TECHNICAL NOTE

From the Eastern Vascular Society

Mandibular subluxation for distal internal carotid exposure: Technical considerations

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Purpose: **Carotid endarterectomy (CEA) has become one of the most commonly performed vascular procedures, because of the beneficial outcome it has when compared with medical therapy alone and because of the anatomic accessibility of the artery. In cases of distal carotid occlusive disease, high cervical carotid bifurcation, and some reoperative cases, access to the distal internal carotid artery may limit surgical exposure and increase the incidence of cranial nerve palsies. Mandibular subluxation (MS) is recommended to provide additional space in a critically small operative field. We report our experience to determine and illustrate a preferred method of MS.**

Methods: **Techniques for MS were selected based on the presence or absence of adequate dental stability and periodontal disease. All patients received general anesthesia with nasotracheal intubation before subluxation. Illustrations are provided to emphasize technical considerations in performing MS in 10 patients (nine men and one woman) who required MS as an adjunct to CEA (less than 1% of primary CEAs). Patients were symptomatic (n = 7) or asymptomatic (n = 3) and had high-grade stenoses demonstrated by means of preoperative arteriography.**

Results: **Subluxation was performed and stabilization was maintained by means of: Ivy loop/circumdental wiring of mandibular and maxillary bicuspids/cuspids (n = 7); Steinmann pins with wiring (n = 1); mandibular/maxillary arch bar wiring (n = 1); and superior circumdental to circummandibular wires (n = 1). MS was not associated with mandibular dislocation in any patient. No postoperative cranial nerve palsies were observed. Three patients experienced transient temporomandibular joint discomfort, which improved spontaneously within 2 weeks.**

Conclusion: **Surgical exposure of the distal internal carotid artery is enhanced with MS and nasotracheal intubation. We recommend Ivy loop/circumdental wiring as the preferred method for MS. Alternative methods are used when poor dental health is observed. (J Vasc Surg 1999;30:1116-20.)**

Exposure of the distal internal carotid artery (ICA) during carotid endarterectomy (CEA) for anatomically high carotid bifurcations or distal occlusive disease requires specialized procedures in some cases. Presence of disease at or above the second cervical vertebrae may complicate an otherwise safe and well-tolerated procedure. Limited accessibility of the distal ICA has resulted in a variety of operative approaches to gain optimal exposure and control.[1-7] Mandibular subluxation (MS) has been recommended to facilitate distal dissection and to potentially reduce the incidence of cranial nerve palsies.[8-11]

We have reviewed our experience with MS to determine a preferred method and to document results. Details of the surgical procedure are described.

PATIENTS AND METHODS

From 1985 to 1998, 10 patients underwent unilateral MS as an adjunct to carotid reconstruction.

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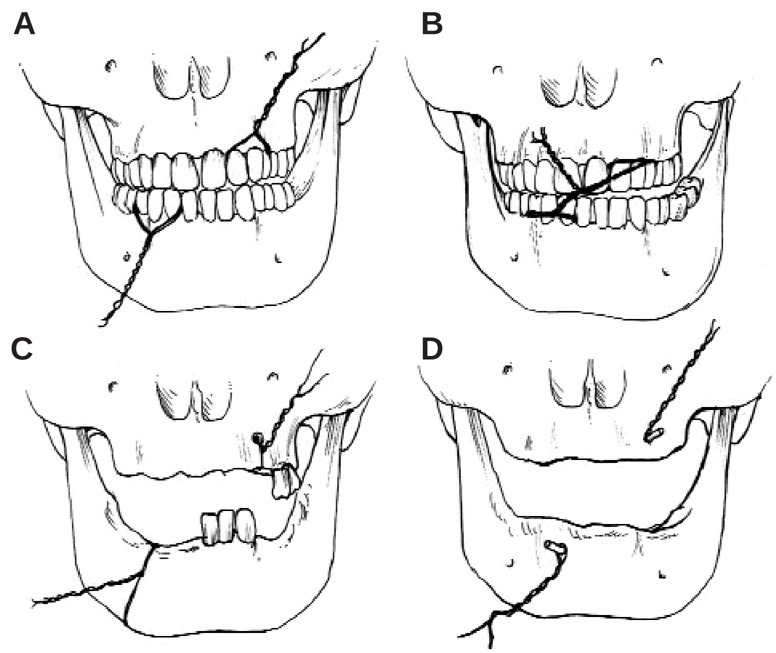

Fig 1. The techniques used to achieve temporary fixation are demonstrated in a frontal view. **A,** Circumdental wires. **B,** Wire fixation with lateral displacement of the mandible on the maxilla. **C,** Circummandibular maxillary peralveolar wires. **D,** Steinmann pins.

This represented less than 1% of our CEA procedures.[12] Preoperative consultation with physicians from the oral maxillofacial surgery or otolaryngology department was obtained in all cases. MS was performed, and the method of stabilization was selected based on the presence or absence of adequate dental stability and periodontal disease. Methods of stabilization consisted of Ivy loop/circumdental diagonal wiring (n = 7), Steinmann pin placement with wiring (n = 1), mandibular/maxillary arch bar wiring (n = 1), and superior bicuspid circumdental to circummandibular wiring (n = 1).[13]

TECHNIQUE

Distal lesions were defined as those superior to a line drawn between the angle of the mandible and the tip of the mastoid process, as originally reported by Blaisdell.[14] Indications for MS included anatomically high bifurcations (n = 5) and distal internal carotid disease (n = 5), extending to the second cervical vertebrae or above. Two patients had kinked carotids, two with recurrent stenoses and one with an aneurysm. CEA was performed in eight cases, and bypass grafting was performed in two instances.

All patients underwent general anesthesia with nasotracheal intubation. In patients with healthy dentition, individual circumdental stainless steel wires (numbers 20 to 24) were placed around the mandibular cuspid and each bicuspid ipsilateral to the vascular lesion. Similar wires were placed around the contralateral maxillary cuspids and bicuspids (Fig 1*A*). MS was then performed by grasping the mandible and manipulating gently, but firmly, anteriorly and inferiorly, then contralaterally, approximately 10 to 15 mm. Ideally, the ipsilateral condyle should be displaced to, but not beyond, the articular eminence. This position was then maintained by twisting the corresponding wires together, resulting in a diagonal fixation (Fig 1*B*). The wire ends were then cut and crimped to avoid injury to the patient or surgeon.

When any of the cuspid or bicuspid teeth had mild to moderate periodontal disease, they were first splinted with arch bars, and fixation was achieved by placing the intra-arch wires over the arch bar lugs or around the splinted teeth and arch bar. This would minimize the force on individual teeth. When severe periodontal disease was present or the teeth were absent, either Steinmann pins or circummandibular/maxillary peralveolar wiring were used. Mandibular Steinmann pins or circummandibular wires were placed in the ipsilateral cuspid-bicuspid region; maxillary Steinmann pins or peralveolar wires were placed in the contralateral cuspid-bicuspid region. Pins were placed directly into the mandible or maxilla through

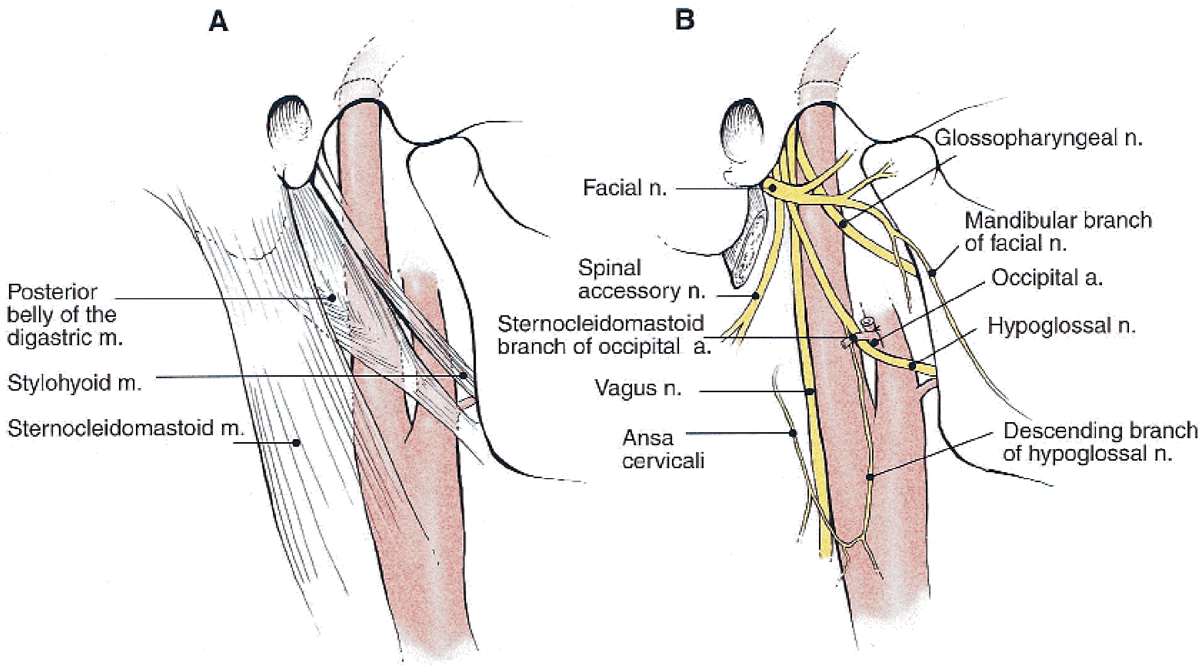

Fig 2. **A,** The enhanced exposure gained by mandibular subluxation, but with the digastric and stylohyoid muscles intact, is demonstrated in this lateral view. **B,** The muscles are divided. Note the close relationships of the cranial nerves to the boundaries of the surgical field. Mobilization of the hypoglossal nerve is facilitated by means of ligation and division of the sternocleidomastoid branch of the occipital artery.

the oral mucosa, taking care to avoid the mandibular neurovascular bundle and tooth roots (Fig 1*D*). Pins were advanced until their points were palpated coming through the lingual/palatal surface of the bone; then they were cut, with approximately 1.0 cm of length protruding labially. Diagonal wiring and subluxation was then performed, and wires were placed around the pins, then tightened. Alternatively, one or more circummandibular wires were placed on the ipsilateral side by using mandibular passing awls or wires with double-end needles. The wires were twisted and tightened to form a loop, and the ends were cut short and crimped. A corresponding number of maxillary peralveolar wires were placed by using either a drill with a wire-passing bur or a maxillary wire-passing awl malleted through the maxilla (Fig 1*C*). MS was achieved and intra-arch wires were placed between the maxillary and mandibular loops and tightened to maintain MS.

The neck was extended, and the head was rotated to the contralateral side for CEA, followed by routine sterile draping. Carotid exposure was performed by extending the superior aspect of the incision toward the mastoid process. Division of the posterior belly of the digastric and stylohyoid muscle is routinely performed, with care taken to mobilize and protect adjacent cranial nerves. Surgical exposure after MS provided improved visualization of the hypoglossal, facial, and glossopharyngeal nerves (Fig 2*A* and *B*). After closure of the cervical incision, circumdental wires, pins, or both were removed, and the mandible was self-reduced to the anatomical position. Dental stability was then reassessed; the oral cavity was suctioned, and extubation was carried out when the patient was awake and neurologically intact. No diet restrictions were ordered, and normal oral intake was resumed by the patient on the first postoperative day before discharge.

RESULTS

All patients underwent successful carotid revascularization, without evidence of cranial nerve dysfunction or postoperative cerebral neurologic complications. Subluxations were completed within 20 to 30 minutes and did not further delay the operative procedure. There were no signs or symptoms of postoperative mandibular dislocation, impairments of mastication, bleeding, infection, or dental injury. No complications caused by wire, pin, or arch bar placements were observed. Three patients exhibited transient temporomandibular joint (TMJ) discomfort, which was

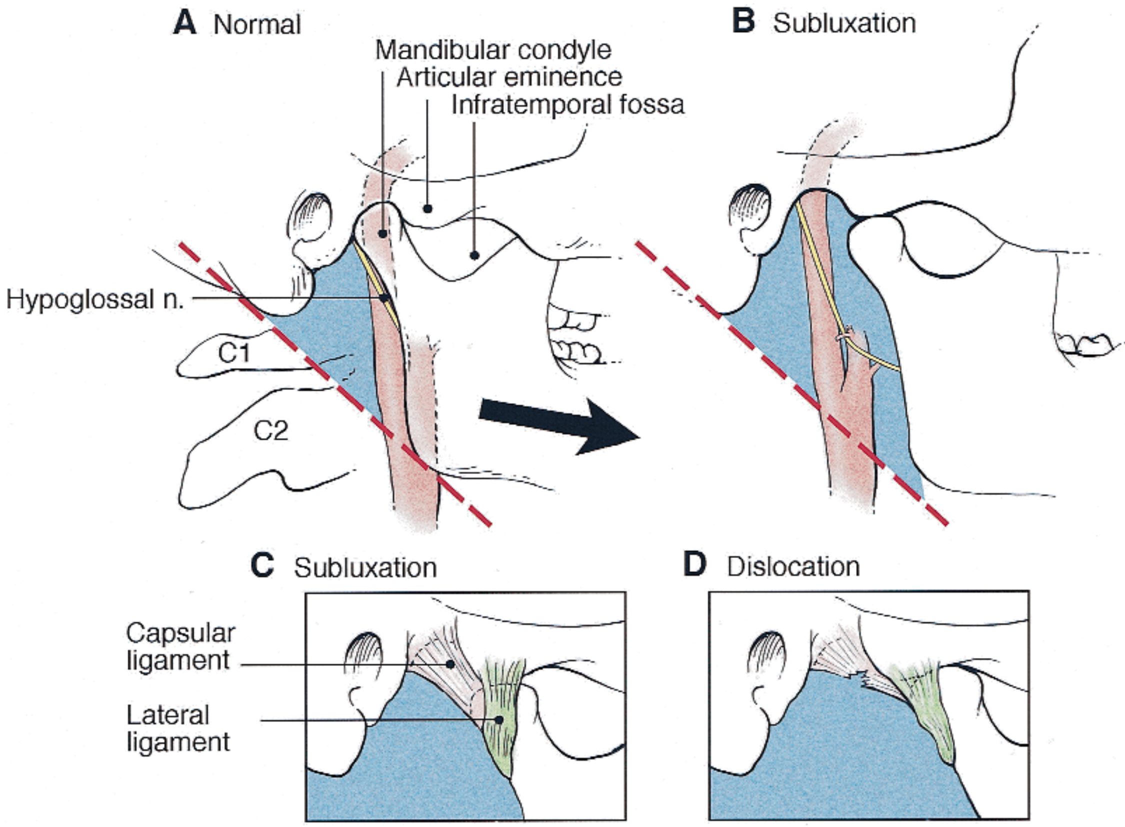

Fig 3. **A,** Normal location of the mandibular ramus without subluxation. Note the high bifurcation of the carotid artery, which is located at the level of the body of the second cervical vertebra and lies above a line drawn between the mastoid process and the angle of the mandible. **B,** The mandibular condyle is pulled forward onto the articular eminence. Note the additional exposure obtained when the subluxed mandible is fixed in place at this position. **C,** Inset view shows desired position of the temporomandibular ligaments during subluxation. **D,** Inset view shows undesired position of the temporomandibular ligaments from dislocation, which may result in tearing of the capsular ligament.

relieved with oral analgesics and cleared within the first 2 weeks postoperatively. All patients resumed an oral diet on the first postoperative day and were discharged without surgical complications. No evidence of TMJ dysfunction or cranial nerve palsies was identified on subsequent follow-up clinical examination.

DISCUSSION

Exposure and control of the distal ICA remains a challenge, because of the limited area for dissection and the concern about cranial nerve injuries. MS as a means of assisting with the surgical management of carotid occlusive disease and trauma has gained clinical acceptance since an early description of the technique by Fry and Fry in 1980.[6] Dossa et al[8] have described variations in surgical approach and operative maneuvers among 14 patients in a well-illustrated report on MS. Mock and colleagues[4] extended the rationale for MS in a report on 12 cadaveric dissections and three clinical cases. These clinicians measured the additional exposure gained by each surgical maneuver and reported that MS added nearly one centimeter of exposure beyond that obtained with division of the digastric. However, preferred techniques for MS remain unfamiliar to many vascular surgeons. These considerations stimulated our report emphasizing the technical aspects of MS.

Temporary unilateral MS with circumdental diagonal fixation has been reported to be safe and effective.[8-11] Certain anatomical considerations, however, must be emphasized when performing this maneuver. A properly performed MS displaces the mandibular condyle past the articular eminence by 2 to 3 mm. This displacement, anteriorly and inferiorly, then contralaterally from the normal resting position of the condyle, translates into an additional distal ICA exposure of as much as 15 mm (Fig 3*A* and *B*).[4] Although subluxation does not incur injury to the lateral or capsular ligaments of the TMJ, avoiding dislocation of the joint reduces the possibility of ligament injury and subsequent difficulty with mastication (Fig 3*C* and *D*). In addition, if dislocation occurs and in the presence of contralateral rotation of the head, the potential exists for compression of the contralateral carotid between the angle of the mandible and the vertebral process.

Minimizing the incidence of cranial nerve palsies requires a knowledge of cervical anatomy (Fig 2*B*). Structures at risk include the hypoglossal nerve, the facial nerve and its marginal mandibular branch, the glossopharyngeal nerve, and the vagus nerve. In addition to avoiding direct injury to these nerves during dissection around the distal carotid artery, care must be exercised to avoid undue traction on retractors, which is another cause of neuropraxia. As the dissection moves superiorly toward the base of the skull, identification of the glossopharyngeal nerve is an important aspect of the procedure, which is facilitated by MS. It should also be recognized, however, that the vertical aspect of the mandibular ramus is moved anteriorly during MS. This displaces the hypoglossal nerve cephalad and anteriorly, along with the posterior belly of the digastric, and care is recommended in dividing the muscle, so hypoglossal injury is avoided.

Familiarity with the techniques of MS has been a valuable adjunct in our surgical management of distal carotid disease. In the absence of postoperative cranial nerve palsies or TMJ dysfunction, we recommend MS for the safe exposure of the distal ICA. We suggest circumdental wiring as the preferred method for MS, with alternative methods to be used in cases of poor dental health.

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