MALAYSIAN SOCIETY OF ANAESTHESIOLOGISTS YEAR BOOK 2014/2015

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Foreword

The Malaysian Society of Anaesthesiologists (MSA) is once again proud to present to our members the eight edition of our Year Book 2015/2016. This year's edition is a bit different from previous years as it is themed on peripheral nerve blocks - regional anaesthesia. Horlocker in his editorial for Regional Anaesthesia and Pain Medicine journal (RAPM) in 1998 had described Peripheral Nerve Blocks as the Regional Anaesthesia of the Millennium.[1]

The advancement of ultrasound had resuscitated the practice of peripheral nerve blocks amongst the anaesthesia fraternity. I am proud that our members embraced this practice whole heartedly with the evidence of reviews and research done which are compiled in this year's year book.

I wish to thank our contributors, from the very senior knowledgeable members to those brilliant younger ones, for their effort and time spent in making this publication complete. I hope the MSA members will appreciate the hard work involved and for that I must thank Dr Mafeitzeral Mamat, the editor, and Dr Shaktivel Palanivel, the co-editor, for all their efforts. We appreciate your perseverance and patience but I am sure the end-product makes it all worthwhile!

I hope MSA members will benefit from our Year Book and look forward to our next issue. Congratulations once again to the team involved, from the contributors, the reviewers and the editor for producing articles of interest and quality.

Dr Raveenthiran Rasiah
President
Malaysian Society of Anaesthesiologists 2015 - 2017

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Preface

Welcome to the 2015/2016 edition of the Malaysian Society of Anaesthesiologists (MSA) Year Book.

"one small step for man, one giant leap for mankind" - Neil Armstrong

Regional anaesthesia has been recognised by the Ministry of Health in 2016 as a special interest training for anaesthesia. This book is one of the first formal references of regional anaesthesia practice in Malaysia.

I embarked on a difficult and time consuming task of compiling materials related to regional anaesthesia and pain medicine. The plan, as challenging as it sounds, is to one day produce a book at par if not better than the ANZCA Blue Book! All big dreams start with little hops and leaps.

It is not traditional to publish technical reviews or work practices, especially if one is not affiliated to a university. The nation is experiencing a huge growth in the medical sector, and we find ourselves swamped with extreme clinical workloads in both public and private hospitals. We do have plenty of good lecturers amongst us who are often invited to present in international forums around the world. This book is a timely effort to encourage more of our colleagues to write and publish internationally.

I must thank all the contributors for their efforts to meet the deadline for publication. Well done!

My upmost gratitude to Miss Molly Kong from the Academy of Medicine of Malaysia for her tremendous effort during the process of producing this year book.

Enjoy the book!

Mafeitzeral Mamat
Shaktivel Palanivel
Editors
MSA Year Book 2015/2016

Erratum For Malaysian Society Of Anaesthesiologists Year Book 2014/2015

1) **The Obese Parturient (page 14-21)**
Norliza Mohd Nor

Table I

the unit is
BMI : kg/m2 (corrected)

2) **Perioperative Pain Management in the Paediatric Patient (page 62-73)**
Lakshmi Thiyagarajan

Dosage error in published Table 1.

The maximum daily dose for term neonates. (37 weeks to 10 days) 60mg/kg/day (corrected)

OH NO! WHAT TO DO....!!
A Guide To Suspected Post Block Neurological Injury

Amiruddin Nik Mohamed Kamil, Azrin Mohd Azidin
Hospital Kuala Lumpur, Kuala Lumpur, Malaysia

INTRODUCTION

The outcome neurological issues following a peripheral nerve block (PNB) can vary from mildly annoying to extremely catastrophic. The damage can be attributed to several factors, ranging from patient's factors, surgical technique and exclusively procedural factors.[1]

Identifiable factors that can lead to nerve injury are mechanical or chemical nerve insult(s). Examples of mechanical trauma include direct nerve injury from inadvertent needle puncture or impalement,[2] pressure/hydrostatic effects of local anaesthetic injection or ischemic, from haemorrhagic compression of the fascicles or the use of epinephrine causing vasoconstriction of vasa nervorum.[1,3]

Prior studies have also implicated varying potential degrees of chemical neurotoxicity in several commonly used local anaesthetic solutions and its adjuvants in vitro.[4-8] It should be noted, however that most of the knowledge on the possible causes of nerve injury are obtained from animal experiments and cadaveric human nerve specimens making its interpretation in relation to actual clinical practice difficult.[1,2]

INCIDENCE

The incidence rate of neuropathy after Peripheral Nerve Blocks (PNB) is generally estimated to be around 0.9 to 18 per 1000 block cases with different rates quoted for techniques.[9,10] Fortunately, permanent neurological injury after PNB is rare in modern anaesthetic practice.[11]

Auroy's landmark study in 1999 yielded the often-quoted risk of 1:4185 for a neurological deficit attributable to the block and 1:7175 for a deficit lasting more than 6 months,[12] Barrington et al.'s more recent study suggests marginally higher risks of 1:2300 and 1:3578, respectively.[13] However, the incidences quoted a variety of PNB techniques ranging from landmark-based to peripheral nerve stimulators and ultrasound guidance.

WHAT TO DO IF THERE IS PROLONGED NEURAL BLOCK?

All post block patients are to be reviewed within a reasonable time after the procedure/block. The return of sensation, the extent and the return of motor function especially in limb blocks, documented. Sensory and motor deficit persisting expected duration of action of the local anaesthetic load is an ominous sign and prompt management is prudent. This may indicate neurological injury.

Additional risk factors for neurological injury include:

- Nerve blocks/regional anaesthesia as sole anaesthetic technique.
- Received Local Anaesthetic (LA) or its adjuvants.
- Received a known load of LA agents with symptoms persisting beyond the expected duration of action for such loads.
- Symptoms or distribution of deficits are consistent with anatomical distribution of specific nerves or regions (dermatomes, myotomes orosteotomes) consistent with the location of the given block.
- Neurological symptoms may be persistent, spread over a wider area or involve worsening grades of neurologic deficit as compared to baseline.

WHAT ARE OUR FURTHER PLANS OF ACTION? MANAGEMENT OF PERIPHERAL NERVE INJURY (PNI)

Management of patients with suspected nerve injury would involve;

a) History taking
b) Physical Examination and neurological assessment
c) Investigation

History Taking

Good communication is important. This helps to relieve anxiety due to the reduced function of a limb and helps to instill trust in patients. Affected patients need good education to better understand the condition, possible progression of neurological deficits and requirements of management.

Part of history taking is investigating the perioperative procedural events with detailed information from the staff who performed and assisted in the blocks, looking through the various forms of block documentation or saved images of the said block as well as the surgical notes for any possible reasons for the observed deficits encountered.

Points of note that would need further clarification include to;

a. Preexisting diseases

Presence of underlying deficit prior to the new neurological insult ie diabetes mellitus with neuropathy and anticoagulant/antiplatelet treatment should be noted

b. **Pattern and grades** of encountered neurological deficit

The deficit(s) can be purely sensory, for example numbness, paresthesia or dysesthesia or present with concomitant motor weakness. Was there a mixed sensory and motor deficit pattern or was it associated with pain? Evolving symptoms or grades of symptoms are danger signs that would require prompt intervention.

c. Questions related to the actual **block procedure**

The **type of block** given - whether there was any difficulty encountered during block procedure.

Was the block performed **under ultrasound guidance** or using landmark technique?

Was **nerve stimulator used** and what were the modes and settings? If it was used, what was the threshold current before LA injection?

Whether the patient was **under general anaesthesia** or heavily sedated during the block performance?

What was the **image quality of both the target nerve and needle**?

Was there an inadvertent **intraneural** injection? Any saved still images or videos can substantiate this and can be reviewed.

Did the patient **complain of paresthesia** during block?

d. **Type of local anaesthetic** (LA) used.

Type of LA used whether short or intermediate to long acting, and what was the anaesthetic load- concentration and volumes?

Any mixing of LA? If there was mixing of LA what was the volume and final concentration?

Usage of **adjuvant** whether with or without vasopressors?

e. Questions related to the **surgical procedure**.

Was the **surgery difficult**?

Any neural complication expected from the surgery; from surgical manipulation or traction or expected nerve oedema?

Was a limb **tourniquet** used and what was the pressure and duration of tourniquet used?

Abnormal limb position during surgery? Was **excessive traction** applied to the limb?

Usage of **cast** postoperatively?

Post-operative monitoring of the blocked limb- for limb compartment syndrome, for example when indicated.

Physical Examination

Ascertain the pattern and grades of neural deficit present whether there is mono or polyneuropathy. This may indicate the probable site of neural injury.

Assessment would involve clues from general inspection and specific evaluation tools of grades of neuropathy.

General Inspection

Whether there was any hematoma at the block site.

Look for clues like abnormal posture or position of the limb for example claw hand (median or ulnar claw).

Check for scars, skin changes, muscle wasting and signs of reflex sympathetic dystrophy.

Specific assessment of motor power and sensory testing must be done to provide grading of baseline neurological damage.

A proper baseline documentation of deficits will be critical ion detecting progression.

Motor power - Assess the force of the muscles using the Medical Research Council (MRC) scale:

0 - no movement
1 - flicker of movement
2 - moves with gravity eliminated
3 - moves against gravity but not resistance
4 - reduction of movement against resistance
5 - full muscle power

Using upper limb dermatomes as an example, specific score for each dermatome can be allocated based on the assessment:

- Shoulder abduction - C5
- Elbow flexion - C5, C6
- Elbow extension - C7, C8
- Wrist flexion - C7
- Wrist extension - C7
- Intrinsic muscles of hand e.g. finger ab/adduction - T1

Alternatively, a composite scoring for muscle groups can be used and compared with the post-block baseline scores as an indicator of block regression.

Sensory Testing

Dermatomal skin testing should be done using a standardized temperature and pain stimuli. Effort must be made to map the area of deficiency and elucidate whether the sensory deficit correlates with specific root / nerve dermatomal distribution.

Investigation

Diagnosis or suspected presence of neural injury are mainly based on clinical grounds. Certain investigative tests may be considered to further evaluate the extent of injury. Two aspects of importance would be to ascertain the **SEVERITY** and the **LEVEL** of nerve damage.

Severity of injury affects the prognosis. Histologically it is determined by the residual integrity of the axons, classified into neuropraxia, axonotmesis and the most severe form, neurotmesis.[14] Tests to be done would depend on the benefits of the various modalities whether a structural or functional cause is suspected. Available tests would include:

1) MRI - Referral to a radiologist and discussion regarding the urgency and capability of appropriate radiological investigation to aid diagnosis process depending on the nature of suspected injury. MRI nerve setting would be an appropriate test if a structural type of injury is suspected.

2) Electro-neurodiagnostic tests - Nerve conduction study (NCS) and electromyography (EMG) are two important functional tests.

Besides obtaining information on the nerve lesion severity, these tests would be able to pin point the level of insult based on the recorded amplitude and velocity changes obtained. A neurologist / neurophysiologist consult for these tests is required and more often than not it is done after four to six weeks, as the neurophysiological changes are more distinctly defined then.

PRINCIPLES OF MANAGEMENT

A Suggested Approach

When faced with the dilemma of whether there is an occurrence of PNI, the attending anaesthetist must have answers to these questions:

- Should there be a **resolution of block** at this point of contact?
- Is there any **presence of evolving neural signs or symptoms**?
- Are the symptoms and signs present **persisting beyond the expected duration of the known load of LA and its adjuvants**?
- Is the deficit **reversible**?
- Is there any **motor component** present?

R**esolution of block** is the ideal end-point that we should strive for but, in real practice, it is made difficult by the various inter and intra-individual pharmacologic variability in clinical response.

Hence, routine periodic audit of practice is of importance to highlight the spectrum and patterns of clinical behaviour of the various loads of LA and its adjuvants towards the multitudes of surgical procedures that we perform.

A **persisting block that extends beyond the predicted duration of the concerned load of anaesthetic** should provide a warning sign of impending injury.

In an acute setting if there is presence of **evolving neural deficit or the presence of weakness**, a remediable cause must be identified early, for example a tight cast / dressing, or an expanding hematoma compressing on the nerve. In the presence of such aetiology, always have a low index of suspicion and seek urgent surgical and neurology consult.

When there is a suspected neuropathy:

1. **Sensory only**

   If the deficit involves **sensory** component only and is resolving during the period of observation, conservative management is the mainstay of therapy.

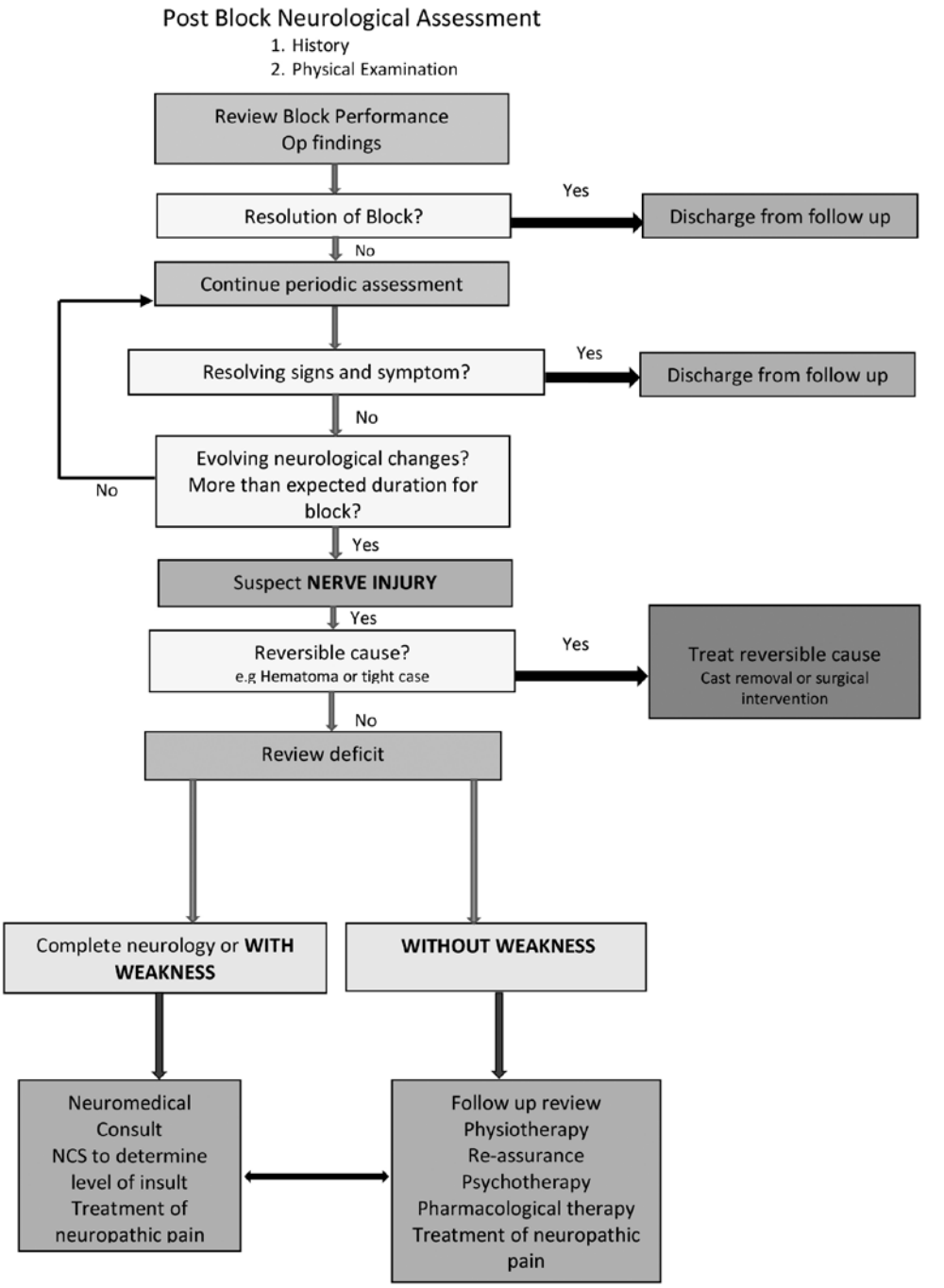
   Patients need to be explained to regarding the course of disease if this is not done during earlier point of contact.

   Counselling and assurance need to be given. A large majority of signs and symptoms will resolve within 6 months in 95% of patients with neuropathy and 99% will usually resolve within a year. Fortunately, permanent deficit is rare.

2. **Sensory with motor involvement**

   If there is associated **motor deficit**, there must be an urgent referral made to a radiologist (referral for radiological investigation), neurologist or neurophysiologist to determine whether there is a structural or physiological basis for the extent of injury. Further consultation with neurosurgeon / hand and microsurgery surgeon is also indicated if there is any evidence of possible surgical reversibility.

ALGORITHM FOR SUSPECTED POST PERIPHERAL NERVE BLOCK NEUROLOGICAL DEFICIT



3. Treat **neuropathic pain early and aggressively** when present.

4. **Rehabilitative therapy** must be instituted as early as possible to help reduce secondary functional restriction as a result of disuse myopathy or fixed deformity.

Follow Up Management

Management at subsequent follow-up is vital.

- There should be an objective **ongoing assessment of neuropathy**.
- Tinnell sign is a clinical tool used to estimate progression of nerve recovery.
- **Physiotherapy / Occupational therapy** referral, if not already done at an earlier point of contact.
- **Review investigation findings** (MRI, NCS/EMG) to confirm severity and the level of lesion to **prognosticate recovery**.
- **Splinting** of the affected limb to avoid further complications related to primary pathology may be required; for example avoidance of foot-drop or immobilization to reduce neuropathic pain due to reflex sympathetic dystrophy.
- **Review of neuropathic pain and symptoms** Escalation of therapy may be required if existing analgesic modality is inadequate. Multimodal treatment using various groups of available analgesic drugs may be required depending on severity of symptoms.
- Prescriptions of **vitamins** for example neurobion or methylcobalamin may be controversial.

CONCLUSION

Periodic objective neurological assessment and early detection are the core fundamentals in managing suspected PNI. Its aetiology may be multifactorial and establishing a cause requires systematic evaluation, hence the need for a formalized guideline on principles of management based on current understanding.

Neuropathy may not be totally eradicated but should it occur, therapeutic and supportive treatment must be instituted responsibly and with empathy. Medico-legal implications may ensue, but managing the patient holistically should be the priority.

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Aggressive Approach To Prevent Post Herpetic Neuralgia (PHN) - Current Hallmark Of Treatment

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SHEARING PAIN OF HERPES ZOSTER

Reactivation of latent Varicella Zoster Virus (VZV) infected neural ganglia produces dematomal skin lesion called Herpes Zoster (HZ) or Shingles. VZV is an exclusively human neurotropic alpha herpes virus which invokes cellular mediated immunity upon developing varicella infection or chicken pox. The virus remains dormant in the cranial nerve ganglia, dorsal root ganglia and autonomic ganglia along the neuraxial for years after the initial infection.

With a decline in immunity, VZV reactivates to produce shingles, which can present anywhere on the body or face. In most situations, complete resolution of symptoms occurs in 2 to 4 weeks.[1]

However, some patients may continue to suffer from prolonged sequalae of shingles, which include chronic pain of post herpetic neuralgia (PHN), meningitis or meningoencephalitis, prolonged itching, ophthalmoplegia, multiple cranial nerve palsy, vasculopathy, myelopathy and various inflammatory disorders of the eye.[2]

EPIDEMIOLOGY OF PHN

More than two thirds of HZ infection occur in those aged 50 and above with an overall lifetime estimated risk up to 30%. The risk of recurrent HZ infection and severe HZ increases in immunocompromised patients.

Pain occurs at different phases of HZ. Based on various definition of PHN, the incidence can range from 7% to 50% at 3 months following HZ onset and 6% to 32% at 6 months.[3] A recent global epidemiology study suggested that up to 80% incidence of PHN occurs beyond the age of 50.[4]

PHASES OF PAIN IN PHN - WHEN TO CALL IT CHRONIC PAIN?

The agreeable point of definition for PHN is still debatable. Research done in the past may have overestimated the incidence of PHN based on 'any associated pain'. However the burden of PHN chronic pain may not be significantly overwhelming in some patients. Therefore a more appropriate definition would be 'clinically meaningful pain' with VAS >30mm and a >3 months duration of pain.[5]

Hence, it would be more practical to classify Shingles pain according to these 3 categories:

(a) Acute herpetic neuralgia within 30 days of infection
(b) Subacute herpetic neuralgia within 30 - 120 days
(c) Chronic PHN beyond 3 months or 120 day[6]

PATHOPHYSIOLOGY OF PAIN IN PHN

PHN is one of the two prominent peripheral neuropathic pain, the other being diabetic peripheral neuropathy. Based on current research, PHN occurs due to structural changes in the affected neurons and biochemical sensitization. The skin biopsy of PHN patients showed markedly reduced number of unmyelinated epidermal/dermal nerve fibres with diminishing nerve density.[7,8] Similarly, dorsal root ganglia showed signs of necrosis and in some cases inflammation that spread to anterior horns leading to motor symptoms.

Biochemically, the structural damage involves satellite glial cells (SGC) which surround neurons in sensory ganglia. This in turn leads to large intercellular calcium waves and intracellular influx upon mechanical stimulation. This results in the augmented release of excitatory neurotransmitter such as glutamate, substance P and calcitonin gene related peptide (CGRP).[9]

RISK FACTORS

Recognizing the risk factors for developing severe PHN would assist us to stratify the symptoms on initial presentation. The MASTER study identified higher acute pain severity, older age, being immunocompromised, lower income group and not receiving antiviral treatments as strong predictors for severe postherpetic illness.[10]

In another analysis of the same cohort, older age group, greater acute pain severity and functional status emerged as independent predictors for PHN.[11] A recent meta-analysis showed that clinical features of acute zoster including prodromal pain, severe acute pain, severe rash and ophthalmic involvement, will more than double the risk of developing PHN.[12]

Furthermore, it was described that psychological factors such as anxiety and depression, lower life satisfaction and greater disease conviction may alter perception of pain. These are psychological determinants for PHN which impact the life of patient socio-economically as well.[13,14] The purpose of establishing clinical predictors is mainly for primary care treatment and preventive HZ vaccination.

BURDEN OF ILLNESS

Chronic neuropathic pain condition impairs health related quality of life and patients' daily function. The amount of days off work, lost of productivity and presence of associated comorbidities such as anxiety, depression and sleep disorder will further accumulate into increasing economic burden and psychosocial dysfunction.[15]

Based on a recent cost analysis study in the US, for each 1000 persons above 50 years vaccinated, 25 HZ cases and 1 PHN can be prevented. The estimated incremental cost saving for each quality-adjusted-life-year (QALY) is more than a quarter of million USD.[16]

CLINICAL PRESENTATION

Pain associated with acute HZ is almost similar to chronic PHN. In more than half of HZ infection, pain may even precede rash and vesicular eruption by up to 7 days. It is commonly perceived as unilateral spontaneous burning pain and paraesthesia, accompanied by itching with varying symptom severity on the affected dermatome. Clinically subtle presentation with main symptom of unilateral dermatomal pain without skin eruptions is called *zoster sine herpete*. There are also reports of neurological dysfunction without skin lesion or rash.

As for PHN, there are 3 main characters of pain disturbance:

(a) A constant deep aching or burning pain commonly perceived over the affected dermatome.
(b) Severe paroxysmal lancinating pain that shears through the area with varying interval and duration.
(c) Persistent mechanical or cold allodynia which is mostly disturbing in majority of patients causing distress on slight tactile contact (clothes/ blankets) or even air flows.[8]

Allodynic pain of PHN progressively increases throughout the day, and this variation appears unaffected even with treatment. The circadian variation may be related to diurnal neurohormonal and neurophysiological changes.[17]

DIAGNOSIS

For research purposes; pain mapping, quantitative sensory testing (QST), capsaicin response test and skin biopsies have been used to study the course of illness and correlation with pain symptoms. QST uses allodynia with foam brush, warmth detection, cold detection and heat pain detection.[3]

In clinical situation, using International Headache Society (IHS) definition of trigeminal PHN in cephalgia may greatly assists diagnosis. Pain persisting or recurring more than 3 months after onset of HZ infection, cranial or facial dermatomal painful lesion, herpetic eruption in the same territory and pain preceding eruption by <7 days are

the criteria for cranial PHN. These could be adapted for non-cranial PHN as well.

Additionally, neuropathic pain inventories such as PainDETECT (Figure 1) can be used to establish diagnosis of PHN. Other questionnaires (Table I) are also useful for diagnosis of neuropathic pain, such as McGill questionnaire, Leeds Assessment of Neuropathic Symptoms and Signs Scale (LANSS), Douleur Neuropathique 4 questions (DN4) and Neuropathic Pain Questionnaire (NPQ).[18]

PREVENTION OF PHN

A good quality of evidence support the use of live attenuated Varicella Zoster Virus (VCV) vaccine for prevention of morbidity and QALY lost related to outcome of HZ, including prevention of PHN. The efficacy of the vaccine to reduce incidence of acute HZ is 51% and hence the incidence of PHN by 67%.[19] Number-needed-to-vaccinate to prevent acute shingles and PHN are 11 (95% CI, 10-13) and 43 (95% CI, 33-53) respectively.[20,21]

The US Advisory Committee for Immunization Practices recommends a single vaccination for adult aged more than 60, including those with past history of HZ and chronic medical conditions.[22]

Treatment in Acute Stage of HZ

Antiviral agents started within 72 hours of rash onset provide accelerated resolution of skin lesions and hence reduce HZ related complications. Famciclovir or Valaciclovir are the antiviral of choice, as they confer similar benefits as Acylclovir, with a better pharmacokinetic profile and fewer adverse effects.[20] However, they have no preventive role for PHN.

Acute pain treatment with multimodal oral analgesics is an essential approach to prevention of PHN. Regular paracetamol and tramadol or oxycodone in acute HZ pain have been described to be effective in prospective studies.[23,24] The average duration of treatment would be 14-30 days in the acute stage of HZ. The choice of tramadol or oxycodone is based on severity of pain. There are

TABLE I: Common items included in neuropathic pain inventories

Items	LANSS	DN4	NPQ	PainDETECT	ID Pain
Pricking, tingling	X	X	X	X	X
Electric shocks, shooting	X	X	X	X	X
Hot, burning	X	X	X	X	X
Numbness		X	X	X	X
Pain evoked by light touch	X		X	X	X
Pain cold, freezing pain		X	X		
Autonomic changes	X				
Brush allodynia	X	X			
Raised soft touch threshold		X			
Raised pinprick threshold	X	X			

painDETECT™

PAIN QUESTIONNAIRE

Date: **Patient:** Last name: First name:

How would you assess your pain **now**, at this moment?

0 1 2 3 4 5 6 7 8 9 10

none max.

How strong was the **strongest** pain during the past 4 weeks?

0 1 2 3 4 5 6 7 8 9 10

none max.

How strong was the pain during the past 4 weeks **on average**?

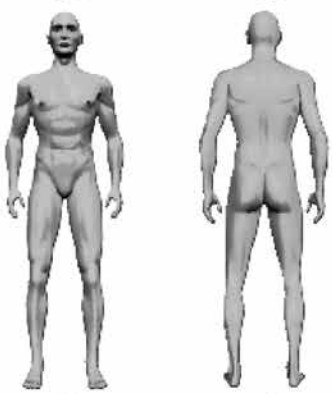
0 1 2 3 4 5 6 7 8 9 10

none max.

Mark the picture that best describes the course of your pain:

- Persistent pain with slight fluctuations ☐
- Persistent pain with pain attacks ☐
- Pain attacks without pain between them ☐
- Pain attacks with pain between them ☐

Please mark your **main area of pain**



Does your pain radiate to other regions of your body? yes ☐ no ☐

If yes, please draw the direction in which the pain radiates.

Do you suffer from a burning sensation (e.g., stinging nettles) in the marked areas?

never ☐ hardly noticed ☐ slightly ☐ moderately ☐ strongly ☐ very strongly ☐

Do you have a tingling or prickling sensation in the area of your pain (like crawling ants or electrical tingling)?

never ☐ hardly noticed ☐ slightly ☐ moderately ☐ strongly ☐ very strongly ☐

Is light touching (clothing, a blanket) in this area painful?

never ☐ hardly noticed ☐ slightly ☐ moderately ☐ strongly ☐ very strongly ☐

Do you have sudden pain attacks in the area of your pain, like electric shocks?

never ☐ hardly noticed ☐ slightly ☐ moderately ☐ strongly ☐ very strongly ☐

Is cold or heat (bath water) in this area occasionally painful?

never ☐ hardly noticed ☐ slightly ☐ moderately ☐ strongly ☐ very strongly ☐

Do you suffer from a sensation of numbness in the areas that you marked?

never ☐ hardly noticed ☐ slightly ☐ moderately ☐ strongly ☐ very strongly ☐

Does slight pressure in this area, e.g., with a finger, trigger pain?

never ☐ hardly noticed ☐ slightly ☐ moderately ☐ strongly ☐ very strongly ☐

(To be filled out by the physician)

never	hardly noticed	slightly	moderately	strongly	very strongly
☐ x 0 = 0	☐ x 1 = ☐	☐ x 2 = ☐☐	☐ x 3 = ☐☐	☐ x 4 = ☐☐	☐ x 5 = ☐☐

Total score ☐☐ **out of 35**

R. Freynhagen, R. Baron, U. Gockel, T.R. Tölle, CurrMed ResOpin Vol 22, 2006, 1911-1920

Figure 1: PainDETECT questionnaire for assessment of neuropathic pain

some evidences supporting use of Lignocaine patch for acute pain in HZ, especially in *Zoster Sine Herpete*.

Early use of tricyclic antidepressant (TCA) after diagnosis of acute HZ for duration of 90 days, with the dose of 25mg daily, reduced PHN prevalence by more than one-half at 6 months.[20,25] The role of gabapentinoids in treating acute HZ pain is contradictory.

Paravertebral or epidural local anaesthetic and steroid injections were shown to have moderate quality of evidence to alleviate acute HZ pain. They are however weakly recommended as they have not been systemically compared against oral pharmacotherapy.[26] Unfortunately, the interventions suggested have only shown minimal benefit in prevention of PHN and hence not recommended as routine treatment.

TREATMENT OF POSTHERPETIC NEURALGIA

The management of PHN can be divided into pharmacological and non-pharmacologial treaments. The latter includes interventional procedures, psychosocial treatments and complementary medicine interventions.

Pharmacological Treatment

PHN treatment with established evidence of efficacy is outlined in recent recommendations by Neuropathic Pain Special Interest Group of the International Association for the Study of Pain (IASP-NeuPSIG) 2015. Tricyclic antidepressant (TCA), gabapentinoids, topical capsaicin, topical lignocaine and opioids have strong evidence for efficacy in PHN. However in specific studies for PHN treatment involving serotonin and noradrenaline reuptake inhibitor (SNRI) is lacking.[27]

Previous recommendation by the same body placed opioid analgesics and tramadol as first or second line treatment. However due to risks involved with misuse, addiction and diversion, tramadol is now categorized as second line and strong opioids as third line treatment.[28]

First Line Treatment

TCA and Gabapentinoids are recommended as first line treatment based on strong evidence of their efficacy in specific PHN studies. Nortriptylline and amitriptylline have been effective antidepressants for PHN, with the former gaining more popularity due to its better tolerable side effects. Dry mouth, urinary retention and palpitation are usual complaints with the therapy. Combined Number-needed-to-treat (NNT) for neuropathic pain in general is 3.6 and Number-needed-to-harm (NNH) of 13.4 at dose ranges from 25 to 150mg/day.

Pregabalin and gabapentin are gamma amino butyric acids analogue which act by modulating calcium influx upon activation of alpha 2 delta subunit, resulting in reduction in excitatory neurotransmitters and diminution of pain signals. Combined NNT for gabapentin including low (900mg/day) and high dose (2400mg/day) usage is 5.1 (4.1-6.8). Pregabalin at dose of 150 to 600mg/day has a combined NNT of 4.2 (3.4-5.4).[30] Common adverse effects are sedation and weight gain. Recent meta-analysis suggests a more modest effect of anticonvulsants on neuropathic pain in general.[29]

Second Line Treatment

The NeuPSIG 2015 guideline recommends topical lidocaine 5%, high dose topical capsaicin (8%) and tramadol as second line agent.

Lidocaine patch 5% with maximum dose of 3 patches applied for 12 hours daily is a viable alternative to the elderly population with poor reserve to tolerate side effects of first line options. It acts by blocking ionic fluxes at sodium channel and preventing pain signal conduction. At the dose of 5%, local penetration produces analgesic effect without complete sensory block. In an fMRI study, lignocaine patch 5% acts centrally by influencing long term perception of pain at the level of ventral striatum and amygdala (reward-related centre).[31] Cream or gel might have similar effects however the clinical trial for its efficacy is still lacking.

High dose topical Capsaicin 8% is FDA approved for PHN. It works by activating TRPV1 receptor at peripheral small diameter sensory neurons. A single 60 minutes application of up to 4 patches results in defunctionalization of nociceptors and peripheral nerve terminal death. Regeneration of epidermal nerve fibres was detected at 12 weeks and was only completed at 24 weeks. This explained the clinical effect of up to 3 months following a single application.[32] Temporary pain following patch removal can be managed with topical lidocaine, short duration of immediate release opioids and cooling of the site. This option, however, is still not available locally.

The role of opioids in PHN has been downgraded for safety concerns. However, the significant non-opioid effects of tramadol on inhibition of noradrenaline and serotonin reuptake is still much relevant in PHN. Studies have shown that tramadol has comparable efficacies to TCAs and could be given as first line medication for elderly with significant cardiovascular disease.

Common complications of tramadol are related to the serotonin abundance resulting in nausea, dizzyness and sedation, as well as inefficacies in poor metabolizers of M1, who lacks CYP2D6 enzyme. Concurrent use of SSRI or MAOI has higher potential for serotonin syndrome. In such case, the new alternative dual agonist i.e. tapentadol which is readily opioid potent without serotoninergic effects has huge potential of benefit usage. Current Tapentadol studies are limited to neuropathic back pain and diabetic peripheral neuropathy.

Third Line Treatment

There are concerns over the third liners possible safety issues and inconclusive level of evidence.

Slow release strong opioids using either oxycodone or methadone are recommended as third line. Extensive psychosocial evaluation, adherence to local guidelines for long term opioids in non-cancer pain and exit strategy need to be deliberated prior to commencement of therapy. Common side effects are constipation, itching and nausea. Endocrine effects such as androgenic suppression, osteoporosis and hypoadrenalism also need to be explained.

Botulinum toxin is recommended only in refractory cases of PHN. It exerts effects by diminishing peripheral sensory neurotransmitters (Glutamate, Substance P, CGRP) and possibly from axonal transport of the toxins. In a recent review for its use in PHN, the clinical effects are observed from week 2 to 16 post treatment. The toxin is administered by multiple injections subcutaneously or perineurally.[33]

Other Inconclusive Treatment for PHN

SNRI, topical clonidine and capsaicin cream, carbamazepine, topiramate and lamotrigine are rated as inconclusive by NeuPSIG for PHN treatment; mainly due to the lack of evidence for specific intervention for PHN neuropathic pain. However, SNRI - the most studied would be Duloxetine - has shown very good analgesic efficacy in patients with general neuropathic pain disorder and with more favourable side effects compared to TCA. SNRI is recommended as first line treatment for neuropathic pain in general.[29]

Combined vs Monotherapy?

Option for combined pharmacological therapy is especially preferred in patients with multiple medical comorbidities, as opposed to maximizing monotherapy to achieve analgesia. Since PHN is a localized condition, combining topical analgesics using lidocaine 5% patch or capsaicin 8% patch with oral analgesics is recommended to mitigate the risk of adverse systemic events with oral antineuropathics.[34] Randomized studies have shown benefits of combined gabapentinoids with duloxetine or TCAs for PHN, compared with increasing doses of monotherapy.[29]

Non-Pharmacological Treatment

Among non-pharmacological approach to PHN, transcutaneous electrical nerve stimulation (TENS) gets more highlights on top of dry needling,

physical reactivation and behavioral therapy. They are adjuncts to mainstay of treatment and work best in combination.

Interventional Treatment for PHN

Evidence for use of spinal cord stimulator and pulse radiofrequency is weak however the limited outcome is encouraging. Intrathecal steroid and sympathetic blocks are not recommended.[26]

CONCLUSION

Postherpetic neuralgia following acute herpes zoster is quite common in the elderly. Vaccination prevention for above 60 age group significantly

PROPOSED PHN TREATMENT ALGORITHM

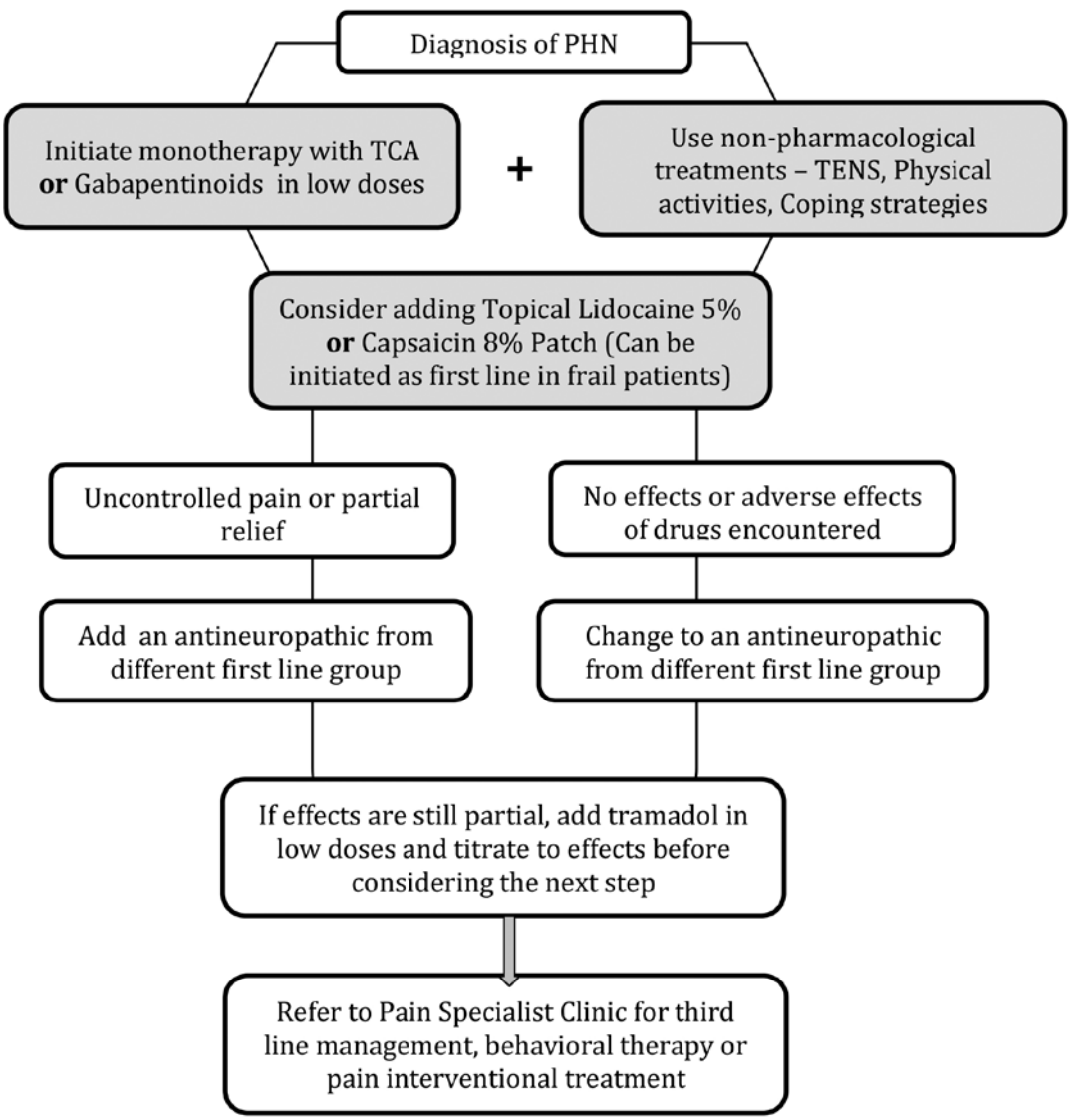


Figure 2: The proposed algorithm for approach to postherpetic neuralgia based on current evidence and guideline. (TCA = Tricyclic Antidepressant, TENS = Transcutaneous electrical stimulation)

impact the burden of disease and pain. Aggressive pain treatment particularly using TCAs during acute stage of Herpes Zoster plays a big role in prevention of persistent PHN pain.

Adding topical lignocaine 5% patch for PHN prevents associated systemic effects with oral therapy especially in frail patients. Based on current evidence and guideline, effective oral medication for PHN includes TCAs (amitriptylline/notriptylline), gabapentinoids (pregabalin or gabapentin), SNRI (duloxetine) and opioids (tramadol or tapentadol).

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Is Nerve Stimulation For Dual Guidance REALLY Necessary?

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INTRODUCTION

The first description of successful ultrasound use in 1989 by Ting and Sivagnanaratnam[1] for axillary brachial plexus block has since herald a new dawn in the expansion of global regional anaesthetic practice, supplanting nerve stimulator as the primary neuro-localization tool.

However, central to this issue in question, current ultrasound technology is still unable to reliably delineate important nerve microstructures down to intra-fascicular level.[2] Although various prior studies have indicated that apparent intra-neural injection may be safe and do not result in persistent neurological symptoms,[2-6] inadvertent intra-fascicular impalement during needle advancement could predispose to a higher risk of post-operative neurological symptoms and needle trespass to these layers must be avoided at all cost.[7]

Dual use of nerve stimulation, as an adjunct to ultrasound, was intended to provide additional physiological information regarding estimation of needle-to-nerve proximity outside the anatomical realms that ultrasound is able to offer and has been recommended as an additional neuro-localization tool by various prominent regional anaesthesia societies since 2009.[8]

Dual Guidance, a technique combining both ultrasound and peripheral nerve stimulator, has been advocated for a safe and more accurate practice of peripheral nerve block within the last decade. Although recommended by most authorities and theoretically thought to confer much benefit, there has been evidence to the contrary.[2-4]

Review of publications in Regional Anesthesia and Pain Medicine journal from 2012 through 2014 revealed dwindling use of dual guidance technique in their study protocols, from 7 research papers in 2012 to 4 in 2013 and only 1 in the 2014.[9-20] Whether this reflects the general trend of practice by regional practitioners globally, or it is only institutionally based, is not known but improved clinical training with upgrades in ultrasound and needle tracking technology may obviate the need for nerve stimulation.

Despite prior studies showing promise in various areas surrounding the practice of dual guidance in peripheral nerve blocks, few key questions remain fully unanswered especially surrounding;

- Dual Guidance and block efficacy
- Dual Guidance and prevention of nerve injury

Use of Nerve Stimulation on Block Efficacy

There had not been any clear definition of 'block efficacy' previously and various characteristics have been utilized as such. Similarly lacking in clarity is what is deemed as 'block success', as motor and or sensory composite scoring,[21-23] need for supplementation[23] surgical anaesthesia or conversion to general anaesthesia[24,25] were few different alternative parameters that had been used as definitions in various studies. Based on these multitudes of different quantitative criteria, multiple single centre studies albeit with small sample sizes have looked at 'block success rates', 'block quality', 'performance times', 'needle passes' and 'complication rates' as surrogates of block efficacy.[21,23-26]

These studies were however conducted on a heterogenous sample population, with a variety of block types, making it difficult to have systematic reviews or meta-analyses specifically powered to address the advantages of dual guidance with respect to block efficacy with a high level strength of evidence.

Beach in his study looked at 'surgical anaesthesia rates' in 94 consecutive patients who had surgery below the elbow with the use of nerve stimulation in ultrasound guided supraclavicular brachial plexus block, according to set criteria of 'well-defined image' and grouped the patients into 'with twitch' and 'without twitch'. He obtained similar surgical anaesthesia rates with both groups and found that in well-defined anatomy and needle position, the twitch monitor does not add any further useful information with respect to the ultimate success of the block and further concluded that a positive motor response to nerve stimulation does not increase the success rate of the block. In addition, it was also noted that nerve stimulation conferred a high false negative rate and suggested that these blocks are usually effective, even in the absence of a motor response.[25]

Chan similarly looked into 'surgical anaesthesia rates' in patients who underwent elective hand surgery under axillary brachial plexus blocks among three groups; between Ultrasound guided (US), dual guidance (US-NS) and nerve stimulation (NS). He found that US guided techniques both yielded similar 'surgical anaesthesia rates' and 'block quality' which was significantly higher than NS group alone. They however failed to demonstrate a higher block success rate when nerve stimulation was added to ultrasound as a confirmatory tool.[21]

Gurkan added 'block performance times' as primary end point besides 'block success rates' based on their working definition in patients scheduled for distal upper limb surgery. Similarly, findings showed high success rates for both ultrasound-only and dual guidance groups (94.5% for both), with significantly shorter procedural times for ultrasound-only group. They concluded that ultrasound guided alone produces block success rate identical to dual guidance, yet with a shorter block performance time.[23]

Dingemans alternatively looked into 'quality of block' as surrogates for efficacy in patients with infra-clavicular ultrasound guided approach for below elbow surgery. It was found that ultrasound guided-only group had a higher proportion of patients achieving 'block quality' as defined by the group, with 86% achieved 'complete blocks' compared with 57% in dual guidance group, higher 'surgical anaesthesia' rates and lower 'block supplementation rates'. Speed of execution in terms of procedural times was also found to be shorter in ultrasound-only group. They concluded that for infra-clavicular approach, visualization of local anaesthetic spread as the end point yields better success rates with shorter performance times.[24]

For femoral nerve blocks, Sites conducted comparisons between ultrasound-only and dual guidance groups on post block pre-operative 'motor and sensory deficits at 40 minutes' and looked at proportions of complete and partial block in 107 knee arthroplasty patients. They also looked at mean time to perform the blocks and numbers of needle redirections as their secondary end-points. Proportions of patients in each group with complete or partial block were slightly dissimilar but the difference was not statistically significant. The mean time for block performance was longer and number of needle redirections significantly higher for dual guidance group. They concluded that the addition of nerve stimulator to a US guided femoral nerve block did not change pre-operative block efficacy.[26]

Summary of findings of the above studies are shown in Table I. Despite the findings and conclusions from these studies, only Dingemans described strict use of nerve stimulation as end-point for dual guidance group in their methodology, irrespective of the spread pattern visualized under ultrasound.[24] Chan, Gurkan and Sites used nerve stimulation as end-point for their dual guidance group, BUT adjusted spread pattern depending on distribution seen under real-time.[21,23,26] Chan did not compare ultrasound-only and dual guidance groups with regards to the tested parameters and no statistical testing was done to look at the differences between these groups. They only performed statistical analyses to compare between groups with and without ultrasound.[21] Gurkan's work was only powered to

detect a difference in performance time and NOT in success rates.[23] Pitfalls within their studies made interpretation and inference to their results and conclusions difficult with a high level of certainty.

Table I: showing a summary of various studies comparing block efficacy
* denotes comparisons which are statistically significant

Author	'Block Success'	Block Time	Needle pass	Complication
Beach 2006 (Supraclvicular) n=94	Overall 89% With twitch 89% Without twitch 92%	Not significant	Not as end point	No complications
Vincent 2007 (Axillary) n=188	US USNS PNS 82.2%* 80.7%* 62.9% Surgical anaesthesia 95%* 92%* 85.5%	US USNS PNS 9.3* 12.4* 11.2	Not as end point	No major complications
Dingemans 2007 (Infradavicular) n=72	'Block quality' Complete blocks US USNS 86% 57%* Surgical anaesthesia 92% 72%* Supplement rate	3.1 v 5.2*	Not as end point	Vascular puncture 2 v 1 Paraesthesia >1/52 1 v 0 Shoulder pain<3/7 0 v 1
Sites 2009 (Femoral) n=107	Complete and partial at 40 mins US USNS 88.1% 95.7% (69%+19.1%) (71.7%+24%) 90.2% 89.1% (motor)	147.8s v 188.2s*	1.1 v 4.2*	No complications
Gurkan 2010 (Infradavicular) n=110	US USNS 94.5% 94.5%	157s v 230s*	Not statiscally significant	Vascular puncture in 2 (USNS)

Is Nerve Stimulation Sensitive in Detecting Intra-Neural Injections?

Although there were no reports of neurological sequelae in various studies in which apparent intra-neural injections were detected,[5,6] prevention of trans-epineurium trespass is the upmost priority as hypothetically it correlates to a lower at risk potential for intra-fascicular transgression.[7] Acquisition of specific motor responses at currents between 0.2 to 0.5 mA, which used to be the end point reflective of the needle to nerve distance estimates, is no longer necessary. The stimulator has since evolved functionally from being a tool to specify neural structures, to a close-proximity sensor, as the set minimal current is now not indicative of distance estimates, but whether there is intra-neural trespass. Prior practice of purposely seeking muscle responses at low threshold currents may even in fact be partly the reason why our blocks works so well! On the contrary, exposing patients to the risk of post block neurological injury.

With regards to the use of nerve stimulation for prevention of neurological injury, there has been evidence to show that not all needle-nerve contacts result in stimulation and motor response or paraesthesia,[5,6,25] and insistence on specifically looking for absolute response may even be detrimental.[5,6,27]

Review of Tsai's animal study further laid credence to this finding. His work in looking at association of needle-to-nerve distance with stimulating current intensity showed that specific muscle response to pig sciatic nerve stimulation was only obtained starting at a distance of 0.1 cm away and trans-epineurally with currents ranging from 0.24-1.48 mA at a distance 0.1 cm (in 70% of the attempts), and 0.15-1.4 mA on the epineurial surface (95%). When the needle was placed intra-neurally however, specific response was observed in 100% of attempts at stimulation with current intensity ranging from 0.08-1.80 mA. Importantly, of these 100% attempts of intra-neural stimulation, only 87.5% could be elicited with low current intensity from 0.08-0.4 mA. In 5 of total 40 attempts (12.5%), a specific response could only be attained with higher current intensity (0.8-1.8 mA). They concluded that although there is a correlation between nerve-to-needle distances with current intensity, currents of low intensity (<0.2 mA) is highly specific, but relatively insensitive of intra-neural needle placement. Dependence on nerve stimulation to decrease risk of an intra-neural injection may not be reliable.[28]

Intra-neural injections are common occurrence than it is originally thought. The intensity of stimulating current may not be a reliable indicator of transgress. Robards using dual end-points in 24 patients for foot or ankle surgery, either apparent intra-neural location of needle tip on ultrasound or elicited motor response between 0.2 and 0.5 mA, found that motor response were acquired **ONLY** upon intra-neural entry as observed under real time in 83.3% (20/24). In 16.7% (4/24), no motor response was obtained with 1.5 mA even when intra-neural trespass occurred. They concluded that absence of motor response does not exclude intra-neural needle placement and, additionally, low-current stimulation was associated with a high frequency of intra-neural trespass.[5]

Similarly Siedel, when conducting conventional technique nerve stimulation guided sciatic nerve blocks in 125 patients, learned that 70 out of 125 patients had intra-neural trespass when observed by a second physician using ultrasound imaging but blinded for the investigator who was performing nerve stimulation. No post block neurological sequelae was discovered during follow up in both studies.[5,6]

Sadly, incidence of post block neurological injury with or without ultrasound guidance was not found to differ significantly.[1] Furthermore, no strong evidence exists in terms of risk reduction when dual guidance is used. Isolated case reports of nerve injury still emerge despite the use of this neuro-physiological monitor and strict adherence to standards in what is believed to be a procedural protocol when using nerve stimulator.[27] These reports highlight the issue of differences in, or the range of incidences of nerve injuries for different

levels of nerve block approaches, highest being the interscalene.[29]

Should dual guidance be used for interscalene block exclusively? Sinha and colleagues showed in 61 patients for outpatient shoulder surgery that successful anaesthesia can be achieved with ultrasound-guided needle placement regardless of motor stimulation threshold above or below 0.5 mA, suggesting that acceptance of ultrasound evidence should preside over specific motor responses as an end-point. They observed responses at current ranges from 0.14 to 1.7 mA, with 25 patients (42%) with stimulating current of less than 0.5 mA and 35 (58%) with more than 0.5 mA even though the needle tip was positioned appropriately in the interscalene groove.[30]

Patients were followed up after surgery for complications but there was no mention of any post block neurological sequelae. The wide range in stimulating current thresholds in this study highlights the possibility of a false negative interpretation if the cut-off current threshold indicating intra-neural injection was set at an absolute value of 0.2 mA. Moreover, the review by Brull and colleagues was in the age where volumes of 30 ml or more of local anaesthetics and with vasopressors at times, were administered for interscalene blocks.[29] Acknowledging multifactorial aetiologies in the development and progression of post block nerve injuries, probable cause for increased incidence in interscalene approach may not be attributed to the block per se. Moayeri uncovered a probable anatomical reason for these differences which could be due to quantitative architectural ratio of neural to non-neural composition of different nerves and also within the same nerve at different locations.[31]

Sauter's work on the effect of tissue impedance on current threshold for nerve stimulation may partly hold the answer to the enigma that is the safe current threshold. His findings were that different approaches or block locations for the same nerve may have different stimulating thresholds and they depend and had an inverse relationship to tissue impedance at the particular site of stimulation. The group also noted that the threshold currents at variable sites of the same nerve were also different when different impulse durations were used. The results of their study indicate that current settings used for nerve stimulation may require adjustments based on surrounding tissue types and impedance.[32] Their conclusion further complicates and challenges our very understanding of what was fifty years ago the 'gold standard' technique in neuro-localization.

Currently, a threshold stimulating current of **less than 0.2** mA **IS** intra-neural, **BUT** no response **OR** other stimulating current **up to 1.7 mA MAY be intra-neural**, depending on what is seen on ultrasound in real-time.[5,6,28] What nerve stimulation would be able to show is that its use only reflects nerve-needle distance but is insensitive to intra-neural needle placement.[28] What is unnerving is that Sauter's discovery shows current threshold depends on various parameters for its correct interpretation, which suggests the possibility that all these while, our application and clinical use of nerve stimulation principles based on **ABSOLUTE VALUES** may be wrong.[31] The use of a different mode of nerve stimulation, Sequential Electrical Nerve Stimulation (SENs), may be more sensitive than the current conventional mode in terms of fine tuning needle-nerve distance estimates, but in terms of preventing intra-neural injection, the likelihood of success is doubtful since similar application and principles of use still apply.[33]

CLick **A**ssociated **A**dequate **S**pread (**CLAAS**) technique; an alternative method?

CLAAS is a technique which utilizes combined appreciable tactile sensation of fascial click and direct real-time visualization of injectate deposition and spread pattern in relation to needle tip and the neural elements. A high degree estimate of a successful block utilizing the CLAAS technique would be predicted when all four pre-requisites are observed, which include:

i) **Tracking** of needle tip presentation from insertion point to neural target
ii) appreciable **fascial click** as the needle is seen at an appropriate distance from the neural structure as interpreted by the operator as the para-neural sheath, **WITH**
iii) appropriate real-time test injectate **spread pattern** between needle tip (or the axis of the needle shaft) and the neural elements, **AND**
iv) **no nerve swelling** at the point of injectate deposition until completion of the delivered bolus

Although the practice of appreciating presence of fascial click is without much clinical evidence,[2] when coupled with strict needle tracking and recognition of appropriate test injection spread pattern, are consistently found to provide valuable information to the experienced regional practitioner with regards to spatial orientation of the peri-neural structures. These precious multitudes of 'anatomical' real-time information may well obviate the need for nerve stimulators to function as a 'physiological indicator' given the low sensitivity of its needle-to-nerve distance estimates especially in prevention of intra-neural injection.[5,6,27,28]

Appropriate test injectate spread pattern **AFTER the click** depends on the angle of needle approach in relation to the neural structure. Three patterns of spread are usually recognizable and are associated with high degree of predicted successful blocks. Test injectate is targeted to occupy the space **between the needle axis or the needle tip**, to the neural structure, **simultaneously displacing** it away from the needle.

I) If the needle approach angle is **tangential (parallel) to the fascia** that surrounds the particular nerve, the **spread** of local anaesthetic administered should be **directed upwards or downwards <u>FROM THE AXIS</u> of the needle** while propelling the neural structures away.

II) If the needle approach angle is **perpendicular to the fascia** of the neural tissue, appropriate **spread** is deemed to occur if the injectate spreads **<u>ALONG THE AXIS</u> of the needle, or diverging away from the needle tip**, directed towards, while pushing the neural structure away.
III) Further suggestions of adequate spread can be alluded if **injectate is seen to circumvent** the neural structure in real-time while the titrated injection bolus is being administered.

To the best of our knowledge, none has attempted to describe what is considered as an 'adequate spread', beyond 'circumferential' distribution[11,20-22,26] 'halo surrounding the nerve'[9] or 'donut sign'[26] which implies observation of appearance **AFTER** a pre-determined volume had been administered. CLAAS technique attempts to provide description of real-time local anaesthetic spread pattern from initial test injection, until its completion by observing relationship of the needle-nerve-local anaesthetic dynamics.

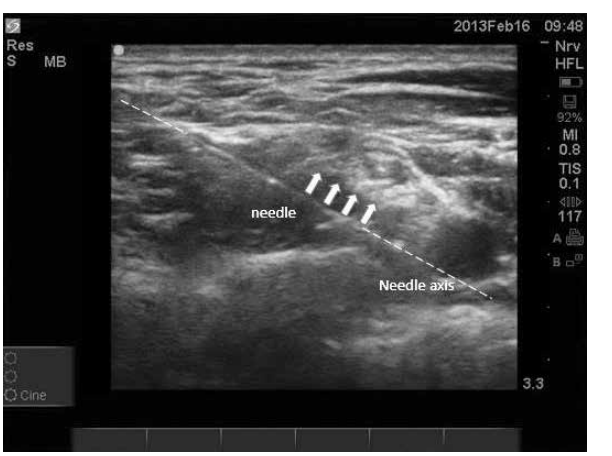

Figure 1: showing supraclavicular brachial plexus block being performed using CLAAS technique with the needle approach angle being tangential to the fascia. Note the local anaesthetic is being deposited between needle axis and the neural elements while simultaneously displacing them away.

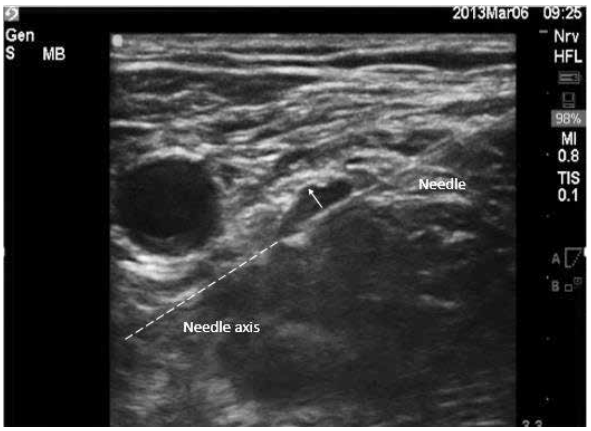

Figure 2: showing femoral nerve block performed using CLAAS technique, with needle approach angle being tangential to fascia iliaca. Note that the local anaesthetic is being deposited and the femoral nerve is simultaneously being pushed upwards and away from a plane between the needle axis and neural elements.

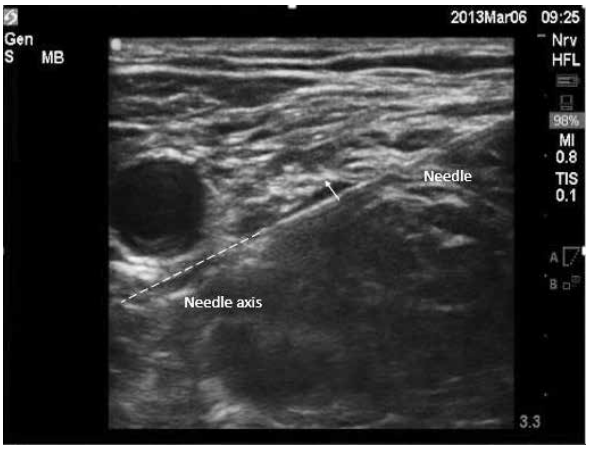

Figure 3: showing femoral nerve block performed using CLAAS technique, with the needle approach angle being tangential to fascia iliaca. Note the local anaesthetic spread is upwards in the space between needle axis and the neural elements, pushing it away from the axis.

CONCLUSION

Currently, evidence within the literature on the clear benefits of dual guidance is lacking at best. C**onventional nerve stimulation** mode **adds no value** with regards to 'block success', predicting safe peri-neural placement of needle tip and avoidance of persistent neurological symptoms through prevention of apparent 'intra-neural' needle misadventure.

There has been **no** evidence however on the use of SENS mode for dual guidance technique. Advocating routine use of nerve stimulation with ultrasound guidance is probably not warranted for every block, all the time but always be mindful of the role of nerve stimulation in addition to ultrasonography in deep or difficult blocks or where images of nerves or needles are degraded.

Continued experience and improved understanding in the use of ultrasound and image interpretation, together with various enhancements in equipment technology may improve overall efficacy of regional anaesthetic practices in the near future in terms of optimizing success rates and eliminate, if possible, the incidence of neural complications. Whenever dual guidance is used, understanding the limitations and advantages of either and both techniques will further enhance understanding on the effective use of the available tools for accurate and safe delivery of regional anaesthetic practice.

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Evolution Of Supraclavicular Brachial Plexus Block

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Often considered the 'spinal anaesthesia of the upper extremity', the supraclavicular approach to the brachial plexus provides excellent anaesthesia of the upper limb with rapid onset.[1] Its use in history dates all the way back to the 1920s, but gradually fell out of favour due to high incidence of pneumothorax, improvement in general anaesthesia safety and safer alternative approaches. With the advent of ultrasound-guided techniques allowing real-time visualisation of anatomy, there has been renewed interest in the block due to increased safety and reduced complication rate.

ANATOMY

The brachial plexus supplies motor and sensory innervation to the upper limb. It is formed by the ventral rami of C5 to T1. They emerge, as roots, between the anterior and middle scalene muscles, then proceed to traverse the posterior triangle, forming three trunks, the upper, middle and lower. Posterior to the mid clavicle, each trunk then divides to form an anterior and posterior division. The divisions then combine to form the lateral, medial and posterior cords, which are named according to their relation to the second part of the axillary artery. Various peripheral nerves, including the terminal branches, emerge from these cords.

A brachial plexus block can be performed at multiple sites along its anatomical path. Common approaches include that at the interscalene, supraclavicular, infraclavicular and axillary levels (Figure 1).[2] At the level of the supraclavicular fossa, the plexus is most compactly arranged, consisting of distal trunks and origins of divisions. Hence, the supraclavicular approach of the brachial plexus has been thought to provide anaesthesia to the entire upper extremity with a rapid onset and in the most consistent manner.

At the supraclavicular fossa, both the brachial plexus and subclavian artery lie above the first rib and the pleura. The brachial plexus is located lateral and posterior to the subclavian artery, while the subclavian vein and anterior scalene muscle are found medial to the subclavian artery. The pleura is usually situated within 1-2 cm medial from the brachial plexus.

INDICATIONS AND BENEFITS

The most common indication of the supraclavicular brachial plexus bock is upper extremity surgery.[1] As with all peripheral nerve blocks (PNBs), supraclavicular brachial plexus block offers an excellent anaesthetic alternative for upper limb surgery. It provides superior, long-lasting analgesia, and avoids potential side effects of a general anaesthesia including nausea, vomiting, dental trauma, sore throat, allergic reactions and intra-operative haemodynamic swings. PNBs indeed offer distinct benefits over general or neuraxial anesthesia in certain clinical situations, especially high risk patients.

HISTORY

The first documented brachial plexus block was performed by William Steward Halsted in 1884, who directly exposed the brachial plexus in the neck with cocaine.[3] It was only in 1911 when Kulenkampff performed the first percutaneous supraclavicular brachial plexus block.[4] In collaboration with Persky,[5] Kulenkampff's technique and experience with 1000 supraclavicular brachial plexus blocks was published in 1928.

However, Kulenkampff's technique of inserting the needle posteriorly, medially and caudally in

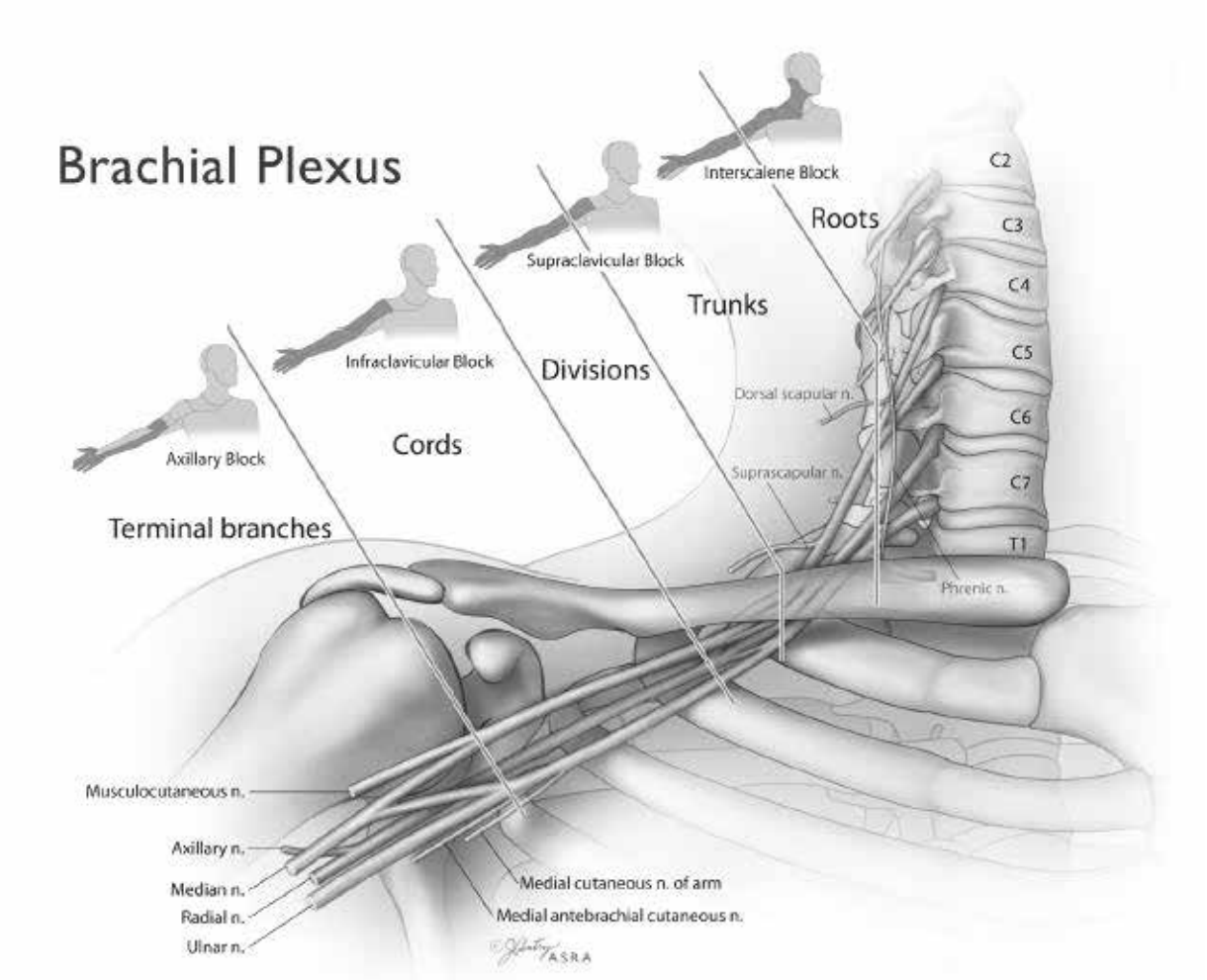


Figure 1: Brachial plexus. Various approaches define individual brachial plexus blocks and their expected distribution of cutaneous anesthesia. Illustration by Jennifer Gentry. *American Society of Regional Anesthesia and Pain Medicine.
(with permission from Wolter-Kluwer) - to obtain Rightslink

the direction of T2 or T3 spinous process, carried an inherent risk of pneumothorax.[5] This, together with improvements in general anaesthesia safety, as well as the advent of reportedly safer alternatives including axillary approach by Accardo and Adriano (1949),[6] Eather and Burnham (1958),[7] later De Jong (1961),[8] supraclavicular approach gradually fell out of favour in the early 1960s.

Until the last two decades, with the introduction of real-time ultrasound guided techniques to reduce risk of inadvertent pleura puncture, the supraclavicular approach of the brachial plexus, with its rapid onset, high success rate and large area of anaesthesia coverage, has gradually regained popularity.[1,2,9,10]

TECHNIQUES

A. Surface Landmark with Paraesthesia Seeking

Classical Approach ('Kulenkampff Technique')

The classical Kulenkampff approach involves the patient to be in the sitting position, with the arm to be 'blocked' lying in the lap with the shoulder relaxed. If the sitting position is not possible, the patient will lie supine, with a pillow under his scapula and his head rotated opposite from the side to be blocked.[4,5]

The needle is inserted at a point middle of the clavicle, crossed by a line projected downward from the external jugular vein. It is advanced lateral to the subclavian artery and is directed posteriorly, medially and caudally to the upper border of the first rib (i.e. in the direction of the T2 or T3 spinous process). The classical approach involves inducing paraesthesia in the finger tips usually at a depth of 1-2cm. This indicates the needle's contact with the plexus. Local anaesthetic is then slowly injected, with paraesthesia increasing temporarily until the local anaesthetic's action causes the sensation to disappear.[4,5]

Modified Techniques

The medial orientation of the needle in the classical approach was associated with increased risk of pleural puncture and pneumothorax, reported 6% incidence.[5] Consequently, attempts to modify the classical technique were described to reduce this risk.

Several modified techniques were published in chronological order:

- MacIntosh & Mushin (1942)[11]
- Lamoureux & Bourgeois-Gavardin (1952)[12]
- Subclavian perivascular technique - Winnie & Collins (1964)[13]
- Parascalene technique - Vongvises & Panijayanond (1972)[14]
- Dupre & Danel technique (1982)[15]
- Brown's plump-bob technique (1988)[16]

There were great diversity of technique with minimal variations revealed that none of them was perfect and free from potential hazard. Below are some techniques worth mention.

Subclavian Perivascular Technique - Winnie & Collins[13]

This is a surface landmark with paraesthesia seeking technique. The needle is inserted at the base of interscalene groove, posterior to the subclavian artery, in the horizontal plane.

The disadvantages of this technique are vascular puncture, hematoma, and pneumothorax (less than 1:1000 in experienced hand).

Dupre & Danel Technique[15]

This is also a surface landmark with paraesthesia seeking technique. Surface landmarks are: the external jugular vein, the sternocleidomastoid muscle, and the clavicular insertion of the trapezius muscle. The needle is inserted at the intersection point between external jugular vein and a line drawn from the top of supraclavicularis minor fossa to edge of external clavicular insertion of trapezius muscle. The advantage is that it did not require location of subclavian artery. No pneumothorax was reported in 136 cases.

Brown's Plump-Bob Technique[16]

This is initially a surface landmark with paraesthesia seeking technique which later incorporate the use of a nerve stimulator. This is performed with the patient supine on a horizontal table with the ipsilateral arm at the side and the head turned opposite the side to be blocked. The point of needle insertion is "immediately adjacent and superior to the clavicle at the lateral-most insertion of the sternocleidomastoid muscle onto the clavicle". The needle direction is anteroposterior - that is, perpendicular to the table - as if following the line of a suspended plumb-bob through the insertion site. Local anaesthetic is injected at a single site after adequate paresthesia or motor response by a nerve stimulator.

B. Surface Landmark with Nerve Stimulator

Locating nerves by obtaining paraesthesia could indicate that the needle tip is intraneural. If local anaesthetic were to be injected despite the paraesthesia, this could potentially result in neural damage and complications. On the contrary, absence of paresthesia does not reliably exclude the possibility of needle-to-nerve contact nor does it prevent post-operative neural injury (PNI). Nevertheless, severe paresthesia that occurs with needle advancement or injection should prompt the cessation of either maneuver, and repositioning of the needle should be considered.[17]

In 1962, Greenblatt[18] was the first to describe the use of a portable solid-state nerve stimulator with variable current output in nerve identification and location. Since then, peripheral nerve stimulation using a low intensity, short duration electrical stimulus to obtain a defined response to locate the nerve/plexus was used in the practice of PNBs. The goal of nerve stimulation is two-prong; firstly, to place the needle tip in close proximity to the target nerve/plexus so as to inject local anaesthetic in the vicinity of the nerve; secondly, for identifying intraneural needle tip placement (i.e. a motor response at $\leq$0.2 mA is obtained only with intraneural needle tip location). It has been reported that flexion of the third and fourth digits simultaneously, without or without other digits, is associated with the highest success rate of a supraclavicular brachial plexus block.[10]

The use of nerve stimulation became common place in clinical practice only in the mid- to late 1990s. Several studies were published using previously described modified surface landmark technique with a nerve stimulator. One of them, Franco et al[19] had performed 1001 subclavian perivascular brachial plexus blocks with a nerve stimulator with 997 blocks (97.2%) were completely successful, 16 blocks (1.6%) were incomplete and needed supplementation; 12 blocks (1.2%) failed and required general anaesthesia. Overall there was 98.8% success rate for regional anaesthesia in this study and no reported clinical pneumothorax or major complications.

Surface landmark with paraesthesia seeking or nerve stimulator is not only associated with a high incidence of pneumothorax, but also vascular puncture and unintended intravascular injection. The latter may lead to local anaesthetic systemic toxicity with resultant cardiovascular collapse. A study by Brown[20] in 1995 showed seizures associated with supraclavicular brachial plexus blocks to be as high as 79 in 10,000. These complications are due to the close proximity of the brachial plexus with the subclavian artery and pleura. Moreover, success of the block with the above techniques is largely dependent on our knowledge and understanding of the anatomy of the brachial plexus. However, it has been shown that there are large anatomical variations in over 50% of the population.[10]

C. Ultrasound-Guided Technique

The use of ultrasound guidance in the practice of regional anaesthesia arguably began in the late 1980s,[21] although ultrasound Doppler technology was used by La Grange[22] in 1978 to locate the subclavian artery, to indirectly facilitate needle positioning in a supraclavicular plexus block. This case series reported a high block success rate, with the absence of intravascular injections. Moorthy et. al.[23] in 1991 used Doppler technology to identify and mark the third part of the subclavian artery (above clavicle) and the first part of the axillary artery. A needle connected to the nerve stimulator is then inserted 2cm superior and posterior to the clavicle, and 1cm lateral and parallel to the identified subclavian artery. They named this technique, lateral paravascular approach with sixty one of the 82 cases (72%) of supraclavicular lateral paravascular block produced a good surgical anaesthesia.

Technology subsequently improved. Kapral et. al.[24] first described direct needle, plexus and local anaesthetic visualization using B-mode ultrasound in 1994. And ever since then, ultrasound-guided nerve blockade has gradually evolved into our daily practice and become the gold standard technique for regional anaesthesia.[25]

Ultrasound compared to other nerve localization technique results in improvement in block quality, meaning faster onset time, better quality of surgical block, longer duration of block and high success rate, which definitely not inferior to other technique (Level 1B evidence).[26] In fact, ultrasound allows visualization and identification of neural and adjacent anatomical structures; detection of anatomical variation;[10] visualize the spread of local anaesthetic and the needle tip, hence can optimally position the needle and avoid potential complications.

In 2003, Vincent Chan et. al.[27] first described combined ultrasound with nerve stimulator for supraclavicular approach in 40 patients. More publications pertaining to ultrasound guided supraclavicular brachial plexus block subsequently ensued.

With the patient lying supine and head rotated opposite from the side to be block, a linear high-frequency ultrasound probe is used to scan the the supraclavicular fossa in a coronal oblique plane, parallel and posterior to the clavicle. The neurovascular structures are identified - the pulsatile hypoechoic subclavian artery and the compact group of hypoechoic nerve structures (often referred to as a 'bundle of grapes') lateral and superficial to it. The probe is then angled until there is simultaneous visualization of both first rib and pleura. Both structures appear hyperechoic on the ultrasound image, with the former generating an anechoic shadow beneath it, while the latter a shimmering shadow (representing lung tissue) and a 'sliding' motion of the pleura with the patient's respiration in observed.[28]

Needle Insertion

With real-time ultrasound guidance, the needle is inserted in-plane with the beam in either a medial-to-lateral or lateral-to-medial direction. But in a sub-analysis of a prospective review of 510 cases, medial-to-lateral approach resulted in more incidence of vascular puncture, neurological deficit and Horner's syndrome though the differences were not statistically significant. There was no reported clinically evident pneumothorax in this study. Overall success rate after first attempt of block using either medial-to-lateral or lateral-to-medial needling direction was 94.6%.[28]

End Point of Injection

The needle is advanced until the fascial sheath is penetrated (felt as a palpable 'pop') and the needle tip is visualised within the sheath compartment. Different end points have been described. One is to guide the needle towards the 'corner pocket' where the first rib lies inferiorly, the subclavian artery medially and the nerves superiorly. Depositing local anaesthetic at this point 'floats' the plexus superficially and results in more reliable blockade of the lower trunk/inferior divisions of the plexus, which has been shown to be cause of failed supraclavicular blocks.[29] Four years after its first description, Brull et al.[30] retold the achievement of corner pocket technique in more than 3000 blocks. This technique successfully blocked the ulnar nerve in at least 85% of patients within 30 mins of local anaesthetic injection with only 1 symptomatic pneumothorax.

However, due to very close proximity to the first rib and the risk of pleural puncture, some authors describe administering two to three smaller aliquots of local anaesthetic at different locations within the plexus sheath as a safer alternative.[1] Tran et al.[31] conducted a randomized controlled trial in 2009 on 92 patients comparing single versus double injection. The double-injection ultrasound-guided supraclavicular block provides no significant advantages compared with its single injection counterpart.

Dual Guidance

Concurrent nerve stimulation with ultrasound guidance is believed to be safer[1] but there were case report of permanent nerve injury on dual guidance[32] and study[33] showed nerve stimulation as an adjunct to ultrasound guidance may have a limited role. For adequately imaged ultrasound guided

supraclavicular nerve blocks, a positive motor response to nerve stimulation does not increase the success rate of the block. In addition, the high false-negative rate of nerve stimulator suggests that supraclavicular blocks under ultrasound guidance are usually effective, even in the absence of a motor response. However, 21% of the patients did not have satisfactory nerve imaging in the same study mentioned earlier.[33] Therefore, there is still a role for dual guidance in peripheral nerve blocks especially in cases involving deep and difficult blocks whereby the sonoimages of needle and neural structures are poorly seen.

If dual guidance is used, Bigeleisen et al[34] in his first human study comparing intraneural versus extraneural stimulation thresholds during ultrasound-guided supraclavicular block showed that there was clinical difference in stimulation thresholds between outside and inside the nerve. Ultrasound was able to clearly detect the location of the needle tip in only 69% of the cases. Stimulation current of less than or equal to 0.2mA is reliable to detect intraneural position of the needle. Stimulation thresholds greater than 0.2 and less than or equal to 0.5mA could not rule out intraneural placement of the needle. Diabetic patients require higher stimulation thresholds both outside and inside the nerve to elicit a motor response.

Based on current evidence, the expert panels advise against purposefully seek needle to nerve contact or intentional intraneural injection.[35]

Volume of Local Anaesthetic

It is believed with ultrasound technique, the spread of the local anaesthetic can be visualized hence reduce the volume required. Several studies reported variable local anaesthetic dosing and volume required for ultrasound guided supraclavicular block (USSCB). The mean required volume is still much lower if compared to non-ultrasound technique,[13,15,16] which often used 30 to 40ml. The choice of local anaesthetic concentration is dependent on the surgical indication.

As an example, Tsui et al[36] described 94.2% success rate with USSCB in 104 patients undergoing hand surgery, using 20 to 30ml mixture of Lidocaine 1.5% and bupivacaine 0.125%. Perlas et al[28] reported 94.6% success among 47 different operators using a mean volume of 33ml for USSCB in 510 patients with Lidocaine 2% and Bupivacaine 0.5% plus epinephrine 5ug/ml. Bigeleisen et al[34] reported 100% success using 25ml admixture of Lidocaine 1% and Bupivacaine 0.25% plus epinephrine 3.33mcg/ml. Brull et al.[30] used 15 - 25ml of local anaesthetic deposited at the corner pocket area for reliable surgical anaesthesia.

Current Recommendation

Due to wide variety of practice in ultrasound guided brachial plexus block, a set of standardized approaches to upper extremity nerve blocks based on the current literature has been proposed.[37]

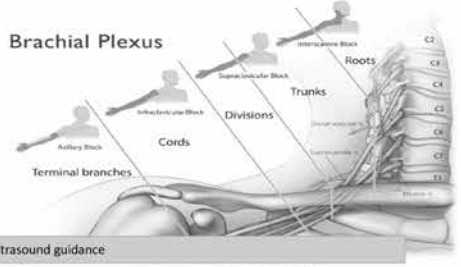
The current recommended technique for ultrasound guided supraclavicular block is needle injection in plane (most common), lateral to medial. Assess the depth of brachial plexus, insert needle in shallow angle and adjust accordingly. The ideal spread of local anaesthetic will be within brachial plexus fascial sheath, lateral to the subclavian artery but superficial to the first rib. Number of injections would be 2 to 3 follow the principle of bolus, observe, and reposition. Recommended volume of local anaesthetic is 20ml. If nerve stimulator is used, a distal motor response of forearm and hand is an acceptable end-point.

COMPLICATIONS AND CONTRAINDICATIONS

The overall complications associated with supraclavicular brachial plexus block is low. These include vascular punctures, local anaesthetic systemic toxicity as a result of fast absorption or unintended intravascular injection, neural damage, sympathetic ganglion blockade with Horner syndrome, recurrent laryngeal nerve blockade, and phrenic nerve palsy.[28,32] The incidence of pneumothorax has reduced significantly since the

Evolution of supraclavicular brachial plexus block (Spinal of the upper extremity)

Supraclavicular approach gradually fell out of favour in the early 1960s with improvements in general anaesthesia safety, as well as the advent of reportedly safer alternatives axillary approach (Accardo and Adriano[6], 1949; Burnham[7], 1958; De Jong[8], 1961). Until the last two decades, with the introduction of real-time ultrasound guided techniques to reduce risk of inadvertent pleura puncture, the supraclavicular approach of the brachial plexus, with its rapid onset, high success rate, provides the most reliable, uniform, predictable and large area of anaesthesia for the upper extremity, has regained popularity.



Surface landmark with paraesthesia seeking

Portable nerve stimulator for nerve identification and location was first introduced in 1962.[14]
The use of nerve stimulation became commonplace in clinical practice only in the mid- to late 1990s.

Surface landmark with nerve stimulator

The use of ultrasound guidance in the practice of regional anaesthesia arguably began in the late 1980s[21], although ultrasound Doppler technology was used by La Grange et. al. to direct needle insertion for peripheral nerve blockade in the 1978 [22] and Kapral et al. first described direct needle, plexus and local anaesthetic visualization using B-mode ultrasound in 1994.[24]

Ultrasound guidance

Macintosh & Mushin[11] 1942

Lamoureux & Bourgeois-Gavardin[12] 1952

Parascalene technique (Vongvises & Panijayanond)[14] 1972

Lateral paravascular approach (Moorthy)[23] 1991

Single versus Double Injection (Tran DQH et. al.)[31] 2009

- Randomized controlled trial, 92 patients; The double-injection ultrasound-guided supraclavicular block provides no significant advantages compared with its single injection counterpart.

Standardization of Technique (Kwofie et. al.)[32] 2013

Due to wide variety of practice in ultrasound guided brachial plexus block, an international panel of experts suggested a set of standardized approaches to upper extremity nerve blocks on the basis of the current literature

Several modified landmark techniques were published in attempt to reduce pneumothorax.
Great diversity of technique with minimal variations revealed none of them was perfect and free from potential hazard

1911

1st supraclavicular brachial plexus block – Kulenkampff technique[4]

- Published in English literature in 1928 – collaborated with Persky: 1000 supraclavicular brachial plexus blocks[5]

1964

Subclavian perivascular technique (Winnie & Collins)[13]

- Surface landmark with paraesthesia seeking
- The needle is inserted at the base of interscalene groove, posterior to the subclavian artery, in the horizontal plane,
- Disadvantage – vascular puncture, hematoma, pneumothorax (less than 1:1000 in experienced hand)

1982

Dupre & Danel technique[15]

- Surface landmark with paraesthesia seeking
- Surface landmarks: the external jugular vein, the sternocleidomastoid muscle, and the clavicular insertion of the trapezius muscle
- The needle is inserted at the intersection point between external jugular vein and a line drawn from the top of supraclavicularis minor fossa to edge of external clavicular insertion of trapezius muscle.
- Advantage: do not require location of subclavian artery
- No pneumothorax in 136 cases

1988

Brown's plump-bob technique[16]

- This is initially a surface landmark with paraesthesia seeking technique which later incorporate the use of a nerve stimulator.
- This is performed with the patient supine on a horizontal table with the ipsilateral arm at the side and the head turned opposite the side to be blocked.
- The point of needle insertion is "immediately adjacent and superior to the clavicle at the lateral-most insertion of the sternocleidomastoid muscle onto the clavicle". The needle direction is anteroposterior—that is, perpendicular to the table—as if following the line of a suspended plumb-bob through the insertion site. Local anaesthetic is injected at a single site after adequate paresthesia or motor response by a nerve stimulator.

2003

Vincent Chan et. al.[27]

- First description of combined ultrasound guidance and nerve stimulator for supraclavicular approach
- 40 cases

2007

Soares et. al.[29]

- Eight ball, corner pocket: optimal needle position for ultrasound guided supraclavicular block
- Transverse sonogram of brachial plexus. In-plane approach, lateral to medial or medial to lateral direction. Needle is positioned between the subclavian artery, first rib and brachial plexus divisions

2009

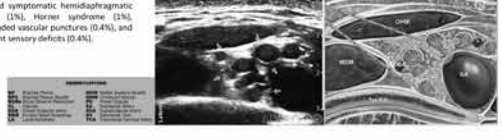
Perlas et. al.[28]

- Ultrasound guided ; 510 cases
- Transverse sonogram of brachial plexus. In-plane approach, lateral to medial or medial to lateral direction.
- Successful surgical anaesthesia was achieved in 94.6% of patients after a single attempt; 2.8% required local anesthetic supplementation of a single peripheral nerve territory; and 2.6% received an unplanned general anaesthetic
- No reported pneumothorax. Complications included symptomatic hemidiaphragmatic paresis (1%), Horner syndrome (1%), unintended vascular punctures (0.4%), and transient sensory deficits (0.4%).

2011

Corner pocket revisited (Brull et. al.)[30]

- More than 3000 blocks
- Corner pocket technique achieved successful ulnar nerve blockade in at least 85% of patients within 30 mins of local anesthetic injection
- Only 1 symptomatic pneumothorax



2015

NYSORA International Standardized Technique

- Technique: Needle injection in plane (most common), lateral to medial; Assess the depth of brachial plexus (BP), insert needle in shallow angle and adjust accordingly.
- Ideal spread of LA: Within BP fascial sheath lateral to the subclavian artery but superficial to the first rib.
- Number of injections: 2 – 3. Bolus, observe, reposition.

Beh ZY, S Fathil, Teo WW (2016)

advent of ultrasound- guided techniques.[28] No incident of pneumothorax in 510 cases received USSCB in study by Perlas et al.[28] Only 5 cases (1%) of symptomatic diaphragmatic paresis, 5 cases (1%) of Horner's syndrome, 2 cases (0.4%) of vascular puncture and 2 cases (0.4%) had neurological deficit.

Phrenic nerve blockade with resultant hemidiaphramic paresis results in a reduction in functional residual capacity by 25%. Patients may present with dyspnea or chest pain, although most affected healthy individuals remain asymptomatic. Diagnosis is made with an upright chest radiography, in which a pneumothorax should be excluded. Rates of transient hemidiaphramic as high as 50% to 67% have been reported, and is reportedly reduced when a lower volume is used.[38] Patient selection is vital, and should be contraindicated in patients with significant respiratory disease or pre-existing contralateral hemidiaphramic paresis.

Real-time ultrasound techniques have also markedly reduced the rates of vascular puncture and unintended intravascular injections.[28] Vessels in the vicinity include the subclavian artery, dorsal scapular artery transverse cervical artery and their venous counterparts. Slight elevation of the head of the bed allows for better drainage and less prominence of the neck veins, the use of colour Doppler before needle placement, aspirating before injection and real-time visualization of local anaesthetic spread during injection are methods used to reduce vascular puncture and intravascular injections.[28]

CONCLUSION

Ever since the introduction of ultrasound guidance in regional anaesthesia, there has been a resurgence of interest in the supraclavicular approach to the brachial plexus. The ability to image the surrounding anatomy and needle placement has significantly reduced the incidence of pneumothorax as well as vascular puncture. Moreover, ultrasound guidance has allowed smaller volumes of local anaesthetic to produce an equally rapid and dense upper extremity blockade. Ultrasound guided supraclavicular brachial plexus block is the most popular regional technique of choice for upper extremity surgery.

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PECS And Quadratus Lumborum (QL) Blocks - Is Now The Time?

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INTRODUCTION

Since the discovery of central neuraxial techniques, epidural blocks had long been the mainstay of anaesthesia/analgesic therapy for multitudes of surgical procedures of the trunk. Over the years, emergence of paravertebral, inter-pleural and intercostal blocks, as available options for thoracic, and the availability of Tranversus Abdominis Plane (TAP), Illio-inguinal/Hypogastric and Rectus Sheath Blocks, for abdominal procedures,[1-3] offered viable alternatives for the technically more challenging epidural techniques. Although these various alternative techniques, fraught with their own technical difficulties, have their own niche and documented successes, none has the reliability and clinical consistency of the epidural technique which still is considered the 'Gold Standard' for various other options to be compared to.[1]

Introduction of ultrasound application into regional anaesthetic practice, while re-visiting previously deemed technically 'difficult' blocks, has accelerated the search for more practical, safer approaches and as clinically efficient as its predecessors. Currently, none is more so extensively investigated than the PECS block for breast procedures and the Quadratus Lumborum (QL) block for abdominal surgeries.[5-11]

PECS BLOCKS

Blanco first described a novel approach for breast surgeries - **the 'pecs block'**[4] in 2011, which involves an inter-fascial local anaesthetic plane injection between Pectoralis major and minor muscles aiming to block the lateral and medial pectoral nerves. These branches, which arise from the brachial plexus, supply the anterior aspect of chest wall over the pectoral muscles. He described this technique in a series of 50 cases over a 2-year period from 2009 to 2011 for reconstructive breast cancer surgery and insertion of sub-pectoral prostheses and reported minimal post-operative analgesic requirement.[4]

However, initial use of the PECS block, as it was known at the time, was limited to mainly insertion of breast expanders and sub-pectoral prosthesis. Other more extensive breast surgeries with or without axillary dissections require anaesthetic coverage of a larger area which involves providing blocks to branches of the intercostal nerves and also to nerves that supply the axillary region.[5]

PECS II Block

In 2012, Blanco provided detailed description of a second version of the PECS block - the **'modified Pecs block' or PECS block type II**. Compared to the previous PECS block type I, this modified version provides more extensive analgesic coverage necessary for wide excisions, tumorectomies and axillary node dissections.[5]

Anatomical Basis of PECS II Block

The neural supply to the structures dissected in breast surgeries involve contributions from different sources which themselves vary between individuals. Besides the more superficial pectoral nerves and the deeper structures supplied by intercostal nerves, axillary clearances require anaesthetizing the intercosto-brachial, the long thoracic and the thoracodorsal nerves to provide appropriate analgesic coverage.[5]

The **neural supply** originates from **two main sources**; brachial plexus and the thoracic spinal nerves, and can be divided into three groups:

A) **Pectoral nerves from the brachial plexus cords:**

a. Lateral pectoral nerve
Arises from C5-7 courses between pectoralis major and minor, and innervates the pectoralis major muscle.

b. Medial pectoral nerve
Arises from C8-T1 and runs deep to pectoralis minor and crosses this muscle to reach the lower third of pectoralis major muscle and innervates both pectoralis major and minor.

B) **T2-6 spinal nerve** which divides into the lateral and the anterior branches:

a. Lateral branches - pierces the intercostal and serratus anterior muscles and gives off anterior and posterior cutaneous branches. The anterior branches innervates lateral chest wall and lateral breast.

b. Anterior branches - pierces the intercostal and serratus anterior muscles anteriorly to supply medial chest wall and medial breast.

c. The lateral cutaneous branch from T2 intercostal nerve does not divide into anterior and lateral branches and continues to the medial arm as Intercosto-brachial nerve (or intercosto-brachialis).

C) **Innervation to the axilla from the brachial plexus trunks:**

Long thoracic nerve
Arises from C5-7 and runs downwards on the outer surface of serratus anterior to the axilla where it supplies serratus anterior.

Thoracodorsal nerve
Arises from C6-8 via the posterior cord, runs deep in the posterior axillary wall to supply latissimus dorsi following the thoracodorsal artery.

This **block is performed** by two needle approaches:

- The **first injection** is the deposition of 10 ml of local anaesthetic between pectoralis major and minor muscles - the **PECS I** block. This is done at a point about 8cm from the midline and about 2cm below the clavicle,[12] at a tangential line from the mid-point of the clavicle caudo-laterally towards the axilla.

- The **second injection** is the infiltration of 20ml of local anaesthetic between pectoralis minor and serratus anterior muscle at the level of the third rib as the linear probe is moved caudo laterally towards the axilla until Gerdy's ligament is seen.

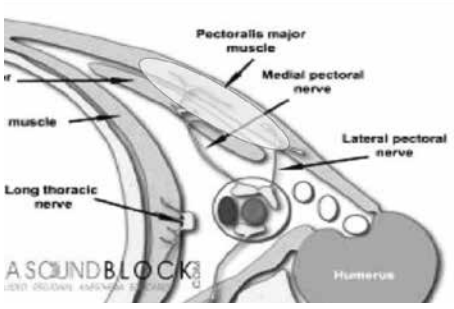

Figure 1: PECS I Block - Yellow shaded area showing interfascial plane for local anaesthetic deposition. Illustration assisted by graphic presentation from UltrasoundBlock.com

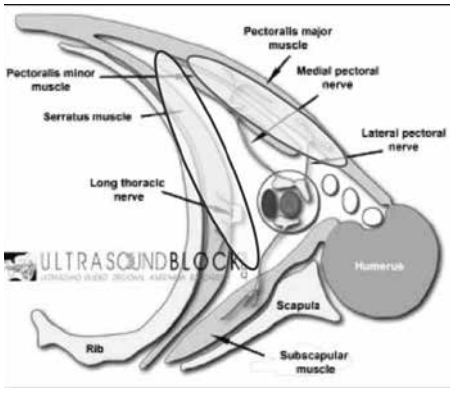

Figure 2: PECS II Block - Yellow shaded area showing interfascial plane for local anaesthetic deposition. Illustration assisted by graphic presentation from UltrasoundBlock.com

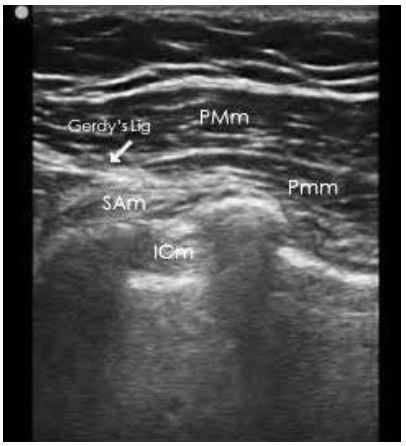

Figure 3: Ultrasound image for the point of 2nd injection for PECS II block.

PMm - Pectoralis Major muscle; Pmm - Pectoralis minor muscle; SAm - Serratus Anterior muscle; ICm - intercostal muscle; Arrow showing Gerdy's Ligament

20ml of local anaesthetics will be deposited at the plane between Pmm and SAm.

(Above of the image is caudo-lateral)

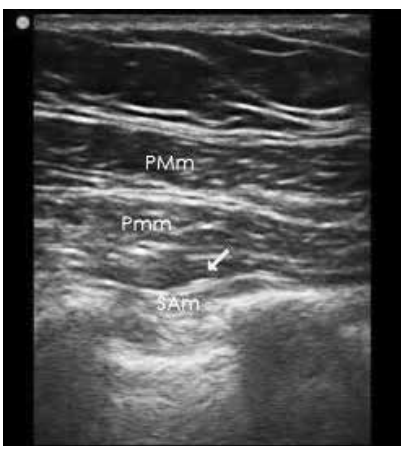

Figure 4: Ultrasound image for the point of 2nd injection for PECS II block.

PMm - Pectoralis Major muscle; Pmm - Pectoralis minor muscle; SAm - Serratus Anterior muscle;

Arrow showing hypoechogenic local anaesthetic deposition at the plane between Pmm and SAm.

(Above of the image is caudo-lateral)

Indications for PECS II Block

PECS II block is probably the better analgesic alternative **for more extensive breast surgeries**, especially **in wide tumour resections** and **in mastectomies that involve axillary clearance**. Anatomical considerations suggest that there are **other 'non-breast' surgeries** that PECS II block could potentially offer post-operative analgesia as well. Besides **axillary surgeries**, there could probably be a role in **thoracoscopic** surgery, **antero-lateral open thoracotomy** and there has been evidence of its use as supplementary anaesthesia in various **proximal arm vascular surgery**.[13]

Although this list is not extensive with other potential indications of its use, some highlight that the findings were non-consistent for the said surgeries and may be affected by various factors such as volume of injectate used, inconsistent spread or actual site of injection. These uncertainties were the basis for Blanco's subsequent work on Serratus Plane Block (SPB) or PECS III Block in 2013.

Serratus Plane Block (SPB) or Pecs III Block

The serratus plane (SPB) or PECS III block was a progression of work from the PECS I and II blocks, in which the **point of injection is made more lateral** in an attempt to consistently achieve a blockade of **lateral cutaneous branches of thoracic intercostal nerves (T2-T12)**. Blanco achieved consistent denervation over T2 to T12 antero-lateral and posterior dermatomal distribution in 4 young healthy volunteers in his observational study.[14]

SPB allows for a higher successful block of lateral branches compared to the 2nd PECS II injection. Whereas in PECS II block, success of the 2nd injection to block these lateral branches depend on the extent of lateral spread which is not consistently reliable. SPB can potentially provide analgesia for cases such as mastectomy and axillary clearance, more extensive thoracotomies or for lattissimus dorsi flaps.

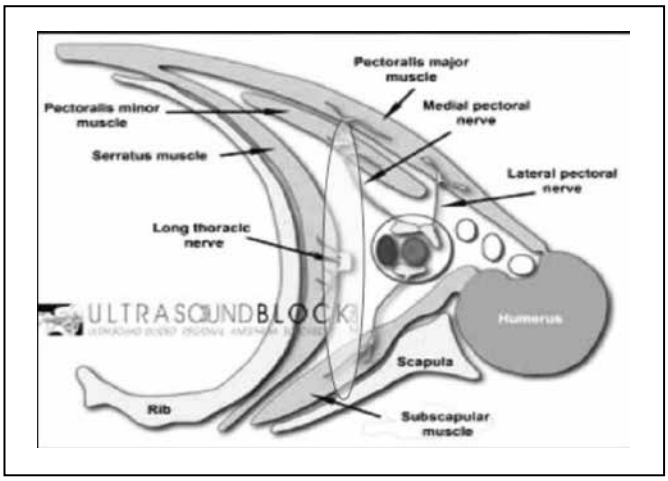

Figure 5: Serratus Plane or PECS III Block - Yellow shaded area showing interfascial plane for local anaesthetic deposition. Illustration assisted by graphic presentation from UltrasoundBlock.com

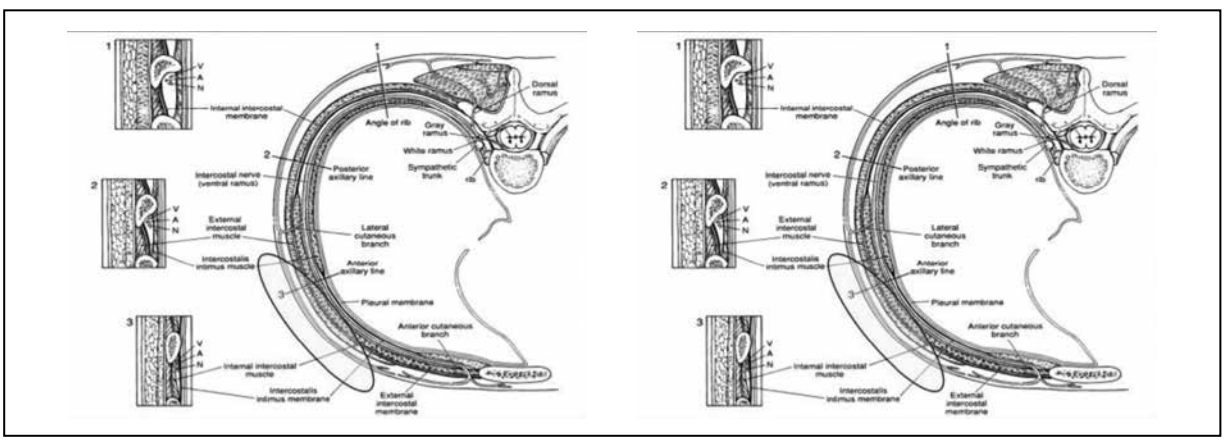

Figure 6: Yellow shaded area showing comparison of local anaesthetic distribution between **2nd injection of PECS II block (above left)** and **SPB or PECS III block (above right)**.

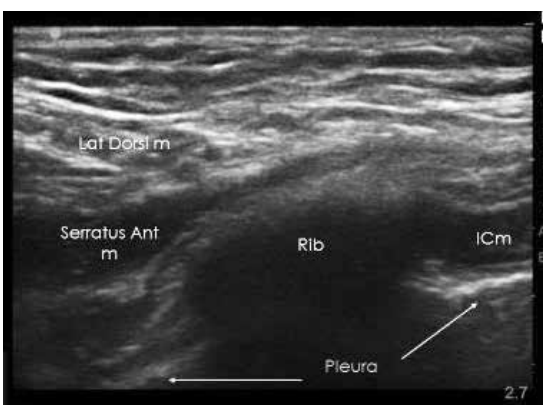

Figure 7: showing the point of injection for **Serratus Plane or PECS III block** over the mid-axillary line. The probe orientation is antero-posterior (right to left of the image)

Evidence for PECS Block

There are only isolated evidence suggesting effectiveness of PECS blocks for breast surgeries in terms of improved Numerical Rating Scores or Visual Analogue Scores (VAS) and a reduction of opioid consumption. **Sopena-Zubira** et al found a higher proportion of patients for breast augmentation and sub-pectoral prosthesis, with favourable pain scores at 8 hours and 24 hours respectively, using **PECS blocks combined with thoracic paravertebral block** compared with **paravertebral alone**. Mean VAS scores were significantly reduced at 8 hours in PECS group but were not statistically significant at 24 hours among the two groups.[6]

Wahba et al also had similar findings in 60 patients after mastectomy. They concluded that patients with **PECS block** had significantly reduced opioid consumption at 24 hours and pain scores in the first 12 hours in comparison with **paravertebral block**.[7] Both authors, however, failed to demonstrate significant clinical superiority of PECS block beyond 12 hours **compared to paravertebral** in terms of pain scores. In fact, Wahba detected significantly improved pain scores in the paravertebral block group beyond 12 hours.

Bashandy and Abbas, who studied 120 modified radical mastectomy patients under **general anaesthesia with and without PECS blocks**, discovered similar findings in terms of reduced VAS and reduced perioperative opioid requirement for the first 12 hours. Although reduction in VAS scores remained significant up to 24 hours, the difference in subsequent morphine requirement between both groups beyond the first 12 hours remained statistically insignificant.[8]

Other evidence for the use of PECS block for other types of surgeries remain scant in literature and were mostly through personal communication with Blanco. The successful use of PECS II block for proximal **upper limb fistula** surgery has also been documented in a small series of cases by Purcell.[13]

Issues with PECS Block

The main issue on the use of PECS Block is the sparsity of a large-sampled evidence. Isolated small sampled population has suggested its efficacy and more studies are expected to show results within the next few years. As of now, a check on *www.clinicaltrial.gov* website revealed at least 13 proposed studies which are related to PECS block and its outcome. Consistency and reproducibility in terms of clinical findings with regards **to site of injection, volume of injectate and technique** of the procedure have been put into question.[15,16]

Blanco stated that his use of 20ml of injectate reliably produced a spread from T2 to T8.[5] Whether this means that the volume is directly proportional to **extent and pattern of spread** has not been investigated in full and reproduced. Whether this proportionality can also be assumed when only a smaller spread is required also needs to be addressed.

There has been recent discussions on the plane of appropriate interfascial injectate deposition for optimal clinical result. Perez believes that appropriate deposition of LA should be at the interfascial plane **between SERRATUS ANTERIOR and the INTERCOSTALS** at the level of r2.[16] compared to Blanco's original description. This has not yet been shown in other published anatomical or clinical studies.

During Blanco's original description of PECS II block, he explicitly clarified that it involves 2 injections. While the first injection was clearly stated as PECS I, at no point in his description did he referred to the second injection as PECS II. **Many appear to** describe PECS (I and II) as **THE POINT OF INJECTIONS**, whereby PECS I is the injection between pectoralis major and minor, while **PECS II IS THE INJECTION BETWEEN PECTORALIS MINOR - SERRATUS ANTERIOR. (Bashandy and Abbas appear to describe PECS this way in their published article)**. There are indications whereby ONLY the 2nd injection is performed and

we do not have a name to describe this second injection alone. For example, is the combined use of supraclavicular brachial plexus block plus this second injection of PECS II which provided excellent results for proximal vascular surgeries in providing adequate medial arm anaesthesia.[13]

It has been acknowledged that, as of now, what was known as PECS III block has been re-classified as Serratus Plane Block to distinguish the different affected area. Fuzier had also suggested for the blocks to be differentiated into 'Pectoral' and 'Axillary Compartmental' Blocks to appropriately describe expected area of denervation.[17] Issues on **nomenclature** will not be resolved until further extensive anatomical studies within the pectoral and axillary regions are done to understand how the blocks work.

There have been comments by surgeons that performance of PECS block causes **disruption along surgical planes** making dissections of margin difficult resulting in incomplete excision of affected nodes. Hence the issue of appropriate timing for the block performance has also being brought into question. This disruption of surgical planes may also be the reason why the block works as it creates a communication between both pectoral and axillary compartments allowing for a more extensive spread of local anaesthetics.[18] To perform the blocks post-operatively on the other hand, would make ultrasonic identification of the planes difficult because of disruption of the tissue planes due to dissections made worse by the ensuing tissue oedema.

RECOMMENDATIONS

As of now, there seems to be a role of PECS II block as an analgesic modality for breast surgery. Whether it is more superior to thoracic paravertebral depends on the type and extent of surgery. For surgeries involving the axilla, PECS block is required as part of 'Axillary Compartment Block', but for medial breast incisions, paravertebral offers denervation of anterior branches of the intercostal nerves which PECS block does not confer. For optimum clinical benefit, it may be **best to combine both PECS with paravertebral** technique as shown by Sopena-Zubira.[6]

As to the timing of block performance, it may be beneficial to perform **PECS block** at least ten minutes **prior to surgery** to allow 'fixation' of the local anaesthetics to the neural structures before surgical stimulus. Further disruption of the planes during surgical manipulation would help extend spread of local anaesthetics between both compartments. In contrast, post-operative performance of PECS block may result in ineffective spread or even inaccurate planar distribution affecting quality of analgesia as a result of tissue oedema.

Recent suggestion by Perez[16] as to what is believed to be a more appropriate plane of interfascial deposition should be interpreted with caution for two reasons. The first being the lack of evidence in terms of anatomical and clinical studies with regards to its effectiveness; and second, referring to the findings by Blanco in 2013 on Serratus Plane Block[13] which suggested that there were no distinct difference in clinical efficacy when local anaesthetics were deposited between the two different planes. These findings, however, were on volunteers and have not since been reproduced. This would hence require further evaluation.

For abdominal surgeries... the Quadratus Lumborum (QL) Block

The last fifteen years has seen the evolution of Transversus Abdominis Plane Blocks (**TAP**); since its development in the 1990's and its first description in 2001 via the landmark approach. Further subsequent refinement led to development of various other approaches of TAP block, from McDonnell and Carney, to 'Classical TAP' (Shibata, El-Dawlatly); 'Subcostal TAP' by Hebbard, and 'Bilateral Dual TAP Block' by Borglum in 2011.[19] Differences in spread characteristics have led investigators to suggest that the more posterior the point of injection is within the TAP plane, the more efficacious is the analgesic effect, providing a wider analgesic window and temporal blockade. This was as evidenced by Abdallah in a

meta-analysis on the effect of posterior TAP block over the lateral approach and in subsequent review by Borglum.[20,21] Carney believed its strength in effect is due to **extension of local anaesthetic spread into the paravertebral space**,[22] making sense of moving the injection point slightly proximal and rostrally beyond the TAP aponeurosis and close to **Quadratus Lumborum** plane (Blanco Block-2007).[23]

Much of the success of QLB has been postulated to be due to;

i) Abdominal spinal nerves (subcostal and the ilioinguinal/iliohypogastric) which **travel across the ventral surface of quadratus lumborum** muscle before coursing within the transversus abdominis plane (TAP).

ii) The quadratus lumborum muscle is within the 'tube-like' **Thoraco-Lumbar Fascia**, extending from iliac crest caudally, and communicating with **endothoracic fascia** with its origin in the thoracic cavity, potentially **extending spread of local anaesthetics towards the thoracic paravertebral spaces**.[22,24,25]

In 2012, Borglum described the Transmuscular Quadratus Lumborum Block approach **(TmQLB)** and compared MRI spread of local anaesthesia among three techniques; i) thoracic paravertebral (TPV), ii) original QL block, lateral to quadratus lumborum muscle (Blanco Block) and iii) Transmuscular QL block (TmQLB) and evaluated its radiological spread and dermatomal anaesthesia. He found that TPV and TmQLB had significantly more rapid block onset compared to the original QL. With regards to clinical spread, TmQLB had dermatomal distribution from T7 to L1 which is similar in efficacy to the Blanco Block. He concluded that **TmQLB gives better block dynamics in terms of providing faster onset without compromising clinical efficacy**. (Borglum presented his findings during the DARA/ESRA Nederland Zone Meeting in February 2013). As of now, the TmQLB approach is the suggested technique for Quadratus Lumborum block. Recently, ElSharkawy described an alternative QL block technique utilizing the longitudinal axis of the quadratus lumborum muscle instead of a transverse approach. A formal clinical comparison between the two approaches is ongoing.[26]

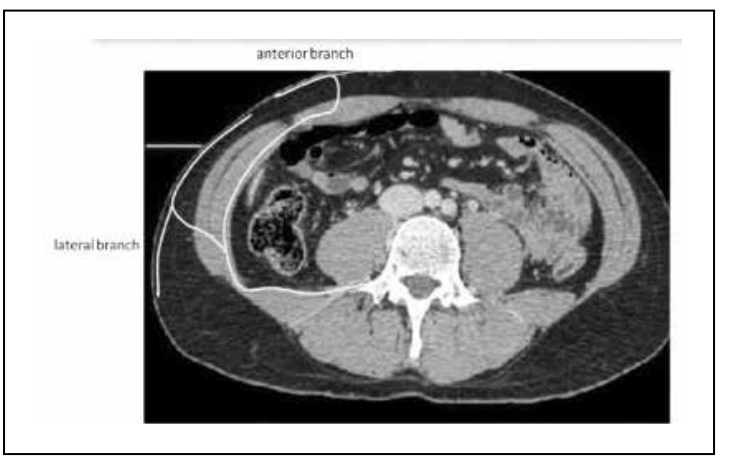

Figure 8: showing the courses of anterior and lateral cutaneous branches of the abdominal spinal nerves

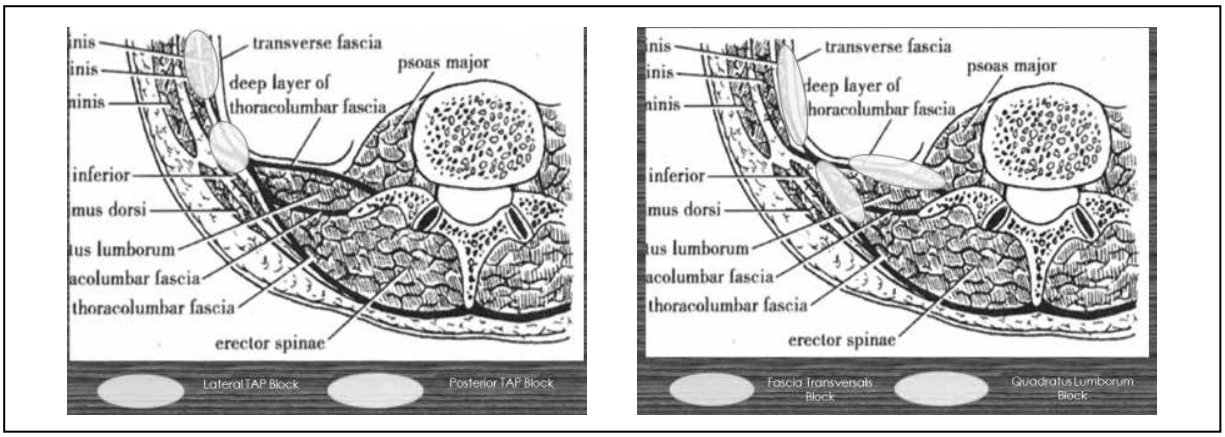

Figure 9: showing the point of injection for TAP block (above left) and the Fascia Transversalis and QL blocks (above right)

Technique of Identification

Identification of appropriate planes can be done either **from ventral to rostral**, or using lumbar vertebra as the landmark and appreciating the "**Shamrock Sign**" or the "**thumbs-up sign**"

i) From ventral to rostral, with the patient in lateral position, appreciate the TAP plane, and align a linear ultrasound transducer laterally, following the transversus abdominis, until the three appreciable layers (external, internal oblique and transversus abdominis) becomes two (internal oblique and transversus abdominis form a **conjoint aponeurosis**). As we move the transducer laterally, a layer of muscle is seen beneath the aponeurosis. This is the Quadratus Lumborum muscle. Needle insertion can be performed through the anterior abdominal wall directed towards this plane between Quadratus Lumborum and Psoas Major muscles, rostral to the deep layer of Thoracolumbar Fascia.

ii) With the patient in lateral position, place a low frequency curvi-linear transducer midway in between the costal margin and iliac crest, (Figure 11) to place the tip of transverse process of the immediate lumbar vertebra at the centre of the screen. (usually corresponds to the L2-L3 vertebra). This will be the stem of the "**Shamrock**" leaf and the immediate muscle

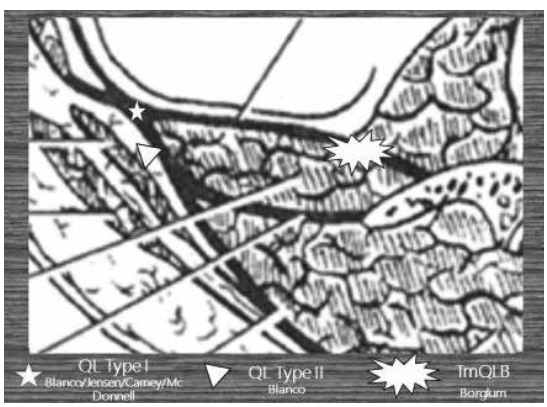

Figure 10: showing the location of multiple approaches of the QL Blocks

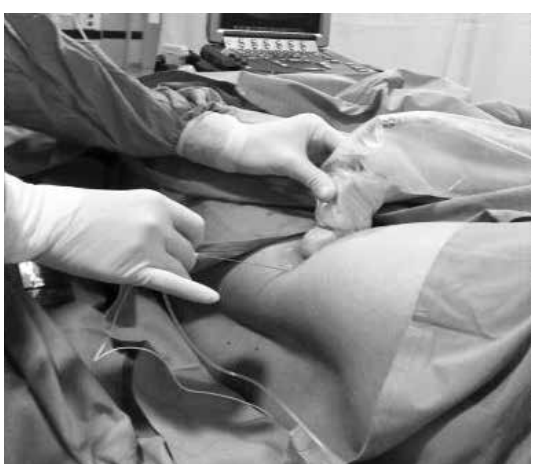

Figure 11: showing positioning, probe placement and needle insertion for TmQLB approach

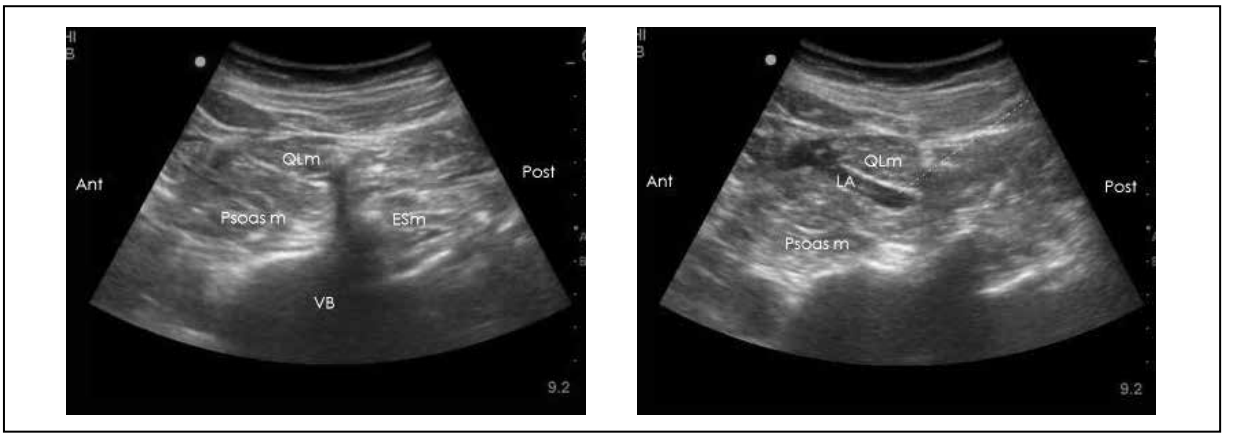

Figure 12: showing relationship between the Quadratus lumborum (QLm), Psoas major (Psoas m) and Erector Spinae muscles (ESm)- the "Shamrock sign" (above left). On the right is the post-block image with local anaesthetic (LA) being deposited in between Quadratus Lumborum (QLm) and Psoas muscle (Psoas m)

above this stem being the Quadratus Lumborum; or the '**thumb of a hands-up sign**'. The 'thumb,' being tips of the lumbar transverse processes will always point to the Quadratus Lumborum muscle. (For some, this transverse process and lumbar vertebra will appear as a '**chair**' with the 'head rest' pointed towards the Quadratus Lumborum muscle). (Figure 12)

Issues on QL block

At this moment, the **TmQLB technique** is the **suggested approach** for QL block and local anaesthetics should be deposited in between Quadratus Lumborum and Psoas Major muscles. However based on current understanding, as long as the local anaesthetic is deposited within Thoracolumbar Fascia, either in between the substance of the Quadratus Lumborum muscle and the intermediate layer of the Thoracolumbar Fascia rostrally (Blanco Block), or between Quadratus Lumborum substance and deep layer of Thoracolumbar Fascia ventrally (TmQLB), a working block would be expected.

Anatomically, only Quadratum Lumborum muscle is within the Thoracolumbar Fascia and not the Psoas major. Ventrally, both these muscles lie deep to **fascia transversalis**; a fascial lining of the retroperitoneal structures that is closely related to Thoracolumbar Fascia. Fascia Transversalis **extends cephalad and communicates with endothoracic fascia through the medial and lateral arcuate ligaments dorsal to the diaphragm**.[27,28] It is believed that through this communication, there could be potential local anaesthestic spread through to endothoracic fascia in the thoracic cavity which also extends to thoracic paravertebral spaces. This close approximation of Thoracolumbar Fascia to Fascia Transversalis may point to the possibility of 'mistaken identity' to the **ACTUAL SITE** of local anaesthetic deposition.

The volume of local anaesthetic based on current literature of TAP blocks suggest volumes of at least 15ml but several published case reports of QL block success suggest minimal volumes of between 20-30ml.[9-11] The amount of injectate can be titrated by following extent of spread by tilting the transducer cephalad while looking for hypoechoic local anaesthetic extending cephalo-medially towards paravertebral space. Further titrations of local anaesthetic aliquots can then be deposited this way based on extent of spread.

From our observation, maximum clinical efficacy can take beyond 30 minutes and hence this block should be performed prior to surgery for optimum perioperative analgesic benefit.

The Evidence for QL Block

There is still lots to do in terms of determining types of surgeries for appropriate types of blocks, doses, best techniques and timing of administration. At the moment, promising results that are being shown by the small body of evidence were only from case reports as there are no large randomized control trials as yet.[9-11] Only 7 currently registered studies for QL blocks are at various stages of processes at *www.clinicaltrials.gov* and we await further results on efficacy and reproducibility. TmQLB approach appears promising but comparative results from suggestions of improved efficacy by ElSharkawy through the paramedian sagittal subcostal approach[26] would be awaited eagerly throughout the regional fraternity.

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Posterior Parasagittal In-Plane Ultrasound Guided Infraclavicular Brachial Plexus Block - A Case Series

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BACKGROUND

Our study focus on the ultrasound guided infraclavicular brachial plexus block which is a cord-level block of the brachial plexus for surgical procedures below mid humerus.

The brachial plexus at this level runs deeper compared to its course proximally, giving rise to impaired needle visualisation due to the steep angle of needle insertion with the current ultrasound-guided approach (lateral para-sagittal in-plane technique).[1] A new ultrasound guided posterior approach parasagittal in-plane infraclavicular block was introduced to improve needle visibility.[2]

However no further follow up study was done. Therefore, we performed a case series of 18 patients with a cadaveric dissection to assess the feasibility of this approach.

METHODS

After obtaining ethics committee approval from the Medical Ethics Committee, University Malaya Medical Center, Kuala Lumpur, Malaysia (IRB reference no. 949.14 dated 17th October 2012, amendment no. 1038.76 dated 19th December 2013) and written informed consent, 18 patients undergoing surgery of the elbow, forearm, wrist, or hand were prospectively recruited based on the criteria below.

The inclusion criteria were patient's age between 18 and 80 years old, American Society of Anesthesiologists (ASA) physical status I - III, body mass index (BMI) between 20 and 35kg/m2 and planned for surgery of the forearm, wrist, or hand. The exclusion criteria were patient's inability to give consent to the study, pre-existing neuropathy, infection at the site of puncture, coagulopathy and allergy to amides local anaesthetics.

Prior to block, an intravenous cannula was inserted at the upper limb contralateral to the surgical site at the induction room. Premedication was given (intravenous midazolam 1-3mg and/or fentanyl 25-50ug) and supplemental oxygen via nasal cannulas at 3L/min was administered.

Standard ASA monitoring (non-invasive blood pressure, electrocardiogram, and pulse oximetry) was applied throughout the procedure.

All patients were given a single shot ultrasound-guided posterior parasagittal in-plane approach infraclavicular brachial plexus block under aseptic technique by one of the three operators (BZY, MSH and LHY).

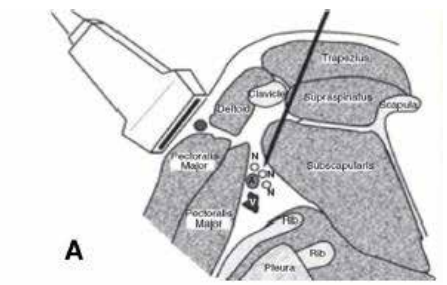
The blocks were performed using a 21G, 100mm insulated short bevel needle (Stimuplex A, B Braun, Melsungen, Germany) without nerve stimulation. A 25-ml local anaesthetic admixture [Lignocaine 2% (100mg) plus Ropivacaine 0.75% (150mg)] was administered. We used an ultrasound machine (Sonosite M-Turbo; Sonosite®, Bothell, WA, USA) with HFL38x/13-6 MHz linear transducer probe.

Patient's arm was allowed to rest in a neutral position by the side during the procedure. The infraclavicular area was cleaned with aqueous iodine solution and draped. The ultrasound probe was covered with sterile sheath and sterile gel applied.

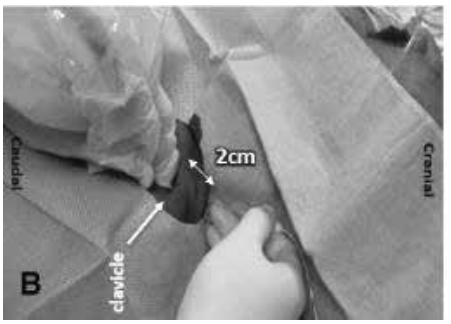
The ultrasound probe was placed below the clavicle and medial to the coracoid process in the deltopectoral groove i.e. para-sagittal view. A short-axis view of the axillary artery was obtained. We adopted the technique as described by Hebbard et. al.[2]

A skin wheal was made with 3mL lignocaine 1%. The needle insertion point was over the trapezius muscle sufficiently posterior to allow the needle to pass between the clavicle and the scapula in the direction of the axillary artery. The insertion point was strictly aligned with the long axis of the ultrasound beam i.e. in-plane technique.

During our pilot study, we identified the ideal needle insertion point would be 2cm posterior to theclavicle to avoid needle tip contact with the inferior surface of the clavicle (Figure 1).



Parasagittal section through the shoulder medial to the coracoid process showing needle and ultrasound probe



Ideal needle insertion point : 2cm posterior to clavicle to avoid needle contact with the inferior surface of the clavicle

Figure 1

The needle was advanced until a fascial click was felt when its tip reached the posterior aspect of the axillary artery (6 o'clock position) which indicated penetration of the septum posterolateral to the artery, confirming a good needle position with a high chance of block success.[3,4] At this point, local anaesthetic was deposited incrementally each time after a negative aspiration, ensuring a U-shaped distribution of local anaesthetic with anterior displacement of the axillary artery, known as 'double bubble sign'.[3,4]

We adopted and modified the data collection and assessment method as described by Tran et. al.[5-7] The anaesthesia assistant recorded the imaging time (defined as the time interval between contact of the ultrasound probe with the patient and the acquisition of a satisfactory sonoanatomy - a complete round short-axis view of the axillary artery), needling time (defined as the time interval between the start of the needle insertion and the end of local anaesthetic injection through the needle) and performance time (defined as the sum of imaging and needling times). The incidence of paraesthesia and vascular puncture was recorded if any.

We assessed the adequacy of motor and sensory blockade at predetermined intervals, every 5 min until 30 min; time zero was defined as the time at which the block needle exit the skin. Sensory blockades of the musculocutaneous, median, radial, and ulnar nerves were graded according to a 3-point scale using a pin prick test, with relative comparison to pin prick sensation in the contralateral limb: 0 = no block, 1 = analgesia (patient could feel touch but not sharp), and 2 = anaesthesia (patient could not feel touch). The sites for sensory assessment were musculocutaneous nerve - lateral aspect of the forearm; radial nerve - the lateral aspect of the dorsum of the hand; ulnar nerve - the volar aspect of the fifth finger and median nerve - the volar aspect of the thumb.

Motor blockades were also graded on 3-point scale with relative comparison to the contra-lateral limb: 0 = no block, 1 = paresis, and 2 = paralysis.

The motor function of each nerves was assessed according to its functional movement.

Musculocutaneous nerve - elbow flexion or forearm supination; radial nerve - thumb extension, wrist and fingers extension; ulnar nerve - thumb adduction or fingers adduction, abduction or flexion of little & ring finger; median nerve - thumb opposition or flexion of index & middle finger. The overall maximal composite score was 16 points. We considered patient was ready for surgery when a minimal composite score of 14 points was achieved, provided the sensory block score was equal or superior to 7 of 8 points. The onset time was defined as the time required to obtain 14 points. Therefore, the anaesthesia-related time was equal to the sum of the performance and onset time.

Following the 30-min block assessment, if the composite score was less than 14 points, a supplemental rescue forearm peripheral nerve blockade, local anaesthetic infiltration by surgeon, or conversion to general anaesthesia was employed at the discretion of the operating anaesthetist.

For these patients, we did not record the onset time and classified them as failed block. Success rate was equivalent to surgical anesthesia, defined as the ability to proceed with surgery without the need for intravenous narcotics, general anaesthesia, rescue blocks or local infiltration by the surgeon.[5-7] If patient experienced anxiety as voiced by himself or determined by the treating anaesthetist, additional administration of intravenous midazolam or propofol was given. Supplemental oxygen was administered during surgery.

The incidence of tourniquet pain, Horner's syndrome, dyspnoea and symptoms suggestive of local anaesthetic toxicity was routinely checked. Postoperatively, patient was served with oral analgesic medication (such as paracetamol, non-steroidal anti-inflammatory drugs) at the justification of the surgeon and allergy history. A week after the surgery, all patients were contacted via phone by our acute pain service (APS) team to enquire about complications such as persistent paraesthesia or motor deficit.

We performed additional evaluation of the ultrasound guided posterior approach infraclavicular brachial plexus block on a cadaver. Similar methodology was employed with a total volume of normal saline 0.9% 25ml mixed with methylene blue (0.2ml) was given. With the help of the anatomists, we dissected the right upper limb and evaluated the spread of the dye solution.

Statistical analysis was performed using SPSS version 20 statistical software (SPSS, IBM Corp). Continuous variables were presented as means (SDs); categorical variables were presented as counts or percentages.

RESULTS

We performed this study on 18 patients, 11 men and 7 women with a mean age of 37.7 years (SD 13.9 years) and mean body mass index of 26.6kg/m2 (SD 4.1kg/m2). In terms of ASA physical status, 11 patients were class I, 6 class II and 1 class III. 7 patients underwent hand surgery, 4 for wrist surgery, 6 for forearm surgery and 1 for elbow surgery (Table I).

Table I: Patient characteristics

Sex (male/female), n	11/7
Age, mean (SD), y	37.7 (13.9)
BMI, mean (SD), kg/m^2	26.6 (4.1)
ASA physical status (I,II,III), n	11/6/1
Types of surgery (hand/wrist/forearm/elbow), n	7/4/6/1

Continuous variables were presented as means (SDs); SD, standard deviation; categorical varibles were presented as counts. BMI indicates body mass index, ASA indicates American Society of Anesthesiologists

We achieved 100% success rate in all patients. None of these patients required the need for intraoperative intravenous narcotics, rescue blocks or local infiltration by the surgeon during operation and no conversion to general anaesthesia. The posterior technique seemed to have a fairly short imaging time (29 s [SD, 15 s]), needling time (4 min 31 s [SD, 1 min]), performance time (5 min 3 s [SD, 1 min 5 s]), onset time (22 min 46 s [SD, 4 min 16 s]) and total anaesthesia related time (27 min 50 s [SD, 4 min 36 s]) (Table II). Most of them achieved composite score of 14 (readiness to undergo operation) by 25 min (Figure 2).

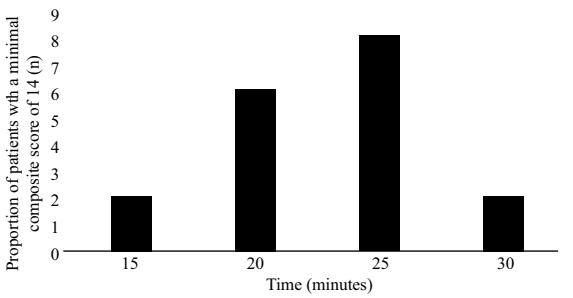


Figure 2: Proportion of patients with a minimal composite score of 14 points according to time. Most patients achived readiness to undergo surgery (also defined as block onset time) by 25 min

27.8% of the patients reported incidence of paraesthesia during the procedure but follow up on all of them one week after surgery revealed no persistent paraesthesia or motor deficit. No adverse event occurred in this study. No incidence of vascular puncture and none experienced tourniquet pain (there were a total of 13 cases required tourniquet application during surgery) (Table II). No Horner's syndrome observed. No patient had dyspnoea or symptoms suggestive of LA toxicity.

From the Figures 3 and 4, the posterior approach exhibited similar pattern of sensory and motor blocks profile. The musculocutaneous nerve was the fastest to achieve sensory anaesthesia and motor paralysis, followed by radial nerve, ulnar nerve and median nerve tend to be the slowest to achieve full blockade.

For the cadaveric dissection, we observed the distribution and spread of the methylene blue dye after the block. We could see that the median and ulnar nerves were less stained as compared with musculocutaneous and radial nerves (Figure 5).

Table II: Block performance data

Imaging time, mean (SD), min: sec	0:29(0:15)
Needling time, mean (SD), min: sec	4:31(1:00)
Preformance time, mean (SD), min: sec	5:03(1:05)
Onset time, mean (SD), min: sec	22:46(4:16)
Total anaesthesia related time, mean (SD), min: sec	27.50(4.36)
Success rate - surgical anaesthesia, n (%)	18(100.0)
Paraesthesia, n (%)	5(27.8)
Vascular puncture, n, (%)	0(0)
Tourniquet pain, n (%) / total cases required tourniqute application	0(0)/13

Continuous variables were presented as means (SDs); SD, standard deviation; categorical varibles were presented as counts or percentage. Imaging, needling, performace, and total anaesthesia-related times were calculated only for patients with a composite score of 14 points at 30 min

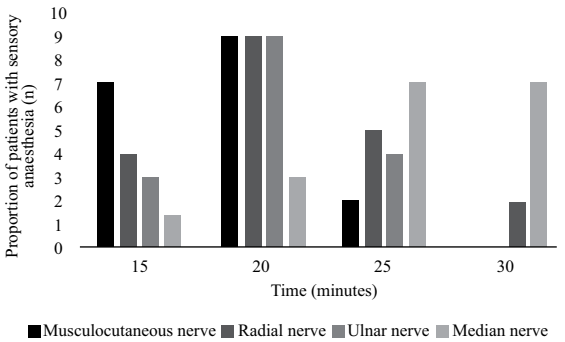


Figure 3: Proportion of patients with sensory anaesthesia (score of 2) according to time in the cutaneous distributions of nerves. The musculocutaneous nerve achieved fastest onset of sensory anaesthesia, followed by radial nerve. The ulnar and median nerve tend to be slower in achieving sensory anaesthesia

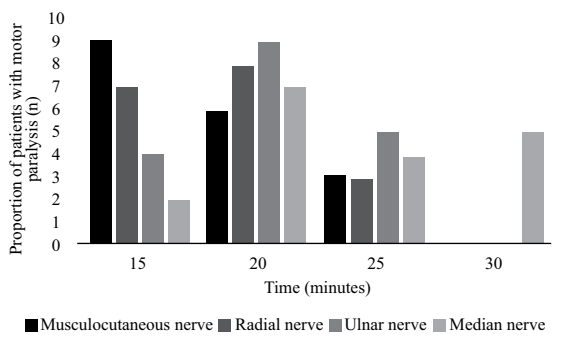


Figure 4: Proportion of patients with motor paralysis (score of 2) according to time in distributions of nerves. The musculocutanaeous nerve achieved fastest onset of motor paralysis, followed by radial nerve. The ulnar was third and median nerve tend to be the slowest in achieving motor paralysis

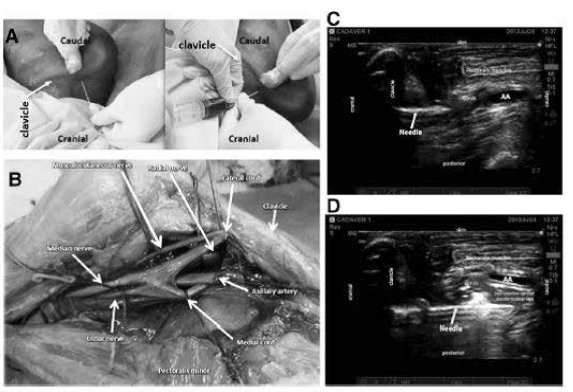


Figure 5

DISCUSSION

In this case series combined with a cadaveric dissection, we evaluated the feasibility of a single shot ultrasound guided posterior approach, parasagittal in-plane infraclavicular brachial plexus block. The results of this study showed that the posterior approach was a feasible technique with high success rate.

The posterior approach had comparable imaging, needling and performance times with conventional method based on previously published data. In a study conducted by Tran et al., 44 patients underwent operations with conventional approach ultrasound guided infraclavicular brachial plexus blocks.[5]

The mean imaging time was 39 s (SD, 39 s), needling time was 4.5 min (SD, 1.4 min) and performance time was 5.1 min (SD, 1.5 min).

In the posterior approach, the needle would not be visible initially as it was obscured by the clavicle shadow. It would only appear on the ultrasound screen after it had travelled for some distance under the surface of the clavicle.

As the needle trajectory was less acute compared to the conventional technique, it would appear in a horizontal fashion and almost directly perpendicular to the ultrasound beam. The needle therefore became more visible due to minimization of refraction and maximization of reflection of ultrasound beam towards the probe (Figure 6).

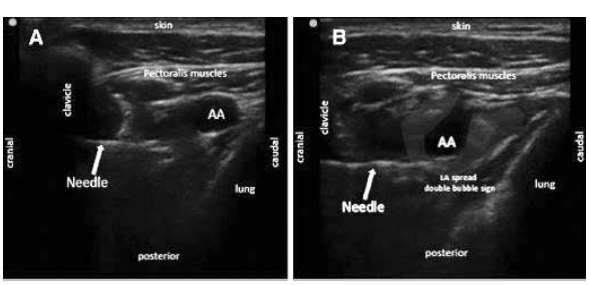


Figure 6: Ultrasound guided posterior parasagittal in-plane infraclavicular brachial plexus block

A: needle trajectory

B: LA deposit on posterolateral aspect of the axillary artery, creating double bubble sign

With deeper nerve targets, the angle of incidence between the structure and the ultrasound beam was more parallel resulting in more ultrasound waves being refracted and reflected away and fewer waves successfully return to the probe. Hence, the needle appeared less visible making the technique more challenging especially for novices.

Despite having good needle visualization with the posterior approach, there were technical difficulties that we faced during the performance of this block. The factors that contributed to this were the size of the neck and its length, various anatomical variations of the clavicle and the size of the area over the supraclavicular fossa (Figure 7).

Short and thick neck would hinder and obstruct the pathway of needle insertion especially when the length of the needle used was quite long as in this case series (Figure 7f). The shape of the clavicle and its various anatomical variations were also found to influence the size of the area above the clavicle. Clavicles which are more angulated in its lateral portion would reduce this area, hence contributing significantly to needling difficulty.

From our case series, we found that the best position for this approach was to get the patient's head to lie flat on the bed or trolley (without pillow) with the head turned to the contralateral side. A sandbag could also be placed underneath the shoulder to increase the space between neck and supraclavicular fossa. 5 or 27.8% of the patients reported incidence of paraesthesia during the procedure but follow up on all of them one week after surgery revealed no persistent paraesthesia or neurological deficit. In a recent study of more than 7000 peripheral nerve and plexus blocks, 30 patients (0.5%) were referred for neurological assessment.[8] Of these 30 patients, only three met the criteria for nerve injury related to peripheral nerve block (0.04%). This study confirms that neurological deficits after peripheral nerve block are rare. However, neurological assessment and follow-up until resolution of the condition is vital.

The posterior approach showed similar pattern of sensory and motor blocks profile. The musculocutaneous nerve, being a branch from the lateral cord, was the fastest to achieve sensory anaesthesia and motor paralysis.

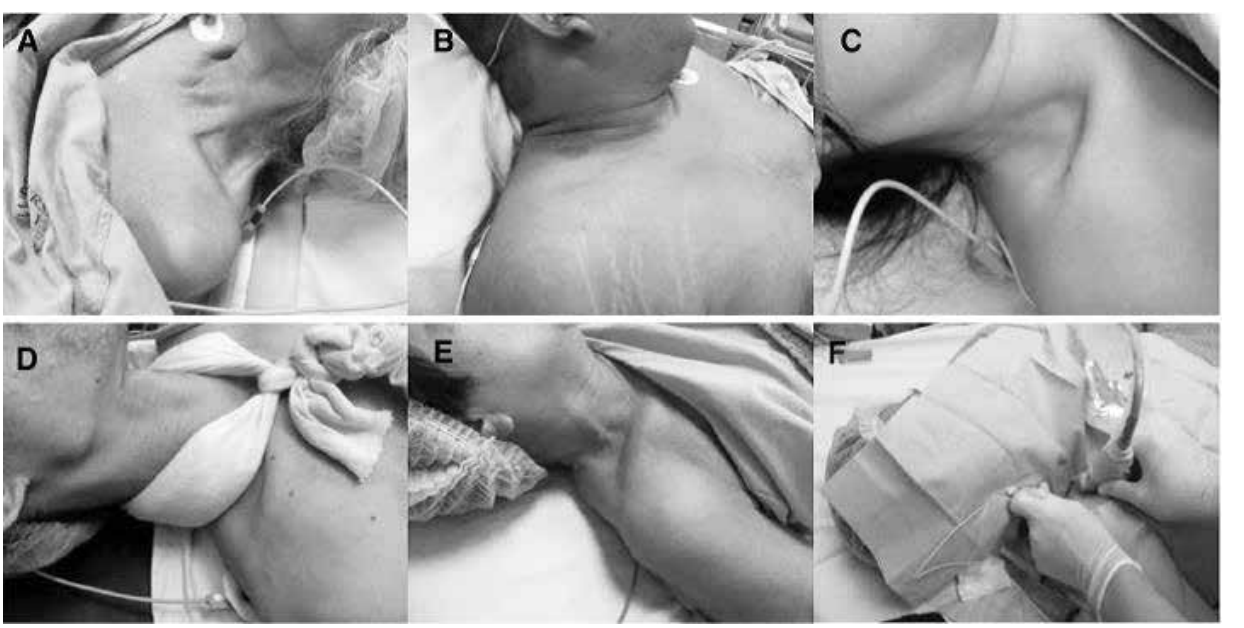


Figure 7: Anatomical variations of the clavicle

Likewise, radial nerve which branch from the posterior cord was the second fastest (almost as quick as musculocutaneous nerve) to achieve full blockade. Sauter et al. observed that, in most of subjects, the lateral cord lies approximately at 9-o' clock, 276º (263º-321º) and posterior cord lied at 8-o' clock, 236º (189º-261º) from the center of the artery.[9]

Rapid blockade of both nerves were due to their close proximity to the target point site of local anaesthetic injection. The ulnar and median nerves are both branches of medial cord, though median nerve also received contribution from the lateral cord. These two nerves tend to take longer time to achieve full blockade.

The medial cord usually lies on the medial aspect of the axillary artery, at 159º (90º-290º) from the center of the artery making local anaesthetic spread to the structure the slowest to take effect.[9]

As for the cadaveric dissection, we observed the distribution and spread of methylene blue dye after performing the block. The imaging and needle visibility were excellent because this cadaver was thin in size. We could see that the median and ulnar nerves were less stained as compared with musculocutaneous and radial nerves (Figure 5), which correlates with the findings of the timing of block onset of each nerve in our study.

The limitation of this study was its small sample size (18 patients and 1 cadaver specimen). The main difference between this block approach and the conventional infraclavicular approach is the site and angle of needle insertion. Otherwise, the end point of local anaesthetic injection remained the same for both approaches.

We stopped recruiting after performing the blocks in these 18 patients because all the blocks had a hundred percent success rate and we did not encounter any major complications other than the technical difficulties as described above. We felt that the number of subjects was adequate and further evaluation of this approach shall be a randomised trial comparing it with the conventional technique. Another limitation of this study is the lack of description with regard to the clarity of the visualised needle.

CONCLUSION

This study demonstrated that the posterior parasagittal in-plane approach is a feasible and reliable technique with high success rate. Future studies shall compare this technique with the conventional lateral parasagittal inplane approach.

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Faster Onset Time Of Supraclavicular Brachial Plexus Block Using Local Anaesthetic Diluted With Dextrose

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INTRODUCTION

Regional anesthesia with local anaesthetics blocks specific nerves to enable pain free surgery, or for intra- and post operative pain relief. Dilution of local anaesthetics with normal saline is a common practice to enable administration of larger volumes of local anaesthetics particularly in cases whereby multiple nerve blocks are needed. This will also minimize the risk of systemic toxicity. Local anaesthetics block the function of sodium channels located in neural tissue, inhibiting depolarization and thus the transmission of nerve impulses.[1] A high sodium concentration is known to antagonize the analgesic effect of local anaesthetics.[2]

On the other hand, dextrose when injected around nervous tissue does not cause any pain on injection and does not cause any long term neurological deficit in animals or humans.[3-5]

Dilution with dextrose would reduce the concentration of sodium ions and hence reduce its antagonistic effect. In the literature, only one study using dextrose as diluent to produce 0.5% ropivacaine for axillary brachial plexus block showed a reduction in the onset time for sensory blockade when compared with dilution with saline.[6]

Our hypothesis was that dilution of the local anaesthetics with dextrose would shorten the onset time compared to saline for a supraclavicular brachial plexus block. In the present randomized and blinded clinical study, 0.75% ropivacaine was diluted with dextrose or saline to produce 0.5% ropivacaine, for ultrasound guided supraclavicular brachial plexus block. The primary aim was to compare the onset time for complete analgesia and motor blockade in both groups. Analysis with regards to the duration of the neural blockade was also carried out.

METHODS

This clinical study was registered at clinical trials.gov (ID no. NCT01815944). After obtaining approval from the Medical Ethics Committee, University Malaya Medical Centre (Ethics committee/IRB reference no. 883.11 dated 19 October 2011), patients aged between 18 and 85 years who were ASA I to III, scheduled for elective or emergency surgery of the hand, forearm and elbow were evaluated for eligibility to be enrolled in the study.

Patients were excluded if they had a history of diabetes mellitus, any neurological deficit, contraindications to supraclavicular brachial plexus blockade, were unable to give consent, or refused to participate. Upon obtaining written informed consent, patients were randomly assigned to either the dextrose (D5%) or nor-mal saline (NS) group.

Randomization was performed using a computer-generated random table and patients were blinded as to their group allocation. Group allocations were concealed in a sealed opaque envelope and were opened by an independent anesthesiologist just before the performance of the block. The same anesthesiologist prepared 20mL 0.5% ropivacaine by diluting 13.3mL of 0.75% ropivacaine with 6.7mL of either dextrose or normal saline, depending on the patient's group allocation.

An anaesthesiologist familiar with the technique, who was blinded to group allocation, performed all ultrasound-guided supraclavicular blocks. Prior to the block, all patients were placed supine on a

trolley and were equipped with routine monitoring, i.e. ECG, SpO2, NIBP, and a patent intravenous line. Patients were given IV midazolam 0.03-0.04mg/kg before the brachial plexus blockade to relieve anxiety but not to the point of being unable to respond clearly.

After the brachial plexus was identified using a Sonosite M-Turbo ultrasound machine and a 13-6 MHz linear probe (Sonosite®, Bothell, WA, USA), the adjacent skin area was cleaned with povidone iodine and draped. Under aseptic technique, a sterile 22G, 50mm short bevel needle (Stimuplex®, B Braun, Melsungen, Germany) was guided in-plane with the ultrasound beam toward the plexus. Once at the appropriate location, local anaesthetic was administered incrementally, each time after a negative aspiration, ensuring expansion and adequate spread around the brachial plexus.

A total of 19mL of local anaesthetic was given each time; 1mL from the initial 20mL prepared being used to prime the catheter for the needle. Evaluation of sensory and motor blockade was then carried out. The same anesthesiologist who performed the blocks and was blinded to group allocation did every evaluation.

Sensory and motor blockade were tested, after injection of the local anaesthetic, every 5 min until total analgesia was obtained in all four nerve distributions, or up till 60 min, whichever was earlier. Sensory loss was tested in the median, radial, ulnar, and musculocutaneous nerve distributions and evaluated using a three point score: two = normal, one = analgesia, i.e. loss of pinprick sensation, or zero = anesthesia, i.e. total sensory loss.

The extent of motor blockade was tested in the distribution of the radial (thumb abduction, finger and wrist extension), ulnar (thumb adduction), musculocutaneous (flexion of the elbow in supination and pronation), and median nerves (thumb opposition) and evaluated using a three-point scale where two = normal movement, one = paresis with some movement possible, and zero = total paralysis.

Block success was defined as loss of sensation to pinprick (sensory score one) in each of the radial, ulnar, median and musculocutaneous nerve distributions, measured up till 60 min after the end of local anaesthetic injection. Patients in whom block success was not achieved after 60 min were excluded from data analysis. They were subsequently given appropriate individual nerve blocks at the axilla or elbow, or were given general anesthesia prior to proceeding with surgery.

Low-dose midazolam (1-3mg) and/or propofol at conscious sedation doses (25-75mg/kg/min) were given during surgery according to the usual standard of care at our center. In the event of inadequate analgesia intraoperatively, boluses of fentanyl (1-2 micg/kg) were given, followed by conversion to general anesthesia if necessary. Any adverse events were noted during and after the block performance.

The onset time for sensory blockade was taken as time from completion of injection of local anaesthetic to time of complete analgesia in all four nerves. Time for motor blockade was taken as time from complete injection of local anaesthetic to time of total motor block of the nerves assessed.

During the postoperative recovery period before being discharged to the ward, pain (verbal response score four or patient request for analgesic) was treated with IV tramadol 25-50mg slow bolus with or without fentanyl 25micg boluses every 5 min as needed.

Once in the ward and when oral intake was allowed, patients received oral paracetamol 1g with oral diclofenac 50mg or celecoxib 200mg, if not contraindicated, when they felt the slightest pain from the operative site and requested oral analgesics.

Patients were told to note the time to first request for analgesics. The block duration was subsequently taken as time from complete analgesia to the time when the patient first feels the slightest pain from the operative site and requests oral analgesics.

Patients were followed up twice; on postoperative day (POD) 1 and once between POD 7-10. They were seen in the ward or were contacted via telephone and asked for the presence of any pain, weakness, numbness, tingling, or any abnormal sensation in the operative extremity. If indicated, they were then told to return to the hospital for further evaluation and management as necessary.

The primary outcome measure for this study was the onset time of sensory blockade defined as the time interval between the end of local anaesthetic infiltration and loss of sensation to pinprick. Dhir et al. reported a mean difference of 4.2 min in the onset time between the two compared groups. The pooled standard deviation was 6.25.

Calculations based on this study showed that 25 patients per group were needed to detect a statistically significant difference between the groups with $\alpha = 0.05$ and a power of 80%. For patient demographics, descriptive statistics were used.

For the onset time of sensory blockade, the independent-t test was used. Individual nerve block times, total duration of block, total procedure time, and onset time for total paresis were also analyzed using the independent *t*-test. Data analysis was done using SPSS version 16 (SPSSInc., Chicago, Illinois, USA). We also calculated the effect size values in this study.

Effect size values are typically computed to compare the effects of different treatments.[7] It provides a measure to assess the magnitude of difference between groups that cannot be obtained solely by focusing on *p*-Values. *p*-Values are dependent on both the magnitude of difference between groups and the sample size. Therefore with other factors held constant, increasing the sample size increases the probability of finding a statistically significant difference.[8]

In this study, effect size values were calculated in addition to *p*-values, to assess the magnitude and to strengthen the validity of our results. The effect size reported in this study was calculated as the 'standardized' mean difference, i.e. as the ratio of mean change to the standard deviation of the change.[8] Effect size values between 0.2-0.5, 0.5-0.8 and >0.8 were taken to denote 'small', 'moderate' and 'large' changes in outcomes respectively.[8] An independent medical statistician carried out all statistical analyses.

RESULTS

The study was carried out between December 2011 and October 2012. A total of 104 patients was evaluated for eligibility, from which 55 were recruited and randomized. Successful blocks were subsequently obtained in 25 patients, in each arm (Figure 1). For demographic data see Table I.

TABLE I: Patient demographics. Values for age, sex, weight, height and ASA class.

	Group NS (*n* = 25)	Group D5% (*n* = 25)
Age, years	**32 (16)**	**34 (13)**
Sex, M:F	**19:6**	**22:3**
Weight, kg	**65 (14)**	**68 (15)**
Height, cm	**159 (30)**	**167 (6)**
ASA class, I/II/III	**23/2/0**	**22/3/0**

Coutinuous data are presented as mean (SD).

There was no difference between the NS and D5% groups with respect to duration of surgery. Halfway through the study (after 23 patients), the anesthesiologist evaluating the block also had to prepare the local anaesthetic solution. There was however a larger number of males in each group.

Mean time for onset of analgesia for the NS group was 45.2 ± 13.9 min while mean time for the D5% group was 37.6 ± 12.9 min. The *p*-value of the test

was 0.05 which is significant at the 5% level. The effect size was 0.567, which depicts a moderate change in outcome. Mean time for onset of analgesia for individual nerves showed no difference between the NS and D5% groups (Table II).

The mean time for onset of motor block (total paralysis) could not be analyzed, as 90% of patients did not have complete paralysis at the endpoint of total loss of sensation to pin prick. The mean time for onset of total paresis was not statistically significant between the NS and D5% groups.

Block procedure time and sensory block duration were also not different between the two groups (Table III). Overall block success was 89% for the D5% group and 92% for the NS group, which were not different. No patient needed rescue analgesia intraoperatively.

Post injection of local anaesthetics, 2 patients, one from each group, developed Horner's syndrome, which they were unaware of, and this resolved spontaneously after 24h observation. One patient from the D5% group complained of weakness and shooting pains in the operative arm on POD 7. However upon further questioning and examination, it was discovered that the patient already had those symptoms bilaterally, prior to the operation and that those symptoms were actually worse on the contralateral arm. However as the symptoms had marginally worsened, the patient was referred for an MRI of the cervical spine. The patient was then referred for a nerve conduction study of the operative arm which confirmed pathology at the level of the spinal cord.

TABLE II: Onset times for analgesia and individual nerves.

	Group NS (*n*=25)	**Group D5% (*n*=25)**	***p*-Value**
Onset of analgesia (min)	45.2 (13.9)	37.6 (12.9)	0.05
Individual nerves			
Radial, min	17.7 (8.9)	17.0 (10.0)	0.82
Median, min	37.4 (16.6)	31.0 (14.6)	0.15
Ulnar, min	40.8 (17.9)	33.9 (15.9)	0.16
Musculocutaneous, min	13.2 (7.7)	16.2 (8.6)	0.20

Values are mean (SD)

TABLE III: Onset times for other end points.

	Group NS (*n*=25)	**Group D5% (*n*=25)**	***p*-Value**
Block procedure time, min	7.5 (2.0)	7.4 (2.1)	0.89
Sensory block duration, min	527.6 (168.4)	583.0 (190.6)	0.30
Onset time for total paresis, min	14.2 (9.6)	10.8 (4.2)	0.13
Duration of surgery, min	109 (79)	89 (44)	0.32

Values are mean (SD)

DISCUSSION

In this study, the mean time for onset of analgesia was 45.2 min and 37.6 min for the normal saline and dextrose groups, respectively. The *p*-value of 0.05, together with a moderate effect size of 0.567,[8] makes us conclude that there is clinical evidence that dilution with dextrose results in a faster onset time of analgesia compared to dilution with normal saline.

In this study, effect size values were calculated in addition to *p*-values, to assess the magnitude and to strengthen the validity of our results.[8] Thus, we could also reasonably infer that this translates to a faster onset time for anaesthesia. This finding is similar to another study by Dhir et al.[6]

Our slightly longer mean time for onset of analgesia as compared to some studies could be attributed to the consistent deposition of local anaesthetic around the brachial plexus sheath (periplexus).[6,9-11] This approach may avoid needle-to-nerve contact and thus reduce the possibility of nerve injury.

However, one study found that up to 40 min was needed for complete analgesia and up to 50 min for total loss of sensation.[11] Mean time for onset of motor block could not be calculated, as a large number of patients did not have complete motor paralysis at the point of total loss of sensation to pin prick. This was unusual, as the concentration of 0.5% ropivacaine used should have produced total motor blockade as well as anesthesia.

However, ropivacaine is also known to have less motor blockade than sensory blockade.[12] This might have accounted for this unusual finding. It could also be due to deposition of local anaesthetic outside the brachial plexus sheath (peri plexus).

Mean block procedure time of about 7.5 min for each group was not expected to be different as a single operator performed all blocks. This time was also comparable to a recent study that reported times of 7.3-7.6 min.[6] Sensory block duration averaged more than 520 min or 8.5 h for both groups. However, the method of evaluating this duration of effect was by subjective patient feedback of the time they first felt pain.

Offset of sensory and motor blockade was not assessed individually until full recovery when the patient had returned to the ward. Patients also received oral analgesia prior to block resolution to avoid rebound pain after return of sensation.

Despite the slightly longer mean time for onset of analgesia in this study, block success of 89% and 92% for the two groups were similar to the success rates for ultrasound guided supraclavicular brachial plexus blocks quoted in other studies, which ranged from 85 to 95%.[9-11]

Horner's syndrome occurred in 2 (3.6%) of the patients in this study. This is slightly higher than 1% cited in one study, but was much lower than 37.5% cited in another.[13] Hence, there is evidence of wide variations in incidence and some studies do not actually report the incidence of Horner's syndrome. Rather than a complication per se, it has been described as an unpleasant side effect with no clinical sequelae. Indeed, the two patients with Horner's syndrome in our study did not know they developed it until told.

The dominance of males in each group can be attributed to the fact that many of these patients were coming for plating of the radius or ulnar due to motor vehicle accidents which have been shown to have a higher incidence in males.[14]

There are notable limitations in this study. The anesthesiologist evaluating the block was blinded till halfway through the study. Due to unforeseen circumstances, the preparation of the local anaesthetic had to be carried out by him in the latter half. This inherently introduces operator bias to the study. However, block evaluation used a very clear and objective end point of loss of sensation to pinprick, which would have decreased the subjectivity of the evaluation by the assessor.

SUMMARY

A faster onset time of analgesia to provide conditions suitable for surgery is what is desired in the daily running of the operating theater list and in optimizing efficient usage of theater time.

Our study suggests a decrease in onset time of analgesia when dextrose was used as a diluent instead of normal saline for ultrasound guided supraclavicular brachial plexus block.

Further studies are required to ascertain if the results are similar for different concentrations of other local anaesthetics, and for other ultrasound guided nerve blocks.

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"Pain Score 0-2 Immediately After Thoracotomy?!" Serratus Anterior Plane Block: A New Promising Analgesic Technique For Post Thoracotomy Pain - Case Series Experiences In Hospital Sultanah Aminah, Johor Bahru

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INTRODUCTIONS

Post thoracic surgery pain is a major issue. Despite 'successful' surgery, patients can be left with significant levels of disability and pain (Figure 1). It favors atelectasis, pulmonary infection and complicates respiratory physiotherapy. Surgical techniques for thoracic surgery have undergone significant changes in recent years.

Similarly, analgesia for patients include a new technique of regional anaesthesia that enhances rapid recovery with a high degree of postoperative comfort. Traditionally, thoracic epidurals, paravertebral blocks, intercostal blocks and intravenous analgesia are common modalities of pain relief for these patients. Unfortunately these procedures are uncomfortable (for patients and anaesthetist!), time consuming and have been associated with serious complications.

The serratus anterior plane block has been described as a safer alternative to high thoracic epidurals and paravertebral blocks. There are several case reports regarding its use for analgesia after multiple rib fractures and breast surgery. Serratus plane block is an evolution of the PECS II block, with two possible compartments, one superficial to serratus muscle and one deep underneath it, which allow to block the thoracic intercoastal nerves, for anaesthesia/analgesia at the level of anterolateral and posterolateral of chest.

We present our initial experience with the serratus block for post-op analgesia after thoracic surgery in a case series of 7 patients.

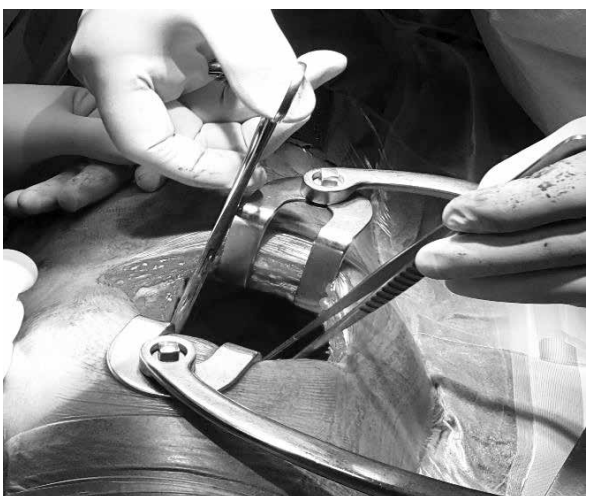

Figure 1: Open thoracotomy from anesthetist's view: Postoperative pain score 7-10/10?

METHOD

7 patients who underwent thoracic surgery between March to May 2016 were recruited. All patients were consented for this technique explaining the risk and benefit to the patients. All patients received multimodal analgesia perioperative with parenteral injection of opioid and COX-2 inhibitor.

The serratus anterior plane block was performed at the end of surgery for post-op analgesia (Figure 2). The ultrasound probe was placed transversely at the mid axillary line slightly superior to the incision site and oriented in anterior- posterior direction. The needle was introduced in plane with the tip deep and above the serratus muscle, using Vygon 120mm needle (Figure 5).

Patients were given a bolus of 40mls of 0.5% Ropivacaine (3-4mg/kg). Using hydrodissection through the fascial planes, the needle was advanced to increase the spread of local anesthetic. A catheter was left about 10-15cm in between the myofascial plane of latissimus dorsi and serratus anterior muscles.

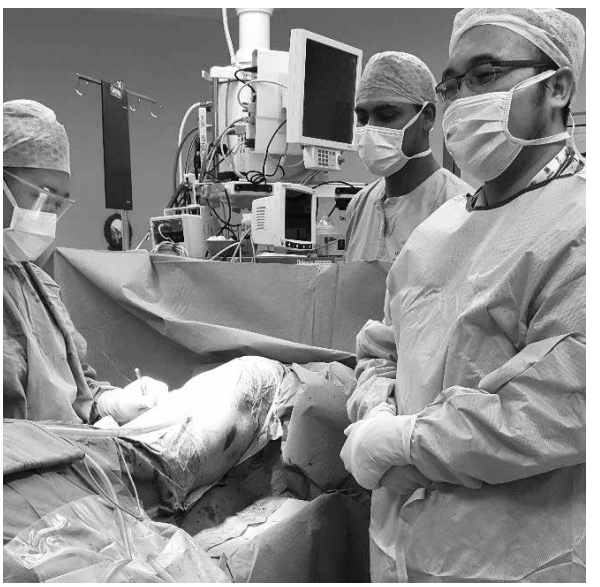

Figure 2: Full aseptic technique at the end of surgery before regional block

Patients were then given 0.2% Ropivacaine with fentanyl 2mcg/ml for infusion at a rate of 5ml/hr, which was started an hour after the first surgical incision.

Post extubation, dermatomal sensation and the least pain score were assessed (at rest, deep breathing on arrival to the ward and after rescue analgesia boluses given before intensive physiotherapy on POD 1). All patients had paracetamol and celecoxib at regular interval.

RESULTS

Pain scores ranged from 0-2 (rest), with a mean of 0.7 and pain scores ranged 1-3 (on deep breathing/ movement), with a mean of 2. All patients required rescue analgesia during intense physiotherapy on POD 1 as they had pain scores of 4-5, and all had a reduction in their pain scores to 0-1 on deep breathing following bolus of Ropivacaine 0.2% 20ml.

The area of sensory loss to cold sensation on arrival to HDW was between T2 - T6 for 5 patients, and T3 - T5 for 2 patients. Mean duration of time taken to do this procedure was 7.7 minutes. None of the patients had any significant hemodynamic, respiratory, LA toxicity complications.

DISCUSSION

Blanco et. al. reported adequate analgesia with injection either superficial or underneath the serratus anterior muscle. The duration of analgesia was longer with the superficial approach (12.5 hrs) as compared to injection underneath the serratus muscle (6.4 hrs).

The lateral cutaneous branches of the intercostal nerves are blocked as they pass through these planes, before dividing into anterior and posterior branches to supply sensation to most of the chest wall. We chose to inject deeper and above the serratus muscle and insert a catheter above serratus.

The sensory nerves of the chest arise from the 2nd to the 6th intercostal nerves. The intercostal nerves (ventral rami of thoracic spinal nerves) run between the inner and intimal intercostal muscles. There are two perforating branches (lateral and anterior), which are cutaneous branches of the intercostal nerve emerges from its location between the internal and intimal intercostal muscles, passing through the external intercostal muscles and the anterior serratus muscle at the mid-axillary line.

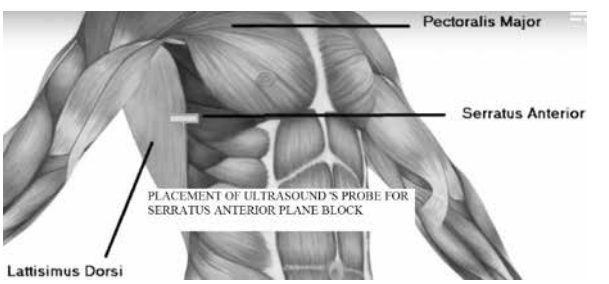

Figure 3: Placement of ultrasound's probe for serratus anterior plane block

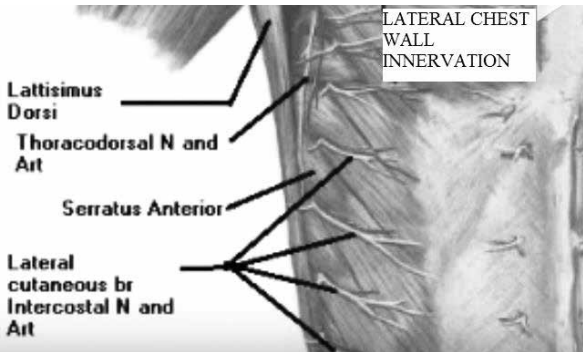

Figure 4: Innervation of Lateral Chest Wall

It then branches at the subcutaneous level into the anterior branch of the lateral cutaneous branch of the intercostal nerve, and the posterior branch of the lateral cutaneous branch of the intercostal nerve, supplying the skin over the scapula and Latissimus Dorsi Muscles (Figure 4).

The injection of local anaesthetic at the mid-axillary line between the anterior serratus muscle and the external intercostal muscles blocks the lateral cutaneous branch of the intercostal nerve, before it divides into anterior and posterior branches. The Lateral Intercostal block technique, described by Bonica is performed 3-4cm posterior to the midaxillary line where the lateral cutaneous nerve pierces the intercostal muscles and divides into anterior and posterior branches. A block at this site is preferable for somatic pain caused by disorders of the chest and abdominal wall.

Initial difficulty was encountered in obtaining appropriate level of analgesia and maintaining it in the post-op period. The pioneers of the block recommended to deposit local anaesthesia at the level of 4th to 5th rib in the midaxillary line. We modified this approach slightly, still depositing local anaesthesia at midaxillary line but slightly superior to the thoracotomy incision (Figure 3 & 5). Our approach made it easier to achieve an adequate level of analgesia and also maintaining it postoperatively.

In this case series, the Serratus Anterior block does appear to be a promising alternative to the thoracic epidural, traditionally considered the gold standard. It must be stressed that the serratus plane block, however is not entirely efficacious as a sole technique but should be used as part of a multimodal regimen. Ropivacaine has a higher threshold than bupivacaine for causing cardiovascular toxicity. Also, adding an opioid to the solution exhibits a local anaesthetic sparing action by reducing the EC_{50} of ropivacaine in a dose-dependent manner.

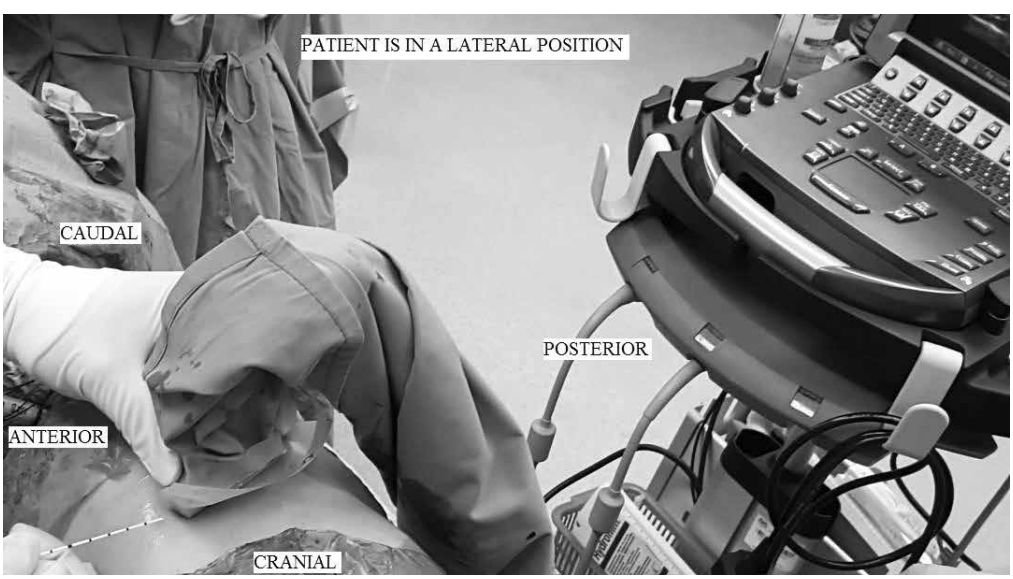

Figure 5: Orientation of the ultrasound probe and needle

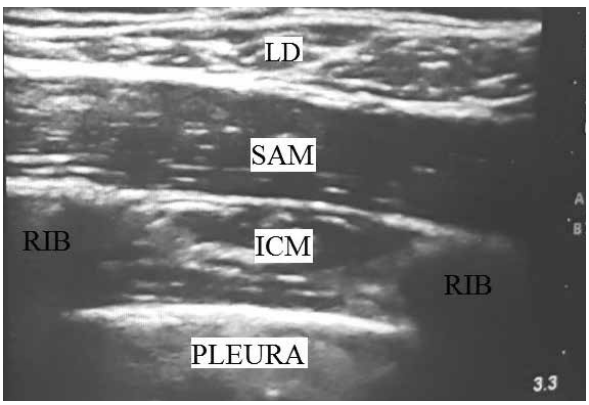

Figure 6: Sonoanatomy of serratus anterior muscle and the surrounding structures

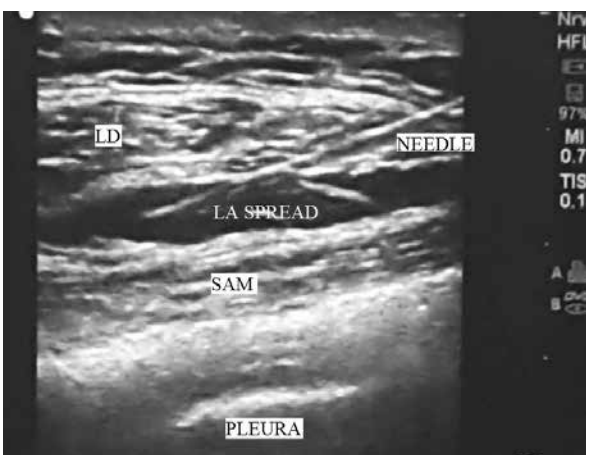

Figure 7: Sonoanatomy of LA spread **above** the serratus anterior muscle

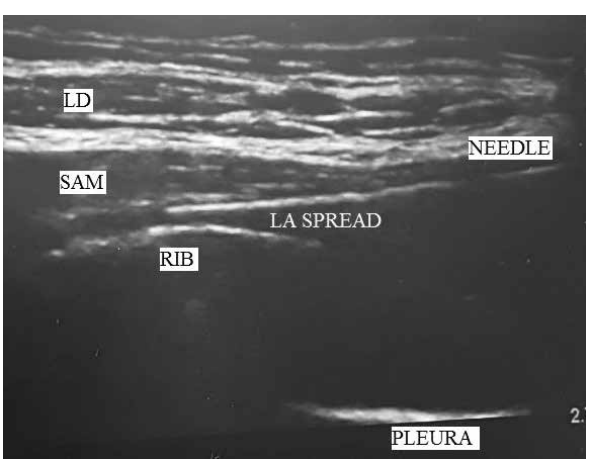

Figure 8: Sonoanatomy of LA spread **below** the serratus anterior muscle

Needle tip placement was easy. We found less acute angulation for the needle and ultrasound's probe alignment (Figure 6, 7 & 8). In fact, Blancho et al observed that large volume local anaesthetic deposits superficial to the serratus anterior muscle spread over a wider area and lasts longer than an injection deep to it.

We believe that rescue analgesia via the catheter as a bolus effectively reduces the pain, possibly due to a more uniform spread of anaesthetic. The efficacy of large volume local anaesthetic boluses may be to due to dispersion of solutions in the myofascial plane. When a large volume of drug is injected with a high injectate pressure, solutions tend to spread more evenly. This longitudinal and uniform spread of drug by the intermittent route leads to a more extensive blockade as compared to the limited, localized degree of blockade by the continuous infusion technique. In contast, continuous infusion of the drug under low pressure, with small volumes, the local anaesthesia has very minimal dispersion from the cateter tip.

Still, we are not entirely convinced the serratus plane block can produce "complete paraesthesia of the hemithorax" because the posterior primary rami, the anterior cutaneous branches of the intercostal nerve (close to the sternum) and the supraclavicular nerves (immediately below the clavicle) are not blocked.

A good thoracic paravertebral and epidural block produces somatic and sympathetic nerve blockade, including the posterior primary ramus, in multiple contiguous thoracic dermatomes.

Serratus Anterior block can be particularly advantageous in patients who may not tolerate the significant sympathetic block associated with thoracic epidurals or those patients in whom a central neuraxial technique is contraindicated due to anticoagulation or thrombocytopenia or other coagulopathy. Unlike an epidural, it can also be safely performed under general anesthesia.

*(Abbreviations: **LD**: Latissimus Dorsi, **SAM**: Serratus Anterior Muscle, **ICM**: Intercostal Muscle)*

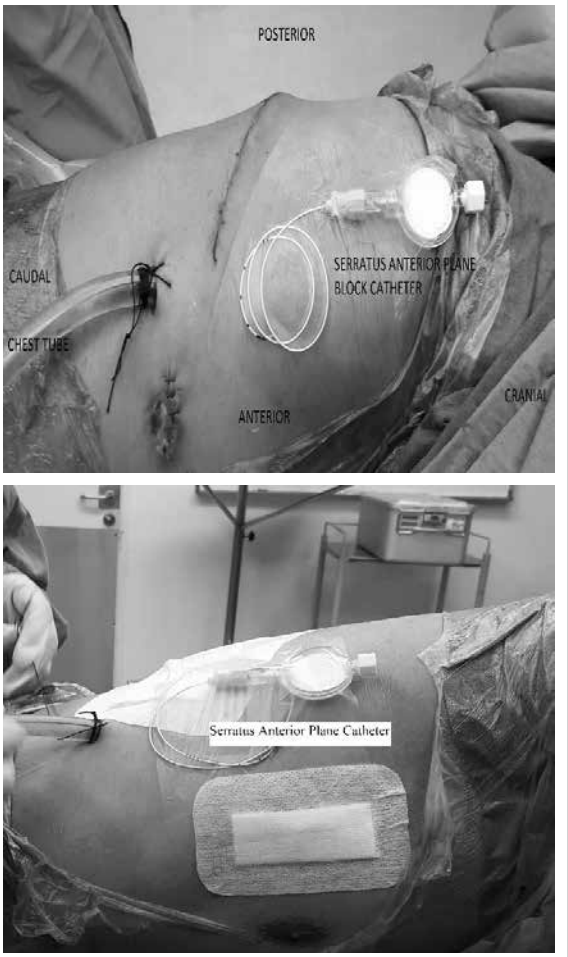

Figure 9: Serratus Anterior Plane Catheter before and after Opsite dressing

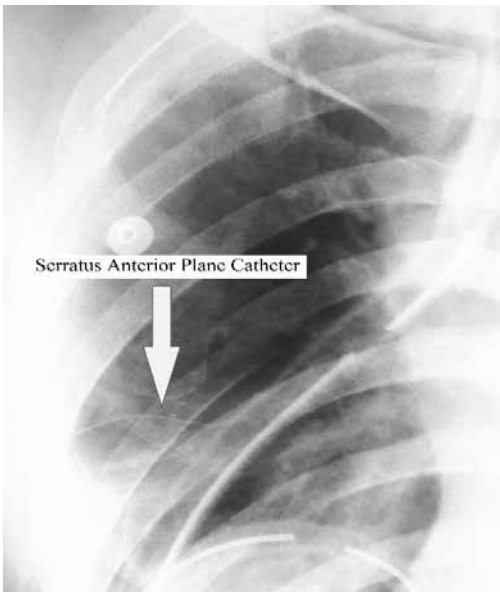

Figure 10: Position of Serratus Anterior Plane Catheter in the Chest X-Ray

CONCLUSION

Serratus anterior plane block is a safe, promising technique, opiod sparing, and provides excellent and long lasting postoperative analgesia following thoracotomy. The block is easily reproducible, and mastered. The serratus plane block should therefore be offered as an option for patients. This study was limited by a relatively small sample size. Randomised controlled trials with bigger patient volumes are required to prove its efficacy.

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Quadratus Lumborum Block As Anaesthesia: Case Series Of Abdominal Hernia Surgery In Hospital Kuala Lumpur

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INTRODUCTION

Successful use of Quadratus Lumborum Block (QLB) as an analgesic modality have been reported previously for various paediatric and adult abdominal surgery.[1-3] To the best of our knowledge, none has explored and reported clinical efficacy of its use as an anaesthetic technique for any type of surgery thus far.

We would like to report a series of 4 patients where Quadratus Lumborum Block (QLB) was performed as the primary anaesthestic technique for hernioplasty surgery.

METHODOLOGY

We recruited 4 patients planned for elective hernioplasty who consented for the ultrasound guided regional block (Quadratus Lumborum block). All had no contraindications to both regional anaesthetic technique and drugs used. All patients were counselled and explained regarding the block procedure during preoperative visit.

We performed QLB based on the transmuscular technique described by Borglum (TmQLB). With patient in lateral position, a low frequency (5-2MHz) curvi-linear transducer is positioned midway between the costal margin and iliac crest (Figure 1), to visualize the tip of transverse process of the immediate lumbar vertebra at the centre of the screen.

This is the stem of "Shamrock" leaf. The immediate muscle above the stem being the Quadratus Lumborum; or the '**thumb of a hands-up sign**'. The 'thumb,' being tips of the lumbar transverse processes will always point to the Quadratus Lumborum muscle (Figure 2a). Thirty (30) ml of 0.5% ropivacaine was deposited in the plane between Psoas major and Quadratus Lumborum muscles as shown in Figure 2b. Subsequent dermatomal sensory block was assessed to cold sensation and the area of reduced sensation was mapped.

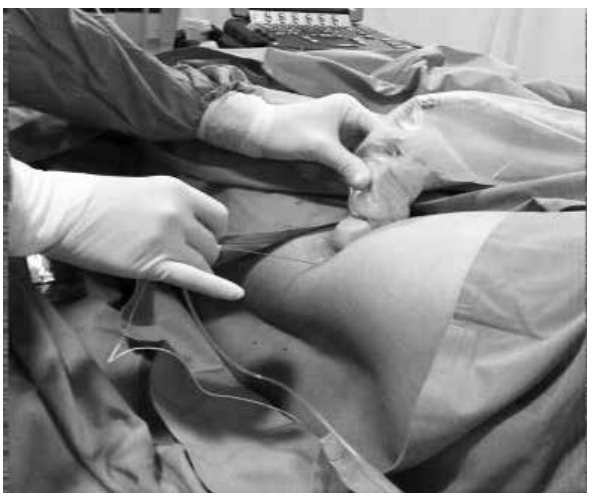

Figure 1: showing positioning, probe placement and needle insertion for Transmuscular Quadratus Lumborum block (TmQLB) approach

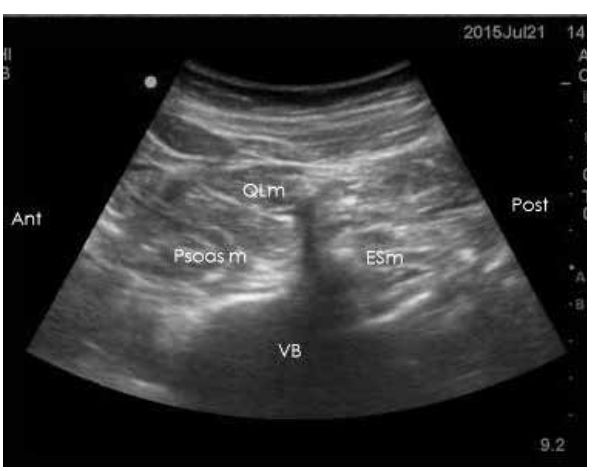

Figure 2a: showing relationship between the Quadratus lumborum (QLm), Psoas major (Psoas m) and Erector Spinae muscles (ESm)- the "Shamrock sign" (above left). Quadratus Lumborum (QLm) and Psoas muscle (Psoas m)

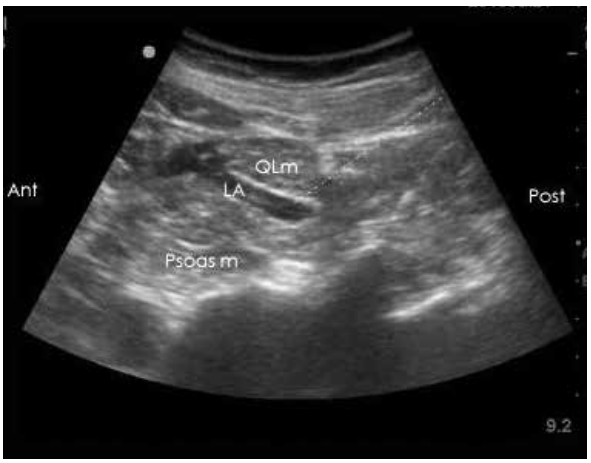

Figure 2b: the post-block image with local anaesthetic (LA) being deposited in between Quadratus Lumborum (QLm) and Psoas muscle (Psoas m)

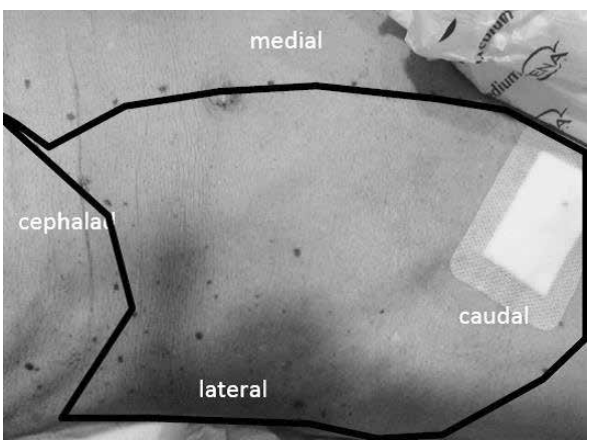

Figure 3: Antero-lateral view

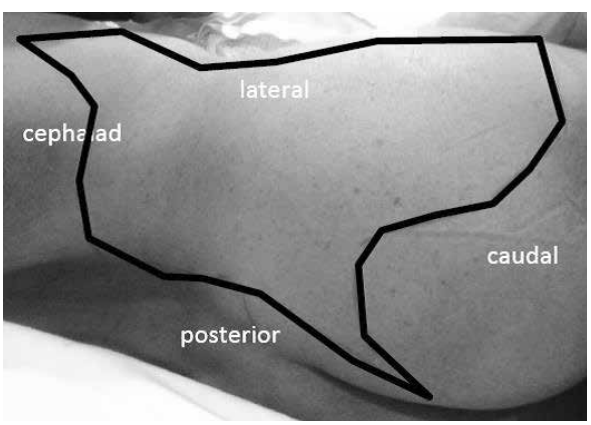

Figure 4: Postero-lateral view

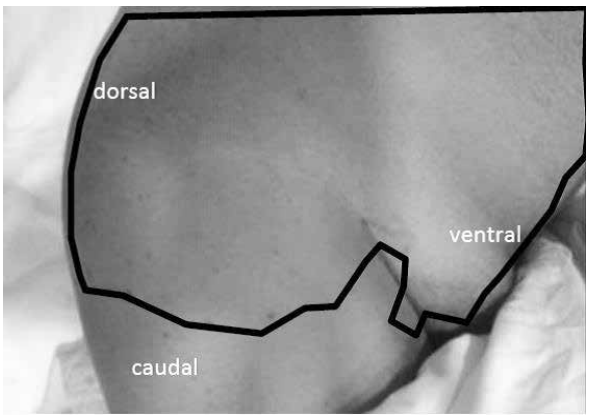

Figure 5: Right Inguinal view

RESULTS

Upon testing for cold sensation, a consistent sensory block from T6 to L1 levels was achieved in 3 out of 4 patients. In another patient, a block from T10 to L1 was achieved with similar volumes. Figures 3 to 5 showing area of reduced sensation to cold.

In all cases, a small volume of supplementary local anaesthetics was administered in the initial stages over the skin and subcutaneous tissue (3-5mls) but none was required beyond this layer until the end of surgery. All cases were successfully performed under Monitored Sedation with target-controlled infusion propofol requiring effect-site propofol concentration of between 0.5 to 2.5µg/ml.

DISCUSSION

We performed QLB based on the transmuscular technique described by Borglum et. al. In 2012, Borglum described the transmuscular Quadratus Lumborum Block approach (TmQLB) and compared MRI spread of local anaesthetics between three techniques;

i) thoracic paravertebral (TPV)
ii) original QLB, lateral to quadratus lumborum muscle (Blanco Block) and
iii) transmuscular QLB (TmQLB)

He evaluated the radiological spread and dermatomal anaesthesia and found that TPV and

TmQLB had significantly more rapid block onset compared to the original QL.[4] With regards to clinical spread, TmQLB had dermatomal distribution from T7 to L1 which is similar in efficacy to the Blanco Block. He concluded that TmQLB:

i) gives better block dynamics in terms of providing faster onset without compromising clinical efficacy compared to Blanco Block.
ii) is efficacious as a Thoracic Paravertebral Block looking at the onset and clinical profile.

Kadam et. al. used 20 to 25ml of 0.5% Ropivacaine in his two case reports as analgesia for abdominal surgery and reported a dermatomal spread from T8-L1.[1,2] These volumes corresponds to per weight volumes of about 0.3ml/kg and they suggested that a volume increment to 0.6ml/kg would be necessary to obtain a wider sensory block.

Visoiu M used a volume of 10 ml of 0.5% Ropivacaine for a 23kg patient for surgery prior to infusion of 5ml/hr of 0.2% Ropivacaine.[3] At our institution, we found that a clinically favourable local anaesthetic onset-to-recovery profile will be achieved reliably with a single shot local anaesthetic concentration of at least two-third of available maximum strength. Based on these reasons, we delivered an injectate volume of 30ml using 0.5% Ropivacaine as our local anaesthetic dose.

Our survey with the local surgeons whose experience was at least 20 cases of adult hernioplasty cases done under local anaesthetic infiltration technique revealed that, on average, a total of between 20 - 30mls of local anaesthetic is usually required for a complete procedure and can even increase beyond 30mls for difficult cases. All layers involved require local anaesthetic infiltration in titrated incremental volumes before surgical manipulation.

The low requirement for propofol which is within the therapeutic range for sedation and NOT for anaesthesia suggests that it was unlikely that the success of surgery was due to propofol. It is also very unlikely that the minimal dose of local anaesthetic infiltration to the skin and subcutaneous tissue alone would allow for completion of the procedure possible.

Input regarding surgical operating conditions were also obtained from the operator in terms of relaxation and ease of surgical manipulation. It was found to be comparable to a subarachnoid block even during manipulation of visceral structures. These reasons suggest that the Quadratus Lumborum Block was the primary anaesthetic component that determined successful completion of the hernioplasty.

CONCLUSION

We believe that Quadratus Lumborum Block is a feasible alternative as a primary anaesthetic technique when combined with sedation for adult hernioplasty surgery. More studies are required to further evaluate the effectiveness and safety of this technique.

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Four Point Injections In Ultrasound-Guided Rectus Sheath Block For Midline Laparotomy In HSI: Case Series

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Pain after midline laparotomy in the recovery room can be challenging to be managed. The usual combination of morphine, fentanyl, ketamine, parecoxib and paracetemol may not always result in low pain scores.

Ultrasound guided bilateral rectal sheath block can be utilized as part of multimodal analgesia after midline laparotomy surgery. (Figure 1)

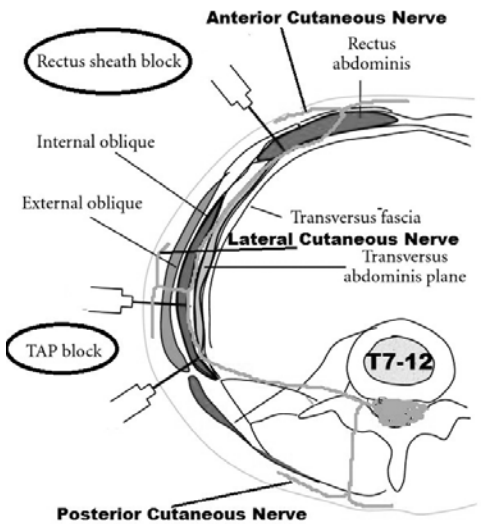

Figure 1: Rectus Sheath Block with Anatomical Pathway of Thoracic Intercostal Nerve

Undesired effects such as hypotension, bradycardia, urinary retention and epidural haematoma can be avoided as compared to if epidural technique was employed.

Schleich first reported the use of bilateral rectus sheath blocks (BRSBs) in 1899. The aim was to provide muscle relaxation and analgesia of the abdominal wall by blocking the terminal branches of the thoracolumbar nerves. This was done within the substance of the rectus abdominis muscle (RAM) via blind and loss-of resistance technique.[1]

The technique was unpopular mostly due to concerns over the possible severe adverse side effects in relation to the vascular and visceral structures. This block is conveniently done now with ultrasound guidance because the RAM layers of the rectus sheath and important vascular structures are easily visualized and identified.[2,3]

METHOD

Twelve patients scheduled for midline laparotomy surgery were planned for this block. Consent was taken from the patient prior to the block procedure in explaining the option, risk and benefit. Patients were given PCA Morphine post operatively to observe the first need of opioids after surgery.

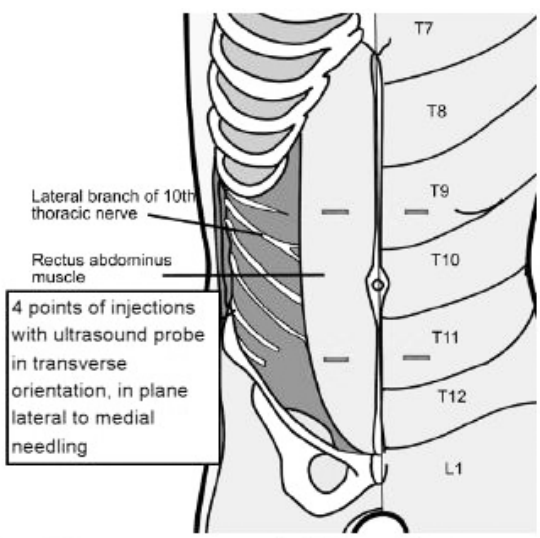

Figure 2: Cutaneous sensory nerve distribution and dermatomes on the abdominal wall

At the end of surgery, the ultrasonographic anatomy of the rectus muscle was identified with a 5-12 MHz 50mm linear probe (GE- Venue 50). The layers of the anterior abdominal wall from superficial to deep were analysed. Interestingly, the layers of

subcutaneous tissue and adipose varies in depth depending on body habitus.

- Deep to the subcutaneous tissues is the **anterior portion of the of the rectus sheath** (a horizontal bright hyperechoic linear structure extending from lateral to medial).

- Deep to the anterior rectus sheath is the rectus abdominis muscle (**RAM**) (relatively hypoechoic in relation to the rectus sheath).

- Deep to the RAM will be **the posterior portion of the rectus sheath** (a horizontal bright hyperechoic structure extending from lateral to medial).

- The deep superior (above the umbilicus) and inferior (below the umbilicus) **epigastric arteries** were visualized in a number of patients as small, pulsatile, anechoic structures located in the deepest aspect of the RAM. Color flow Doppler confirmed the the presence of blood flow within the arteries.

- Deep to the posterior portion of the rectus sheath will be the **transversalis fascia** (a hyperechoic linear structure).

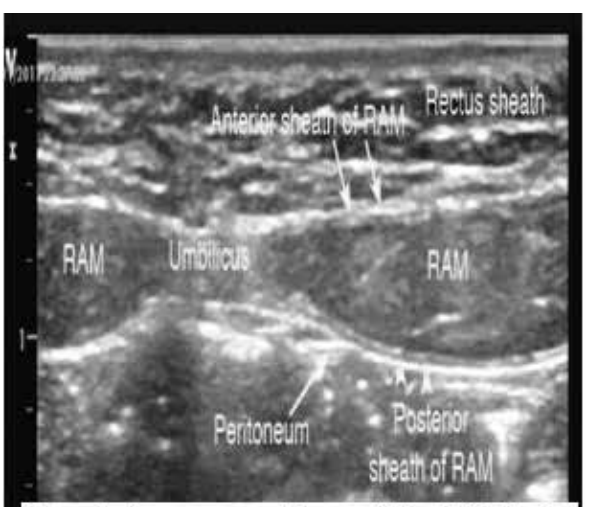

Figure 3: Sonoanatomy of Rectus Abdominis Mucle

- Deep to the rectus sheath and transversalis fascia is the **peritoneal cavity**, which is identified by the presence of peristaltic movements of the bowel loops (**Figure 3**).

- The probe was positioned (**Figure 2**) transversely 2cm above (2 points) and below (2 points) the umbilicus at 1 cm medial to linea semilunaris bilaterally. Typically, a 21-gauge, 100mm (or 20-gauge, 150mm) needle is inserted 3cm lateral to the lateral edge of the transducer and guided "in-plane" (**Figure 4**).

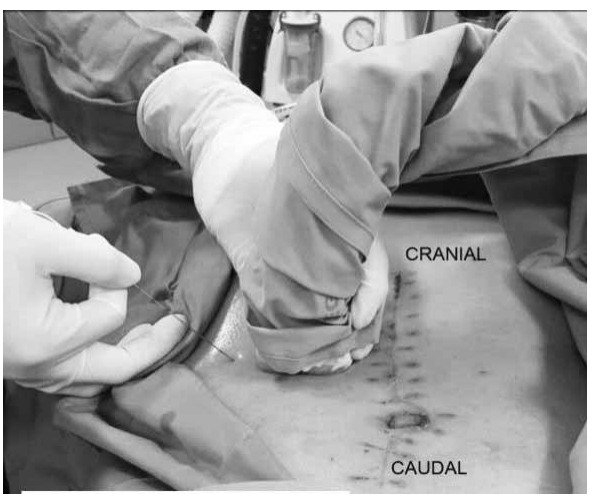

Figure 4: Inplane needing from lateral to medial

The needle was introduced in the long axis parallel to the ultrasound probe to **reach the lateral border of the rectus muscle**. It was advanced carefully until the tip of the needle is positioned deep to the potential space between the deepest (posterior) border of the **RAM** and **superficial to the posterior aspect** of the rectus sheath.

This target site will be referred to as the "**posterior rectus sheath compartment.**" It is seen between the posterior aspect of the rectus abdominis and its sheath.

At this point, a small volume (1-3ml) of local anaesthetic is placed to confirm correct placement within the posterior rectus sheath compartment, shown by the appearance of an anechoic fluid collection.

Subsequently, 10mls of local anaesthetic is incrementally injected while observing for the expanding anechoic fluid collection.

As the local anaesthetic is injected, it will often result in clear dissociation of the deep border of the RAM from the posterior rectus sheath (**Figure 5**).

Improved local anaesthetic spread may be speed up by advancement of the needle further medially as the anechoic fluid collection expands the posterior rectus sheath compartment in a lateral-to-medial fashion.

After local anaesthetic injection, the transducer can be translated in a cephalad to-caudad fashion to visualize cephalad-to-caudad spread within the posterior rectus sheath compartment.

The same procedure is repeated on the other 3 points for a better blockade coverage over the midline incision. Total Volume of LA used was 40ml.

If a continuous catheter technique is desired, the similar steps above are followed except that a Tuohy tip needle is used and, after fluid expansion of the posterior rectus sheath compartment, a 19-gauge wire-reinforced catheter is placed 5cm beyond the needle tip. The needle is removed and the catheter is secured to the skin and concealed with a sterile clear transparent dressing.

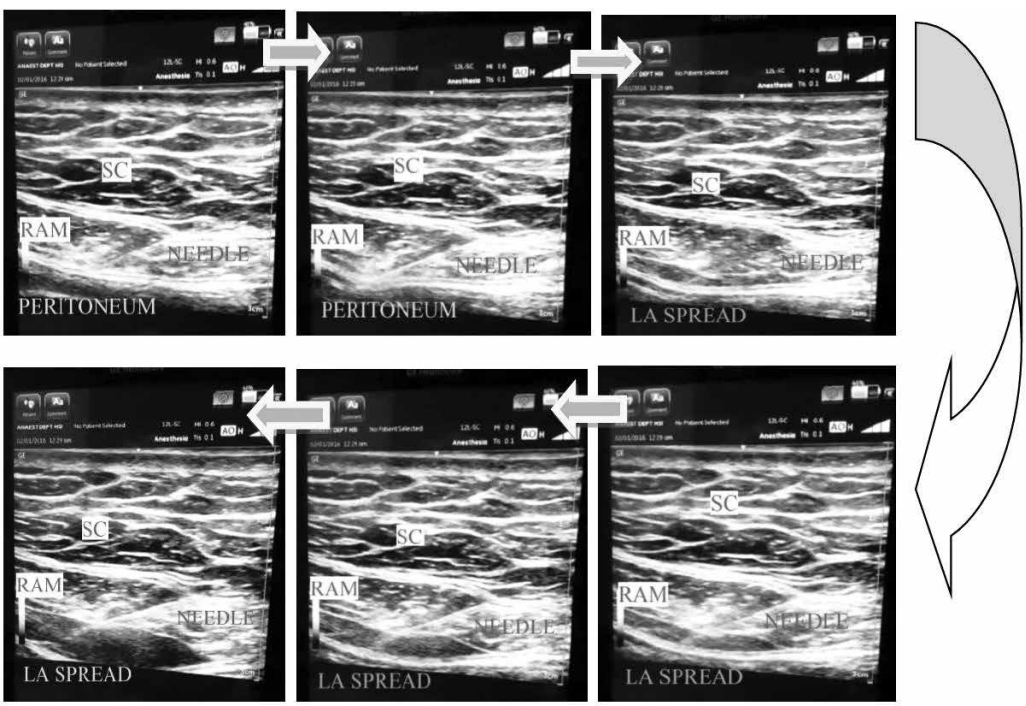

Figure 5: Sequential of Rectus Sheath Block Injection Under Real Time Ultrasound Guidance

"The target site for local anesthetic deposition is deep to the RAM, but superficial to the posterior aspect of the rectus sheath".

"The terminal thoracolumbar nerves are too small to be visualized as discrete structures; thus, rectus sheath block are a "compartment block"

All patients were provided with patient controlled analgesia (PCA) morphine for rescue analgesia post operatively. Time to first consumption was recorded.

RESULTS

All patients had 0 pain score when assessed in the recovery bay after the surgery. Patients were found to start requiring rescue morphine between 6 to 9 hours. There were no sign and symptom of local anaesthetic toxicity recorded.

DISCUSSION

This block caters somatic analgesia over the midline anterior abdominal wall from the symphysis pubis inferiorly to the xyphoid process superiorly. For that reason, it is recommended for vertical midline (or paramedian) surgical incisions.

Rectus sheath block was mainly used previously for umbilical **hernia repair or laparoscopic gynaecologic** procedures.[4-6] However with new techniques of needling and visualisation learnt via ultrasound-guided peripheral nerve blockade, the indications now include analgesia for **vertical midline laparotomy incisions** for either **lower or upper** abdominal surgery.[7-10] The duration of the block may be prolonged by placement of catheters within the rectus sheath.

Rectus sheath block **do not produce** complete anesthesia-analgesia for major abdominal surgical procedures because it does not cover the viscera. This block should be considered as part of a **multimodal analgesic approach** which include NSAIDs or COX-2 inhibitors, acetaminophen, ketamine, gabapentin, and systemic opioids. One great advantage is the lack of sympathectomy block and hypotension that is commonly associated with thoracic epidural anaesthesia.

Being a compartment block (similar to transverse abdominis plane (TAP) block), it is sensible to perform this block in the operating room **after induction** of general anesthesia but **prior to surgical incision or emergence**. Performing it prior to the surgical incision may decrease the intraoperative analgesic (opioid) requirements.

Alternatively, this block can be used **as a "rescue block technique"** (in case of either unexpected severe postoperative pain after an abdominal surgical procedure or unforeseen failed epidural analgesic technique). The movement of the anterior abdominal wall with respiratory excursions is one of the caveats and may displace the needle out of the imaging plane.

Anatomical Pathway of the Thoracolumbar Nerves

The anterior part of abdomen is innervated by the right and left T7 to L1 thoracolumbar nerves. At the level of the linea semilunaris, the nerve perforate the rectus sheath posteriorly, innervate the rectus muscle, cross the muscle, and end as an anterior cutaneous branch supplying the skin.[12,13]

The nerves then enter the lateral aspect of RAM and give away to the formation of a nerve plexus that runs craniocaudally within the muscle in close relation to the lateral branch of the deep epigastric artery.[13]

The thoracolumbar nerves typically pierce the posterior border (89%) and less commonly the lateral border (11%) of the RAM, with the nerves piercing the posterior border within 1.6 to 2.6 cm from the lateral edge of the RAM. The nerves provide both muscular and cutaneous branches to innervate the muscle fibers and overlying skin.

The branches of the thoracolumbar nerves **do not cross midline**. This potential space would allow dispersion of LA at several levels, enabling an effect on several intercostal nerves to provide somatic pain relief for abdominal wall structures superficial to the peritoneum.

Local Anaesthesia Solutions

The drugs solution used were 20ml ropivacaine 0.375% with 1:400,000 epinephrine with

dexamethasone 4mg per side. For paediatric patients, the suggested dosing is 0.5ml/kg ropivacaine 0.25% with epinephrine 1:400,000) per side.[14]

Kitayama et. al. suggested adding epinephrine to **decrease local anesthetic peak plasma concentration (Cmax)**, as spread of local anesthetic will surround a relatively large surface area for vascular absorption into the systemic circulation.[15] Based on initial pharmacokinetic studies, the time to peak plasma concentration (Tmax) is approximately 45 minutes.[14]

Hence, the patient should be checked for possible signs or symptoms of local anaesthetic systemic toxicity **for a minimum of 45 minutes after completion** of rectus sheath block.

Dexamethasone is believed to prolong and compliment the duration of LA. It acts as an adjuvant. The anticipated duration of RSBs is approximately 6-10 hours. Thus, there should be a backup analgesic plan for when the analgesic effects dissipate.

For a continuous catheter technique, a **small continuous infusion** (2-3ml/hr) is advocated simply to maintain the catheter tip patent. **Intermittent bolus injections** of 10-20mls of ropivacaine 0.2% per side every 6-10 hours is recommended to maintain satisfactory postoperative analgesia.[11]

CONCLUSION

Rectus sheath block is an effective and safe postoperative analgesic approach for midline laparotomies. Favorably, catheter based technique with regular boluses of drugs every 6-10 hours is more beneficial in prolonging the quality of analgesia.

Excellent analgesia combined with no motor block of the limbs and no mandatory connection to infusion devices will allow patients for early mobilization. This would result in major clinical benefits such as decreased risk for deep vein thrombosis and pulmonary embolus, reduced incidence of atelectasis, avoidance of respiratory infection and minimal motor deconditioning.

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