQB implant®, ADVANCE Japan) and HA-coated made of plasma-spray method. All HA-coated implant fixtures were 6-mm in length. This survey was carried through May 2012.

All implants gained biointegration. Post-operative complications such as sinusitis, nasal bleeding and rhinorrhea didn't appear. Two implants of the same case failed after 2-years loading.

TCSE procedure using HA-coated short implants without bone graft was found to be effective on the implant placement for the atrophic posterior of the maxilla.