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Review Article

Spinal Hemianesthesia: Unilateral and Posterior

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Introduction

Spinal anesthesia involves the use of small amounts of local anesthetic injected into the subarachnoid space to produce a reversible loss of sensation and motor function. The injection of local anesthetic in the subarachnoid space can result in hemodynamic and respiratory changes. If it were possible to limit anesthesia for the surgical field, certain undesirable effects of spinal anesthesia could be avoided.

The first description of the use of segmental anesthesia was performed by Jonnesco 1909 [**1**], each attempting to restrict the extent of somatic and sympathetic paralysis to the operative site. Among such techniques are fractional segmental spinal analgesia [**2-5**], where localization is achieved by intermittent injection of small amounts of agents into the subarachnoid space via an indwelling catheter or needle, and unilateral spinal analgesia [**6-8**], where anesthesia is confined to one side of the body by the subarachnoid administration of hypobaric or hiperbaric solutions with the patient placed in the lateral position. In 1961, Tanasichuk and his colleagues [**9**] described a particular technique of spinal anesthesia in patients receiving one limb orthopedic surgery, which they named Spinal Hemianalgesia. In practice, a conventional unilateral spinal anesthesia technique can only result in a motor hemi-block and a sensory block preferential to one side.

The dural sac in the vertebral canal is formed by external-dura mater, internal-pia mater and arachnoid membranes. Spinal cord and nervous radicles involved by pia are located within the dural sac. Posterior radicles form sensory roots and anterior radicles form motor roots. Lumbosacral nerves may be blocked in three different ways: First, with patients in the lateral position; Second, with patients in the sitting position, and finally third, with patients in the prone position. The site of sensory block spinal anesthesia is generally considered by blockade of the posterior roots (sensory). To perform the puncture with patients in the prone position, a pad has to be placed under the abdomen to correct lordosis and increase spinal interspace [10]. Thus realization of the posterior spinal is also a form of spinal hemianesthesia. A practical definition of Spinal Hemianesthesia could be an attempt of achieving an asymmetrical distribution of spinal block between the operated and nonoperated sides of the patients: unilateral spinal anesthesia and posterior spinal anesthesia.

Anatomy

Surrounding the spinal cord in the bony vertebral column are three membranes. From the immediate overlay of the cord to the periphery, there are the pia mater, the arachnoid mater, and the dura mater [11]. Between the pia and the arachnoid is the space of interest in spinal anesthesia, the subarachnoid space. In this space are the cerebrospinal fluid (CSF), spinal nerves, a trabecular network between the two membranes, blood vessels that supply the spinal cord, and the lateral extensions of the pia mater, the dentate ligaments. The spinal cord normally terminates above the first lumbar intervertebral space as the conus medullaris. However, normal variability amongst patients, or abnormal conditions such as a tethered cord, may mean that the spinal cord terminates unusually caudad.

Cerebrospinal fluid

The clinical response to spinal anesthesia is influenced by several factors. 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 [12]. Interindividual variability in lumbar CSF volume may be an underestimated factor associated with variation in the spread of intrathecal local anesthetic. This volume cannot be accurately predicted on the basis of physical characteristics such as height and weight [13,14].

Advances in radiographic imaging and computer processing techniques have contributed greatly to our ability to accurately estimate CSF volume. The lumbosacral CSF volume estimated using two-dimensional magnetic resonance imaging showed a significant interindividual variation [15]. Using three-dimensional magnetic resonance imaging the authors reported wide interindividual variation of estimated lumbosacral CSF volume and the inverse relationship between CSF volume and BMI [16].

In healthy volunteers who received hyperbaric lidocaine or isobaric bupivacaine spinal anesthesia, was found a strong inverse relationship between lumbosacral CSF volume and peak sensory cephalad blockade height and anesthetic duration [13,14]. Similarly, in patients randomized to receive hyperbaric bupivacaine either in the lateral or sitting position, lumbosacral CSF volume is inversely correlated with the spread, onset, and duration of anesthesia [17].

Spinal nerves

The spinal cord is the continuation of the brainstem; it lies protected within the vertebral column of the spine. Each spinal nerve is formed by the combination of nerve fibers from the dorsal and ventral roots of the spinal cord. The dorsal roots carry afferent sensory axons, while the ventral roots carry efferent motor axons. The fusion of sensory and motor roots results in spinal nerve. The spinal nerve emerges from the spinal column through an opening (intervertebral foramen) between adjacent vertebrae. Its function is to innervate the skin, posterior joints, muscles, spine, thorax, abdomen and upper and lower limbs.

The distance between the left and right spinal nerve roots is nearly 10-15mm in the lumbar level. Such a small distance should

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reasonably prevent from producing a strictly unilateral block of spinal nerve roots.

Unilateral spinal anesthesia

It is necessary to introduce the local anesthetic in the right place, to avoid mixing and diluting it in the CSF, administered at a volume and concentration that are enough to produce anesthesia and allow the realization of the surgical intervention without causing cardiovascular changes. Restricted spinal block is performed to decrease the extension of the surgical blockade to the side being operated, as well as to maintain the anesthesia for a period compatible with the procedure.

Theoretically, the injection of a non-isobaric local anesthetic should induce a unilateral spinal anesthesia in patients in a lateral decubitus position. It should be possible to influence the spread of anesthesia by changing the patient's position, and the hemodynamic effects of the block should only be minimal.

The most important factors to be considered when performing a unilateral spinal anesthesia are: type and gauge of the needle, density of the local anesthetic relative to the CSF, position of the patient, speed of administration of the solution, and dose/concentration/volume of the anesthetic solution.

Needles

A high success rate with unilateral spinal block was reported with 20G and 22G [**9**], and 29G [**18**] needles. The gauge and type of needle seems to be more specifically related with the incidence of side effects. When a liquid is injected through a needle, the speed of administration is important to determine whether the flow will be laminar or turbulent. A turbulent flow provides a fast mixture of the local anesthetic with the CSF, producing a homogenous mixture that reduces the baric gradient between them, avoiding migration of the anesthetic solution. The slow injection is related with a greater prevalence of unilateral spinal block [**19**]. The gauge and type of needle seems to be more specifically related with the incidence of side effects.

Baricity

The difference in density between the CSF and local anesthetics is a factor that should be considered to restrict the distribution of solutions within the subarachnoid space. Theoretically, unilateral spinal block could be obtained with hypobaric [**20**] or hyperbaric [**21**] solution injected into the subarachnoid space, with the patient in lateral position, so that the anesthetic forms a layer above (hypobaric) or below (hyperbaric) the midline. Slow injection speeds along with low doses and concentrations could provide conditions for preferential lateral distribution.

The difference in baricity between hyperbaric solutions and CSF is greater than between hypobaric solutions and CSF. This may be one reason for the differences in the reliability of the blockade. When comparing the same dose (5 mg) of hyperbaric bupivacaine with hypobaric bupivacaine, the greater volume of the hypobaric resulted in a greater dispersion of anesthesia. This may be the reason why many authors use and trust preferably in hyperbaric solutions.

Position

The puncture sitting position is incompatible with obtaining unilateral spinal anesthesia. Thus, for the unilateral spinal anesthesia the puncture should be performed with the patient in lateral recumbency. Both hyperbaric and hypobaric solutions have been used. The position of the patient during and immediately after the injection of the anesthetic influences the dispersion of drugs injected in the subarachnoid space. Thus, the use of a solution with a density lower or higher than that of the CSF is, in theory, capable to control the distribution of the spinal block. Maintenance of the lateral decubitus for a determined length of time might restrict the surgical block to the side to be operated. However, it is difficult to define the ideal length of time, since it is influenced by the type of anesthetic and the dose administered. In fact, when full doses (high doses) are used, the blockade migrates even when changing position one hour later [**20**]. On the other hand, the slow administration of low doses of hypobaric and hyperbaric solutions and maintaining the patient in lateral decubitus for 15 to 30 minutes results in, virtually, a restricted distribution to the side to be operated on, therefore producing surgical block only in one side [**22-25**].

Rate of injection

Even if the injection rate seems to be of minor relevance for cephalad spread. Several studies have shown that conventional injection eventually cause turbulence and providing rapid mixing of the anesthetic with the LCS, especially when fine needles are used. The turbulence that occurs in LCS using very rapid injection may increase the initial mixture of local anesthetic in the LCS, so producing this high concentration of the solution in the non-dependent part of the spinal canal. This effect has been demonstrated in vitro when using fast injections [**26**]. Different needle gauges have different internal diameters, resulting in different rates of flow. Reducing to half the internal diameter of the needle results in a flow rate four times lower. The slow injection is related with a greater prevalence of unilateral spinal block.

Concentration, volume and dose of anesthetic solution

In the lateral decubitus position, concentration, volume, and dose of local anesthetic solution injected into the subarachnoid space will be strictly related to obtaining concentration gradient between the dependent side and the non-dependent. Therefore, small or reduced doses of hyperbaric or hypobaric local anesthetics are sufficient to achieve a unilateral block. The dosage is also importance for the fixing of the local anesthetic. If we regard nerve fibers as a compartment, a relative or absolute surplus of a local anesthetic is not fixed completely. Even after longer periods, the local anesthetic "free" can be redistributed after changes in patient position. It was demonstrated in 234 patients that a dose of less than 0.05mg/cm of height of hyperbaric bupivacaine, significantly more often resulted in a unilateral motor and sensory block [**27**]. Therefore, dose reduction can be regarded as an important factor for a successful unilateral spinal anesthesia.

Comparing 5 mg isobaric hypobaric and hyperbaric sidedness was obtained in 80% of patients with hypobaric, 76% with hyperbaric and only 28% with isobaric [**25**]. The subarachnoid compartment is sealed and the closeness of values for the specific weight can lead to a homogeneous distribution, with bilateral result. Thus, it was shown that isobaric solutions for their specific weight very close to the specific gravity of the LCS, always offer bilateral blockade, regardless of the position taken by the patient.

Maintenance of the lateral decubitus positions

The dosage is also importance for the fixing of the local anesthetic. The position of the patient during and immediately after the injection of the anesthetic influences the dispersion of drugs injected in the subarachnoid space. Thus, the use of a solution with a density lower or higher than that of the CSF is, in theory, capable to control the distribution of the spinal block. Maintenance of the lateral decubitus for a determined length of time might restrict the surgical block to the side to be operated. However, it is difficult to define the ideal length of time, since it is influenced by the type of anesthetic and the dose administered. In fact, when full doses (high doses) are used, the blockade migrates even when changing position one hour later [**22**]. On the other hand, the slow administration of low doses of hypobaric or hyperbaric solutions and maintaining the patient in lateral decubitus for 15 to 30 minutes results in, virtually, a restricted distribution to the side to be operated on, therefore producing surgical block only in one side [**19,23-25**]. However, for short duration of surgeries when using lidocaine 1.5% or 2% hyperbaric (15-20 mg) or 0.6% hypobaric lidocaine (18-24 mg), the time of maintaining in lateral decubitus should be 5 to 10 minutes [**28**].

Recovery of block

Recovery from spinal anesthesia depends primarily on the local anesthetic. Although spinal anesthesia can compete with the most modern anesthetics in general anesthesia for ambulatory surgery, length of hospital release will depend on the dose and type of anesthetic used. With a reduction in the intrathecal dose of lidocaine 75 mg to 10 mg, the time to reach criteria discharge decreased from 162 min for 75-91 min [**29**]. When using hypobaric 0.15% bupivacaine for unilateral spinal, the dose of 4.5 mg gave duration 1:55 h, 6 mg was 2:15 h and 7.5 mg was 3:15, indicating that the duration is dose dependent). Likewise, when using 0.6% hypobaric lidocaine the duration is dose-dependent, being 1:03 h with 18 mg, 1:21 h with 24 mg and 1:29 h with 30 mg [**31**].

With newer anesthetics and techniques developed, patients can be discharged earlier than when conventional spinal anesthesia was used. With the absence of sensory, motor and sympathetic block in one of the members, the hospital does not require a release complete recovery of the operated limb.

It became apparent that the traditional assumption about the sequence of return of neurological function after spinal anesthesia (sympathetic, sensitive, motor and finally proprioception) may not apply to selective spinal anesthesia. Adequate analgesia for surgery can be provided as a light touch, proprioception, motor blockade and sympathetic function are preserved [**32**].

Local anesthetics

Dosage is more important than concentration or volume with respect to spread of spinal anesthesia particularly when solutions have the same baricity. Posture should be used to control the spread of hypobaric and hyperbaric solutions. The practice of employing minimal doses of intrathecal agents so that only the nerve roots supplying a specific area and only the modalities that require to be anesthetized are affected. Theoretically, unilateral spinal block could be obtained with hypobaric or hyperbaric solution injected into the subarachnoid space, with the patient in lateral position, so that the anesthetic forms a layer above (**hypobaric**) or below (**hyperbaric**) the midline. Hypobaric and hyperbaric tetracaine was used in the initial study in 1961 [**9**].

a) Hypobaric Anesthetic

In the initial study [**9**], two patients received hypobaric 0.1% tetracaine in distilled water and hence were positioned laterally so that the side to be blocked was uppermost. In Brazil, the first report on unilateral spinal block was by Gouveia & Labrunie in 1985 using 0.1% hypobaric tetracaine [**33**]. After a few months, the same authors published a report on the use of 0.15% hypobaric bupivacaine [**34**].

In Brazil the most commonly used anesthetics in spinal anesthesia remain with lidocaine, bupivacaine, levobupivacaine and enantiomeric excess (S75:R25). Hypobaric solutions are obtained from isobaric through the following dilutions:

- Hypobaric 0.6% Lidocaine

Isobaric 2% lidocaine = 1.5 mL (= 30 mg) + Distilled water = 3.5 ml 3 mL = 18 mg 4 mL = 24 mg 5 mL = 30 mg

- Hypobaric 0.15% Bupivacaine

Isobaric 0.5% bupivacaine = 1.5 mL (= 7.5 mg) + Distilled water = 3.5 ml 3 mL = 4.5 mg 4 mL = 6 mg 5 mL = 7.5 mg

- Hypobaric 0.15% Levobupivacaine (S75:R25)

Isobaric 0.5% levobupivacaine = 1.5 mL (= 7.5 mg) + Distilled water = 3.5 ml 3 mL = 4.5 mg 4 mL = 6 mg 5 mL = 7.5 mg

Due to the large diffusion and safety of bupivacaine in spinal anesthesia, it is not surprising that most of the studies on unilateral spinal block use this agent.

b) Hyperbaric Anesthetic

The initial study, the other 40 patients [**9**] received a hyperbaric tetracaine solution which was prepared in glucose 10%. Hyperbaric bupivacaine is prepared with the addition of glucose, and additions of glucose were tested at 5% and 10%, with the 8% concentration presenting less variation in the extent of blockade. Small doses of bupivacaine (5-8 mg) result in a restricted blockade after 10-15 minutes in the lateral decubitus position [**35**]. Adequate unilateral spinal anesthesia for lower limbs orthopedic surgery with 5mg of 0.5% hyperbaric bupivacaine was obtained for all patients [**21**].

The study of different doses of 0.4% enantiomeric excess levobupivacaine (S75: R25) for unilateral orthopedic surgeries reflected in a dose-dependent duration of action [**36**]. Low doses of 4, 6 and 8 mg provided recovery times of 75, 117, and 174 minutes, respectively, with positive correlation between doses [**36**].

To study the different presentations of lidocaine, such as the 1.5% and 2% hyperbaric [**37,38**], in procedures with short duration, I use 15 to 20 mg of the hyperbaric solutions. When using lidocaine, the patient should remain in lateral decubitus for 5 to 10 minutes.

Posterior spinal anesthesia

Many anesthesiologists are familiar with saddle block to help anorectal or perineal surgeries. Lumbosacral nerves may be blocked in three different ways: the first, with patients in the lateral position; the second with patients in the sitting position, and finally the third, with patients in the prone position. A special spinal anesthetic technique was described in 1961 [**9**], in which patients would receive anesthesia in just one limb for orthopedic surgeries, and was called hemi-spinal anesthesia. This technique induces sensory and motor block preferentially on one side. The dural sac in the vertebral canal is formed by external, dura mater, internal, called pia mater and arachnoids membranes. Spinal cord and nervous radicles involved by pia are located within the dural sac. Posterior radicles form sensory roots and anterior radicles form motor roots. To perform the puncture with patients in the prone position and a pad has to be placed under the abdomen to correct lordosis and increase spinal interspace [**10**].

Needles

Not enough to prefer one type of needle puncture in the prone position information. This way, you can use pencil point needles or sharp tip. Similarly, the gauge and type of needle seems to be more specifically related with the incidence of side effects.

Baricity

By definition, baricity is the ratio between injected solution density and CSF density. Local anesthetics' density may be decreased by water dilution. The baricity of the solution being injected and the position of the patient are the primary determinants of the dispersion of the drug. The solutions used in spinal blocks should be considered hypobaric when their densities are lower than the lower limit of the confidence interval of the density of the human CSF [**39**]. All hypobaric solutions (0.6% lidocaine, 0.15% bupivacaine, and 50% enantiomeric excess 0.15% levobupivacaine) are hypobaric at body temperature [**40**].

Small-dose of hypobaric lidocaine 0.6% can provide adequate spinal anesthesia for short perirectal or perianal surgical procedures for patients requiring the prone jack-knife position [**31**]. Low hypobaric bupivacaine doses (6 mg) injected in the rate of 1mL.15s-1 through 27G Quincke needle have induced posterior spinal anesthesia (sensory) in 90% of patients [**41**]. Only three patients have presented some level of lower limbs motor block.

Position

Posterior radicles form sensory roots and anterior radicles form motor roots. To perform the puncture with patients in the prone position, a pillow has to be placed under the abdomen to correct the lordosis an increase spinal interspaces. The patients were placed in the prone jack-knife position with a pillow, and the dose and type of anesthetics were injected in this position aiming at inducing anesthesia solely in the posterior radicles, thus avoiding anterior blockade. One advantage of the minimum motor block observed with this technique was the patient's ability to go from the operating table to the stretcher and of early ambulation.

The main advantage of this method of spinal block for this procedure includes hemodynamic stability, patient satisfaction with the absence of motor block in the lower limbs, fast recovery and no urinary retention.

Rate of injection

In this type of anesthesia can only use hypobaric anesthetic. Thus, the injection speed should be 1mL/15s, with any kind of local anesthetic.

Maintenance of the ventral positions

The spinal block performed with the patient in the jack-knife position provided surgical analgesia with relaxation of the sphincter, and lasting long enough in every patient. Most importantly, it allowed the patient to remain in this position, providing for better surgical exposure.

Recovery of block

The recovery depends on the type and dose of anesthetic used. The 0.6% lidocaine provides recovery dose dependent, being around 63 minutes with 18 mg, 81 minutes with 24 mg and 89 minutes with 30 mg [**31**]. With 0.15% hypobaric bupivacaine, the duration was 115 minutes with 4.5 mg, 135 minutes with 6 mg and 195 minutes with 7.5 mg [**30**].

Local anesthetics

The onset of action was rapid and the duration of action was dose dependent. Low doses of hypobaric bupivacaine or hypobaric lidocaine can be safely used anorectal surgery in patients operated in the jackknife position (ventral decubitus).

Low-dose hypobaric 0.6% lidocaine blocked only the posterior nerve roots in 94% with 3 mL, in 84% with 4 mL and 74% with 5 mL [**31**]. The highest sensory blockade was obtained with 5 mL. The quality of the subarachnoid block produced by 3 mL of hypobaric 0.15% bupivacaine or 3 mL of hypobaric 0.6% lidocaine is similar, except for more prolonged blockade with bupivacaine. The distribution of hypobaric solutions depends on patient positioning and anatomy of the spine.

Advantages of spinal hemianesthesia

All patients undergoing surgical procedures in the prone position or only one leg can benefit from this type of anesthesia.

Advantages unilateral spinal anesthesia

A practical definition of unilateral spinal anesthesia could be an attempt to achieve an asymmetric distribution of spinal anesthesia between the operated side and the non-operated side. The logic to produce a restricted spinal anesthesia is to minimize the extent of the blockade on the operated side, obtaining surgical anesthesia lasting almost surgical procedure.

The increased interest of unilateral spinal anesthesia has occurred mainly by hemodynamic benefits. Hypotension is a common complication of spinal anesthesia occurring in up to 33% of patients when higher doses of local anesthetics are used [**42**]. When hemodynamic changes were compared between bilateral and unilateral spinal anesthesia spinal anesthesia with the same dose of hyperbaric bupivacaine (8 mg), the frequencies of hypotension were 22.4% and 5% respectively [**43**]. In patients with cardiovascular risk, the anesthetist tries to avoid circulatory depression performing a selective unilateral spinal anesthesia. A bilateral sympathetic block can be avoided with unilateral spinal anesthesia, and presumably this technique has advantages over the hypotension.

During spinal anesthesia patients may feel uncomfortable because of their inability to move his legs. Unilateral spinal anesthesia is better accepted by patients, once expressed his satisfaction at being able to at least partially move the opposite leg, so not feeling completely paralyzed.

Unilateral block saves the experience of healthy patient undergoing a reversible drug-induced paraplegia and possibly the feeling of helplessness as a result of the grounding. For most patients, a unilateral spinal anesthesia may be at least a psychological advantage.

Advantages posterior spinal anesthesia

Patients plastic surgery, anorectal surgery, vascular surgery and orthopedic surgery, when performed in the prone position may be anesthetized and remain in this position during the surgical procedure. A slight cefalodeclive during puncture allow hypobaric anesthetic block predominantly posterior roots. Thus, the block had been restricted lower roots preventing its dispersion to the higher roots. The fact that there is a predominance of sensory roots at the expense of the motor roots, these patients have an excellent analgesia and motor blockade absent or mild, allowing patients to move from the surgery table to stretcher.

Another important advantage is the reduction in the incidence of cardiovascular changes, since the attached motor sympathetic ganglion roots. As virtually no motor block, becomes responsible for this low incidence.

Conclusions

Obtaining a selective blockade (unilateral or posterior) depends on the anesthetic, dose, and time spent in the lateral decubitus or prone position.

The state of the art in unilateral spinal block [**28**] suggests that, in order to obtain anesthesia restricted to one limb, one can use pencil point or cutting needles, preferentially 27G, with the opening directed to the side one wishes to anesthetize. The posterior spinal anesthesia does not depend on the type of needle

In unilateral spinal anesthesia can be used hyperbaric and hypobaric anesthetic. Otherwise, the posterior spinal block so you can use hypobaric anesthetic. Despite the preference for bupivacaine, there is room to use low doses of enantiomeric excess (S75-R25) bupivacaine and lidocaine. The rate of administration should always be standardized. Hypobaric solutions should be administered at a rate of 1 mL.15 sec-1, and twice the time (1 mL.30 sec-1) for hyperbaric solutions. When using bupivacaine the patient should remain in lateral decubitus for 15 to 20 minutes, and for lidocaine, 5 to 10 minutes.

References

1. Jonnesco T. Remarks ON GENERAL SPINAL ANALGESIA. Br Med J 2: 1994; 2: 1396-1401.
2. Brown S. Fractional segmental spinal anesthesia in poor risk surgical patients: report of 600 cases. Anesthesiology.1952; 13:416- 428.
3. Hubbard ST, Schneider GF, Kenney LJ. High segmental spinal anesthesia. J Thor Surg 1950; 20:43- .
4. Saklad M, Dwyer CS, Kronemberg S, Neves E. Sorkin M. Intraspinal segmental anesthesia: Preliminary report. Anesthesiology. 1947; 8: 270-287.
5. Tuohy EB. Continuous spinal anesthesia. Anesthesiology 1944; 5: 142-148.
6. Hander HT. Unilateral lumbale spinale anesthesia mit hyperbarer lösung. Anaesthesit 1959; 5: 145-146.
7. Lund PC, Rumball AC. Hypobaric pontocaine spinal anesthesia: 1,640 consecutives cases. Anesthesiology 1947; 8: 181-199.
8. Smith SM, Rees VL. Use of prolonged continuous spinal anesthesia to relieve vasospasm and pain in peripheral embolism. Anesthesiology.1948; 9: 229-238.
9. Tanasichuk MA, Schultz EA, Mathews JH, Van Bergen FH. Spinal hemianalgesia: an evaluation of a method, its applicability, and influence on the incidence of hypotension. Anesthesiology. 1961; 22: 74-85.
10. Kahn CH, Blank JW, Warfield CA. Lumbar Spinal Nerve Root. em: Hahn MB, McQuillan PM, Sheplock GJ: Regional Anesthesia: an Atlas of Anatomy and Techniques. Mosby-Year Book, Inc, 1996: 285-294.
11. Brown DL. Atlas of regional anesthesia. W.B.Saunders Co, 1999 2nd Edition. Chapter 41: Neuraxial Anatomy, 305-311.
12. Stienstra R, Greene NM. Factors affecting the subarachnoid spread of local anesthetic solutions. Reg Anesth.1991; 16: 1-6.
13. Carpenter RL, Hogan QH, Liu SS, Crane B, Moore J. Lumbosacral cerebrospinal fluid volume is the primary determinant of sensory block extent and duration during spinal anesthesia. Anesthesiology. 1998; 89: 24-9.
14. Higuchi H, Hirata J, Adachi Y, Kazama T. Influence of lumbosacral cerebrospinal fluid density, velocity, and volume on extent and duration of plain bupivacaine spinal anesthesia. Anesthesiology. 2004; 100: 106-14.
15. Hogan QH, Prost R, Kulier A, Taylor ML, Liu S, Mark L. Magnetic resonance imaging of cerebrospinal fluid volume and the influence of body habitus and abdominal pressure. Anesthesiology. 1996; 84: 1341-9.
16. Sullivan JT, Grouper S, Walker MT, Parrish TB, McCarthy RJ, Wong CA. Lumbosacral cerebrospinal fluid volume in humans using three-dimensional magnetic resonance imaging. Anesth Analg. 2006; 103: 1306-10.
17. Higuchi H, Adachi Y, Kazama T. The influence of lumbosacral cerebrospinal fluid volume on extent and duration of hyperbaric bupivacaine spinal anesthesia: a comparison between seated and lateral decubitus injection positions. Anesth Analg. 2005; 101: 555-60.
18. Meyer J, Enk D, Pener M. Unilateral spinal anesthesia using low-flow injection through a 29-gauge Quincke needle. Anesth Analg. 1996; 82: 1188-1191.
19. Enk D, Prien T, Van Aken H, Mertes N, Meyer J, et al. Success rate of unilateral spinal anesthesia is dependent on injection flow. Reg Anesth Pain Med. 2001; 26: 420-427.
20. Imbelloni LE, Beato L, Gouveia MA. Low hypobaric bupivacaine doses for unilateral spinal anesthesia. Rev Bras Anestesiol. 2003; 53: 579-585.
21. Imbelloni LE, Beato L, Cordeiro JA. Unilateral spinal anesthesia with low 0.5% hyperbaric bupivacaine dose. Rev Bras Anestesiol. 2004; 54: 700-706.
22. Povey HMR, Jacobsen J, Westergaard-Nielsen J. Subarachnoid analgesia with hyperbaric 0.5% bupivacaine: effect of a 60-minutes period of sitting. Acta Anaesthesiol Scand. 1989; 33: 295-297.
23. Kuusniemi KS, Pihlajamäki KK, Pitkänen M, Korkeila JE. A low-dose hypobaric bupivacaine spinal anesthesia for knee arthroscopie. Reg Anesth. 1997; 22: 534-538.
24. Kuusniemi KS, Pihlajamäki KK, Jaakkola PW, Jaakkola PW, Pitkänen MT, Korkeila JE. Restricted spinal anaesthesia for ambulatory surgery: a pilot study. Eur J Anaesthesiol. 1999; 16: 2-6.
25. Imbelloni LE, Beato L, Gouveia MA, Cordeiro JA. Low-dose plain, hyperbaric or hypobaric bupivacaine for unilateral spinal anesthesia. Rev Bras Anestesiol. 2007; 57: 261-271.
26. Holman SJ, Robinson RA, Beardsley D, Stewart SF, Klein L, Stevens RA. Hyperbaric dye solution distribution characteristics after pencil-point needle injection in a spinal cord model. Anesthesiology. 1997; 86: 966-973.
27. Pittoni G, Toffoletto F, Calcarella G, Zanette G, Giron GP. Spinal anesthesia in outpatient knee surgery: 22-gauge versus 25-gauge Sprotte needle. Anesth Analg, 1995; 81: 73-79.
28. Imbelloni LE. The state of the art of unilateral spinal block (Editorial). Rev Bras Anestesiol. 2007; 57: 589-591.

29. Chilvers CR, Vaghadia H, Mitchell GWE. Small-dose hypobaric lidocaine-fentanyl spinal anaesthesia for short duration outpatient laparoscopy: II optimal fentanyl dose. Anesth Analg. 1997; 84: 65-70.

30. Imbelloni LE, Gouveia MA, Vieira EM, Cordeiro JA. A randomised, double-blind comparison of three different volumes of hypobaric intrathecal bupivacaine for orthopaedic surgery. Anaesth Int Care. 2009; 37: 242-247.

31. Imbelloni LE, Gouveia MA, Vieira EM, Cordeiro JA. Selective sensory spinal anaesthesia with hypobaric lidocaine for anorectal surgery. Acta Anaesthesiol Scand. 2008; 52: 1327-1330.

32. Vaghadia H. Spinal anaesthesia for outpatients: controversies and new techniques. Can J Anesth. 1998; 45: 64-70.

33. Gouveia MA, Labrunie GM. Raquianestesia hipobárica com tetracaína 0,1%. Rev Bras Anestesiol, 1985; 35: 232-233.

34. Gouveia MA, Labrunie GM. Raquianestesia hipobárica com bupivacaína 0,15%. Rev Bras Anestesiol, 1985;35:519-521.

35. Esmaoğlu A, Boyaci A, Ersoy O, Güler G, Talo R, Tercan E. Unilateral spinal anesthesia with hyperbaric bupivacaine. Acta Anaesthesiol Scand. 1998 ;42: 1083-1087.

36. Imbelloni LE, Gouveia MA, Carneiro AF, Grigorio R. Reducing the concentration to 0.4% enatiomérico excess hyperbaric levobupivaine (R25:S75) provides unilateral spinal anesthesia. Study with different volumes. Rev Bras Anestesiol, 2012; 62: 654-664.

37. Imbelloni LE, Carneiro ANG. Comparison of 1.5% and 2% lidocaine with dextrose for spinal anesthesia. Rev Bras Anestesiol, 1999; 39:9-13.

38. Imbelloni LE, Beato L. Lidocaine 2% with or without glucose 8% for spinal anesthesia for short orthopedic surgery. Can J Anesth 2005; 52: 887-888.

39. Lui ACP, Polis TZ, Cicutti NJ. Densities of cerebrospinal fluid and spinal anaesthetic solutions in surgical patients at body temperature. Can J Anaesth. 1998; 45: 297-303.

40. Imbelloni LE, TSA, Moreira AD, Gaspar FC, Gouveia MA, TSA, Cordeiro JA. Assessment of the densities of local anesthetics and their combination with adjuvants. An experimental study. Rev Bras Anestesiol. 2009; 59: 154-165.

41. Imbelloni LE, Vieira EM, Gouveia MA, Netinho JG, Cordeiro JA. Hypobaric 0.15% Bupivacaine versus hyperbaric 0.5% bupivacaine for posterior (dorsal) spinal block in outpatient anorectal surgery. Rev Bras Anestesiol. 2006; 56: 571-582.

42. Carpenter RL, Caplan RA, Brown DL, Stephenson C, Wu R. Incidence and risk factors for side-effects of spinal anaesthesia. Anaesthesiology. 1992; 76: 906-916.

43. Casati A, Fanelli G, Aldegheri G, Colnaghi E, Casaletti E, Cedrati V, et al. Frequency of hypotension during conventional or asymmetric hyperbaric spinal block. Reg Anesth. 1999; 24: 214-219.

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