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The Incidence of Paresthesia and Neurologic Complications after Lower Spinal Thoracic Puncture with Cut Needle Compared to Pencil Point Needle. Study in 300 Patients

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Abstract

Background: Anesthesiologists are reluctant to considerer higher levels for spinal anesthesia largely due to direct threats to spinal cord. Paresthesias are relatively common during spinal needle insertion; however, the clinical significance of the paresthesia is unknown. The main objective of this prospective study was to evaluate the incidence of paresthesia and neurologic complications after lower thoracic spinal anesthesia with a cut needle compared to a pencil point needle.

Methods: Low thoracic spinal puncture (T_{10}-T_{11}) was performed in 300 patients in elective surgery using different techniques in this single-blind prospective trial. Patients randomized to 2 groups: group 1, subarachnoid puncture using a cut needle without introducer and group 2, subarachnoid puncture using a pencil point needle with introducer. In both groups patients were in the lateral or sitting position.

Results: Paresthesias occurred in 20/300 (6.6%) of patients. Seven patients experienced a paresthesia with cut needle compared with 13 patients with pencil point, without statistical difference. All paresthesias were transient. No neurologic complications were observed in all patients during this study.

Conclusions: Our data suggest that all transient paresthesia are transitory. Lower thoracic puncture is safe. Traumatic injury to the spinal cord is a rare cause of neurologic deficits in the thoracic puncture.

Key words: Paresthesia; Anesthesia; Subaracnoid; Needles; Spinal

Introduction

Spinal anesthesia is commonly used in many surgical procedures. It has particular advantages that it is a very safe and simple method and that only very small dose of drugs produces profound effect. However, anesthesiologists are reluctant to considerer higher levels for spinal anesthesia, largely due to direct threats to spinal cord. High spinal anesthesia has been employed for operations on the skull, on the throat and on the thorax [1]. Segmental spinal anesthesia of the lower thoracic and upper lumbar dermatomes was produced in ten adult human subjects by the intrathecal deposition of 0.5 ml. of 5 per cent procaine HC1 (25 mg) at the 12th thoracic vertebral level [2]. Recently the anatomy of the thoracic spinal canal was investigated with MRI in 19 [3] and 50 [4] patients, and it has been demonstrated the safety of the segmental spinal anesthesia at T_{10} by using the combined spinal-epidural technique [5] or single puncture [6]. The T_{10} level was the landmark correctly identified by the largest number (92%) of anesthesiologists. However, only 2% performed procedure thoracic spinal anesthesia [7].

Neurologic complications associated with spinal anesthesia can be due to toxic effects of the injected agent, incorrect placement of a needle causing direct neural tissue damage, infectious agents, or spinal cord compromise due to ischemia [8]. Direct trauma to nervous tissue may occur at the level of the spinal cord, nerve root, or peripheral nerve. Two thirds of anesthesia related neurological complications are associated with either paresthesia (direct nerve trauma) or pain during injection (intra neural location) [9]. Paresthesia during regional anesthesia is an unpleasant sensation for patients and, more importantly, in some cases it is related to neurological injury. Relatively very few studies have been conducted on thoracic spinal anesthesia.

In the handbook of "Thoraco-abdominal Nerve Block", states that the puncture of the dura/arachnoid can be done deliberately [10]. Recently, the anatomic explanation was done by the low incidence of neurologic complication during accidental perforation in thoracic epidural [11]. The first end-point of this prospective study was to evaluate the incidence of paresthesia and neurologic complications after lower thoracic spinal anesthesia with a cut needle compared to a pencil point needle. The second end-point was verified by removing the stylet from the needle and ascertaining that no cerebral spinal fluid (CSF) can be withdrawn. It was not objective this study to evaluated the quality of the spinal anesthesia.

Material and Methods

This prospective study was approved by the Ethics Committee of the institution and a signed informed consent was obtained after the procedure was explained to the patients who agreed to participate. All patients were classified as American Society of Anesthesiologists (ASA) Physical Status 1 and 2 and no contra-indications to regional anesthesia. Previous spinal surgery, back pain, obstetric patients

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were excluded, sepsis or local infection at the site of spinal puncture. As we believed Quincke needle because of its form would produce less paresthesia cases, sample sizes were calculated for statistically proving at most 4% risk of paresthesia for this needle (compared to 12% as showed by Hopkinson et al. [12]), at 80% power and the adopted 5% significance level, were of at least 142 patients per group. We chose 150 for guaranty against data loss. Three hundred patients, aged 18 and 85 years, ASA physical status I and II, who did not receive premedication in the ward, scheduled to elective surgery under spinal anesthesia, participated in the study. The data collection form included age, gender, weight, height, presence or absence of paresthesia, location of paresthesia, presence or absence of cerebrospinal fluid (CSF) after paresthesia, and presence or absence of a discernable spinal block. For the purpose of this study, paresthesia was defined as an electric, shooting or burning sensation, or pain felt in the leg, buttocks, or perineum.

Every patient was submitted to a six hour fasting period prior to the procedure. Before the anesthesia, a peripheral venous access was placed for hydration with Ringer's Lactate and administration of medication during the procedure. Patients were monitored with continuous ECG, heart rate, pulse oxymetry and non-invasive blood pressure. Before the blockade, patients received 1μg.kg^{-1} of fentanyl intravenously and 1 mg of midazolam.

A single-blind prospective study of patients scheduled for elective surgery, randomized to 2 groups: group 1, subarachnoid puncture using a 27G cut needle (B.Braun Melsungen S.A.) without introducer and group 2, subarachnoid puncture using a pencil point needle (B.Braun Melsungen S.A.) with introducer. Patients were placed on the lateral decubitus (75 patients cut needle and 75 patients pencil point needle) or sitting position (75 patients cut needle and 75 patients pencil point needle). After cleansing the skin with alcoholic chlorhexidine, the skin of the puncture site was infiltrated with 1% lidocaine. The puncture was median, at the T_{10}-T_{11} interspace. If the pain met the criteria for a paresthesia, the needle's stylet was removed and the hub observed for free flow of CSF. If CSF was observed the local anesthetic was injected at 1 ml.15s^{-1}. If CSF was not evident after paresthesia, the needle was withdrawn and redirected while continuing to observe for paresthesia and CSF. In case of a failed block after a thoracic injection, a new approach would be placed in the lumbar region and the patient would be excluded.

Variable	Group 1 Cut point (n=150)	Group 2 Pencil point (n=150)
Age (years)	43.54 (16.43)	40.51 (15.13)
Weight (kg)	74.14 (14.98)	70.40 (11.87)
Height (cm)	170.13 (8.19)	168.67 (6.89)
Gender (M/F)	105/45	98/52
ASA (1/2)	87/63	85/65

Table 1: Demographic data: mean (sd).

Site	Group 1 Cut point (n=7)	Group 2Pencil point (n=13)
Left limb	2	6
Left thigh	0	1
Two thighs	4	3
Right thigh	1	1
Two limbs	0	1
Right limb	0	1

Table 2: Site of paresthesia.

Variable		Cut point (n=150)	Pencil point (n=150	p-value
Neurologic	1th day	150 (100)	149 (99.3)	1.0*
	3rd day	-	1 (0.7)	1.0*
	10th day	-	1 (0.7)	1.0*
	30th day	-	-	1.0*
PDHP	No	146 (97.3)	147 (98)	0.99
	Yes	4 (2.7)	3 (2)	

*Fisher's exact Test

Table 3: Complications: Count (percentage).

After performing the block, the anesthesiologist or resident filled out the data collection sheet and turned it in. Local anesthetic solutions (isobaric or hyperbaric) used and its distribution were not commented because it is not the purpose of this study. Patients were followed-up for 1th, 3rd, 10th and 30th days postoperatively over the phone to gather information regarding the presence of headache, temporary neurological symptoms, or back pain. Headache was classified as postdural puncture headache (PDPH) if it worsened when the patient was in the sitting position, was located in the occipital or frontal region. Back pain was considered a transitory neurological symptom (TNS) if the patient experienced pain and/or decreased sensitivity in the back, buttocks, and legs after recovery, which resolved in 72 hours. All patients were examined between 30 and 35 days after puncture by the anesthesiologist. If there any complaints or concerns the patient would be referred to a neurologist. Serious complications such as epidural hematoma, infection, or permanent nerve injury were evaluated

Between groups comparisons of continuous variables were done by t test, non-parametric Kruskal-Wallis test, Fisher's exact Test and Likelihood ratio test for independent samples.

Results

Three hundred patients were studied and no patients were excluded. Both groups were statistically similar with regard to age, height and weight and all categorical variables (Table 1), except presence of CSF when removal of stylet (99.3% cut point against 89.3% pencil point, p-value=0.003 by Fisher's test).

The observed overall incidence of paresthesia associated with spinal needle insertion was 6.6%. There were no significant difference between the spinal cut 27-G needle (4.67%) and spinal pencil point 27-G needle (8.67%). Paresthesia occurred in 40% on the left limb, 5% on the right limb, 5% on the two limbs, 35% both thighs, 10% right thigh and 5% left thigh (Table 2). All paresthesias were transient and without residual sequel. Only one patient with pencil point needle complained of pain until the 10th day (Table 3). The incidence of PDPH was 2.3%, without significant difference between the needles (Table 3). All PDPH were benign and no blood patch was needed. They disappeared until the 3th day.

There is no evidence of association between needle, insertion (lateral decubitus or sitting position) and paresthesia (p-value=0.09, Likelihood ratio test) (Table 4).

The majority of paresthesias were associated with the free flow of CSF when the stylet was removed in the cut needle 6/7 patients against the 9/13 patients with the pencil point needle, without significant difference (p-value=0.010, Likelihood ratio test). There was not a significant difference among patients that suffered paresthesia on the necessity to change needle (1 cut point x 2 pencil point) for failure in the CSF back flow (p-value=0.044, Likelihood ratio test).

Studying only patients with paresthesia we find that the incidence was greater in the lateral position (75%) than in the sitting position (25%) but without significant difference (Table 5).

No patient experienced pain on local anesthetic injection. All patients developed spinal anesthesia; there were no patchy blocks. No patient was obtained paresthesia complained of neurological symptoms at follow-up. There were no serious complications such as epidural hematomas, infection, or permanent nerve injuries in both groups.

Paresthesia	Cut Point			Pencil Point		
	Position		Total	Position		Total
	Lateral	Sitting		Lateral	Sitting	
Yes	5	2	7	10	3	13
No	70	73	143	65	72	137
Total	75	75	150	75	75	150

Likelihood ratio test for independent samples: p-value=0.96

Table 4: Paresthesia according to needle and patient position: count.

Free flow CSF	Cut Point			Pencil Point		
	Position		Total	Position		Total
	Lateral	Sitting		Lateral	Sitting	
Yes	4	2	6	6	3	9
No	1	0	1	4	0	4
Total	5	2	7	10	3	13

Likelihood ratio test for independent samples: p-value=0.010

Table 5: Patients with paresthesia and free flow of CSF: count.

Discussion

Paresthesia can occur with any technique of spinal anesthesia, but are of potentially greater significance when the needle is inserted above the termination of the spinal cord. We observed a 6.6% incidence of paresthesias during low thoracic spinal needle placement. In the present study, we compared frequencies of paresthesia for the cut point needle (4.67%) and pencil point needle (8.67%) for low thoracic spinal anesthesia and it was not found that the pencil point needle caused paresthesia more frequently than cut needle during the procedure.

Eliciting paresthesia during spinal needle insertion indicates that the tip of the needle is adjacent to spinal nerve roots, or, potentially, the spinal cord. Needle size and shape may influence the incidence of paresthesias, and other complications during spinal procedures. A retrospective review [13] reported permanent neurological deficits in six of 4,767 consecutives spinal anesthetics (0.13%). They identified paresthesia during needle placement as a significant risk factor for the development of subsequent persistent neurological deficits. In this study, after low thoracic spinal puncture none of the 20 patients (6.6%) that suffered paresthesia developed a neurologic deficit. In this study, needle induced trauma (paresthesia) rarely results in permanent neurologic injury.

During attempts to insert a spinal needle into the lumbar subarachnoid space, patients occasionally experience paresthesia with a reported frequency ranging from 0.4% [9], 6.3% [13] to 20.7% [14]. Without good comparative data it is impossible to say whether one type of needle is more likely to be associated with spinal cord problems, but there is some supporting information. No serious complications were encountered, although a low incidence of transient paresthesias was observed during dural puncture with both spinal needles during low thoracic spinal anesthesia. These paresthesias are benign and cause only momentary discomfort to the patient. The overwhelming majority of paresthesias were associated with the free flow of CSF when the stylet was removed in the cut needle (6/7 patients) against the 9/14 patients with the pencil point needle. An association was not found between the type of the spinal needle and the incidence of paresthesias.

Concern about the safety of pencil point needles was voiced as early as 1993 [15] when they described a high incidence of paresthesia. Their frequency has been noted to be a high as 12% with standard spinal anesthesia [10] and 26% with the CSE technique [16], figures which are higher than had been documented previously with cutting needles. Paresthesia on insertion of pencil point needles has been a topic of debate recently, particularly as its occurrence with Quincke point needles seems very rare [14,17]. An incidence of 26.6% in a series of 90 patients undergoing a combined spinal epidural technique for Caesarean section using a pencil point spinal needle has been found [10]. Paresthesia associated with spinal puncture has not been reported in the literature and that, in this experience, has only occurred after the introduction of pencil point needles. In our study the incidence of paresthesia was 6.6% with no patients reporting permanent neurological symptoms.

Paresthesia occasionally occurs during dural puncture or injection of local anesthetic for spinal anesthesia. Recently it was described seven cases in which neurologic damage followed spinal or CSE technique using an atraumatic (pencil point) spinal needle [18]. All patients experienced pain during needle insertion. In this prospective study, none of the patients who suffered paresthesia it occurred during injection of local anesthetic.

This study aimed to determine the possibility and the safety of the low thoracic spinal puncture with different types of needle. The low incidence of paresthesia permits to state that thoracic spinal anesthesia is safe with both needles, against what have already been said [18].

It is well known that anesthetists often fail to correctly identify the vertebral level. In 2000, the authors [19] investigated anesthetist's ability to identify a marked lumbar space; they showed that vertebral levels were identified correctly only 29% of the time. In the rest, the true level was between one space below and four spaces above the assumed level. It was noted that in 19% of patients the spinal cord ended below the level of the first lumbar vertebra. In this study, with a low thoracic puncture we had no permanent neurologic sequel.

Normally, subarachnoid puncture is realized in the dural sac with the stylet inside the needle. It was found that removing the stylet from the needle reduces the incidence of paresthesia during lumbar puncture from 28.6% to 8.9% [20]. In this study, we compared the pencil point needle used with introducer against the cut needle point without introducer. It was part of the protocol not to remove the stylet. The stylet did not influence the incidence of paresthesia.

Combined epidural-subarachnoid puncture leads to a higher incidence of paresthesia in comparison with simple spinal puncture, probably because the lumbar puncture is performed on a dural sac that has been previously deformed due to the "tent effect" caused by the epidural needle [20]. In the three groups the incidence of paresthesia was more frequently in the 1st, 2nd, 5th spinal roots [20]. As normally lumbar puncture is realized in the expected to be L_3-L_4 in the posterior and medial zone of the dural sac, were the sacral roots of 2nd to 5th lie. Considering that the lower never are of higher origin, and that the lumbar nerves come form a thoracic level, it is easy to understand why the thoracic puncture provides lumbar paresthesia. Despite the approach was placed in a low thoracic level (T_{10}-T_{11}), all paresthesias corresponded to the lumbosacral plexus (L_1-S_4).

The lumbar puncture or even the thoracic puncture (high epidural) can be realized in the sitting position or in the lateral decubitus. It is known that the position of the patient during the lumbar puncture may influence the incidence of paresthesia [21]. The sitting position presented a lower incidence of paresthesia as compared against lateral decubitus position [21]. In the present study, the incidence of paresthesia was the same in the sitting position as compared with the lateral decubitus position, in discordance of the authors [21].

There is not a comparative study of incidence of paresthesia with different types of needle in single shot spinal anesthesia. The incidence of paresthesia in our study was 4.67% in the cut needle

group and 8.67% in the pencil point needle group, similar to the incidence reported by other investigators in lumbar spinal anesthesia [8,12]. In this study 45% of all paresthesia occurred on the left side, and 35% of all paresthesia occurred in two thigs, without neurological damage. The incidence of PDPH is the same with both needles.

Horlocker et al. [22] reported that there was no direct neurologic complication in 4,298 thoracic surgery patients undergoing lumbar epidural catheter placement in anesthetized patients. Acute paraplegia after epidural anesthesia can result from spinal cord compression, spinal cord infarction and cord trauma. Accidental dural puncture during needle insertion occurred in 0.16 – 1.3% instances in a series of 51,000 epidural catheters [23]. In 1,071[24], 1,240 [25] and 113 [26] patients submitted a thoracic epidural block occurred accidental puncture of the dura-mater in 1.2%, 0.4% and 4.4% respectively. In all of 20 patients no neurological sequel was observed.

This study with 300 patients demonstrated that thoracic spinal puncture with cut point needle and pencil point needle presented the same incidence of paresthesia as the lumbar approach, and without sequel. The incidence of paresthesia when using these cut point needles, however, is the same that has been observed with pencil point needles. Despite not having found a significant difference, the utilization of the introducer seems safer for the beginner in this technique.

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