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Nerve Block For Thoracic and Abdominal Regions

An Essay
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Anesthesiology

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List of Contents

List of Abbreviations

5-HT **:** 5-hydroxytryptamine

AMPA **:** Amino-3-hydroxy-5-methylisozole-4-propionic acid

CPK **:** Creatine phosphokinase

CVA **:** Cerebrovascular Accident

DRG **:** Dorsal Root Ganglia

EAA **:** Excitatory Amino Acids

EUS **:** Endoscopic Ultrasound

GABA **:** Gama Amino Butyric Acid

NMDA **:** N-methyl D-aspartate

NRM **:** Nucleus Raphe Magnus

NS **:** Nociceptive Specific

PABA **:** Para Amino Benzoic Acid

PAG **:** Periaqueductal Gray

PVNB **:** Paravertebral Nerve Block

RF **:** Reticular Formation

SP **:** Substance P

STT **:** Spinothalamic Tract

TAP **:** TransversusAbdominis Plane

TENS **:** Transcutaneous Electrical Nerve Stimulation

VAPS **:** Visual Analog Pain Score

WDR **:** Wide Dynamic Range

List of Figures

List of Figures (Cont.)

Introduction

Pain often has its source in the peripheral nervous system. The perceived pain actually stems from nerve impulses that reach the central nervous system by way of afferent fibers. These fibers are termed nociceptive afferents because they are specialized in conveying signals concerning potential damage or health risks origination from outside or inside the body. In a cutaneous nerve about 90% of fibers are nociceptive. Numerically, C fibers constitute the largest group , about 90% of all the fibers contained in a typical skin nerve ***(Manfred Zimmermann, 2004).***

Thoracic paravertebral block (TPVB) produce analgesia by blockade not only of the intercostal nerves but also of their dorsal rami and sympathetic chain. TPVB demonstrated the best preservation of pulmonary functions after thoracotomy. FEV1,FVC, values had all returned to approximately 75% of their preoperative values by 48 hours postoperatively ***(Peter H Norman et al., 2005).***

There are variety of techniques for approaching celieac plexus block, they can be summarized as posterior or anterior. the posterolateral one has become the most practical and proven technique by aneasthiologist as it allows access to both the splanchnic nerves and celieac plexus ***(Samuel.C.Sayson and Somayaji Ramamurrhy, 2004).***

Visceral and sympathetically maintained pain in perineal area associated with malignancy in pelvis may be effectively treated by neurolysis of ganglion impar. Patients with clinical picture of vague pain, burning, and localized perineal pain frequently associated with urgency may benefit from this block ***(Richard Rouck, 2000).***

Blockade of intercostals nerves interrupts C fiber afferent transmission of impulses to spinal cord. A single intercostals

injection of a long acting local anesthetic can provide pain relief and improve pulmonary functions in patients following thoracic surgery for up to 6 hours. To achieve longer duration of analgesia, a continuous extrapleural intercostals nerve block technique may be used in which a catheter is placed percutaneously into an extrapleural pocket by the surgeon this allows frequent dosing of local anaesthetic agents and avoid multiple needle injections ***(Mark A Chaney, 2009).***

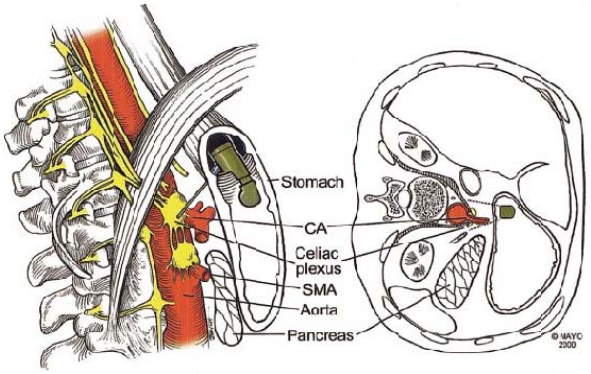
Superior hypogastric block in addition to being diagnostic, it can be potentially therapeutic in cases of interactable visceral pain of either neoplastic or non-malignant origin ***(Lana Wania et al., 2005).***

Anatomy of celiac plexus and splanchnic nerves :

Celiac plexus is situated retroperitoneally in paravertebral areolar tissue at anterolateral edge of the first lumbar vertebra on both sides. It lies posterior to the stomach and pancreas, anterior to the crura of diaphragm and the aorta where it envelopes the origins of the celiac artery (fig.1). It receives efferent fibers from splanchnic nerves bilaterally, and post-ganglionic fibers from upper lumbar sympathetic ganglion and terminal branches of both vagi (fig. 2).It receives afferent fibers of both sympathetic and parasympathetic from viscera (afferent visceral nociceptive fibers). The celiac plexus is formed by the right and left celiac ganglia and interconnecting nerve fibers. It is located anterolateral to the aorta immediately caudal to the origin of celiac artery. The number of ganglia varies from 1 to 5 on both sides and size from 0.5 to 4.5 cm in diameter. In the longitudinal axis the ganglia are positioned anywhere between T12-L1 disc space to the middle of the L2 vertebral body. Their relationship to the celiac artery is more consistent; on average they are 0.6 cm caudal to the artery on the right and 0.9 cm caudal to the artery on the left. However, significant individual variation is seen. The splanchnic nerves have their cell bodies at: * from T5 or T6 to T9 or T11(greater), * T10 and T11(lesser) and * T11 and T12 (least). After running in the posterior mediastinum, the nerves enter the abdomen at variable distance above the L1 vertebral body traversing the crura of diaphragm. They then pass to celiac ganglia. Therefore, by blocking the celiac plexus, one can interrupt nociception and any sympathetically mediated pain from the viscera ***(Chaturvedi, 2001; Iki et al., 2004).***

The celiac plexus includes a number of smaller plexuses: hepatic plexus, splenic plexus ,gastric plexuses ,pancreatic plexus and suprarenal plexus. Other plexuses that are derived from the celiac plexus: renal plexus ,testicular or

ovarian plexus, superior and inferior mesenteric plexuses ***(Garcia et al.,2007).***



CA: Celiac artery SMA: superior mesenteric artery

Fig.1: Anatomy of celiac plexus***(Levy and Wiersema,2003).***

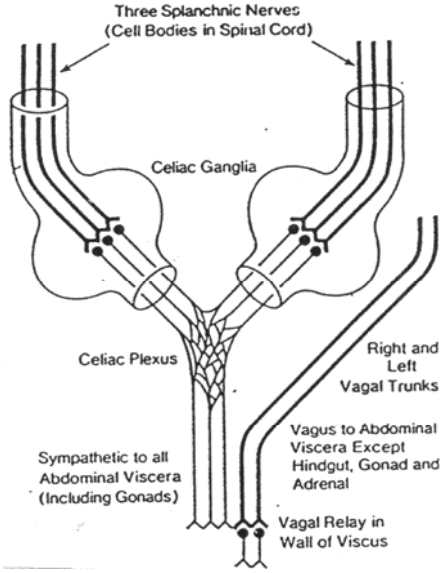


Fig.2: Constituents of celiac plexus ***(Bonica, 2001)***

Anatomy of paravertebral space :

Paravertebral space is a narrow, triangular space lateral to the vertebral column. It is bounded posteriorly by the superior costotransverse ligament, anterolaterally by the parietal pleura, medially by the vertebrae and the intervertebral foramina and superiorly and inferiorly by the heads and necks of adjoining ribs ***(Morgan et al., 2006).***

Communications :

Because the paravertebral space is continuous with the surrounding spaces (fig.3), injection of local anesthetic can provide anesthesia to several dermatomes due to superior or inferior spread into adjacent paravertebral space,medial diffusion into the epidural space and also lateral diffusion into the intercostal space***(Conacher,2003).***

Fig.3: Anatomy of the thoracic paravertebral space***(www.Nysora.com).***
(1) Superior costotransverse ligament.
(2) Paravertebral space.
(3) Dispersion of a solution within the paravertebral space.
(4) Distances between transverse processes 2.5 cm lateral to the superior aspect of the spinous process.

Contents(fig.4)

A)Loose fat and areolar connective tissue.

B)Spinal nerves: - There are 31 pairs of spinal nerves: 8 cervical, 12 thoracic, 5 lumbar, 5 sacral and one coccygeal. Each is formed by the fusion of an anterior and posterior spinal root.

- The anterior (ventral) roots: are motor and emerge in series from the anterior grey column of the spinal cord, each as a tuft of nerve rootlets.

- The posterior (dorsal) roots: are sensory and enter the cord in series along a postero-lateral groove overlying the posterior grey column. Each posterior root carries a ganglion, immediately distal to which the anterior and posterior roots meet to form a spinal nerve.

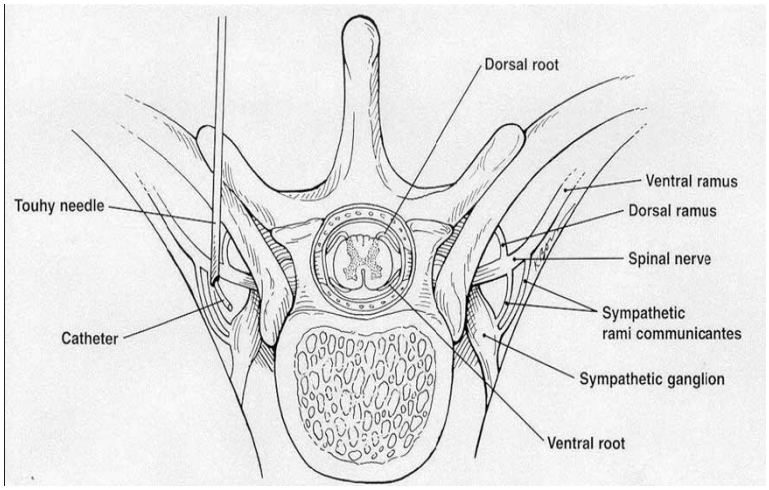


Fig.4.Paravertebral space and its contents***(Lönnqvist and Richardson, 1999).***

The arrangement of a 'typical' spinal nerve is as follows:

1. The posterior primary ramus: passes backwards between the transverse processes and then divides into a medial and lateral branch. These supply the adjacent vertebral muscles and send (from one or other branch) a cutaneous supply to the overlying skin.

● ***The thoracic posterior primary rami:***

All the thoracic posterior primary rami divide into medial and lateral branches, all of which supply the dorsal muscles. The medial branches of the upper six thoracic nerves reach and supply the skin immediately adjacent to the vertebral

spines, whereas the lateral branches of the lower six thoracic nerves are cutaneous as well as motor.

The cutaneous branches descend for a distance which increases from above downwards, before they supply the skin. Thus, T1 supplies an area immediately inferior to its corresponding vertebra, whereas T10 and 11 innervate the skin over the loin and T12 runs along the iliac crest, and then sends twigs over the upper gluteal region.

● ***The lumbar posterior primary rami:***

All the lumbar posterior rami divide into medial and lateral branches that supply the overlying lumbar muscles. The lateral branches of the upper three, in addition, reach the skin over the postero-superior iliac spine and innervate the adjacent gluteal region.

2-The anterior primary ramus:-supply the arm, the leg and the front and sides of the neck, thorax and abdomen with their motor and sensory innervation. The trunk is supplied, in the main, by the segmentally placed thoracic anterior rami; the neck and limbs are served by the cervical, brachial, lumbar and sacral plexuses ***(Ellis, 2004).***

● ***In the lumber region:-***

The anterior branches of L1through L4 with a contribution from T12 form the Lumber plexus ***(Desine and Terese, 2005)***.

C)Sympathetic Ganglia:-

The preganglionic fibers of the sympathetic flow originate in the intermediolateral horn of the grey matter of the spinal cord. They exit the vertebral foramen accompanying the anterior root of a thoracic nerve, just beyond the foramen, the sympathetic fibers go ventrally via the white rami

communicantes to the ganglia of the sympathetic chain. Some of the sympathetic outflow ends in the segmental ganglion anastomosing with ganglionic fibers; others pass directly through the ganglion, still as preganglionic fibers ending in the collateral ganglia ***(Michael, 1996)*.**

Within the sympathetic segmental ganglia, preganglionic and postganglionic fibers synapse. Some of the postsynaptic nerves return to their respective segmental nerves via the gray rami communicantes, innervating blood vessels, sweat glands, and the pilomotor muscles of the skin. Other postganglionic fibers may run three to six dermatomes caudal or cephalad through the sympathetic trunks to terminate in more distal ganglia. Still others pass through the vertebral ganglia to end in a variety of nerve plexi, such as the cardiac plexus and hypogastric plexus ***(Jordan, 1985).***

The position of the sympathetic ganglia varies depending on the anatomic level of the spinal cord where they are found. The first thoracic sympathetic ganglion becomes fused with the lower cervical ganglion to form the inferior pole of the stellate ganglion ***(Raghavender, 1999).***

In general as one descends from T2 to L2, the site of the ganglia move from just beneath the rib to the anterolateral surface of the vertebrae ***(Michael, 1996).***

The second thoracic ganglion lies just anterior to the medial portion of the neck of the rib. The next three or four ganglia lie in front of the corresponding head of the rib. The lower thoracic ganglia T7 to T10 are located just below the rib along the posterior superior surface of the vertebrae. The T11 and T12 ganglia are on the lateral surface of the vertebrae, approximately, whereas the lumbar ganglia move progressively more toward the antero-lateral surface ***(Jordan, 1985).***

Anatomy of intercostal nerve :

There are 12 pairs of thoracic anterior primary rami: the upper 11 comprise the intercostal nerves and the 12th is termed the subcostal nerve. They are responsible for the innervation of the muscles of the intercostal spaces and of the anterior abdominal wall, and for the cutaneous supply of the skin of the medial aspect of the upper arm and of the anterior and lateral aspects of the trunk from the level of the angle of Louis to just above the groin. In addition, each nerve is joined to its corresponding thoracic sympathetic ganglion by a white and grey ramus communicans.

The 3rd to 6th intercostal nerves are wholly typical; the others all exhibit variations, to a greater or lesser degree.

Intercostal nerves 3–6 ***(the 'typical' intercostal nerves)*** (fig.5).

They enter their intercostal spaces across the anterior aspect of the corresponding superior costotransverse ligament to lie below the intercostal vessels, first between the posterior intercostal membrane and the pleura and then, at the rib angles, between the internal intercostal and the innermost intercostal muscles. Near the margin of the sternum, each nerve passes in front of the internal thoracic vessels and transversus thoracis (sternocostalis) and pierces the internal intercostal muscle, anterior intercostal membrane (the fibrous anterior part of the external intercostal muscle) and the overlying pectoralis major to become an *anterior cutaneous nerve* of the thorax.

Branches from these four 'typical' intercostal nerves are:

1. ***Muscular*****,** to the intercostal muscles.
2. ***Collateral*****,** which run along the lower border of each intercostal space, and either rejoin the main nerve or end as separate anterior cutaneous nerves.

3. ***Lateral cutaneous*,** which reach the skin in the mid-axillary line and divide into anterior and posterior branches.

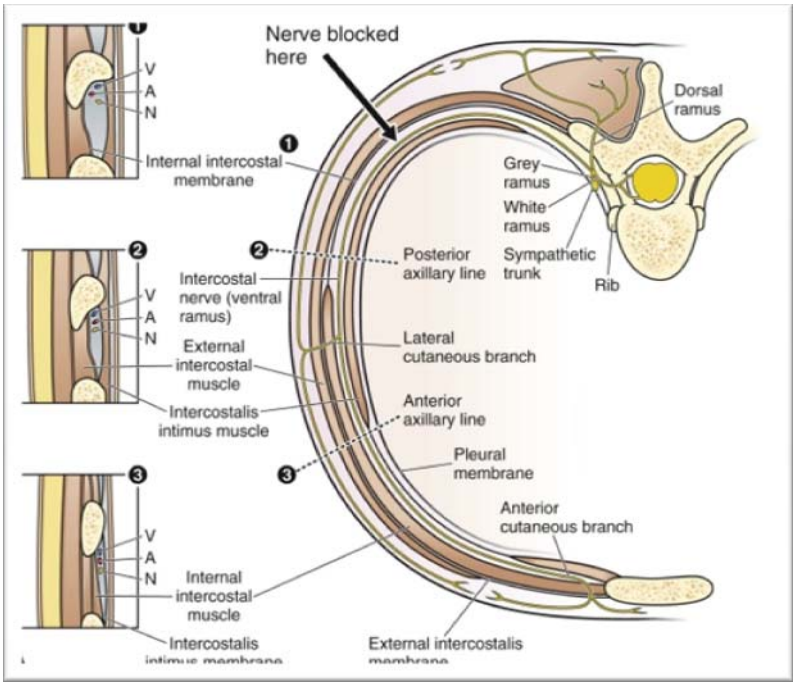


Fig.5:Course and anatomy of the typical intercostals nerve***.(Roberts,2009)***

Atypical intercostal nerves :

The **1st intercostal nerve** (**T1**) sends a large contribution which passes across the front of the neck of the 1st rib, lateral to the superior intercostal artery, to enter into the composition of the brachial plexus.The remaining, and smaller, part of the nerve constitutes the 1st intercostal nerve proper. It has no lateral cutaneous branch and its anterior cutaneous branch, if indeed present at all, is small.

The **2nd intercostal nerve** differs from the 'typical' intercostal nerves only in that its lateral cutaneous branch crosses the axilla to supply the skin over the medial aspect of the upper arm; this branch is termed the *intercostobracbial*