Numerous techniques have been described for C1–2 fixation. Rigid fixations in which transarticular screws are used have been demonstrated to be safe and highly effective for C1–2 stabilization in most patients, with the final result being fusion. These procedures afford immediate rigid fixation and provide greater stiffness in rotation and anteroposterior translation than posterior wiring techniques, such as the Gallie or Brooks fusion, and they obviate the need for halo vest immobilization. The use of transarticular screws is biomechanically desirable, but in some cases they cannot be used easily. Especially in cases in which there is a larger groove of the VA in the axis, often called “a high-riding transverse foramen,” a safe screw trajectory is either impossible to attain or is associated with a substantial risk of iatrogenic artery damage in up to 20% of cases. Additional poor candidates for C1–2 transarticular screw fixation are those who suffer from thoracic kyphosis, obesity, or a fixed cervical deformity that prohibits the correct angle for screw placement. To avoid or minimize the risks and disadvantages associated with C1–2 transarticular screw fixation, one screw fixation method is becoming more popular; in this procedure the C-1 lateral mass screws are used in conjunction with C-2 pedicle screws. Although injury to the hypoglossal nerve has been reported to be associated with C1–2 transarticular fixation, little is known about the relationship between C-1 lateral mass screw placement and the hypoglossal nerve. We describe a unique case of hypoglossal nerve palsy following C1–2 screw–rod fixation. The hypoglossal nerve is one of the structures that can be damaged during C-1 lateral mass screw placement.

Case Report

Histology and Examination. This 67-year-old man presented to another hospital after suffering posterior neck pain following a hyperextension neck injury. He had been treated with halo vest immobilization for 4 months after the diagnosis of a C-2 odontoid fracture was made, but successful fusion did not occur. He was then transferred to our hospital. On admission, a physical examination did not reveal any notable findings except severe persistent pain and tenderness on the posterior aspect of his neck. Computed tomography scanning showed a Type 2 odontoid fracture with transverse ligament disruption, but there was no focal area of cord compression. Magnetic resonance imaging revealed no C1–2 spinal cord injury. The

Hypoglossal nerve palsy after posterior screw placement on the C-1 lateral mass

Case report

JAE TAEK HONG, M.D., PH.D., SANG WON LEE, M.D., PH.D., BYUNG CHUL SON, M.D., PH.D., JAE HOON SUNG, M.D., PH.D., IL SUB KIM, M.D., AND CHUN KUN PARK, M.D., PH.D.

Department of Neurosurgery, St. Vincent Hospital, the Catholic University of Korea, Suwon; and Department of Neurosurgery, Kangnam St. Mary’s Hospital, the Catholic University of Korea, Seoul, Korea

Atlantoaxial fixation in which C1–2 screw–rod fixation is performed is a relatively new method. Because reports about this technique are rather scant, little is known about its associated complications. In this report the authors introduce hypoglossal nerve palsy as a complication of this novel posterior atlantoaxial stabilization method. A 67-year-old man underwent a C1–2 screw–rod fixation for persistent neck pain resulting from a Type 2 odontoid fracture that involved disruption of the transverse atlantal ligament. Posterior instrumentation in which a C-1 lateral mass screw and C-2 pedicle screw were placed was performed. Postoperatively, the patient suffered dysphagia with deviation of the tongue to the left side. At the 4-month follow-up examination, bone fusion was noted on plain x-ray studies of the cervical spine. His hypoglossal nerve palsy resolved completely 2 months postoperatively.

To the authors’ knowledge, this is the first report in the literature of hypoglossal nerve palsy following C1–2 screw–rod fixation. The hypoglossal nerve is one of the structures that can be damaged during C-1 lateral mass screw placement.
integrity of the transverse atlantal ligament could not be verified using magnetic resonance imaging; however, on the patient’s left side, avulsion of the transverse ligament tubercle from its attachment to the C-1 lateral mass as well as lateral displacement of the C1–2 joint was demonstrated on CT scanning, which suggested transverse atlantal ligament disruption.

Operation. The patient underwent posterior C1–2 screw–rod fixation in which the Harms–Melcher technique was used: 3.5 × 30 mm polyaxial screws (DePuy Acromed, Raynham, MA) were inserted bicortically into the lateral mass of C1, and 3.5 × 26 mm polyaxial screws were placed into the pedicle of C2 bilaterally. Immediately postoperative radiographs and CT images (Fig. 1 left) confirmed good positioning of all hardware. However, dysphagia and mild dysarthria developed immediately after surgery. The patient also experienced severe pain in his tongue due to inadvertent tongue biting. Thus he required feeding through a nasogastric tube for approximately 4 weeks. On neurological examination we observed a slight left-sided deviation of the tongue, which is a classic symptom of unilateral hypoglossal nerve palsy. A barium swallow x-ray study ruled out any injury or obstruction to the esophagus or pharynx.

Postoperative Course. The hypoglossal nerve palsy improved over the next 6 weeks, and there was no evidence of tongue wasting. Functionally, the patient exhibited complete recovery from his dysphagia and dysarthria at his 2-month follow-up examination. Lateral dynamic radiography of the cervical spine performed 4 months after surgery revealed evidence of posterior bone fusion and no cervical instability (Fig. 1 right). At his 8-month follow-up examination, the patient exhibited no neurological deficits or neck pain.

Discussion

Atlantoaxial fusion is a challenging procedure for most spine surgeons because of the variable anatomy of this region and its proximity to important structures. During the past three decades there have been significant improvements in atlantoaxial fusion techniques, and various methods of atlantoaxial fixation have been described in the literature. Since Magerl and Seemann introduced the technique for C1–2 transarticular screw fixation in 1979, it is widely accepted that this type of fixation is the strongest construct for treating patients with C1–2 instability. Nonetheless, C1–2 transarticular screw fixation can cause serious injury to the VA. Furthermore, patient habitus (for example, obesity or thoracic hyperkyphosis) may prohibit attainment of the low angle needed for correct placement of the screw across C-1 and C-2. Goel, Harms, and their colleagues separately introduced the procedure in which a C-1 lateral mass screw and C-2 pedicle screw are placed individually. This procedure also avoids the potential complication of VA injury, thereby increasing the feasibility of intraoperative fracture reduction and imposing very little restriction for insertion of the C-2 pedicle screws because of the large trajectory angles compared with transarticular screws. Investigators of many biomechanical studies concur that the C1–2 screw–rod fixation technique is comparable to C1–2 transarticular screw fixation with respect to biomechanical stability.

Despite the advantage of C-1 lateral mass screw fixation, one of its potential problems is injury to the neurovascular structures around the cervical vertebrae. Most surgeons understand that the C-1 screw can irritate or damage the C-2 nerve root, VA, and spinal cord because of their proximity. However, because of the rather scanty data and lack of long-term follow-up studies, the exact incidence of injury to neurovascular structures associated with this new technique cannot be properly analyzed. In addition, relatively little attention is given to the possibility of injury to ventral neurovascular structures such as the ICA and hypoglossal nerve. The hypoglossal nerve emerges from the anterior condylar canal in the skull base and passes downward between the ICA and jugular vein. In cadaveric studies researchers have found that the usual location of the hypoglossal nerve is dorsal to the ICA and lies approximately 2 to 3 mm lateral to the middle of the anterior aspect.
Hypoglossal nerve palsy after screw placement of the C-1 lateral mass. To avoid VA injury, a slightly medial angulated approach is recommended during C1–2 transarticular screw insertion. If transarticular C1–2 screw placement is performed precisely according to the Magerl technique, the hypoglossal nerve is unlikely to be injured because the screw exit site is located on the medial side or in the middle of the C-1 lateral mass. In the present case, we are not certain as to the exact cause of this patient’s transient hypoglossal nerve palsy. It may have been caused by insertion of a bicortical screw that was too long or by inadvertent deep penetration during the pilot hole drilling or tapping. Although Ryken, et al., have demonstrated that bicortical cervical vertical screws are superior to unicortical screws in terms of pullout strength and decreased wobble, excessive penetration of the lateral mass of C-1, especially with a straight or divergent trajectory, may put the hypoglossal nerve and ICA at risk. Therefore if the ICA and accompanying hypoglossal nerve are located aberrantly along the medial sides in front of the C-1 lateral mass, we recommend unicortical screw fixation. Bicortical C-1 fixation is strongest, but unicortical C-1 lateral mass fixation is stronger than subaxial lateral mass fixation.

There have been several reports of hypoglossal nerve injury caused by C1–2 transarticular screw fixation. However, no cases of hypoglossal nerve injury have been reported after C-1 lateral mass screw fixation. In terms of VA injury, C-1 lateral mass screw fixation is known to be relatively safe compared with C1–2 transarticular screw fixation. One often overlooks the need to orient the C-1 lateral mass screw medially during placement. However, it should be emphasized that the insertion angle of the C-1 lateral mass screw should be slightly medial to avoid the ventral neurovascular structures during bicortical screw fixation. Moreover, medial angulation of the C-1 lateral mass screw is important to obtain longer screw purchase length. It is obvious that for cancellous bone screws, a longer purchase length can effectively increase screw pullout strength.

Conclusions
The hypoglossal nerve is one of the structures that can be damaged during C-1 lateral mass screw fixation. Hypoglossal nerve palsy can be avoided by performing a medially directed angle approach to insert the screw and by carefully selecting a screw that is not too long. Unicortical screws are preferred to bicortical ones at the C-1 and C-2 levels to reduce the risk of penetration during surgery. Preoperative CT or magnetic resonance imaging should be performed to help in selecting the optimal screw length and for better approximation of the desired medial angulation of the screw.

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Address reprint requests to: Sang Won Lee, M.D., Ph.D., 93-6 Jidong Paldal-ku Suwon, Kyonggi-do 442-723, South Korea. email: nslsw@yahoo.com.