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, 2, 3], offered viable alternatives for the technically more challenging epidural techniques. Although these various alternative techniques, fraught with their own technical difficulties, has 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, were 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 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

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

b. Medial pectoral nerve

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 nerves** 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:

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:

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 deposition of 10 ml of local anaesthetic between pectoralis major and minor muscles – the **PECS I** block. This is done at a point about 8 cm from the midline and about 2 cm below the clavicle [12], at a tangential line from the mid-point of the clavicle caudo-laterally towards the axilla.
- The **second injection** is infiltration of 20 ml 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.

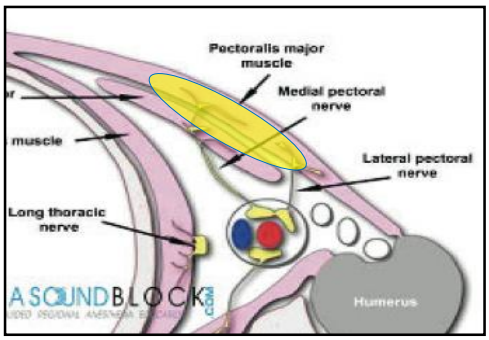

Figure 1: **PECS I Block**- Yellow shaded area showing interfascial plane for local anaesthetic deposition. Illustration assisted by graphic presentation from UltrasoundBlock.com

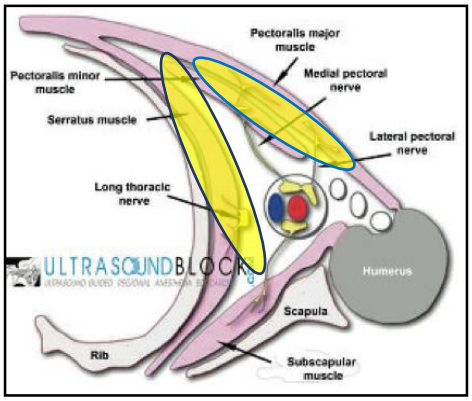

Figure 2: **PECS II Block**- Yellow shaded area showing interfascial plane for local anaesthetic deposition. Illustration assisted by graphic presentation from UltrasoundBlock.com

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

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

Left of the image is caudo-lateral

Figure 4: Ultrasound image post 2nd injection of 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.

(Left 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.

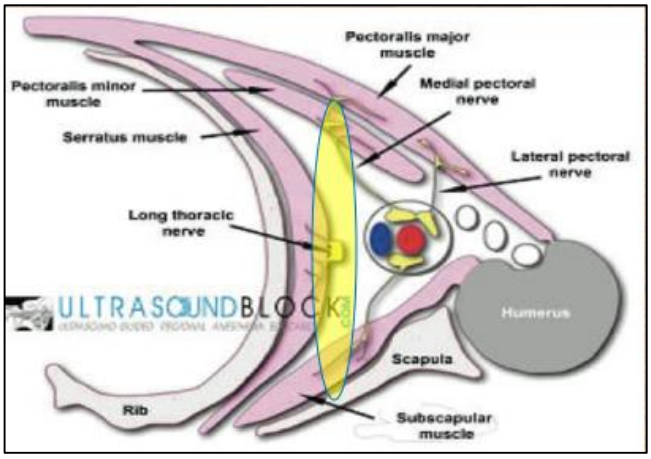

Figure 5**: Serratus Plane or PECS III Block**- Yellow shaded area showing interfascial plane for local anaesthetic deposition. Illustration assisted by graphic presentation from UltrasoundBlock.com

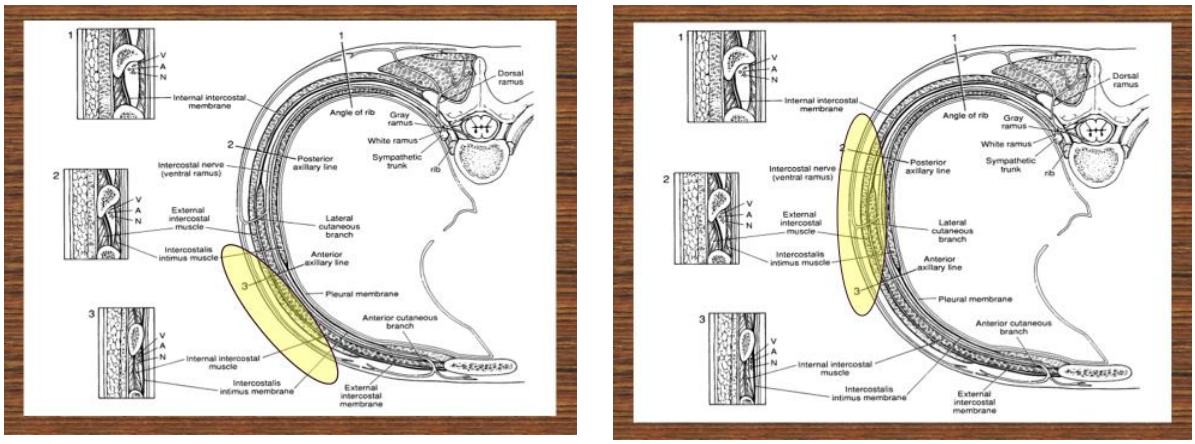

Figure 6: Yellow shaded area showing comparison of local anaesthetic distribution between **2nd injection of PECS II block (above left)** and **SPB or PECS III block (above right).**

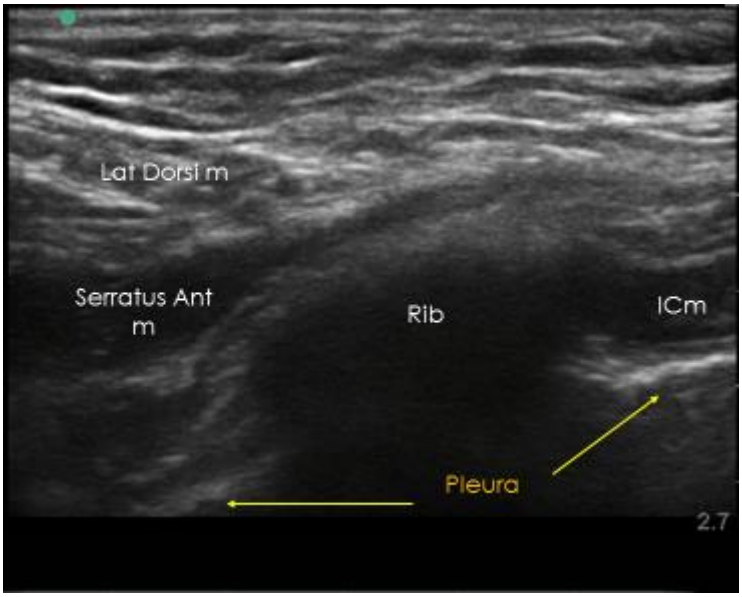

Figure 7 showing the point of injection for **Serratus Plane or PECS III block** over the mid-axillary line. The probe orientation is antero-posterior (right to left of the image)

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 have 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 have 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 of 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 20 ml 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 2nd injection alone. For example, is the combined use of supraclavicular brachial plexus block plus this 2nd 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 has 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]

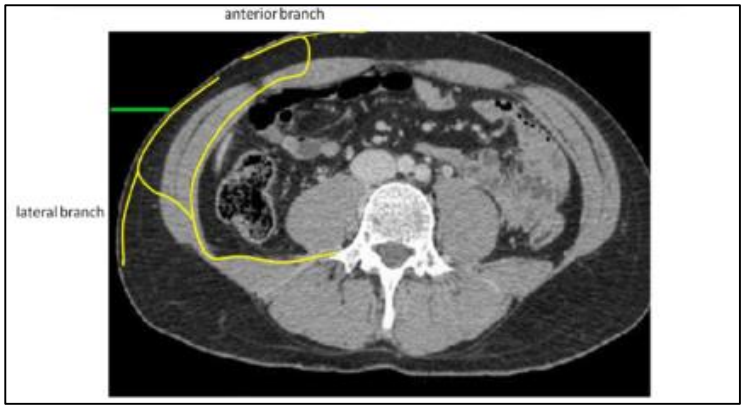

Figure 8 showing the courses of anterior and lateral cutaneous branches of the abdominal spinal nerves

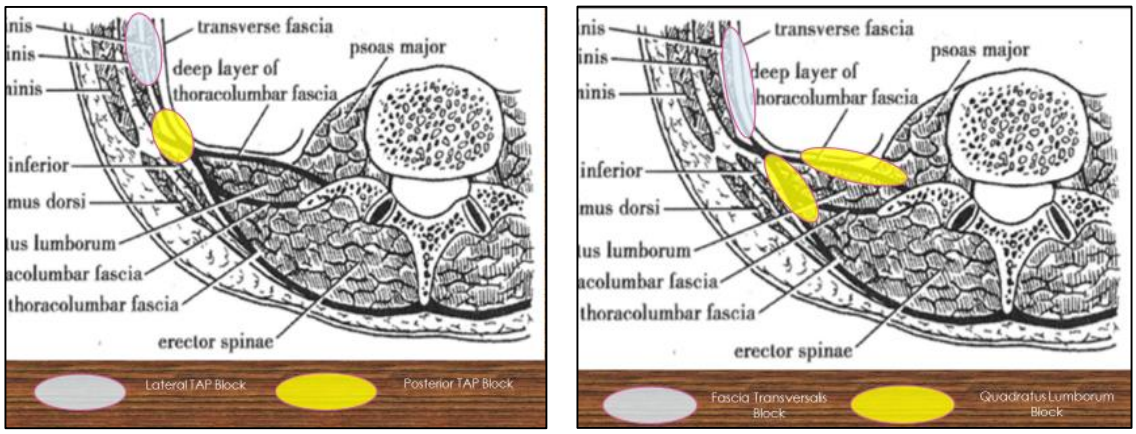

Figure 9 showing the point of injection for TAP block (above left) and the Fascia Transversalis and QL blocks (above right)

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**.) Follow laterally until 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 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)

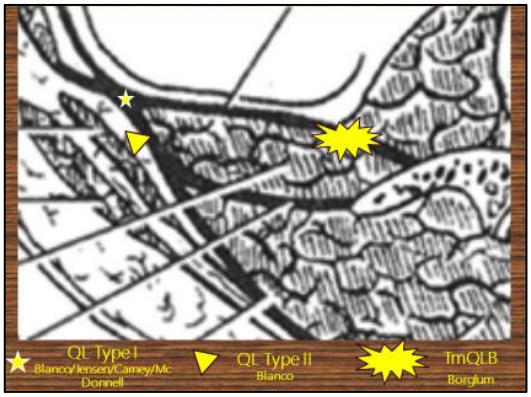

Figure 10 showing the location of multiple approaches of the QL Blocks

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

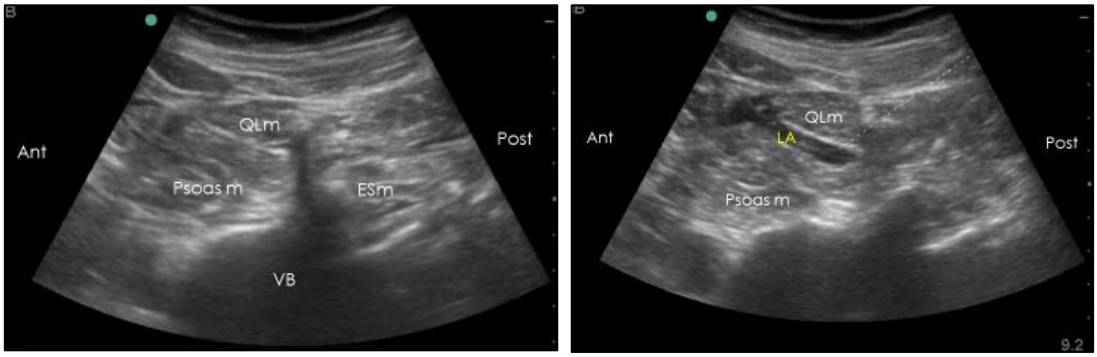

Figure 12 showing relationship between the Quadratus lumborum (QLm), Psoas major (Psoas m) and Erector Spinae muscles (ESm)- the "Shamrock sign" (above left). On the right is the post-block image with local anaesthetic (LA) being deposited in between Quadratus Lumborum (QLm) and Psoas muscle (Psoas m)

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 this 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 15 ml but several published case reports of QL block success suggest minimal volumes of between 20-30 ml.[9,10,11] 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.[9,10,11] 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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