International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

A Comparison of Fast v/s Slow Spinal Injection Speed on Hypotension and Sensory Level Onset: A Randomised Study

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Abstract: ***Spinal anaesthesia is commonly employed for procedures involving lower abdominal and limb regions. While this technique induces a profound nerve block, it is associated with significant hypotension. The purpose of the study was to evaluate the influence of injection speed in spinal anaesthesia. We studied 120 patients undergoing elective lower abdomen and lower limb surgeries. They were randomly allocated into two groups, Group F received a 0.5% heavy bupivacaine spinal anaesthetic agent at 15 seconds and Group S at 60 seconds. Time to reach T_{10} sensory level along with changes in heart rate (HR), systolic and diastolic blood pressure (SBP, DBP), measured at baseline, 1, 3, 5 and 10 minutes after injection was recorded. In group F, the time to attain T_{10} sensory block was 6 ±2 minutes, whereas in group S it was 8±2 minutes ($p<0.01$).50% of cases in Group F produced hypotension and 30% in Group S with $p=0.01$. The fast spinal injection group resulted in early onset of sensory level at T_{10} ($p<0.01$) and more incidence of hypotension ($p=0.01$) with the fast injection speed. We suggest using fast injection speed with adequate IV fluid preloading.***

Keywords: Spinal Anaesthesia, Injection speed, Hypotension, T_{10} Sensory level, Bupivacaine

1. Introduction

Spinal anaesthesia is a widely used technique in surgical procedures, providing effective analgesia and anaesthesia. It is easy, inexpensive and faster to perform. Nevertheless it is associated with adverse effects such as urinary retention, nausea, vomiting, bradycardia, and most common being hypotension.

Various factors contribute in achieving an appropriate sensory block level with spinal anaesthesia. These factors include the type of local anaesthetic, dosage, injection site, volume in the subarachnoid space, patient's position, and demographic characteristics [1 - 4], the injection rate of the local anaesthetic drug [5 - 6].

The impact of injection speed on the spread of spinal anaesthesia is debated in the literature. Some studies indicate that faster injection leads to more extensive spread [7 - 10], while others suggest greater spread with slower injection [11 - 15] or report no significant difference [15 - 19] in spread. Lanz E noted that in a spinal canal model an increase in the speed of injection enhances the spread of local anaesthetic solution [20].

2. Method

Our study is a prospective, randomised and single blind study. A total 120 patients undergoing elective lower abdominal and limb surgeries were included. All patients had undergone a thorough pre operative assessment and those who were under ASA Physical Status I & II, within the age group of 18 to 60 years were included. Patients who refused to include in study, who had had deformity of spine, infection at local site or allergic to local anaesthetic agent were excluded from the study. All the patients were kept nil by mouth 10 hours prior to surgery. Large bore intravenous access was secured and Inj. Glycopyrrolate 0.2 mg IV, Inj. Ondansetron 0.15 mg/kg IV was given.

In this study the 120 patients were allocated randomly according to a sealed envelope technique to two groups of sixty each

- Group F: Injection speed of spinal anaesthetic agent of 15 seconds
- Group S: Injection speed of spinal anaesthetic agent of 60 seconds

On reaching the operating room, standard monitors such as pulse oximeter, electrocardiogram, and non - invasive blood pressure were attached. Baseline HR and blood pressure were recorded.

Under all aseptic and antiseptic precautions, dural puncture was done in midline approach in sitting position, L_3 - L_4 interspace, using 25G Quincke's needle after free flow of CSF and 3.5 ml of 0.5% hyperbaric bupivacaine drug given in all patients.

Duration of injection of the drug was measured using a stopwatch on mobile. Patients in Group F received the spinal drug in 15 seconds and Group S received the spinal drug in 60 seconds. The patients were then turned into supine position immediately after spinal injection.

These assessments were made by loss of pinprick sensation as a sensory endpoint for dermatome sensory anaesthesia in the anterior axillary line. The time to reach T_{10} sensory level was recorded.

Blood pressure, heart rate, and the extent of motor block were recorded as baseline and at 1, 3, 5, 7 and 10 minute measurement intervals.

If the systolic blood pressure decreased to a level 30% below the patient's preoperative baseline level, Inj. Mephentermine 6 mg/ml IV bolus was given.

Statistical analysis:
This study included a total of 120 patients in Group F (n = 60) and Group S (n = 60). Descriptive statistics of both groups were expressed as mean and SD for continuous variables and percentage for categorical variables. Chi - square was applied to test statistical significance for categorical variables. Percentage calculation was done using Medcalc. com online software. The p - value was calculated using www.graphpad. com t - test calculator. The p value of 0.05 was taken as significant.

3. Results

The data of 120 patients were analysed. Mean age, sex, weight and ASA physical status were comparable in both groups. All patients had successful spinal anaesthesia and no one was withdrawn from the study.

The mean time to achieve T_{10} sensory level was faster in Group F (6±2 mins) as compared to Group S (8 ±2 mins) with $p < 0.01$. (Table I)

There was a difference observed in the incidence of hypotension between two groups. Hypotension was noted in 50% cases of Group F and 30% in Group (p=0.01). Similar results were obtained in other studies as well. (Table II)

The mean arterial blood pressure fell more in the Group F than Group S (p<0.001). (Table III)

4. Discussion

The hypothesis of this study was to assess the time taken to reach sensory block T_{10} and the incidence of adverse events such as hypotension in patients having lower abdomen or limb procedures that can be influenced by the injection speed of the spinal anaesthetic agent (0.5% hyperbaric bupivacaine) - Slow vs Fast injection speed.

In our study, thirty - three - fold variation in the intrathecal injection rate of 3.5 ml of hyperbaric bupivacaine (15 vs.60 sec) caused hypotension in 50% in Group F with p<0.01.

Spinal anaesthesia is a widely used technique in surgical procedures, providing effective analgesia and anaesthesia. It is easy, inexpensive and faster to perform. But, it is associated with physiological adverse effects such as urinary retention, nausea, vomiting, bradycardia, and most common being hypotension.

Numerous clinical trials examining the effects of various spinal injection rates on sensory block level have been conducted, with varying degrees of success. These studies' contradictory findings could be the consequence of variations in the spinal needle, the local anaesthetics, temperature, injection speed, and patient [21] [22] [23].

T_{10} sensory block level was faster in Group F (6 ±2 mins), in contrast delayed in the Group S (8 ±2 mins), p<0.01. Similar findings were noted by Jacob that Group F took 1.85 ±1.14 min to accomplish T_{10} block, while Group S took 3.98 ±1.58 mins, $p < 0.001$.

Hypotension was more common and occurs at a fast injection speed, which is related to the production of turbulent flow and the early initiation of sympathetic blocking. Complete sympathectomies with blocking of cardio accelerator fibres is more likely to result from it [24]. In a study by Tugcugil ([25], slow injection speed resulted in the delay of hypotension since it does not generate turbulent flow.

In our study, the hypotension tension was produced in 50% of the cases with fast injection speed and 30% with slow injection speed. Similarly, Simon et al [26] found that slow injection speed decreased the incidence of hypotension from 92% to 68%. Our study was distinct from their study as it was not randomised, and the injections were performed in the left lateral decubitus position (ours was in a sitting posture). He also demonstrated that slow injection speed resulted in significantly lower incidence of hypotension compared to fast injection speed ($p < 0.05$).

Fast injection speed causes turbulence in the subarachnoid area when the drug reaches the sympathetic afferent fibres, which act as a constriction to stop cephalic spread. The size, shape, bevel direction, and injection speed are among the several variables that influence current generation [23]. According to Tugcille's [25] research, a slow injection speed delays hypotension and does not produce turbulence.

With slow injection speed, the drug tends to travel further along the surface contacted in the original direction whereas the fast injection produces a turbulent pattern, causing the distribution to be less directional and more diluted [27 - 28]. Additionally, a fast injection may produce well movement of CSF and pressure changes that tend to keep the solution near the injection site whereas a slow injection may allow the solution to spread according to the baricity and gravity [14].

Glass models of spinal cord are often used to study the factor of injection speed, but they omit any representation of the coquina and spinal cord which may act as efficient baffles to the generation of fluid currents [12].

In the study, by Kim [29], if the force at the time of injection increases, the occurrence of turbulence affects the distribution of anaesthetic solution and increases block height. This corresponds to our finding of Group F that, less time taken to reach the T_{10} sensory level.

According to the study of Kang [30], fast injection speed will cause decrease in blood pressure (65% cases, p<0.05) and slow injection speed will cause drug to distribute locally and

there will be a second layer of injected liquid, so the anaesthesia block will be less [26] [31].

Slow injection speed offers advantages by reducing the occurrence of hypotension. But it will require cooperation from the patient side to sit steadily for a duration of 60 seconds. During spinal anaesthesia, it was difficult to maintain a steady hand for a longer period of time and also injection speed may not be consistent

In our study, patients in group S remained in the sitting posture for 45 seconds longer than patients in group F, although both group patients were placed supine right after the injection. This could have contributed to group S's trend toward a lower block. Povey HM's study showed that sitting for 25 minutes did not impact sensory level compared to sitting for 2 minutes [32].

Additionally, because the injections were given by hand, it's possible that different groups' injection speeds weren't consistent. A thirty three fold difference may not have been reliably achieved between the two groups. It's possible that the intrathecal injection speed differences were too small to distinguish between different sensory block levels. It might have been required to inject at a significantly slower rate than 0.05 ml/sec. Bourke et al. found in their in vitro study evaluating the speed of injection in a spinal canal model, that injection through a 25G Whitacre needle at rates greater than 0.017 ml/sec was associated with varying degrees of turbulence [33]. However, we considered that our slow injection rate of 0.05 ml/sec was within a clinically relevant range.

Another in vitro study of Holman AJ ([34] hyperbaric dye distribution characteristics after pencil point needle injection in a spinal cord model suggests that transition from laminar to a more turbulent flow occurs at 6 ml/min (0.1 ml/sec). In our study, it is likely that fast injection speed Group F (0.175ml/sec) patients experienced more turbulent flow whereas group S (0.05ml/sec) patients should have experienced non - turbulent laminar flow.

5. Conclusion

We recommend faster injection speed use. Also to minimise the occurrence of hypotension, it should be with adequate preloading.

Tables:

Table I: Effect of T_{10} sensory level

	Our Study (mins)	Jacob [35] (mins)
Group F	6 ±2	1.88 ± 1.4 (15 secs)
Group S	8 ±2	3.98 ±1.58 (60 secs)

The T_{10} sensory level was achieved faster in Group F compared to Group S.

Table II: Hypotension

	Our Study	TugcugilE [25]	Singh [6]
Group F	50%	36.70%	80%
Group S	30%	15%	76%
Volume of drug (ml)	3.5	1.8	2.2

Hypotension was observed in Group F

Table III: Mean Systolic Blood Pressure

	Our Study (mmHg)	Jacob [35] (mmHg)
Group F	87±10	76.5±12.8
Time to lowest SBP	8 mins	8th min
Group S	96±11.3	80.65±17.92
Time to lowest SBP	8 mins	8th min

Fall in Blood Pressure with fast injection speed compared to slow injection speed at a similar time after spinal anaesthesia.

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