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A novel approach for brachial plexus block

Aim: The line from the midpoint of the sternocleidomastoid muscle to the midpoint of the clavicle was considered the surface projection of the brachial plexus in the supraclavicular region in a previous report using radiological and anatomic techniques. The needle insertion site was the point between the clavicular one-third and cervical two-thirds of this line. The aim of the present study was to determine the clinical efficacy of these suggested landmarks.

Materials and methods: Brachial plexus block was performed in 60 healthy adult patients undergoing elective surgery on an upper extremity using the above-mentioned new surface landmarks.

Results: The characteristics of the block resemble those in the interscalene technique. Brachial plexus block was performed with a high success rate (98.5%) and minor complications including phrenic nerve palsy (45%), Horner syndrome (15%), and recurrent nerve block (1.6%). No major complication such as pneumothorax or accidental intravascular insertion was observed.

Conclusion: The new landmarks were not dependent on patients' physical features or deeper anatomic structures. The surface landmarks based on bony prominences were defined easily. Brachial plexus block was performed with a high success rate and is considered a safe alternative to the classically described techniques.

Key words: Regional anesthesia, technique, brachial plexus block

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Brakiyal pleksus blokajı için yeni bir yaklaşım

Amaç: Sternokleidomastoid kasın orta noktasından klavikulanın ortasına uzanan hattın brakiyal pleksusun yüzeysel yansıması olduğu radyolojik ve anatomic tekniklerin kullanıldığı bir çalışmada gösterildi. İğne giriş noktası bu hattın üçte bir klavikular ve üçte iki servikal bölümü olarak tanımlandı. Bu çalışmanın amacı belirtilen başvuru noktalarının klinik etkinliğinin belirlenmesidir.

Yöntem ve gereçler: Brakiyal pleksus blokajı elektif üst ekstremite cerrahisi uygulanan altmış sağlıklı erişkinde yukarıda belirtilen yeni yüzeysel noktaların ışığında gerçekleştirildi.

Bulgular: Bloğun özellikleri interskalen tekniğe benziyordu. Brakiyal pleksus blokajı yüksek başarı oranı (% 98,5) ve frenik sinir bloğu (% 45), Horner sendromu (% 15), ve rekürren sinir bloğu (% 1,6) gibi minör komplikasyonlarla gerçekleştirildi. Pnömotoraks veya yanlışlıkla intravasküler girişim gözlenmedi.

Sonuç: Yeni başvuru noktaları hastanın fiziksel özelliklerine veya derin anatomic yapılara bağımlı değildir. Kemik yapılara dayanan yüzeysel noktalar kolaylıkla bulunmaktadır. Brakiyal pleksus blokajı yüksek başarı oranı ile gerçekleştirilmiştir ve klasik olarak tarif edilmiş tekniklere alternatif olabileceği düşünülmektedir.

Anahtar sözcükler: Rejyonel anestezi, teknik, brakiyal pleksus blokajı

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Introduction

Regional anesthetic techniques in an upper extremity may be performed using different anatomical landmarks. The classical approaches include interscalene or supraclavicular perivascular techniques in the supraclavicular region, and infraclavicular technique and blockade at the axillary groove have been described previously (1-4). The characteristics of neural blockade may differ according to

the site chosen. The level of anesthesia is superior if the block is performed closer to the neck. However, the complication rate may increase proportionately.

Brachial plexus (BP) block in the supraclavicular region provides a more intense and wider distribution of analgesia. However, the close relationship with the pleura, subclavian artery, phrenic nerve, and cervical vertebrae creates considerable risk, and difficulty in precise determination of anatomic landmarks in obese patients is a further limiting factor. Therefore, the supraclavicular approach is preferred infrequently (5).

Use of ultrasound guided nerve blocks is increasing in regional anesthesia practice (6). Provision of deeply seated nerve and defining anatomic relations before performing the block is essential under the guidance of ultrasound. It is crucial to follow the nerve to the upper and lower site during imaging to identify false appearance or pathologies (7).

Surface projection of BP was determined in a report using anatomical and radiological techniques including ultrasound and magnetic resonance (MR) imaging (8). The purpose of the present study was to assess the clinical utility and safety of these landmarks.

Materials and methods

The study was performed with ethics committee approval and informed consent was obtained from the participants. Sixty adult patients with ASA physical status I and II undergoing upper extremity surgery were enrolled in this study. The patients were premedicated with midazolam 1-2 mg IV before blockade. Essential monitoring with ECG derivation II, peripheral oxygen saturation (SpO_2), and noninvasive arterial blood pressure measurement was performed every 5 min. Supplemental oxygen at 2 L min^{-1} was delivered with a nasal cannula.

The head was turned slightly to the contralateral side and surface landmarks were marked on the skin. The first line was drawn from mastoid process to the sternal insertion of the sternocleidomastoid (SCM) muscle. The second line was drawn from midpoint of the first line to the midpoint of the clavicle. The point between the clavicular one-third and cervical two-thirds of this line was chosen as the needle insertion site (Figure 1A and B) and the area was prepared and draped. A skin wheal was performed with 1 mL of lignocaine (1%) using a hypodermic needle. A 21 gauge short-beveled and 50 mm long Teflon-coated needle (Stimuplex®, B. Braun Melsungen AG, Melsungen, Germany) was connected to the nerve stimulator (Stimuplex® HNS11 B. Braun Melsungen, Germany), which was set at 1 mA with 2 Hz frequency. The needle was inserted perpendicular to both sites and directed to the neck at 60-70° angles to the skin at the sagittal plane until the muscle twitch was observed. The stimulation was gradually reduced to lower than 0.5 mA while still observing the muscle twitch. The local anesthetic mixture consisting of 10 mL of prilocaine 1% and 20 mL of lignocaine 1.5%

Figure 1. Surface landmarks of BP, A: The insertion point is marked by X. B: The needle is on the insertion site.

(total 30 mL) in epinephrine 1/200,000 was administered in 5 mL increments with gentle aspirations. All the blocks were performed by the same author (AA). The depth of the needle insertion was determined by marking the length of the needle at the skin before withdrawal. The needle was redirected a few degrees to both sides when no muscle contraction was elicited or phrenic nerve stimulation (diaphragm contraction) was observed. Motor blockade and sensory blockade were assessed by evaluating the ability of voluntary movements of muscle groups and pain sensation to the pinprick test. The observation period was accepted as 30 min maximum and the degrees of motor and sensory block were determined.

Partial or complete sensation to the pinprick test, lack of motor paralyses, or partial movement on nerve distribution were accepted as failed sensory and motor block, respectively. The surgery started when the level of block was intense. The quality of block was determined as good (no supplemental anesthetic was required), satisfactory (intravenous or local supplementation was required), and failed (necessity for general anesthesia). Our primary outcome was to assess the quality of block during the intraoperative period; therefore pain scale during the postoperative period was not determined. Chest X-rays were obtained from patients to check the possibility of minimal pneumothorax or hemi-diaphragmatic elevation for excluding phrenic nerve block immediately after the operation. Patients were observed the day after surgery for respiratory distress and SpO_2 was determined for checking any deviation from initial values the day after surgery. A telephone interview was performed 1 week and 1 month after the block to determine neural complications including paresthesia, dysesthesia, prolonged anesthesia, or unexpected motor deficit.

Data were expressed as mean ± standard deviation of the mean (mean ± SD) and range where appropriate.

Results

The study group consisted of 60 ASA I/II (56/4) adult patients: 16 male and 44 female, with a mean age of 40 ± 13 (18-70) years, mean weight of 73 ± 12 (45-95) kg, and mean height of 164 ± 8 (150-190) cm. Nineteen patients (31.7%) had a body mass index over 30. Types of surgery are shown in Table 1.

Table 1. Types of surgery (n).

CCT release	21
Trigger finger	6
Excision of tumors	9
Skin grafts	8
PEF	4
ORIF	12

CCT: Carpal and cubital tunnel, PEF: Positioning and external fixation; ORIF: Open reduction internal fixation.

Brachial plexus was achieved at a depth of 31.6 ± 3.5 mm on average. The majority of patients required tourniquet placement (54, 90%) and no patient complained about tourniquet pain during the surgery. The surgery lasted 66 ± 41 (15-165) min and no patient required additional anesthesia. The quality of block was good in 50 patients (84%). Nine patients (15%) needed additional IV sedative and opioid supplementation and 1 patient (1.6%) who underwent bone graft placement at the distal radius after osteotomy required general anesthesia. The quality of block is shown in Table 2. Sensory and motor block of ulnar nerve failed in patients 8 and 10 of the patients, respectively. On the other hand, the surgery was not affected by the nerve distribution of incomplete or failed block and was not influenced by the success rate. The overall success rate was 98.5%, consisting of good and satisfactory results based on the analgesic requirements during surgery. BP was found in 38 patients at the first insertion, while second attempt was required 17 patients and more than 2 attempts were made in the remaining 5 patients. A bony prominence (Chassaignac's tubercle) was felt in 4 of these patients and the phrenic nerve was found (observed by diaphragmatic contractions) in 2 of the patients.

No major complication was detected such as pneumothorax, inadvertent vessel puncture, or subarachnoid injection. Minor complications such as phrenic nerve block (45%), Horner syndrome (15%), and recurrent nerve block (1.6%) were observed, but they resolved within hours.

Table 2. Characteristics of sensory and motor blockade of peripheral nerves (N).

	Onset (min)	Complete (min)	Failure rate n (%)
Sensory block			
Musculocutaneous N.	3.3 ± 4	13.2 ± 6	2 (3.3)
Median N.	3.5 ± 3	16.8 ± 9	5 (8.4)
Radial N.	4.7 ± 5	18.4 ± 7	3 (5)
Ulnar N.	5.6 ± 7	21.6 ± 8	8 (13.4)
Motor Block			
Musculocutaneous N.	4.1 ± 4	12.7 ± 6	3 (5)
Median N.	4.6 ± 7	13.8 ± 9	6 (10)
Radial N.	3.9 ± 8	16.4 ± 11	4 (6.6)
Ulnar N.	5.7 ± 6	19.7 ± 13	10 (16.7)

There was no neurological complication related to the block in the follow-up period.

Discussion

We present a new technique for BP block using new surface landmarks that can be reached easily, based on bony prominences and not dependent upon the patients' physical characteristics. The clinical application of these landmarks showed that BP block can be performed with a high success rate and with minimal complications. The BP block can be performed in a neutral position and thus may provide a safer alternative for patients in whom the upper extremities are fractured and difficulties arise on positioning. The insertion point is distant from important anatomical structures and the complication rate was lowered by directing the needle cranially. The quality of block was similar to that of interscalene brachial plexus block. We concluded that directing only a few degrees laterally on the line was necessary to find out if BP failed at first attempt. Therefore, searching for the trunks of BP and related complications may decrease.

Kulenkampf first described brachial plexus block in the supravclavicular region in 1912 (9). In this technique, serious complications such as inadvertent pleural or arterial puncture may occur while attempting paresthesia. Subclavian perivascular approach and interscalene approach to the BP are the 2 other classically described techniques. In the interscalene technique, the interscalene groove between the anterior and middle scalene muscles is required to be located under the SCM muscle (1). While it was not reported so in the original study, the physician should be cautious while adjusting the angle of the needle to avoid serious complications due to the close anatomic relationship with the cervical vertebrae. Supraclavicular perivascular technique is another technique for BP block with a high success rate and a lower rate of complications (2). On the other hand, the complication rate was higher in a study using the same approach, including inadvertent puncture of the subclavian artery (25%), Horner syndrome (64%), and recurrent laryngeal nerve block (1.3%) despite the use of a nerve stimulator (10). The technique described by Winnie (2) was modified by Moorthy et al. (11) using a Doppler probe and stimulating needle for proper positioning of the subclavian artery and precise location. However, the success rate was lower than in previous studies. A higher success rate was reported in a study conducted by the same group (12). Complication rates of these last 2 studies were not reported in detail and the authors reported no major complication. A modification of this technique was described using MR in healthy volunteers and optimal needle direction at a sagittal plane was proposed (13). However, the suggested angle for needle insertion may vary between 20° and 33° according to the patient and might be difficult to perform. In addition, clinical application may be necessary for determining the complication rate of this radiological study.

The landmarks in the present study denote a line rather than a point, which lies over the BP and may provide flexibility to the anesthesiologist and facilitate imaging studies. For BP block that was performed under the guidance of ultrasound in a previous report the level that was chosen for the insertion point was the same as in our study (14). The technique might be safely applied in obese patients as shown in our study group; the body mass index in 19 of the patients was over 30. The needle was directed cranially to avoid complications and inserted perpendicularly using a wider angle than in an article using the same direction but preferring a narrower angle (15). However, the direction of the needle was not mentioned clearly and the external jugular vein was taken as the landmark in their report. The importance of needle angle during insertion was emphasized in a cadaver study in order to avoid entering the spinal canal (16).

Several other techniques described previously also used palpable structures and the external jugular vein was considered a landmark likely to be inconsistent, with varying success and complication rates (17,18). Surface landmarks and blocking techniques were described for pediatric patients in a report using anatomical and clinical findings and it was termed the parascalene approach, but the success rate using the same technique has yet to be determined in adults (19). The complication rate including phrenic nerve block was considerably higher in the technique named the intersternocleidomastoid approach for BP block (20). The anterior approach to the BP, named the "plumb-bob" technique, was described for avoiding pneumothorax (21). However, a simulating study with MR resulted in failure (22). In their report, Nguyen et al. (23) described transscalene brachial plexus block to overcome well known complications related to the classical approach that influences requirements of a new and safer alternative to the interscalene technique. According to block characteristics, our technique seems to meet these expectations.

In conclusion, clinical use of the surface landmarks was found to be efficient, and the quality and characteristics of block resemble those of the interscalene approach with a high success rate and without major complications.

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