Taiwanese Journal of Orthodontics

Volume 33 | Issue 4 Article 2

2021

# Comparing Outcomes and Stability after Single- and Two-piece LeFort I Osteotomies in Patients with Cleft Lip and Palate

Chanin Jittithaworn
*Graduate Institute of Dental and Craniofacial Science, Chang Gung University, Taoyuan, Taiwan*

Chun-Shin Chang
*Department of Plastic and Reconstructive Surgery, Chang Gung Memorial Hospital, Taoyuan, Taiwan*

Chiung Shing Huang
*Graduate Institute of Craniofacial and Oral Science, Chang Gung University, Taoyuan, Taiwan*

Cheng-Hui Lin
*Department of Plastic and Reconstructive Surgery, Chang Gung Memorial Hospital, Taoyuan, Taiwan*

Ellen Wen-Ching Ko
*Chang Gung Memorial Hospital, Taipei, Taiwan*



## Recommended Citation

Jittithaworn, Chanin; Chang, Chun-Shin; Huang, Chiung Shing; Lin, Cheng-Hui; and Ko, Ellen Wen-Ching (2021) "Comparing Outcomes and Stability after Single- and Two-piece LeFort I Osteotomies in Patients with Cleft Lip and Palate," *Taiwanese Journal of Orthodontics*: Vol. 33 : Iss. 4 , Article 2.
DOI: 10.38209/2708-2636.1115
Available at: https://www.tjo.org.tw/tjo/vol33/iss4/2

# Comparing Outcomes and Stability after Single- and Two-piece LeFort I Osteotomies in Patients with Cleft Lip and Palate


## Abstract

**Purpose:** LeFort I osteotomy is used to correct and improve the maxillary hypoplasia in secondary cleft deformities. However, surgical complex and challenge would be the risk factor of postsurgical instability. This study compared surgical and postsurgical changes in maxillary and mandibular movements and stability in patients with cleft lip and palate (CLP) who underwent single- or two-piece LeFort I osteotomies.

**Materials and Methods:** Forty-five patients with CLP were included, of whom 30 and 15 received single- and two-piece LeFort I osteotomies, respectively. Cone-beam computed tomography was administered at three time points (T0: presurgery; T1: <1-month postsurgery; and T2: ≥1-year postsurgery) to evaluate surgical (T1–T0) and postsurgical (T2–T1) changes in maxillary and mandibular movement and stability. The overall movement, arch width, and relapse rate were measured and compared between the groups. Potential factors influencing skeletal stability were surgical change, segmental maxilla, cleft types, age, sex, and prior alveolar bone graft placement were analyzed.

**Results:** There revealed a significant difference in maxillary relapse between the 2 groups in the sagittal plane. The two-piece group had a higher relapse rate than did the single-piece group across all planes. No significant difference between maxillary expansion and constriction was observed in the two-piece group. In maxilla, surgical change influenced all dimensions of surgical relapse, and surgical approach, which involved single- and two-piece procedures, influenced only the sagittal plane ($P < 0.05$). In mandible, only surgical change influenced mandibular relapse in the three planes; other factors did not reveal any significant correlation.

**Conclusion:** The outcome indicated that the two-piece group had more maxillary sagittal relapse after surgery. Surgical change was the main factor influencing maxillary and mandibular stability. Sagittal overcorrection might be required for patients with two-piece LeFort I advancement in patients with cleft.



## Keywords

Cleft lip and palate; Maxillary osteotomy; LeFort I osteotomy; Relapse; Stability





## Cover Page Footnote

ACKNOWLEDGMENTS We thank Ms. Emily Yu-Ting Lin for providing technical support in the 3D data management process. Conflict of Interest Statement The authors claim that there are no competing interests. FUNDING None. ETHICAL APPROVAL This study was approved by the Institutional Review Board of Chang Gung Memorial Hospital (No. 202001881B0). PATIENT CONSENT Not required. STATEMENT BY AUTHORS All authors have viewed and agreed to the submission.

ORIGINAL ARTICLE

# Comparing Outcomes and Stability after Single- and Two-piece LeFort I Osteotomies in Patients with Cleft Lip and Palate

Chanin Jittithaworn [a], Chun-Shin Chang [b,d], Chiung Shing Huang [a,c,d], Cheng-Hui Lin [b,d], Ellen Wen-Ching Ko [a,c,d,*]

[a] Graduate Institute of Craniofacial and Oral Science, Chang Gung University, Taoyuan, Taiwan
[b] Department of Plastic and Reconstructive Surgery, Chang Gung Memorial Hospital, Taoyuan, Taiwan
[c] Department of Craniofacial Orthodontics, Chang Gung Memorial Hospital, Taipei, Taiwan
[d] Craniofacial Research Center, Chang Gung Memorial Hospital, Linkuo, Taiwan

## ABSTRACT

*Purpose*: **LeFort I osteotomy is used to correct and improve the maxillary hypoplasia in secondary cleft deformities. However, surgical complex and challenge would be the risk factor of postsurgical instability. This study compared surgical and postsurgical changes in maxillary and mandibular movements and stability in patients with cleft lip and palate (CLP) who underwent single- or two-piece LeFort I osteotomies.**

*Materials and methods*: **Forty-five patients with CLP were included, of whom 30 and 15 received single- and two-piece LeFort I osteotomies, respectively. Cone-beam computed tomography was administered at three time points (T0: pre-surgery; T1: <1-month postsurgery; and T2: ≥1-year postsurgery) to evaluate surgical (T1−T0) and postsurgical (T2−T1) changes in maxillary and mandibular movement and stability. The overall movement, arch width, and relapse rate were measured and compared between the groups. Potential factors influencing skeletal stability were surgical change, segmental maxilla, cleft types, age, sex, and prior alveolar bone graft placement were analyzed.**

*Results*: **There revealed a significant difference in maxillary relapse between the 2 groups in the sagittal plane. The two-piece group had a higher relapse rate than did the single-piece group across all planes. No significant difference between maxillary expansion and constriction was observed in the two-piece group. In maxilla, surgical change influenced all dimensions of surgical relapse, and surgical approach, which involved single- and two-piece procedures, influenced only the sagittal plane ($P < 0.05$). In mandible, only surgical change influenced mandibular relapse in the three planes; other factors did not reveal any significant correlation.**

*Conclusion*: **The outcome indicated that the two-piece group had more maxillary sagittal relapse after surgery. Surgical change was the main factor influencing maxillary and mandibular stability. Sagittal overcorrection might be required for patients with two-piece LeFort I advancement in patients with cleft.** *Taiwanese Journal of Orthodontics 2021;33(4):156−165*

*Keywords:* Cleft lip and palate; Maxillary osteotomy; LeFort I osteotomy; Relapse; Stability

## INTRODUCTION

The LeFort I osteotomy is used to correct maxillary deformities in patients with cleft lip and palate (CLP) to improve dental occlusion, facial appearance, and self-esteem.[1] In patients with CLP, maxillary hypoplasia can cause midface hypoplasia, an asymmetric facial structure, and maxillary deformities (in terms of width and shape), which affect the alignment of the teeth with the mandible.[2] According to studies, 21%−30% of patients with CLP required the LeFort I osteotomy.[3,4]

Skeletofacial reconstruction in patients with CLP is challenging because the dentofacial deformities might cause maxillomandibular discrepancy associated with maxillary hypoplasia.[5] Because of the

Received 6 August 2021; revised 21 September 2021; accepted 3 October 2021.
Available online 1 December 2021.

* Corresponding author at: Graduate Institute of Craniofacial and Oral Science, Chang Gung University, Taoyuan, Taiwan. Fax: +886 2 25148246.
E-mail address: ellenko.wc@msa.hinet.net (E.W.-C. Ko).

*https://doi.org/10.38209/2708-2636.1115*

complexity of CLP care, multidisciplinary care teams are required to provide optimal care to patients with CLP.[6] The overall treatment protocol at the Chang Gung Craniofacial Center is presented in Table 1.[7] The fundamental treatment for cleft orthognathic surgery is similar to that for noncleft patients, which mainly involves maxillary advancement and mandibular setback.[8] However, a few exceptions exist: severe palatal scarring and tissue noncompliance could lead to complex surgery.[6] To improve the effectiveness and efficiency of treatment, the LeFort I osteotomy can be combined with double- or multiple-piece osteotomies.[9] A segmental LeFort I maxillary osteotomy can be conducted in alveolar cleft defects to close the cleft gap, align and coordinate the dental arch in the transverse dimension, and maximize intercuspation.[8] Moreover, the segmental approach may enable the soft tissue closure of oronasal fistulae by moving the bony margins closer and reducing soft tissue tension repair.[9] However, segmental maxillary osteotomies have been reported to be risk factors for surgical relapse. The rate of maxillary relapse might differ between single-piece and segmental LeFort I maxillary osteotomies,[9,10] and the stability of LeFort I osteotomies in patients with CLP is usually worse than that in other patients.[11] Other risk factors, such as the extent of maxillary advancement,[11] inferior repositioning of the maxilla, cleft type,[12] and nonrigid fixation,[13] have also been considered.

Long-term stability after LeFort I advancement is a major concern for surgeons and orthodontists and thus affects the formulation of treatment plans.[14] A recent systematic review revealed that the sagittal relapse rate afer a LeFort I osteotomy with rigid fixation and 2.5–7.2-mm maxillary advancement was 20% in patients with CLP.[15]

To prevent and manage skeletal instability or relapse, determining factors that could affect skeletal stability might be useful. Accordingly, we conducted this study to compare the outcomes and stability levels of single- and two-piece LeFort I osteotomies performed on patients with CLP by measuring the centroids of the osteotomies; we also conducted a retrospective analysis to determine potential factors for skeletal relapse. The null hypothesis was that: single- and two-piece LeFort I osteotomies which performed on patients with CLP would not differ significantly with respect to the surgical stability.

*Table 1. Cleft treatment protocol in the Chang Gung Craniofacial Center.*[7]

| Timing | Treatment |
|---|---|
| First visit | Nasoalveolar molding |
| 3–5 months | Lip surgery |
| 9–12 months | Palate surgery |
| 2.5 years | Speech assessment every 6 months |
| 3.5 years Speech therapy | Speech therapy |
| 4 years | VPI surgery |
| 5–6 years | Lip & nose revision if indicated |
| 8–9 years | First-stage orthodontics for bone graft preparation |
| 9–11 years | Secondary alveolar bone grafting |
| >12 years | Definitive orthodontics |
| 17–18 years | Orthognathic surgery/lip & nose revision |

## MATERIALS AND METHODS

### Participants

Patients were divided into two groups depending on whether they underwent single- or two-piece LeFort I maxillary osteotomies (single- or two-piece group, respectively). The sample size was calculated using G*Power (version 3.1.9.4; Universität Kiel, Germany). On the basis of the difference in horizontal maxillary relapse at point A between postoperative time points, the minimum sample size required for a two-sample *t* test was determined to be 31; this was determined at 95% significance and 80% power.

The present study was conducted in accordance with the Declaration of Helsinki for medical protocols and ethics, and the Institutional Review Broad of Chang Gung Memorial Hospital approved the study protocol.

### Data collection

The patients' medical records, including images of computed cone-beam tomography (CBCT), were collected at three times points in both groups: 1 month before surgery (T0), within 1 month after surgery (T1), and at the debonding visit (T2).

The patients' CBCT images were analyzed using an i-CAT scanner that was operated at 120 kVP and 36.9 mAs, with the slice thickness set to 2 mm. Moreover, the extended field of view was 22 (height) × 16 (depth) $cm^2$, scanning time was 40 s, and voxel size was 0.4 × 0.4 × 0.4 $mm^3$. During the CBCT scanning process, each patient's head was positioned with the Frankfort horizontal plane parallel to the ground, and the patient was requested to avoid swallowing, keep the mouth closed, and maintain centric occlusion. Patient data were recorded in the Digital Imaging and Communications in Medicine format.

The CBCT images were oriented using three-dimensional (3D) reference planes (Figure 1). CBCT

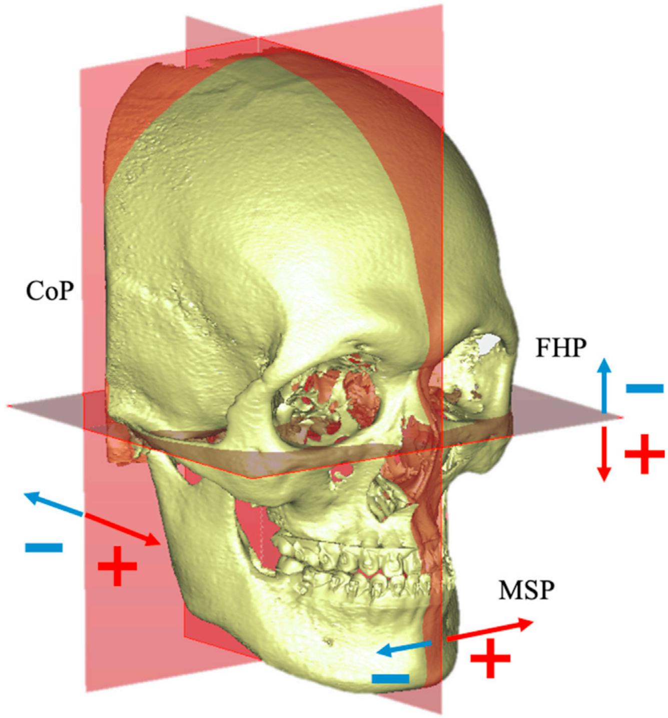


*Figure 1. Three internal reference planes and linear measurements. The Frankfort horizontal plane (FHP) is formed by the bilateral orbitale (Or) and the midpoint between the bilateral porion (Po). The midsagittal plane (MSP) is formed by the plane perpendicular to the FHP, passing through the nasion (Na) and basion (Ba). The coronal plane (CoP) is formed by the plane perpendicular to both the FHP and the MSP, passing through the basion (Ba). The linear measurements were conducted in three planes. (1) In the transverse plane, distances were measured relative to the MSP; a positive sign (+) indicates the deviated side, and a negative sign (−) indicates the nondeviated side. (2) In the vertical plane, distances were measured relative to the FHP; a positive sign (+) indicates the downward direction. (3) In the sagittal plane, distances were measured relative to the CoP; a positive sign (+) indicates the forward direction.*

images obtained at T0, T1, and T2 were superimposed using a surface-based technique. The concordance of the superimposition results was registered at the anterior cranial base and in the frontonasal area; the concordance was confirmed to be less than 1.5 mm in all samples. All landmarks were marked on the 3D objects by the same examiner.

## Procedure of surgical orthodontic treatment

### *Presurgical orthodontic preparation*

All patients received presurgical orthodontic treatment. Three problems are commonly encountered in presurgical orthodontic treatment: missing lateral incisors, residual alveolar clefts, and maxillary hypoplasia.[8] Accordingly, the aims of presurgical orthodontic treatment are to level and align the teeth to relieve crowding and eliminate dental interference in order to achieve maximum intercuspation, which help to setup a predictable surgical occlusion and improve stability.[16] If a patient has adequate alveolar continuity, then a single-piece LeFort I osteotomy should be performed. However, if a patient has previously received an inadequate alveolar bone graft (ABG), incompatible maxillary and mandibular arch forms, or an inadequate missing lateral space closure, then a two-piece segmental LeFort I maxillary osteotomy should be performed.[8] When segmental LeFort I was planned for the applicable patients, the teeth adjacent to the cleft gap were required to be upright with sufficient supporting bone before surgery.[8]

### *Surgical planning*

The patients' 3D craniofacial images were acquired using the i-CAT scanner. On the basis of the acquired 3D objects, measurements and surgical plans were implemented using Simplant O&O software (v. 3.0, Materialise, Leuven, Belgium). In the segmental group, the maxillary dental model was cut and rescanned to assess any maxillary constriction or expansion in the transverse dimension. The maxillomandibular complex was advanced or moved on the basis of the surgical objectives for addressing occlusal problems and improving facial aesthetics.[17]

### *Surgical procedure*

For the treatment of patients with CLP, the surgical approach adopted at Chang Gung Memorial

Hospital entails executing an osteotomy of the pterygomaxillary junction by using a right-angled oscillating saw instead of the classic osteotome-based approach. This oscillating saw can also be used to cut the lateral, anterior, and medial maxillary walls parallel to the occlusal plane, which can bilaterally preserve two reference points on the maxilla: the lateral buttress and the pyriform aperture. Although occlusal problems could be addressed using a single-piece LeFort I osteotomy, the maxilla could be divided into two pieces depending on a patient's problem.[18] Gingivoperiosteoplasty (GPP), which is designed to remove soft-tissue barriers against alveolar bone fusion and allow bone conduction from both edges, might be used instead of ABG for some patients who have small gaps during LeFort I ostetomies.[19] Rigid fixation can be achieved using monocortical bone plates and screws or biocortical screws. This surgery led to the advent of two-jaw surgery, in which the LeFort I osteotomy is combined with bilateral sagittal split osteotomies.

3D cephalometric measurements

Three reference planes were created (Table 2; Figure 1). After 3D objects obtained from the images acquired at T0, T1, and T2 were superimposed (Figure 2), cephalometric measurements were conducted using Simplant O&O. Landmark localization was evaluated as the agreement between manually marked landmark positions on the 3D craniofacial objects and the corresponding positions determined on the CBCT images by the same examiner.

*Linear measurements*

The centroid of a triangle is the intersection of the three medians of the triangle; the same concept was applied to measure the movements of the maxilla and mandible. Specifically, overall maxillary movements were evaluated by measuring the mean displacement of three landmarks on the maxilla (namely nasopalatine foramen, right greater palatine foramen, and left greater palatine foramen) and

*Table 2. Definitions of reference planes and cephalometric landmarks.*

| | Abbreviation | Definition |
|---|---|---|
| Reference planes | | |
| Frankfort horizontal plane | FHP | The plane formed by bilateral Or and the midpoint of the porion. |
| Midsagittal plane | MSP | The plane perpendicular to the FHP, passing through Na and the basion. |
| Coronal plane | CoP | The plane perpendicular to the FHP and MSP, passing through the basion. |
| Landmarks | | |
| Nasopalatine canal | NP | The most posterior point of the incisive canal at the level of the palatal bone exit. |
| Greater palatine canal right | GpR | The most posterior point of the greater palatine canal at the level of the palatal bone exit on the right side. |
| Greater palatine canal left | GpL | The most posterior point of the greater palatine canal at the level of the palatal bone exit on the left side. |
| Mental foramen right | MfR | The most posterior point of the mental foramen at the level of the labial bone exit on the right side. |
| Mental foramen left | MfL | The most posterior point of the mental foramen at the level of the labial bone exit on the left side. |
| Genial tubercle | GT | The tip of the genial tubercle. |

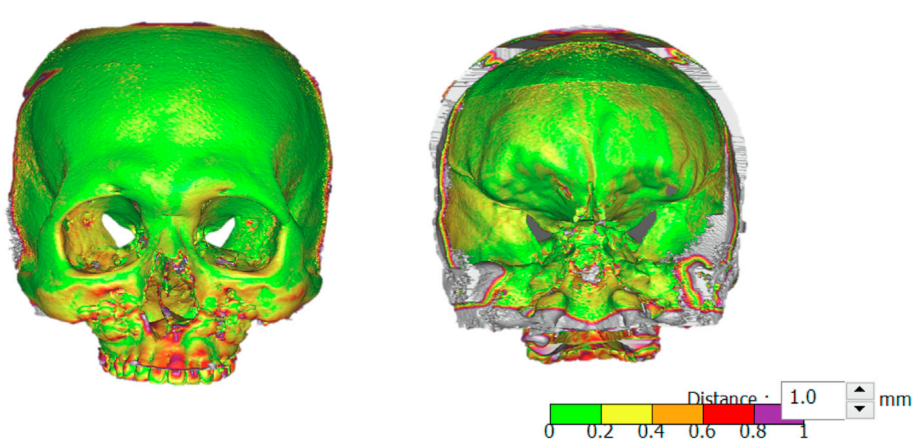


*Figure 2. Superimposition of images acquired at two time points, which was performed at the anterior cranial base, with accuracy verified using a distance color map.*

Taiwanese Journal of Orthodontics
2021;33(4):156−165

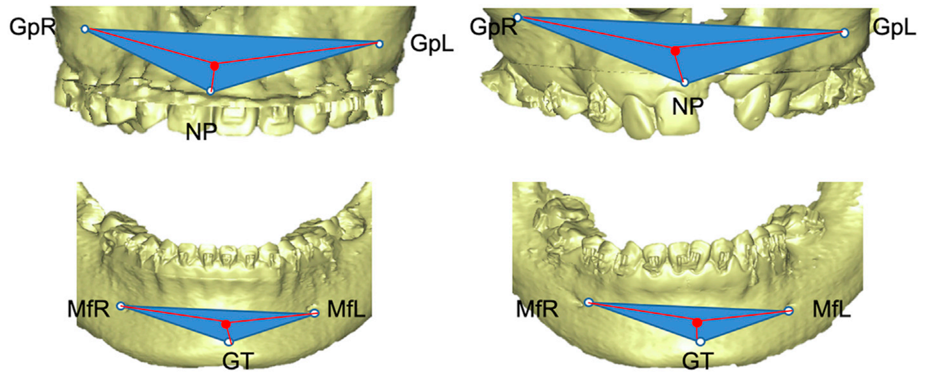


*Figure 3. Four triangles used to represent the maxilla and mandible between single- and two-piece procedures; the A and B panels present the triangles representing the maxilla in the single-piece and two-piece procedures, respectively, and the C and D panels present the triangles representing the mandible in the single-piece and two-piece procedures, respectively. The maxillary triangle was constructed using the nasopalatine foramen (NP) and the greater palatine foramens (GpR, GpL). The mandibular triangle was constructed using the genial tubercle (GT) and mental foramens (Mf).*

three landmarks on the mandible (genial tubercle, right left mental foramen, and left mental foramen), as illustrated in Figure 3.

Maxillary changes in the transverse dimension were assessed as differences in the total shortest distance from the right and left greater palatine foramen to the midsagittal plane. Surgical changes were assessed as differences in the movement of the centroid between T0 and T1, postsurgical changes were assessed as the differences in the movement of the centroid between T1 and T2, and total change was assessed as the difference in the movement of the centroid between T0 and T2.

### Statistical analysis

A paired *t* test was used to compare surgical and postsurgical changes in maxillary width within each group, and a two-sample *t* test was used to compare such changes between the groups.

Multiple linear regression was used to evaluate whether age, sex, CLP type (single or bilateral), surgical approach (single- or two-piece surgery), ABG, and amount of surgical movement were related to postoperative stability. The level of significance was set to $P < 0.05$.

To assess intraexaminer reliability, 15 CBCT images were randomly chosen to evaluate the reliability of the landmark localization process. In this assessment, the landmarks were reidentified and remeasured at 3-week intervals, and the consistency between them was evaluated using the intraclass correlation coefficient (ICC) and Dahlberg's formula.

## RESULTS

### Patient demographics

Table 3 presents a summary of the patients' demographic data before treatment. The mean age of the patients was 21.5 years, and the majority of the patients were men. Moreover, 69% of the patients had previously received an ABG. No significant differences in sex, mean age, cleft type, or history of ABG were observed between the two groups. Only the mean duration of postoperative follow-up differed significantly between the groups ($P = 0.002$).

### Intraexaminer reliability

The ICC for linear measurements was 0.992, and the measurement error determined using Dalberg's

*Table 3. Patient demographics.*

| Parameter | Single-piece (n = 30) | Two-piece (n = 15) | P |
|---|---|---|---|
| Female, n (%) | 12 (40) | 7 (46) | 0.74 |
| Mean age (SD) at surgery, years | 20.1 ± 4.9 | 24 ± 7.7 | 0.09 |
| Unilateral cleft, n (%) | 25 (83) | 12 (80) | − |
| Bilateral cleft, n (%) | 5 (16) | 3 (20) | − |
| Previous alveolar bone graft, n (%) | 23 (76) | 8 (53) | 0.16 |
| Mean duration (SD) of postoperative Follow-up, months | 1.43 ± 0.5 | 1.83 ± 0.5 | 0.002[a] |

Data are presented as mean ± SD.
[a] Indicates statistically significant difference ($P < 0.05$).

formula was 0.21 mm. These results indicate excellent intraexaminer reliability (95% confidence interval).

### Overall surgical and postsurgical changes in movement

Tables 4 and 5 list the surgical and postsurgical changes in maxillary and mandibular movement, respectively. No significant differences in surgical or postsurgical changes in maxillary or mandibular movement were observed between the groups; however, the postsurgical change in maxillary movement in the sagittal plane differed significantly between the groups ($P < 0.05$). The two-piece group tended to have a higher relapse rate than did the single-piece group across all dimensions of the maxilla.

### Surgical and postsurgical changes in maxillary width

We considered maxillary width as an absolute value that was unaffected by movement direction. We observed a significant difference between the groups in terms of surgical changes ($P < 0.001$) but not postsurgical changes (Table 6). When take movement direction into consider, postsurgical changes in the two-piece group involved maxillary expansion and constriction (Table 7, Figure 4). Among patients who exhibited maxillary expansion (n = 6), the amount of expansion was 2.31 ± 2.23 mm; among those who exhibited maxillary constriction (n = 9), the amount of constriction was 1.87 ± 1.34 mm. Accordingly, no significant difference in postsurgical change of maxillarey transverse dimension was observed between patients who exhibited expansion and those who exhibited constriction. In postsurgical changes, the patients tended to exhibit more relapse in exapnsion group but no statistical significance.

### Factors influence maxillary and mandibular relapse

Tables 8 and 9 present significant factors influencing maxillary and mandibular relapse. Surgical change (one of the factors) influenced all dimensions of surgical relapse, and surgical approach, which involved single- and two-piece procedures, influenced only the sagittal plane ($P < 0.05$) (Table 8). Only surgical change influenced mandibular relapse in the three planes; by contrast, the other factors did not reveal any significant correlation (Table 9).

## DISCUSSION

This study evaluated skeletal stability and surgical and postsurgical changes in maxillary and mandibular movements in patients with CLP who underwent single- and two-piece LeFort I maxillary osteotomies. These movements were evaluated by measuring the mean displacement of three landmarks on the maxilla and mandible after surgery and during follow-up; these landmarks were not affected by the cutting or bone remodeling processes during surgery. The results reveal a clinically significant relapse in maxillary movement in the sagittal plane but did not reveal any significant mandibular

*Table 4. Overall surgical changes (T0–T1) and postsurgical changes (T1–T2) in maxillary movement.*

| Maxilla | Surgical changes (T1–T0) | | | Postsurgical changes (T2–T1) | | | Relapse rate | |
|---|---|---|---|---|---|---|---|---|
| | Single-piece (mm) | Two-piece (mm) | P value | Single-piece (mm) | Two-piece (mm) | P value | Single-piece | Two-piece |
| Sagittal | 4.03 ± 1.89 (Forward) | 4.97 ± 1.96 (Forward) | 0.15 | −0.36 ± 0.95 (Backward) | −1.61 ± 1.44 (Backward) | 0.004** | 8.01 | 33.77 |
| Vertical | −0.11 ± 1.72 (Upward) | −0.52 ± 1.24 (Upward) | 0.28 | 0.01 ± 1.97 (Downward) | 0.14 ± 0.76 (Downward) | 0.97 | 10.39 | 26.09 |

T0, presurgery; T1, within 1 month after surgery; T2, debonding visit.
**indicates statistically significant difference: $P < 0.01$.

*Table 5. Overall surgical changes (T0–T1) and postsurgical changes (T1–T2) in mandibular movement.*

| Mandible | Surgical changes (T1–T0) | | | Postsurgical changes (T2–T1) | | | Relapse rate | |
|---|---|---|---|---|---|---|---|---|
| | Single-piece (mm) | Two-piece (mm) | P value | Single-piece (mm) | Two-piece (mm) | P value | Single-piece | Two-piece |
| Sagittal | −4.03 ± 3.38 (Backward) | −4.88 ± 3.74 (Backward) | 0.66 | 1.28 ± 1.64 (Forward) | 2.09 ± 1.45 (Forward) | 0.06 | 29.09 | 42.82 |
| Transverse | −0.89 ± 1.70 (Non-deviated) | −1.20 ± 2.18 (Non-deviated) | 0.89 | 0.83 ± 1.20 (Deviated side) | 0.97 ± 1.22 (Deviated side) | 0.76 | 93.25 | 80.83 |
| Vertical | 1.26 ± 1.99 (Downward) | 1.48 ± 1.93 (Downward) | 0.72 | −1.00 ± 1.70 (Upward) | −1.44 ± 1.45 (Upward) | 0.46 | 79.36 | 97.29 |

T0, presurgery; T1, within 1 month after surgery; T2, debonding visit.

Taiwanese Journal of Orthodontics
2021;33(4):156–165

*Table 6. Surgical changes (T0–T1) and postsurgical changes (T1–T2) in maxillary width.*

| Maxilla | Surgical changes (T1–T0) | | | Postsurgical changes (T2–T1) | | |
|---|---|---|---|---|---|---|
| | Single-piece | Two-piece | P value | Single-piece | Two-piece | P value |
| Width (absolute value) | 0.61 ± 0.60 | 2.06 ± 1.83 | 0.001** | 0.74 ± 0.78 | 1.00 ± 0.84 | 0.24 |

T0, presurgery; T1, within 1 month after surgery; T2, debonding visit.
** Indicates statistically significant difference: $P < 0.01$.

*Table 7. Surgical changes (T0–T1) and postsurgical changes (T1–T2) in maxillary width in the two-piece group.*

| Maxilla | Two-piece (surgical expansion, n = 6) | | | Two-piece (surgical constriction, n = 9) | | |
|---|---|---|---|---|---|---|
| | T1–T0 | Postsurgical T2–T1 (Expansion n = 3) | Postsurgical T2–T1 (Constriction n = 3) | T1–T0 | Postsurgical T2–T1 (Expansion n = 3) | Postsurgical T2–T1 (Constriction n = 6) |
| Width | 2.31 ± 2.23 | 0.87 ± 0.93 | −1.79 ± 0.89 | −1.87 ± 1.34 | 0.94 ± 0.70 | −0.66 ± 0.40 |

T0, presurgery; T1, within 1 month after surgery; T2, debonding visit.

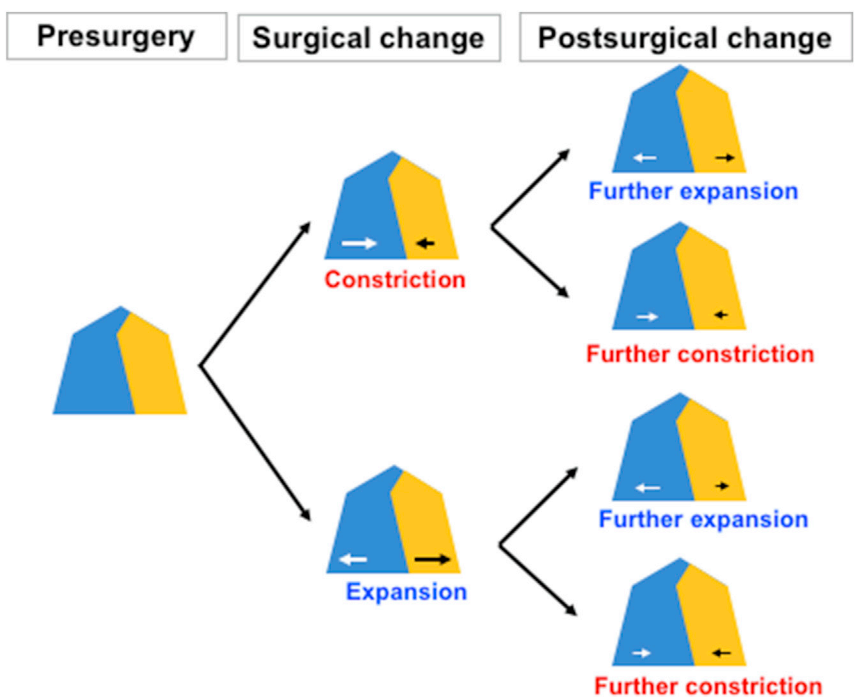


*Figure 4. Topographic presentation of the two-piece group involved surgery plans for maxillary expansion and constriction regrading different progressive outcomes to debonding. The osteotomy locate at alveolar cleft or afftected missing lateral incisors. The arrows indicate movements measuring at the greater palatine foramens to the midsagittal plane.*

*Table 8. Linear regression for maxillary relapse.*

| Maxillary relapse | Age | Gender | Cleft type | Surgical approach (single-piece/two-piece) | Previous ABG | Surgical change |
|---|---|---|---|---|---|---|
| Sagittal plane (Anterior/posterior) | 0.99 | 0.22 | 0.89 | 0.009** | 0.59 | 0.00*** |
| Vertical plane (Superior/inferior) | 0.90 | 0.47 | 0.95 | 0.97 | 0.23 | 0.03* |
| Width | 0.56 | 0.21 | 0.70 | 0.67 | 0.28 | 0.045* |

The p value indicated regression coefficient.
* indicate statistical significant difference: $P < 0.05$.
** indicate statistical significant difference: $P < 0.01$.
***indicate statistical significant difference: $P < 0.001$.

*Table 9. Linear regression for mandible relapse.*

| Mandibular relapse | Age | Gender | Cleft type | Surgical approach (single/two-piece) | Previous ABG | Surgical change |
|---|---|---|---|---|---|---|
| Sagittal plane (Anterior/posterior) | 0.84 | 0.61 | 0.26 | 0.72 | 0.64 | 0.00*** |
| Vertical plane (Superior/inferior) | 0.31 | 0.51 | 0.83 | 0.24 | 0.68 | 0.001** |
| Transverse plane (Left/right) | 0.46 | 0.41 | 0.73 | 0.76 | 0.87 | 0.01* |

The p value indicated regression coefficient.
* indicate statistical significant difference: $P < 0.05$.
** indicate statistical significant difference: $P < 0.01$.
***indicate statistical significant difference: $P < 0.001$.

movement between 2 groups. The amount of surgical change was suggested to be a factor influencing maxillary and mandibular stability.

In the two-piece group, the maxillary relapse rate in the sagittal plane was 33.77%, which is higher than that (20%) obtained in a recent meta-analysis conducted by Jiang.[15] Although Houston et al.[20] and Posnick and Ewing[21] have reported that maxillary relapse was not correlated with surgical movement in the horizontal and vertical dimensions, Heliovaara et al.[11] revealed that with greater maxillary advancement, more relapse was evident. This finding is consistent with those of other studies that have observed a significant correlation between maxillary advancement and relapse.[11,12,20,22] Problems with long-term stability in patients with CLP who have received LeFort I osteotomies involving maxillary advancement might be due to the tension from previous lip surgery, scarring of palatal tissue, or pharyngeal and alveolar bone repair.[11,23,24] This implies that segmental LeFort I osteotomies require overcorrection in the sagittal plane.

Our results reveal favorable maxillary stability in the vertical plane in both groups; the amount of relapse was less than 1 mm in both groups, which is similar to the relapse reported by other studies.[9,20,21] Furthermore, previous studies have reported that maxillary stability in the vertical plane was affected by vertical changes[12,22]; however, such a relationship was not observed in the present study.

During cleft orthognathic surgery, there are two procedure which could improve stability. Previous alveolar bone graft to maxillary osteotomy help the continuity of dental arch which might reduce risk of transverse relapse.[22] In our study showed that there was no significant different maxillary relapse between expansion and constriction groups. However, history of ABG is not the contributing factor that impact on skeletal stability in the maxillary width. Another procedure that could impact on stability is type of fixation. Previous cleft studies have revealed that miniplates fixation is better than wire fixation in term of reducing relapse.[13,21]

ABG placement prior to a maxillary osteotomy helps stabilize the continuity of the dental arch, which might reduce the risk of transverse relapse.[22] Our study indicated no significant difference in maxillary relapse between patients who exhibited maxillary expansion and those who exhibited maxillary constriction. However, ABG history is not a possible factor influencing skeletal stability in terms of maxillary width.

Patients with CLP could present dentofacial deformities that are characterized by malocclusion, midface retrusion in three dimensions, midline discrepancy, and asymmetry. To correct such deformities, orthognathic surgery is required. The cleft treatment approach currently applied at the Chang Gung Craniofacial Center was derived by modifying simple LeFort I maxillary advancement with the correction of malocclusion into a patient-centered approach that focuses on skeletofacial reconstruction using two-jaw surgery to improve facial profile and symmetry.[25] If treatment requires solving maxillary problems in the transverse plane or adjusting a patient's occlusion, a segmental LeFort I osteotomy can be performed.[26] Postoperative orthodontic treatment might have a compensatory effect on postoperative stability in both single- and two-piece LeFort I maxillary osteotomies.[9,27] The achievement of long-term stability after the LeFort I osteotomy procedure indicates a successful outcome.[15] Relapse after orthognathic surgery is more common in patients with CLP than in patients without CLP.[8,28,29] In mandible, only surgical change influenced mandibular relapse in the three planes; the other factors did not reveal any significant correlation. Thus, sagittal jaw discrepancy overcorrection is recommended for patients with CLP.

This study has some limitations pertaining to the evaluations and comparisons of the outcomes of orthognathic surgery in patients with CLP and those without CLP. The patients' characteristics varied according to the types and morphology of CLP and according to residual scarring from prior surgery. In addition, the sample size was relatively small. A larger sample size might have revealed a more solid evidence base in long-term stability between the groups. Furthermore, the study applied a retrospective design without randomization, possibly rendering it inadequate for exploring confounding factors.

## CONCLUSION

The study indicated that the two-piece group had more maxillary sagittal relapse after surgery. Surgical change was the main factor influencing maxillary and mandibular stability. Sagittal overcorrection might be required for patients with two-piece LeFort I advancement in patients with cleft.

## FUNDING

None.

## ETHICAL APPROVAL

This study was approved by the Institutional Review Board of Chang Gung Memorial Hospital (No. 202001881B0).

### Conflict of Interest Statement

The authors claim that there are no competing interests.

## ACKNOWLEDGMENTS

We thank Ms. Emily Yu-Ting Lin for providing technical support in the 3D data management process.

## REFERENCES

1. Heliövaara A, Ranta R, Hukki J, Rintala A. Skeletal stability of Le Fort I osteotomy in patients with isolated cleft palate and bilateral cleft lip and palate. *Int J Oral Maxillofac Surg* 2002; **31**(4):358–63.
2. Cheung LK, Samman N, Hui E, Tideman H. The 3-dimensional stability of maxillary osteotomies in cleft palate patients with residual alveolar clefts. *Br J Oral Maxillofac Surg* 1994; **32**(1):6–12.
3. Good PM, Mulliken JB, Padwa BL. Frequency of Le Fort I osteotomy after repaired cleft lip and palate or cleft palate. *Cleft Palate Craniofac J* 2007;**44**(4):396–401.
4. Voshol IE, van der Wal KG, van Adrichem LN, Ongkosuwito EM, Koudstaal MJ. The frequency of Le Fort I osteotomy in cleft patients. *Cleft Palate Craniofac J* 2012;**49**(2):160–6.
5. Denadai R, Chou PY, Pai BC, Chen C, Lin CC, Huang CS, et al. Skeletofacial reconstruction for cleft-related deformities: four decades of evolving cleft care. *Ann Plast Surg* 2020;**85**(1): 3–11. Available from: https://doi.org/10.1097/sap.0000000000002187.
6. James JN, Costello BJ, Ruiz RL. Management of cleft lip and palate and cleft orthognathic considerations. *Oral Maxillofac Surg Clin* 2014;**26**(4):565–72.
7. Chen PK. Chang Gung technique of unilateral cleft lip repair. In: Shi B, Sommerlad BC, editors. *Cleft lip and palate primary repair*. Berlin: Springer; 2013. p. 105–58 [Chapter 7] *Available from:* https://link.springer.com/chapter/10.1007/978-3-642-38382-3_7.
8. Roy AA, Rtshiladze MA, Stevens K, Phillips J. Orthognathic surgery for patients with cleft lip and palate. *Clin Plast Surg* 2019;**46**(2):157–71.
9. Watts GD, Antonarakis GS, Forrest CR, Tompson BD, Phillips JH. Single versus segmental maxillary osteotomies and long-term stability in unilateral cleft lip and palate related malocclusion. *J Oral Maxillofac Surg* 2014;**72**(12): 2514–21.
10. Erbe M, Stoelinga PJ, Leenen RJ. Long-term results of segmental repositioning of the maxilla in cleft palate patients without previously grafted alveolo-palatal clefts. *J Cranio-Maxillo-Fac Surg* 1996;**24**(2):109–17.
11. Heliövaara A, Ranta R, Hukki J, Rintala A. Skeletal stability of Le Fort I osteotomy in patients with unilateral cleft lip and palate. *Scand J Plast ReConstr Surg Hand Surg* 2001;**35**(1):43–9.
12. Hirano A, Suzuki H. Factors related to relapse after Le Fort I maxillary advancement osteotomy in patients with cleft lip and palate. *Cleft Palate Craniofac J* 2001;**38**(1):1–10.
13. Ayliffe PR, Banks P, Martin IC. Stability of the Le Fort I osteotomy in patients with cleft lip and palate. *Int J Oral Maxillofac Surg* 1995;**24**(3):201–7.
14. Dowling PA, Espeland L, Sandvik L, Mobarak KA, Hogevold HE. LeFort I maxillary advancement: 3-year stability and risk factors for relapse. *Am J Orthod Dentofacial Orthop* 2005;**128**(5):560–7.
15. Jiang L, Zheng Y, Li N, Chen X, Lu Z, Tong H, et al. Relapse rate after surgical treatment of maxillary hypoplasia in non-growing cleft patients: a systematic review and meta-analysis. *Int J Oral Maxillofac Surg* 2020;**49**(4):421–31.
16. Saltaji H, Major MP, Altalibi M, Youssef M, Flores-Mir C. Long-term skeletal stability after maxillary advancement with distraction osteogenesis in cleft lip and palate patients: a systematic review. *Angle Orthod* 2012;**82**(6):1115–22.
17. Lonic D, Pai BC, Yamaguchi K, Chortrakarnkij P, Lin HH, Lo LJ. Computer-assisted orthognathic surgery for patients with cleft lip/palate: from traditional planning to three-dimensional surgical simulation. *PLoS One* 2016;**11**(3): e0152014.
18. Chou PY, Denadai R, Yao CF, Chen YA, Chang CS, Lin CC, et al. History and evolution of orthognathic surgery at Chang Gung Craniofacial Center: lessons learned from 35-year experience. *Ann Plast Surg* 2020;**84**(1S Suppl 1):S60–8.
19. Wang YC, Liao YF, Chen PK. Outcome of gingivoperiosteoplasty for the treatment of alveolar clefts in patients with unilateral cleft lip and palate. *Br J Oral Maxillofac Surg* 2013;**51**(7):650–5.
20. Houston WJ, James DR, Jones E, Kavvadia S. Le Fort I maxillary osteotomies in cleft palate cases: surgical changes and stability. *J Cranio-Maxillo-Fac Surg* 1989;**17**(1):9–15.
21. Posnick JC, Ewing MP. Skeletal stability after Le Fort I maxillary advancement in patients with unilateral cleft lip and palate. *Plast Reconstr Surg* 1990;**85**(5):706–10.
22. Thongdee P, Samman N. Stability of maxillary surgical movement in unilateral cleft lip and palate with preceding

alveolar bone grafting. *Cleft Palate Craniofac J* 2005;**42**(6):664−74.

23. Adlam DM, Yau CK, Banks P. A retrospective study of the stability of midface osteotomies in cleft lip and palate patients. *Br J Oral Maxillofac Surg* 1989;**27**(4):265−76.
24. Freihofer Jr HP. Results of osteotomies of the facial skeleton in adolescence. *J Maxillofac Surg* 1977;**5**(4):267−97.
25. Denadai R, Pai BC, Lo LJ. Balancing the dental occlusion and facial aesthetic features in cleft orthognathic surgery: patient-centered concept for computer-aided planning. *Biom J* 2020;**43**(2):143−5.
26. Marchetti C, Pironi M, Bianchi A, Musci A. Surgically assisted rapid palatal expansion vs. segmental Le Fort I osteotomy: transverse stability over a 2-year period. *J Cranio-Maxillo-Fac Surg* 2009;**37**(2):74−8.
27. Gomes KU, Martins WD, de Oliveira Ribas M. Horizontal and vertical maxillary osteotomy stability, in cleft lip and palate patients, using allogeneic bone graft. *Dental Press J Orthod* 2013;**18**(5):84−90.
28. Kerawala CJ, Stassen LF, Shaw IA. Influence of routine bone grafting on the stability of the non-cleft Le Fort 1 osteotomy. *Br J Oral Maxillofac Surg* 2001;**39**(6):434−8.
29. De Riu G, Meloni SM, Raho MT, Gobbi R, Tullio A. Delayed iliac abscess as an unusual complication of an iliac bone graft in an orthognathic case. *Int J Oral Maxillofac Surg* 2008;**37**(12):1156−8.