Long-Term Results of Vertical Height Augmentation Genioplasty using Autogenous Iliac Bone Graft

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Finally, I dedicate this thesis to my family: my parents, my wife Dr. Seon-A Lim, and my children, Chan-Ho and Jae-Ho..

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ABSTRACT

Long-Term Results of Vertical Height Augmentation Genioplasty using Autogenous Iliac Bone Graft

Objective. In order to clarify the clinical utility of the vertical height augmentation (VHA) genioplasty using autogenous iliac bone graft (IBG), this study examined the postsurgical changes in hard and soft tissues of the chin and the stability of the grafted bone.

Study design. Twenty-three patients who had undergone VHA genioplasty using autogenous IBG were evaluated radiographically and clinically. A comparison study of the changes in hard to soft tissues after surgery in all 23 patients was performed with preoperative, 1-month, 3-months, 6-months, and/or 1-year postoperative lateral cephalograms by tracing. Stability, bone healing, and complication of the grafted bone was evaluated by follow-up roentgenograms and clinical observation.

Results. Between the preoperative and 6-month postoperative tracings, an average vertical augmentation of the osseous segment was 4.2 mm at menton and that of the soft tissue menton was 4.0 mm. There was a high predictability of 1: 0.94 between the amounts of hard versus soft tissue changes with surgery in the vertical plane. The position

of the genial bone segment was stable immediately after surgery and soft tissue was not changed significantly from 1 month to 1 year after operation. Clinical and radiological follow-up results of the iliac bone graft showed normal bony union and were generally stable.

Conclusions. VHA genioplasty using IBG is a reliable method for predicting hard and soft tissue changes and for maintaining postoperative soft tissue of the chin after surgery.

Key Words: vertical height augmentation genioplasty, iliac bone graft, postsurgical change, hard and soft tissue.

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INTRODUCTION

Maxillofacial deformities are commonly associated with the chin area. When it is appropriate in size, shape, and position, the chin can enhance the normal harmony and symmetry of the face. Thus surgical procedures in the chin area are often required to improve overall harmony of the face.[1-5] Vertical deficiency of the chin is the one of such deformities and clinically manifests decreased anterior lower facial height, deep labiomental fold, and low mandibular plane angle.[6-9]

For correction of this type of chin deformity, Converse and Wood-Smith[6] first described insertion of a corticocancellous block bone into a symphyseal osteotomy site to vertically augment the chin in 1964. Afterwards, several authors have reported vertical height augmentation (VHA) genioplasty using autogenous bone or alloplastic material graft.[7-11]

However, when a surgeon considers the ideal strategy for vertical height augmentation of the chin, one should have confidence not only in surgical technique, but also in postoperative stability of the grafted material and soft tissue changes relating to bone position. But to the best of our knowledge, quantitative and qualified investigations for predicting osseous and soft tissue changes after VHA genioplasty have been lacking in comparison to those for advancement or vertical reduction genioplasties. Moreover, controversies still exist about graft materials.[5,10-14]

The authors have treated vertical chin deficiencies with horizontal osteotomy of the chin and interpositional autogenous iliac bone graft (IBG) for several years (**Fig. 1 and 2**). And this method has given satisfactory results to surgeons as well as to the patients. The goal of this study was to examine the postsurgical changes in the hard and soft tissues of the chin as well as the stability of the grafted iliac bone after VHA genioplasty.

Figure 1. This patient underwent orthognathic surgery accompanied maxillary impaction, mandibular setback with bilateral vertical ramus osteotomy, and vertical height augmentation genioplasty with horizontal advancement. A and B, Preoperative clinical features. C and D, 1 year postoperative features.

A

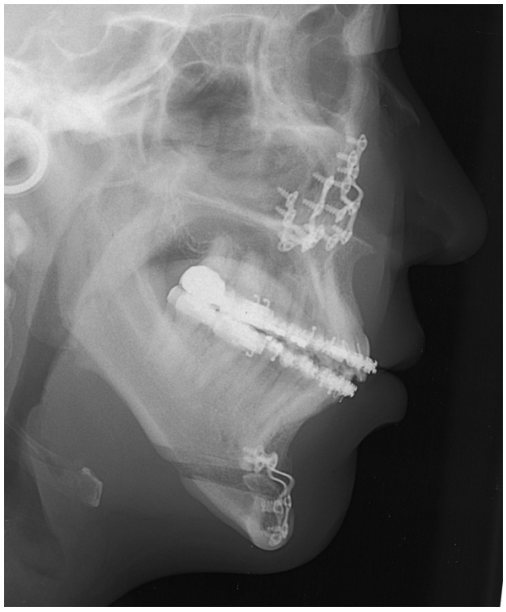
B

C

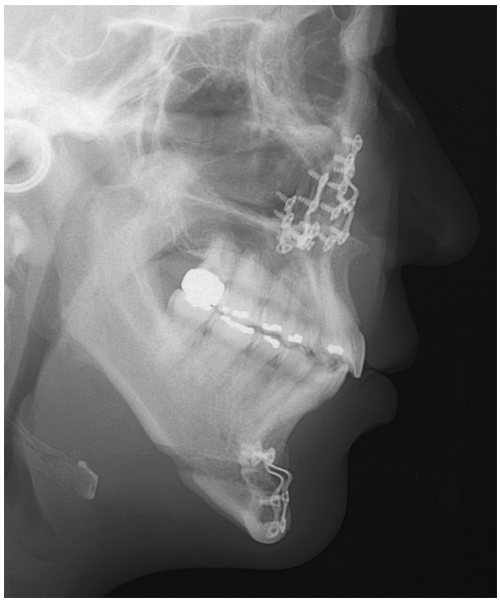
D

Figure 2. Serial lateral cephalographs of the same patient as Figure 1. A, Preoperative radiograph revealed that the patient had an open bite, vertical and horizontal deficiency of the chin. This case was planned as 8 mm vertical augmentation and 6 mm horizontal advancement genioplasty. B, 3 months postoperative cephalograph showed normal bone healing process in the grafted area. C, In 6 months postoperative radiograph appropriate bone union was made. After taking this radiograph, the patient underwent removal of plates and screws. D, 1 year after surgery, genial segment and soft tissue were well stabilized.

A



B



C

D

Patients and Methods

Subjects and Material

The sample of subjects selected for this study included twenty three patients who underwent VHA genioplasty by means of horizontal sliding osteotomy of the symphysis with interpositional autogenous IBG at the Department of Oral and Maxillofacial Surgery, Dental College Hospital, Yonsei University, Seoul, Korea, for the period 1994 to 2004. All of these patients, 8 male and 15 female, were of Korean national descent. Their ages ranged from 18 to 30 years old, and the mean age was 24.4 years old at the time of surgery. Other surgeries associated VHA genioplasty were seen in **Table I.** Fourteen patients were combined by two-jaw surgery (60.1%), and two patients were combined by angle reduction (8.7%). In 4 of the all the cases, genial advancement was accompanied with VHA genioplasty simultaneously.

Table I. Other surgery combined with VHA genioplasty

Name of operation	Number of patients
Maxillary impaction and mandibular setback	8 (2)
Maxillary impaction and mandibular advance	6 (1)
mandibular setback	3
mandibular advance	4 (1)
Angle reduction	2
Total	23 (4)

( ) : cases that accompanied with advancement genioplasty

Lateral cephalograms of hard and soft tissues were taken preoperatively, immediately and 1 month, 3 months, 6 months, and/or a minimum of 1 year postoperatively. A comparison study of hard to soft tissue changes after VHA genioplasty in all 23 patients was performed with preoperative, 1-month, 3-months, 6-months, and/or 1-year postoperative films. For changes in hard versus soft tissues, preoperative and 6-month postoperative films were used. 6-month postoperative films, rather than that of other postoperative films, were used because soft tissue changes of the face after surgery is stabilized during this period. For all the 23 patients, 6-months postoperative radiographs were available. 19 patients were followed up for more than 1 year. All of the patients were required to undergo the removal of osteosynthetic plates and screws 6 to 8 months after VHA genioplasty.

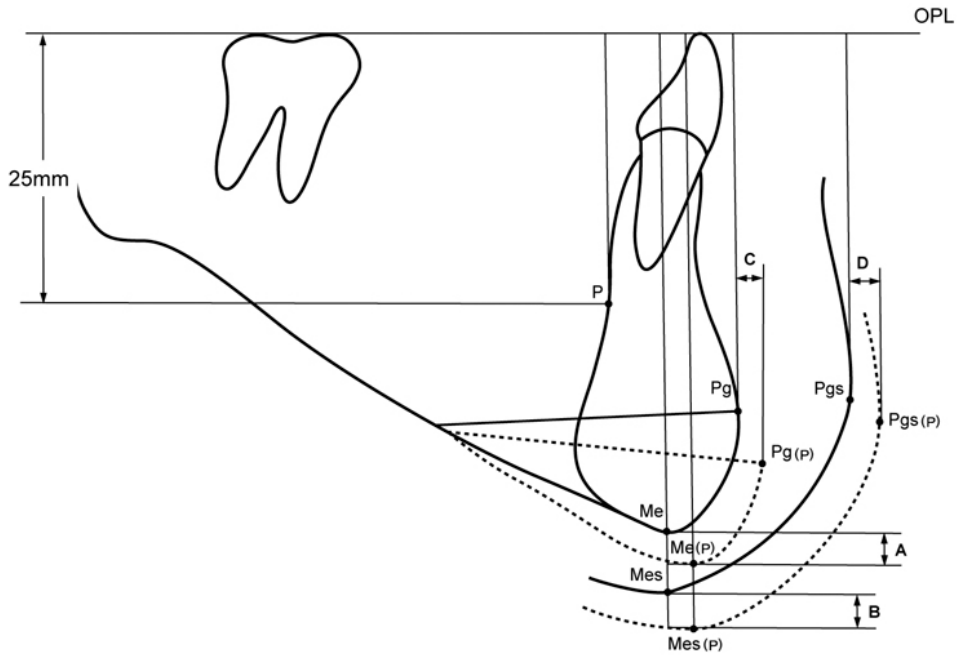
About the stability of the grafted iliac bone, vertical resorption was recognized by comparing hard tissue changes included in the above method. Bone healing and integration to osteotomized segment were observed in lateral cephalograms and panoramic roentgenograms. Complications arisen at recipient as well as donor site were investigated with medical records.

Analytic Method

To evaluate the postsurgical changes in the hard and soft tissues of the chin after VHA genioplasty, the analytic method of this study was quoted from a method established by Park et al in 1989.[3] Dr. Park is one of the authors of this article. Reference landmarks and planes used for this study were illustrated in **Fig. 3** as follows:

Figure 3. Reference landmarks and planes used for this study are illustrated. *Solid line* is preoperative tracing; *broken line* is postoperative tracing. A and B, the amounts of

vertical hard and soft tissue changes respectively. C and D, the amounts of horizontal hard and soft tissue changes respectively.



1. OPL (occlusal plane); a horizontal plane tangent to the uppermost convex area of the most posterior tooth and of the tip of the most anterior tooth of the mandible

2. Me (hard tissue menton); the most inferior point of the symphysis of the mandible

3. Mes (soft tissue menton); the point on the skin of mental area across Me on a perpendicular line drawn from OPL

4. Pg (hard tissue pogonion); the most anterior point on the symphysis of the mandible tangent to a perpendicular line drawn from OPL

5. Pgs (soft tissue pogonion); the most anterior point of the soft tissue chin tangent to a perpendicular line drawn from OPL

6. P (posterior reference point); a point where a perpendicular line to OPL crosses the posterior aspect of the lingual cortex of the symphysis 25 mm below the OPL

The measurements analyzed were as follows (**Fig. 3**)

1. VHM (vertical position of the hard tissue menton); the perpendicular distance from OPL to MePL

2. VSM (vertical position of the soft tissue menton); the perpendicular distance from OPL to Mes

3. VTS (vertical thickness of the soft tissue chin); the distance from Me to Mes on the perpendicular line from OPL

4. HHP (horizontal position of the hard tissue pogonion); the distance from the point P to Pg parallel to OPL

5. HSP (horizontal position of the soft tissue pogonion); the distance from the point P to Pgs parallel to OPL

6. HTS (horizontal thickness of the soft tissue chin); the distance from Pg to Pgs parallel to OPL

Reference lines and points on each of the lateral cehalometric films were traced on 0.07 mm acetate sheets with a 0.3 mm lead pencil by one investigator. And all measurements were performed by the same individual with a caliper that was accurate to +0.1 mm. To ensure the precision of tracing and measurements, vertical position of the hard tissue menton (OPL to MePL) and horizontal position of the hard tissue pogonion (P to Pg) in all preoperative samples were traced and measured four times. The paired *t* test was undertaken to evaluate the difference in the measurements.

The measures of vertical and horizontal chin position were subjected to the repeated one-way ANOVA test in all postsurgical intervals. Pearson's correlation

coefficients were additionally calculated for vertical and horizontal hard and soft tissue measurements to determine whether they were significantly related. The statistical program used for this study was SAS package for Windows version 8.1 (SAS Institute, Inc. USA).

Results

Analysis of measurement values by tracing

The analysis of measuring accuracy showed no significant results and there was no statistically significant difference in the repeated measures ($P > 0.05$).

To evaluate the vertical changes of genial osseous segment by surgery, the immediate postoperative tracing was compared with the preoperative tracing. The amount of vertical augmentation of the osseous segment ranged from 3.0 to 8.0 mm with an average 4.52 mm (**Table 2**).

Between the preoperative and 6-month postoperative tracings, an average vertical augmentation of the osseous segment was 4.20 mm at menton and that of the soft tissue menton was 4.02 mm (**Table 2**). The ratio of vertical hard/soft tissue change was 1:0.96 with preoperative and 6-month postpoperative tracings. The correlation coefficient between these variables was 0.743 ($P < 0.0001$), which explained they had statistically high relationship (**Table 3 and Fig. 4**). The average change of vertical thickness of the soft tissue chin was measured -0.17 mm from preoperative to 6-month postoperative. The average change of vertical thickness of the soft tissue was not statistically different (**Table 2**).

About horizontal movement of genial segment, intended horizontal advancements were 4 cases (range 4-6 mm) but in measuring the other 19 cases for this study, horizontal advancements ranged from 0 to 2 mm. An average horizontal movement of the osseous segment was 1.74 mm at pogonion between the preoperative and immediate postoperative. Between the preoperative and postoperative 6-month, average

horizontal movements of the hard and soft tissue were 1.52 and 1.39 respectively. And the horizontal thickness of the soft tissue chin was changed -0.13 mm on average. The average change of horizontal thickness of the soft tissues was not statistically different (**Table 2**). The ratio of changes in horizontal hard tissues to soft tissues was 1:0.91 with preoperative and 6-month postpoperative tracings. The correlation coefficient between these variables was 0.960 (**Table 3 and Fig. 5**).

Table II. The amount of positional change of hard and soft tissues by VHA genioplasty.

	Preoperative to immediate (n=23)	Immediate to 1M (n=23)	1M to 3M (n=23)	3M to 6M (n=23)	6M to 1Y (n=19)	Preoperative to 6M (n=23)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
VHM	4.52 (1.45)***	-0.15 (0.28)	-0.11 (0.21)	-0.07 (0.23)	0.03 (0.26)	4.20 (1.28)***
VSM	5.63 (1.70)***	-1.46 (1.07)***	-0.13 (0.41)	-0.02 (0.28)	0.05 (0.33)	4.02 (1.23)***
VTS	1.11 (1.47)	-1.30 (1.06)***	-0.02 (0.46)	0.04 (0.30)	-1.43 (3.32)	-0.17 (0.90)
HHP	1.74 (1.84)***	-0.15 (0.28)	-0.09 (0.25)	0.02 (0.24)	0.00 (0.24)	1.52 (1.77)***
HSP	3.02 (1.70)***	-1.28 (0.64)***	-0.26 (0.30)***	-0.09 (0.25)	0.00 (0.29)	1.39 (1.46)***
HTS	1.28 (0.72)***	-1.13 (0.69)***	-0.17 (0.39)	-0.11 (0.37)	-2.00 (4.56)	-0.13 (0.55)

VHM (vertical position of the hard tissue menton); VSM (vertical position of the soft tissue menton); VTS (vertical thickness of the soft tissue chin); HHP (horizontal position of the hard tissue pogonion); HSP (horizontal position of the soft tissue pogonion); HTS (horizontal thickness of the soft tissue chin)

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$, repeated one-way ANOVA test.

Table III. Statistical results of hard and soft tissue changes at 6 month after VHA genioplasty.

Group (n=23)	Mean difference	SD	t-statistic	Significance	Correlation
VHM vs VSM	-0.17	1.25	-0.47	0.6403	0.743 ($P < 0.001$)
HHP vs HSP	-0.13	1.63	-0.27	0.7868	0.961 ($P < 0.001$)

VHM (vertical position of the hard tissue menton); VSM (vertical position of the soft tissue menton); HHP (horizontal position of the hard tissue pogonion); HSP (horizontal position of the soft tissue pogonion)

In 4 intervals from immediately to 1-year postoperatively, the hard and soft tissue changes were shown in **Table 2**. From immediately to 1-month postoperatively, soft tissue variables (VSM, VTS, HSP, and HTS) showed statistically significant changes. Except the above variables and HSP from 1-month to 3-month postoperatively, other variables for vertical and horizontal hard and soft tissue changes as well as for the thickness of soft tissues were not significantly different in other measurement sections.

Figure 4. Scattergram shows the relationship between the vertical change in hard and soft tissue menton with preoperative and 6-month postoperative tracings.

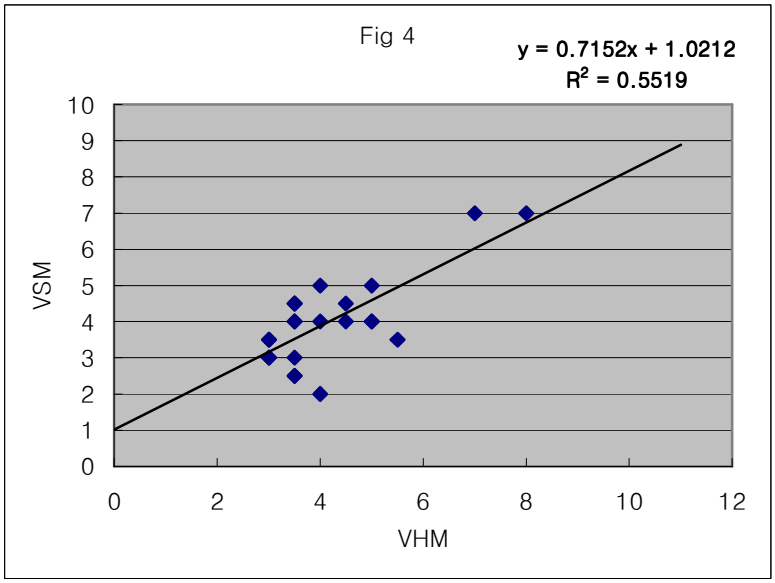
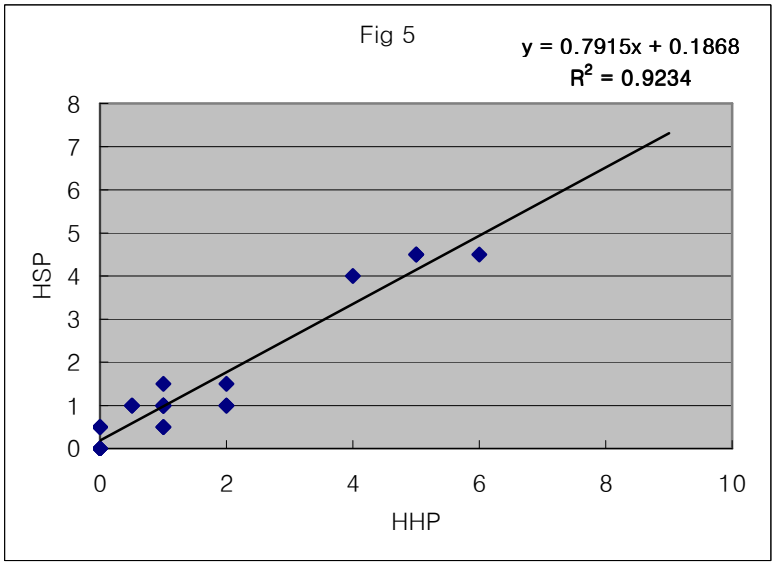


Figure 5. Scattergram shows the relationship between the horizontal change in hard and soft tissue pogonion with preoperative and 6-month postoperative tracings.



Stability of the grafted iliac bone

There were no notable complications such as infection or wound dehiscence of chin area with regard to bone graft. In the 3 cases, remarkable postoperative swelling and hematoma in submental area was developed but disappeared spontaneously within 14 days without any other treatment. In donor site, there were also no complications such as permanent gait disturbance or infection.

In lateral cephalograms and panoramic roentgenograms, it was observed that bone healing and integration to upper and lower chin bone was completed until 6 months after surgery in all cases. And as seen in the above results about measurement analysis, the amount of hard tissue changes were well maintained until postoperative 1 year period after removal of osteosynthetic plates and screws. This showed indirectly that there was no remarkable vertical resorption of the grafted iliac bone.

Discussion

Reviewing previous three literatures, the ratio of vertical change of hard/soft tissue ranged from 1:0.89 to 1:1.[7,10,15] Of these literatures, only one report by Rosen[10] had quantitative data, which analyzed 8 cases of VHA genioplasty for mean follow-up of 11.1 months and the ratio was 1:0.89. But Rosen's study concerned the interpositional bone placement of porous, block hydroxyapatite (Interpore 200). The others were one occasional report by Wessberg et al[7] and one text by Wolford and Fields[15]. Wessberg et al[7] reported one case VHA genioplasty using autogenous iliac bone graft during 6 months after surgery, and they described that a 75% horizontal and a 100% vertical movement of soft tissue reposition could be expected with the osseous repositioning.

In this study of 23 cases, the ratio of vertical and horizontal change of hard/soft tissue was at postoperative 6 months 1:0.96 and 1:0.91 with relatively high correlations, respectively. Many studies have reported ratios of horizontal change of hard/soft tissues after advancement of genioplasty ranging from 1:0.85 to 1:1[3,16-19], which were similar to the ratio reported in this study. In addition, vertical thickness of the soft tissue at menton area and horizontal thickness of the soft tissue at pogonion were well maintained once the genial segments moved downward and forward. The reason that soft tissue variables showed statistically significant changes from immediately to 1-month postoperatively was thought of as due to postsurgical soft tissue edema.

It is known that vertical deficiency of genial area is often manifested with mandibular retrognathism. However, in this study mandibular setback accompanied with VHA genioplasty had relatively high frequency compared to mandibular advancement (11 cases versus 10 cases). This may be due to the fact that most orthognathic surgeries in

Korea are mandibular setbacks for mandibular prognathism.[20]

It has been reported that interpositional graft for VHA genioplasty was performed with alloplastic material or autogenous bone.[7,10,14] The advantages of the use of alloplastic material are simplicity, the elimination of donor site morbidity, and the absence of resorption in the graft material. The disadvantages of alloplastic material include brittle nature, higher infection rates, rejection, and the occasional bone resorption under the material.[5,10-13] Autogenous bone graft is advantageous as it does not cause foreign body reaction, has less chance of infection, and carries a high predictability of soft tissue response in spite of the possibility of donor site morbidity. Thus autogenous bone graft is more popular than allogenic graft.[5,11,21,22] This was the reason that the authors used autogenous bone from iliac crest for VHA genioplasty, and the results were very successful. It has been reported that corticocancellous bone graft from the iliac crest used to repair the maxillofacial complex had problems of resorption.[22,23] But in this study, the hard and soft tissues of the operation area were very stable even 6 months after the removal of plates and screws. This indicates that there were no significant vertical resorptions of the grafted corticocancellous bone block.

CONCLUSIONS

In this study, the ratio of vertical hard/soft tissue change was 1:0.96 with preoperative and 6-month postpoperative tracings. The correlation coefficient between these variables was 0.743 ($P < 0.0001$), which explained they had statistically high. The average change of vertical thickness of the soft tissue was not statistically different.

The ratio of changes in horizontal hard tissues to soft tissues was 1:0.91 with preoperative and 6-month postpoperative tracings. The correlation coefficient between these variables was 0.960. The average change of horizontal thickness of the soft tissues was not statistically different.

There were no notable complications of chin area with regard to bone graft and donor site. Bone healing and integration to upper and lower chin bone was completed until 6 months after surgery in all cases. And the amounts of hard tissue changes were well maintained until postoperative 1 year period after removal of osteosynthetic plates and screws.

These results imply that VHA genioplasty appears to be a reliable method for predicting hard and soft tissue changes and for maintaining postoperative soft tissue of the chin after surgery. Interpositional IBG for this surgery is very stable without any complications.

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ABSTRACT in Korean

장골 이식을 이용한
수직 증강 이부 성형술 후의 장기간 결과

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김 기 정

<지도교수 이 의 웅>

연구목적: 본 연구는 장골이식을 이용한 수직 증강 이부성형술의 장기간의 결과를 확인하기 위하여 이부에 이식된 골편의 안정성과 더불어 경조직과 연조직의 수술 후 변화를 조사하였다.

연구방법: 본 연구는 장골이식을 이용한 수직 증강 이부성형술을 시행받은 23명의 환자에 대해 임상적 방사선학적 검사를 시행하였다. 수술 후 경조직과 연조직의 변화를 비교하기 위하여 수술전과 수술후 1개월, 수술 후 3개월, 수술 후 6개월, 그리고 수술 후 1년의 방사선사진을 채득하여 두부계측분석을 실시하였다. 안정성과 골편의 치유, 이식된 골편에 의한 부작용은 방사선사진과 임상적 검사를 통하여 평가되었다.

연구결과: 수술전과 수술 후 6개월의 계측분석을 비교한 결과 menton 부위에서 경조직의 수직적 증가량은 평균 4.2 mm 이었으며 같은 부위의

연조직의 증가량은 4.0 mm 이었다. 경조직과 연조직의 수직적 상관관계는 1: 0.94 의 높은 예측가능성을 보였다. 이부의 골편은 수술 후 안정성을 보였으며 수술 후 1개월에서 1년까지 연조직은 유의한 변화를 보이지 않았다. 임상적 방사선학적 검사에서 이식된 장골 골편은 정상적인 골성결합을 보였으며 일반적으로 안정된 결과를 나타냈다.

결론: 장골이식을 이용한 수직 증강 이부성형술은 경조직과 연조직의 변화가 예측 가능한 안정적인 술식이며 수술 후 이부의 연조직의 모양을 유지할 수 있는 방법이다.

핵심되는 말: 수직 증강 이부성형술, 장골이식, 수술후 변화, 경조직, 연조직