REVIEW ARTICLE

ANATOMICAL BASIS AND MECHANISM OF FASCIAL PLANE BLOCK

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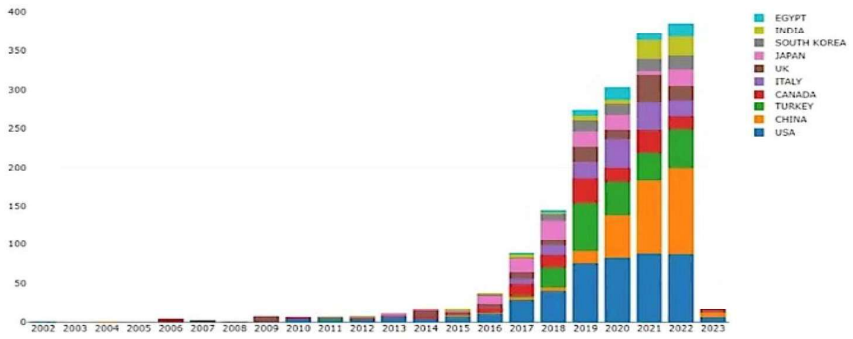
Abstract: *Fascial plane blocks (FPBs) have witnessed a surge in clinical practice as integral components of opioid-sparing multimodal analgesia. Unlike traditional techniques, FPBs deposit local anaesthetics into inter-fascial spaces, relying on complex mechanisms such as bulk flow, diffusion, and vascular uptake to modulate pain. While often effective, these blocks can be clinically unpredictable due to variables like fascial porosity, anatomical connectivity, and muscle dynamics. This review elucidates the anatomical basis and pharmacological behaviour of FPBs, underscoring their value when neuraxial blocks are contraindicated, while acknowledging significant knowledge gaps regarding their consistency and precise mechanisms.*

Keywords: *Fascial plane block, Regional anaesthesia, Multimodal analgesia, Fascial anatomy, Mechanism of action, Local anaesthetic pharmacokinetics*

Fascial plane blocks (FPB), including TAP, PECS, ESP, QL, SAP, RSB and many others, represent a growing and diverse group of regional anaesthesia techniques. These blocks leverage the anatomical spaces between fascial layers to deposit local anaesthetics (LA), providing analgesia without targeting nerves directly. While their popularity has surged, questions persist regarding their predictability, pharmacological behaviour, and precise mechanisms of action.

Over the last two decades, with the introduction of ultrasound in regional anesthesia practice, the fascia plane block has seen an unprecedented acceptance in clinical practice. It's easy to perform and in most situations, gives good post-operative pain relief making it a suitable component of multi modal analgesia technique. Easy to perform, rapid onset and part of ERAS make FPB an attractive component of opioid sparing post-operative MMA.



Explosive number of publications related to fascial plane block in the last decades

They are many in numbers namely TAP, PECS, ESP, QL, SAP, RSB, Clavipectoral, MTP, SSPP, SIFI, RISS, PIFB, SPEDI, ACB, IPACK, RLB, PIP, EOIC etc. but the question that comes frequently to our mind is, are they clinically relevant?

Over the last decade several large studies have shown the efficacy of these FPB as an integral part of multimodal analgesia postoperatively.

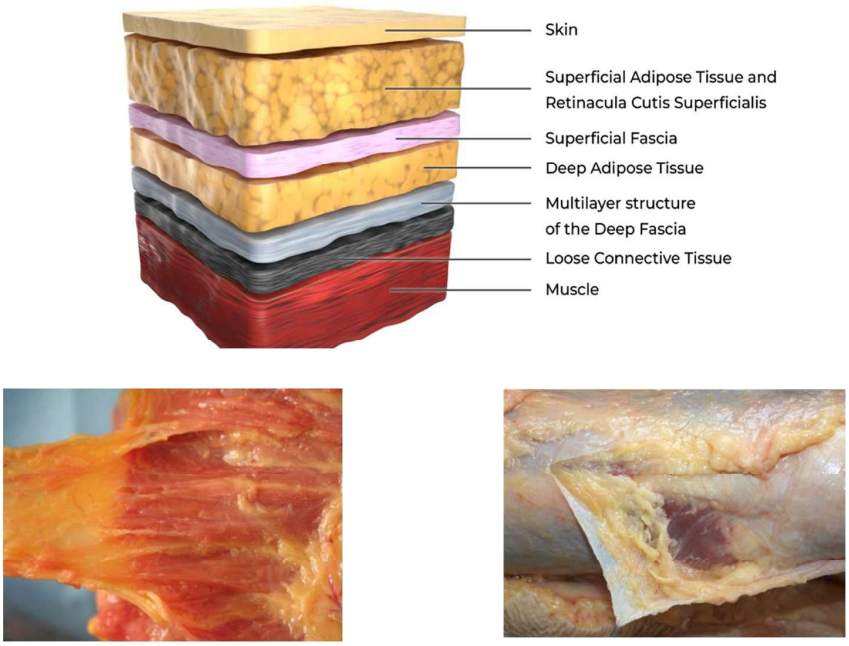
Few of the landmark studies published in recent years on FPB

Fascia plane blocks are not always predictable, and the mechanism is not fully understood, they are heterogeneous in nature but useful in absence of neuraxial, paravertebral or plexus block.

What we definitely know about FPB is that nerves run through fascial plane, LA can spread out of FP to adjacent compartments, FPBs do not always result expected blockade like plexus block, FPBs produce peak plasma Lignocaine concentration equal to IV Lignocaine and Bupivacaine, Ropivacaine & Lidocaine have similar mechanism of action in FPB.

But what we still don't know for sure whether cadaver studies on FPB can replicate clinical effects, what determines the LA spread beyond the fascial plane and vascular absorption, what is the influence of volume, concentration and mass of LA on FPB and if additive improves FPB outcome.

Anatomy of a Fascia

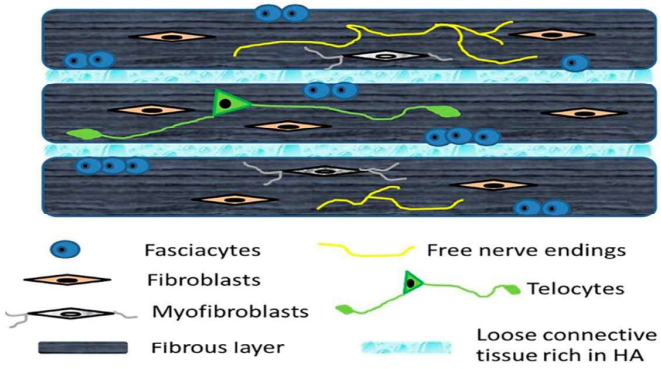


Epimysial (left) and aponeurotic fascia

There are 3 fundamental fascial connective layers in human Superficial fascia, Deep fascia, Muscle related fascia (Epimysium, Perimysium & Endomysium)

Grossly fasciae are classified into four layers - Superficial, Deep, Visceral and Parietal whereas some clinician classifies it functionally as

Linking, Fascicular, Compression and Separating. Fasciae are made up of collagen fibres; it is the richest sensory organ in our body. Fasciae attach, stabilise, impart strength, maintain vessel patency, separate muscles, and enclose different organs in our body. From a microscopic perspective, fasciae are composed of various cell types embedded within an extracellular matrix rich in collagen and hyaluronan.



Cellular component of a fascia

Fibroblasts- help produce collagen and other fibres that provide structural support.
Fasciacytes-specialized cells that are responsible for producing hyaluronan.
Myofibroblasts- are fibroblasts with contractile abilities, helping regulate the basal tone of fascial tissues.
Telocytes- are newly identified cells possess long, thin extensions called telopodes that form networks within the fascia.

Characteristic of a fascia

Fascia is a complex structure existing in superficial and deep fascia; deep fascia is classified as either epimysial or aponeurotic. Fascia is permeable

and perforated and the fasciae planes communicates with each other. Somatic and sympathetic nerves travel through the fascial layers.

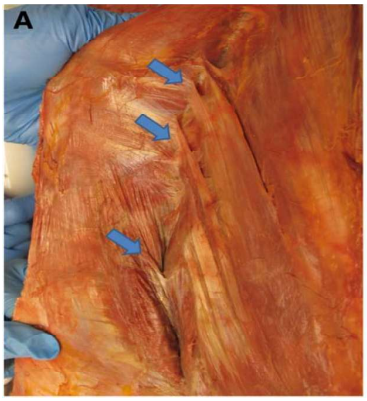
Table *1. Difference between Epimysial and Aponeurotic fascia*

	Epimysial	Aponeurotic
Thickness	Thinner (150–200 μm)	Thicker (600–1400 μm)
Grouping	Specific to each muscle	May envelop several muscles
Action	Localized	Transmits muscular forces over greater distance
Adherence	Usually adherent to muscles via fibrous septa	Easily separable from muscle
Anatomical location	Found in deep fascia of trunk muscles (eg, pectoralis major and latissimus dorsi) and the epimysium of limbs	Found in the thoracolumbar fascia, rectus sheath, and deep fascia of limbs (eg, fascia lata)
Block examples	PECS II, SAP, and TAP	Adductor canal, ESP, fascia iliaca, QL, and rectus sheath

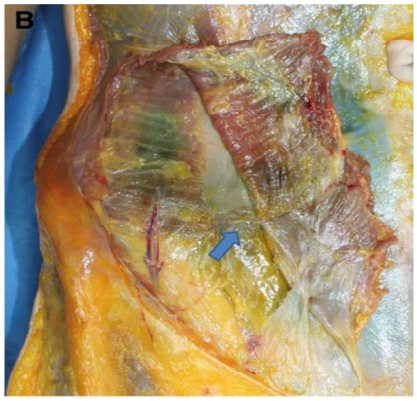
Biomechanical properties of Fascia & Fascia dynamic

When muscles contract, the related fascia get stretched leading to drug spread, fasciae may also have its own contractile element and behave like piezoelectric materials of second harmonic generation that converts mechanical force applied into energy.

Line of fusion either anatomical or post - operative creates compartments that may limit LA spread in a fascia plane block

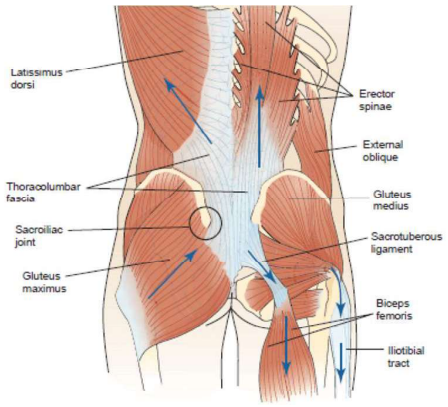


Linea alba



post-surgical adhesions

Interfacial connectivity



Connections between fasciae like thoracolumbar fascia, Endothoracic fascia and gluteal fascia allow drugs to spread without clear boundaries.

MECHANISM OF ACTION OF FASCIA PLANE BLOCK

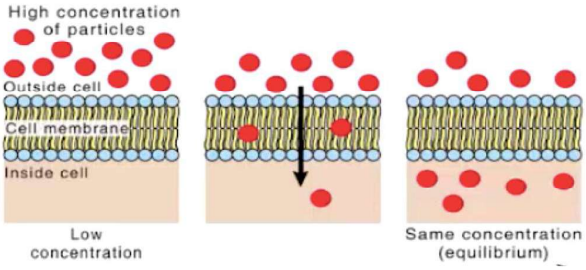
The local anaesthetics blocks the nerve endings situated in the fascial plane or it may directly block the peripheral nerves running through the fascial plane like in RSB, PECS etc. or it may block the nerves/ root in the adjacent compartment like in ESP block.

The mechanism of fascial plane block can be broadly divided into 3

1. Bulk flow
2. Diffusion
3. Vascular uptake

Bulk flow allows rapid dispersion of local anaesthetics in the fascial plane after the injection and block the nerve endings, the extent of bulk flow depends on the force of injection, recoil of distended fascia and influenced by positioning of patient and gliding of fascia on muscle contractions.

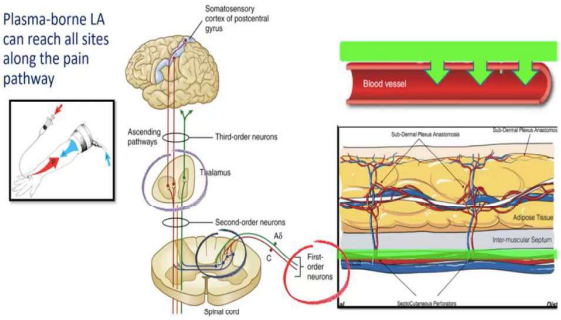
Whereas diffusion of anaesthetics happens slowly through all fascia to neighbouring structures through random walk of Brownian motion. Fascial layers are porous and perforated.



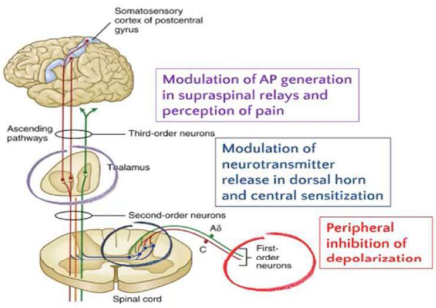
Diffusion of anaesthetics through fascia

Due to this slow process of anaesthetic dispersion, the fascial plane block can keep progressing beyond 45 minutes.

The vascular uptake of local anaesthetics from the site of injection brings the drug to the central circulation and probably behaves the same way as that of IV lignocaine or Bier's block, vascular uptake of anaesthetics may contribute to potential local anaesthetics toxicity.

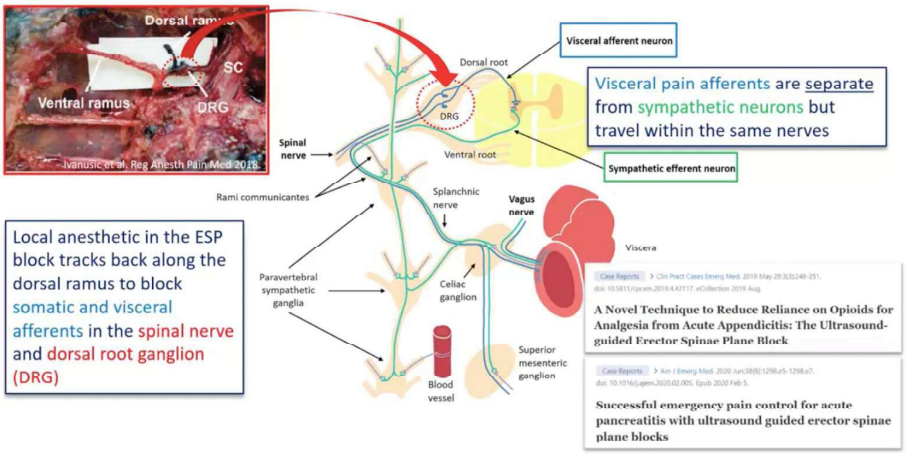


Vascular uptake of Local anaesthetic



Mechanism of IV lignocaine

Relevance of sympathetic innervation and control of visceral pain following fascial plane block like ESP where visceral afferent and somatic afferent converge in the dorsal root ganglia and can give visceral pain relief.



Variables affecting fascial plane block success

It is difficult to replicate same pattern of sensory block even when an FPB is performed by the same practitioner in the same subject, several factors contribute to the variability of the block.

Anatomical factors – Cutaneous innervations are more complex than described and multi segmental innervation and cross over innervation are common leading to a patchy or incomplete sensory block. Post-surgical adhesions, anatomical separation and interfacial connectivity influence LA spread in FPB.

Physiological factors – FPB are not same as plexus block as drug is deposited far away from the target in most situation. Age related muscle laxity and fascial contractility influence the bulk flow of LA leading to a variable block. Vigorous muscle contraction following FPB make the drug spread unpredictable.

Technical factors – Instead of fascia, intramuscular injections will lead to inadequate block. Volume, concentration and speed of injection also play a role in variability in FPB.

Challenges and Knowledge Gaps

- Lack of consistency in block outcomes.
- Difficult to replicate sensory block patterns in every individual.

- Influence of LA volume, concentration, and additives still under investigation.
- Cadaveric studies only partially replicate clinical effects.

Clinical Relevance

FPBs are particularly useful for post- operative pain management in settings where neuraxial or plexus blocks are contraindicated or not possible. However, they should not be expected to produce dense motor or sensory blockade as seen with traditional nerve blocks. Their role is increasingly valuable in multimodal analgesia (MMA) strategies, especially for postoperative pain control.

Conclusion

Fascia plane blocks represent an evolving area in regional anaesthesia. Despite promising results, their unpredictable efficacy, complex anatomy, and variable pharmacokinetics underscore the need for further research. Clinicians must approach FPBs with an understanding of their unique dynamics and limitations to optimize their utility in perioperative pain management.

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