Spinal anesthesia for hip surgery – particularities

Spinalna anestezija u kirurgiji kuka – posebitosti

Marina Barković[1*], Aleksandra Šurdonja-Bobinac[1], Katarina Šakić-Zdravčević[2]

[1]Clinic for Orthopaedic Surgery Lovran, Faculty of Medicine University of Rijeka, Rijeka, Croatia

[2]School of Medicine, University J.J. Strossmayer in Osijek, Clinic Bagatin, Osijek, Croatia

Received: 10.07.2014
Accepted: 18.12.2014

Abstract. Spinal anesthesia is generally accepted as the first choice for hip surgery due to the deep nerve block affecting a large part of the body achieved through a relatively simple procedure of injecting a small amount of local anesthetic. By controlling the factors that influence the widening of the blocked area, the desired type of block can be achieved, the variability of which can be attributed to factors such as cerebrospinal fluid density, lumbar lordosis or volume of lumbosacral cerebrospinal fluid, namely, its dilution through the injection of isobaric anesthetic solution. However, it is important to know that in certain indications surgical anesthesia needs to be accomplished by a general endotracheal anesthesia. Spinal anesthesia of acceptable height and solidity is achieved through adequate intrathecal distribution of the local anesthetic solution, therefore the difference between the density of liquor and the injected solution of local anesthetic provides the main effect on the intrathecal spread of anesthetics. Anticipated spinal anesthesia is achieved by a hyperbaric or hypobaric solution of local anesthetic; in other words, hyperbaric solutions "sink" while the hypobaric solutions "swim" in such a way that the level of caudal or cranial spread of local anesthetic will depend on the mutual interaction of the density of the solution and the patient's body posture.

Key words: bupivacaine; hip arthorplasty; spinal anesthesia

Sažetak. Općenito, spinalna anestezija predstavlja anesteziju izbora za operacije kuka radi dubokog nervnog bloka koji se postiže u velikim dijelovima tijela relativno jednostavnim injiciranjem male količine lokalnog anestetika. Upravljanjem čimbenicima koji utječu na širenje blokade dijela tijela može se pridonijeti željenom tipu spinalnog bloka, dok se velika varijabilnost pripisuje brojnim čimbenicima kao što su: gustoća cerebrospinalne tekućine, lumbalna lordoza ili volumen lumbosakralne cerebrospinalne tekućine, odnosno njezino razrjeđenje injiciranom otopinom izobaričnog anestetika. Stoga je vrlo važno da se, u pojedinim indikacijama, kirurška anestezija postigne općom endotrahealnom anestezijom. Spinalna anestezija dostatne visine i čvrstoće bloka postiže se dostatnom raspodjelom otopine lokalnog anestetika intratekalno, a razlika između gustoće likvora i injektirane otopine lokalnog anestetika ima glavni učinak na intratekalno širenje anestetika. Predvidljiva se spinalna anestezija postiže hiperbaričnom ili hipobaričnom otopinom lokalnog anestetika; ovdje se radi o gravitacijskom učinku, hiperbarične otopine "tonu" a hipobarične "plivaju" tako da će stupanj kaudalnog ili kranijalnog širenja, odnosno raspodjele lokalnog anestetika, zavisiti o uzajamnom djelovanju gustoće otopine i položaja tijela pacijenta.

Ključne riječi: artroplastika kuka; bupivakain; spinalna anestezija

***Corresponding author:**
Marina Barković, MD, MSc
Clinic for Orthopaedic Surgery Lovran, Faculty of Medicine University of Rijeka
Šetalište Maršala Tita 1, 51 415 Lovran, Croatia
e-mail: marinabarka@gmail.com

http://hrcak.srce.hr/medicina

INTRODUCTION

Generally accepted spinal anesthesia represents the anesthetic technique of choice because profound nerve block can be achieved in a large part of the body by the relatively simple injection of a small amount of local anesthetic[1-4]. However, the main challenge of the technique is to control the intrathectal spread of the local anesthetic to accomplish a sufficiently high and deep, solid block for this kind of surgical procedures.

The great variability of spinal blocks among the patients was first noticed by August Bier, the pioneer of spinal anesthesia, in his first clinical applications during the August 1898[1-4]. Distribution of spinal anesthesia depends on many factors which influence the spread of local anesthetics through the cerebrospinal liquid, as process which it is not entirely possible to control. Over a hundred years ago Arthur Barker concluded that the most predictable local anesthesia is accomplished by a slow injection of local anesthetics and a small quantity of added glucoses to achieve a hyperbaric solution which is easier to supervise in its intrathectal spread[1-4]. Through research of local anesthetics (ropivacaine and levobupivacaine) and the conducted experiments, the main points of Barker's conclusion are again resurfacing as important guidelines to achieve the needed predictability of spinal anesthesia[1-4].

In certain indications, surgical anesthesia for hip surgery is accomplished by general endotracheal anesthesia with an objective supervision of systemic relaxation.

DEFINITION

Spinal anesthesia of adequate height and solidity is performed through adequate intrathecal distribution of local anesthetic solution, because the difference between the density of liquor and the injected solution of local anesthetic provides the main effect on the intrathecal spread of anesthetics[4].

According to recent studies[4-8], anticipated spinal anesthesia is accomplished by a hyperbaric or hypobaric solution of local anesthetic; in other words, the gravity of solutions makes the difference: hyperbaric solutions "sink" while hypobaric solutions "swim" in such a way that the level of caudal or cranial spread of local anesthetic will depend on the mutual interaction of the density of the solution and the patient's body posture, making a more predictable and solid spinal block. Spinal isobaric local anesthetic solution, i.e. *pure solution,* the density of which is similar to the density of cerebrospinal liquor, has shown a significant unpredictability of the maximum height of sensory block, which is attributed to factors such as the density of cerebrospinal fluid, lumbar lordosis or volume of lumbosacral cerebrospinal fluid respecting its dilution through injection of isobaric anesthetic solution[5,6]. Recent studies suggest that the unpredictability of the upper limit of sensory block with the isobaric anesthetic is clinically important because 10 % of the patients required additional anesthesia to endure their hip surgeries. According to the study, the upper sensory limit varied within 13 segments (Th1 – L1)[6].

If the spinal anesthesia does not reach the required block height and intensity, or a need for an additional surgical anesthesia arises during the procedure, it can be accomplished by the general endotracheal anesthesia with the objective supervision of systemic relaxation.

Although it is believed that a patient's body posture does not affect the spread of the isobaric solution, possible acceptability of such an anesthetic in hip surgery procedures with the techniques of spinal anesthesia administered in a seated body position could be explained by isobaric anesthetic's baricity which is on the "verge" towards a hypobaric solution and thus is distributed rostrally[6,7]. Controlling the rostral spread of an isobaric solution administered in the sitting position can be a challenge in the sense of cranial widening of the spinal block.

In most cases, the intrathecal distribution of local anesthetics ends 20-25 minutes after the injection and an objective assessment of spinal anesthesia is required before the surgical procedure. Assessment of the afferent function blockade is carried out by measuring the loss of

sensation to cold, pinprick and touch. Temperature perception is lost before the "needle punch" pain sensation, and both are lost before the touch sensation. A desired sensory block for hip surgery is inside the (Th6-8) height of thoracal dermatomes. Likewise, assessment of proprioception sensation loss can be confirmed by a simple verification of the patient's ability to sense raised leg posture.

Finally, a precise assessment of the depth of the sensory block is achieved with tetanic 50Hz stimulations at the level of belly (Th10) with the duration of 5 seconds, starting with a 10 mA voltage through to 60 mA. Research has shown that the maximal 60 mA[4,9,10] limit provides the same stimulation intensity as the painful surgical incision[9,10].

Assessment of the efferential function blockade is supervised with a progressive loss of motoric function according to the modified Bromage scale ranging from 0 to 3 (without motoric blockade, loss of motoric function in the hip, in the knee, in the ankle). There are even more precise systems to measure the strength in individual joints, assessment of paralysis of the abdominal wall with electromyography methods and the complex studies of electrical stimulation of action potentials for groups of motor fibers of areas in question (H-reflex or M-wave, which are compound motor action potentials that represent complex muscular potential function), but the complexity of muscular movement and the level of innervation still result in weak, incomplete[4,8-10] and unobjective assessment of the height of motoric block.

A sympathetic block which is caused by spinal anesthesia produces cardiovascular changes: hypotension and bradycardia, which may be severe in some cases. To provide an apt and correct answer, knowledge and experience in the perioperative guidance and complete supervision of patients are needed also with spinal anesthetic techniques.

INDICATION

Anesthesia for hip surgery needs to meet the surgical demands of modern surgical techniques performed in the supine or lateral patient position, as well as the needs of the so-called minimally invasive techniques. The basic demand of such procedures is the minimal skin incision and maximal preservation of the muscular hip integrity with the required surgical anesthesia, including necessary muscular relaxation. This is accomplished by a satisfactory height and firmness of the spinal block. If the spinal anesthesia does not fulfill the demands of the surgical anesthesia, it is supplemented with the general endotracheal anesthesia with an objective supervision of muscular relaxation. For this reason, in certain number of cases, especially in the minimally invasive techniques, anesthesia for hip surgeries is *combined.*

During hip surgeries in lateral decubitus position, it is always required to consider possible complications of intubation, if it is needed. If it is confirmed that the endotracheal intubation could be difficult to perform in supine position, we recommend general anesthesia from the start, with intubation while the patient is in a supine position and before the patient is posited into the final body placement for the operation itself.

TECHNICAL IMPLEMENTATION

For a more comfortable implementation of spinal anesthetic techniques, sedation of the patient is required. There are different approaches to preoperative sedation guidance, which are usually dependent on the institutional organization and the possibilities for supervision of the patients. One modus is to administer a sufficient amount of peroral diazepam on the way to the operating room and, upon initiation of the anesthetic technique in the preparation room, to further sedate the patient intravenously with midazolam and an opioid analgesic in the required dosage. The patient's other leg is bandaged with a sock to alleviate the effects of sympathetic blockade caused by the spinal anesthesia.

Preoperative preparation starts 30 minutes before the spinal anesthesia by administering 10 ml/kg of crystalloids and 200-300 ml of colloids with the beginning of spinal anesthesia itself. Hydration is then continued at 5 ml/kg rate, further intraoperative hydration being guided mainly by

the blood loss, diuresis and the other estimations of the patient's cardiovascular reserve.

Circulation instability, i.e., decrease in blood pressure caused by a sympathetic blockade, is treated with 10 mg ephedrine if the middle arterial pressure falls below 60-75 mmHg, depending on the patient's cardiopulmonary status, while bradicardia below 50 beats per minute is treated by atropine.

PROCEDURE OF SPINAL ANESTHESIA WITH HYPERBARIC BUPIVACAINE FOR HIP SURGERIES APPLIED IN THE SUPINE POSITION

The operating table is in the horizontal position, the patient is seated in a stable position so that their legs are dangling over the edge of the table, the knees being on the table edge, and their forearms folded, flexed on the chest. The assistant is holding the patient by their shoulders (Figure 1).

Intravenous analgesic sedation is given prior or immediately after the patient is laid down on his back, depending on the assessment of the anesthesiologist. It should be noted that the in duration of the spinal block with hyperbaric bupivacaine is the shorter the higher its level, to prevent unnecessary prolongation of immediate surgical preparation. Another point worth noting is that the patient should be placed in the Trendelenburg position if after 8 minutes the blockage is not advancing at the required pace. Space L2-3 is punctuated, a volume of approximately 3.5 ml of 0.5 % hyperbaric bupivacaine is injected in 15 seconds with the needle aperture focused cranially. Immediately after the anesthetic injection, the patient is laid on his back. The dynamics and quality of the spinal anesthesia must be assessed during 15 minutes, after which the patient should be positioned in the posture for the surgical procedure.

SPINAL ANESTHESIA TECHNIQUE WITH HYPOBARIC BUPIVACAINE FOR HIP SURGERIES PERFORMED IN THE LATERAL APPROACH

When the patient is operated in the lateral body position, we can administer spinal anesthesia with the patient lying on their side. The operating table is held horizontally so that the spinal column is also held horizontally (Figure 2).

L2-3 space is punctuated, the spinal needle is oriented up (towards the hip scheduled for surgery) and the hypobaric solution is injected during 15 s. The patient stays in the lateral position until the sensory height of spinal anesthesia reaches profound blockage at Th10. The solution is created from approximately 3.5 ml of isobaric 0.5 % bupivacaine (17.5 mg) and 1.5 ml distilled sterile

It is always necessary to additionally evaluate the anesthetic dosage which suits best the needs of a particular patient.

Figure 1. Safe positioning of the patient for the spinal technique with hyperbaric anesthetic solutions

Figure 2. Positioning of the patient for the spinal technique with hypobaric anesthetic solutions

water. It is always required to additionally consider the level of the marked interspinal space taking into consideration the important anatomical inter-individual variations between patients.

COMPLICATIONS

All complications of spinal and general anesthesia are possible, as well as those of the surgical procedure itself. Usually, bradycardia and hypotension occur, but circulation arrests are also possible. In our Clinic, we had the experience of a successful neurological resuscitation of a patient who was in a ten-minute circulation arrest following a spinal anesthesia that was administered for early postoperative reoperation scheduled after a fall and injury at the orthopedic department.

POSTOPERATIVE FLOW

After the operation, the patient is transferred into the postoperative care unit and is assessed every 30 minutes until blockage regression occurs. The patient is under the supervision of highly trained medical nurses who autonomously start resuscitation procedures if needed.

CONCLUSION

For operative procedures performed in the supine position, spinal anesthesia with hyperbaric bupivacaine is recommended, and for procedures in the lateral position, a spinal anesthesia with a hypobaric buvacaine solution.

If the spinal anesthesia does not reach the required height and solidity of blockage, or the need for additional surgical anesthesia arises during the procedure itself, general endotracheal anesthesia should be applied with objective supervision of systemic relaxation.

Conflicts of interest statement: The authors report no conflicts of interest.

REFERENCES

1. Maurer SG, Chen AL, Hiebert R, Pereira GC, Di Cesare PE. Comparison of outcomes of using spinal versus general anesthesia in total hip arthroplasty. Am J Orthop 2007;36:E101-6.
2. Fidrych R, Sokół-Kobielska E, Pisowłocki A. The advantages of spinal anesthesia in total hip replacement. Ortop Traumatol Rehabil 2005;7:680-4.
3. Parvizi J. The merits of regional anesthesia for patients undergoing total hip replacement. Am J Orthop 2007;36:E100.
4. Hocking G, Wildsmith JA. Intrathecal drug spread. Br J Anaesth 2004;93:568-78.
5. Faust A, Fournier R, Van Gessel E, Weber A, Hoffmeyer P, Gamulin Z. Isobaric versus hypobaric spinal bupivacaine for total hip arthroplasty in the lateral position. Anesth Analg 2003;97:589-94.
6. Schiffer E, Van Gessel E, Fournier R, Weber A, Gamulin Z. Cerebrospinal fluid density influences extent of plain bupivacaine spinal anesthesia. Anesthesiology 2002;96:1325-30.
7. Logan MR, McClure JH, Wildsmith JA. Plain bupivacaine: an unpredictable spinal anaesthetic agent. Br J Anaesth 1986;58:292-6.
8. Kooger Infante NE, Van Gessel E, Forster A, Gamulin Z. Extent of hyperbaric spinal anesthesia influences the duration of spinal block. Anesthesiology 2000;92:1319-23.
9. Alley EA, Kopacz DJ, McDonald SB, Liu SS. Hyperbaric spinal levobupivacaine: a comparison to racemic bupivacaine in volunteers. Anesth Analg 2002;94:188-93.
10. Gautier P, De Kock M, Huberty L, Demir T, Izydorczic M, Vanderick B. Comparison of the effects of intrathecal ropivacaine, levobupivacaine, and bupivacaine for Caesarean section. Br J Anaesth 2003;91:684-9.