# Accuracy of Needle-Tip Localization by Ultrasound Guidance Lumbar Selective Nerve Root Block: A Prospective Clinical Study of 78 Lumbar Nerve Roots Block

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***Objective:*** *Selective nerve root block (SNRB) is the accepted procedure for diagnostic and therapy in lumbar radicular back pain management. The present study was to determine the accuracy of needle-tip under ultrasound guidance subsequently confirmed with fluoroscopy in patients who underwent SNRB. To date, no study comparing these two techniques has been performed.*

***Material and Method:*** *After the IRB approval, a prospective trial was conducted to determine the accuracy of ultrasound guidance SNRB in 40 consecutive patients with lumbar radicular pain undergoing fluoroscopic guidance SNRB between January 2010 and January 2011. Firstly, needle-tip was located at the desired optimal landmark under ultrasound guidance and then subsequently fluoroscopic confirmation of needle-tip position was done. Finally, the injection was performed as usual. The primary outcome was the accuracy of needle-tip placement comparing between under ultrasound and subsequently fluoroscopic confirmation. The secondary outcome was the associated factors of the accuracy of needle-tip under ultrasound guidance.*

***Results:*** *Seventy-eight lumbar nerve roots were injected in the patients that underwent SNRB under fluoroscopic guidance. The accuracy of needle-tip on each lumbar nerve root under ultrasound guidance with fluoroscopic confirmation ranged from 7.14% to 80.95%. Mean of the accuracy of needle-tip under ultrasound guidance comparing with subsequently fluoroscopic confirmation was 62.82% while 95%CI ranged from 51.13 to 73.50%. The age older than 65 years old was significantly associated with the poor accuracy under ultrasound guidance (p-value =* 0.0095*).*

***Conclusions:*** *To position the needle-tip under ultrasound guidance is feasible and has good safety profile. The accuracy could be achieved individually. However, because the accuracy of ultrasound guidance technique depends on the operator, a steep learning curve and larger prospective clinical study is needed.*

***Keywords****: Lumbar radicular back pain, Lumbar selective nerve root block, Fluoroscopic guidance SNRB, Ultrasound guidance SNRB, Accuracy of needle-tip*

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Lumbar selective nerve root block (SNRB) is the accepted procedure in lumbar radicular back pain both for its diagnostic and therapeutic pain management[1-8]. SNRB is useful in diagnosis of lumbar radicular pain, generally when imaging is puzzling. It is also useful as a therapeutic modality following a successful diagnostic block. To perform lumbar SNRB, the conventional technique is done under fluoroscopic guidance to localize the needle tip at the desired intervertebral level[1]. General disadvantage of fluoroscopy is radiation exposure risk. Ultrasound guidance is the alternative technique that might be helpful in localization of the needle tip without radiation exposure risk[9]. The present study was to determine the accuracy of needle-tip localization under ultrasound guidance comparing with the fluoroscopy subsequently in patients who underwent SNRB. The primary outcome is to determine the

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accuracy of needle-tip under ultrasound guidance for lumbar SNRB subsequently fluoroscopy. Secondary outcome was the associated factors of the accuracy of needle-tip under ultrasound guidance.

## Material and Method

The present study was approved by the ethical board at the Faculty of Medicine, Ramathibodi Hospital, Mahidol University. Informed consent was obtained from all patients. Forty consecutive patients were scheduled for lumbar SNRB. The inclusion criteria were patients with lumbar radicular pain already treated conservatively after at least six months and/or confusing in the imaging diagnosis. The characteristics of all consecutive patients are shown in Table 1. In addition, the patients that could not go on the open surgery were included. The exclusion criteria were patients with coagulation problems and a history of drugs allergy including contrast media, steroid and xylocain. The patients with progressively neurological deficit, acute traumatic, infectious, or pathologic cases were excluded. The numbers of roots for lumbar SNRB varied from 1 to 4 roots in each patient. As shown in Table 2.1, the 78 lumbar nerve roots included one Rt L3 root, 21 Rt L4 roots, 14 Rt L5 roots, one Lt L3 root, 24 Lt L4 roots and 17 Lt L5 roots. The mean age was 54.4 years (range 28-77 years). The study included 24 females and 16 males. The mean BMI was 24 kg/m$^2$. There were three patients (7.5%) with scoliotic lumbar spine, five patients (12.5%) with previous lumbar operation with rods and screws and 32 patients (80%) with no significant lumbar spine deformity. All patients were assessed at Neurosurgery OPD and electively scheduled for lumbar SNRB under fluoroscopy. All consecutive patients were injected by the first and second author, randomly, using identical procedure. Ultrasound (BK medical ultrasound, class I type B) with curved array transducer (Abdomen, Obstetric, 8808e) at a frequency of 2.5 MHz were used before fluoroscopic guidance. According to the lumbar SNRB, under fluoroscopy procedure, the patients were sterile-prepared and prone positioned. A sterile ultrasound probe and spinal needles (Terumo) 20 G x 3.5 inch (0.9 x 90 mm were prepared. The procedure was conducted in Fluoroscope-shielded room. First, the ultrasound probe was applied in parallel to the spinal axis. After adjustment, desired inter-vertebral

**Table 1.** Baseline characteristic of the patients

| Patient character | Data |
|---|---|
| Sex n = 40 | |
| Female (n/%) | 24/60 |
| Male (n/%) | 16/40 |
| Age, years (mean ± SD) | 54.40 ± 12.53 |
| BMI, kg/m$^2$ (mean ± SD) | 24.02 ± 3.41 |
| Appearance of spine | |
| Normal alignment (n/%) | 32/80 |
| Rods and screws (n/%) | 5/12.50 |
| Scoliosis (n/%) | 3/7.50 |

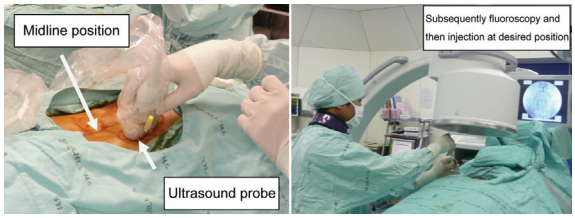


**Fig. 1** Orientation of ultrasound probe and fluoroscopy

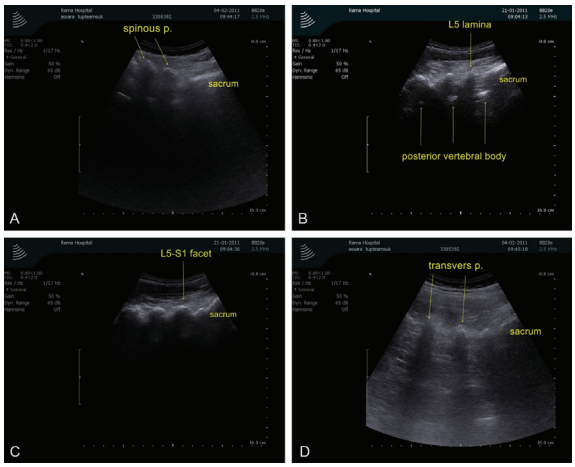


**Fig. 2** Ultrasound image in planes of spinous process (midline position); A, lamina; B, facet; C, and transverse process; D

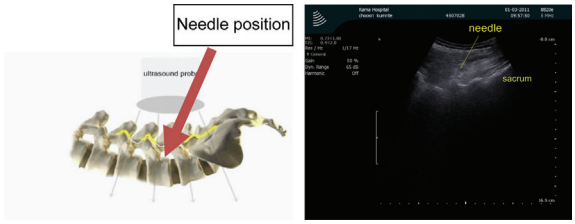


**Fig. 3** Under ultrasound guidance, needle-tip is identified comparing with the ultrasound view on the right

**Table 2.1.** Number of lumbar nerve root block

| Root | Rt L3 | Lt L3 | Rt L4 | Lt L4 | Rt L5 | Lt L5 | Total |
|---|---|---|---|---|---|---|---|
| Root block, n (%) | 1 (1.28) | 1 (1.28) | 21 (26.92) | 24 (30.77) | 14 (17.95) | 17 (21.79) | 78 (100) |

level was checked to the most caudal of facets. The L5-S1 articular facet joint, was identified. Therefore, the optimal location of each nerve root by under ultrasound guidance was on the mediolateral direction (axial plane) lateral to the facet (L4-5 facet for L4 root, L5-S1 for L5 root) and on the rostocaudal direction (sagittal plane) caudal to the basal portion of the transverse process. It is 1 cm-depth from the facet echo. The skin entry point of the needle insertion is about 10 cm from midline or at least, more lateral to the tip of transverse process. Only for the L5-S1 level, the most lateral and caudal site entry point might be limited with the ala of the Ilium. The spinal needle was placed just lateral to the ultrasound probe and inserted at the optimal site while real time movement of the needle tip was observed. After satisfactory ultrasound guidance and the needle-tip was on the desired position, subsequent fluoroscopy was checked in AP and lateral view. If the needle-tip position was not in the desired position, needle-tip adjustment was performed under fluoroscopic guidance until it was in the proper position. If subsequent fluoroscopy showed the needle-tip was in position, the contrast agent, Iopamiro 300$^{R}$, was injected under fluoroscopy. At the desired position, 40-mg of Triamcinolone acetate plus 2 cc of Xylocain without adrenaline was injected.

***Statistical analysis***

With the SPSS, results were expressed as mean standard deviation (SD) and frequency (%). The comparisons were carried out using Chi-square test or Fishers Exact test for discrete variables and student t-test for continuous variables. A-two tailed p-value less than 0.05 was considered statically significant.

**Results**

SNRB injections were performed randomly by the first and second author under ultrasound guidance with subsequent fluoroscopy. In Table 2.2, the needle-tip position under ultrasound guidance is shown. It was classified into three categories. The first category, II, is for optimal needle tip position, at both the desired intervertebral level and exact right position after subsequent fluoroscopy. The second category; I, is for desired intervertebral level but not in the exact right position after subsequently fluoroscopy. The third category, 0, is for incorrect level. The result included three roots for category 0, 26 roots for category I and 49 roots for category II. After subsequent fluoroscopy, Iopamiro 300$^{R}$ was injected to confirm the accuracy of needle-tips that were at the exactly right position on AP and lateral view. In some patients, there was radiated pain down the leg, along the distribution of the nerve that was injected.

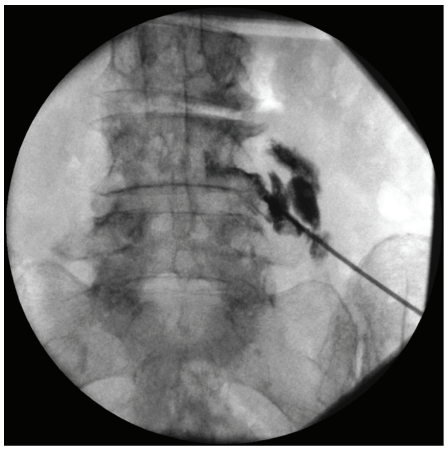

**Fig. 4** SNRB in a scoliotic lumbar spine

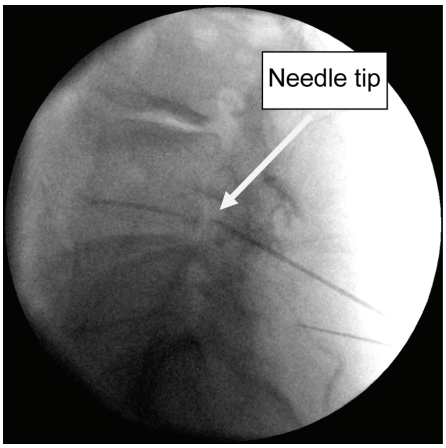


**Fig. 5** Lateral view from fluoroscopy

**Table 2.2.** Number of the characteristic of needle tip position

| Root | 0, n (%) | I, n (%) | II, n (%) | 95% CI | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| Rt L3 (n = 1) | 0 (0) | 1 (100) | 0 (0) | | |
| Lt L3 (n = 1) | 0 (0) | 1 (100) | 0 (0) | | |
| Rt L4 (n = 21) | 0 (0) | 4 (19.05) | 17 (80.95) | | |
| Lt L4 (n = 24) | 0 (0) | 5 (20.83) | 19 (79.17) | | |
| Rt L5 (n = 14) | 1 (7.14) | 10 (71.43) | 3 (21.43) | | |
| Lt L5 (n = 17) | 2 (11.76) | 5 (29.41) | 10 (58.82) | | |
| Total (n = 78) | 3 (3.85) | 26 (33.33) | 49 (62.82) | 51.13 | 73.50 |

Needle-tip position classification under ultrasound guidance
0 = incorrect level
I = at the desired intervertebral level but not in the exactly right position after subsequently fluoroscopy
II = optimal needle tip position both at the desired intervertebral level and exactly right position after subsequently fluoroscopy

**Table 3.** Association between accuracy and characteristic of patients for age and BMI

| Patient character | 0 (n = 7) | 1 (n = 33) | p-value* |
|---|---|---|---|
| Age, years (mean $\pm$ SD) | 65.0 $\pm$ 8.9 | 52.0 $\pm$ 12.0 | 0.0095 |
| BMI, kg/m$^2$ (mean $\pm$ SD) | 24.5 $\pm$ 2.19 | 23.7 $\pm$ 3.56 | 0.2107 |

The accuracy of needle-tip determination under ultrasound guidance 0 = inaccurate, 1 = accurate
* By student t-test

Concerning the result under the ultrasound guidance, particularly the accuracy of the needle-tip, there were two groups being identified including inaccurate (defined as "0") and accurate (defined as "1"). As in Table 3 and 4, the accuracy of the needle-tip and some factors including age, sex, BMI and spinal alignment were determined for statistical significant relationship by student t-test and Chi-square test.

**Table 4.** Association between accuracy and characteristic of patients for sex and appearance of spine

| Patient character | 0 (n = 7) | 1 (n = 33) | p-value* |
|---|---|---|---|
| Sex | | | |
| Female (n/%) | 4/57.14 | 20/60.61 | |
| Male (n/%) | 3/48.86 | 13/39.39 | 1.000 |
| Spinal alignment | | | |
| Normal alignment (n/%) | 4/57.14 | 28/84.85 | |
| Rods and screws (n/%) | 2/28.57 | 3/9.09 | |
| Scoliosis (n/%) | 1/14.29 | 2/6.06 | 0.161 |

The accuracy of needle-tip determination under ultrasound guidance 0 = inaccurate, 1 = accurate
* Chi-square test or Fishers Exact test

## Discussion

Lumbar selective nerve root block (SNRB) is useful in both diagnosis and treatment of lumbar radicular pain[8,10]. The conventional fluoroscopic guidance is commonly performed with contrast injection to define needle-tip for the desired and correct position. The well-known disadvantage of the fluoroscopy is radiation exposure risk. Ultrasound identifies the anatomical target and makes it feasible to perform SNRB[11] while eliminating exposure to radiation. A numbers of reports showed that ultrasound guidance in lumbar spinal procedure is a possible but difficult technique[1,6,11-19]. Although the spinal bony anatomical identification of lumbar region is poorly identified by ultrasound, under the low frequency of general commercial ultrasound machine, it is feasible to identify lumbar spinal anatomy. In Ramathibodi Hospital, 40 consecutive patients electively enrolled to receive lumbar SNRB in the operating room. The indications

were lumbar radicular pain that radiated down to the leg without abnormal imaging, mild to moderate lumbar disc bulging, or failed back surgery syndrome.

Although all consecutive patients were injected randomly by the first or second author, the internal validity remained as an identical procedure by well trained surgeons was done. Furthermore, the technique was performed consistently in the anatomical laboratory prior to performing the injection. The most common injected levels were L4-5 and L5-S1 respectively. The nerve root is deep within the foramen and it cannot be easily visualized under ultrasound guidance. Some cases can be visualized with a high-echoic cord-like structure at 1-1.5 cm depth to the edge of facet echoic line. Optimal needle-tip position could be identified according to the trajectory from laterocaudal of the foramen. In case of scoliosis, the landmark under ultrasound guidance does not differ from those with normal spinal alignment. In case of post-operation, retained rods and screws could be visualized clearly under ultrasound guidance and subsequent fluoroscopy. A low ultrasound frequency of 2.5 MHz was used. It could penetrate deeper but gave fuzzier image. Occasionally, a brief pain was radiated down to the leg thus this would prove that the needle-tip was at the nerve root. The trajectory of L5-S1 foramen is in a more perpendicular orientation to the patient's back comparing to the other level. The definition of needle-tip position was confirmed by injection of 2 to 3 cc of Iopamiro 300$^{R}$ under fluoroscopic guidance. Finally, some needle-tip position had been adjusted under fluoroscopic guidance in AP and lateral view. This could be achieved for an optimal position and used to define needle-tip accuracy determination. The accuracy of needle-tip under ultrasound guidance is 62.82% while 95% CI ranged from 51.13 to 73.50%. The age of 65 years old (SD $\pm$ 8.9) has significant association with the accuracy of needle-tip position (p-value = 0.0095). Because the degeneration and osteophyte of the spine in old age, it caused deterioration of ultrasound identification when compared to some younger patients. There was no significant difference in gender, BMI and spine characteristic for the accuracy of needle-tip. Because the visualization from ultrasound is operator dependent, a spinal image could be achieved. There was no serious complication peri-procedurally and at follow-up.

## Conclusion

To position needle-tip under ultrasound guidance is feasible and has a good safety profile. However, the accuracy is achieved individually. Because the accuracy of ultrasound guidance technique depends on the operator, a steep learning curve and larger prospective clinical study is needed.

## Potential conflicts of interest

None.

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## *การศึกษาความแม่นยำของการสอดเข็มเพื่อการฉีดยาระงับอาการปวดหลังระดับเอวโดยอาศัยเครื่องตรวจคลื่นเสียงความถี่สูงตามด้วยเครื่องฉายรังสีเอกซเรย์: การศึกษาแบบไปข้างหน้าของการสอดเข็มเพื่อการฉีดยาระงับอาการปวดหลังระดับเอว*

***สรยุทธ ชำนาญเวช, ณรงเดช เวชกามา, วีระพันธ์ ควรทรงธรรม***

***วัตถุประสงค์:*** *เพื่อศึกษาความแม่นยำของการสอดเข็มเพื่อการฉีดยาระงับอาการปวดหลังระดับเอวโดยอาศัยเครื่องตรวจคลื่นเสียงความถี่สูง*

***วัสดุและวิธีการ:*** *ทำการศึกษาแบบไปข้างหน้าในผู้ป่วยที่มีอาการปวดหลังส่วนล่างร่วมกับการปวดร้าวลงขาที่ได้รับการรักษาที่หน่วยประสาทศัลยศาสตร์ โรงพยาบาลรามาธิบดี ระหว่างเดือนมกราคม พ.ศ. 2553 ถึง มกราคม พ.ศ. 2554 โดยศึกษาผู้ป่วยจำนวน 40 ราย เริ่มต้นด้วยการระบุตำแหน่งของเส้นประสาทที่ต้องการด้วยเครื่องตรวจคลื่นเสียงความถี่สูง หลังจากนั้นตรวจสอบและเปรียบเทียบความแม่นยำของวิธีดังกล่าวด้วยเครื่องฉายรังสีเอกซเรย์ในเส้นประสาททั้งหมด 78 เส้น*

***ผลการศึกษา:*** *ความแม่นยำของการสอดเข็มเพื่อการฉีดยาระงับอาการปวดหลังระดับเอวโดยอาศัยเครื่องตรวจคลื่นเสียงความถี่สูง ตามด้วยเครื่องฉายรังสีเอกซเรย์ได้ร้อยละ 62.82 โดยมีช่วงความมั่นใจร้อยละ 95 ที่ 51.13-73.50 และพบว่าผู้ป่วยที่มีอายุตั้งแต่ 65 ปีขึ้นไปมีผลต่อความแม่นยำของการสอดเข็มอย่างมีนัยสำคัญ*

***สรุป:*** *มีความเป็นไปได้ในการหาตำแหน่งของปลายเข็มด้วยการสอดเข็มเพื่อการฉีดยาระงับอาการปวดหลังระดับเอวโดยอาศัยเครื่องตรวจคลื่นเสียงความถี่สูง การฝึกหัดในห้องปฏิบัติการเพื่อให้ผ่านพ้นช่วงการฝึกทักษะเพื่อความชำนาญ (steep learning curve) จากแพทย์ผู้เชี่ยวชาญมีความสำคัญเป็นอย่างยิ่งทั้งการสอดเข็ม และการใช้เครื่องตรวจคลื่นเสียงความถี่สูง นอกจากนี้การสอดเข็มโดยใช้เครื่องตรวจคลื่นเสียงความถี่สูงในผู้ป่วยสูงอายุมีโอกาสคลาดเคลื่อนสูง การเพิ่มจำนวนของกลุ่มตัวอย่างให้มีมากขึ้นมีความจำเป็นเพื่อให้เกิดความแม่นยำและน่าเชื่อถือสำหรับการศึกษาต่อไปในอนาคต*