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# Three-dimensional Camera Imaging in Postoperative Evaluation of Distraction Osteogenesis

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**Summary:** Distraction osteogenesis needs to be regularly assessed in some way to monitor the degree of advancement. X-ray is used for the general evaluation of osteotomy. However, radiation exposure should be avoided. The purpose of this study is to evaluate 3-dimensional (3D) camera imaging for postoperative evaluation. Three patients who underwent Le Fort I or III advancement osteotomy using rigid external distraction and internal distraction were observed in this study. The degrees of the distractions were evaluated using VECTRA H1 3D imaging in addition to computed tomographic (CT) scans. In the VECTRA 3D imaging, the tilt and size of the faces were corrected using the dedicated software for imaging. The preoperative and postoperative images were superimposed, and the distances of motion between the landmarks were measured. In CT scans, the bone distances between osteotomy points of the pterygomaxillary junction were analyzed. As the VECTRA 3D imaging can be compared by overlaying previous photographs, it served as a good tool to evaluate the distractions. However, both the soft-tissue movement measured by VECTRA and CT bony measurements did not match the total amount of movement for the internal distraction devices. The bony advancements were less than the amount of distraction. The soft tissues shrank after the distraction was completed in all cases. Three-dimensional camera imaging is considered to be a useful tool for the evaluation of distraction osteogenesis.
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## INTRODUCTION

Distraction osteogenesis in surgical treatments such as Le Fort advancement osteotomy requires assessment by x-ray or computed tomographic (CT) scan to monitor the degree of advancement.[1,2] However, radiation exposure should be avoided in children.[3,4]

Daily evaluation of the progress of maxillary distraction can be evaluated visually because the soft-tissue profile changes occur after maxillary distraction, but objective evaluation of the soft-tissue profile is necessary. The purpose of this study is to evaluate 3-dimensional (3D) camera imaging as a method following maxillary distraction.

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## PATIENTS AND METHODS

We assessed 3 patients who underwent Le Fort I or III advancement osteotomy using both rigid external distraction and internal distraction.[5] The facial advancement by distraction was evaluated using VECTRA H1 3D imaging in addition to CT scans. Case 1 is an 8-year-old girl with Crouzon syndrome who underwent Le Fort III mid-face advancement osteotomy. The internal distraction device was fixed on the zygomatic arch. Case 2 is a 19-year-old man with bilateral cleft lip and palate who underwent Le Fort I maxillary advancement osteotomy. Case 3 is an 18-year-old man with bilateral cleft lip and palate who underwent Le Fort I maxillary advancement osteotomy. The internal distraction device was fixed on the maxilla in both cases 2 and 3. In all 3 cases, the external distraction device was detached 1 week after distraction; however, the internal devices were kept and used as fixation materials and removed 6 months after distraction.

### Three-Dimensional Camera Imaging

Handy VECTRA H1 3D imaging was taken regularly. Before evaluation, the 4 fixed points in the distraction

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process were decided (Fig. 1) (**See Fig.**, **Supplemental Digital Content 1**, which displays the 4 fixed points were also marked on the postoperative image, **http://links.lww.com/PRSGO/B85**). And then, the tilt and size of the face were corrected using VECTRA dedicated software. For evaluation, the landmarks subnasal (SN) and both sides of wire-penetrated site (WP) were selected (Fig. 2).

**Fig. 1.** In VECTRA 3D imaging of case 1, 4 fixed points, both sides of the pupils and medial point of the eyebrows, were marked, and the tilt and size of the face were corrected and overlaid on top of each other.

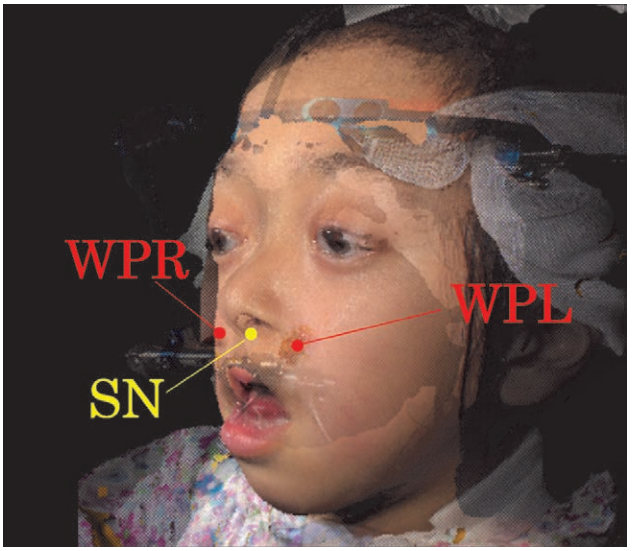


**Fig. 2.** The SN and both sides of WP were selected as landmark points. SN is a subnasal point in the cephalometric radiograph. WP is a point where the tow wire penetrated the cheek. WPL, left wire-penetrated site; WPR, right wire-penetrated site.

The preoperative and postoperative images were superimposed against each other, and the preoperative to postoperative distances relative to landmarks SN and both sides of WP were measured (Fig. 3).

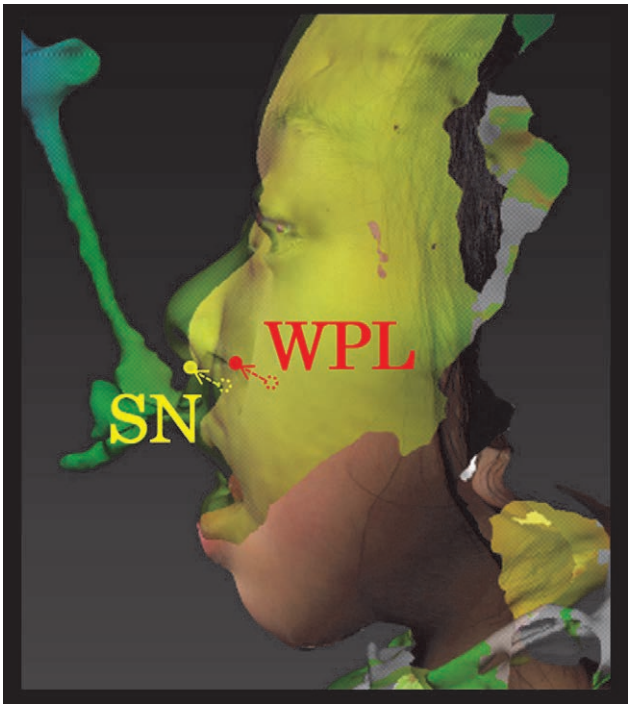


**Fig. 3.** The overlying preoperative and postoperative photographs 39 days after operation. The changes can be compared visually. The distances from preoperative to postoperative against landmarks SN and both sides of WP (WPR and WPL) were measured. WPL, left wire-penetrated site; WPR, right wire-penetrated site.

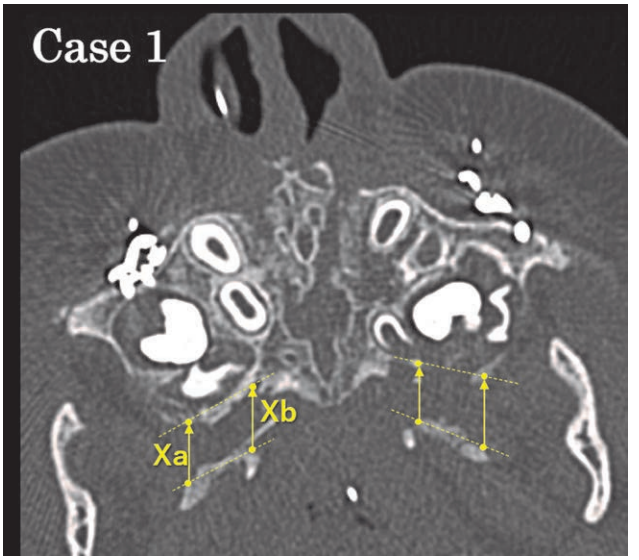


**Fig. 4.** In CT scans, the bone distances between osteotomy points at the PMJ were analyzed. The average values of the distances at both ends of the bone osteotomy sides were measured as (Xa + Xb)/2. PMJ, pterygomaxillary junction.

### CT Scans

CT scans were taken preoperatively and postoperatively (case 1: postoperative day 40; case 2 and case 3: postoperative day 100). For evaluation, the bone distances between osteotomy points of pterygomaxillary junction were analyzed (Fig. 4).

## RESULTS

### Three-Dimensional Camera Imaging

We could see the actual facial changes by distraction and view the progress of the distraction from VECTRA images. VECTRA 3D images could be compared easily by overlaying previous photographs on top of each other to allow measurements of the distance from preoperative to postoperative points against landmarks such as SN and both sides of WP.

From the results, it was found that both the amount of soft-tissue movement measured by VECTRA and that of bone movement by CT scan did not match the total amount of movement for the internal distraction devices (Table 1). The total amount of the external distraction devices was much larger than ones of the internal distraction device. It was thought that SN points showed the average soft-tissue profile change between both WP points after distraction. In all of the cases, the soft tissue shrank after the distraction was completed (Table 1).

### CT Scans

CT scans are suitable for examining data in detail. The bone distances between osteotomy points were analyzed. The measurements showed that bone advancement in CT scans were lower than the advancement scores of the internal distractions (Table 1).

**Table 1. Summary.**

| | Landmarks | Preoperative | POD 4 | POD 12 | POD 20 | POD 40 | POD 60 | POD 100 |
|---|---|---|---|---|---|---|---|---|
| Case 1 | | | | | | | | |
| The distances from preoperative to postoperative against landmarks (mm) | SN | 0 | — | — | 6.76 | 11.7 | 8.53 | — |
| | WPR | 0 | — | — | 5.93 | 11.7 | 8.85 | — |
| | WPL | 0 | — | — | 7.41 | 10.6 | 9.46 | — |
| Bone advancement (mm) | CT scans | | | | | | | |
| | Right | 0 | — | — | — | 14.2 | — | — |
| | Left | 0 | — | — | — | 8.92 | — | — |
| Total amount (mm) | Internal distractions | | | | | | | |
| | Right | 0 | 1.0 | 8.5 | 16.5 | 20.5 | 20.5 | 20.5 |
| | Left | 0 | 1.0 | 8.5 | 16.5 | 20.5 | 20.5 | 20.5 |
| | External distractions | | | | | | | |
| | Right | 0 | 1.0 | 20.0 | 27.0 | 38.5 | — | — |
| | Left | 0 | 1.0 | 20.0 | 30.5 | 39.5 | — | — |
| Case 2 | | | | | | | | |
| The distances from preoperative to postoperative against landmarks (mm) | SN | 0 | 6.39 | 5.21 | 7.46 | — | — | 6.08 |
| | WPR | 0 | 4.61 | 7.29 | 7.92 | — | — | 7.43 |
| | WPL | 0 | 4.96 | 7.80 | 7.25 | — | — | 7.26 |
| Bone advancement (mm) | CT scans | | | | | | | |
| | Right | 0 | — | — | — | — | — | 13.7 |
| | Left | 0 | — | — | — | — | — | 12.7 |
| Total amount (mm) | Internal distractions | | | | | | | |
| | Right | 0 | 4 | 11 | 14.5 | 14.5 | 14.5 | 14.5 |
| | Left | 0 | 4 | 10.5 | 13.25 | 13.25 | 13.25 | 13.25 |
| | External distractions | | | | | | | |
| | Right | 0 | 9.5 | 16.5 | 23.5 | — | — | — |
| | Left | 0 | 16.5 | 24.5 | 29.0 | — | — | — |
| Case 3 | | | | | | | | |
| The distances from preoperative to postoperative against landmarks (mm) | SN | 0 | 8.09 | 8.81 | 11.0 | — | — | 4.33 |
| | WPR | 0 | 13.5 | 10.9 | 12.5 | — | — | 7.60 |
| | WPL | 0 | 8.92 | 12.9 | 12.2 | — | — | 9.58 |
| Bone advancement (mm) | CT scans | | | | | | | |
| | Right | 0 | — | — | — | — | — | 7.58 |
| | Left | 0 | — | — | — | — | — | 10.0 |
| Total amount (mm) | Internal distractions | | | | | | | |
| | Right | 4 | 8 | 14 | 14 | 14 | 14 | 14 |
| | Left | 0 | 4 | 10 | 10 | 10 | 10 | 10 |
| | External distractions | | | | | | | |
| | Right | 0 | 14 | 26 | 26 | — | — | — |
| | Left | 0 | 14 | 28.5 | 28.5 | — | — | — |

For each case, the upper part of the table describes the distances from preoperative to postoperative values against landmarks SN and both sides of WP and CT scans. The lower part of the table shows the total amount of distraction in internal and external devices. Case 1: An 8-year-old girl with Crouzon syndrome. The distraction was started at 1 mm/d from POD 4. The distraction was completed at 20.5 mm. Case 2: A 19-year-old man diagnosed with bilateral cleft lip and palate. The distraction was started at 1 mm/d from POD 1. The distraction was completed at 15 mm. Case 3: An 18-year-old man diagnosed with bilateral cleft lip and palate. After the down fracture of Le Fort I osteotomy, the motion of the right maxilla was insufficient, so 4-mm initial gap was set on the right-side internal distraction. The distraction was started at 1 mm/d from POD 1. The distraction was completed at 10 mm.
POD, postoperative day; WPL, left wire-penetrated site; WPR, right wire-penetrated site.

## DISCUSSION

X-rays are used for the evaluation of distraction.[1,2,6] However, frequent x-ray exposures should be minimized or avoided, especially in children.[3,4]

Cephalometric radiography is necessary to evaluate accurate bone advancement, but it is difficult in children because the external distraction device may bump against the cephalometric device. Using ordinary lateral x-rays, detailed analysis becomes more difficult because the inclinations and rates of magnification of the face change each time.

Also, CT scans cannot be used for daily assessment because of radiation exposure. In our study, the amount of movement measured by CT scan did not match the total extension amount of the external and internal distraction devices. The differences of the external device and internal device are caused by elongation of the extension wire and bending of the bones. Such a phenomenon may be stressful for the surgeons. Visual evaluations have no risk of radiation exposure, but it is only subjective findings. However, 3D camera imaging can be taken any number of times because there is no risk of radiation exposure.[7] Especially with the handy type, images can be taken easily even when the patient is restless. In addition, distraction results may be monitored easily using the VECTRA 3D imaging device because the images can be changed to various sizes and evaluated from all angles, and therefore they can be easily compared by overlaying previous photographs on top of each other.[7]

There have been reports of various studies on soft-tissue changes by movement of the bony structures in facial distraction and various ratios of soft-tissue changes have been reported.[8–10]

However, those ratios are not consistent, as we found in this study. And soft tissue is dynamic and varies in thickness depending on the muscle movement and emotions.[8]

In distraction, it is important to confirm that daily advancement and the relationship between soft- and hard-tissue advancement ratios may not always be necessary. Most surgeons determine endpoints for distraction, visually. We believe that 3D camera imaging can become an ideal objective tool of the soft-tissue profile changes in evaluating distraction. We must improve the method further to make it more accurate.

## CONCLUSION

Three-dimensional camera imaging is considered to be a useful tool of soft-tissue profile evaluation of distraction osteogenesis.

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## PATIENT CONSENT

*The patient provided written consent for the use of her image.*

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