Ultrasound-guided Brachial Plexus Block at the Supraclavicular Level: A New Parasagittal Approach

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Introduction

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INTRODUCTION

Brachial plexus blocks are widely used to provide anaesthesia for upper limb surgery. Regional anaesthesia usually works if the local anaesthetic is put in the right place. Therefore the key to a successful regional anaesthesia is nerve location. The first brachial plexus block was performed under direct visualisation after surgical exposure. Thereafter the technique for nerve location has progressed from blind paraesthesia techniques to electrical nerve stimulation with or without ultrasound-guidance. Although many different approaches to the brachial plexus have been described, there is widespread acceptance that injecting at the supraclavicular level is the most reliable method in terms of spread of local anaesthetic agent. However, the fear of pneumothorax is frequently quoted by anaesthetists as a reason to avoid this approach. Certainly the quoted rate of between 1 and 6% is of considerable concern given the potential seriousness of this complication. Ultrasound-guidance for brachial plexus blocks has shown to improve success and complication rates. A supraclavicular approach described by Chan et al with probe resting posterior to the clavicle, with posterolatero-antromedial orientation provides a very stable location, but has the disadvantage of “looking” across the first rib, with the apex of the lung visualised close to the Plexus. If the tip of the needle is not accurately seen on the Ultrasound image, a pneumothorax is possible. This case series examines the technique and clinical usefulness of a new posterior parasagittal approach to the brachial plexus at the supraclavicular level, utilising the arc of the first rib to provide a deep limit to needle transit, and probe stability by resting against the scalene muscles medially, and clavicle anteriorly.

METHODS

After hospital ethics committee approval and written informed consent, 60 patients scheduled for elective day case hand surgery received ultrasound guided supraclavicular brachial plexus block utilising the posterior parasagittal approach. Patients were excluded if they had neurological deficit in the upper limb or had contraindication to supraclavicular brachial plexus block. Data collected included surgical procedure, duration of surgery, time required for block performance (time elapsed from local anaesthetic for needle insertion to the end of local anaesthetic injection), time of onset of sensory and motor block of the median, radial and ulnar terminal nerves, the proportion of blocks needing supplementation, postblock complications and patient satisfaction. All blocks were performed by a single operator (AS).
The patient was positioned supine with the head turned gently to the contralateral side, and a pillow in a normal position under the head and shoulders. A pen was placed at the root of the neck (Fig. 1) and the skin underlying the pen was marked (Fig. 2). The pen therefore lies against the skin overlying the trapezius muscle posteriorly and the scalene muscles anteriorly, in a strictly parasagittal plane, with the arc of the first rib underneath. A high frequency (5 to 10 MHz) ultrasound probe (SonoSite Micromax; SonoSite, Inc. Bothwell, USA) was placed along this parasagittal line in the anterior part of the supraclavicular fossa (Fig. 3). At this point the subclavian artery is seen with the brachial plexus in close proximity. A 23G 60 mm needle (TOP Neuropole needle, TOP Corp. Tokyo) was advanced, without using a nerve stimulator, from the anterior border of the trapezius muscle “in plane” with the ultrasound probe. In this way the shaft of the needle can be seen approaching the plexus and the advancing needle tip adjusted for depth and distance to obtain optimum placement. On entering the sheath of the plexus, 1% Prilocaine was injected after negative aspiration. Direct observation of the spread of local anaesthetic allowed clinical decisions whether to redirect the needle to ensure spread throughout the plexus. The injection was completed when the plexus sheath was filled with local anaesthetic as judged by the operator. Anaesthesia to ethyl chloride spray and motor block were checked by an independent observer every minute for up to 30 minutes in the median, ulnar, radial and musculocutaneous nerve distributions. A successful block was defined as complete sensory and motor block in all regions assessed within 30 minutes of local anaesthetic injection. Anaesthetic failure in the surgical area would be supplemented with local anaesthetic infiltration or general anaesthesia if necessary. All patients were asked whether they had any respiratory discomfort prior to discharge from the unit. Chest radiograph was ordered only if patients complained of respiratory discomfort.

Continuous data are expressed as mean ± SD.

RESULTS
Sixty patients completed the study. There were 33 males and 27 females. Surgical duration was 71.9 ± 35 minutes. All blocks were performed by a single operator (AS). In all
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patients, the supraclavicular plexus was visualised within seconds of probe placement. The local anaesthetic volume used was 25.7 ± 5 ml. The blocks were completely successful in 54 patients. No patient complained of tourniquet discomfort. Six patients required minor peripheral local anaesthetic infiltration during the surgical procedure.

The block procedure took 4 ± 1.5 minutes. Sensory block was completed in radial nerve distribution by 12 ± 4.7 minutes, ulnar nerve distribution by 13.3 ± 5.6 minutes and in the median nerve distribution by 13.4 ± 5.1 minutes. The motor block was complete in 14.1 ± 5.2 minutes.

Patient satisfaction with the block procedure was high, with 84% reporting “excellent” satisfaction, and “good” satisfaction in 16%.

Complications due to the block included small vessel arterial puncture in one patient and Horner's syndrome in four patients.

DISCUSSION

The results of this prospective study suggest that the parasagittal approach for supraclavicular brachial plexus block is a clinically useful and safe technique for accurate nerve localisation. This approach improves the speed of execution and quality of supraclavicular block.

There have been various ultrasound guided approaches described for supraclavicular brachial plexus blockade. Kapral et al³ imaged the plexus 3 cm superior to the midpoint of the clavicle in the sagittal plane. The needle orientation relative to the ultrasound probe was not described. De Andres et al⁷ utilised an out of plane approach to the plexus in the sagittal plane. The disadvantages with the out of plane approach include difficulty in visualising the needle tip with the resultant increased risk of inadvertent arterial or pleural puncture.

Perlas and Chan et al⁸ utilised a coronal oblique plane with the ultrasound probe placed parallel and immediately posterior to the clavicle. The needle was advanced in plane from either medial to lateral or lateral to medial direction after visualising a short axis view of the brachial plexus and the subclavian artery. The medial to lateral approach was associated with risk of arterial puncture in the region of 0.4%.

The parasagittal approach described here enables the operator to locate the arc of the first rib and the apex of the pleural dome. Most supraclavicular approaches rely, implicitly or not, upon the first rib for safety. Visualisation of the arc of the first rib in the plane of the ultrasound beam and needle creates a secure deep safety feature (Fig. 4). At this anatomical point, the subclavian vein is well-separated from the brachial plexus and the subclavian artery, with the plexus positioned posterior to the artery. There are therefore no major structures of concern in the needle path before the needle approaches the brachial plexus. An in-plane approach helps in visualising the needle shaft and more importantly, the needle tip. By approaching the plexus in a nearly horizontal plane to the ultrasound beam except in very deep cases, the reflection back to the probe is maximised, giving a clear image of the needle. This technique ensures that the needle tip does not trespass the first rib or the pleural dome thereby theoretically eliminating the risk of pneumothorax. Whilst this study is underpowered to demonstrate this safety, ongoing personal and hospital audit data has confirmed safety of the technique.

A rapid examination technique whereby the artery, plexus, vein, and apex of lung are all located and positively identified allows understanding of variance from normal anatomy and accurate location. The study was performed without the use of a nerve stimulator as it was rapidly found that with direct visualisation of spread, the operator quickly adapted to observation of spread rather than of twitches. Patients frequently report dislike of nerve stimulation effects, and with the introduction of ultrasound-guidance, would appear to be unnecessary as a routine practice. The positioning for the patient is very comfortable, possible variations include the use of a head ring, or lateral.

Fig. 4: Block needle approaching the brachial plexus from the right (posterior) with subclavian artery anteriorly, and the continuous line of the arc of the first rib acting as a deep safety marker. A small amount of local anaesthetic (2 ml) has been injected, spreading at two/three o'clock towards the artery.
The block procedure time (4 ± 1.5 minutes) is comparable with Williams et al9 (5 ± 2.4 minutes) and Chan et al (9 ± 4.4 minutes).6,8 In the latter study, blocks were performed by inexperienced operators. However, in the present study the onset of sensory block was quicker (13 ± 5 minutes) using a much smaller volume (25 ± 5 ml) of local anaesthetic when compared to Chan et al (40 ml). A prejudged volume of local anaesthetic agent was not used in this study; the injection was stopped when the operator felt that the plexus sheath was filled with the local anaesthetic agent. Only 10% of the patients required peripheral supplementation in our study when compared to Williams et al9 (15%).

In conclusion, parasagittal approach to the supraclavicular plexus described here enhances visualisation of the structures in the supraclavicular fossa, is associated with a rapid onset time using a smaller volume of local anaesthetic agent, no need for nerve stimulation, and an excellent success rate with theoretically minimal risk of pneumothorax.

Poststudy note: This approach has been monitored, with ongoing audit confirming reliability and safety with a much larger number of patients. It is quickly learnt by trainees, which may give an opportunity for further studies.

REFERENCES