Journal of Cranio-Maxillofacial Surgery (2007) **35**, 91–102

doi:10.1016/j.jcms.2006.12.004, available online at http://www.sciencedirect.com

Condyle as the point of rotation for 3-D planning of distraction osteogenesis for hemifacial microsomia

Jun-Young PAENG, Jee-Ho LEE, Jong-Ho LEE, Myung-Jin KIM

Department of Oral and Maxillofacial Surgery (chair: Prof. Jong-Ho Lee, DDS PhD), Dental Research Institute, College of Dentistry, Seoul National University, Seoul, Korea

SUMMARY. Aim: **The purpose of this study is to present an exact simulation method for mandibular rotational movement in distraction osteogenesis for hemifacial microsomia.** Methods: **Three-dimensional (3-D) surgery simulation software programmes (V-Works and V-Surgery; Cybermed, Seoul, Korea) were used, based on 3-D CT data in addition to the conventional data, which included facial photography, panoramic radiograph, cephalogram, and dental models. After measuring the mandibular deficiency (horizontal and vertical) from a 3-D model reconstructed using the software, the angulation of the distraction device to the mandibular border (posterior or inferior) was determined. The rotation axis in the V-Works simulation was defined as the line perpendicular to the plane made by condylion and the distraction vector location on the mandible. The mandible moves along the plane around this rotational axis during distraction. After the 3-D simulation with the software programme, mock surgery on a rapid prototyping model was performed. This planning method was applied to models of two hemifacial microsomia patients.** Results: **With this protocol, it was possible to simulate the rotational movement of the mandible on the axis passing through the condylar head of the unaffected side.** Conclusion: **The sequential planning procedure presented in this paper is considered to be helpful in performing effective preoperative simulation of distraction osteogenesis for hemifacial microsomia © 2007 European Association for Cranio-Maxillofacial Surgery**

Keywords: **distraction osteogenesis; three-dimensional; hemifacial microsomia**

INTRODUCTION

Distraction osteogenesis (DO) has proven to be a successful alternative to orthognathic and reconstructive surgery for treating craniofacial deficiencies or deformities (*Costantino* and *Buchbinder*, 1996; *Barkate*, 1997; *Taylor* and *Stal*, 1998). For a good result, accurate treatment planning is essential. The movement of bony segments in craniofacial distraction osteogenesis is three dimensional (3-D), including not only lengthening, but also rotational movement of bones. Accurate simulation of mandibular movement is fundamental in treatment simulations such as the planning for orthognathic surgery involving the autorotation of the mandible. Due to the complex 3-D form and function of the mandible, it has become evident that clinicians need to control the direction and magnitude of the distraction force in 3-D space.

The progress of imaging technology and the development of numerically controlled mathematical models makes it possible to create 3-D images of the maxillofacial structures. Clinicians can plan and perform virtual surgery on the patients' images with the aid of software, before the operation. One of the great advantages of this virtual surgery planning is that multiple simulations and repeated procedures are possible.

There have been significant limitations to the precision of mandibular distraction for achieving a desirable occlusal and facial aesthetic outcome. The occlusion is very difficult to achieve with DO and the mandibular movement including both linear and rotational changes is complex. Among the craniofacial distractions, mandibular distraction in particular needs 3-D prediction, because mandibles exhibit rotational as well as linear movement during the distraction process.

Many planning methods have been developed to simulate the distraction procedure preoperatively, but these methods had some limitations (*Gateno* et al., 2000; *Troulis* et al., 2002). To overcome these limitations, many devices, have also been developed that can adjust the vector and angle during distraction. Recently, moulding of the regeneration by altering the angulation of the external distraction device using interdental elastics has been reported (*Kunz* et al., 2000; *McCarthy* et al., 2003). However, precise prediction of the results before distraction is still of paramount importance during the planning phase, regardless of the design of the distraction device.

For mandibular distraction, intraoral or external devices can be used. Intraoral devices have the advantages of invisibility and a lack of facial scars. Despite some intraoral devices being multidirectional, many intraoral devices are unidirectional, and they are therefore predominantly dependent on the orientation of the device which is set during the operation. This means that it is difficult to change the direction of the vector during active distraction. Also, intraoral devices have limitations in their available length and are not appropriate for the cases that need long distraction distances. Thus an intraoral device is ideal

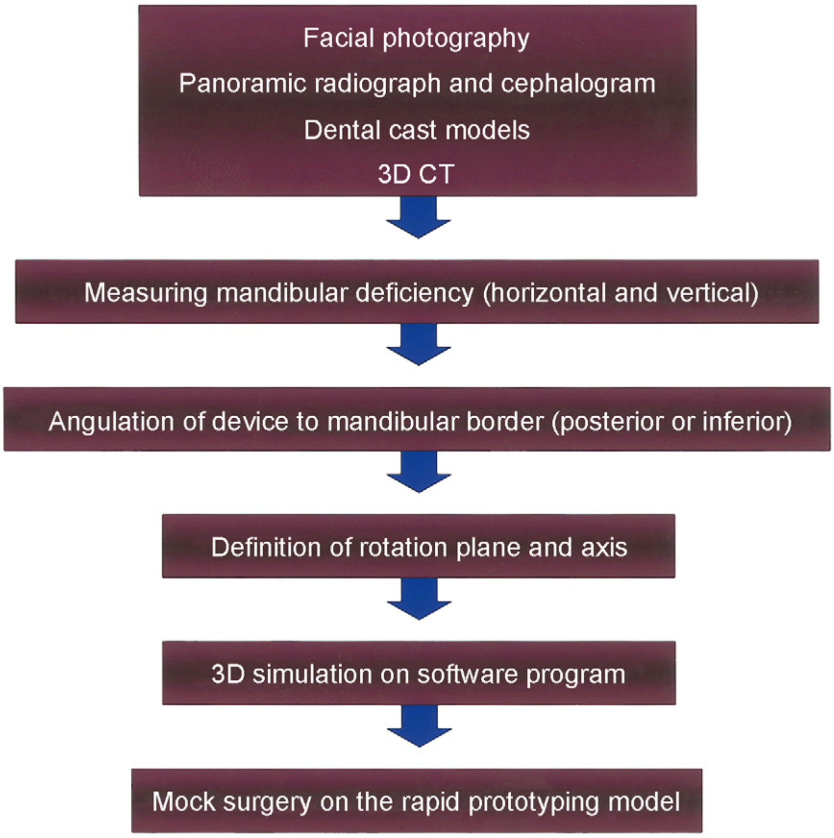
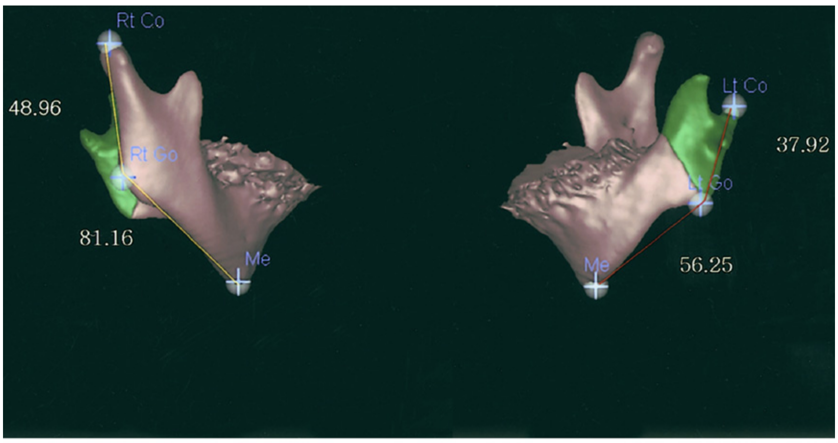


Fig. 1 – Treatment planning process for mandibular distraction.



Unaffected side **Affected side**

Estimated amount of distraction

Vertical = 48.96 – 37.92 = 11.04 mm

Horizontal = 81.16 – 56.25 = 24.81 mm

Fig. 2 – Estimating the amount of deficiency.