Efficacy of Ultrasound-Guided Axillary Brachial Plexus Block: A Comparative Study with Nerve Stimulator-Guided Method

Fu-Chao Liu[1,2], MD; Jiin-Tarng Liou[1,2], MD; Yung-Fong Tsai[1], MD; Allen H. Li[1], MD, PhD; Yuan-Yi Day[1], MD, PhD; Yu-Ling Hui[1], MD; Ping-Wing Lui[1], MD, PhD

Background: The aim of this study was to compare the efficacy of axillary brachial plexus block using an ultrasound-guided method with the nerve stimulator-guided method. We also compared the efficacy of ultrasound-guided single-injection with those of double-injection for the quality of the block.

Methods: Ninety patients scheduled for surgery of the forearm or hand were randomly allocated into three groups (n = 30 per group), i.e., nerve stimulator-guided and double-injection (ND) group, ultrasound-guided and double-injection (UD) group, and ultrasound-guided and single-injection (US) group. Each patient received 0.5 ml kg^{-1} of 1.5% lidocaine with 5 µg kg^{-1} epinephrine. Patients in the ND group received half the volume of lidocaine injected near the median and radial nerves after identification using a nerve stimulator. Patients in the UD group received half the volume of lidocaine injected around the lateral and medial aspects of the axillary artery, while those in the US group were given the entire volume near the lateral aspect of the axillary artery. The extent of the sensory blockade of the seven nerves and motor blockades of the four nerves were assessed 40 min after the performance of axillary brachial plexus block.

Results: Seventy percent of the patients in the ND and US groups as well as 73% of the patients in the UD group obtained satisfactory sensory and motor blockades. The success rate of performing the block was 90% in patients in the ND and UD groups and 70% in the US group. The incidence of adverse events was significantly higher in the ND group (20%) compared with that in the US group and the UD group (0%; $p = 0.03$).

Conclusions: Ultrasound-guided axillary brachial plexus block, using either single- or double-injection technique, provided excellent sensory and motor blockades with fewer adverse events.
(Chang Gung Med J 2005;28:396-402)

Key words: ultrasound- or nerve stimulator-guided, axillary brachial plexus block.

Brachial plexus block via the axillary approach is a common technique to provide anesthesia for surgery of the forearm and hand. Success in performing the nerve block has been enhanced by the aid of nerve stimulator, ultrasound, fluoroscopic roentgenogram or computerized tomography.[1-4]

Numerous methods such as transarterial, single or multiple paresthesia, or catheterization into the plexus sheath have been used to improve the success rates of this block.[5-7] Since vessels and nerves in the brachial plexus region are embraced within the axillary sheath,[3,8] the application of ultrasound with high-resolution imaging permits accurate real-time targeting of the plexus sheath and allowing the spread of the local anesthetics. For the supraclavicular approach, several pieces of evidence have demonstrated that the ultrasound-guided method is better than the one guided by a nerve stimulator, especially when the local anesthetics were given using the double-injection rather than single-injection technique.[9-12] However, little has been reported on using the ultrasound-guided axillary approach for the brachial plexus block. This prospective randomized study was aimed to test the hypothesis that the quality of the axillary brachial plexus blockade guided by ultrasound was better than those using a nerve stimulator and produced fewer adverse effects. We also envisaged that the double-injection technique had better efficacy than the single-injection guided by ultrasound.

METHODS

The Ethics Committee of the Chang Gung Memorial Hospital approved this study, and all patients gave their informed consent before the conduct of the study. Ninety patients with ASA physical status class I-II scheduled for elective surgery of the hand, wrist, or forearm were randomly divided into three groups for axillary brachial plexus block according to a randomization table. Patients in the nerve stimulator-guided and double-injection (ND) group (n = 30) received lidocaine using the double-injection technique with the aid of nerve stimulator. Those in the ultrasound-guided and double -injection (UD) group received lidocaine using the double-injection technique guided by ultrasound (n = 30). Patients in the ultrasound-guided and single-injection (US) group (n = 30) were given lidocaine using the ultrasound-guided single injection technique. Patients who refused the regional anesthesia were excluded from this study, as were those with dementia, peripheral neuropathy or hypersensitivity to local anesthetics.

Upon arrival to the operation room, all patients received monitoring that included non-invasive blood pressure, electrocardiogram and pulse oximetry. Midazolam, 20 µg kg⁻¹, was given intravenously for sedation 10 min before the block was administered. The patients were placed supine with the arm abducted 90 degrees and flexed at the elbow with the forearm supinated. The pulse of the axillary artery was palpated at the attachment of the major pectoral muscle. Each patient received a total of 0.5 ml kg⁻¹ lidocaine (1.5%) with epinephrine (5 µg ml⁻¹). The skin and subcutaneous tissue overlying the artery was infiltrated with 2 ml of the local anesthetic solution. Patients in the ND group received brachial plexus block via the axillary approach using a 22-gauge, 50-mm, short-beveled insulated needle connected to the negative lead of the nerve stimulator (Stimuplex Dig RC; Braun, Melsungen, Germany). Using a stimulation of 2-Hz, the needle was inserted superiorly near the artery to identify the median nerve, and inferiorly to locate the radial nerve. Half of the lidocaine solution was injected around each nerve. In the UD and US groups, a 12-MHz ultrasound probe (Type 8805; B-K Medical, Denmark) with an ultrasound machine (Model 2102, HawK; B-K Medical, Denmark) was used to visualize the structure of the axillary region and to guide the needle insertion in the appropriate direction. Under the guidance of the ultrasound, the artery and vein were easily distinguished by the pulsatile motion of the artery and the compressibility of the venous wall. A 23-gauge, 60-mm needle was inserted near the axillary artery in the superior (lateral) and inferior (medial) direction in the UD group. Fifteen milliliters of the local anesthetic solution was injected in each direction. Each patient in the US group received a single injection of 30 ml of lidocaine at the superior (lateral) aspect near the axillary artery. As the injected solution spread around the artery, the ultrasound image revealed a sharp ring-like formation surrounding the artery, which is thought to represent the filling of the axillary brachial plexus sheath.

All of the brachial plexus blocks were performed by the same anesthesiologist and were assessed by another one anesthesiologist was unaware of the group assignments. From the needle puncture on the skin guided by nerve stimulator or the application of the ultrasound on the skin to the completion of the lidocaine injection was counted as the duration of performing the block. The extent of

the block was evaluated at 40 min after the injection. Sensory loss was defined as loss of pinprick sensation. Sensory block was assessed based on the response to the pinprick with a 25-gauge needle in the areas supplied by the following nerves, i.e., lateral cutaneous nerve of the arm, musculocutaneous nerve, radial nerve, median nerve, ulnar nerve, and medial cutaneous nerve of the arm and forearm. Motor block was evaluated by examining the following responses: (1) extension of the elbow and wrist (radial nerve); (2) pronation of the arm, flexion of the wrist, and opposition of the wrist, as well as opposition of the 2nd and 3rd fingers and the thumb (median nerve); (3) flexion and opposition of the 4th and 5th fingers toward the thumb (ulnar nerve); and (4) flexion of the elbow (musculocutaneous nerve). Loss of motor power was defined as reduced contraction (paresis) or loss of contraction (paralysis). Anesthetic failure was managed with supplemental intravenous analgesics or general anesthetics as appropriate. Midazolam was administered intravenously in 1 mg increments to patients who requested sedation during surgery. Intravenous fentanyl was administered in 50 mg increments in case of tourniquet pain. The adverse effects of these blocking techniques were recorded and were followed up in the outpatient pain clinic.

Parametric variables are expressed as mean ± SD, and were compared using ANOVA between the groups. Qualitative variables are expressed as number (percentage) in each category and were analyzed using chi-square or Fisher's exact test. $p < 0.05$ was considered statistically significant. To detect a 20% difference in the adverse rate (20% vs. 0%), 30 patients in each group were required to obtain a 0.05 level of alpha with a power of 0.80. The statistical analysis was performed using the SPSS package (version 10.0 for windows) and GraphPad software (version 2.0).

RESULTS

Demographic data and the characteristics of the blocks are presented in Table 1. The time (min) needed to perform the block was significantly longer in patients in the ND group than those in the UD group and the US group ($8.2 ± 1.5$ min vs. $6.7 ± 1.3$ min and $6.5 ± 1.3$ min, respectively; $p < 0.005$). The efficacy of the blocks is showed in Table 2. There

Table 1. Demographics Data

	ND Group (n = 30)	UD Group (n = 30)	US Group (n = 30)
Gender (M/F)	16/14	14/16	16/14
Age (years)	40.8 ± 13.7	43.0 ± 11.6	45.2 ± 11.4
Weight (kg)	63.6 ± 7.6	60.2.6 ± 8.1	62.4 ± 8.3
Height (cm)	163.3 ± 7.0	162.6 ± 5.6	164.0 ± 6.2
Duration of block performed (min)	8.2 ± 1.5 *	6.7 ± 1.3	6.5 ± 1.3
Duration of operation (min)	45.7 ± 12.1	46.3±11.5	48.7 ± 12.8
Types of operation			
Wrist arthroscopy	6	5	5
Carpal tunnel release	6	7	5
Tendon surgery	3	2	4
Arthrodesis/arthroplasty	5	4	6
Palmar fasciotomy	3	2	1
Miscellaneous	2	5	4

Abbreviations: ND Group: nerve stimulator-guided and double-injection; UD Group: ultrasound-guided and double-injection; US Group: ultrasound-guided and single-injection.

* Significantly different in the ND Group compared to UD Group and US group in chi-square test ($p < 0.01$).

Data are expressed as mean ± SD or the number of patients.

Table 2. Characteristics of Axillary Brachial Plexus Analgesia (40 min after injection)

	ND Group No. (%)	UD Group No. (%)	US Group No. (%)
Sensory block	27 (90)	27 (90)	25 (83)
Lateral cutaneous nerve of arm	21 (70)	22 (73)	22 (73)
Musculocutaneous nerve	29 (97)	27 (90)	22 (73)
Radial nerve	29 (97))	27 (90)	22 (73)
Median nerve	30 (100)	30 (100)	29 (97)
Ulnar nerve	29 (97)	30 (100)	26 (87)
Medial cutaneous nerve of forearm	30 (100)	30 (100)	29 (97)
Medial cutaneous nerve of arm	29 (97)	29 (97)	26 (87)
Motor block			
Musculocutaneous nerve	21 (73)	22 (73)	21 (70)
Radial nerve	28 (93)	27 (90)	21 (70)
Median nerve	29 (97)	28 (93)	28 (93)
Ulnar nerve	27 (90)	28 (93)	26 (87)
All nerves	21 (70)	22 (73)	21 (70)
except musculocutaneous n.	27 (90)	27 (90)	21 (70)

Data are number of patients (percentage).

Without significantly difference in chi-square test in three groups.

were no statistical differences for the blockades of all sensory and motor nerves (chi-square, degree of freedom = 2) among the three groups. Seventy percent of the patients in the ND (n = 21) and US (n = 21)

groups as well as 73% of the patients in the UD group obtained satisfactory sensory and motor blockades for the seven nerves innervating the upper extremity. The success rate of performing the block for all the nerves, except for the musculocutaneous nerve, was 90% in the patients of the ND and UD groups (n = 27 per group) and 70% in the US group. The success rate for blocking the musculocutaneous and radial nerves were lower than for the other nerves in all three groups, but without statistically significant differences. The incidence of tourniquet pain, adverse events and the need for supplemental analgesics are shown in Table 3. Two patients (7%) in the US group, two patients (7%) in the ND group as well as one patient (3%) in the UD group experienced tourniquet pain. Four (13%) patients in the US group and three patients (10%) in both the UD and ND groups requested intravenous analgesics, while only one patient (3%) in the US group required general anesthesia. Patients in the ND group experienced a higher incidence of adverse effects such as paresthesia, axillary vessels puncture and subcutaneous hematoma than those in the other two groups. For instance, three patients in the ND group developed paresthesia and three patients had subcutaneous hematoma secondary to puncture of the axillary artery. The incidence of adverse events was significantly higher in the ND group (20%) compared with the incidence in the US group and the UD group (0%; $p = 0.03$).

Table 3. Tourniquet Pain, Supplemental Analgesics and Complications

	ND Group No. (%)	UD Group No. (%)	US Group No. (%)
Tourniquet pain	2 (7)	1 (3)	2 (7)
Supplemental			
Intravenous analgesic	3 (10)	3 (10)	4 (13)
General anesthetics	0 (0)	0 (0)	1 (3)
Total	3 (10)	3 (10)	5 (17)
Surgical successful rate	27 (90)	27 (90)	25 (83)
Adverse events			
Paraesthesia	3 (10)	0 (0)	0 (0)
Axillary vessels puncture	3 (10)	0 (0)	0 (0)
Subcutaneous hematoma	1 (3)	0 (0)	0 (0)
Tota	6 (20)*	0 (0)	0 (0)

Data are number of patients (percentage).

* Statistical difference in ND group compared to UD group and US group in chi-square test ($p = 0.03$).

DISCUSSION

This prospective randomized study demonstrated the efficacy and safety of three methods for axillary brachial plexus block. We sought to determine a simple and safe anesthetic technique for surgery of the upper extremities. In our study, successful block of the brachial plexus nerves was defined as anesthesia that was sufficient for a pain-free surgery without the need for supplemental anesthetics. Our results demonstrated no significant differences in the rate of successful blocks among patients in all three groups. This result was consistent with that reported by Williams et al. in which the rate of successful block under ultrasound guidance was similar to that using nerve stimulator for the supraclavicular approach in the brachial plexus block.[11] Our success rate was however not in line with those reported by Sandhu and Capan[12] and Oottaki et al.[13] in which the ultrasound-guided method was used for infraclavicular approach. We believe that the injection level of the brachial plexus and injection site in the plexus sheath were responsible for the above discrepancies in the efficacy of the block between the two techniques guided by ultrasound and nerve stimulator. It has been reported that nerve stimulator-guided double-injection technique had a better quality of analgesia than the single-injection method,[2,10,14] but this was not revealed in our results.

In our present study, the single-injection technique with ultrasound guidance had a success rate of 83%, which was higher than those reported in other studies in which the single-injection was applied without the aid of ultrasound guidance (43-83%).[7,15,16] But our results were lower than those reported by Chan et al.[17] and Karpal et al.[18] where a success rate of 85%-95% was achieved, under ultrasound guidance, in the brachial plexus block via the supraclavicular approach. For our patients in the US group, there was a higher effectiveness in sensory and motor analgesia in blocking the radial and musculocutaneous nerves compared with the results of studies where single-injection technique was used without ultrasound navigation.[7,15,16] We found that using real-time ultrasonography could increase the safety and efficacy of the block since it allowed visual confirmation of the axillary structures and accurate localization of the needle, all of which promoted the

effective infiltration of the local anesthetic into the brachial plexus sheath.[8,19] Injection of local anesthetic into the brachial plexus sheath near the median nerve laterally en route the axillary artery was shown to facilitate the spread of local anesthetic around the musculocutaneous nerve.[14,,20,21] The assessment of sensory and motor analgesia at 40 minutes after the injection was based on the notion that local anesthetic would achieve a better spreading within the axillary sheath after this period, which might improve the efficacy of blocking the radial nerve.[11,18,20]

According to the results of Baranowski and Pither[7] and Inberg et al.,[10] double-injection technique guided by nerve stimulator had similar efficacy in comparison with multiple injection techniques in performing the brachial plexus block for surgery of the forearm and palm. A success rate of 72-92% has been obtained for analgesia when the musculocutaneous nerve was not included in the statistical analysis. In our study, successful effective sensory and motor blockades of all seven nerves innervating the upper extremity were obtained in 21 patients in the ND and US groups (70%) and 22 patients in the UD group (73%). Except for the musculocutaneous nerve and lateral cutaneous nerve, the success rate of an effective block for all nerves was 90% in both the ND and UD groups, and 70% in the US group. A lower success rate of the block was seen in the US group due to poor spreading of the local anesthetic around the ulnar nerve. When the musculocutaneous nerve was not included, the success rate for the surgery (90%) was similar to that for an effective block in both of the ND and UD groups, but it was greater in the NS group (83%) showing that this might be dependent on the surgical site. The double-shot techniques in the ND and UD groups achieved 90% surgical success rates similar to that reported by Inberg et al. (92%) where nerve stimulator-guidance was used.[10] However, the result was superior to that reported by Baranowski and Pither[7] in which nerve stimulator was applied. Ootaki et al. also reported a greater success rate for surgery (95%) using ultrasound-guided infraclavicular brachial plexus block.[14]

For identification of the nerves and increasing the success rate in the axillary brachial plexus blockade, blind techniques guided by nerve stimulator have been commonly used during the past decade. However, performing the neural blockade using the blind method substantially increased the risk of unintentional puncture of blood vessels or causing nerve injuries. The incidence of nerve injury as a result of axillary brachial block ranged from less than 1%[22] to 19%.[23] Using paresthesia as a sign for targeting the nerve had a higher incidence of developing persistent neuropathy. Selander et al. reported a high incidence of postoperative nerve injury (2.8%) in patients where paresthesia was sought during the axillary brachial plexus block compared with those undergoing a perivascular puncture technique (0.8%).[24] Using low currents (0.5 mA) during nerve stimulation for neural blockade were still applied in many ultrasound-guided neural blockade techniques. The elicitation of paresthesia or muscle twitch response was not welcome for most patients. Thus, the anatomic landmark for the axillary artery was sought under ultrasonographic guidance that offered accurate placement of the injection needle while avoiding the puncture of nerve structures during the injection. In our study, no complaints were received from patients in the ultrasound-guided group. Three cases of elicitation of paresthesia were reported in the double-shot injection in patients who received the nerve stimulator-guided technique. Pearce et al. reported a 3% incidence of hematoma (6 out of 200 patients) when the brachial plexus sheath was inserted during the injection.[25] Our results showed that the incidence of adverse events was significantly higher in the ND group (20%) as compared with those in the ultrasound-guided groups (0%).

Several lines of evidence showed that ultrasound-guided axillary brachial plexus blocks allowed significant reductions in the use of supplemental analgesics and provided better quality of blocks compared with the nerve stimulator-guided technique.[9,12,17,18] Also, in our study, the time needed to perform the block under ultrasound guidance was significantly shorter than that in the ND group. Although a time difference of 1 to 2 min for performing the block may be clinically insignificant, it may have implications on the feelings of the patients.

In conclusion, the brachial plexus blockade via axillary approach guided by ultrasound with either the double-or single-injection method offers excellent quality of sensory and motor block equivalent to that of the nerve stimulator-guided technique, but with fewer adverse effects.

REFERENCES

1. Lavoie J, Martin R, Te'trault JP, Cot'e DJ, Colas MJ. Axillary plexus block using a peripheral nerve stimulator: Single or multiple injections. Can J Anaesth 1992;39:583-6.

2. Jose DA, Xavier SB. Ultrasound in the practice of brachial plexus anaesthesia. Reg Anesth Pain Med 2002;27:77-89.

3. Yang WT, Chui PT, Metreweli C. Anatomy of the normal brachial plexus revealed by sonography and the role of sonographic guidance in anaesthesia of the brachial plexus. Am J Roentgenol 1998;171:1631-6.

4. Mukherji SK, Wagle A, Armao DM, Dogra S. Brachial plexus nerve block with CT guidance for regional pain management: Initial results. Radiology 2000;216:886-890.

5. Cockings E, Moore PL, Lewis RC. Transarterial brachial plexus blockade using high dose of 1.5% mepivacaine. Reg Anesth 1987;12:159-64.

6. Selander D. Catheter technique in axillary plexus block. Acta Anaesthesiol Scand 1977;21:324-9.

7. Baranowski AP, Pither CE. A comparison of three methods of axillary brachial plexus anaesthesia. Anaesthesia 1990;45:362-5.

8. Ting PL, Sivagnanaratnam V. Ultrasonographic study of the spread of local anaesthetic during axillary brachial plexus block. Br J Anaesth 1989;63:326-9.

9. Sandhu NS, Sidhu DS, Capan LM. The cost comparison of infraclacicular brachial plexus block by nerve stimulator and ultrasound guidance. Anesth Analg 2004;98:267-8.

10. Inberg P, Annila I, Annila P. Double-injection method using peripheral nerve stimulator is superior to single injection in axillary plexus block. Reg Anesth Pain med 1999;24:509-13.

11. Williams SR, Chouinard P, Arcand G, Harris P, Ruel M; Boudreault D; Girard F. Ultrasound guidance execution and improved the quality of supraclavicular block. Anesth Analg 2003;97:1518-23.

12. Sandu NS, Capan LM. Ultrasound-guided infraclavicular brachial plexus block. Br J Anaesth 2002;89:254-9.

13. Ootaki C, Hayashi H, Amano M. Ultrasound-guided infr-aclavicular brachial plexus block. An alternative technique to anatomical landmark-guided approaches. Reg Anesth Pain Med 2002;25:600-4.

14. Coventry DM, Barker KF, Thomson M. Comparison of two neurostimulation techniques for axillary brachial plexus blockade. Br J Anaesth 2001;86:80-3.

15. Koscielniak-Nielsen ZJ, Stens-Pedersen HL, Knudsen-Lippert F. Readiness for surgery after axillary block: Single or multiple injection techniques. Eur J Anaesth 1997;14:164-71.

16. Lanz E, Theiss D, Jankovic D. The extent of blockade following various techniques of brachial plexus block. Anesth Analg 1983;62:55-8.

17. Chan Vincent WS, Perlas A, Rawson Regan RN, Odukoya O. Ultrasound-guided supraclavicular brachial plexus block. Anesth Analg 2003;97(5):1514-7.

18. Kapral S, Jandrasits O, Schabernig C, Likar R, Reddy B, Mayer N, Weinstabl C. Lateral infraclavicular plexus block vs axillary block for hand and forearm surgery. Acta Anaesthesiol Scand 1999;43:1047-52.

19. Partridge BL, Katz J, Benirschke K. Functional anatomy of the brachial plexus sheath: Implications for anaesthesia. Anesth 1987:66:743-7.

20. Salvatore S, Antonella L, Paolo P. Axillary brachial plexus blocks using peripheral nerve stimulator: A comparison between double- and triple-injection techniques. Reg Anesth Pain Med 2001:26:499-503.

21. Yamamoto K, Tsubokawa T, Shibata K, Kobayashi T. Area of paresthesia as determinant of sensory block in axillary brachial plexus block. Reg Anesth 1995;20:493-7.

22. Stan TC, Krantz MA, Solomon DL, Poulos JG, Chaouki K. The incidence of neurovascular complications following axillary brachial plexus blocks using a transarterial approach. Reg Anesth 1995;20:486-92.

23. Urban MK, Urquhart B. Evaluation of brachial plexus anaesthesia for upper extremity surgery. Reg Anesth 1994;19:175-82.

24. Selander D, Edshage S, Wolff T. Paresthesiae or no paresthesiae? Acta Anesthesiol Scand 1979;23:27-33.

25. Pearce H, Lindsay D, Lelie K. Axillary brachial plexus block in two hundred consecutive patients. Anesth Intens Care 1996;24:453-8.

超音波導引與神經刺激器導引術在腋下臂神經叢阻斷上之比較

柳復兆[1,2]　劉錦棠[1,2]　蔡永豐[1]　李漢倫[1]　戴元基[1]　許汝寧[1]　呂炳榮[1]

背　景： 比較超音波導引術及神經刺激術在腋下臂神經叢阻斷上之效能；並同時比較在超音波導引下單點與雙點注射其麻醉阻斷能力之差異。

方　法： 本實驗共有 90 位接受前臂和手部之病患，以隨機分配的方式分成 3 組，每組均爲 30 位病患。第一組爲利用神經刺激器雙點注射，第二組爲利用超音波導引雙點注射，第三組爲利用超音波導引單點注射。每一位病患均接受含 5 μg kg⁻¹ epinephrine 總量 0.5 ml kg⁻¹ 之 1.5% lidocaine 局部麻藥於腋下臂神經叢注射，第一組在利用神經刺激器找到正中神經後先給予神經周圍半量局部麻藥注射，然後再找到尺神經或橈神經給予另外半量注射。第二組在超音波導引下找到腋動脈並與第一組相同高度之腋動脈內、外緣做雙點注射。第三組爲同樣利用超音波導引在相同腋下位置，僅定位在腋動脈外緣單點注射。麻醉阻斷程度之評估，包括手臂 7 條感覺神經和 4 條運動神經。

結　果： 在神經刺激器雙點注射組和超音波導引單點注射組均獲得 70% 足夠感覺和運動阻斷，在超音波導引雙點注射組獲得 73% 足夠感覺和運動阻斷。對於滿足手術完成之阻斷成功率，在神經刺激器雙點注射組和超音波導引雙點注射組是 90%，超音波導引單點注射組是 70%；至於併發症之發生率，在神經刺激器雙點注射組是 20%，較超音波導引注射兩組之 0% 高，並有統計上意義（$p = 0.03$）。

結　論： 超音波導引腋下臂神經叢阻斷術無論是單點或雙點注射法均能提供較優良之感覺和運動阻斷並較少併發症。

（長庚醫誌 2005;28:396-402）

關鍵字： 超音波導引，神經刺激器導引，腋神經叢阻斷。