Brachial Plexus Block for Upper Limb Surgery, Coracoid Infraclavicular Approach versus Axillary Approach

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Abstract: Regional anesthesia of the extremities and of the trunk is a useful alternative to general anesthesia in many situations. Peripheral nerve blocks have attracted renewed interest because of their role in reducing postoperative pain and shortening outpatient recovery. The aim of the study is to compare brachial plexus block performed by the axillary &the coracoids infraclavicular routes using peripheral nerve stimulator as regard block performance time, onset of sensory block, motor block intensity, block duration ,success and failure rates. This study was carried out in Tanta University Hospital over forty adult patients of both sex, ASA physical state type I and type II. Patients were classified into two groups: group (C) recieve Infraclavicular coracoids approach and group (A) recieve Axillary approach of brachial plexus block. Each group contains 20 patients. All patients were scheduled for elective surgery of the hand, wrist, or forearm. All blocks were done using a nerve stimulator and an insulated needle (50 mm and 22-gauge). The stimulating current set to 1.5mA and the stimulus frequency to 1Hz and the impulse duration to 0.1 ms. There was no much difference in the age of the patients group C vs group A (37.60 ±12.22 vs38.30 ±14.20) respectively. There was no statistically significant difference in the time needed to perform the block in both coracoid and axillary groups ranged in both groups between 3-8 minutes. The onset of sensory blockade was more rapid in the axillary group vs coracoid group (19.05±1.93 vs30±3.61).The duration of block was significantly longer in the axillary group (58.15 ± 1.60) than the coracoid group (48.50±8.53). So, this study reinforces that axillary block was more successful and resulted in more complete block than the coracoids block and better spread of analgesia and longer duration of anesthesia.

[**Reda** S. Abdelrahman, Sohair M. Soliman, Magdy E. Elbably **Brachial Plexus Block for Upper Limb Surgery, Coracoid Infraclavicular Approach versus Axillary Approach**] Journal of American Science 2012;8(3):538-544]. (ISSN: 1545-1003). http://www.americanscience.org. 72

Keyword: PNBs peripheral nerve blocks, ARNI anesthesia- related nerve injury.

1. Introduction

The brachial plexus block (BPB) is routinely performed since it is as effective as general anesthesia in anesthetizing the upper limbs and is less invasive. As with other areas in medicine, the technique for the BPB has been improved upon by the development of medical technology. Patient having upper extremity surgery, regional anesthesia can provide a combination of minimal systemic impairment and excellent localized postoperative analgesia. Several approaches exist to produce local anesthetic blockade of the brachial plexus. It is not clear which is the technique of choice for providing surgical anesthesia of the upper extremity (Liu and Salinas, 2003).

In the infraclavicular approach the deposition of local anesthetic is performed at the level of the cords and branches of the brachial plexus above and below the formation of the axillary nerve and musculocutaneous(Jaime *et al.,* 2004). In the axillary brachial plexus block, the terminal nerves of the brachial plexus are contained with the axillary artery in a common sheath. The artery is easily palpable and serves as a useful landmark for the axillary block. The paresthesia, transarterial, and nerve stimulator techniques have all been used successfully for elbow, forearm, wrist and hand procedures (Koscielniak-Nielsen et al; 2002, Chan VW et al; 2001 and Davis et al; 1991)

The improvement of the nervous location through an electrical current has allowed knowing the different motor responses from peripheral nerves, and to offer to anesthetic procedures and analgesics insurances, reliability and effectiveness (Michael , 2006 and Zaragoza-Lemus *et al*.; 2008).

Hence this study was carried out to compare brachial plexus block performed by the axillary & the coracoids infraclavicular routes using peripheral nerve stimulator.

2-Patients and Methods

This study was carried out in Tanta University Hospital over 40 patients (32 males &8 females), ASA physical state type 1 and 2. All patients were scheduled for elective surgery of the hand, wrist, or forearm. Informed written consent was obtained from every included patient.

Exclusion criteria include: patients with diseases affecting sensory or motor functions of the upper extremity, pregnant patients and allergy to local anesthetics.

Preparation: A wide bore I.V fluids was started, blood pressure cuff and a pulse oximetry probe were attached to non- involved arm and 3 ECG electrodes over the patient's chest. An electrode was placed over the patient's acromion and connected to the positive lead of the nerve stimulator.

Premedication: All patients received intravenous fentanyl® in a dose of 1µg/kg b. wt. 5 min before the block performance. Patients were assigned to one of the following two groups (20 patients each):
* Group (C): Infraclavicular coracoid approach.
* Group (A): Axillary approach.

Local anesthetic material:

A mixture of equal parts of 0.5% bupivacaine and 2% lidocaine was used with a total volume of 40 ml.

The nerve stimulator:

All blocks were done using a nerve stimulator and an insulated needle (50mm and 22-gauge). The stimulating current set to 1.5 mA and the stimulus frequency to 1 Hz and the impulse duration to 0.1 ms.

Techniques:

(Group C) coracoid Infraclavicular approach:

Patient Positioning:The patient was in the supine position with the head facing away from the side to be blocked. It is best to keep the arm abducted and flexed in the elbow to keep the relationship of the landmarks to the brachial plexus constant. When a certain level of comfort with the technique is reached, the arm can be in any position during block performance. Attention should be paid when the arm is supported at the wrist to allow clear unobstructed detection of the twitches of the hand.

Surface Landmarks:

The following surface anatomy landmarks are useful in identifying the estimated site for an infraclavicular block: Sternoclavicular joint, Medial end of the clavicle, Coracoid process, Acromioclavicular joint, Head of the humerus.

Technique:

Local anesthetic skin infiltration:

The needle insertion site was identified 1 cm medial and 1 cm caudal to the cracoid process and marked by a pen and infiltrated with local anesthetic using a 25-gauge needle. The local anesthetic was infiltrated a bit deeper into the pectoralis muscle to decrease the discomfort during needle insertion as well as soreness after the completion of the block procedure.

Needle insertion:

A 10-cm long, 22-gauge insulated needle, was attached to the negative lead (cathode) of the nerve stimulator & inserted directly perpendicularly to the skin and advanced until motor responses were observed in the muscles supplied by one of the four nerves (median, musculocutaneous, radial or ulnar) in synchrony with the stimuli The stimulating current was set to 1.5 mA, the stimulus frequency to 1 Hz and the impulse duration to 0.1 ms. The current was gradually decreased, while the needle-tip approached the stimulated nerve. The needle is withdrawn subcutaneously and re-inserted more cephalad or more caudal until a motor response from the muscles supplied by another nerve was obtained. Satisfactory positioning of the needle was obtained when stimulation by 0.3–0.5 mA elicited visible muscle contractions in the muscles supplying each nerve.

A local twitch of the pectoralis muscle was typically elicited as the needle advanced beyond the subcutaneous tissue. Once the pectoralis twitches disappear, the needle advancement should be slow while looking for the twitches of the brachial plexus.

Satisfactory positioning of the needle was obtained when stimulation by 0.3–0.5 mA elicited visible muscle contractions. Each of the two sites was injected with half of the selected dose of the local anesthetic material (20 ml).

Tips:

- To find the coracoid process place your hand in the groove between the deltoid and pectoralis major muscles and gently palpate laterally.
- The patient can use a pillow behind the head but the shoulder and back should lie flat against the table.
- Brachial plexus stimulation is typically obtained at a depth of 5 to 8 cm.
- When the pectoralis twitch is absent despite appropriately deep needle insertion, the landmarks are checked as the needle is most likely inserted too cranially (underneath the clavicle).
- The bevel of the needle should be facing down to facilitate nerve stimulation and reduce the risk of vascular puncture (subclavian or axillary artery and vein).
- Twitches from the biceps or deltoid muscles should are not accepted, since the musculocutaneous and axillary nerve, respectively, may depart the brachial sheath before the coracoid process.
- A twitch of the pectoralis muscle is observed first and indicates a too shallow placement of the needle. As contractions of the pectoralis muscle cease, the needle is slowly advanced until the twitches of the brachial plexus are elicited. This usually occurs at a depth of 5-8 cm.
- After the twitches of the pectoralis muscle cease, the stimulating current is lowered to below 1.0 mA to decrease patient discomfort. The needle is

then slowly advanced or withdrawn until hand twitches are obtained at 0.2 - 0.3 mA.

- Directing the needle out of the parasaggital plane is avoided because this increases the risk of pneumothorax.
- Directing the needle out of the parasaggital plane laterally may place the needle lateral to the cords resulting in anesthesia of only one or two of the terminal nerves of the brachial plexus.
- Flexion or extension of the elbow or wrist can result in motion of fingers without movement of the intrinsic muscles of the hand and this should not be accepted.

(Group A) axillary approach:

Patient Positioning:

The patient lied in the supine position with the head facing away from the side to be blocked. The arm on the side of the block placement should be abducted and form a roughly 90^{o} angle in the elbow joint. Excessive abduction in the shoulder joint was avoided because it makes palpation of the axillary artery pulse difficult. Excessive abduction can also result in stretching and "fixing" of the brachial plexus. Such stretching of the brachial plexus components increases the vulnerability of the plexus during needle advancement. Stretching may increase the risk of nerve injury because the plexus components are fixed and more likely to be penetrated by the needle rather than "roll" away from the advancing needle.

Surface landmarks:

- Surface landmarks for the axillary brachial plexus block include: Pulse of the axillary artery, Coracobrachialis muscle, Pectoralis major muscle.

Technique:

After a thorough skin preparation, the pulse of the axillary artery was palpated high in the axilla. Once the pulse was felt, it was straddled between the index and the middle finger and firmly pressed against the humerus to prevent "rolling" of the axillary artery during block performance. At this point, movement of the palpating hand and the patient's arm was minimized because the axillary artery is highly mobile in the adipose tissue of the axillary fossa.

Local anesthetic skin infiltration:

The axillary artery was marked by a pen and the subcutaneous tissue overlying the artery was infiltrated with local anesthetic using a 25-gauge needle. Local anesthetic is best infiltrated tangentially rather than at a single insertion point. This both ensures a superficial injection and allows for needle repositioning during block performance if required.

Needle insertion:

A 10-cm long, 22-gauge insulated needle, attached to the negative lead (cathode) of the nerve stimulator & inserted above the axillary artery and advanced until motor responses from the median and the musculocutaneous nerves were consecutively obtained. The needle is withdrawn and reinserted below the artery until motor responses from the ulnar and radial nerves were obtained. Each of the four nerves is injected with 1/4th of the selected volume of the local anathetic material (10 ml) after obtaining the maximum response by the stimulating current of 0.3–0.5 mA. Injections were made slowly, while repeatedly aspirating the needle.

Measurements

1) The time to perform the block was defined as the time from the initial insertion of the needle to its removal.
2) The sensory onset time of the block was assessed in all the upper limb areas every 5 min until 30 min after the last injection; axillary nerve (lateral side of the upper arm), musculocutaneous nerve (lateral side of the forearm), radial nerve (dorsum of the hand over the 2nd metacarpophalangeal joint), median nerve (thenar eminence), ulnar nerve (little finger), medial cutaneous nerves of the arm (medial side of the upper arm) and of the forearm (medial side of the forearm).
3) Sensory block was assessed with a 25-gauge needle and was considered as complete if analgesia or anesthesia was observed at 30 min in all the sensory areas below the elbow.
4) Motor block was assessed every 5 min until 30 min for 4 motor nerves the radial (thumb abduction), median (third finger flexion), ulnar (fifth finger flexion), musculocutaneous (elbow flexion), and axillary (arm abduction) nerves and then compared to the contralateral arm. Motor block was scored 0= no motor block; 1= minor movements; 2 = no movement.
5) Adverse effects were recorded (e.g) occurrence of local anesthetic toxicity, nausea or vomiting .
6) Duration of the block, success and failure rates.

Statistical Methods:

Statistical presentation and analysis of the present study was conducted, using the mean, standard deviation (t. test), and chi-square test by SPSS V.16.

4-Results

The present study was carried out on forty patients scheduled for surgery on the upper limb (forearm or hand).

Patients were classified into two groups:

* Group (C): Infraclavicular coracoid approach.

* Group (A): Axillary approach. Each of the two groups contains 20 patients. Demographic and clinical data of patients and controls are shown in table (1).

Table (1) shows no significant differences between the two groups as regard age ,sex, weight and physical status.

There was no statistically significant difference in the time needed to perform the block in both coracoid and axillary groups and the time ranged in both groups between (3-8) minutes. In the coracoid group Mean ± SD was (5.86 ± 1.30) while in the axillary group was (5.80 ± 1.39). (P. *value* = 0.963) .

The onset of sensory blockade was more rapid in the axillary group and ranged between (16-22 minutes) with Mean ± SD (19.05 ± 1.93) than the coracoid group as the onset time ranged between (25-35 minutes) with Mean ±SD (30 ± 3.61). So, patients of the axillary group were sooner ready for surgery than patients of the coracoid group. (P.value = 0.001*) motor block was assessed every 5 min from the end of the block until 30 min in the distribution of the motor nerves.

Motor block was significantly more intense in the axillary group than the coracoid group and resulted in a better quality of motor block (*P-value*=0.016*).

Total duration of the block measured from the end of performance of the initial block to first appearance of pain or touch sensation in the fingers was recorded. The duration was significantly longer in the axillary group and ranged between (40-81 minutes) with Mean ± SD (58.15 ±1.60) than the coracoid group where the duration ranged between (48.50 ± 8.53 minutes) with Mean ± SD (48.50 ± 8.53). This allows for a longer duration of surgery and longer duration of post-operative analgesia in patients of the axillary group than patients of the coracoid group. (*P. value* =0.002*).

As shown in Tables (2) side effects and complications met with both groups were recorded.

Blood was aspirated from four patients (one from coracoid group and three from axillary group), suggesting vascular puncture. Hematomas were observed in two patients from the axillary group after performance of the block and they did not require treatment (P.value = 0.041 *) .

Tourniquet pain was reported by one patient in the coracoid group and four patients in the axillary group. (P.value = 0.039 *)

Muscle pain at the site of injection occurred in two cases of the coracoid group (P.value = 0.001*)

As shown in table (3) axillary block was significantly more successful than the coracoid block and resulted in more complete blocks (85% of cases) than the coracoid block (60% of cases). (P-*value* = 0.049 *)

Table 1: patients demographic data and anaesthesia variables in the two groups:

	Coracoid group	Axillary group	p. value
Age	37.60 ± 12.22	38.30 ±14.20	0.868
Weight	70.25 ± 5.74	70.60 ±6.34	0.856
Sex m\f	17/3	15/5	0.429
Block performance time (minutes)	5.86 ± 1.30	5.80 ± 1.39	0.963
Sensory onset time in minutes	30 ± 3.61	19.05 ± 1.93	0.001*
Block duration (min)s	48.50 ± 8.53	58.15 ± 1.60	0.002*

(*) Indicates statistical significance.

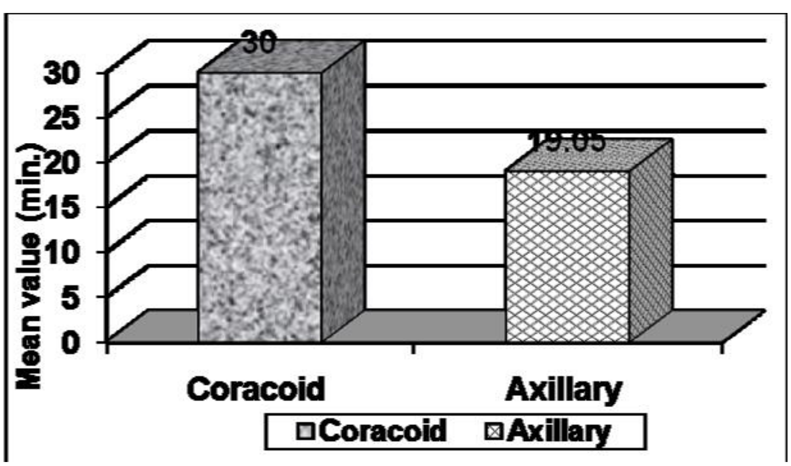

Fig 1: Sensory onset time in both coracoid and axillary groups in minutes.

Table (2): Side effects and complications in both groups:

		Complications in both groups		
		Vascular puncture	Tourniquet pain	Muscle pain
Coracoid	%	5	5	10
Axillary	%	15	20	0
P-value		0.041 *	0.039 *	0.001*

(*) Indicates statistical significance.

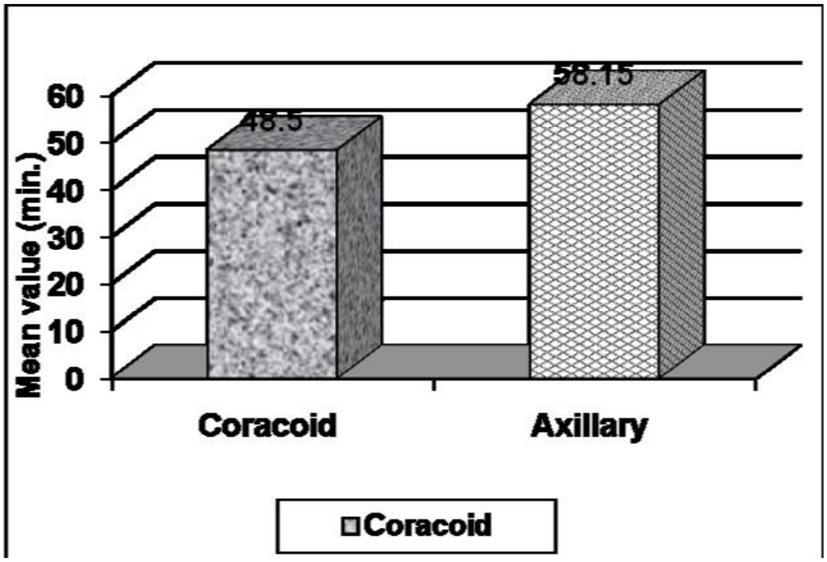

Fig 2: Total block duration in both coracoid and axillary groups.

Table (3): Success rate of both approaches

No.	Coracoid	Axillary
20	Complete blocks	Complete blocks
%	60%	85%
Chi-square	3.097	
P.value	0.049 *	

(*) Indicates statistical significance.

4-Discussion

Regional anesthesia for upper limb surgery can be performed by brachial plexus block via several approaches. Brachial plexus block is indicated for upper extremity surgery, and many techniques are available. The key to success depends on the accuracy of needle placement, nerve localization, and local anesthetic injection. Current techniques of nerve localization rely on surface anatomic landmarks for estimating brachial plexus location. However, at the time of needle insertion, the search for target nerves remains "blind"; thus, nerve blockade can be frustrating and time consuming. Most often, block failures result from imprecise needle placement, and even in experienced hands, the failure rate can be as high as 10–15%. (Tran de QH. *et al.,* 2009 and Borgeat A. *et al.,* 2001). Perivascular axillary brachial plexus block is a popular technique owing to its low complication rate and ease of performance. This technique can provide good surgical conditions at the hand, forearm and arm (Baranowski AP. and Pither CE., 1990 and Hill DA *et al.,*1992).

The coracoid infraclavicular block is performed at the level of the divisions and cords of the brachial plexus where they envelope the subclavian artery (Jandard C. *et al.,* 2002 and Kilka HG. *et al.,* 1995) The coracoid infraclavicular brachial plexus block is a relatively new technique for which the coracoid process is the anatomic point. With this approach, it is possible to cover all sensory territories of the distal part of upper limb (Raj PP. *et al.,* 1973 and Brown DL. *et al.,* 1998).

In this study we compared brachial plexus block performed by the axillary & the coracoid infraclaviular routes using a peripheral nerve stimulator as regard block performance time, onset of sensory block, motor block intensity, block duration and success rate.

The result of the present study is the finding that the axillary approach to the brachial plexus using four injections of the local anesthetic material resulted in a faster onset and fewer incomplete blocks than the coracoid approach using two injections. The axillary approach was also less painful and more comfortable to the patient with little side effects.

The coracoid approach had the following advantages over the axillary: the coracoid approach can be done with the arm in the neutral position, which is important for patients with an arthritic or stiff shoulder joint, and the coracoid process is easily palpable even in obese patients. The local anaesthetic is injected above the head of the humerus, avoiding the limitations reported in axillary block (Pere P. *et al.,* 1992 and Hadzic A. *et al.,* 1998) and ensures proximal spread of local anaesthetic.

However, our results indicate that injection at the cord level using the coracoid approach did not improve block effectiveness. In spite of the use of a double injection technique, only 60% of patients in the coracoid group had complete analgesia distal to the elbow, compared with 85% in the axillary group using a quadraple injection technique.

The relationship between number of injections and block effectiveness is in concordance with a study of(Bouaziz *et al.,* 1997) , who obtained 54% success after double injection axillary block and 88% after quadruple injection midhumeral block, and with the study of (Koscielniak-Nielsen, 2000) in which double injection resulted in 62% and quadruple injection resulted in 88% success.

The low effectiveness of the coracoid approach may be explained by insufficient spread of a local anaesthetic to the medial cord, from which the ulnar and the medial cutaneous nerves arise. (Thompson and Rorie, 1983) showed that the axillary neurovascular sheath is divided by connective tissue septae, which limit diffusion of local anaesthetic to the terminal nerves.

The results of our study indicate that similar septae may also exist at the cord level, and the double injection technique is not enough to ensure a high success rate (Thompson and Rorie, 1983).

Whiffler, 1981 reported 93% success using up to 60 ml of local anaesthetic. On the other hand, Raj *et al.,* 1973 had over 95% success using 20–30 ml. As much as 80 ml injected at one site into the axillary neurovascular sheath resulted in only 54% success (Koscielniak-Nielsen *et al.,* 1999). These contradictory results indicate that the volume of local anaesthetic is not a major determinant of success.

In our study, we observed that the block performance time did not differ between the two groups, ranged in both groups (3-8 minutes), despite double the number of nerves stimulated in the axillary group (four nerve stimulations) compared with double nerve stimulations in the coracoid group, and was similar to other studies of axillary block using multiple electrolocation (Koscielniak-Nielsen ZJ *et al.,* 1998). This may be explained by the deeper position of the cords in the coracoid approach. (Koscielniak-Nielsen, 2000) compared the coracoid infraclavicular and axillary techniques with the use of peripheral nerve stimulator and did not find a difference in terms of the duration of performance of the block between the groups.

Our results show that, shorter block latency in the axillary group was partly caused by the more uniform analgesia below the elbow. Therefore, the total time to complete block was shorter using axillary rather than coracoid approach and the readiness for surgery was faster with the axillary approach than with the coracoid approach. (Whiffler, 1981) also had obtained similar results& concluded that the thick axillary sheath was probably responsible for this effect.

In our study motor block was significantly more intense in the axillary group than the coracoid group and resulted in a better quality of motor block and the duration was significantly longer in the axillary group than the coracoid group. This allows for a longer duration of surgery and longer duration of post-operative analgesia in patients of the axillary group than patients of the coracoid group. In the study of Kapral *et al.,* 1999 and Ertug *et al.,* 2005 who compared axillary & infraclavicular approaches, the motor block was not significantly different between the two groups.

In conclusion the axillary approach to the brachial plexus using four injections technique resulted in a faster onset of block and a better spread of analgesia and longer duration of anesthesia than the coracoid approach using two injections technique.

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3/1/2012