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Overview on spinal anaesthesia

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Abstract
On August 24, 1898, August Bier and his assistant Hildebrandt undertook experiments on their own bodies, which were part of their historic initial investigations of spinal anesthesia. This article will address the anatomy in cadaver and with the aid of ultrasound and magnetic resonance. Understanding the cerebrospinal fluid and the specific gravity of solutions injected into the subarachnoid space. Factors associated with the variable clinical response to spinal anesthesia are local anesthetic dose, baricity, patient positioning, site of injection, body habitus, speed of injection, and age.

Keywords: anaesthesia, spinal, CSF fluid, CNS

Introduction

The administrations of a safe and efficacious anethesia demands not only observation, but also a technology that iluminates far beyond what we can perceive with our natural senses. Since its beginning in 1898, the practice of the spinal anestesia has entered a phase of gradual understanding with a variety of suppositions about its action in the spinal nerves. In its description of the "cocainization of the spinal cord", words used and justified by Bier because of its short time of action [1], he tries to explain and understand its mechanism. Cocaine spreads in the cerebo-spinal fluid (CSF) and makes contact not only with mielinated nerves, but also with the posterior root ganglia. He, Bier, believed that the insensibility of pain after the subarachnoid injection of a small quantity of cocaine was due to the action of the drug on these nerves without the sleeve and, probably, also on the ganglia. A great impulse pushed local anestesia because of the results obtained with the injection of cocaine around the spinal cord and cauda equina, a method that, because of its short time of action was called lumbar block or lumbar anesthesia

A great push was given to local anesthesia by the results of the injection of cocaine around the spinal cord. The result was then called "lumbar anestesia". The short action of cocaine motivated Dean [2] to try the continuous spinal anesthesia. He used to state the great value of the lumbar anesthesia that protected patients from the surgical shock and much more, that all should understand the lesson as soon as possible. In 1909, Jonnesco presents two fundamental topics for the understanding of the spinal anesthesia [3]: a) approaching the spinal canal must be placed at the midpoint of the inervation of the surgical site; b) the solution must have the addition of a drug, stricnine, that is well tolerated and provides vasoconstriction that prolongs the action of the anestesia without harm to superior centers. With the thoracic approach, analgesia is complete in two or three minutes. In the lumbar approach analgesia is provides in a longer time, more slowly, but it will be ready in about 10 minutes. While spinal anestesia is the technic of choice for a variety of surgical procedures, it has always been difficult to control the width and depth of the anestesia. Lumbar spinal anesthesia starts by blocking the cauda equina. For it to spread cranially the volume must be increased, change the site of puncture for a higher one or modify the level of the table. Kirschner [4] proposed a new method to induce spinal anestesia through the injection of the drug in the midpoint of the surgical site, maintaining the position until the end of the porcedure. In the years 1934 and 1935, Etherington-Wilson [5, 6] proposed the use of a glass column to explain the fundamentals of the various solutions available. He divided the spinal block in three zones: a) low spinal, limited to the first lumbar segment; b) intermediate spinal limited to above the tenth thoracic segment c) high spinal, limited above the fifth thoracic segment. In 1947, Saklad et col [7] proposed the utilization of segmental spinal anesthesia, based in the anterior work. [4] The authors produced segmental spinal anestesia for a variety of surgical procedures. Mechanism of the Spinal Anesthesia The injection of local anesthetics in the CSF provides block of the spinal cord as of the spinal roots that will form the peripheral nerves. This way, the conduction block is a simple form to explain its mechanism of action. The theory provides a variety of explanation of the actions of local anesthetics in the spinal cord. In the dorsal and ventral horns, local anesthetics block sodium channels and inhibit not only the generation but also propagation of electrical activity. [8] Other neuronic channels of the medula, such as the calcium channels, are important for the activities of aferent and eferent impulses. Local anesthetics may have similar action in the calcium channels, when administered intrathecally, and may reinforce analgesic action in the spinal cord [9].

A variety of neurotransmiters are involved in the nociceptive transmission in the dorsal horn of the spinal cord, such as the P substance and gama-aminobutiric-acid. The depth of the spinal anestesia may be obtained with small variation of the evoked somatosensorial potentials in the anesthetized area [10]. This way, the interruption of electric information by the local anesthetic may be the primary mechanism for the spinal cord block.

Anatomy

The spinal cord is a prologation of the Central Nervous Sistem (CNS), that descends through the vertebral column, down the tube formed by the vertebral rings. It is protected by the membranes dura-mater, arachnoid-mater and pia-mater, and imersed in the cerebro-spinal liquid (CSF). It also emits nevous filaments, the anterior radicula (motor fibers) and the posterior radiculae (sensitive fibers) from the antero-lateral and postero-lateral sulcus of the medula, respectively. Both radicula go to the conjugation foramen formed by each superposed pair of vertebra. After the formation of the ganglia of the posterior roots by the posterior radiculae they turn themselves to the sensitive portion of the nerves, unite to the anterior radiculae that emerge from the spinal canal as spinal nerves.

Cerebrospinal Fluid

After the injection of local anesthetics in the subarachnoid space a dilution occurs in the CSF before the local anesthetics reaches the spinal cord to adere to it. So, the individual variation in CSF volume and its distribution in the subaracnoid space will affect spinal anestesia. Magnetic ressonance image (MRI) has demonstrated a great variability of volume of CSF volume among individuals, that goes from 28 to 81 mL. [11] Interestingly, obese patients have substantially less CSF, in about 10 mL. Studying the regression of hyperbaric lidocaine and isobaric bupivacaine it was observed a correlations between hight and their sensitive and motor bocks [12].

Baricity of the solutions Spinal anestesia occurs when a solution of local anesthetic is injected in the subarachnoid space. It corresponds to the action of a drug (local anesthetic) in the radicula (the system that conducts the impulse). An interaction will occur between the CSF and the anesthetic solution. The anesthetic solution as much as the CSF has physic propriety: their densities. The density of something (be it solid, liquido or gaseous) is the relation between itself and the substance with wich it is being compared. In the case of liquids it is compared to the water. So, the density of an anesthetic solution or of the CSF is the result of a comparison to the water that is the patern [13].

Values of CSF determined in modern equipment vary from 1.00103 to 1.00013 among healthy adults of both genders [14]. This way, local anesthetic solutions of densitty greater than 1.00103 are called hyperbaric solutions. Densities under 1.00013 are called hipobaric solutions. All solutions with densities between 1.00103 and 1.00013 are called isobaric solutions, even when they have a different behaviour in the CSF of the patient. Posteriorly, another study analized the densities of anesthetic solutions and all adjuvants commomly used in spinal anestesia. It was concluded that anesthetic solutions that contain glucose (7.5% or 8%) are all hyperbaric in relation to the CSF. The density difference is so great that they are all hyperbaric for any patient. Even when they are diluted, the presence of glucose still maintains the hyperbaricity in relation to the CSF [15]. Also in this study it was confirmed that all anesthetic solutions without glucose and with diluted concentration are hypobaric in any patient. Its density is bellow the density of the CSF [15]. The use of hyperbaric, isobaric and hypobaric solutions in the spinal canal has shown that each solution has its proper action, dispertion and duration of sensitive and motor blocks.

The use of hyperbaric, isobaric and hypobaric solutions in the spinal canal has shown that each solution has its proper action, dispertion and duration of sensitive and motor blocks. So, in 2006, Gouveia and Imbelloni proposed a new understanding of the spinal anestesia based in all three solutions [16].

a. **Hyperbaric Solutions:** Giving lumbar spinal anesthesia in a sitting patient the block is stablished from the site of injection to the sacral canal, independent of the descent of the solution. If the patient is maintained in this position, hyperbaric solution will descend sacrally where it may fix to the terminal rootlets. If the dose is small (as 5 mg of hyperbaric bupivacaine or 20 mgheyperbaric lidocaine) a saddle blcok will be stablished [17, 18]. If the dose is greater than 15 -20 mg for bupivacaine of 75-100 for lidocaine), maintaining the patient in the sitting position may provoque what we may call the “sacral kidnapping of the drug”, providing a good amount of drug to only a few radiculae, and certainly providing condition for a farmacological atack to the central nervous system, that will surely terminate as a cauda equina syndrome and its consequences. The same phylosophy is due to pacients receiving hyperbaric anestesia in a bad position, or with an important lordosis that may make it difficult the distribution of the anesthetic solution in the spinal canal [19].

The same doses injected in a patient lying laterally that returns to the recumbent position will distribute posterioirly along the dural sac as cephalad as caudad. In the dorsal decubitus heavy solutions will privilegie the posterior radiculae, offering a longer sensitive block while the motor block will last shorter. The final result will be a lumbar spinal anestesia with a thoracic level of analgesia. The motor block derived from the dilution of hyperbaric solutions will finish before the sensitive block, what is desirable. Tha is what is normally done, and seldom understood [16]. And if the patient moves his feet all get anxious because the block has finished. No, it has not finished. The motor block has finished while the sensitive block still will last for a good time. For unilateral block, half the dose must be used. It is half dose for half block. The patient must be kept in the lateral position for up to 20 minutes for fixation (depending on the drug). After fixation the patient may be placed in the recumbent position. Using only a small dose of hyperbaric solution in a patient in the lateral decubitus, a predominant sensitive block is obtained with or without motor block or the most a motor block of very short duration. To obtain a higher block one must use a small head down tilt for a few minutes. That is what desirable, ascending moviment to thoracic levels. Because of these factors, the utilization of hyperbaric solution for surgeries with the patient in the prone position is a highly dangerous indication, as are the high levels without a surgical necessity, since the hyperbaric solution offers the privilege of the block to the motor roots and its upward movement privilege the motor roots in its thoracic ascending route. This position will certainly provide some anesthesia to a non surgical field and an extended unnecessary motor block to intercostal nerves with all its consequences, as hypoxia and cardiac arrest in the worst condition [20].

b. Hypobaric Solutions Diluted solutions may also be employed aiming selectively a sensitive block, offering tha patient the comfort of analgesia without motor block. It is an old technique, as old as the spinal anestesia itself. With less common indications and a low frequency of use, we do not have an industrial hypobaric solution commercially available. Home made solutions are easy to be prepared. Starting from isobaric solutions is reccommended. To prepare it by yourself will demand a sterilized ampoule o distilied water, a sterilized ampoule of isobaric 2% lidocaine or 0,5% bupivacaine and a 5 ml sterilized syringe. With the syringe you can aspirate 1.5ml of either solution and add 3.5ml of distilled water. The final solution will be 30 mg of 0.6% hipobaric lidocaine or 7.5mg of 0.15% hypobaric bupivacaine Both prepared solutions have a specific gravity bellow the one of the CSF15. Do not use 0, 9% NaCl. After aspirantion of CSF, the injection must be injected very slowly, taking 15 seconds for each mililiter, to permit the floating of the solution in the posterior part of the spinal canal (or upper level in this case), prefering the sensitive rootlets. This solution is very used for posterior spinal blocks (relative to the posterior rootlets of the spinal cord) or pure sensitive block that must be performed with the patient in the ventral position with the hips elevated by a pack of pads. We use a sandbag. The sandbag or the pack of pads must be placed under the prone abdomen to reduce the lumbar lordosis opening the interspaces. It is specially indicated for surgeries of hemorroid or sacral cists. For the treatment of varicose veins, the surgery must be started in the prone position while permitting the fixation of the drug in the sensitive rootlets before turning the patient to recumbent position, and producing unwanted motor block and missing sensitive block. When needed, the patient will be able to turn himself (or herself) to the recumbent position to finish the treatment.

c. **Isobaric Solutions:** In reality there is not an isobaric soutions. As the human CSF solution density varies from 1.00306 to 1.00036, this solution, with a density of 0.99930, is very close to the CSF density

After the block in the lateral position the patient will be placed in the recumbent position, what will permit the solution to float anteriorly, promoting an intense motor block in the blocked limb with some minor influence in the oposite limb [16]. This is the explanation of the longer time of motor blockade provided by the isobaric soutions [16, 22]. If blocked in the sitting position, the solution has a tendency to ascend to reach thoracic level [23].

Conclusion

The spinal anestesia is old, simple, easy and a popular technique. Anatomy, physiology and pharmacology are very important and necessary for its understanding. Investigations about physiological effects of the spinal anesthesia reveal complex interaction in a variety of systems. The security of agentes used and complications of the technique applied are always under surveillance to imporve the results. A deeper analisis will be necessary to fully solve all problems discussed in this article for a better understanding and utilization of this speceial technique.

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