Prevention of Phantom Sensations After Spinal Anesthesia

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Abstract

Background and Objectives: Phantom limb sensation (PLS) after the spinal anesthesia is an unpleasant experience. The occurrence rate was 80 to 83 per cent from previous studies. The purpose of this study is to evaluate the incidence of PLS, comparing between placing the lower limbs in the neutral position when analgesic level reach L1 dermatome (L1 group) and T6 dermatome (T6 group).

Methods: Ninety ASA physical status I-II patients, 19-50 year of age, scheduled for lower abdominal surgery under spinal anesthesia were enrolled. Immediately after the spinal injection, the patients were placed supine with one of lower limbs flexed (both hip and knee) and the other kept straight in the neutral position. The analgesic levels were checked every minute; the flexed limbs were turned to the neutral position when the analgesic level reached L1 and T6, the L1 group and the T6 group respectively. The images of the lower limbs and patients' satisfactions were evaluated 15 minutes after the blockage.

Results: Twenty per cent of the patients in the L1 group experienced PLS of the flexed limbs while 82.2 per cent of the patients in the T6 group did ($P<0.05$). None of the patients in the L1 group felt unsatisfied with PLS, on the other hand, 11.1 per cent of the patients in the T6 group expressed their dissatisfaction and would like to have their limbs extended.

Conclusions: This study revealed that by placing the lower limbs in the neutral position immediately after the spinal injection, before the unwanted positions are memorized, could effectively minimize phantom limb sensation after spinal anesthesia.

Key words : Spinal Anesthesia, Phantom Limb Sensation

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Occasionally, patients who are undergoing spinal anesthesia ask for a straightening or a lowering of their lower limbs even though they are lying supine with their lower limbs already extended in the neutral position. This incorrect perception of their lower limbs' position was defined as the "Natural Phantom sensation" by Henderson and Smyth in 1948[1]. Later in 1964, Prevoznik and Eckenhoff reported the phantom limb sensation (thereafter: PLS) during spinal anesthesia. The patient who experiences PLS, sometimes feels an uncomfortable sensation until the anesthesia dissipates or the motor power of their lower limbs returns[2]. In 1979, Khurana et al put the patients in flexed limb on abdomen position or lithotomy position until the motor blockage of spinal anesthesia was complete and found the incidence of PLS as high as 80-83 per cent[3]. The purpose of this study was to compare the incidence of PLS that happened in two techniques: one with the lower limbs in the neutral position when analgesia level reached L1 dermatome (thereafter: the L1 group), and the other when it reached T6 dermatome (thereafter: the T6 group) in order to derive a more effective method to prevent PLS.

METHOD

After obtaining approval from the institutional ethical committee and informed consent from each patient, this prospective, randomized, double blind study took place at King Chulalongkorn Memorial Hospital, a 1,500- bed university hospital, affiliated with the Royal Red Cross Society of Thailand. All the subjects recruited were of physical status class I-II, based on the criterion given by the American Society of Anesthesiology (ASA), and were scheduled for lower abdominal surgeries under spinal anesthesia. Patients who had any contraindication to spinal anesthesia or previously had a lower limb amputation were excluded. No premedication was given to any of the subjects.

Under the surveillance of the first anesthesiologist, the patient was asked to lie, either in the left or in the right lateral decubitus position (knee-chest). They were blind-folded with cloth and tape. Spinal block was performed with 1.2-2 mL of 5 per cent hyperbaric lidocaine and 0.1 mL of 1:1000 adrenaline. Immediately after the spinal injection, the patients were placed in the supine position with one of the lower limbs (the dependent limb at the time of spinal block) flexed (both hip and knee) and the other kept straight in the neutral position. After the spinal injection, the dermatome levels of sensory blockage were checked by pinprick test every minute for 8 minutes. The flexed limb was turned to the neutral position when analgesic level reached L1 and T6 in L1 group and T6 group respectively.

Fifteen minutes after the blockage, without knowing what was done, the blinded second anesthesiologist evaluated the image of the lower limbs by 4- step questions as follows;

Step 1 question : Are both of your legs different from each other ? If they are different, describe the differences. (If the patient can not answer, move to step 2 question).

Step 2 question: What are the positions of your left and right knees and your left and right hips? (If the patient can not answer, move to step 3 question).

Step 3 question: Are your left and right knees flexed or extended? If it is flexed, is it in knee-chest, upright or lateral deviated position? If it is extended, does it lie side by side separate from each other or elevated into the air? (If the patient can not answer, move to step 4 question).

Step 4 question: The patient selects their limb positions from the picture of different limb positions.

The patients' satisfaction was also evaluated by the second anesthesiologist.

Power analysis was employed to determine the size of the groups. Statistical comparison was performed with chi-square analysis for categoric variables and unpaired t-test for continuous variables, $p < 0.05$ was considered significant.

RESULTS

Of the 90 recruited subjects in the study, 7 were male and 83 were female, with no statistical difference in age, weight, height, education background and the side selection of the lower limbs to be positioned in both groups (Table 1).

There was no difference in the median level of sensory analgesia by pinprick between the groups at any time during the first 8 minutes (Fig. 1). The average time of analgesic level that reached the L1 and the T6 dermatome in both groups was 1.6 ± 0.7 and 4.4 ± 1.2 minutes. Eleven patients in the L1 group and 5 patients in the T6 group had their flexed limb extended too late, i.e., at T12–T10 and T5-T4 respectively, and experienced PLS (Table 2). Most of the patients responded to the opened ques-

Table 1. Patient characteristics.

	The L1 group n=45	The T6 group n=45
Sex (male: female)	7:38	0:45
Age (year) (mean ± SD)	30±7	30±7
Weight (kg) (mean ± SD)	63±10	63±11
Height (cm) (mean ± SD)	157±8	155±5
Education		
Primary school	-	1
Secondary school	13	12
High school	17	18
University	15	14
Side of selected limb (Lt./Rt.)	21/24	24/21

tions to explain their lower limb positions (88 patients responded to the step 1 and the step 2 questions, 1 patient to the step 3 question and 1 patient could not answer any of the questions.) (Table 3).

From the explanation of positional sense of the 90 patients, we found that the incidence of PLS was significantly lower in the L1 group (9 of 45 patients, 20%) than in the T6 group (37 of 45 patients, 82.2%); $P<0.05$. Seven patients in the L1 group experienced PLS of the flexed limbs in the same designed position (Fig. 2A), 1 patient experienced PLS in the position for urinary bladder catheteriza-

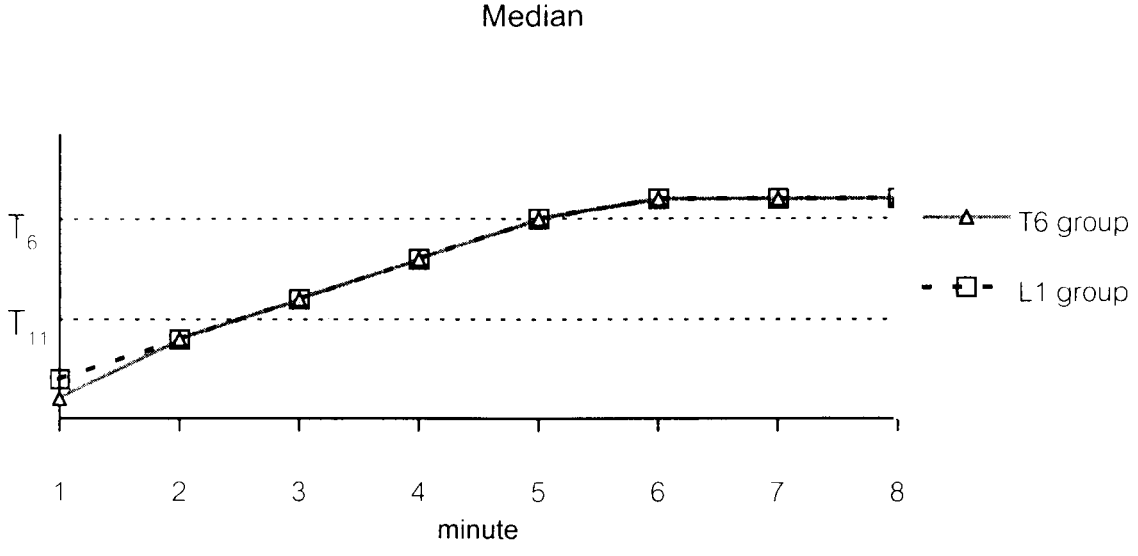
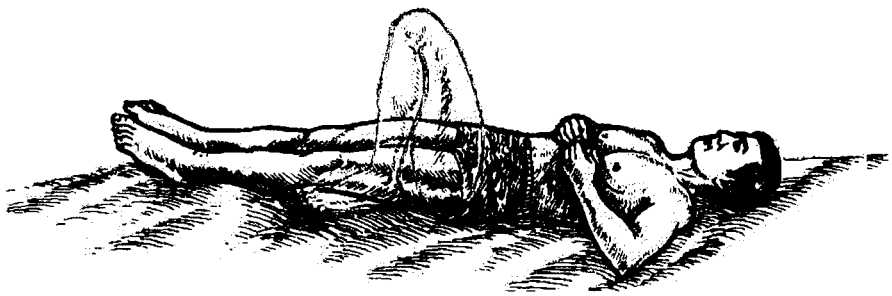


Fig. 1. The median analgesia levels.

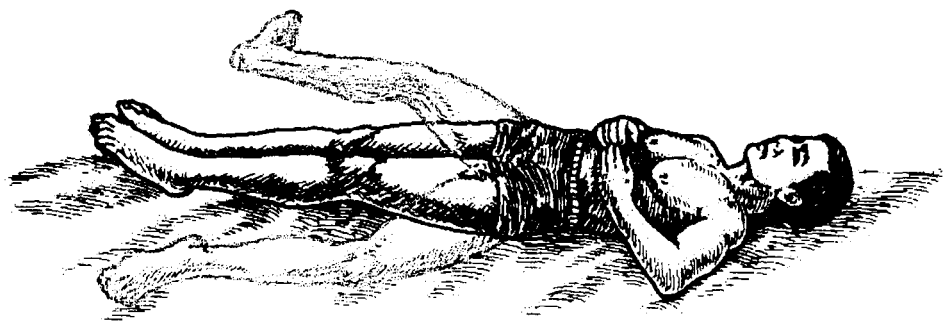
Table 2. Time and analgesic level when the flexed limb was turned to the neutral position.

	The L1 group n=45	The T6 group n=45
Average time that extended the flexed limb (min)(mean ± SD)	1.6±0.7 (1-4)	4.4±1.2 (1-8)
No. of patients who extended the flexed limb when analgesic level reached		
L1	34	-
T12	4	-
T11	2	-
T10	5	-
T6	-	40
T5	-	3
T4	-	2

A = PLS of the flexed limbs like the designed position



B = PLS in the position for urinary bladder catheterization



C = PLS of knee-chest position for spinal blockage

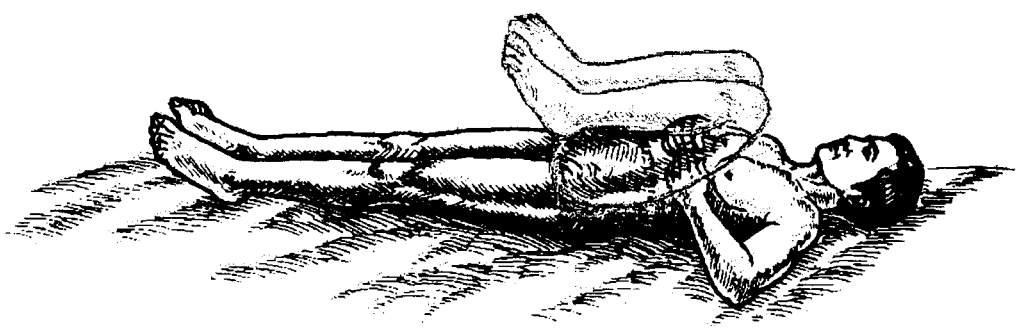


Fig. 2. The positional sense of the lower limbs at 15 min after spinal anesthesia: A= PLS in the position of flexion like the designed position, B and C= PLS in different from the designed position (B = PLS in the position for urinary bladder catheterization, C = PLS of knee-chest position for spinal blockage).

Table 3. 4-step questions.

Question	The L1 group n=45	%	The T6 group n=45	%
Step 1	35	78	37	82
Step 2	9	20	7	16
Step 3	1	2	-	
Step 4 (picture)	-		1	2

tion (Fig. 2B), 1 patient experienced PLS of knee-chest position for a spinal blockage (Fig. 2C). While 36 of the patients in the T6 group experienced PLS of flexed limb in the same designed position, 1 patient experienced PLS in the position for urinary bladder catheterization (Table 4).

There were 11 patients in the L1 group and 5 patients in the T6 group that extended the flexed limb too late (their legs were turned to the neutral position when the analgesic level reached above the L1 and T6 dermatomes) (Table 2). If these patients were excluded from each group, the incidence of PLS would be greatly different between the groups (3 of 34 patients, 8.8% in the L1 group and 34 of 40 patients, 85% in the T6 group); $P<0.01$.

None of the patients in the L1 group but 11.1 per cent in the T6 group felt unsatisfied with their position and all of them had PLS.

DISCUSSION

Melzack mentioned the central mechanism explaining the PLS and phantom limb pain among amputees, patients with spinal cord injuries, and with brachial plexus avulsion. He suggested that this is deafferentation of sensory and proprioceptive senses through the spinal cord to the upper central nervous system. In the meantime, this is still repetitive self sustaining activity of the senses which might be painful or uncomfortable prior to the injury in some areas of the central nervous system, such as ventro-basal area of thalamus from which those feelings are transmitted to the cerebral cortex[4,5].

In the model proposed by Andersen and Eccles to account for repetitive, rhythmic brush of activity in ventro-basal of thalamus (Fig. 3), the in-puts of sensory and proprioceptive senses (a) from the limbs arriving along the lemniscal fibers of the spinothalamic tract activate the thalamic neurons (T cells). Then the T cells project the impulses (b) to the cerebral cortex for perception and at the same time the T cell project the collateral axon impulse (c) to the inhibitory neuron (I cell) that project the impulse back to the T cell (d). The T cell is briefly inhibited, then after the disinhibition and rebound excitation the T cell fiber spontaneously reactivates the recurrent loop. This repetitive activity within the closed loop could continue for a prolonged period of time so the sensory and proprioceptive senses were memorized until the new in-puts from the lower limbs arrive and the same process could be repeated again[6].

In cases of amputees, patients with spinal cord injury, and patients with brachial plexus avulsion, as well as subjects under spinal anesthesia, the new sensory and proprioceptive senses are lost and the last sensory and proprioceptive senses sustain memory for a prolonged period[7].

This study was designed to investigate PLS after spinal anesthesia, comparing the lower limbs in the neutral position when the analgesic level reached the L1 dermatome (L1 group) and the T6 dermatome (T6 group), which may be different in proprioceptive blockage of the lower limbs.

The study found 37 patients in the T6 group experienced PLS in the position of knee flexion like the designed position, although both their lower

Table 4. The positional sense of the lower limbs at 15 min after spinal anesthesia.

The positional sense	The L1 group n =45	%	The T6 group n =45	%
PLS	9	20	37	82*
Like the designed position	7	16	36	80
Different from the designed position	2	4	1	2
Neutral position	36	80	7	16*
No sensation	0	0	1	2

* $P<0.05$

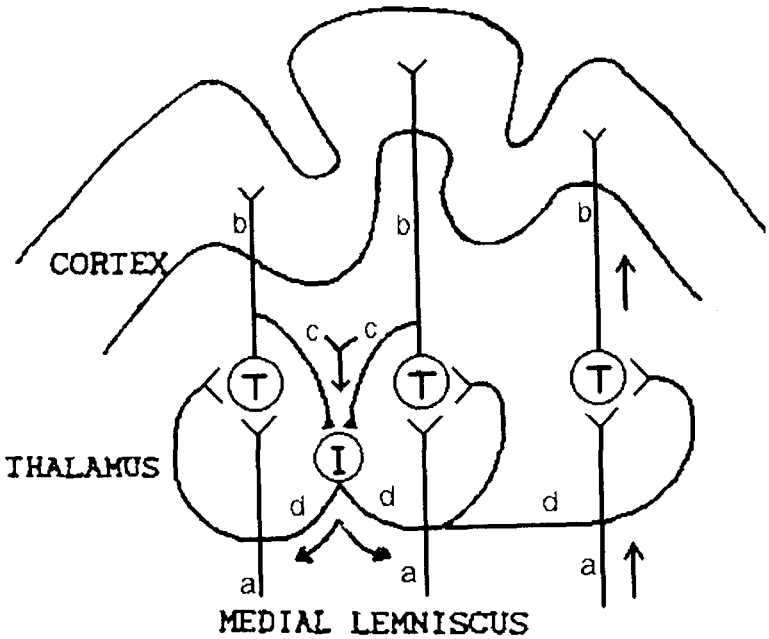


Fig. 3. The model to explain self sustaining activity (modified from model of Andersen and Eccles)[6].

limbs were straightened in the neutral position. One possible explanation for this PLS is that the proprioceptive afferent fibers from the lower limbs had been completely blocked before turning to the neutral position. Without the new proprioceptive sense of the neutral position from the lower limb to replace the self-sustaining image of the previous flexed knee position (designed position) in the thalamus and cerebral cortex then the sense of the flexed knee position still persisted.

In the L1 group, when the sensory blockage progressed up to the L1 dermatome, the flexed limb was turned straight to the neutral position, there were 36 patients who did not experience PLS. According to the differential axial blockage theory, determined by Arrow and Sarnoff, the susceptibility of nerve tissue to blockage was dependent on the fiber size by Gasser and Erlanger[8-10]. At the time when the analgesic level by pinprick test reached the L1 dermatome, it was possible that the proprioceptive afferent fibers of the lower limbs were still intact. So the feeling of the lower limbs being straightened, could transmit to the upper central nervous system and erase the memory of the previous position of the limbs. Therefore, the patient experienced a new neutral position throughout the course of spinal anesthesia.

The sensory blockage level was checked every minute after spinal block, 11 of 45 patients in the L1 group had their flexed limb extended too late, i.e., when the analgesic reached the levels of T12–T10. Among these 11 patients, 5 felt their limb in the neutral position, 5 felt PLS like the designed position and 1 felt PLS like the knee-chest position. If these 11 patients were excluded from the study, we found that the incidence of PLS in the L1 group would be only 8.8 per cent (3 of 34 patients). With a higher sensory blockage that the flexed limb was turned straight to the neutral position (T12–T10), the patient had more proprioceptive blockage and more experienced the phantom limb (5 of 11 patients, 45.5%). Therefore turning the flexed limb to neutral position earlier, the incidence of PLS would be least.

One patient in the L1 group, and one in the T6 group, experienced PLS of the posture used for catheterization of the urinary bladder. It can be explained that at the very moment of catheterization

the proprioceptive afferent was still intact and that last position was then memorized. One possible explanation for one patient in the L1 group who experienced the knee-chest position like the position of spinal anesthesia is that the onset of proprioceptive blockage was begun at the same time as the spinal injection.

However, a small number of patients in both groups did not follow the above explanation. The proprioceptive afferent fibers from the lower limbs of 7 patients in the T6 group were still intact at the time sensory analgesic level reached the T6 dermatome (1-8 minutes) at the same moment the flexed limb was straightened which would be the last positional sense and so there was no PLS outcome. The time sensory analgesic level reached the L1 dermatome, the flexed limb was straightened (1-4 minutes), the proprioceptive afferent fibers of 2 out of 34 patients in the L1 group were blocked and the last positional sense would be the flexed knee position and PLS was the outcome. It was possible that there was an alternate route for the postural and kinetic information from the lower body to the brain areas, e.g., in the study of Kuntz and Saccomanno in 1942 about the cat that had a high lumbar cord transection. It was found that pupillary dilatation occurred after the pinching skin of the hind limb ipsilateral to an intact sympathetic chain but that the ipsilateral reflex was lost when the spinal cord and sympathetic trunk were both transected at the same level(11,12).

In summary, the results from the study indicate that the group in which the flexed lower limb was turned to the neutral position when analgesic level reached L1, experienced a lower incidence of PLS than the group that had the lower limbs returned to the neutral position when analgesic level reached the T6 dermatome (20% and 82.2% respectively). Moreover, some of the patients in the T6 group felt unsatisfied with PLS and wanted to have their limbs extended (11.1%). The authors concluded that in order to reduce the incidence of uncomfortable PLS, the anesthesiologist should place the patient's lower limbs straight in the neutral position after the spinal injection, or at least when the sensory blockage by pinprick test reached L1 dermatome, or in 1-4 minutes after spinal injection.

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การป้องกันการเกิดภาวะ phantom sensation ภายหลังได้รับยาชาเข้าช่องไขสันหลัง

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ในระหว่างการเฝ้าสังเกตและดูแลผู้ป่วยที่ได้รับยาชาเข้าช่องไขสันหลัง (spinal anesthesia) นั้น บ่อยครั้งที่ผู้ป่วยจะขอร้องให้เหยียดขาผู้ป่วยออกหรือวางขาลง ทั้งที่ขณะนั้นผู้ป่วยอยู่ในท่านอนหงาย และขาทั้งสองข้างเหยียดตรงแล้ว ภาวะการจดจำท่าทางของขาที่ผิดไปจากความเป็นจริงดังกล่าว เรียกว่า phantom limb sensation (PLS)

การศึกษานี้เปรียบเทียบอุบัติการณ์การเกิดภาวะการจดจำท่าทางของขาที่ผิดไปจากความเป็นจริงที่เกิดหลังการได้รับยาชาเข้าช่องไขสันหลังในผู้ป่วย 2 กลุ่ม กลุ่มละ 45 ราย คือกลุ่ม L1 ซึ่งมีการจัดท่าของขาให้ชันเข่าจนเมื่อระดับชาสูงถึง lumbar dermatome ที่ 1 แล้วจึงทำการเหยียดขาตรงเทียบกับในกลุ่ม T6 ซึ่งมีการจัดท่าของขาให้ชันเข่าจนซึ่งมีการจัดท่าของขาให้ชันเข่าจนเมื่อระดับชาสูงถึง thoracic dermatome ที่ 6 แล้วจึงทำการเหยียดขาตรง

พบว่าผู้ป่วยในกลุ่ม L1 มีความรู้สึกว่าขาอยู่ในท่าไม่ตรงกับความเป็นจริงน้อยกว่ากลุ่ม T6 อย่างมีนัยสำคัญทางสถิติ (P value <0.05) กล่าวคือ ในกลุ่มที่ L1 พบจำนวน 9 ราย คิดเป็นร้อยละ 20 และในกลุ่ม T6 พบจำนวน 37 ราย คิดเป็นร้อยละ 82.2 นอกจากนี้มีผู้ป่วยจำนวน 5 ราย คิดเป็นร้อยละ 11.1 ในกลุ่ม T6 รู้สึกไม่พอใจกับท่าทางของขาที่รู้สึกว่าชันเข่าอยู่ทั้งที่ในขณะนั้นขาเหยียดตรง

ดังนั้นในการที่จะป้องกันการเกิดภาวะการจดจำท่าทางของขาที่ผิดไปจากความเป็นจริงที่เกิดหลังจากได้รับยาชาเข้าช่องไขสันหลังและอยู่ในท่าที่ไม่สบาย จึงควรเหยียดขาให้ตรงก่อนการชาสูงเกินระดับ lumbar dermatome ที่ 1

คำสำคัญ : Phantom sensation, การฉีดยาชาเข้าช่องไขสันหลัง

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