Does unilateral hip flexion increase the spinal anaesthetic level during combined spinal–epidural technique?

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ABSTRACT

Needle-through-needle combined spinal–epidural (CSE) may cause significant delay in patient positioning resulting in settling down of spinal anaesthetic and unacceptably low block level. Bilateral hip flexion has been shown to extend the spinal block by flattening lumbar lordosis. However, patients with lower limb fractures cannot flex their injured limb. This study was conducted to find out if unilateral hip flexion could extend the level of spinal anaesthesia following a prolonged CSE technique. Fifty American Society of Anesthesiologists (ASA) I/II males with unilateral femur fracture were randomly allocated to Control or Flexion groups. Needle-through-needle CSE was performed in the sitting position at L2-3 interspace and 2.6 ml 0.5% hyperbaric bupivacaine injected intrathecally. Patients were made supine 4 min after the spinal injection or later if epidural placement took longer. The Control group patients (n=25) lay supine with legs straight, whereas the Flexion group patients (n=25) had their uninjured hip and knee flexed for 5 min. Levels of sensory and motor blocks and time to epidural drug requirement were recorded. There was no significant difference in sensory levels at different time-points; maximum sensory and motor blocks; times to achieve maximum blocks; and time to epidural drug requirement in two groups. However, four patients in the Control group in contrast to none in the Flexion group required epidural drug before start of surgery. Moreover, in the Control group four patients took longer than 30 min to achieve maximum sensory block. To conclude, unilateral hip flexion did not extend the spinal anaesthetic level; however, further studies are required to explore the potential benefits of this technique.

Key words: Anaesthetic techniques-combined spinal-epidural, anaesthetic techniques-subarachnoid, anaesthetics local - bupivacaine, position-hip flexion

INTRODUCTION

The combined spinal–epidural (CSE) technique is a very commonly used method for central neuraxial blockade. It combines the advantages of spinal as well as epidural blocks and avoids their disadvantages. Several CSE techniques are described, but needle-through-needle is the most widely reported technique in the literature and is likely to be the most frequently used.[1] Needle-through-needle CSE requires that subarachnoid blockade is initiated before placing and securing the epidural catheter. This results in an inevitable delay in attending to the developing neural blockade[2,3] and in cases of significant delay, the final characteristics of the block may be altered.[4] While injecting hyperbaric local anaesthetic solutions in the sitting position, any delay in positioning can lead to settling down of spinal anaesthetic and unacceptably low level of block.[5] When the patient is made supine after this, the cephalad spread of local anaesthetics is limited by the lumbar lordosis.[6] This problem can be overcome and adequate level of block can be achieved in cases of delayed patient positioning if lumbar lordosis can be flattened by using some manoeuvre.

Bilateral hip flexion has been radiologically shown to

flatten the lumbar lordosis.[7,8] It was also used along with the Trendelenburg position as a rescue strategy to increase the spinal anaesthetic level after the spinal block.[6] However, in trauma patients with lower limb fractures, flexion of only uninjured limb is possible. The literature does not mention the effect of unilateral hip flexion on extent of lordosis obliteration and level of spinal block. This study was conducted to find out if unilateral hip flexion could extend the level of spinal anaesthesia following a prolonged CSE technique.

METHODS

Following approval from institutional ethics committee, 50 American Society of Anesthesiologists (ASA) I and II male patients, aged 18–60 years, with unilateral femur fractures, scheduled for elective fracture fixation under CSE were included. Patients having bilateral fractures were excluded. Those with height less than 150 cm or more than 180 cm were also excluded. Written informed consent was obtained from all the patients before inclusion in the study. The patients were randomly allocated, using a sealed envelope technique, to one of the two groups—Control or Flexion.

In the operation theatre, 18G intravenous (IV) cannula was inserted on the dorsum of hand and 500 ml Ringer lactate was infused. CSE was performed in the sitting position using needle-through-needle technique at L 2-3 interspace and 2.6 ml 0.5% hyperbaric bupivacaine injected intrathecally. Time from the end of spinal injection to fixation of epidural catheter was recorded. The sitting position was maintained for a minimum of 4 min, i.e., 240 s from the end of spinal injection even if the time to epidural fixation was less than that. Patients were made supine at the end of this 4-min period or later if epidural placement took longer. The position of the operating table was kept horizontal throughout the procedure. The Control group patients ($n=25$) lay supine with legs straight, whereas the Flexion group patients ($n=25$) had their uninjured hip and knee flexed and the hip slightly externally rotated. In addition to asking the patients to flex the hip and the knee as much as possible, an assistant helped them to maintain the flexion. This position was maintained for 5 min after which patients were returned to the supine position with legs straight. Levels of sensory and motor block were assessed every 5 min for initial 30 min after the end of spinal injection and then every 15 min until regression of sensory block by two dermatome levels or complaints of pain or discomfort by the patient, whichever was earlier. This time point was considered

as the end point of the study period. Epidural test-dose followed by top-up dose, if required, was given at this time. The sensory block level was assessed by pinprick with the 21 G needle and Bromage Score modified by Breen *et al.*[9] was used to assess the motor block level in the uninjured limb [Table 1]. The first assessment was performed 5 min following spinal injection, i.e., 1 min after the patient was changed from sitting to supine position. The second evaluation was 10 min following spinal injection. In the Flexion group patients, this time point was after the patients were returned to the supine position after maintaining hip flexion for 5 min. Thus, the patients in both the groups were in the supine position at this time. The 5 and 10 min readings were missed in patients in whom it took longer than 5 and 10 min, respectively, to fix the epidural catheter. Initial two readings (5 and 10 min from the spinal injection) of the spinal blockade were recorded by the anaesthetist present at the time of performance of CSE. After this, all the assessments were carried out by the second anaesthetist blinded to the patient grouping as by this time all the patients had been returned to the supine position with legs straight.

The times to the maximum sensory level and motor block and the time to epidural drug requirement were noted. Heart rate and non-invasive blood pressure were monitored throughout anaesthesia and surgery and recorded every 5 min for initial 30 min after the spinal injection.

To analyze the sensory level attained, the dermatomal levels were counted in sequence starting from the lowest level so that S5=1, S1=5, L5=6, L1=10, T12=11 and so on. Due to the supine position of the patients, the lowest level noted was S1. If there was no effect at the S1 level or readings were missed due to epidural catheter fixation taking longer than 5 or 10 min, the level was recorded as 0 for the purpose of statistical analysis. Statistical analysis was performed using SPSS version 13.0. On the basis of the results of initial 10 cases, 25 patients in each group were required to detect a difference of two levels in the maximum sensory block using the Mann–Whitney *U*-test with an α-error of 0.05 and a β-error of 0.2. Data are expressed

Table 1: Modified Bromage score (Breen *et al.*)[9]
1 = Complete block (unable to move feet or knees)
2 = Almost complete block (able to move feet only)
3 = Partial block (just able to move knees)
4 = Detectable weakness of hip flexion (between scores 3 and 5)
5 = No detectable weakness of hip flexion while supine (full flexion of knees)
6 = Able to perform partial knee bend

as mean (SD) or median (range). The demographic profile was analyzed by Student's *t*-test, whereas sensory and motor blocks were analyzed using the Mann–Whitney *U*-test. Repeated measures ANOVA was used to compare haemodynamic parameters in the two groups. A *P*-value <0.05 was considered statistically significant.

RESULTS

The two groups were comparable with respect to age, weight and height. The mean (SD) age of the patients was 38.1 (14.7) years in the Control group and 35.5 (13.4) years in the Flexion group. The mean (SD) weights in the Control and Flexion groups were 63.9 (8.9) kg and 62.3 (8.3) kg, respectively, and the mean (SD) heights were 168.8 (4.4) cm and 167.0 (5.3) cm, respectively.

There was no significant difference in the heart rate and systolic blood pressure during first 30 min in the two groups [Figures 1 and 2] (*P*>0.05). One patient in the Control group developed hypotension which was treated with fast IV fluids and injection mephentermine 3 mg. The maximum sensory level achieved in this patient was T10. All the other patients in both the groups maintained their heart rate and blood pressure and did not require administration of atropine or any vasopressor throughout anaesthesia and surgery.

There was no statistically significant difference in the time taken from the spinal injection to epidural catheter fixation in Control and Flexion groups [195 (121) s and 231 (163) s, respectively, *P*=0.20]. It ranged from 90 s to 525 s in the Control group and from 120 s to 840 s in the Flexion group. In the Control group time from spinal injection to epidural catheter fixation exceeded 240 s in four patients (350, 410, 505, and 525 s). Blood came in the catheter in two patients while cerebrospinal fluid (CSF) was aspirated in the other two; catheters were removed and reinserted in adjacent intervertebral spaces. In the Flexion group, epidural catheter fixation took more than 240 s in six patients (295, 335, 370, 375, 545, and 840 s). In one case, it was due to difficulty in threading the catheter; in two patients, dura got punctured at the time of catheter insertion so that the epidural technique was repeated in the adjacent space; and in the other three cases, blood appeared in the catheter at the time of insertion necessitating removal of catheter as well as needle and repeating the space identification and catheter insertion.

The median (range) sensory block levels at different time points were not different in the two groups (*P* > 0.05). Figure 3 shows the number of dermatomes blocked till 60 min in each group. There was no significant difference among the groups in the median (range) maximum sensory block level, median (range) maximum motor block, mean (SD) time to achieve maximum sensory level and mean (SD) time to achieve maximum motor block [Table 2]. Although the mean time to achieve the maximum sensory level was
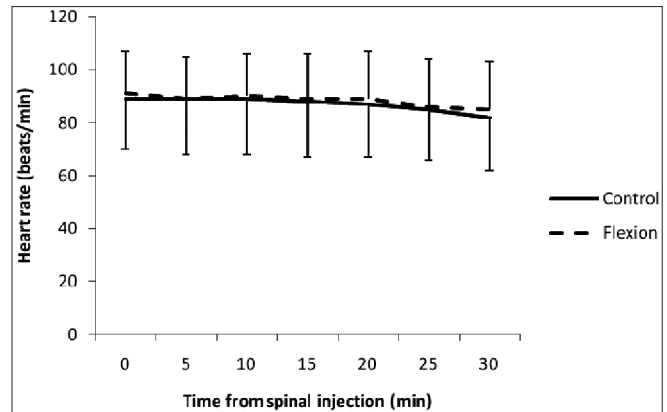

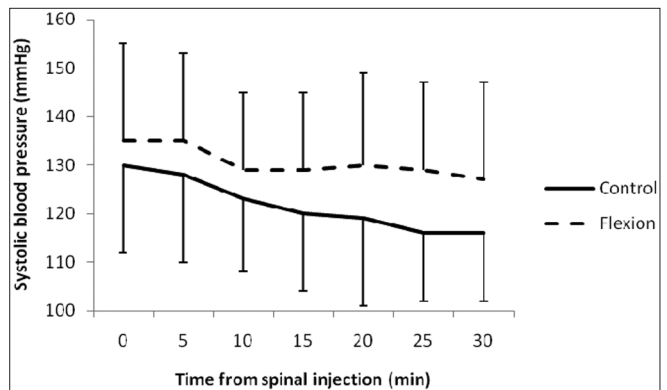**Figure 1:** Changes in heart rate
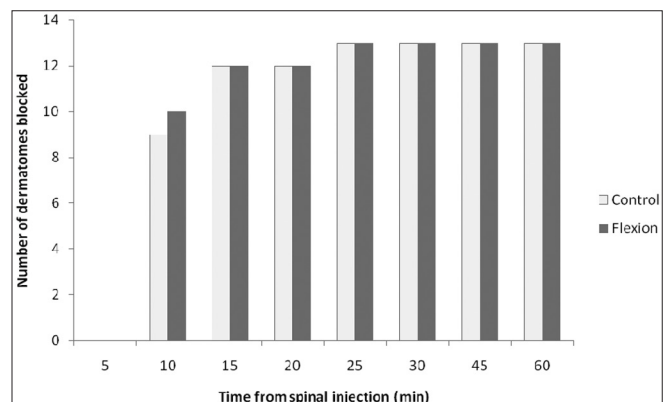

Figure 2: Changes in systolic blood pressure

Figure 3: Pattern of sensory blockade after spinal injection

Table 2: Block characteristics			
	Control group (*n*=25)	Flexion group (*n*=25)	*P* value
Maximum sensory level	T10 (L5–T5)	T10 (T12–T5)	0.542
Maximum motor block	1 (1–4)	1 (1–3)	0.266
Time to maximum sensory level (min)	23.2 (12.8)	21.2 (6.8)	0.797
Time to maximum Motor block (min)	18.6 (10.3)	18.2 (5.9)	0.481

Values are median (range) or mean (SD), *n*=number of patients

statistically similar in the two groups, it ranged from 10 to 30 min in the Flexion group in contrast to a much wider range of 5–60 min in the Control group. In the Control group, four patients achieved the maximum sensory level after 30 min; three patients at 45 min and one at 60 min.

Mean time to epidural drug requirement appeared to be longer in the Flexion than in the Control group, i.e., 120.8 (24.7) s vs. 100.6 (47.7) s; however, this difference could not achieve any statistical significance (P=0.476). Four patients in the Control group did not achieve a sufficient level of block and thus required supplementation through epidural catheter before start of surgery. On the other hand, adequate surgical level of block was attained in all the patients in the Flexion group. The time from spinal injection to epidural catheter fixation in all the four Control group patients requiring supplementation before the start of surgery was less than 240 s, and these patients were made supine at 240 s as per the protocol.

As in some cases, time to epidural catheter fixation was longer than 240 s and therefore, these patients sat for a longer period than others. The statistical analysis was repeated after excluding these cases to rule out the effect of long duration of sitting. However, no significant difference could be seen in different variables between the two groups (P>0.05). Following this, we studied patients with longer sitting periods, i.e. four patients in the Control group and six patients in the Flexion group. The maximum sensory block levels in these patients varied from T8 to T11 in the control group and T9 to T10 in the flexion group. Spearman's correlation was applied in these patients to find out any association between time from spinal injection to epidural catheter fixation and other variables, i.e. maximum sensory and motor blocks, times to achieve maximum sensory and motor blocks and time to epidural drug requirement. No correlation could be seen in these variables.

DISCUSSION

This study examined the potential of unilateral hip flexion to extend the level of spinal block in cases of delayed positioning after needle-through-needle CSE. While using needle-through-needle technique of CSE, the drug is injected in the subarachnoid space before inserting and fixing the epidural catheter. This necessitates CSE patients to sit for 3–4 min longer than the patients receiving only subarachnoid block.[10] Spinal injection in the sitting position causes a hyperbaric solution to pass caudally due to influence of gravity and amount of the solution passing caudally depends on the time the patient remains sitting.[4] Therefore, considerable delays in making the patient supine can lead to dependent pooling of the local anaesthetic resulting in the saddle block. In this study, all the blocks were performed in the sitting position as our patients had their lower limbs fractured and thus the lateral position was uncomfortable for them. We made the patients supine 4 min after the spinal injection to mimic delays of 3–4 min. Although we could not find any statistically significant difference in the maximum levels of block between the two groups, four patients in the Control group needed supplementation through epidural catheter before starting surgery due to very low levels of the block.

During performance of needle-through-needle CSE, sometimes very long delays can occur due to unexpected problems, e.g., catheter entering a blood vessel, difficulty in catheter insertion, paraesthesia during advancement[1] or dural puncture with the catheter. In this study, the positioning of patients in the supine position was delayed for much longer periods because of such reasons in 10 patients. In most of these cases, further attempts at catheter placement were needed. Roberts and Brighouse[5] reported a case where the CSE technique was performed in the sitting position. Following spinal injection of heavy bupivacaine, there was a difficulty in inserting the epidural catheter resulting in a delay in making the patient supine. Adequate level of block could not be achieved that necessitated administration of general anaesthesia to this patient. According to Lesser *et al.*[3] while giving CSE anaesthetic, brisk action is required at the end of the intrathecal injection if an epidural catheter is to be placed before the local anaesthetic has fixed as delays in catheter placement are likely to result in inadequate spread of local anaesthetic. Similarly, Familton and Morgan,[2] while discussing the 'Needle-through-needle' technique for

CSE anaesthesia in the lateral position in obstetrics, suggested that if extradural catheter fails to thread after the spinal injection, further insertion attempts should be abandoned and the patient should be turned onto the other side to produce a bilateral block. Despite this evidence of inadequate spread of local anaesthetic in cases of a prolonged sitting or lateral position, studies assessing the effect of the prolonged sitting position on the level of spinal block have shown controversial results.

Povey *et al.*[11] and Veering *et al.*[12] did not find significant differences in the maximum spread of sensory levels in the different groups; however, the time to attain maximum levels was more in the patients who sat for the longest time. The patients of Povey *et al.* sat for 2 min or 60 min.[11] The maximum cephalic spread of sensory analgesia was almost similar, but the time to maximum spread was 12.5 min in the 2 min group vs. 75 min in the 60 min group. The patients studied by Veering *et al.* were elderly and received 3 ml hyperbaric bupivacaine.[12] They sat for 2, 5, 10, or 20 min. The highest obtained levels of analgesia occurred later in the 20 min group. It appears from these studies that even after a prolonged sitting position, adequate levels of block can be achieved but it may take longer to achieve these levels. In clinical practice, it may not be always possible to wait for such long durations and hence there may be a need for some positional manipulations to attain the required block levels within the appropriate time period.

The peak of lumbar lordosis is at the L4 vertebral level or L3-4 intervertebral space.[13] The drug pooled in the sacral region can ascend upward if the lumbar lordosis can be flattened. Bilateral hip flexion can flatten the lumbar lordosis.[7,8] However, trauma patients with lower limb fractures cannot flex their injured limb. The effect of unilateral hip flexion on obliteration of lumbar lordosis has not been studied. Therefore, we hypothesized that unilateral hip flexion should increase the level of spinal block during the needle-through-needle CSE technique with delay in completing the procedure in the sitting position.

The Trendelenburg position is frequently used to extend the level of block. However, it may be less effective if cephalad spread of hyperbaric local anaesthetic is limited by lumbar lordosis.[6] Kim *et al.* used hip flexion along with the Trendelenburg position as a rescue strategy to increase the spinal anaesthetic level after the spinal block.[6] They were successful in increasing the level of the sensory block by using hip flexion; however, the combination of hip flexion and Trendelenburg position resulted in very high levels of block, i.e. median (range) of T4 (T8-C6) for a maximum level of pinprick and T3 (T6-C2) for a maximum cold sensory block. This uncontrolled spread of spinal drug also resulted in a higher incidence of hypotension and bradycardia in the hip flexion group. In the present study, the Trendelenburg position was not used along with hip flexion to avoid the possibility of such uncontrolled spread of spinal bupivacaine.

In this study, no significant difference could be seen in sensory levels, motor blocks and mean time to epidural drug requirement between the two groups. However, all the patients in the Flexion group had attained a maximum sensory level by 30 min, whereas four patients in the Control group took longer than 30 min to achieve the maximum block level. Moreover, all the patients in the Flexion group attained adequate block levels to start surgery whereas four patients in the Control group required epidural drug before surgery. Thus, there may be some potential benefit of unilateral hip flexion in extending the level of spinal block, though we could not demonstrate any obvious advantage of this technique in this study.

It may be argued that there is no need to flatten the lumbar lordosis in order to extend the level of spinal block in the CSE technique as more local anaesthetic can be administered through the epidural catheter. However, this would require unnecessary administration of additional local anaesthetic. Moreover, any beneficial effect of unilateral hip flexion in the CSE technique could be extrapolated to the spinal anaesthetic technique without epidural catheter *in situ* or situations when there is failure to insert epidural catheter. During spinal anaesthesia, low levels of block can result because of technical, pharmacologic,[14] or anatomical[15] variables. Failure to insert epidural catheter during the CSE technique, though not very common, has been reported in many studies.[16,17] If unilateral hip flexion was successful in extending the level of spinal block, it could be used in such situations to achieve adequate block levels in patients with unilateral lower limb fractures.

This study has certain limitations. First, four patients in the Control group and six in the Flexion group sat for longer periods than others. An attempt was made to find out the correlation between this duration of sitting and the quality of block. However, this number

was very small and the negative results could have been because of the small number of patients included in the analysis. Second, the level of block below S1 could not be assessed as the patients were lying in the supine position and we did not want to move them during the initial post-block period. Therefore, the effect of spinal block could only be seen once the level reached S1. For the same reason, the median sensory block level at 5 min was recorded as 0 in both the groups.

Hirabayashi *et al.* examined the mechanical effects of the leg position on vertebral structures by magnetic resonance imaging.[8] They demonstrated that lumbar lordosis disappeared with full flexion of both hips and knees. However, they did not study the effect of flexion of one limb on lumbar lordosis. We feel this concept of unilateral hip and knee flexion needs to be explored by radiological imaging and further clinical studies so that its potential benefits, if any, can be utilized in managing trauma patients with unilateral lower limb fractures in whom bilateral flexion of knees and hips is not possible.

CONCLUSION

In conclusion, unilateral hip flexion did not extend the spinal anaesthetic level in cases of delayed patient positioning while performing needle-through-needle CSE. However, further studies are required to explore the potential benefits of this technique.

ACKNOWLEDGEMENTS

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