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Change in Skin Temperatures in Lumbar Sympathetic Ganglion Block Showing Three Different Contrast Spread Patterns

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Abstract : We hypothesized that if a fluoroscopic image of the lumbar sympathetic ganglion block (LSGB) showed the spread patterns of contrast at both the L2/3 and L4/5 disc areas, then this would demonstrate a more profound blockade effect because the spread patterns are close to sympathetic ganglia. Forty five patients were classified into three groups(Group A : contrast spreads at the ventral side of both L2-L3 and L4-L5 disc areas, Group B : contrast spreads at one disc level of L2-L3 or L4-L5, Group C : no contrast spreads around either L2-L3 or L4-L5 disc areas) according to their contrast spread pattern. Preblock and maximum postblock temperature (T^{pre}, T^{post}, ℃), the preblock temperature difference between the ipsilateral and contralateral great toe (DT^{pre}, ℃), and the postblock temperature difference between the ipsilateral and contralateral great toe (DT^{post}, ℃) were measured and calculated. DT^{net} was calculated as follows. $DT^{net} = DT^{post} - DT^{pre}$. Group A showed the most significant changes in DT^{post} (7.5 ± 1.2℃, p = 0.015), and DT^{net} (6.9 ± 1.0℃, p = 0.017) compared to group C. Other parameters including $T^{1℃}$, T^{pre}, T^{post}, and DT^{pre} were similar between groups. Group A showed significant sympatholytic effect compared to group C. To obtain a more complete sympathetic block, assessing the contrast spread pattern after the LSGB is an important step as well as measuring skin temperature.

Key Words : Lumbar sympathetic ganglion block, Skin temperature

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Introduction

Lumbar sympathetic ganglion block (LSGB) is commonly performed in the diagnosis and treatment of various pain states including complex regional pain syndrome, frost bite, peripheral vascular disease, acute herpes zoster and cancer pain [1,2].

In order to obtain a successful sympatholytic effect and diminish the risk of complications, it is preferable to target a lumbar sympathetic ganglion rather than a sympathetic chain. However, the lumbar sympathetic ganglia are variable in numbers, sizes and location. There tends to be fusion of L1 and L2 ganglia in most patients, and it is known that the ganglia are usually aggregated around the L2-L3 and L4-L5 discs [3-5]. Because of this proximity of sympathetic ganglion to the intervertebral disc and the benefits of avoiding genitofemoral neuralgia, LSGB via a transdiscal approach has been advocated [6]. However, this technique carries several risks including discitis, nerve root injury, accelerated disc degeneration, disc herniation and rupture of the anterior annulus [3,6]. Although the needle is not placed directly anterior to the intervertebral disc using a transdiscal method, if the spread pattern of contrast solution mixed with local anesthetics fully encounters the intervertebral disc space by a conventional paravertebral method, we can expect similar effects by the transdiscal approach. We hypothesized that if a fluoroscopic image of the LSGB shows a more vertical contrast spread and the contrast agent fully covers both the L2-L3 and L4-L5 disc areas, the LSGB would demonstrate a more profound blockade effect due to its proximity to the sympathetic ganglia.

Using skin temperature (Ts) changes as an index of sympatholysis, we tested the hypothesis that a lumbar sympathetic block showing a contrast spread pattern at the ventral side of both the L2-L3 and L4-L5 disc areas would result in a more significant increase in temperature. The Ts was measured at the ipsilateral great toe, calf, thigh and contralateral great toe. The maximal temperature changes, preblock and postblock temperature differences between the ipsilateral and the contralateral great toe were evaluated and compared between groups of three different contrast spread patterns.

Materials and Methods

1. Patients

This study was approved by the institutional review board and hospital ethics committee. Written informed consent was obtained from each patient prior to the LSGB procedure. We enrolled 55 consecutive patients who were believed to have complex regional pain syndrome (CRPS) type I, failed back surgery syndrome and spinal stenosis. All these patients had severe unilateral leg pain and they had previously been successfully treated with LSGB.

Fifty five patients were divided into three groups according to their contrast spread pattern seen on the fluoroscopic images. Group classification and interpretation of the fluoroscopic images was done immediately after the block procedure by the pain physician who performed the LSGB. Those patients whose fluoroscopic image showed a contrast spread pattern at the ventral side of

both L2-L3 and L4-L5 disc areas were classified as belonging to group A. Patients with a contrast spread at one disc level (L2-L3 or L4-L5) were classified as belonging to group B. Patients having no contrast spread pattern around either L2-L3 or L4-L5 disc areas were classified as belonging to group C (Fig. 1). We defined contrast solution as being present around the L2-3 or L4-5 disc areas if the contrast mixture covered at least half of the intervertebral disc. Among fifty five patients, ten patients were excluded because eight patients whose fluoroscopic image showed a psoas muscle shadow (5 patient from group A, three patient from group B on the fluoroscopic image) after the LSGB and 2

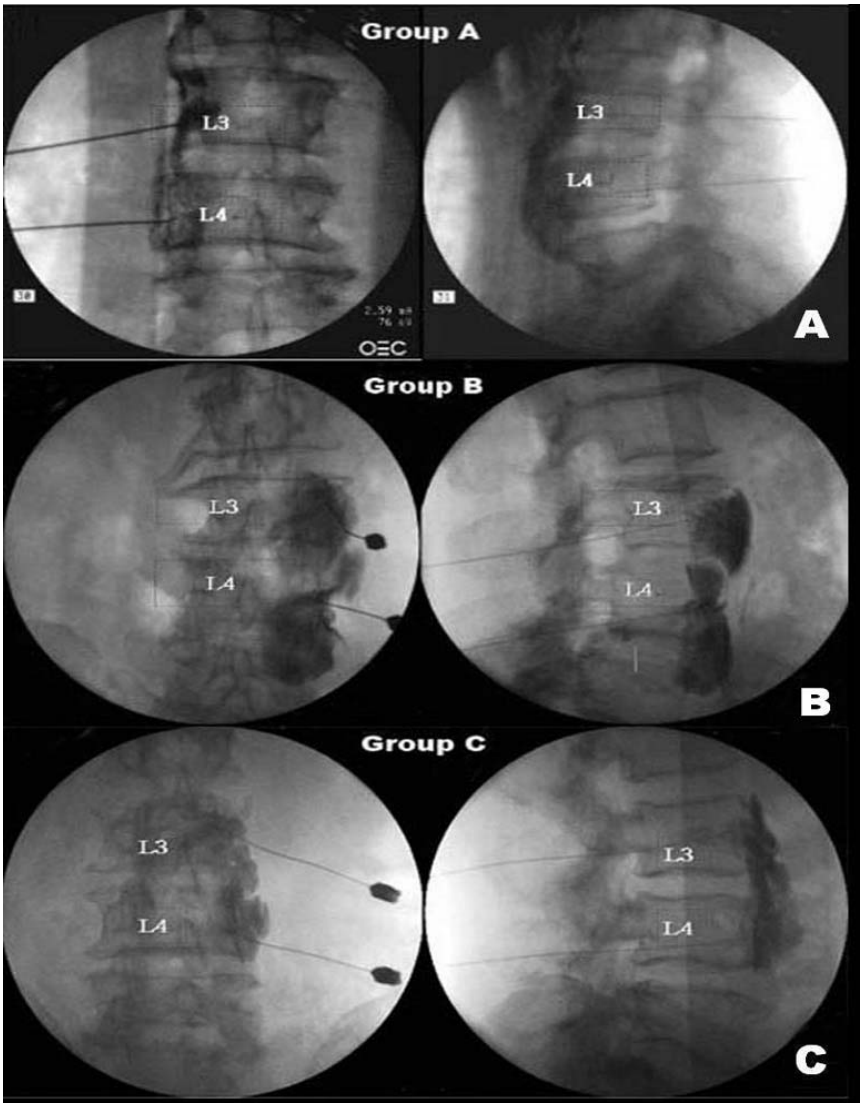

Fig. 1. This figure demonstrates the anteroposterior and lateral fluoroscopic images of groups A, B and C. (A) Group A shows contrast spread at both the L2-3, L4-5 disc space. (B) Group B shows contrast spread only in one of the L2-3 or L4-5 disc spaces. (C) Group C shows contrast spread in none of the L2-3 and L4-5 disc spaces.

patients whose Ts of the ipsilateral great toe more than 30℃ before the procedure. Ultimately, 45 patients were enrolled in the study. Repositioning or redirecting of the needle was not done in order to get a specific contrast spread pattern.

2. Regional block technique

All lumbar sympathetic blocks were performed under fluoroscopic guidance using a unilateral two needle technique. Patients were placed in the left or right lateral position on the fluoroscopic table depending on which leg was painful, and their backs were draped using a sterile technique. The third and fourth lumbar vertebras were identified and their spinous process was marked. Two skin wheals were made with 1% lidocaine at 6 to 7 cm lateral to the lower margin of the L3 and L4 spinous process.

Two 5-inch and 22-gauge block needles were used to perform this sympathetic block. We targeted the anterolateral margin of the upper one third of the L3 and the lower one third of the L4 vertebral body. The two needles were advanced slowly in order, guided by a lateral fluoroscopic view. After bony contact was made at about a depth of 2 inches, the block needle was withdrawn into the subcutaneous tissue and redirected at a slightly steeper angle and was then walked off the anterolateal margin of the vertebral body. Confirmation of the final needle position was accomplished using the anteroposterior and lateral views. After negative aspiration for blood and cerebrospinal fluid, 2 ml of contrast agent was injected at each level. After confirming proper contrast spread, we injected a mixture of 2 ml of the contrast agent, omnipaque (Nycomed Ireland Ltd., Cork, Ireland) and 2 ml of 0.75% ropivacaine at each level.

3. Temperature monitoring

Ambient temperature in the three groups was controlled to minimize the difference of Ts between groups; the target temperature was approximately 23℃. Ambient temperature was measured at a site remote from the heat-generating monitoring equipment and was reported as the average temperature for the entire period of the study. Changes in Ts (℃) were measured as an indicator of the efficacy of the sympathetic block. To measure the Ts, adhesive thermocouple probes (Hewlett Packard, M1205A, Germany) were tightly attatched to the plantar surface of the ipsilateral (painful side) great toe, calf, thigh and the contralateral great toe for 30 minutes after the LSGB. We defined the preblock temperature value (T^{pre}) at least 10 minutes after attaching the thermocouples probes. Just after injecting the mixture of local anesthetics and contrast agent, Ts at the designated sites was measured at 2-minute intervals. Ts monitoring was carried out by one of the authors who was blind to the patients' disease and the group. The time (second) required for a 1℃ increase in temperature ($T^{1℃}$), preblock and maximum postblock temperatures (T^{pre}, T^{post}, ℃), the preblock temperature difference between the ipsilateral and contralateral great toes (DT^{pre}, ℃), and the postblock temperature difference between ipsilateral and contralateral great toe (DT^{post} , ℃) were measured and calculated. DT^{net} was calculated as follows: $DT^{net} = DT^{post} - DT^{pre}$.

4. Statistical analysis

Statistical analysis was performed using SPSS 14.0 and all results were presented as a mean ± the standard deviation (SD) or number of patients. $P < 0.05$ defined statistical significance. Normality tests were performed using Kolmogorov-Smirnov tests.

Chi-square and one way ANOVA test were used to compare the mean values of the three groups of demographic data. A one way ANOVA test was used to compare the mean values of the $T^{1℃}$, T^{pre}, T^{post}, DT^{post}, DT^{pre}, and DT^{net} (Table 2).

Results

There were no significant differences in the patients' characteristics, distribution of diseases or ambient temperatures in the three groups (Table 1).

T^{pre} at the great toe was not significantly different between groups (27.8 ± 1.9℃, 27.7 ± 2.2℃ and 27.3 ± 1.5℃ for groups A, B and C respectively, $p = 0.898$, Table 2). T^{post} was the highest for group A; however, it did not show any statistical difference compared to groups B or C ($p = 0.056$, Table 2). DT^{post} was highest for group A and this difference was statistically significant (7.5 ± 1.2℃, 5.9 ± 1.5℃ and 4.9 ± 1.1℃ in the group A, B and C, respectively, $p = 0.015$, Table 2). DT^{net} was also significantly high in group A (6.9 ± 1.0℃, 5.6 ± 2.1℃ and 4.8 ± 1.2℃ for groups A, B and C, respectively, $p = 0.017$, Table 2).

Discussion

We measured the lower extremity Ts changes and as we hypothesized, the patients in group A showed the most significant changes in Ts gradient in the great toe

Table 1. Demographic data

Variable	Group A (n=14)	Group B (n=16)	Group C (n=15)	P
Age (years)	49.4 ± 15.0	57.4 ± 12.9	61.7 ± 9.6	P = 0.139
Sex (Male/Female)	4/10	8/8	8/7	
Height (cm)	162.3 ± 7.7	162.9 ± 7.8	160.1 ± 6.5	P = 0.848
weight (kg)	65.5 ± 11.7	63.6 ± 8.7	64.4 ± 13.9	P = 0.629
Disease (number of patients)				
CRPS	2	1	2	
FBSS	3	2	3	P = 0.657
Spinal stenosis	9	13	10	
Ambient temperature (℃)	25.3 ± 0.1	24.5 ± 0.1	24.5 ± 0.1	P = 0.659

Values are mean ± SD or number of patients. CRPS is complex regional pain syndrome, FBSS is failed back surgery syndrome. There were no significant differences among the three groups.

Table 2. Cutaneous temperature changes between groups

Variable	Group A (n=14)	Group B (n=16)	Group C (n=15)
Preblock temperature of ipsilateral great toe (T^{pre}, ℃)	27.8 ± 1.9	27.7 ± 2.2	27.3 ± 1.5 (P: 0.898)
Maximum postblock temperature of ipsilateral great toe (T^{post}, ℃)	33.0 ± 1.10	33.5 ± 0.7	32.7 ± 1.8 (P: 0.056)
Preblock temperature difference between ipsilateral and contralateral great toe (DT^{pre}, ℃)	0.2 ± 0.06	0.3 ± 0.07	0.2 ± 0.04 (P: 0.455)
Postblock temperature difference between ipsilateral and contralateral great toe (DT^{post}, ℃)	7.5 ± 1.2*	5.9 ± 1.5	4.9 ± 1.1 (P: 0.015)
Net change of temperature (DT^{net}, ℃)	6.9 ± 1.0*	5.6 ± 2.1	4.8 ± 1.2 (P: 0.017)
Time to 1℃ increase ($T^{1℃}$, sec)	207.3 ± 95.2	182.6 ± 64.2	203.6 ± 77.4 (P: 0.463)

Values are mean ± SD. DT^{net} is the differences between DT^{post} and DT^{pre}.
*P < 0.05 for group A versus group C.

(DT^{post}, DT^{net}). We targeted the upper L3 and lower L4 vertebral body to deliver local anesthetic around the L2-3 and L4-5 disc space where the lumbar sympathetic ganglia usually aggregate. Although we did not intentionally reposition the block needle to achieve a specific contrast spread pattern, we could get three kinds of contrast spread pattern like group A, B and C. In the fluoroscopic images for group A, the L2-3 and L4-5 disc spaces of all patients were fully covered by the contrast mixuture. Obviously, there would be a greater possibility of a local anesthetic reaching the sympathetic ganglia in group A compared to groups B or C. We did not get a significant value regarding the degree of vertical spread: however, achieving a greater vertical spread of a local anesthetic would be beneficial, considering the variation in the number and location of sympathetic ganglia.

Ohno *et al.* [6]. showed a similar contrast spread pattern to that in the present study using a transdiscal approach through the L2-3 and/or L4-5 areas. However, they did not monitor the increase in skin temperature after the LSGB but checked the magnitude of Ts increase simply by palpation of the patient's foot. Therefore a direct comparison with our clinical outcome is limited.

In order to assess the degree of sympathetic block, several reliable methods can be used. Subjective measures include pain relief, warmth, change in skin color, and anhidrosis. Objective tests include measurements of Ts and blood flow, provocative sweat tests, and sympathetic skin response tests[7,8]. Kistler *et al.* [9]. demonstrated that temperature change provides a good index of skin blood flow by using infrared thermography, laser doppler flowmetry, and photoplethysmography. They concluded that measuring skin temperature is simple to do and analyze. Ts measurement is

also inexpensive, noninvasive, and relatively well correlated with regional blood flow changes [10].

We could observe the most significant increases of Ts after LSGB only in the great toe, and this result is in accordance with the study by Werdehausen *et al.* [11]. They concluded that the earliest and greatest rise of Ts occurred at the great toe (10.6 ± 0.4 ℃), became smaller proximally, and was negligible above the ankles, irrespective of the type and extent of block. Kim *et al.* [12]. recommended the plantar surface of the feet as a site of temperature measurement because they showed the most significant change in temperature following a LSGB.

No guidelines exist as to what magnitude of temperature change would predict a clinical successful sympathetic block. When we determine a complete sympathetic block, monitoring of Ts alone is not enough; therefore, using both Ts and sweat tests is recommended as the more reliable method [7,13]. Tran *et al.* [14]. reported as a change of Ts of 8.7 ± 0.8℃ at the great toe after successful LSGB, and Kim *et al.* [13]. reported a change in Ts of 6.2 ± 2.68℃ at the plantar surface of the feet. We could observe a change of Ts (DT^{post} , DT^{net}) of more than 7℃ in group A.

Several limitations could be found in our study. First, we relied on changes in Ts alone rather than combining Ts with the sweat test or laser doppler flowmetry to assess the degree of sympathetic block. Second, the amount of time spent observing after the LSGB was relatively short. Third, a correlation study was not performed between the visual analogue scale and the magnitude of Ts change. Actually, Tran *et al.* [14]. demonstrated that maximum temperature of the great toe correlated with the relief of allodynia.

Summary

To obtain a more complete sympathetic block, assessing the contrast spread pattern after LSGB is an important step as well as the Ts measurement or a sweat test and if the magnitude of Ts increase is minimal, repositioning of the block needle could be considered to achieve a contrast spread pattern as in group A.

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