Curvilinear Segmental Mandibular Reconstruction Utilizing Distraction Osteogenesis and Early Open Callus Manipulation

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Summary: The authors present a new technique for reconstruction of large curvilinear mandibular defects with distraction osteogenesis and early open callus manipulation. In phase 1, transport disks are created from mandibular bone and distracted across the entire length of the defect, without the restriction from a mandible plate fixation. This allows for full-length distraction until enough regenerate is obtained to reconstruct the defect without the need for additional bone grafts. Taking advantage of the soft moldable regenerate, the second and final operative procedure allows for the manipulation, repositioning, and fixation of the transported segments in the ideal position creating perfect tridimensional form and symmetry of the mandible arch. In addition, the consolidation phase is shortened by the early removal of distractors, substantially reducing the total length of treatment. This article describes 2 clinical cases treated according to this technique, one with a 6-cm mandibular defect where a sagittal plane manipulation was performed, and the other with a 7-cm defect and axial plane manipulation. Five years postsurgery, both patients had achieved full stable reconstruction without the need for bone grafting, and had obtained good facial symmetry, with no recorded complications. This technique serves to establish bone transport as a valuable alternative to bone free flaps in the reconstruction of large curvilinear segmental mandibular defects. (Plast Reconstr Surg Glob Open 2017;5:e1229; doi: 10.1097/GOX.0000000000001229; Published online 24 January 2017.)

SEGMENTAL MANDIBULAR DEFECTS

Segemental mandibular defects represent one of the most challenging reconstructive problems, particularly when curvilinear parts are involved. Microvascular bone free flaps remain the gold standard in large defect reconstruction.1–3 However, the morbidity associated with long operating and hospitalization times suggests the need for less invasive reconstructive techniques in selected patients with increased surgical anesthetic risks.3,4 Additionally, donor-site morbidity remains a concern particularly in young active patients, especially when limbs or iliac crest are selected. In such cases, distraction osteogenesis (DO) has been proposed as a valuable treatment option, despite the extended treatment time, the need for multistage procedures and bone grafting for bone union at the compression focus and vector control difficulties.5–7 These disadvantages could be obviated, by the technique developed by the first author, used to treat 2 patients with large curvilinear defects.

CASE REPORTS

Case 1
A 20-year-old man, presented with severe facial asymmetry (Fig. 1) consequent to the treatment of a right temporo-mandibular joint arthroplasty for osteoarthrosis. The patient was diagnosed with a 7-cm mandibular defect which extended through the left margin of the mandible and nasofacial skin. The patient underwent phase 1 transport disk creation, distraction, and callus manipulation. In phase 2, the transported segments were repositioned, fixed, and bone grafting was performed. Five years postsurgery, the patient had achieved full stable reconstruction with good facial symmetry, and had no recorded complications.

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poral fossa malignancy at age 1, with surgical excision and radiotherapy (40 rad).

A stereolithographic model was constructed for preoperative planning (Fig. 2).

The buccal cortex of the parasympyseal area was subperiosteally dissected through a submandibular approach, and a vertical osteotomy was performed immediately distal to the canine, creating a 5-cm transport disk. The premolded distractor device was fixed.

Distraction protocol was followed reaching 6 cm (Table 1).

The second procedure was performed 1 week after the end of the distraction phase. The distractor device was approached through the previous scar. Dissection over the body and footplates allowed for safe removal of the device avoiding damage of the regenerate identified between the bone stumps. The premolded reconstruction plate was fixed first at the symphysis. A nonlocking screw was placed at the most mesial stump of the transported segment, to act as a rotating axis, and manipulation with bone forceps was applied distally, to rotate the entire transported segment through 45° in a clockwise direction. Another nonlocking screw was tightened at the distal end of the transport segment, completing adaption to the plate in the ideal position. Additional locking screws were placed to reinforce the fixation.

No complications occurred, facial symmetry was achieved (Fig. 1), and good consolidation was confirmed by computed tomography allowing for dental implant placement 3 months after the second procedure (See figures, Supplemental Digital Content 1, http://links.lww.com/PRSGO/A365; Supplemental Digital Content 2, http://links.lww.com/PRSGO/A366; Supplemental Digital Content 3, http://links.lww.com/PRSGO/A367; and Supplemental Digital Content 4, http://links.lww.com/PRSGO/A368).

Case 2

A 52-year-old man, presented with a tridimensional mandible defect resulting from the excision of intraoral squamous cell carcinoma 6 years before. The buccal aspects of the remaining ascending ramus and symphysis...
were subperiosteal dissected using a submandibular approach. Two transport disks of 2 cm were created and were fixed with distractor devices (Fig. 3). Distraction protocol was followed reaching 7 cm (Table 1).

The second operative procedure was performed 1 week after the end of the longest posterior distraction phase and 17 days after the end of the shorter anterior distraction phase. Distractor devices and the regenerated segments were approached as described in Case 1. The devices were removed and a premolded reconstruction plate was fixed to the mandibular stumps. After axial manipulation, the transport disks were brought together to close contact and were fixed in the ideal position, utilizing nonlocking screws for perfect adaptation to the plate.

No complications were recorded, and good consolidation with bone continuity of the mandible arch was observed on computed tomography 1 year after the second procedure (See figures, Supplemental Digital Content 5, http://links.lww.com/PRSGO/A369, Supplemental Digital Content 6, http://links.lww.com/PRSGO/A370).

**DISCUSSION**

Microvascular bone flaps remain the gold standard technique for the reconstruction of segmental mandibular defects, although donor-site morbidity, difficult adaptation to the defect, technical requirements, and contraindications in high-risk patients argue in favor of alternatives such as DO.

Internal distractors offer important advantages, including better stability, a lower incidence of infection, a lower incidence of unaesthetic scars, and greater patient comfort. Both patients described in this article were treated with internal devices and were able to pursue normal lives during the distraction phase.

Problems attributed to bone transport include difficult distraction vector planning and control, the need for bone grafting, and long treatment times. Additional difficulties arise when curvilinear segments need to be reconstructed. In such cases, curvilinear distraction represents an alternative, but requires even longer treatment times and/or additional operations.

In this article, we describe a new technique that obviates most of these problems. In the initial phase, without the restriction imposed by previous reconstruction plate fixation, a regenerate is created that is larger than the defect. This eliminates the need for additional bone grafting. The second stage, performed before consolidation, allows for ideal tridimensional repositioning of segments guided by premolded plates. These support the new regenerate in position even in curvilinear segments, avoiding soft-tissue compression and regenerate retraction. The total length of treatment is shortened because the consolidation phase with distractors in place is eliminated, and only 2 surgeries are required.

At the 5-year follow-up, both patients had achieved stable curvilinear reconstructed segments, one in the region of the mandibular angle, and the other in the parasympyseal region, demonstrating that early open callus manipulation can be safely performed in both sagittal and axial planes. Full reconstruction was obtained with DO alone with no requirement for additional bone grafting. Each patient underwent only 2 operations, and the duration of treatment and hospitalization was reasonable compared with alternative procedures (Table 1).

Closed callus molding was reported, using external distraction devices or orthodontic elastics to prevent problems related to vector planning or control. Experimental studies performed by Kunz show that molding can be performed immediately after the end of the distraction phase. Additionally, Wei et al have shown that molding could be successfully performed 8 weeks into the consolidation phase. Pereira was the first to report about open callus manipulation in bone transport for maxillary reconstruction. As far as we know, this article represents the first report of this technique in mandibular reconstruction.

Because these are the first and only 2 reported cases, further clinical experience is needed to evaluate the predictability of this technique. Experimental studies are needed to establish the safety of the procedure regarding consolidation and to determine the optimal timing of open callus manipulation.
We describe a new technique wherein DO reconstruction of large curvilinear segmental mandibular defects is effective and stable, requiring only 2 surgical procedures, eliminating the consolidation phase and using the second surgical procedure for distraction device removal, open manipulation and fixation of segments in the ideal position without the need for additional bone grafting.

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PATIENT CONSENT
The patient provided written consent for the use of his image.

REFERENCES