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Review Article

REVIEW: COMPARSION BETWEEN ATRAUMATIC AND TRAUMATIC LUMBAR PUNCTURE NEEDLES

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ABSTRACT

Postdural puncture headache (PDPH), mainly resulting from the loss of cerebral spinal fluid (CSF), is a well-known iatrogenic complication of spinal anesthesia and diagnostic lumbar puncture. Spinal needles have been modified to minimize complications. Modifiable risk factors of PDPH mainly included needle size and needle shape. However, whether the incidence of PDPH is significantly different between cutting-point and pencil-point needles was controversial. Modern international guidelines supportthe use of atraumatic needles forlumbar puncture. As the diagnostic lumbarpuncture in neurological patients isa frequent routine investigation, whichis in our settings still performed withtraumatic needles, we hereby presenta review of the literature on the use oftraumatic and atraumatic needles.The use of noncutting or pencil-point spinal needles should become the standard for performing diagnostic lumbar puncture.

Keywords: Post-dural puncture headache, Spinal anesthesia, traumatic and atraumatic needles, CSF

INTRODUCTION

The brain has two fluid compartments: interstitial and cerebrospinal fluid (CSF). Davson CSF system is called the ―sink brain‖ because there is a slow flow of liquid from the parenchyma to the interstitial space and thence to the spinal fluid1. The presence of this liquid compartment has many advantages, first by supporting the growth of brain. The brain is less dense than water, and, despite having an average weight of 1,500 kg, when suspended in CSF, weighs only 50 g floating in this liquid medium. Therefore, the CSF protects the brain against trauma mainly against the base of the skull. The CSF also regulates the pressure variations caused by intracranial expansive processes or venous obstruction, reducing the intracranial contents by flow through the foramen magnum, reflecting the Monro-Kellie-Burrows doctrine2‘ 3, where the intracranial total volume is the sum of brain volume, the intracranial blood and CSF. As the intracranial volume is constant, any change in the brain parenchyma or blood volume is compensated by the decrease in the volume of CSF4. Another function is the removal of the products generated by brain metabolism. The brain is devoid of lymphatic vessels, then, such products fall in the interstitial and go directly into the venous system or to CSF[2,5].

The CSF also contributes to the distribution of biologically active substances through the brain, as in the hypothalamic-pituitary complex. The thyrotrophic-releasing and luteinizing hormone leave the hypothalamic secretory cells and go to CSF of the third ventricle. Fluctuation in these hormones in CSF brings physiological and behavioral changes in animals, making crystal this route of communication between regional structures of the brain through the spinal fluid. Similarly, electrolyte, CSF and osmolality changes modify the systemic controls, changing intake and excretion of liquids and other substances6.

CSF production is a specialized process performed mainly by the choroid plexus. Less than 10% of this production is extrachoroidal, coming primarily from the interstitial fluid. The total volume of human‘s CSF ranges from 140 to 270 ml, 25% of which are within the ventricles and the subarachnoid space fills the remainder 2. The CSF secretion is continuousand replaces the entire volume from 3 to 4 times in 24 hours at an approximate rate of 0.4 ml / min, in which is an autonomously controlled production by peptidergic signals (vasoactive intestinal peptide and neuropeptide Y) and adrenergic 1, 6. The absorption of CSF is a continuous flow, without transport mechanisms, with an absorption corresponding to production. At the microscopic level, it‘s possible to see that the vacuoles are formed in the wall of the arachnoid villi unidirectionally to the venous sinuses. Therefore, despite the production of CSF held at a constant, absorption is made in dependence of CSF pressure and another factors 5. CSF is produced by the choroid plexus located within the cerebral ventricles (lateral, third and fourth ventricles). Soon after its formation, the CSF goes to subarachnoid space through the Luschka and Magendie foramina and reaches the brain and spinal cord surface. Therefore, any disease involving the central nervous system produces changes in the composition of the CSF, turning it into a sentinel diagnosis of neurological diseases. The ease of obtaining samples for analysis, through correct lumbar puncture, translates into powerful investigative tool in cases of infectious, neoplastic, autoimmune, neuropediatric, neurological and internal medicine in general. The collection of CSF is not always carried out by experts; it is a medical procedure, often in urgent situations where it's frequently made by the attending physicians7. This procedure can also be performed with diagnostic and therapeutic purposes, such as injection of radio-paque substances, radioactive substances, anesthetic proposed (spinal anesthesias), intrathecal chemotherapy treatments, for relief of intracranial hypertension, neurological disorders, among other conditions 6.

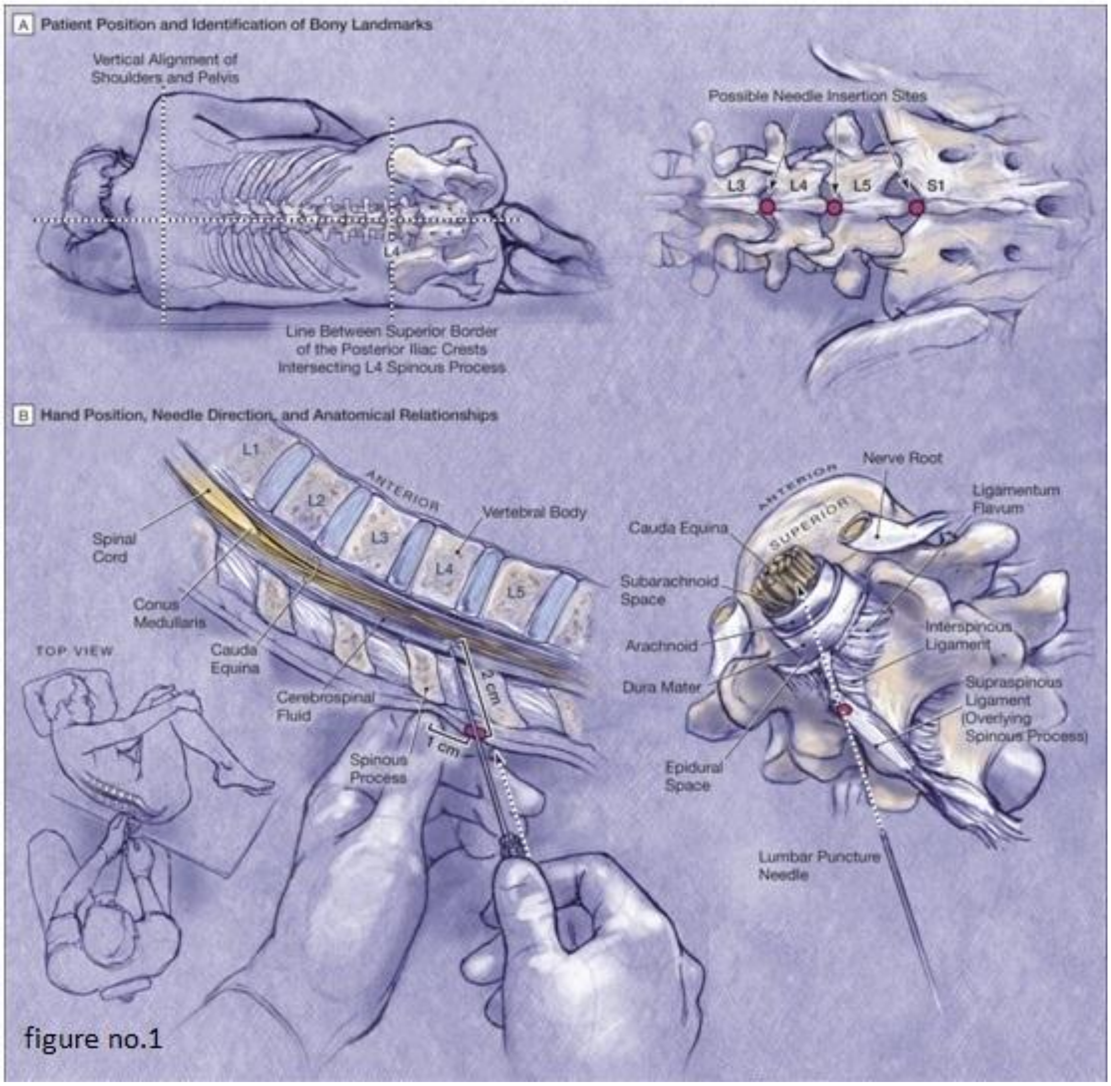

Figure no1 Lumbar puncture is usually performed with the patient in the lateral recumbent position. To avoid rotation of the vertebral column, align the patient's shoulders and pelvis in a plane perpendicular to the bed. A line connecting the superior border of the posterior iliac crests intersects the L4 spinous process or the L4-L5 interspace. Insert the lumbar puncture needle in the midline of the L3-L4, L4-L5 (most commonly), or L5-S1 vertebral interspace. These interspaces are below the end of the spinalcord, which terminates at the level of L1. Angle the needle towards the patient's umbilicus and advance it slowly. The needle will penetrate the ligamentum flavum,dura, and arachnoid to enter the subarachnoid space, where cerebrospinal fluid is located.

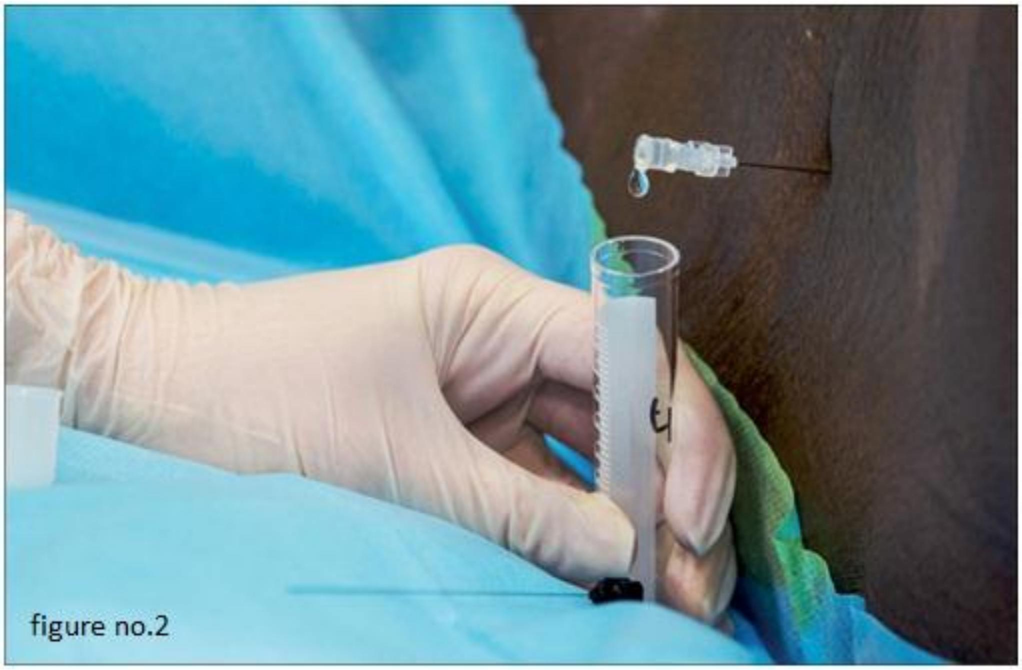

Figure no 2: CSF extraction for diagnostic purpose

Lumbar puncture is one of the most common invasive procedures in modern medicine. It is used routinely by physicians not only to diagnose disease through sampling or imaging, but also to treat by delivering chemotherapy or anaesthesia, or reducing intracranial pressure8, 9. It remains one of the most widely practiced procedures, being performed by various specialists, such as neurologists, neurosurgeons, paediatricians, anaesthesiologists, emergency physicians, radiologists and internists. While the safety profile of lumbar puncture has improved drastically since its inception in the 1800s, it remains plagued by often debilitating patient complications, the most prominent of which is headache. Postlumbar puncture headaches are classically described as postural in nature and frontal–occipital in location. These headaches can severely impact patient well-being, often requiring hospitalisation and potentially, invasive therapy10.

A headache occurring within 5 days after lumbar puncture, and being aggravated when standing or sitting and relived when lying flat, is defined as postdural puncture headache (PDPH) on the grounds of the International Classification of Headache Disorder, 3rd edition11. It is the drawback to the use of spinal anesthesia or diagnostic lumbar puncture12, 13 resulted from the loss of CSF and the following tension on meninges aroused by the hole created in the dural tissues[12]. PDPH was usually mild with no limitation of activity and required no treatment while patients with severe PDPH were confined to bed. An epidural blood patch (EBP), injecting the blood of the patients own into the epidural space to patch the hole created in the dural tissues, was often used to treat severe PDPH14.

Headache is postulated to occur as a result of leakage of cerebrospinal fluid (CSF) from the site of the dural tear created during the puncture. This leakage results in a decrease in CSF pressure, causing traction of pain-sensitive structures in the cranium. Multiple factors, such as needle gauge, needle tip design, patient position and operator experience, have been proposed to affect the incidence of headache following lumbar puncture. Of prime importance is the needle tip design. Spinal needles can be broadly characterised as being atraumatic or traumatic depending on their tip configuration15. Traumatic or ‗conventional' needles are the most commonly used. They feature a bevelled tip, designed to puncture through tissue, with an opening at the tip to facilitate collection of CSF or injection of therapeutics. In contrast, atraumatic needles are blunted, with a pencil-point tip and a side port for injection or collection. Theoretically, atraumatic needles dilate the dural fibres, splaying them during the procedure, and following removal of the needle, allow them to gradually return to their original position, in contrast to traumatic needles, which tear and damage the dural tissue [10, 16].

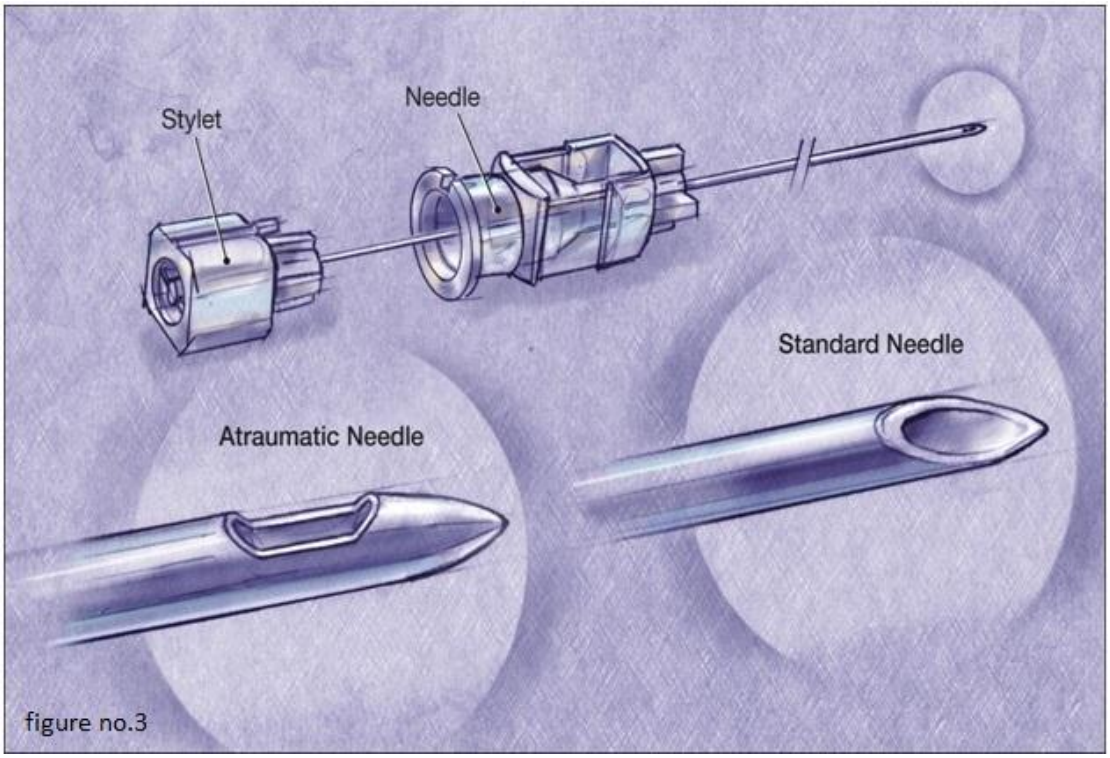

Figure no 3: Atraumatic versus traumatic lumbar puncture needles

Atraumatic needles include Whitacre, Atraucan,Sprotte, Cappe and Deutsch, among others. Traumatic needlesinclude Quincke, Greene, Hingson Ferguson, Lutz, Brace andRovenstine, among others. Traumatic needles are characterized bya bevelled tip that cuts the dura mater. In contrast, atraumaticneedles are characterized by a pencil-point design. It has beenstated that noncutting or atraumatic needles produce a separationof the tissue fibres that heals easily after removal of the needle.Cutting or traumatic needles, on the other hand, favour loss oftissue and trigger a large inflammatory reaction that requires a longtime to heal [15, 17, 18].

Needle type	Traumatic	Atraumatic
Skin puncture	Easy	Harder Skin can be punctured first prior to insertion of the LP-atraumatic needle by using the 18G or green 19G local anaesthetic needle
Puncture of the Ligamentum flavum and dura	A "give" (or »plop«) is felt on passing through the ligamentumflavum and dura	Dural puncture is not felt
Dural puncture hole	Triangular, larger	No cutting of dural fibers
Use of local Anaesthethics	Not mandatory	Yes
Obtaining CSF	Reliable, fast	Reliable, can be slower
Several LP -attempts	Usually not	Usually not; the first attempts of LP are more successful with atraumatic needle
PDPH incidence	High	Low
Duration of Hospitalisation	Prolonged	Shortened
Routine use	Yes	No
Overall (total) costs of patient care with LP	Higher due to complications, esp.PDPH	Lower; immediate discharge after procedure

Table 2: Characteristics of traumatic and atraumatic needle use in lumbar puncture: presents the advantages anddisadvantages of the use of traumaticand atraumatic needles for lumbarpuncture

Modifiable risk factors of PDPH included the needle size, needle shape, bevel orientation and inserting angle, stylet replacement, and operator experience19 [19]. Needle size might be the most significant factor in the development of PDPH [18, 19, 20]. Spinal needles generally used today are 22 to 27 G, but sizes ranging from 19 to 30 G are available[12]. The incidence of PDPH after spinal anesthesia performed with Quincke, an cutting needle, is 36% with 22 G needle, 25% with 25 G needle, 2% to 12% with 26 G needle, and less than 2% for smaller than 26 G needles [20, 21, 22, 23, 24]. The smaller needle diameter reduces the incidence of PDPH [19, 25]. However, even the use of 29 G needles will reduce the complication, they are too thin to use26. Spinal needle, which is extremely thin (29 G or smaller), would increase the rate of failure for spinal anesthesia. And multiple dural punctures caused by unsuccessful puncture would increase the rate of PDPH

[20, 27, 28, 29, 30]. And sometimes CSF is too viscous to come through a small needle31.

As for the tip design, the cutting-point needles were easier to insert through the skin and ligaments, while the pencil-point needles were easier to recognize the dura mater32, 33[32,33]. Some studies argued that the incidence of PDPH was not significantly different between cutting-point and pencil-point needles34, 35 ,while some opposited, arguing noncutting needle lead to lower rate of headache36, 37, 38. A previous meta-analysis published in 2000 has compared the frequency of PDPH between Quincke (a cutting-point spinal needle) and pencil-point spinal needles which suggested that pencil-point spinal needle will significantly reduce PDPH rate compared with Quincke spinal needles[36].

Every year approximately 400,000 diagnostic lumbar punctures are performed by neurologistsin the United States39. Recent studies have shown that the ―atraumatic,‖ pencil-point Sprottespinal needle is associated with a lower incidence of postlumbar puncture headache comparedto the conventional ―cutting‖ Quincke needle40,41. Although the use of the atraumatic needle isstandard practice among anesthesiologists for spinal anesthesia, only 2% of neurologists routinelyuse atraumatic needles. The most common reasons given by neurologists for not usingthe atraumatic needle are nonavailability and expense[42].

CONCLUSION

There is lot of controversy to use whether traumatic or atraumatic spinal needle for lumbar puncture. Lots of researches are going on.Pencil-point spinal needle was significantly superior compared with cutting spinal needle regarding the frequency of PDPH, PDPH severity. In view of this, we recommend the use of pencil-point spinal needle in spinal anesthesia and lumbar diagnosticpuncturethan cutting spinal needle regarding the frequency of Post-dural puncture headache.

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