치의과학석사 학위논문

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탈단백 우골을 이용한 측방 접근 상악동 거상술의 5년 방사선 추적 관찰

2013년 8월

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이 논문을 치의과학석사 학위논문으로 제출함

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전진의 치의과학석사 학위논문을 인준함

2013 년 8 월

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ABSTRACT

A 5-year radiographic evaluation of maxillary sinus floor elevation with lateral window approach using deproteinized bovine bone grafts

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Objectives. The posterior maxilla is composed of mostly cancellous bone and little cortical bone, and the bone density of posterior maxilla is 5~10 times lower than that of anterior mandible. And implant installation in posterior maxilla is often restricted by the resorption of alveolar ridge and the pneumatization of maxillary sinus. Maxillary sinus floor elevation is a recommended procedure to overcome these anatomical limitations. Although there were many studies that showed survival or success rates of implants with sinus floor elevation, long-term volume or height changes of grafted maxillary sinus had rarely been investigated. The aim of the present study was to evaluate the bone height changes in 5 years after maxillary sinus floor elevation using deproteinized bovine bone grafts by radiographic measuring and to consider various factors that affect these changes.

Materials and Methods. Twenty-six patients were included. Panoramic radiographs in each patient were taken and inspected during 5-year period: preoperatively, at the time of maxillary sinus floor elevation (T0), 1 year after elevation (T1), 2 years after elevation (T2), 3 years after elevation (T3) and 5 years after elevation (T4). Bone height measurements were performed at four locations: at the most distal point of the implant platform (L1), at the halfway between implants (L2), at the 3mm distal point from the most posterior implant (L3) and the initial lowest residual bone height preoperatively (L0). The changes of augmented alveolar bone heights were traced and evaluated. Statistical analyses were performed to assess whether factors such as locations, residual bone height, the timing of implant placement, the surface characteristics of implants and the connection types between fixtures and abutments had an effect on these changes.

Results. The mean initial bone height was 3.19 ± 1.25 mm and the mean augmented bone height was 17.85 ± 2.46 mm after sinus floor elevation. The mean decrease of height in 5 years was 2.20 mm (12.3%). Repeated measures ANOVA showed that at all three locations there was significant decrease of bone height in time ($P < 0.001$) and a greater reduction (1.25 mm) was present in the first period than any other three periods. Delayed implantation group showed significantly more resorption in the first year than simultaneous implantation group ($p<0.05$), but no significant difference was found afterwards. However, the factors such as locations, residual bone height, the surface characteristics of implants and the connection types between fixtures and abutments had no significant effect on these changes.

Key words: Maxillary sinus floor elevation, Height change of bone graft, Residual alveolar ridge

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전 진

-CONTENTS-

I. INTRODUCTION

The posterior maxilla is composed of mostly cancellous bone and little cortical bone, and the bone density of posterior maxilla is 5~10 times lower than that of anterior mandible.[1] With aging process, cortical bone becomes thinner and the density of lamellar bone decreases. That makes smaller bone-implant contact, slow and weak osseointegration, insufficient primary stability which compromises implant success.[2] Moreover after loss of tooth, atrophy of alveolar ridge of posterior maxilla and pneumatization of maxillary sinus result in short residual bone height, often limit available support for proper implant length. These anatomical limitations make implant installation difficult and prognosis poor.[3,4] Maxillary sinus floor elevation was introduced by Tatum[5], Boyne and James[6] to overcome these anatomical limitations. Maxillary sinus floor elevation has been a recommended procedure for the augmentation of available bone in maxilla and the basic protocol of sinus floor elevation was grafting bone particles or substitutes into spaces made by elevating Schneiderian membrane of maxillary sinus.

Many bone grafts are used in maxillary sinus floor elevation such as autografts, DFDBA (Demineralized Freeze Dried Bone Allograft), hydroxyapatite, β-tricalcium phosphate, deproteinized bovine bone, and some combination of the above. Block and Kent[7] suggested requisites of ideal bone graft for sinus floor elevation which included osteoinductive property, osteoconductive property, maintenance of mature bone with time in the elevated spaces. Autogenous bone grafts were considered as the “gold standard” because they are osteoinductive, reliable and biocompatible with no adverse antigenicity.[8] In 1996, The Academy of Osseointegration Sinus Consensus Conference[9] concluded that the autogenous bone grafts were most effective grafting materials. Nevertheless autogenous bone grafts had disadvantages which included donor site morbidity and increased surgical time for harvesting the graft.[10] And the harvested cancellous bone can resorb, jeopardizing space maintenance. Therefore in recent years, the tendency is to use substitutes of autogenous bone in sinus floor elevation.[11] Simunek et al.[12] and Handschel et al.[13] argued that deproteinized bovine bone is successfully used as a substitute of autogenous bone for sinus floor elevation.

Wallace et al.[14] reported a systematic review on specific surgical techniques, whether simultaneous or delayed placement of implant, the use of barrier membranes covering the lateral bony window, graft material types, and the surface characteristics, the length and width of the implants in sinus floor elevation. Although there were many studies that showed success or survival rates of implants with sinus floor elevation,[14,15] few studies on long-term changes in graft height after maxillary sinus floor elevation had been published.

The first aim of the present study was to evaluate the height changes of grafted sinus in a 5-year follow-up in patients treated with maxillary sinus floor elevation procedures using deproteinized bovine bone. The second aim was to consider factors that affect these changes such as measurement locations, simultaneous versus delayed implant placement, initial residual bone height, the surface characteristics of implants and connection types between fixtures and abutments.

II. MATERIALS AND METHODS

1. Subjects

Patients were included who had been treated with a maxillary sinus floor elevation procedure and implant placement in Seoul National University Dental Hospital from July 2004 to October 2007. Twenty six patients (12 woman, 14 men) with a mean age 60.1(SD=8.46, range 41-77) were included. A total of 79 implants were installed and all sinus grafting procedure was done using deproteinized bovine bone grafts (Bio-Oss® or OCS-B®). The research protocol was approved by the Institutional Research Board of the University Hospital (# CRI12040).

Inclusion criteria

Inclusion criteria for enrollment in this study were as follows:

- Patients who underwent maxillary sinus floor augmentation procedure with deproteinized bovine bone and implant installation due to loss of tooth on molar or premolar region
- Patients who had panoramic radiographs taken at specific terms: preoperatively, directly after, 1 year after, 2 year after, 3 year after and 5 year after maxillary sinus floor elevation
- Delayed loading after 6-7 month healing period after implant installation

Exclusion criteria

Exclusion criteria were as follows:

- Additional guided bone regeneration process or inlay, onlay graft procedure involved
- Full edentulism
- Systemic disease such as diabetes, rheumatoid arthritis or other endocrine problems
- History of paranasal sinus disease or previous sinus surgery

2. Clinical examinations

Reviewing surgical and prosthodontic procedures in charts, examined the following retrospectively.

- The amount of bone graft materials used in maxillary sinus floor elevation
- Types of implant system
- Success or failure of implant installed
- Whether simultaneous or delayed implant placement
- Healing period before loading

3. Radiographic examinations

In each patient panoramic radiographs taken before the procedure, directly after (T0), 1 year after (T1), 2 year after (T2), 3 year after (T3) and 5 year after (T4) maxillary sinus floor elevation were used for morphometric measurements. The quality of each panoramic radiograph was classified as 'Optimal for obtaining diagnosis information' or 'Adequate for diagnosis' by the clinical image quality grade classification.[15] Height measurements of residual maxillary bone of these radiographs were performed on image software program. To compensate the magnification rate, the measurement was calibrated with the actual length of the fixtures and secondarily the length of canine in case fixtures were not available. Measurements were performed at four locations (Fig. 1).

① The bone height at the distal side of the implant platform (L1)

② The bone height from the alveolar crest at the middle between implants (L2)

③ The bone height at the 3mm distal of the most distal implant (L3)

④ The lowest residual alveolar bone height before procedure (L0)

4. Statistical analysis

After measuring available bone height of augmented posterior maxilla, statistical analyses were performed to assess whether there were correlations of the amount of vertical reduction with locations, initial residual bone height, simultaneous versus delayed implant placement, internal or external connection modes and the surface characteristics of implant system.

① Repeated measures ANOVA was used to assess the differences in vertical bone height in time (T0, T1, T2, T3 and T4) at three locations respectively (L1, L2 and L3).

② Pearson correlation was used to assess relationship between initial bone heights (L0) and bone height changes with time (T0, T1, T2, T3 and T4).

③ One-way ANOVA was used to assess whether the cumulative bone height changes was effected by measurement locations (L1, L2 and L3).

④ T-test was used to assess whether the cumulative bone height changes was effected by simultaneous or delayed implant placement.

⑤ T-test was used to assess whether the cumulative bone height changes was effected by internal or external connection modes of implant.

⑥ One-way ANOVA was used to assess whether the cumulative bone height changes was effected by surface characteristics of implant system.

III. RESULTS

Maxillary sinus floor elevation and bone augmentation procedures were performed unilaterally in 21 patients and bilaterally in 5 patients that makes 31 cases in 26 patients. A total of 79 implants were installed and average 1.90 cc of deproteinized bovine bone grafts was used. Overall implant success rate was 100% without failure. A mean residual vertical bone height (L0) was 3.19mm (±1.25), right after maxillary sinus floor augmentation a mean bone height was 17.85mm (±2.46) (L1: 18.15mm (±2.58), L2: 18.01mm (±2.19), L3: 16.85mm (±2.31)), 5 years after augmentation a mean bone height was 15.65mm (±2.48) (L1: 15.88mm (±2.59), L2: 15.80mm (±2.21), L3: 14.83mm (±2.43)). That makes 2.20mm (12.3%) resorption in 5 years (table 1). There is a statistically significant reduction of vertical bone height in time at all locations ($P<0.001$).

Among four different time period(①T0~T1, ②T1~T2, ③T2~T3, ④T3~T4), more than half of resorption took place in the first time period (T0~T1, 1.25mm, 56.8%). After the first year a mean vertical resorption in each time period was 0.44mm, 0.21mm, 0.10mm respectively. The resorption rates of each time period were 0.10, 0.037, 0.018, 0.0047mm/1 month (Fig. 2).

There was no statistically significant difference in the cumulative resorption of vertical bone height among the three measurement locations (L1, L2 and L3) (Fig. 3, Table 2). Pearson Correlation between initial bone heights (L0) and graft height changes with time (T0, T1, T2, T3 and T4) were far from 1 or -1, therefore no significant correlation was found (Table 3).

Between simultaneous and delayed implant placement there was a statistically significant difference in the resorption of vertical bone height in the first year and no significant difference in the other time periods (Fig. 4, Table 4). Also no statistical difference in the cumulative resorption was found between internal/external abutment connection modes (Fig. 5, Table 5) or the surface characteristics of implant system (Fig. 6, Table 6).

IV. DISCUSSION

Many animal studies have shown that deproteinized bovine bone appears to be an excellent bone substitute for autograft and it has been successfully used in maxillary sinus floor augmentation. However, bone graft augmented in sinus cavity will resorb with time.[17] Hatano et al.[18] reported that after sinus augmentation with autogenous bone and xenograft mixture, a decrease in graft height appeared in the first 2–3 years and non-resorbable grafts are recommended to prevent this resorption.

In the present study a 5-year follow-up of the vertical dimensional changes in augmented sinus was assessed. A mean augmented bone height was 17.85mm, a mean reduced bone height in 5 years was 2.20mm (12.56%).

Schlegel et al.[19] argued that Bio-Oss® due to its non-resorbable property prevents early resorption and promotes regeneration of defect site. And early resorption of Bio-Oss® (14.6% in 90 days, 16.5% in 180 days) can be explained by contraction of surrounding connective tissues and remodeling process into vital bone. In the present study using Bio-Oss®, OCS-B® there was a greater reduction in the first period than any other three periods, which showed 1.25mm decrease of height (fig. 2). It is consistent with the findings of Reinert et al.[20] which showed an initial vertical bone resorption of 7% during the first year and only minimal bone resorption after the first year. Zijderveld et al.[21] also reported that an initial loss of vertical height, especially in the first 6 months, was followed by a period of little or no change. In this study histological or histomorphometric methods were not used and bone density or micrographs of remodeled bone were not observed. But with comparison with previous studies the vertical bone change rate can be considered to be within normal range.

Panoramic radiographs have previously been used to study the grafted sinus floor and its relationships with dental implants.[22-24] However, limitations exist to assess the changes of the maxillary sinus floor on two-dimensional radiographs due to poor visualization.[25] Some author recommended the use of computed tomography to identify the outline of the grafted sinus floor and to measure the height and volume of bone available for implant placement.[25-27] Magnetic resonance imaging can also be used to facilitate accurate evaluation of grafted sinus floor.[28] However, because of ethical, medicolegal and financial reasons we were not allowed to perform CT or MRI scans with a yearly frequency unless necessary. Moreover Ozyuvaci et al.[29] found no statistically significant differences in measuring vertical height between the radiographs and the tomographs. So in the present retrospective study, only panoramic radiography was used to evaluate the augmented maxillary sinus.

The initial bone height (L0) did not have a significant effect on the change in mean graft height over 5 years. A previous study[30] showed that the amount of native bone could be a determining factor to decide simultaneous or delayed implant installation because it would affect implant stability, but does not affect the amount of bone resorption. Geurs et al.[31] and Block et al.[32] also reported there was no significant correlation between residual bone height and the change of grafted bone height with time.

There was also no statistically significant difference in the cumulative resorption in time between measurement locations L1, L2 and L3. Zijderveld et al.[21] measured vertical bone heights at three locations which were the first bone to implant contact at the distal side of the implant, halfway between two implants and the site 5mm distal to the most posterior implant and concluded that there was also no statistically significant difference among all three locations.

In this study, a significantly more bone height reduction took place for the delayed implant installation group compared to simultaneous implant installation group in the first year. Re-entry procedure with delayed implantation might have caused more bone resorption by flap elevation.[33] However after the first year there was no statistically significant difference between groups. Ozuvaci et al. concluded that the both simultaneous and delayed implant installation are successful methods because there was no statistically significant difference in vertical bone changes and success rates between two groups.[29]

A recent study[34] has shown that peri-implant crestal bone level changes were significantly greater in the external connection than in the internal connection. On the contrary Astrand et al.[35] argued that no difference in marginal bone changes was observed in between external and internal connection system. In the present study no difference in grafted bone height reduction was found between external and internal connection.

The surface characteristics of implants such as surface energy and roughness dictate the biological response.[36,37] However no statistically significant difference in grafted bone height reduction among SLA, TiUnite, RBM surface groups was found.

The available bone height augmented by maxillary sinus floor elevation decreased most in the early time period. A mean total resorption in five years was 2.20mm and 56.8% of total resorption (1.25mm) occurred in the first year and resorption rates decreased with time. After early remodeling period grafted bone height is stably maintained and implant success rate was 100% in this study. Therefore maxillary sinus floor augmentation using deproteinized bovine bone can be considered as a predictable and reliable procedure.

V. CONCLUSIONS

Panoramic radiographs of patients who treated with maxillary sinus floor elevation using deproteinized bovine bone were analyzed. The initial bone height was 3.19mm and directly after maxillary sinus floor elevation a mean augmented bone height was 17.85mm, a mean reduced bone height in 5 years was 2.20mm which is interpreted as 12.3% decrease. Repeated measures ANOVA showed that there was a statistically significant reduction over time in vertical bone height at L1, L2 and L3 ($p<0.001$). There was a greater reduction in the first period (T0-T1) than in any other three periods, which showed 1.25mm decrease of height and reduction rate is decreasing with time. Delayed implantation group showed significantly more resorption in first year than simultaneous implantation group ($p<0.05$), but no significant difference was found afterwards. However, the factors such as locations, residual bone height, the surface characteristics of implants and the connection types between fixtures and abutments had no significant effect on these changes.

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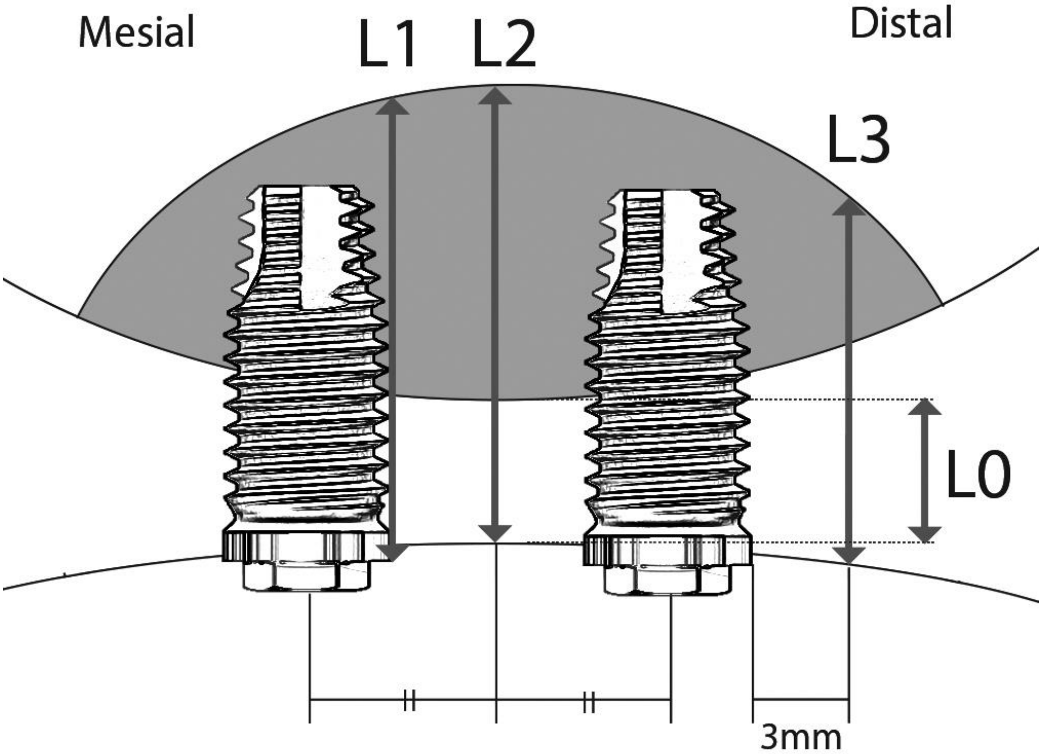

Fig. 1 Measures were performed at four locations. L1: the bone height at the distal side of implant platform. L2: the bone height from alveolar crest at the middle of each implant. L3: The bone height at the 3mm distal of the most distal implant. L0: the lowest residual alveolar bone height preoperatively.

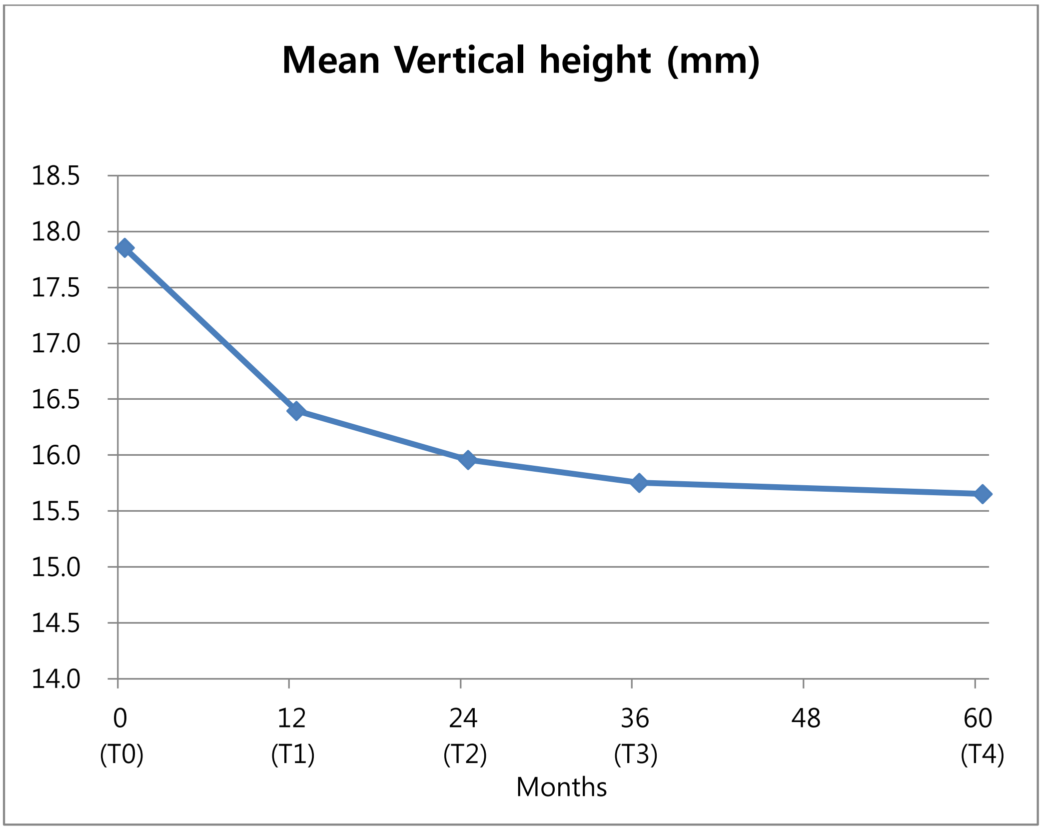

Fig. 2 Mean vertical height (native maxilla and graft) form T0~T4 (mm).

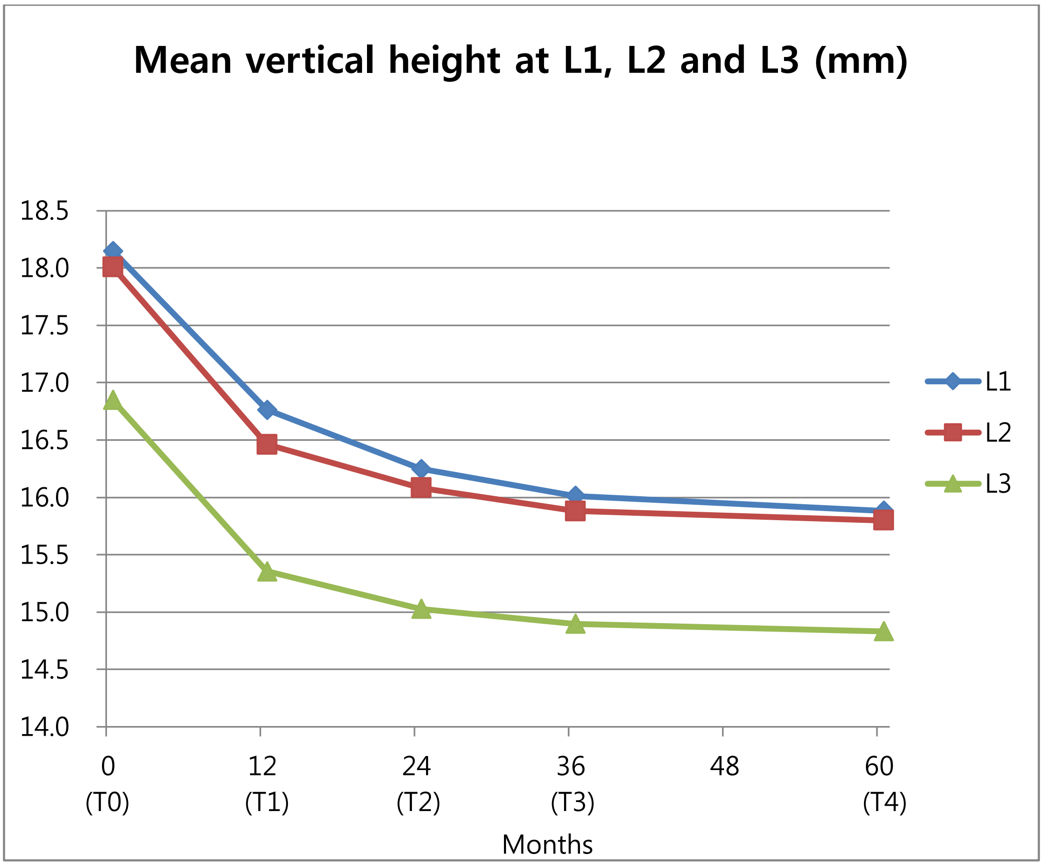

Fig. 3 Mean vertical height (native maxilla and graft) form T0~T4 at Location L1, L2 and L3 (mm).

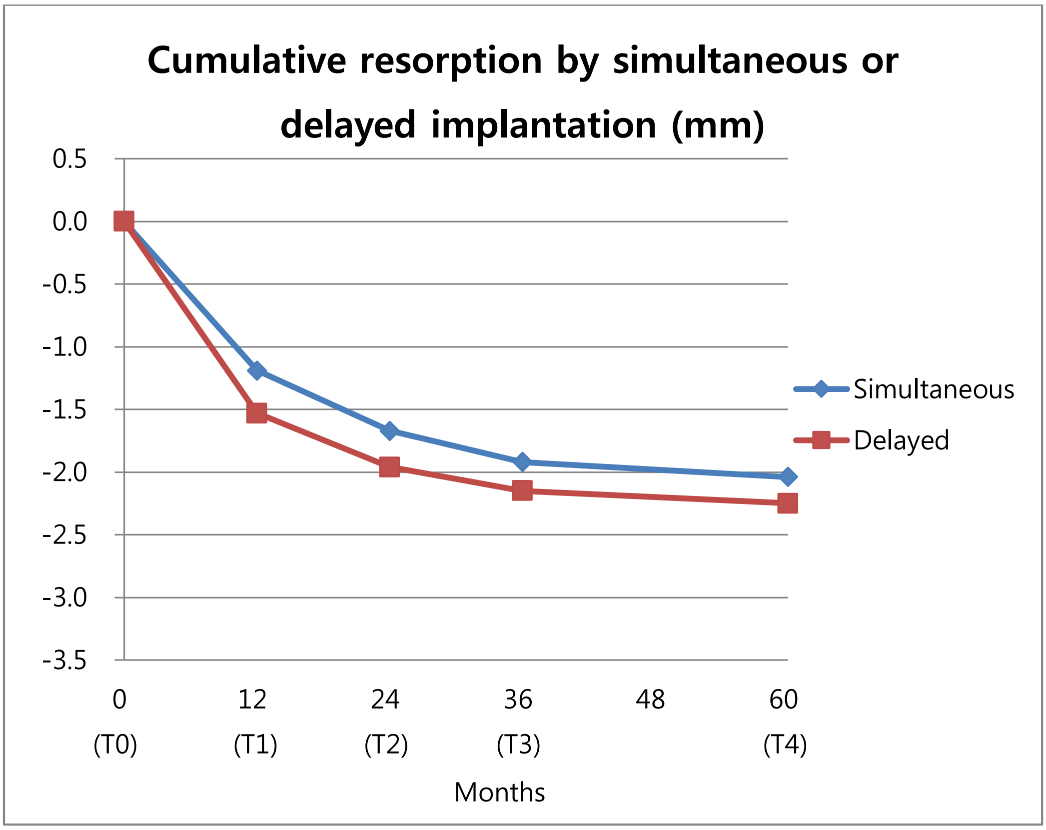

Fig. 4 Cumulative resorption by simultaneous or delayed implantation (mm).

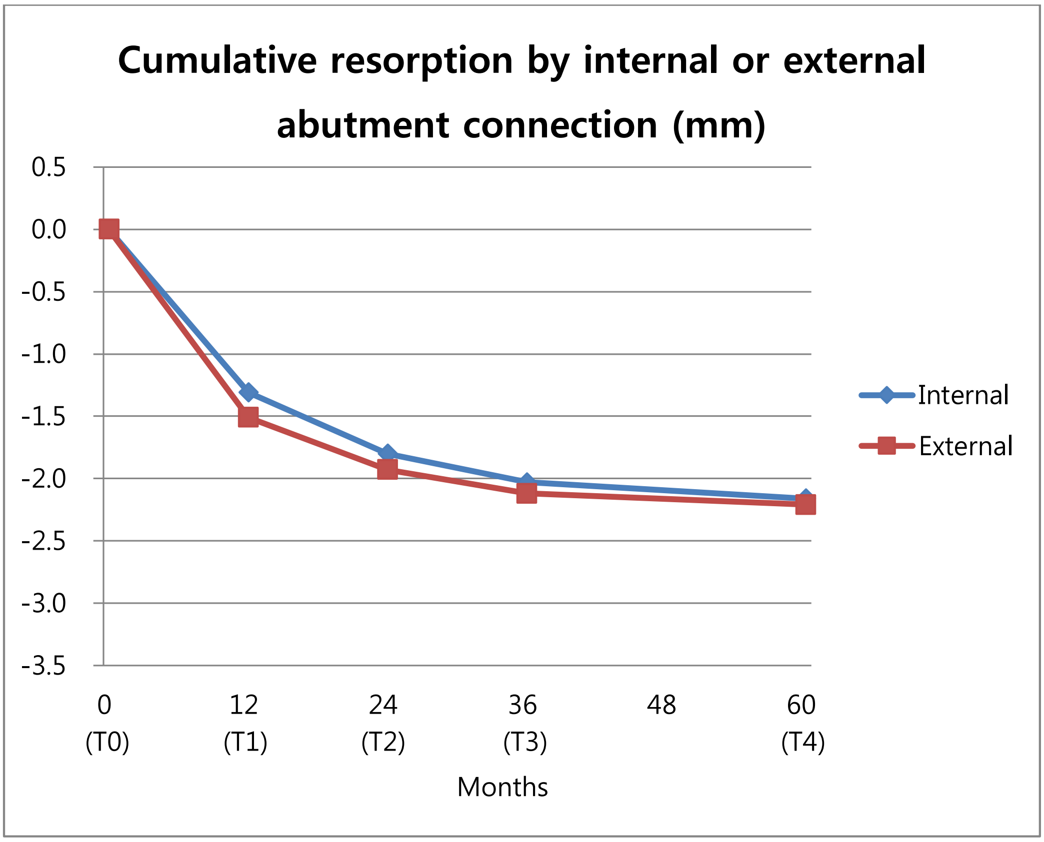

Fig. 5 Cumulative resorption by internal or external abutment connection (mm).

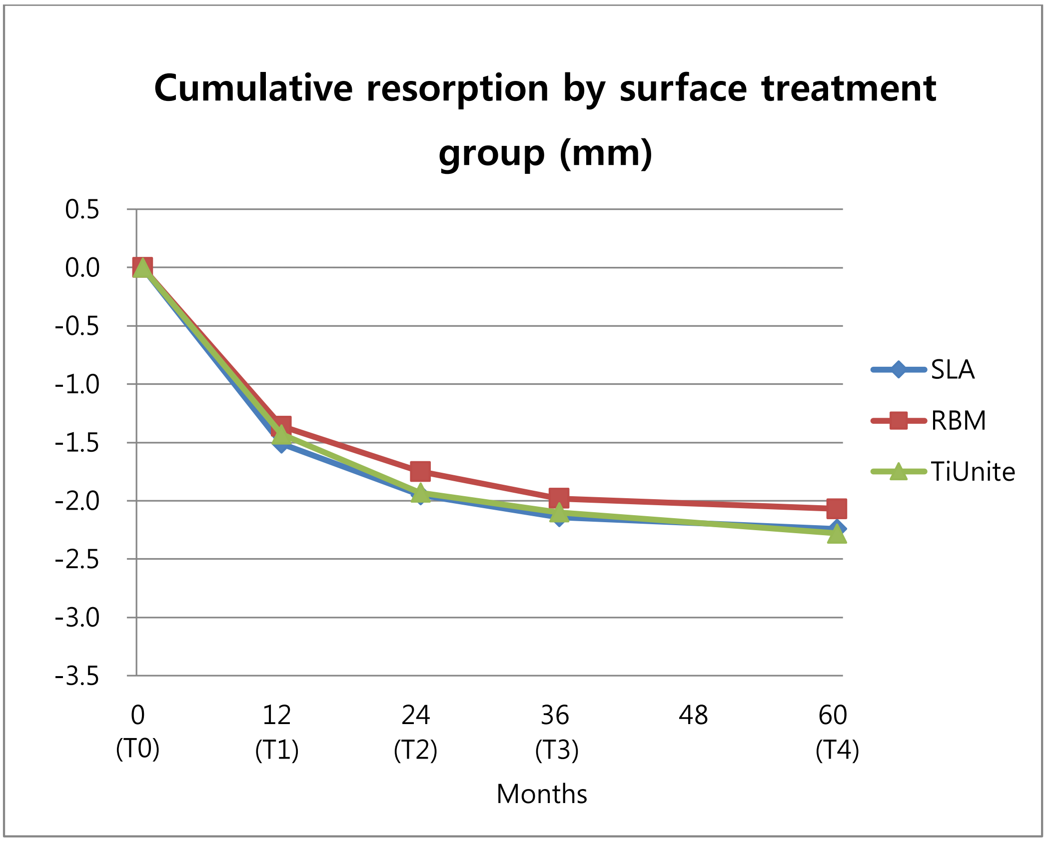

Fig. 6 Cumulative resorption by surface treatment group (mm).

Table 1. Mean vertical bone height (and SD) in mm at locations L1, L2 and L3 at T0, T1, T2, T3 and T4 moment

Moment	Bone height of L1 (n=79)	Bone height of L2 (n=48)	Bone height of L3 (n=31)	Mean Vertical bone height
T0	18.15 (±2.58)	18.01 (±2.19)	16.85 (±2.31)	17.85 (±2.46)
T1	16.76 (±2.52)	16.46 (±2.19)	15.36 (±2.42)	16.40 (±2.46)
T2	16.25 (±2.53)	16.08 (±2.21)	15.03 (±2.42)	15.96 (±2.46)
T3	16.01 (±2.55)	15.88 (±2.21)	14.90 (±2.43)	15.75 (±2.47)
T4	15.88 (±2.59)	15.80 (±2.21)	14.83 (±2.43)	15.65 (±2.48)

Table 2. Cumulative resorption (and SD) among measurement location L1, L2 and L3

Time Interval	Location	N	Cumulative resorption (±SD)	p-value
T0-T1	L1	79	1.39 (±0.66)	0.442
	L2	48	1.55 (±0.84)	
	L3	31	1.49 (±0.65)	
T0-T2	L1	79	1.90 (±0.91)	0.863
	L2	48	1.93 (±0.91)	
	L3	31	1.82 (±0.66)	
T0-T3	L1	79	2.14 (±0.97)	0.614
	L2	48	2.13 (±0.93)	
	L3	31	1.95 (±0.67)	
T0-T4	L1	79	2.27 (±1.03)	0.454
	L2	48	2.21 (±0.93)	
	L3	31	2.02 (±0.66)	

Table 3. Pearson correlation between L0 and bone height at each moment T0, T1, T2, T3 and T4

	T0	T1	T2	T3	T4
Pearson correlation between L0 and bone height at each moment	-0.054	-0.084	-0.091	-0.094	-0.094

Table 4. Cumulative resorption (and SD) between simultaneous installation and delayed installation of implants

Time Interval	Simultaneous or delayed installation	N	Cumulative resorption (±SD)	p-value
T0-T1	Simultaneous	38	1.19 (±0.47)	0.009 *
	Delayed	120	1.53 (±0.76)	
T0-T2	Simultaneous	38	1.67 (±0.62)	0.071
	Delayed	120	1.96 (±0.91)	
T0-T3	Simultaneous	38	1.92 (±0.69)	0.179
	Delayed	120	2.15 (±0.97)	
T0-T4	Simultaneous	38	2.04 (±0.68)	0.253
	Delayed	120	2.25 (±1.00)	

* a statistically significant value

Table 5. Cumulative resorption (and SD) between internal and external connection types of implants

Time Interval	Internal or external connection types	N	Cumulative resorption (±SD)	p-value
T0-T1	Internal	44	1.31 (±0.64)	0.118
	External	114	1.51 (±0.74)	
T0-T2	Internal	44	1.80 (±0.86)	0.397
	External	114	1.93 (±0.86)	
T0-T3	Internal	44	2.03 (±0.90)	0.576
	External	114	2.12 (±0.92)	
T0-T4	Internal	44	2.16 (±0.91)	0.750
	External	114	2.21 (±1.95)	

Table 6. Cumulative resorption (and SD) between surface characteristics of implants.

Time interval	Surface characteristics	N	Cumulative resorption (±SD)	p-value
T0-T1	SLA	88	1.51 (±0.86)	0.507
	TiUnite	44	1.36 (±0.41)	
	RBM	26	1.43 (±0.56)	
T0-T2	SLA	88	1.95 (±1.02)	0.445
	TiUnite	44	1.75 (±0.57)	
	RBM	26	1.93 (±0.65)	
T0-T3	SLA	88	2.14 (±1.06)	0.613
	TiUnite	44	1.98 (±0.70)	
	RBM	26	2.10 (±0.67)	
T0-T4	SLA	88	2.24 (±1.08)	0.552
	TiUnite	44	2.07 (±0.73)	
	RBM	26	2.28 (±0.70)	

국문초록

탈단백 우골을 이용한 측방 접근 상악동 거상술의 5년 방사선 추적 관찰

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전 진

1. 연구목적

상악 구치부의 골밀도는 하악 전치부의 골밀도의 5~10분의 1에 해당하는 빈약한 골질을 보이며, 피질골이 거의 없거나 얇고 대부분이 망상골로 구성되어 있다. 또한 치아가 상실된 후 잔존 치조제의 위축과 상악동 함기화(pneumatization)로 인하여, 임프란트 식립에 제한이 생기는 경우가 많다. 상악동 거상술은 이런 상악 구치부의 해부학적 한계를 극복하기 위해 우선으로 추천되는 시술이다. 상악동 거상술과 임프란트 생존률, 성공률의 상관관계에 관한 연구는 다수 있지만 상악동 내에 이식된 골대체제의 높이나 부피 변화에 대한 장기간의 연구는 많지 않다. 본 연구의 목적은 방사선학적 계측을 통하여 상악동 거상술 및 골 이식술 후 이식재의 높이 변화의 추이를 살펴보고, 그 변화에 영향을 주는 변수를 고찰하는 것이다.

2. 방법

2004년 7월부터 2007년 10월 사이에 서울대학교 치과병원에서 측방 접근법으로 상악동 골이식술 및 임프란트 식립을 한 26명의 환자를 대상으로 연구하였다. 상악동 골이식술을 시행한 환자의

수술직후(T0), 1년(T1), 2년(T2), 3년(T3), 5년(T4) 경과 시에 촬영된 파노라마 사진을 이용하였다.

네 개의 측정 지점을 이용하여 방사선 사진 분석을 시행하였다. 네 지점은 다음과 같다. 수복한 각각 임플란트 플랫폼 원심부에서의 상악동 높이(L1), 식립된 다수 임플란트의 중간 위치에서의 상악동 높이(L2), 최후방 임플란트의 3mm 원심에서의 상악동 높이(L3), 술전 남아있던 치조제 높이의 최저값(L0).

상악 구치부의 증가된 잔존 치조골의 높이를 측정하여, 시간 경과에 따른 변화량과 측정 위치, 임프란트 동시 혹은 지연 식립 여부, 임플란트 표면 특성, 지대주와의 연결 방식과의 연관성을 분석하였다.

3. 결과

술 전 상악골의 평균 높이는 3.19 ± 1.25mm이었고, 상악동 골이식술 직후 평균 높이는 증가량은 17.85 ± 2.46mm이었으며 골이식술 5년 후 높이 감소량의 평균은 2.20mm로 12.3%의 감소율을 보였다. 각 기간 및 모든 측정위치에서 통계학적으로 유의한 이식재 높이의 감소를 보였다($p<0.001$). 초기 1년 기간 동안의 감소량이 1.25mm으로 반 이상(56.8%)의 흡수가 이 기간에 나타났다. 임플란트 지연 식립시에 동시 식립 보다 잔존 치조제의 흡수가 첫 일년 기간에 유의하게 많았으나 ($p<0.05$) 장기적인 차이는 없었다. 술 전 잔존치조제의 높이와 이식재의 높이 감소는 통계적으로 유의한 상관관계가 없었으며, 임플란트 표면 특성, 지대주와의 연결 방식에 따른 이식재의 감소율도 유의한 차이는 없었다.

주요어: 상악동 골이식술, 이식재의 높이 변화, 잔존치조제

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