Neonatal Distraction Osteogenesis: Converting Virtual Surgical Planning Into Operative Reality

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Abstract

Background: Mandibular distraction osteogenesis (DO) has become an accepted method to manage severe cases of micrognathia-induced airway obstruction in neonates. (1-2) Current imaging used to plan these procedures aids in surgical planning, but offers only a rough guide for the operating room. To our knowledge we offer the first description of virtual surgery used to guide DO in the mandible of a neonate. Such technology can serve an important role in DO and offers objective guidance in device selection, vector planning and operative guide positioning.

Methods: A virtual surgical plan was created and tested using three-dimensional reconstructions of the patients' CT scans, custom guides and distraction device. The plan simulated the positioning of the osteotomy and device as well as the distraction vector (Figure 1). In the operating room the virtual plan acted as a step-by-step guide for the execution of the procedure.

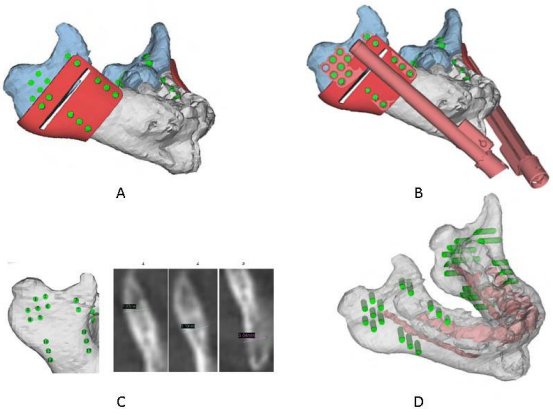

Figure 1. 3D virtual model of the patient's mandible with the cutting guide in place - green areas represent potential screw position.

Results: This virtual planning was used for 3 neonates. As predicted from testing on stereolithographic models, the morphology/topography of each mandible was unique such that the customized guide would only "snap-on" if appropriately placed in the planned position. The guide was secured with two 0.028 K wires at the preplanned sites, and the osteotomy was performed. The guide was then replaced with the distraction device by sliding it over the K wires using the preplanned holes in a technique similar to the Seldinger method used for angiocatheter placement. The device was then secured (Figure 2). A total advancement of 20mm was performed bilaterally. Hardware was removed 3 months post-operatively. At follow-up the children have excellent cosmetic results and have successfully avoided tracheotomy.

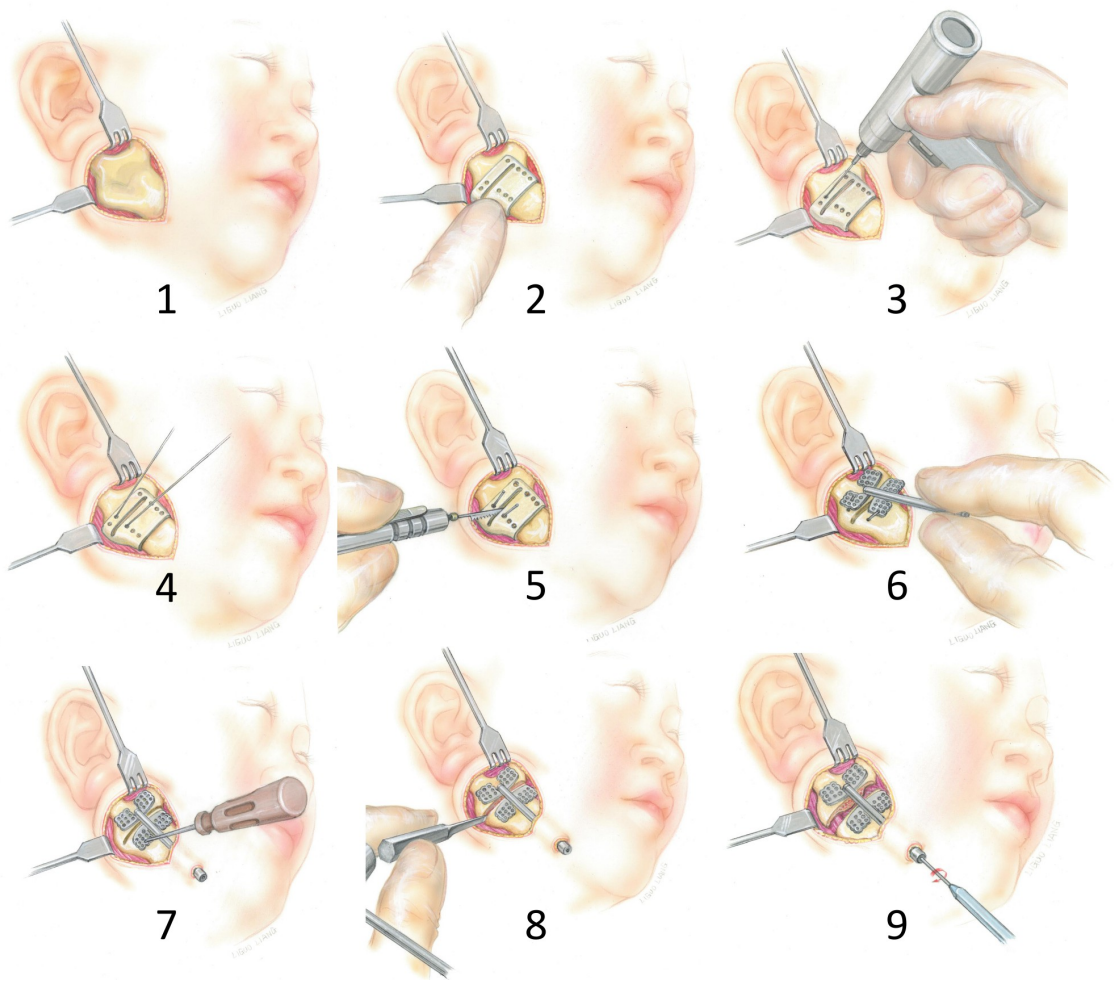

Figure 2. The steps of the operation are shown in this schematic.

Conclusions: Virtual surgical planning can serve an important role in the planning and execution of mandibular distraction osteogenesis by allowing the surgeon to choose a distraction device and vector that has been preoperatively tested for each patient. Additionally, by using custom guides and their virtual counterparts, the surgeon can seamlessly transform the virtual plan into the actual operative steps to achieve successful device placement and the desired distraction vector.

References

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Nothing to Disclose