Ultrasound-Guided Axillary Brachial Plexus Block in Patients with Chronic Renal Failure: Report of Sixteen Cases

Fu-Chao Liu[1,2], MD; Lung-I Lee[1], MD; Jiin-Tarng Liou[1,2], MD; Yu-Ling Hui[1], MD; Ping-Wing Lui[1], MD, PhD

In this report, 16 patients with end-stage renal disease undergoing forearm arteriovenous shunt surgery were subjected to an ultrasound-guided axillary approach for brachial plexus nerve block. Two doses of 15 ml lidocaine 1.5% were injected using a double-shot technique The spread of the solution within the plexus sheath could be visualized using a high-resolution 12-MHz imaging probe. Most patients (94%) experienced an excellent analgesia in the regions innervated by median, ulnar and radial nerves with a lower percentage of complete analgesia (63%) in the areas innervated by musculocutaneous nerve. Three patients, who complained of pain during the surgery required further supplements of narcotics. There were no complications such as, nerve injury, puncture of the axillary vessels or other systemic reactions. This technique provides adequate analgesia - without complications and without difficulty - for extremity surgery in patients with end-stage renal diseases. *(Chang Gung Med J 2005;28:180-5)*

Keywords: ultrasound-guided, axillary plexus block, end-stage renal disease.

To minimize the risk of complications, deliver a local anesthetic around the target nerves. Risk of complications is a significant in patients suffering from chronic renal failure because of impairment in blood coagulation.(1) Ultrasound guidance has the advantage of real-time identification of the neural plexus anatomy, and directly determinesthe spread of local anesthetic within the plexus sheath.(2) In this report, we applied the ultrasound-guided technique for axillary plexus block in 16 patients with end-stage renal disease and on whom we performed an arteriovenous (AV) shunt or bridge graft fistula surgery at the forearm.

CASE REPORT

With informed patient consent and Ethical Committee approval, 16 patients (aged 59.5±17.0 yr, ASA III) scheduled for the creation or repair of the vascular access for hemodialysis at the forearm were enrolled in this study (Table 1). We excluded patients who were morbidly obese or those with a past medical history of epilepsy, liver disease or allergy to local anesthetics (LA).

There was non-invasive monitoring of the 16 patients upon arrival in the operating room. Sedation of the 16 patients with Midazolam (20 μg/kg, IV)

From the [1]Department of Anesthesiology, Chang Gung Memorial Hospital, Taipei; [2]Graduate Institute of Clinical Medical Sciences, Chang Gung University, Taoyuan.
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Address for reprints: Dr. Ping-Wing Lui, Department of Anesthesiology, Chang Gung Memorial Hospital and Chang Gung University. No. 5, Fushing St., Gueishan Shiang, Taoyuan, Taiwan 333, R.O.C. Tel.: 886-3-3281200 ext. 3624; Fax: 886-3-3281200 ext-3624; E-mail: pwlui@cgmh.org.tw

occurred five minutes before the block procedure. Each patient was positioned supine with the arm abducted 90˚ and bent. The structure of the axillary region is clearly shown by a 12.0-MHz probe (Type 8805) using the 2102 HawK; B-K Medical, Denmark ultrasound machine (Fig. 1). Inserting a 6.0-cm, 23 gauge needle, concurrent with the ultrasound, two doses of 15 ml LA solution (lidocaine 1.5% with epinephrine 5 (μg/ml) were injected using a double-shot technique. An observation of a ring-like sharp shadow (Fig. 2) surrounding the axillary artery and nerve occurred on completion of inserting the solution.

The same team of anesthesiologists, performed the blocks in all 16 cases. The extent of the sensory and motor blocks was evaluated 30 minutes after the LA injection.[3] Sensory block was assessed in the areas innervated by following nerves, i.e., lateral cutaneous nerve of the arm, musculocutaneous, radial, median, ulnar and medial cutaneous nerves of the arm and forearm. Sensory block was scored[4] as: 0 = normal sensation; 1 = hyperalgesia; 2 = dull; 3 = no sensation. Motor block was assessed according to the following movements, i.e., extension of the elbow and wrist (radial n.); arm pronation, wrist flexion/opposition, and 2nd & 3rd fingers and thumb opposition (median n.); flexion/opposition of the 4th & 5th fingers towards the thumb (ulna n.); and elbow flexion (musculocutaneous n.). Muscle power was graded as: 0 = normal; 1 = slightly reduced contraction; 2 = moderately reduced contraction; and 3 = loss of contraction. The sensory and motor blockades of score 2 or 3 were considered adequate for this kind of procedure. Failure of the block (score 1) results from a local infiltration of LA or IV supplement of narcotics.

The mean and standard deviation (SD) in Table

Fig. 1 Ultrasound image of axillary anatomy. BI (bicep muscle); TRI (tricep muscle); CB (coracobrachial muscle); H (humerus); a (axillary artery); v (axillary veins); arrows (needle injection site).

Table 1. Demographic Characteristics of Patients and Complications

Patient (No)	Age (years)	Gender (M/F)	Weight (kg)	Operation	Complication		
					VP	ND	other
1	67	M	62	A-V shunt	—	—	—
2	58	F	49	A-V shunt	—	—	—
3	61	F	64	A-V shunt	—	—	—
4	72	F	51	A-V shunt	—	—	—
5	54	M	58	A-V shunt	—	—	—
6	59	M	71	Bridge graft fistula	—	—	—
7	65	F	64	Bridge graft fistula	—	—	—
8	78	M	47	A-V shunt	—	—	—
9	70	M	67	A-V shunt		—	—
10	81	F	48	A-V shunt	—	—	—
11	52	M	59	Bridge graft fistula	—	—	—
12	62	F	65	A-V shunt	—	—	—
13	45	M	56	A-V shunt	—	—	— —
14	65	F	63	A-V shunt	—	—	—
15	61	F	52	Bridge graft fistula	—	—	—
16	57	F	62	A-V shunt	—	—	—

Abbreviations: VP: vessels puncture; ND: nerve damage.

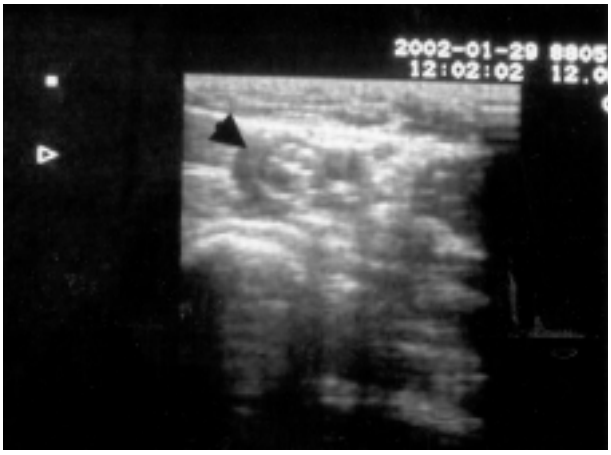

Fig. 2 The speed of local anesthetic solution surrounding the axillary artery and nerve as a ring-like formation (arrow) revealed by ultrasound image.

1 (age: 59.5 ±17.0 years; weight: 58.6 ±7.4 kg) present the demographic characteristics of the patients. Table 2 shows the extent of the sensory and motor block for different nerves. The medial cutaneous nerves of the forearm, median and ulnar nerves in the arm, showed a higher success rate of adequate sensory block (94%) compared to other nerves. Both median and ulnar nerves had 94% adequate analgesia for motor block. Only 63% of the 16 patients obtained adequate sensory analgesia in the area innervated by the musculocutaneous nerve, while 69% of the patients experienced complete motor analgesia, notably the lowest success rate among others. Three patients needed intravenous analgesia, of which one patient required local infiltration of local anesthetic and intravenous anesthetics during the procedure. The remaining patients received supplements of fentanyl 50 μg and midazolam 5 mg for

Table 2. Effectiveness of Brachial Plexus Blockade and Supplements

Patient	Sensory							Motor				Supplements		
(No)	LCA	MC	R	M	U	MCF	MCA	MC	R	M	U	LA	IVA	GA
1	2	2	3	3	3	3	2	2	3	3	3	-	-	-
2	2	3	3	3	3	3	3	3	3	3	3	-	-	-
3	2	1	2	3	2	2	2	1	2	3	2	-	-	-
4	2	2	2	3	2	2	2	2	3	3	2	-	-	-
5	2	2	3	3	3	3	2	2	3	3	3	-	-	-
6	2	2	2	2	3	2	1	2	2	2	3	-		-
7	2	2	3	2	2	2	1	2	3	2	2	-	-	-
8	3	2	3	3	3	3	3	2	3	3	3	-	-	-
9	0	1	1	1	2	1	0	0	1	1	2	+	+	-
10	3	2	3	3	2	2	2	3	3	3	2	-	-	-
11	1	1	2	2	1	2	1	1	2	2	1	-	+	-
12	3	2	3	2	3	2	2	2	3	2	2	-	-	-
13	2	2	3	3	3	3	2	2	3	3	3	-	-	-
14	1	1	1	3	2	2	1	1	1	3	2	-	+	-
15	2	1	2	2	3	2	2	1	2	3	2	-	-	-
16	2	2	2	2	3	2	2	2	2	2	3	-	-	-
N=16	12	11	14	15	15	15	11	12	14	15	15	1	3	0
(%)	(75)	(63)	(86)	(94)	(94)	(94)	(75)	(69)	(86)	(94)	(94)	(6)	(19)	0

Abbreviations: LCA: lateral cutaneous nerve of the arm; MC: musculocutaneous nerve; R: radial n; M: median n; U: ulnar n; MCA: medial cutaneous nerves of the arm; MCF: medial cutaneous nerves of the forearm. Sensory block was scored: 0: normal sensation; 1: hyperalgesia; 2: dull (analgesia); 3: no sensation (anesthesia). Motor block was assessed; i.e., the extension of the elbow and wrist (R: radial nerve); the pronation of the arm; flexion and opposition of the wrist; and opposition of the second and third fingers and thumb (M: median nerve); the flexion and opposition of the fourth and fifth fingers towards the thumb (U: ulna nerve); and the flexion of the elbow (MC: musculocutaneous nerve). Muscle power was graded: 0: normal power; 1: slightly reduced contraction (slight paresis); 2: moderately reduced contraction (moderate paresis); and 3: loss of contraction without power (paralysis). LA: local anesthetics; IV: intravenous anesthetics; GA: general anesthesia. Data N and (%) are number of patients and (percentage), score ≧ 2.

surgical pain. There were no complications related to this procedure.

DISCUSSION

Patients with chronic renal failure is a high-risk group for general anesthesia because of the concomitant diseases with coronary artery disease, diabetes mellitus and hypertension.[5] Brachial plexus block is the more advantageous or effective choice in creating a vascular access for hemodialysis. The simplicity and the low risk of complications such as pneumothorax in the axillary approach accounts for its common usage.[6]

This report in which axillary brachial plexus block was performed under ultrasound guidance in patients with end-stage renal disease undergoing surgery for vascular access. The report yields an 81% success rate in achieving adequate analgesia, which is significantly lower than Sandhu's report in which a 90.4% complete block was obtained.[7] Other reports also demonstrated that supra- and infra-clavicular brachial plexus blockades under ultrasound guidance attained a 95% complete block.[3,8] It is conceivable that the success rate of the block varies depending on different techniques, sites and the number of nerves blocked. For example, the infra-clavicular approach and not the axillary brachial plexus block in patients with end-stage renal disease was used in Sandhu's report. During the procedure for vascular access, adequate blockage of the surgical area innervated by the radial and/or musculocutaneous nerves is necessary. However, these areas are usually problematic inbeing consistently blocked if the axillary approach is employed.[9] The study indicates that ultrasound-guided or double-injection techniques have the advantages of enhancing the onset of analgesia and improving the quality of the block in comparison with blind- or single-shot methods. In our series, only ten minutes is required to achieve the block. Our findings did however demonstrate an incomplete sensory and motor block in the musculocutaneous nerve in 37% and 31% of patients, respectively, the simplicity and rapidity of execution under ultrasound guidance are significant benefits.

Performing the neural block under the blind method substantially increases the risk of unintentional puncture of blood vessels or nerve injury. The incidence of nerve injury from axillary block ranges from less than 1% to 19%.[10,11] Using paraesthesia as a sign for targeting the nerve had a higher incidence of developing persistent neuropathy than the standard method using transarterial puncture (2.9% vs. 0.8%).[12] Sonographic guidance offers accurate placement of the injection needle and thereby can improve the quality of the nerve block, furthermore diminish the related vascular and neurological complications. In our study, we applied ultrasound-aided axillary plexus block with a 12-MHz probe that provides a high-resolution imaging. This enhances the observation of the needle during insertion as well as the spread of the local anesthetic solution within the plexus sheath. The zero complication result in our cases supports the notion that ultrasound-navigated injection is a simple and safe technique in performing axillary plexus block.

The lidocaine dose (7.7 mg/kg) used in our study resembles that reported by Ootaki (7.4 mg/kg),[3] but remains significantly less than Sandhu's (9.3 mg/kg).[7] Richard[13] also demonstrated an absence of toxic symptoms in patients with chronic renal failure when lidocaine was used in a dose of 6-7 mg/kg without epinephrine. In previous studies, administration of lidocaine up to 18 mg/kg remained within the safety margin of systemic toxicity.[14] Bromage demonstrated a 38% decrease in the analgesic duration during brachial plexus block in patients suffering from chronic renal failure.[1] This phenomenon reflects a faster systemic uptake of the drug as the result of an increase in cardiac output in these patients. In our cases, we added a relatively small yet effective amount of epinephrine into the lidocaine solution in order to reduce the toxicity through systemic absorption. An increase in the volume or concentration of local anesthetic solution shows an improved quality of sensory and motor analgesia.[4] The upper limit for a safe dose of local anesthetic for complete or adequate brachial plexus block has not been established, however, the recommended upper limit of safe dosage with lidocaine for bolus injection was around 300-500 mg without adrenaline.[15]

In conclusion, high-resolution ultrasound-guided axillary brachial plexus block with lidocaine provides adequate analgesia without complications for A-V fistula surgery in patients with end-stage renal diseases.

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腎衰竭病人經超音波導引腋下臂神經叢阻斷術：十六病例報告

柳復兆[1,2] 李隆億[1] 劉錦棠[1,2] 許汝寧[1] 呂炳榮[1]

腎衰竭者爲手術中常見之高危險病人，並易引發手術麻醉後不少併發症。藉著超音波輔助使用在腎衰竭病人身上之神經阻斷麻醉術，文獻上報告很少。我們在16位腎病末期接受前臂動靜脈分流術和血管重建移植術病患身上、利用高解析度12-MHz探頭之超音波導引順利完成腋下臂神經叢阻斷。我們使用雙次注射法，每次注射15毫升濃度1.5%之lidocaine局部麻醉，第一次注射位置在腋動脈外側；第二次注射位置在腋動脈內側。16位病人中有94%病人在正中、尺和橈神經支配部分獲得良好止痛效果，而止痛效果較差的情形則分佈在肌皮神經支配的範圍，僅63%病人有良好止痛效果；其中有3位病人在術中會感覺疼痛，疼痛情形在給予靜脈止痛藥物後改善，其餘病人均獲得良好麻醉阻斷。由於此麻醉方式操作簡單且過程均在超音波影像下執行，故能提供較高之準確性、安全性和舒適性。整個麻醉中，無血管穿破、神經電擊和麻醉藥物反應的現象，也無任何麻醉併發症產生。(長庚醫誌2005;28:180-5)

關鍵字：超音波導引，腋神經叢阻斷，末期腎病。

[1]長庚紀念醫院　林口院區　麻醉部，[2]長庚大學　醫學院　臨床醫學研究所
受文日期：民國93年3月24日；接受刊載：民國93年6月15日。
索取抽印本處：呂炳榮醫師，長庚紀念醫院　麻醉部。桃園縣333龜山鄉復興路5號。Tel.: (03)3281200轉3624; Fax: (03)3281200轉3624; E-mail: pwlui@cgmh.org.tw