CLINICAL ANATOMY OF THE SPINE AND SPINAL CORD

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Abstract: The spine and spinal cord are central structures in human anatomy, providing both mechanical support and neural function. This article explores the clinical anatomy of the vertebral column and spinal cord, highlighting their structural organization, functional significance, and implications in clinical practice.

Keywords: spine, spinal cord, vertebral column, neuroanatomy.

INTRODUCTION

As is known, the spinal column consists of 7 cervical, 12 thoracic and 5 lumbar vertebrae with the adjacent sacrum and coccyx. It has several clinically significant curves. The characteristics of individual vertebrae affect the technique, first of all, of epidural puncture. The spinous processes depart at different angles at different levels of the spine.

MATERIALS AND METHODS

Access to the epidural (ED) and subarachnoid space (SA) is achieved between the plates (interlaminar). The superior and inferior articular processes form facet joints, which play an important role in the correct positioning of the patient before ED puncture. The correct positioning of the patient before ED puncture is determined by the orientation of the facet joints. Since the facet joints of the lumbar vertebrae are oriented in the sagittal plane and provide forward and backward flexion, maximum flexion of the spine (fetal position) increases the interlaminar spaces between the lumbar vertebrae.

RESULTS AND DISCUSSION

Identification of the required intervertebral space is the key to the success of epidural and spinal anesthesia, as well as a prerequisite for patient safety.

In clinical settings, the choice of the puncture level is made by the anesthesiologist through palpation in order to identify certain bone landmarks. It is known that the 7th cervical vertebra has the most pronounced spinous process. At the same time, it should be taken into account that in patients with scoliosis, the most prominent spinous process may be the 1st thoracic vertebra (in about ⅓ of patients).

The line connecting the lower angles of the scapulae passes through the spinous process of the 7th thoracic vertebra, and the line connecting the iliac crests (Tuffier's line) passes through the 4th lumbar vertebra (L4) [1].

Identification of the required intervertebral space using bone landmarks is far from always correct. The results of the study by Broadbent et al. (2000) are known, in which one of the anesthesiologists marked a certain intervertebral space at the lumbar level with a marker and tried to identify its level with the patient in a sitting position, the second made the same attempt with the patient lying on his side. Then a contrast marker was attached above the mark and magnetic resonance imaging was performed. Most often, the true level at which the mark was made was located from one to four segments lower, compared to the values indicated by the anesthesiologists participating in the study. It was possible to correctly identify the intervertebral space in only 29% of cases. The accuracy of the determination did not depend on the patient's position, but worsened in overweight patients. By the way, the spinal cord ended at the L1 level in only 19% of patients (in the rest at the L2 level), which created a threat of damage if a high puncture level was chosen incorrectly [2].

The anterior longitudinal ligament runs along the anterior surface of the vertebral bodies from the skull to the sacrum, which is rigidly fixed to the intervertebral discs and the edges of the vertebral bodies. The posterior longitudinal ligament connects the posterior surfaces of the vertebral bodies and forms the anterior wall of the spinal canal.

The vertebral plates are connected by the yellow ligament, and the posterior spinous processes are connected by the interspinous ligaments. The supraspinous ligament runs along the outer surface of the spinous processes of C7–S1. The pedicles of the vertebrae are not connected by ligaments, as a result of which intervertebral openings are formed, through which the spinal nerves exit [3].

The yellow ligament consists of two leaves fused along the midline at an acute angle. In this regard, it is stretched like an "awning". In the cervical and thoracic spine, the ligamentum flavum may not be fused in the midline, which causes problems in identifying the EP using the loss of resistance test. The ligamentum flavum is thinner in the midline (2–3 mm) and thicker at the edges (5–6 mm). In general, it is thickest and densest at the lumbar (5–6 mm) and thoracic (3–6 mm) levels, and thinnest in the cervical spine (1.5–3 mm). Together with the vertebral arches, the ligamentum flavum forms the posterior wall of the spinal canal. When passing the needle through the medial approach, it must pass through the supraspinous and interspinous ligaments, and then through the ligamentum flavum. With the paramedian approach, the needle bypasses the supraspinous and interspinous ligaments, immediately reaching the ligamentum flavum. The yellow ligament is denser than the others (80% consists of elastic fibers), therefore, the increase in resistance when the needle passes through it, followed by its loss, is known to be used to identify EP. The distance between the yellow ligament and the dura mater in the lumbar region does not exceed 5-6 mm and depends on factors such as arterial and venous pressure, pressure in the spinal canal, pressure in the abdominal cavity (pregnancy, abdominal compartment syndrome, etc.) and the chest cavity (arterial ventilation) [4].

The spinal canal has three connective tissue membranes that protect the spinal cord: the dura mater, the arachnoid mater, and the pia mater. These membranes participate in the formation of three spaces: epidural, subdural, and subarachnoid. The spinal cord (SC) itself and its roots are covered by a well-vascularized pia mater, the subarachnoid space is limited by two adjacent membranes - the arachnoid and dura mater. All three SC membranes continue in the lateral direction, forming a connective tissue covering of the spinal roots and mixed spinal nerves (endoneurium, perineurium, and epineurium). The subarachnoid space also extends for a short distance along the roots and spinal nerves, ending at the level of the intervertebral foramina.

CONCLUSION

Correct understanding of the anatomy of the spine and the structures of the spinal canal is absolutely necessary in the daily practical work of an anesthesiologist-resuscitator. It is the key to the success of performing neuraxial blocks, and also allows to reduce to a minimum the number of complications of neuraxial anesthesia, which are sometimes life-threatening.

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