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Fluoroscopic Observation of the Occipitoatlantoaxial Complex during Intubation Attempt in a Rheumatoid Patient with Severe Atlantoaxial Subluxation

Ichiro Takenaka, M.D., Kazuyoshi Aoyama, M.D.,† Tamao Iwagaki, M.D.,† Hiroshi Ishimura, M.D.,† Yukari Takenaka, M.D.,‡ Tatsuo Kadoya, M.D.§*

ATLANTOAXIAL subluxation (AAS) is found in 11–46% of patients with rheumatoid arthritis.[1] Rheumatoid patients with AAS may be at risk of life-threatening neurologic injury caused by exacerbation of the subluxation in the head and neck position during airway maneuver; therefore, appropriate management of the cervical spine is essential.[2–5] Tokunaga *et al.*[6] have recommended the protrusion position, which is equal to the posture used in anesthesiology as the sniffing position, during intubation attempt in these patients to reduce subluxation. In contrast, previous studies have shown that accomplishment of the protrusion position sometimes results in worsening AAS in rheumatoid patients with severe instability of the occipitoatlantoaxial (OAA) complex.[7,8] In cases of severe OAA instability, appropriate head and neck position during airway maneuver is poorly understood despite its importance. Minimizing movement of the cervical spine may be the only method for avoiding exacerbation of AAS and protecting the spinal cord.

It is often difficult to predict the degree of cervical spine motion for laryngoscopy and intubation because the motion varies from individual to individual.[9] Moreover, prediction is all the more difficult in patients with rheumatoid arthritis because their trachea is sometimes difficult to intubate.[10] These indicate that, despite the necessity of minimizing cervical movement, the degree of the motion is not known until laryngoscopy and intubation are performed. Observation of the cervical motion during airway maneuver may provide a safer management. We report a case of fluoroscopic observation of the OAA complex during laryngoscopy and intubation in a rheumatoid patient with severe AAS.

Case Report

A 66-yr-old, 160-cm, 43-kg woman was scheduled to undergo surgical repair of a fractured femur. She was known to have an unstable cervical spine because of rheumatoid arthritis, which had been described in our previous report.[8] Airway examination consisted of Mallampati Class 2 with a mouth opening of 4 cm and hyomental distance ratio of 1.31.[11] The patient could move her head and neck without limitation, but preoperative assessment of the cervical spine with lateral cervical spine radiography in flexion and extension provided evidence of instability at the OAA complex. The atlas-dens intervals (ADI) in flexion and extension were 10 mm and 2 mm, respectively. The ADI was defined as the distance between the posterior surface of the anterior arch of the atlas and the anterior surface of the dens.[1,8] We counseled general anesthesia with awake fiberoptic intubation or regional anesthesia because her previous operations had been safely performed under these anesthetic techniques. Nevertheless, the patient refused them because of the stress she had experienced on previous operations. Combination of the Airway Scope (AWS, AWS-S100; HOYA-Pentax, Tokyo, Japan) and the bougie (Portex Venn reusable endotracheal tube introducer; Smith Medical, Keene, United Kingdom) can minimize the cervical spine motion during intubation attempt with reasonable intubation time.[12] We planned intubation using this method after induction of general anesthesia while fluoroscopically observing the cervical spine motion. Previous studies have shown that compression of the spinal cord occurs in rheumatoid patients with AAS when the ADI is more than 9 mm.[1,2] In addition, the patient was asymptomatic when the ADI was 10 mm in flexion. We determined that permissible ADI was 9 mm or less.

In the operating room, the patient lay supine on the table, and her head was placed on the flat table without a pillow. We confirmed that she was neurologically asymptomatic, and we fluoroscopically observed the status of the OAA complex. The ADI was 3.7 mm in this position (fig. 1A). After induction of general anesthesia and muscle relaxation, the AWS blade, to which a 7.0-mm internal diameter reinforced endotracheal tube and the bougie passing into the tube were set, was inserted into the mouth, and its tip was positioned beneath the epiglottis. After obtaining the minimal glottic view for intubation by lifting the epiglottis, the bougie was inserted into the trachea, and then the tube was advanced over it. Passage of the bougie and the tube was easy. An experienced anesthetist fluoroscopically observed the status of the OAA complex throughout laryngoscopy and intubation. The outside diameter of the endotracheal tube (10 mm) was used as a landmark for permissible ADI of 9 mm. Laryngoscopy produced extension of 15.0 degrees between the occiput and the axis, and AAS worsened (ADI of 6.8 mm, fig. 1B). The subluxation was corrected after laryngoscopy and intubation (ADI of 3.9 mm, fig. 1C). The operation was completed uneventfully and lasted for 131 min. The patient did not have any neurologic deficits postoperatively.

Discussion

We have recently showed that median extension angle between the occiput and the axis required for intubation

* Director of Surgical Center, † Staff Anesthetist, § Chief Anesthetist, Department of Anesthesia, Nippon Steel Yawata Memorial Hospital, Kitakyushu, Japan; ‡ Professor, Emergency Life Saving Technique Academy, Kitakyushu, Japan.

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Address correspondence to Dr. Takenaka: Surgical Center, Nippon Steel Yawata Memorial Hospital, 1-1-1 Harunomachi, Yahatahigashi-ku, Kitakyushu 805-8508, Japan. takenaka.i@ns.yawata-mhp.or.jp.

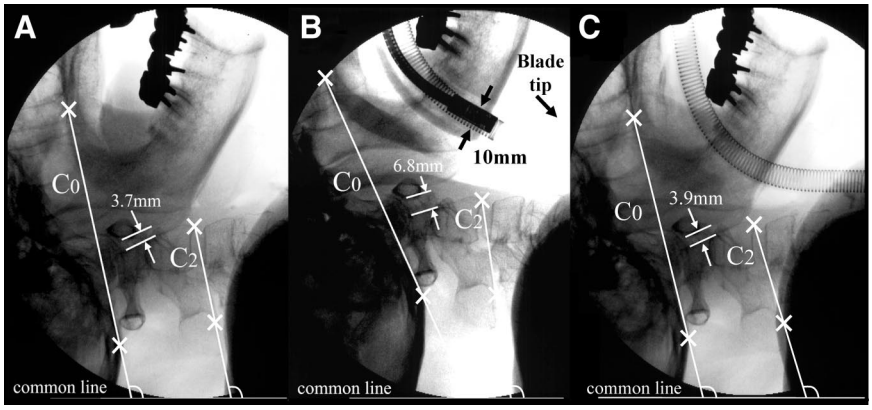

Fig. 1. Still images (*A*) before, (*B*) during, and (*C*) after intubation with combination of the Airway Scope (HOYA-Pentax, Tokyo, Japan) and the bougie. To minimize movement of the cervical spine during intubation attempt, the glottic exposure is limited to that necessary to allow passage of the bougie and the endotracheal tube (*B*). *Reference lines* for the (*C0*) occiput and the (*C2*) axis are defined as the McGregor line and the line passing through the anterior, inferior margin of the C2 vertebral body and the lower cortical margin of the spinous process, respectively.[8,9,11,12] *Reference lines* do not intersect on the radiograph; therefore, the C0 or C2 angle is defined as the difference in angle between the C0 or C2 reference line and the common line that is the ventral vertical edge, respectively. The angle between the C0 and C2 (C0-2 angle) in each radiograph is calculated as the difference between the C0 and the C2 angles. Extension angle of the C0-2 created by laryngoscopy is defined as the difference between the C0-2 angle before laryngoscopy and that during laryngoscopy. Laryngoscopy produces extension of 15.0 degrees at the C0-2, leading to exacerbation of atlantoaxial subluxation (*B*). Note that the atlas-dens interval, which is defined as the distance between the posterior surface of the anterior arch of the atlas and the anterior surface of the dens,[1,8] increases from 3.7 mm (*A*) before laryngoscopy to 6.8 mm (*B*) during laryngoscopy and intubation. (*C*) The subluxation is corrected after intubation (3.9 mm).

with combination of the AWS and the bougie is 7.0 degrees in subjects with normal cervical spine, which is minimal level among intubation methods.[12] However, extension angle of 15.0 degrees was needed in this patient, which was an unexpected greater degree of extension (fig. 1B). The AWS blade was closely placed in the oral cavity and the pharynx because of a relatively small oral cavity and a moderately severe limitation in mouth opening. When the epiglottis was elevated by the AWS blade, most of forces applied by the blade were directly transmitted not only to the mandible but also to the hard palate (skull). Santoni *et al.*[13] have pointed out that unstable spines move abnormally in response to physiologically normal forces applied by the laryngoscope blade. Thus, forces applied to the hard palate (skull) might result in a greater extension than normal at unstable OAA complex.

The extension of the OAA complex produced by laryngoscopy led to exacerbation of AAS (fig. 1B). We considered a possible mechanism as follows. In this patient, many ligaments contributing the stability of the OAA complex were disrupted as a result of long-standing rheumatoid arthritis.[8] Moreover, the splinting action of the muscles surrounding the neck on the cervical spines was lost because of general anesthesia and muscle relaxation. Thus, the occiput and the atlas were separated from the subaxial cervical vertebrae. The OAA extension during laryngoscopy rotated the head, which produced elevation of the head against the cervical spine because the axis of rotation was not the center of the skull.[14] At that time, only the head (occiput) and the atlas were pushed forward, leaving the subaxial cervical spine behind, and AAS occurred. The degree of the head elevation resulting from the OAA extension was mild, so the subluxation did not become severe. Although it is believed that extension of the OAA complex reduces the subluxation in rheumatoid patients with AAS,[4] our finding indicates that the subluxation can worsen even in extension. Close attention should be paid to this respect when managing the airway in these patients.

Fluoroscopic observation prevented excessive subluxation, despite occurrence of a greater degree of the cervical movement. There are some advantages of fluoroscopy as monitoring in status of the OAA complex in rheumatoid patients with AAS. First, to minimize the cervical motion and AAS during airway maneuver, the head and neck positions, intubation methods, and additional airway maneuvers (*e.g.*, manual in-line stabilization) are freely chosen under visual control. Also, these can be changed on the way when excessive subluxation occurs. Second, fluoroscopy provides useful information regarding the cervical spine, not only during airway maneuver but also during general anesthesia and surgery (fig. 1C), for example, in the lateral decubitus or prone position. Finally, the cervical spine motion is left as a record. The disadvantage of this method is the necessity of the assistant who watches the degree of AAS on the fluoroscopic monitor screen, although estimation of the subluxation is not difficult. Other problem is the radiation exposure. Giordano *et al.*[15] have clarified that considerable radiation exposure to patient and surgeon is encountered during cervical spine imaging with a C-arm fluoroscope. Thus, every possible measure for reducing radiation dose to patient and anesthetist should be enforced.

In summary, we fluoroscopically monitored the status of the OAA complex during laryngoscopy and intubation in a rheumatoid patient with severe AAS. Fluoroscopic observation was useful for avoiding excessive subluxa-

tion and provided a safer management of the airway to this patient.

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