Ultrasound Guided Neuraxial Block In Pediatrics

Essay Submitted for complete fulfillment of the
M.Sc. degree in anaesthesia

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Abstract

In recent years, anatomically based ultrasound is one of the most exciting advances in technology in relation to pediatric regional anesthesia. The use of ultrasound in neuraxial anesthesia in adults is somewhat limited because of the reduced visibility of the spinal canal resulting from poor ultrasound beam penetration through the ossified bony vertebral column. In theory, ultrasound could be of much greater value in the young pediatric population where there is limited ossification, thus allowing good visual resolution of the anatomy and block-related equipment or solutions.

Key word

PRA- *Neuraxial Block*- *anaesthesia*- Cmax

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ALL	anterior longitudinal ligament
C	cervical vertebra
CSF	cerebrospinal fluid
Cmax	maximum concentration
CNS	central nervous system
CVS	cardiovascular system
DRG	dorsal root ganglion
ECG	electrocardiogram
IASP	International Association for the Study of Pain
LA	local anesthesia
L	Lumbar vertebra
MGluR	metabotropic glutamate receptors
mL	Milliliter
mm	Millimeter
NABs	neuraxial blocks
NK1	neurokinin-1
NMDA	N-methyl-Daspartate
PACU	post anesthesia care unit
PCEA	patient-controlled epidural analgesia

PDPH	post dural puncture headache
PLL	posterior longitudinal ligament
S	sacral vertebra
T	thoracic vertebra
Tmax	maximum time
US	ultrasound
3D	3 dimensions
4D	4 dimensions

Introduction

In a 2005 editorial, Denny noted that "Regional anesthesia always works provided you put the right dose of the right drug in the right place. When it does not work, it is usually because the local anesthetic has not been put in the right place".

Pediatric regional anesthesia (PRA) has today reached widespread use and become more popular , supported by reassuring data from the international literature showing the safety and efficacy of this technique. The benefits of regional techniques include avoidance of perioperative opioids and their associated side effects, early ambulation, and excellent pain control, with the absence of adverse side effects including postoperative nausea and vomiting, have increased their use in this age group

Combined regional and general anesthesia may actually improve outcome and thereby decrease hospital stay. Though 89% of the blocks were performed under sedation/anesthesia, only 0.9/1000 complications occurred, with no deaths and no sequelae, comparing favorably with similar surveys in adults, showing that PRA is at least as safe as RA in awake adult patient

In recent years, anatomically based ultrasound is one of the most exciting advances in technology in relation to pediatric regional anesthesia. The use of ultrasound in neuraxial anesthesia in adults is somewhat limited because of the reduced visibility of the spinal canal resulting from poor ultrasound beam penetration through the ossified bony vertebral column. In theory, ultrasound could be of much greater value in the young pediatric population where there is limited ossification, thus allowing good visual resolution of the anatomy and block-related equipment or solutions.

Introduction

A thorough knowledge of the regional anatomy and its specific anatomical landmarks is an essential for performing successful nerve block and it can not be substituted by probing with a needle attached to a nerve stimulator.[1]

The anatomy described in adults is not always applicable to children as anatomical landmarks in children vary with growth. landmarks, commonly used in adults, tend to lack definition in young children partly because of poorer muscle development and patient cooperation which used to locate them and most children are under a light general anesthesia when the nerve block is being performed. [2]

Anatomy of the vertebral column and the spinal cord:

The spinal canal is surrounded by 3 protective sheaths. From the outside to the inside they are: dura mater, arachnoid and pia mater. The potential space between the dura and arachnoid is called subdural space. The cerebrospinal fluid (CSF) flows between the arachnoid and pia mater in the space called subarachnoid space. [3]

The spinal cord begins cranially at the foramen magnum, as a continuation of the medulla oblongata and ends caudally as the conus medullaris, at the level of the lower border of L1 in adult, and at the upper border of L3 in children (fig. 1). From this end, a prolongation of the pia mater called the filum terminale attaches the spinal cord to the coccyx. The dura ends at the level of S_2. [3]

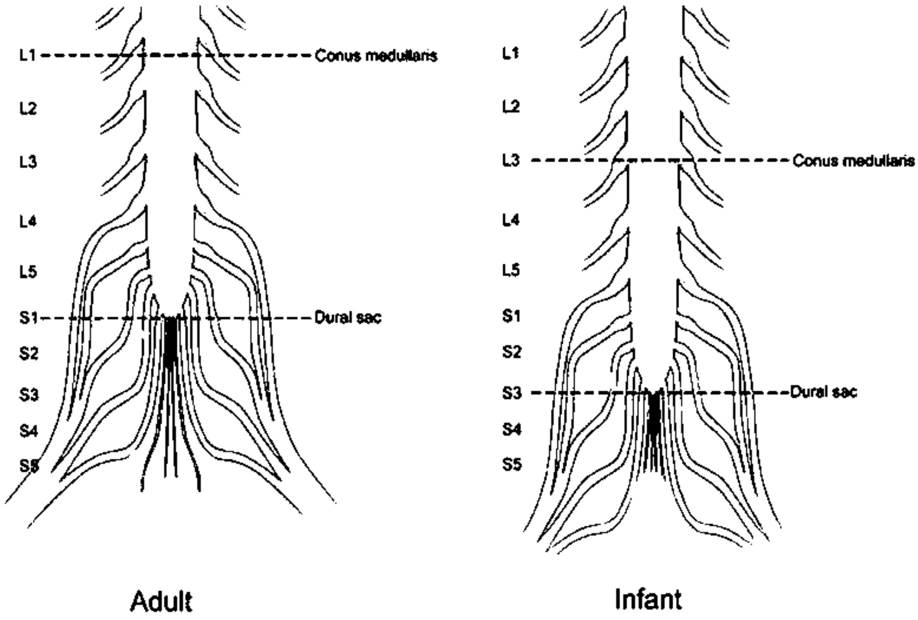

Figure (1): Comparisons between levels of the conus medullaris and the dural sac in the infant versus the older child or adult. [6]

The spinal cord is composed of white matter surround a core of gray matter which appears in cross section as H shape, ventral (motor) and dorsal (sensory) horns. The white matter is described as having anterior, lateral and posterior white columns. [3]

There are 31 pairs of spinal nerves; each one being formed by two roots, a ventral or motor root and a dorsal or sensory root. The dorsal root has the dorsal root ganglion. [3]

Because the spinal cord is shorter than the vertebral column, the spinal nerves descend a variable distance in the spinal canal before exiting through the intervertebral foramen. The most distal lumbar and sacral nerves travel the longest distance inside the spinal canal, forming what is known as the cauda equina. As the spinal nerve pierces the dural sac, it draws with it a dural sleeve. [3]

There are 8 cervical nerves. The first cervical nerve exits between the occipital bone and C_1, the 8^{th} cervical nerve exits between C_7 and T_1. Distal to T_1 each spinal nerve exits below the corresponding vertebra. [(3)]

The vertebral column has a series of curvatures in the anteroposterior plane. The cervical and lumbar curvatures have an anterior convexity (lordosis) and the thoracic and sacral have posterior convexity (xiphosis) (fig. 2). [(3)]

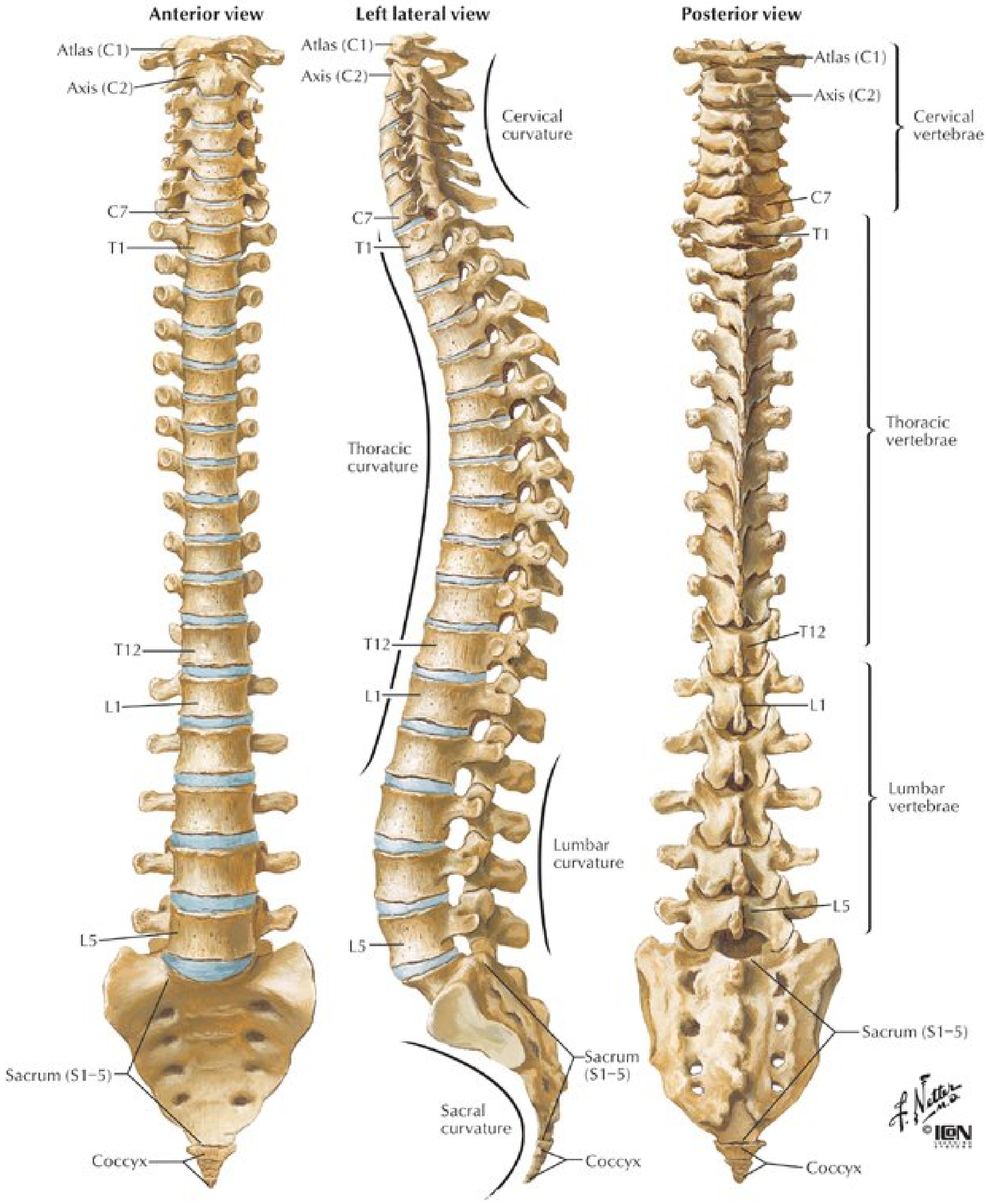

Figure (2): Vertebral column curvatures [5]

The blood supply to the spinal cord comes from one anterior spinal artery and two posterior spinal arteries. These arteries anastomose to form longitudinal vessels, reinforced by segmental arteries that enter the vertebral canal trough the intervertebral foramina. [3]

The anterior two thirds of the spinal cord are supplied by the anterior spinal artery reinforced in the neck by branches of the vertebral artery. [4]

In the thoracic region the anterior spinal artery receives only a few radicular arteries from the aorta. In the lumbar region a large branch called radicularis magna or artery of Adamkiewicz, reinforces the anterior spinal artery. It arises 78% of the times on the left side, and typically enters the spinal canal through a single intervertebral foramen between T_8 and L_3. [4]

Anatomy of the vertebrae and spinal ligaments:

Vertebrae are the 33 individual bones that interlock with each other to form the spinal column. The vertebrae are divided into regions: 7 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 4 coccygeal. Only the top 24 bones are moveable; the vertebrae of the sacrum and coccyx are fused. [3]

Intervertebral discs:

Each of the 24 movable vertebrae in your spine are separated and cushioned by an intervertebral disc, keeping them from rubbing together. [5]

Discs are designed like a radial car tire. The outer ring, called the annulus fibrous, contain the gel-filled center called the nucleus pulposus (fig. 3). [5]