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Airway management for cervical spine surgery

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Cervical spine surgery is one of the most commonly performed spine surgeries in the United States, and 90% of the cases are related to degenerative cervical spine disease (the rest to cervical spine trauma and/or instability). The airway management for cervical spine surgery represents a crucial step in the anesthetic management to avoid injury to the cervical cord. The crux for upper airway management for cervical spine surgery is maintaining the neck in a neutral position with minimal neck movement during endotracheal intubation. Therefore, the conventional direct laryngoscopy (DL) can be unsuitable for securing the upper airway in cervical spine surgery, especially in cases of cervical spine instability and myelopathy. This review discusses the most recent evidence-based facts of the main advantages and limitations of different techniques available for upper airway management for cervical spine surgery.

Airway management for cervical spine surgery

In the United States, spine surgery for treatment of degenerative cervical spine disease is most commonly performed, with approximately 350,000 anterior cervical surgeries performed in the United States annually. The majority of cervical spine surgery is performed to treat degenerative disease; however, only 5–7% of cervical spine surgery cases were undertaken to treat trauma and/or instability [1]. Airway management for cervical spine surgery is the key for successful perioperative anesthetic management. In this paper, we will discuss the relevant topics related to the airway management for cervical spine surgery such as anatomy, congenital abnormalities, different techniques for upper airway management, and perioperative airway complications associated with cervical spine surgery.

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Anatomy of the cervical spine

Upper cervical spine

The occipitoatlantoaxial unit is one of the most complex articulating structures in the human body. This unit supports the head and allows the necessary range of movement of head and neck, while protecting the spinal cord and adjacent vital structures. The first cervical vertebra (C1), the atlas, is the uppermost vertebra, which lacks a distinctive body. However, it is characterized by having thick anterior and posterior arches that blend laterally into large masses. These lateral masses articulate with the occipital condyles of the skull via their large kidney-shaped depressions on their superior aspects. The weight of the skull is transferred into the second cervical vertebra (C2) by C1 flatter inferior surfaces. The C2 is characterized by its prominent odontoid process (dens). The odontoid process arises from the upper surface of the C2 body. The interval between the posterior aspect of the odontoid process and the anterior aspect of the posterior ring of the atlas is termed the posterior atlas–dens interval and is the space available to the spinal cord. The space available to the cord at C1 may be divided into one-third odontoid, one-third cord, and one-third space. The one-third space allows for some encroachment of the spinal lumen without compromising the cord. In a normal spine, the space available for the cord is approximately 20 mm. Cord compression does not occur when the space available for the cord is $>$ 18 mm but occurs if $<$ 14 mm[2]. Alar and apical ligaments fan upward from the odontoid process to insert into the anterior margins of the foramen magnum [2,3].

Lower cervical spine

The lower five cervical vertebrae are anatomically more typical vertebrae. The transverse processes are unique features with their laterally projecting costal processes and foramen transversarium, which transmits the vertebral artery through most of the cervical spine. The arches of the second to seventh cervical vertebrae articulate via horizontally oriented facet joints. Anterior and posterior longitudinal ligaments cover the anterior and posterior surfaces of the bodies of cervical spine vertebrae, respectively. The anterior longitudinal ligament extends over the anterior arch of the atlas to terminate as the anterior atlantooccipital ligament, while the posterior longitudinal ligament extends over the posterior surface of the axis and the odontoid process to terminate as the tectorial membrane. The tectorial membrane in turn inserts into the basiocciput [2]. The ligamentum flavum is a very thin structure in the cervical region but is thicker in the lumbar spine region. The ligamentum nuchae in the cervical spine region is the continuation of the supraspinous ligament [2].

Congenital anomalies of the cervical spine

Achondroplasia

It is characterized by a large skull with a narrow foramen magnum. The skull base is relatively small with short flattened vertebral bodies with large intervertebral disk heights [4], which prevent the extension of the head. Therefore, direct laryngoscopy could be very difficult or even impossible.

Down's syndrome

Down's syndrome (trisomy 21) is present in approximately 0.15% of the population. It is characterized by cervical ligamentous laxity and skeletal anomalies that could result in cervical instability. The subluxation of atlas (C1) anteriorly on the axis (C2) results in atlantoaxial instability, which occurs in about 15% of individuals with Down's syndrome [4]. Therefore, several cases of severe neurologic complications have been recorded after surgical management or positioning in patients with Down's syndrome [5]. The American Academy of Pediatrics and the Special Olympics have recommended routine radiologic screening for subluxation in patients with Down's syndrome. Atlantoaxial subluxation should be considered if the anterior atlantodental interval (ADI) is >4–5 mm in flexion–extension films of the cervical spine. Computed tomography (CT) scanning of the cervical spine