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ScienceDirect
Surgical Neurology 71 (2009) 504 – 509
SURGICAL NEUROLOGY
www.surgicalneurology-online.com

Peripheral Nerves

Brachial plexopathy due to massive swelling of the neck associated with craniotomy in the park bench position

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Received 25 January 2007; accepted 27 August 2007

Abstract

Background: During prolonged neurosurgical procedures, anesthetized patients are at risk for position-related complications. We report a rare combination of neck swelling and brachial plexopathy as operative position-related complications.

Case Description: This 56-year-old woman was placed in the left park bench position for removal of a tentorial meningioma in the right posterior fossa. At 2 hours after the 10-hour procedure, her left neck began to swell with progression during the next 10 hours to involve the face on the same side and the face and neck on the opposite side. Computed tomography showed swelling of the muscles and deep soft tissue primarily on the left. No brain edema was observed. She was conservatively treated with orotracheal intubation, placed in the head-up position, and received anticoagulants. Her swelling subsided by the 20th postoperative day; however, she manifested weakness in the proximal muscles of the left upper extremity. Magnetic resonance imaging revealed swelling of the brachial plexus on the left; electrophysiologic studies were compatible with damage to the upper trunk of the brachial plexus. She was discharged 2 months after surgery with improved weakness.

Conclusion: Possible pathologic mechanisms are kinking of the jugular vein due to extremely flexed neck position during surgery and associated delayed swelling of the neck and brachial plexus. The cerebral venous return may have been maintained by anastomosis between the internal jugular and the vertebral venous system. To prevent such complications, we must take great care of the anesthetized patients when placed in the forced neck position.

Keywords: Brachial plexopathy; Craniotomy; Intraoperative position; Neck swelling; Venous return

1. Introduction

During prolonged neurosurgical procedures, anesthetized patients subject to the effects of gravity and mechanical force exerted for positioning the neck and extremities are at risk for decubitus, air embolism, and damage to the cervical spinal cord, brachial plexus, and peripheral nerve [2]. We encountered a previously unreported combination of position-related complications, that is, massive swelling of the neck and face [3,5-8,10,11], and brachial plexopathy in a patient who underwent posterior fossa surgery in the park bench position.

2. Case report

This 56-year-old previously healthy woman, 154 cm in height and 43 kg in weight, presented with speech difficulty and gait disturbance. Neuroimaging revealed a 5-cm diameter tentorial meningioma in the right posterior fossa and obstructive hydrocephalus. No laboratory abnormalities including coagulopathy were found. She underwent preoperative intravascular embolization and removal of the tumor via right suboccipital craniotomy. After orotracheal intubation with a 7.5-mm armored tube, a central venous

Abbreviations: CT, Computed tomography; CTA, CT angiography; MRA/V, Magnetic resonance arteriography/venography.

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0090-3019/$ – see front matter © 2009 Elsevier Inc. All rights reserved.
doi:10.1016/j.surneu.2007.08.043

catheter was inserted in the right internal jugular vein. She was then placed in the left park bench position, and the head was fixed with neck flexion (2-fingerbreadth clearance between the chin and thorax was confirmed). We used approximately 20° rotation of the neck to the opposite side and an approximately 10° bend to the left. The axilla was supported by an axillary roll. Before opening the dura, 300 mL of 20% mannitol were administered. During cutting of the tentorium for removal of the tumor origin, venous sinus bleeding from the cut edge was controlled, and no brain swelling was observed. The tumor was totally removed. During the 10-hour procedure, the patient's position remained unchanged. Her mean intraoperative systolic blood pressure was 100 mm Hg. The total amount of fluid delivered was 4500 mL; her urine output was 955 mL, and she did not require blood transfusion.

Upon removal of the surgical drapes, erosion of the skin on the left side of the neck was observed. Postoperative care was in the semi-Fowler's position under mechanical ventilation with mild sedation: spontaneous movement of all extremities was observed. Her mean systolic blood pressure was maintained at 120 mm Hg. Swelling of the neck on the left side was noted 2 hours after the operation (Fig. 1). Neck swelling on the left due to swelling of the muscles and deep soft tissue, detected by computed tomography (CT) (Fig. 2A), was monitored and treated conservatively. However, it progressed over the next 10 hours to involve the face on the left and the face and neck on the right side. She was unable to open her eyes, and conjunctival edema was noted. A CT scan showed marked swelling and displacement of the trachea toward the right and thrombus formation in the right internal jugular vein (Fig. 2B). Because there was no CT evidence of brain edema, we considered the venous return of the brain to be preserved. To improve the swelling, she remained in the head-up position with neutral neck position, and we administered heparin to maintain 1.5 times the international normalizing ratio. She was mildly sedated and breathed through an orotracheal tube left in place to secure the airway. The swelling gradually subsided, and she was extubated uneventfully on the 11th postoperative day. Neurologic examination performed at that time, the first postoperative neurologic examination, showed weakness in the deltoid, biceps, and brachioradialis muscles on the left; at manual muscle testing, her score was 0/5; there was no weakness in the trapezius, triceps, and hand muscles. She showed dysesthesia and hypesthesia in the shoulder, radial side of the arm, and thumb on the left. Magnetic resonance imaging obtained on day 15 revealed no cervical cord lesion; however, there was swelling of the brachial plexus on the left (Fig. 3).

Fig. 1. Picture showing left neck swelling at 2 hours after surgery. There are skin erosions and blisters of the skin suggestive of excessive forced neck position during surgery.

A CT scan obtained on day 20 showed that the swelling had subsided (Fig. 2C).

Electrophysiologic studies were obtained on day 32. Electromyography showed acute denervation in the left deltoid, biceps, and brachioradialis muscles. Motor nerve conduction study revealed slow conduction in the left suprascapular, axillary, and musculocutaneous nerve. These findings confirmed damage to the upper trunk of the brachial plexus.

She underwent rehabilitation, received vitamin B_{12}, and was discharged 2 months after surgery; her manual muscle test score at discharge was 3/5. She has been followed up for 9 months, and the weakness improved; her manual muscle test score at this time was 4/5. Sensory disturbances in the left arm persisted.

3. Discussion

Swelling of the neck, face, and tongue after neurosurgical procedures has rarely been reported in the field of anesthesiology [3,5-8,10,11]. As shown in Table 1, both adults and children can manifest this iatrogenic condition, and most affected individuals had undergone posterior fossa surgery in the sitting position. Because this position requires prolonged excessive neck flexion, kinking of the internal jugular vein may contribute importantly to obstruction of the venous return of the head and neck. However, Narayan and Rao [8], who performed Doppler study when their patient manifested facial and neck swelling after infratentorial surgery in the lateral position, did not detect thrombus formation in the internal jugular vein. Furthermore, there was no association with conditions conducive for thrombus formation, for example, hypovolemia and coagulopathy. Ellis et al [3] suggested that bilateral occlusion of the internal jugular vein plays an important role in soft tissue swelling; however, in most cases, there was no intraoperative brain edema. Compensatory venous drainage via abundant venous anastomoses between the sigmoid sinus and vertebral venous plexus, that is, the mastoid and condylar emissary veins [1], may explain this phenomenon, and patients with poorly developed anastomoses may acquire brain edema. Swelling has also been reported in patients operated in the supine position with neck flexion, the lateral position with flexion, lateral bend, and rotation. Disturbed lymphatic and venous

drainage due to compression of the tongue by the orotracheal tube and of the oral airway may contribute to local swelling of the tongue. Furthermore, in children, anatomical factors such as short neck, high larynx, small tracheal diameter, and large tongue (secondary to high larynx and insertion of the tongue) may exaggerate this condition [6]. Ellis et al [3] attributed the delayed onset of swelling in the first few hours after extubation to the gravity-induced maintenance, despite neck flexion, of sufficient venous return during surgery in the head-up position. Postoperative management with the patient's head in the lower position and an elevation in the blood pressure may exaggerate existing soft tissue swelling due to congestion and increased tissue permeability. In most patients, swelling persisted for 1 day to 12 weeks irrespective of antiswelling agents administered; most patients exhibited swelling for 2 to 3 weeks. In the process of recovery from swelling-induced compression of the venous system, it may be necessary that the venous return in the external jugular system be restored via the development of a collateral venous pathway. Airway obstruction due to swelling requires reintubation or tracheostomy to prevent death by asphyxia.

To avoid position-related swelling, McAllister [6] recommended not using an oral airway that may compress and occlude venous drainage of the tongue, inserting a bite

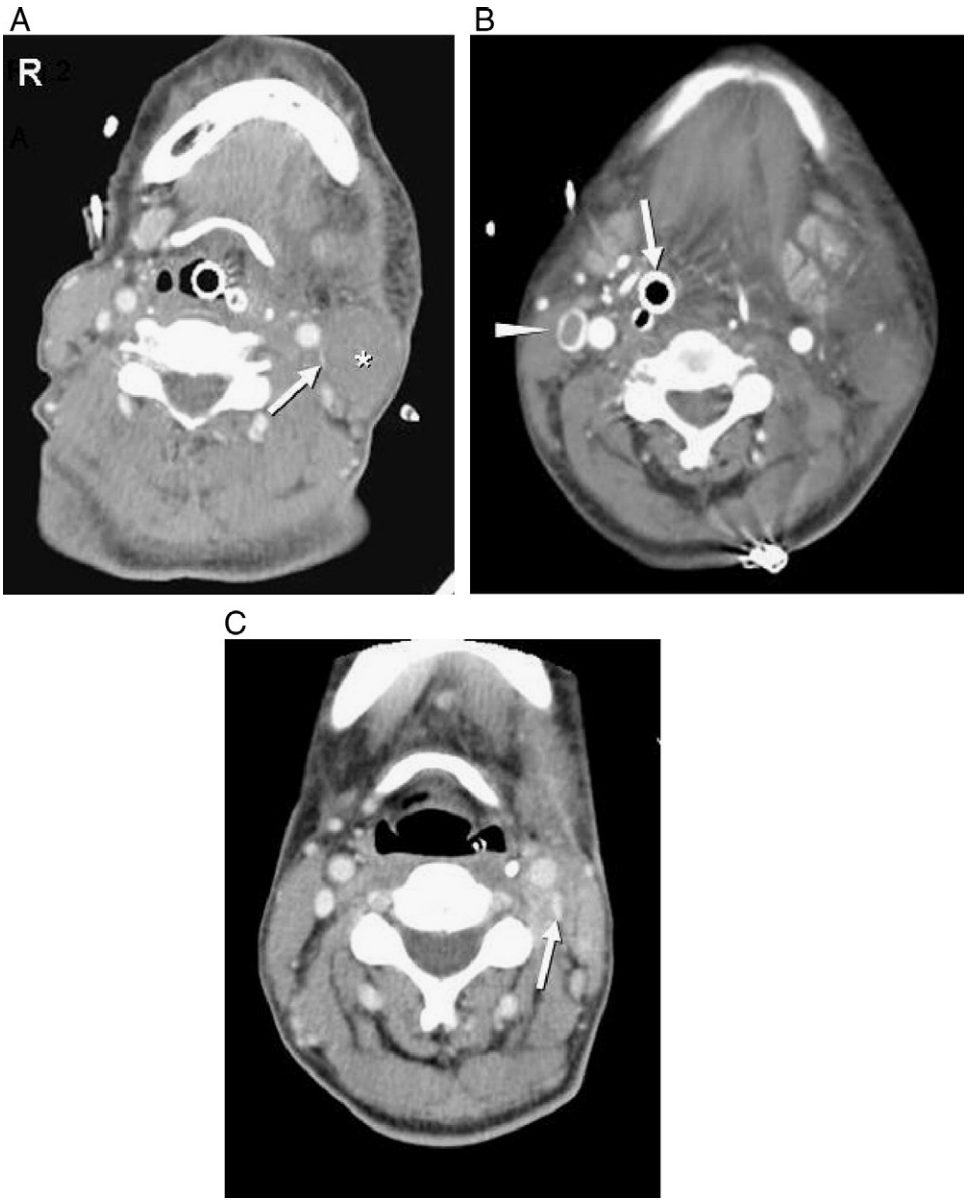

Fig. 2. Consecutive postoperative contrast-enhanced computed tomographs of the neck. A: At 2 hours after surgery, there is neck swelling on the left because of swelling of the muscles and deep soft tissue. The left internal jugular vein is markedly compressed (arrow) by the swollen sternocleidomastoid muscle (asterisk). A central venous catheter inserted in the right internal jugular vein is also seen. B: Progressive swelling at 1 day after surgery. There is marked displacement of the trachea toward the right (arrow). Note thrombus formation in the right internal jugular vein (arrowhead). C: By the 20th postoperative day, there is almost complete resolution of the swelling. The internal jugular vein is normalized; its caliber on the left is normal (arrow), and the thrombus on the right has disappeared.

Fig. 3. Diffusion-weighted magnetic resonance image, coronal view, obtained 15 days after surgery demonstrates swelling of the brachial plexus on the left (asterisk). There is persistent swelling of the ipsilateral soft tissue.

Fig. 4. Right common carotid angiogram, venous phase (lateral view), at the completion of intravascular coil embolization via the middle meningeal artery. There is opacification of the vertebral venous system through an anastomosis from the sigmoid sinus (arrow).

block to avoid tongue compression by the teeth, and avoidance of extreme flexion of the head against the chest that may compress the airway, tube, and tracheal rings against the base of the tongue.

In our patient, we postulate that the following pathologic mechanisms led to massive swelling. The relative overflexed neck position, despite the absence of a short neck and obesity, may have triggered consecutive deterioration due to compression of the left internal jugular vein. After releasing the flexed neck position and placing the head in a lower position, postoperative blood pressure elevation may have led to exaggeration of her neck swelling on the left. The secondary swelling of the neck on the right side may have been a consequence of thrombus formation in the ipsilateral internal jugular vein (probably related to insertion of a central venous catheter) rather than intraoperative compression of the internal jugular vein, because swelling on the right appeared approximately 20 hours after the initial neck

Table 1
Summary of cases with face and neck swelling after neurosurgical operation

Author (y)	Age/sex	Surgery			Postoperative swelling			
		Position	Time (h)	Brain edema	Region	Onset[a]	Duration	Outcome
McAllister [6] 1974	22 mo/M	Sitting	6	No	Tongue	Immediate	4 d	Death[b]
	45y/M	Sitting	10	No	Tongue	Immediate	1 d	Good
Ellis et al [3] 1925	21y/M	Sitting	14	Yes	Tongue Lip Face Neck	Immediate	3 wk	Good
Tattersall [10] 1984	30y/F	Sitting	12	No	Tongue Lip Face	Immediate	22 d	Death[b]
Munshi et al [7] 1989	8y/M	Sitting	10	Yes	Tongue[c] Lip[c] Face[c] Neck[c]	Immediate	5 d	Good
Mayhew et al [5] 1985	16 mo/M	Sitting	5	Unknown	Tongue	20 min	12 wk	Good
Teeple et al [11] 1986	56y/F	Supine	8	No	Tongue[c]	Immediate	3 wk	Good
Narayan and Rao [8] 1999	40y/F	Left lateral	8	No	Face[c] Neck[c]	Immediate	3 wk	Good
Present case	56y/F	Left park bench	10	No	Face Neck	2 h	10 d	Left brachial plexopathy

[a] Period after the surgery.
[b] Death due to asphyxia.
[c] Unilateral swelling.

swelling on the left. Compensation of the cerebral venous return may depend on abundant venous anastomoses between the sigmoid sinus and vertebral venous plexus. A retrospective study of angiograms revealed the existence of the venous anastomoses in our case (Fig. 4).

Brachial plexus injury is one of the most common nerve injuries in anesthetized patients, especially those under general anesthesia, and is related to the intraoperative position, such as sustained neck extension, and malposition of the arms [2]. In our patient, however, brachial plexopathy appeared not to be attributable to direct position-related mechanical damage but to delayed secondary damage due to neck swelling, because contraction of the proximal muscles in the affected extremity was observed immediately after surgery. The axillary roll in this case was used as our previous cases with craniotomy in the park bench position, in which no brachial plexopathy was experienced, and we believe the plexopathy is not due to compression in the axilla. Magnetic resonance imaging findings on the brachial plexus may suggest swelling due to edema, as is found in cases with brachial plexus injury [4,9]. Swelling may contribute to disturbed venous return of the structure per se and/or compression by swollen neighboring neck tissue including the scalene muscles.

Although the precise incidence of such serious complications is unknown, the case reported here was the only 1 (0.67%) among our 150 patients subjected in the course of the last 10 years to craniotomy in the park bench position. Because some patients with postoperative erosion of the skin on the neck, suggestive of excessively forced neck position, did not develop swelling, its occurrence may depend on the individual anatomical tolerance of the venous return to the forced neck position.

In conclusion, in patients undergoing surgery with the head in forced position, the risk of such rare but possibly life-threatening complications must be considered. Great care must be taken both in placing the anesthetized patient in the forced neck position and in postoperative care. To the best of our knowledge, this is the first case of brachial plexopathy associated with neck swelling after a neurosurgical procedure.

References

[1] Braun JP, Tournade A. Venous drainage in the craniocervical region. Neuroradiology 1977;13:155-8.
[2] Cheney FW, Domino KB, Caplan RA, et al. Nerve injury associated with anesthesia. A closed claims analysis. Anesthesiology 1999;90:1062-9.
[3] Ellis SC, Bryan-Brown CW, Hyderally H. Massive swelling of the head and neck. Anesthesiology 1975;42:102-3.
[4] Kneeland JB, Kellman GM, Middleton WD, et al. Diagnosis of diseases of the supraclavicular region by use of MR imaging. AJR Am J Roentgenol 1987;148:1149-51.
[5] Mayhew JF, Miner M, Katz J. Macroglossia in a 16-month-old child after a craniotomy. Anesthesiology 1985;62:683-4.
[6] McAllister RG. Macroglossia—a positional complication. Anesthesiology 1974;40:199-200.
[7] Munshi CA, Dhamee MS, Gandhi SK. Postoperative unilateral facial oedema: a complication of acute flexion of the neck. Can Anaesth Soc J 1984;31:197-9.
[8] Narayan VB, Rao GSU. Unilateral facial and neck swelling after infratentorial surgery in the lateral position. Anesth Analg 1999;89:1290-1.
[9] Rapoport S, Blair DN, McCarthy SM, et al. Brachial plexus: correlation of MR imaging with CT and pathologic findings. Radiology 1988;167:161-5.
[10] Tattersall MP. Massive swelling of the face and tongue. A complication of posterior cranial fossa surgery in the sitting position. Anaesthesia 1984;39:1015-7.
[11] Teeple E, Maroon J, Rueger R. Hemimacroglossia and unilateral ischemic necrosis of the tongue in a long-duration neurosurgical procedure. Anesthesiology 1986;64:845-6.

Commentary

In this case report, Shimizu et al describe a rare complication of operative positioning, which resulted in a delayed severe postoperative brachial plexopathy. The authors have extensive experience with the park bench position for craniotomies and used appropriate precautions to avoid neck hyperflexion or direct axillary compression of the plexus. Indeed, the patient awakened with good strength in the involved extremity, but then developed massive swelling of the neck and face with tracheal deviation over the next few hours postoperatively. This swelling gradually subsided, but the patient had a persistent axonotmetic deficit in the distribution of the upper trunk of the brachial plexus. The precise mechanism of this deficit is unclear. The authors provide a plausible explanation, which includes a presumption of ipsilateral internal jugular vein compression. They believe that, postoperatively, blood pressure elevation along with a lowered head position resulted in exacerbation of neck swelling. The contralateral internal jugular vein was also thrombosed, likely because of a central venous catheter. Fortunately, the brain had adequate collateral venous drainage and did not swell or obtain venous infarction. Subsequently, the patient was managed well postoperatively in the head-up position with anticoagulation and prolonged intubation until the swelling resolved, and fortunately, is making a satisfactory neurologic recovery.

This report serves as a reminder that our usual operative positioning precautions may not be adequate protection against neurologic injury in all patients. For example, the “2-fingerbreadth rule” for the distance between the mandible and the sternum does not always avoid excessive internal jugular vein compression, particularly when the neck is rotated and laterally flexed. Patients are often in this position for many hours and, as in this case, are hypovolemic (after mannitol administration) and hypercoagulable. They may have central venous lines in place and several prior venipunctures in other neck veins. Perhaps the use of a Doppler probe would help to avoid this type of event.

Somatosensory-evoked potential monitoring may be used intraoperatively not only for assessment of the brain and spinal cord but also the brachial plexus. In any patient with a