Int. J. Oral Maxillofac. Surg. 2017; xxx: xxx–xxx
http://dx.doi.org/10.1016/j.ijom.2017.06.003, available online at http://www.sciencedirect.com

International Journal of Oral & Maxillofacial Surgery

Clinical Paper
Orthognathic Surgery

Intraoral vertico-sagittal ramus osteotomy: modification of the L-shaped osteotomy

J. Iwanaga[1,2,3], S. Kikuta[1], M. Nakamura[1], A. Koba[1], K. Ogata[1], S. Toyofuku[4], R. S. Tubbs[3,5], J. Kusukawa[1]

[1]Dental and Oral Medical Center, Kurume University School of Medicine, Kurume, Japan; [2]Department of Anatomy, Kurume University School of Medicine, Kurume, Japan; [3]Seattle Science Foundation, Seattle, Washington, USA; [4]Department of Dental and Oral Surgery, St. Maria Hospital, Kurume, Japan; [5]Department of Anatomical Sciences, St. George's University, Grenada

J. Iwanaga, S. Kikuta, M. Nakamura, A. Koba, K. Ogata, S. Toyofuku, R.S. Tubbs, J. Kusukawa: Intraoral vertico-sagittal ramus osteotomy: modification of the L-shaped osteotomy. Int. J. Oral Maxillofac. Surg. 2017; xxx: xxx–xxx.

Abstract. The sagittal split ramus osteotomy and intraoral vertical ramus osteotomy carry the potential risk of postoperative nerve paralysis, bleeding, and fracture and dislocation of the condyle. In 1992, Choung first described the intraoral vertico-sagittal ramus osteotomy for the purpose of avoiding postoperative dislocation of the condyle. However, there is still potential for damaging the inferior alveolar nerve and maxillary artery with this technique. The authors have developed a modified technique to minimize these risks. An evaluation of surgical experience and patient outcomes with the use of this technique is presented herein. One hundred twenty-two sides in 97 Japanese patients diagnosed with a jaw deformity were analyzed. This technique includes a horizontal osteotomy that is performed at a higher position than in the original Choung procedure. Intraoperatively, there was no unexpected bleeding from the operative site. Proximal segment dislocation from the glenoid fossa was observed on one side (0.82%). Non-union of the osteotomy was not observed in any patient. Intraoperative fracture of the coronoid process occurred in 2.46%, but none necessitated treatment of the fracture. Nerve dysfunction was found in 2.46% at the 12-month postoperative follow-up. The modified technique presented herein was developed to reduce postoperative nerve dysfunction and intraoperative hemorrhage.

Key words: mandibular osteotomy; anatomy; intraoperative complications; postoperative complications; hemorrhage; maxillary artery; inferior alveolar nerve; sagittal split ramus osteotomy.

Accepted for publication 6 June 2017

The sagittal split ramus osteotomy (SSRO) and the intraoral vertical ramus osteotomy (IVRO) are currently the most common orthognathic surgical procedures for jaw deformities[1,2]. However, both of these procedures carry the potential risk of postoperative nerve damage, bleeding, and fracture and dislocation of the condyle. In 1992, Choung first described the intraoral vertico-sagittal ramus osteotomy (IVSRO) for the purpose of avoiding the postoperative dislocation of the condyle that results from rotational movement of the condyle-bearing fragment[3,4]. Choung developed the IVSRO to achieve the following three aims: minimize condylar displacement, minimize inferior alveolar nerve damage, and reduce postoperative iatrogenic temporomandibular joint (TMJ) symptoms.

In Choung's experience, the IVSRO resulted in no dislocation of the condyle[3]. Although Choung reported that IVSRO

0901-5027/000001+05

Please cite this article in press as: Iwanaga J, et al. Intraoral vertico-sagittal ramus osteotomy: modification of the L-shaped osteotomy, *Int J Oral Maxillofac Surg* (2017), http://dx.doi.org/10.1016/j.ijom.2017.06.003

showed better outcomes than SSRO and IVRO, the number of patients treated was very small. Therefore, further data are needed to confirm the results. Since the development of the IVSRO, few studies have applied this technique to patients, and these studies have reported different outcomes[5–11]. However, the IVSRO still has the potential for damaging the inferior alveolar nerve and maxillary artery, as well as other complications[12]. To provide a potentially safer outcome, the present authors have developed a modified 'L-shaped' IVSRO technique (based on the Choung I osteotomy) for the treatment of jaw deformities that might reduce the potential for nerve and artery damage. The aim of this study was to evaluate the outcomes of this modified L-shaped IVSRO technique performed at the authors' hospital.

Materials and methods

Patients and protocol

One hundred and twenty-two sides (56 right, 66 left; 25 bilateral) in 97 Japanese patients who had been diagnosed with a jaw deformity and underwent IVSRO during the years 1998–2016 at the Dental and Oral Medical Center, Kurume University Hospital, were evaluated retrospectively. Twenty-four of the patients were male and 73 were female; they ranged in age from 17 to 54 years (mean age 23.44 ± 6.74 years). The study protocol was approved by the institutional ethics committees and the study was performed in accordance with the requirements of the Declaration of Helsinki (64th WMA General Assembly, Fortaleza, Brazil, October 2013).

The anesthesia used, amount of mandibular movement (right, left), and intra- and postoperative complications (e.g., unexpected bleeding, proximal segment dislocation from the glenoid fossa, non-union of the osteotomy, intraoperative fracture of the coronoid process, nerve dysfunction) were recorded. The same surgeon performed all operations and all patients received preoperative and postoperative orthodontic treatment.

The inclusion criteria for the subjects were (1) at least 12 months of follow-up, and (2) the patient had undergone IVSRO either unilaterally or bilaterally. Genioplasty ($n = 19$) and removal of the buccal fat pad ($n = 3$) were supplementary procedures in these cases. Patients who had conditions or a history indicating a greater propensity to altered recovery patterns, or systemic conditions such as a pre-existing orofacial sensory disturbance, a history of facial trauma or operation, diabetes mellitus, or significant psychiatric disorders were excluded from this study.

Modified L-shaped IVSRO procedure

This procedure comprises a modified version of the L-shaped IVSRO technique (Choung I osteotomy)[3]. The initial incision is made from the anterior border of the ascending ramus to the external oblique line at the level of the second molar. The lateral surface of the mandible extending from the sigmoid notch to the upper half of the mandible is exposed with a ramus retractor following the initial incision. A portion of the temporalis tendon is stripped off the coronoid process with a Bauer retractor to identify the anterior aspect of the sigmoid notch. The medial surface of the mandible is also exposed to avoid injury to the maxillary artery. Decortication is performed parallel to the original sagittal plane from the mid-sigmoid notch area inferior to the anti-lingula prominence and then inferiorly to the upper half of the mandible (Fig. 1A). A vertical osteotomy with a partial thickness cut is made with a Lindemann bur to the sigmoid notch as a guide groove (Figs 1B and 2). Additional full-thickness cutting of the subcondylar notch area is performed with a sagittal saw (Fig. 1C). A Lindemann bur is inserted horizontally at the same level as the mandibular foramen. The horizontal osteotomy is performed, protecting the soft tissue using a ramus retractor. Next, the proximal and distal segments are split with a thin spatula osteotome or bone-separator, and the L-shaped osteotomy is completed (Fig. 1D).

The proximal and distal segments of the mandible were not fixed with wires or with a plate and screws in any of the patients. After surgery, intermaxillary fixation was performed for 1 week and elastic intermaxillary fixation for 6 months or more.

Results

All of the 97 patients who underwent the IVSRO procedure did so under general anesthesia through nasotracheal intubation. The amount of mandibular movement ranged from −11 to 2 mm (mean −3.3 ± 3.4 mm) on the right side and from −9 to 5 mm (mean −2.8 ± 3.6 mm) on the left side.

Intraoperatively, there was no unexpected bleeding from the operative site. Proximal segment dislocation from the glenoid fossa was observed on one side (0.82%), which was treated in a second surgery. Non-union of the osteotomy was not seen in any patient (Fig. 3). Intraoperative fracture of the coronoid process

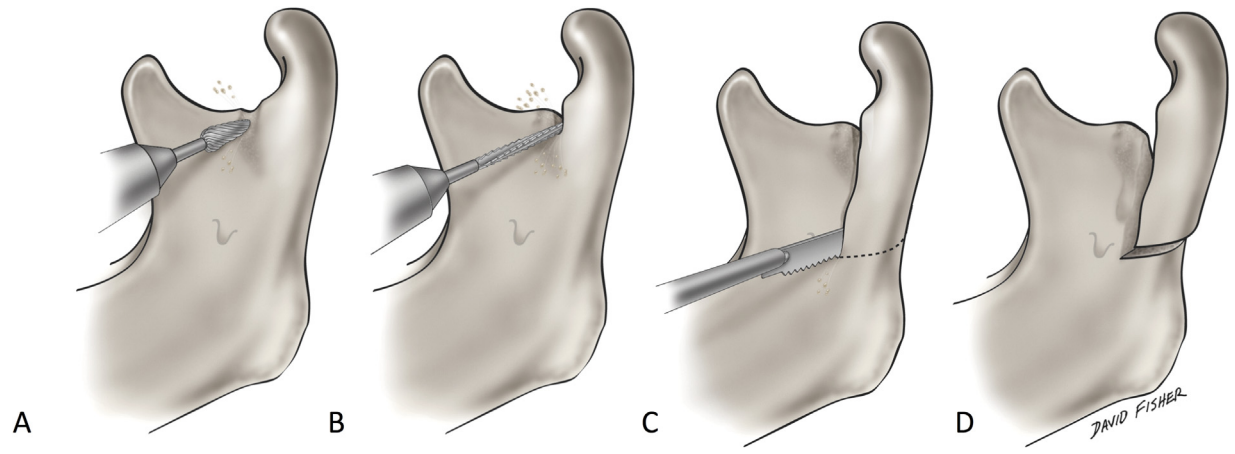

Fig. 1. Procedure for the modified L-shaped IVSRO technique: (A) decortication of the cortical bone; (B) partial thickness cutting with a Lindemann bur; (C) full-thickness cutting with the sagittal saw; (D) completion of the modified L-shaped osteotomy.

Please cite this article in press as: Iwanaga J, et al. Intraoral vertico-sagittal ramus osteotomy: modification of the L-shaped osteotomy, *Int J Oral Maxillofac Surg* (2017), http://dx.doi.org/10.1016/j.ijom.2017.06.003