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## Anesthetic Management for Surgical Corrections of Severe Flexion Deformity of the Cervical Spine

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Surgical correction of severe flexion deformities of the cervical spine from ankylosing spondylitis is associated with difficult airway management and possible damage to spinal cord function. Flexion of the cervical spine in ankylosing spondylitis is a chronic process during which the spinal cord adapts to gradual anatomic distortion, and neurologic function often is maintained. Surgical correction with extension of the cervical spine can produce irreversible damage to the spinal cord either by occlusion of the blood supply to an area of the cord or by compression and stretching the cord.

A popular anesthetic technique for this procedure involves local anesthesia supplemented by analgesia from either inhalation of nitrous oxide or iv narcotics.<sup>1</sup> Several authors have stressed that the airway is maintained, and neurologic function is monitored continuously in the awake patient.<sup>1-3</sup>

Application of the flexible fiberoptic bronchoscope<sup>4,5</sup> and evoked potential averaging<sup>6,7</sup> may reduce the risk of general anesthesia in these patients. The trachea can be intubated prior to induction of anesthesia. Spinal cord function can be monitored, in part by extracting from the EEG the electrophysiologic response of the relay nuclei and somatosensory cortex to stimulation of a peripheral nerve. This is accomplished by a specialized computer, which averages the cortical response to repetitive stimuli and produces an interpretable wave-

form. The following case demonstrates the value of both instruments before and during the administration of general anesthesia for correction of severe cervical flexion deformities.

### REPORT OF A CASE

A 66-year-old, 140-cm, 50-kg woman had severe flexion deformity of the cervical spine associated with rheumatoid arthritis and ankylosing spondylitis involving the hands, feet, and vertebrae. Her preexisting cervical flexion had increased significantly following a fall four months prior to admission. The degree of cervical flexion became so severe that her chin was pressed into her chest wall over the manubrium, and the tip of her nose touched the chest wall over the body of her sternum (fig. 1). She had been unable to remove her upper denture for four months and was forced to take nutrition through a straw. She was taking aspirin and had no other significant medical problems.

Physical examination revealed an immobile neck. Neither extension nor rotation of the head could be accomplished actively or passively. The upper lip was pressed against the anterior chest wall, and the lower lip was not visible. The larynx and trachea were not palpable. The kyphosis involved all of the cervical and thoracic vertebrae. The only other positive physical findings were those consistent with rheumatoid arthritis.

Roentgenographic examination of the cervical and thoracic spine revealed anterior kyphosis measuring 113° between the T7 and C1 vertebrae. The entire cervical and thoracic spine was fused, with ossification of the anterior longitudinal ligament. The odontoid process was completely resorbed. There was marked subluxation of the C1-C2 intervertebral joints, with anterior displacement of the C1 vertebra. The width of the spinal canal at the level of the C1 vertebra was 0.8 cm. There were old compression fractures at C4 and C7, which produced anterior angulation of the spine of 30° between the C4 and C5 vertebrae and of 30° between the C7 and T1 vertebrae.

Preoperative evaluation of spinal cord function included evaluation of somatosensory-evoked potentials (SEP) following dermatome stimulation over the arms and legs. The response latency was increased for all peaks following stimulation of the left C7-T3 and the right C7-C8 dermatomes. The response amplitude was not decreased over these areas. The waveforms were normal following stimulation of other arm and leg dermatomes.

Preoperative blood tests, urinalysis, electrocardiogram, chest roentgenogram, and analysis of arterial blood gases were normal. The surgical plan was to mobilize the cervical spine with laminectomies of the C7 and T1 vertebrae, plus foraminectomies at the C7-T1 levels. The cervical spine would then be manually extended and immobilized with a halo brace. All possible operative and anesthetic complications were explained carefully to the patient. She elected to undergo surgery to lessen the severe disability caused by her deformity.

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Three preoperative visits were utilized to establish good rapport with the patient and to explain the awake fiberoptic intubation of the trachea. No preoperative medication was administered. In the operating room, arterial and venous catheters were inserted under local anesthesia. Monitoring included continuous arterial blood pressure, urinary output, electrocardiogram, and cortical- and brain-stem-evoked potentials following stimulation of both posterior tibial nerves and measured over contralateral somatosensory cortex and at the innion.

Five per cent cocaine was applied topically to the right nostril. An 8.0-mm endotracheal tube was lubricated and inserted through the right nostril into the oropharynx. An Olympus® BF4C3 fiberoptic bronchoscope was inserted through the endotracheal tube and advanced 4–5 cm beyond the tip of the tube. Identification of the vocal cords took about 10 min; the difficulty of exposure was due to posterior displacement of larynx and decreased space between the tip of the epiglottis and posterior pharyngeal wall (fig. 2). The tip of the bronchoscope was manipulated to displace the epiglottis anteriorly and expose the vocal cords. The vocal cords were anesthetized with 2 ml of 4% lidocaine injected through the working channel of the bronchoscope. After one min, the tip of the bronchoscope was advanced between the vocal cords and another 2 ml of 4% lidocaine were sprayed into the trachea. Tracheal intubation was completed on the fourth attempt to advance the tube over the bronchoscope. This was accomplished during peak inspiration by simultaneously advancing the tube and rotating it through 90° along its long axis. Entire intubation time was 15 min. The patient was calm throughout the procedure and showed no signs of discomfort.

Once the position of the endotracheal tube was further verified by auscultation and observation, anesthesia was induced with 150 mg thiopental iv. Anesthesia was maintained with 1–1.5% inspired enflurane and 50% nitrous oxide. The enflurane concentration was adjusted to maintain the mean arterial pressure above 80 mmHg. Ventilation was controlled to maintain PaCO<sub>2</sub> between 35–40 mmHg.

Following surgical mobilization, the cervical spine was slowly extended in small increments. Following each increment, the SEP waveform was evaluated. Extension of the cervical spine continued until a loss of amplitude was found in the waveform. The neck then was flexed gradually until the evoked potentials were normal. The cervical spine was immobilized in this position, and the wound was closed.

The patient moved all extremities on command prior to transport to the recovery room. Her vital signs were stable throughout the postoperative period. Intubation of the trachea was maintained for 31 h postoperatively to avoid possible compromise of the airway by the hematoma resulting from fracture of the anterior longitudinal ligament. Extubation of the trachea was then accomplished without difficulty.

The postoperative course was complicated by phlebitis of the right leg which resolved with treatment. The patient was discharged from the hospital on the 21st postoperative day.

## DISCUSSION

Osteotomy of the cervical spine to correct flexion deformities was first reported in 1953.<sup>2</sup> Simmons<sup>1</sup> described the successful correction of 11 patients without mortality or major morbidity. Surgery was performed with local anesthesia supplemented with nitrous oxide or narcotic analgesia. The technique was developed to minimize the danger of airway obstruction and to permit intraoperative evaluation of neurologic function. All of these patients remained responsive and cooperative, but should an anxious or uncooperative patient



FIG. 1. Lateral view of face and neck of the patient lying in her bed.

require cervical osteotomy to avert total disability, a technique for safe general anesthesia would be required.

Munson *et al.*<sup>8</sup> reported cervical osteotomy in a similar case under nasotracheal general anesthesia. Intubation of the trachea was achieved with the help of the wire hook described by Bearman.<sup>9</sup> However, the degree of cervical deformity in their case was not as severe as one reported here. The chin of the patient was kept 2 cm from the sternum with the use of skeletal traction so that they had enough access to the mouth to pass the wire hook to manipulate the endotracheal tube anteriorly and complete blind nasotracheal intubation. This approach was not feasible in our case.

Fiberoptic endotracheal intubation is very effective

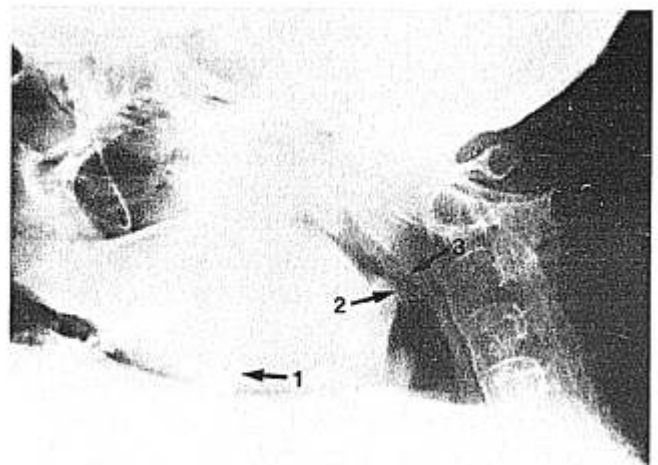


FIG. 2. Lateral roentgenogram of the upper cervical spine showing a narrow anterior-posterior dimension of the hypopharynx at the level of epiglottis. Arrow number 1 points to the mandible, number 2 to the epiglottis, and number 3 to the posterior pharynx.

with patients suffering from rheumatoid arthritis and ankylosing spondylitis.<sup>10</sup> The lack of mobility of the head and neck increase the difficulty of adequate exposure of the larynx with rigid laryngoscopy. Blind nasotracheal intubation could be impossible, while the stimulation of the larynx could cause laryngospasm in patients who are not sedated and have no topical anesthesia. Also, repeated attempts at tracheal intubation could increase the likelihood of trauma and laryngeal edema. Tracheostomy remains a final resort, but in this patient it was not possible. Flexible fiberoptic bronchoscopy has several advantages. With experience, the bronchoscope can be advanced into the trachea without significant discomfort in awake patients. It permits application of topical anesthesia to the airway, reducing the possibility of laryngospasm.

Each structure in and around the airway can be visualized prior to advancing the tip of the bronchoscope. Thus, structures such as the epiglottis can be avoided or gently manipulated and the severity of trauma can be minimized. If fiberoptic nasotracheal intubation fails, surgery can then proceed under local anesthesia without the hazards of traumatized airway.

Cortical-evoked potentials following peripheral stimulation yield information about the nerve conduction velocity along the peripheral sensory nerve and the sensory tracts of the CNS.<sup>7</sup> The pattern of the response also indicates changes in the number, size, and synchrony of postsynaptic potentials produced in the sensory cortex by standard stimulation, although other neurologic functions, such as motor function, are not directly assessed during monitoring of SEP. Wide trauma to the spinal cord that does not primarily involve the sensory pathway but that is a result of surgical retraction or compression of larger blood vessels can be detected by SEP.<sup>11</sup> Modest reductions in arterial blood pressure can augment damage produced by direct pressure on the cord.<sup>11,12</sup> The effects of commonly used drugs on SEP have been studied. Volatile anesthetic apparently depress CNS function and prevent recording of reliable cortical-evoked potentials. In this patient, 1–

1.5 MAC enflurane did not markedly suppress the response to supramaximal stimulation of the posterior tibial nerve. The device of simultaneous recording of the cortical and brain-stem SEP, which exhibit widely different drug sensitivity, alleviates, but does not solve this problem.

In summary, we have shown that flexion deformities of the cervical spine can be corrected under general anesthesia. Our patient represents the most severe flexion deformity thus far reported. Despite this, airway management and neurologic monitoring were accomplished safely during general anesthesia.

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