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Overview

Spinal anaesthesia – An update

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Because of its simplicity and high success rate spinal anaesthesia (SA) belongs to the most common used regional anaesthesia techniques. In many institutions it is regarded as a standard method for surgical procedures like C section, transurethral resection of prostate or femoral neck fracture in the elderly. Although used for more than a century, much has been learned in the last two decades regarding the anatomy, physiology, pharmacology, and applications of spinal anaesthesia *(2)*.

ANATOMY AND PHYSIOLOGY

Modern radiological imaging technology has provided new and important insights into anatomical and patophysiological aspects of spinal anaesthesia regarding the position of conus medullaris and its vertebral level, the more active role of arachnoid membrane than previously assumed.

The arachnoid membrane is a structure of obvious interest representing not only the important barrier of intrathecal space but also actively processing and transporting local anaesthetic agents (LA) and neurotransmitters during neuraxial blockade *(7)*.

Concerning the mechanism of action of SA, the distribution and spread of LA within the lumbosacral space play a crucial role in reaching the spinal cord and spinal nerve roots at the level required for surgery.

By using the magnetic resonance imaging great variability between individuals in volume of lumbosacral CSF could be shown, with the range of 28–81 mL. The lumbosacral CSF volume has been demonstrated to be the most important factor affecting the peak sensory block and duration of spinal anaesthesia *(8–10)*.

SPINAL ANAESTHESIA AND HYPOTENSION

Spinal anaesthesia is by far the most common used regional anaesthesia technique in the elderly. Removing the pre-existing increased sympathetic tone by bilateral preganglionic sympathetic block caused through the intrathecal injection of LA will make elderly patients more susceptible to decrease in systemic vascular resistance (SVR)followed by blood pressure drop. However, it has been shown that despite the significant drop in SVR, the stroke volume and cardiac output are only slightly decreased under spinal anaesthesia even in the group of patients with impaired left ventricular function *(11)*.

It has long been the clinical impression that systemic hypotension is dependent on the number of dermatomes blocked. However, during spinal anaesthesia with plain bupivacaine, a large interindividual variation has been found in the spread of the sensory block and no constant

clear relationship between those two variables could be found in the elderly *(12, 13)*. Consequently, advanced age appears to play only a minor role as a predictor of the segmental spread of spinal anaesthesia.

PREVENTION AND TREATMENT OF HYPOTENSION

The question of an adequate treatment and/or avoidance of hypotension during SA are still subject to debate.

Preloading the patient with intravenous fluid (electrolyte and/or colloid) is widely used; however any increase in cardiac output, stroke index and central venous pressure that may be achieved is of short duration and the vasodilatation, as the primary cause of hypotension, remains uncorrected *(14–19)*.

Moreover, intravenous fluid could cause even further decrease in SVR. An important question is also the timing of fluid infusion. It seams logical to administer fluid whilst the block is evolving i.e. during the first minutes after induction of SA because of redistribution to the extra cellular space hence reducing the potential benefits of preloading *(13)*. Under such circumstances, vasopressors are useful therapeutic option and are frequently administrated in small intravenous boluses. Giving them by intravenous infusion is more efficient; sudden peaks and falls in blood pressure can be better controlled and in many of the cases completely avoided *(14–16, 20)*.

The choice of vasopressors remains a controversial topic; ephedrine, metaraminol and adrenaline have been all successfully used. Phenylephrine has also been shown effective the treatment of hypotension in elderly patients with Th8/Th10 block without causing bradycardia *(20)*.

MODIFICATIONS OF THE TECHNIQUE – SELECTIVE SPINAL ANAESTHESIA

The primary goal of all modifications developed over the time is cardiovascular stability during spinal anaesthesia. This can be achieved by injection of a small dose of LA solution blocking selectively only nerve roots supplying the surgical field in lateral or sitting position *(21–26),* and/or by combining minimal dose of LA with opioids *(27)*.

Probably the most suitable modification for longer or even shorter procedures in haemodynamically compromised patients is continuous spinal anaesthesia (CSA). Compared with the single-injection technique and continuous epidural anaesthesia, it may have the following benefits:

First, the slow titration of LA through an intrathecally placed catheter could be particularly beneficial in haemodynamically compromised patients. Second, the duration of anaesthesia is not only controlled during long cases but also permits rapid recovery. Finally, there is a greater control of the extent of blockade, which additionally decreases the incidence of hypotension.

A number of clinical studies has compared CSA with conventional spinal and epidural anaesthesia, demonstrating fewer episodes of hypotension and bradycardia and lesser need for vasopressors with CSA *(28–33)*. A number of recently published case reports has also demonstrated that a properly performed CSA could be the method of choice in selected high-risk patients *(34, 35)*. Moreover, many studies have shown that excellent postoperative analgesia can result from intrathecal administration of either opioids or LA *(36)*.

Sedation is an important component of patient management during regional anaesthesia. Elderly patients are more sensitive to the centrally acting sedatives and analgesics during SA with the less predictable degree of response as well. Moreover, SA itself may cause sedation, sleep and lower BIS scores presumably through the reduction in afferent input to the reticular activating system *(37–39)*.

Hypothermia is common during spinal anaesthesia, particularly in elderly patients. Low core temperature may not trigger protective autonomic response and hypothermia may be perceived neither by patient nor by anaesthesiologist. Temperature monitoring and warming the patient are therefore strongly recommended *(40)*.

ARE ELDERLY AT HIGHER RISK FOR COMPLICATIONS?

Osteoarthritis and osteoporosis are skeletal changes that are likely to accompany aging. Spinal stenosis occurs in patients with extensive degenerative changes and although frequently unrecognized it is a common condition in the elderly. A recently published Swedish large retrospective study involving 1.260.000 spinal and 450.00 epidural anaesthetics listed osteoporosis as an important risk factor for spinal canal haematoma particularly in female patients undergoing epidural anaesthesia for total knee replacement *(41)*.

In the same study, 32 cases of permanent cauda equine syndromes were reported, spinal stenosis was diagnosed in 13 patients after the damage has already occurred. The report suggests that in the presence of spinal stenosis neuraxial nerve blocks should be performed only after careful consideration.

Longstanding lumbar spine disease may form localized areas of inflammation, adhesions and scarring of the arachnoid or neural tissue. Such changes will frequently lead to a decreased mobility of neural structure within the subarachnoid space and may account for the increased incidence of paresthesia compared with the patients group without symptoms of lumbar spine pathology *(42)*.

Achieving the adequate position for spinal anaesthesia may be difficult in trauma, elderly, as well as in obese patients. Because of the difficulties in flexing the hip and lower spine in this patients the distance between conus medullaris and the Tuffier's line may not be increased which may increase the potential for neurological dam-

age *(43)*. However, although studies on difficulties in performing SA in elderly patient are rather scarce, at least one has shown that SA could only be marginally more difficult in geriatric patients *(44)*.

CHOICE OF LOCAL ANAESTHETIC AGENT

Various procedures may have specific needs for local anaesthetics. In the past years, ropivacaine and levobupivacaine have been the most studied drugs used in spinal anaesthesia. However, none of them have offered clear advantages over bupivacaine except for slightly shorter duration and faster onset *(45–48)*.

Chloroprocaine has been reintroduced recently for spinal anaesthesia and preservative – free solution is available for off-label use *(49)*.

Compared with small dose of lidocaine and bupivacaine, 2-chloroprocaine shows clear shorter duration of sensory block and faster resolution of motor block allowing faster voiding and discharge after ambulatory surgery *(50)*. The results of these preclinical studies make low dose 2-chloroprocaine an almost ideal drug for spinal anaesthesia in outpatients. However, more data on safety are required before it can be introduced in clinical practice.

SUMMARY

Spinal anaesthesia is one of the oldest anaesthesia methods. Despite the developments of many safe but more sophisticated techniques of general anaesthesia, it has regained popularity due to the new developments and its benefits for certain patient populations and a surgical procedures as well. In spite of remaining technically simple procedure, performing spinal anaesthesia requires sound knowledge of applied physiology and pharmacology. New local anaesthetics and techniques are being investigated for procedure oriented applications. Safety of drugs for intrathecal injections and complications from spinal anaesthesia continue to be examined and re-examined in order to improve safety of the technique. Despite the recent developments not all"mysteries"of spinal anaesthesia are cleared up; more studies will be needed to further understand and improve the clinical use of spinal anaesthesia.

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