

# Utilities of Peripheral Nerve Blocks beyond the Operating Room: A Narrative Review

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## Abstract

Intravenous analgesia has been the standard method employed to alleviate pain. However, intravenous analgesia cause higher rate of systemic side-effects, patient discomfort and longer hospital stays. In recent times, peripheral nerve blocks (PNB) have become the most preferred choice for a variety of procedures in operating room. PNBs lower the risks of peri-operative challenges, they involve in lowering the number of opioid-related complications, and they mitigate the need for general anaesthesia. Further, peripheral nerve blocks with the assistance from ultrasound technology provide superior choices over traditional pain-relieving methods practiced in the operating room. Objective of the current review article is to throw light on the peripheral nerve blocks and their utilities other than operation theatres. Also, this review article throws light on the several utilities of peripheral nerve blocks in trauma cases, block on arrival, upper limb, lower limb, chest and abdomen, head injury, maxillofacial injuries, uses in central vein canulations, recurrent ventricular tachycardia, interventional radiology, chronic pains with acute presentation and gangrene of limbs.

**Keywords:** Analgesics, Emergency, Pain, Peripheral nerve block.

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Email: drkaypee99@yahoo.com

Received: May 2020

Accepted: May 2020

## Introduction

Acute pain is one of the most prevalent concerns for the emergency physician within the emergency department (ED).<sup>[1]</sup> Pain management is an important but often challenging task for emergency providers. Oral and intravenous analgesics have inherent risks, which may limit their use in certain populations, such as the elderly. Non-steroidal inflammatory drugs, for example, can cause kidney injury and gastrointestinal bleeding and are associated with high rates of hypersensitivity reactions. Opiates can cause sedation, apnoea, and hypotension. In addition, the use of opiates in the emergency department (ED) has been linked to subsequent misuse, addiction, and overdose. As a result of concerns regarding the safety profiles and addiction potential of analgesics, patients often receive suboptimal pain management in the ED. Under such circumstances, intravenous analgesia is often the most common method employed to alleviate pain. However, this leads to either high rates of unwanted systemic effects (respiratory depression, hypotension, altered sensorium, etc.) or under-dosing (oligoanalgesia).<sup>[2]</sup>

In view of this background, the popularity of peripheral nerve blocks (PNB) within the emergency department is consistently increasing. PNBs are getting overwhelming support is due to its ability to ameliorate the concerns of peri-

operative challenges. This in-turn significantly lessens the number of adverse events that are concerned with opioid intake. The adverse events include but are not limited to respiratory depression and confusion.<sup>[3]</sup> As mentioned earlier, peripheral nerve blocks with the assistance from ultrasound technology provide superior choices over conventional practices to manage pain in the patients admitted within emergency department. Studies have shown that with minimal training, emergency providers can perform nerve blocks successfully in both paediatric and adult patients in the ED settings. Ultrasound-guided nerve blocks also can be performed quickly and require only basic equipment that is already available in most EDs. Most importantly, the administration of a nerve blocks for some injuries (e.g., hip fractures) is associated with improved analgesia, decreased intravenous narcotic use, and improved morbidity and mortality when compared to use of intravenous analgesics alone.<sup>[4]</sup>

The present review focuses on finding out the functioning of peripheral nerve blocks and its utilities within the emergency department.

### Peripheral Nerve Block in Emergency Department

Peripheral nerve blocks are the safe alternative over general anaesthesia and offer sufficient anaesthesia to the patient in the event of painful episodes. Blocking the peripheral nerves with the assistance from ultrasound techniques help to

ameliorate different kinds of pain for the patient admitted in the emergency department. Peripheral nerve block neither need hemodynamic monitoring nor prolonged post-procedure observation. Additionally, peripheral nerve block involves minimum usage of local anaesthetic agents, which provide comfort to the ailing patients.<sup>[5]</sup>

**Understanding Peripheral Nerve Block and its functioning**

Peripheral nerve block constitutes injecting local anaesthetic agent (s) in proximity to the target nerve or nerve group. These local anaesthetic agents temporarily associate

themselves with the sodium channels within the nerves and form complexes. Such complexes result in temporarily inactivation of the target nerve. This in turn causes temporarily stoppage of the conduction mechanism of the target nerve, which hampers the target nerve’s motor, sensory and other autonomic impulses directed towards the brain. In spite of its effective functioning, local anaesthetic agents can result in systemic toxicity towards its target nerves. Following table includes the list of nerve anatomy that permits safe and effective usage of peripheral nerve blocks.<sup>[6]</sup>

**Table 1: Nerve anatomy**

SN	Nerve anatomy	Description
1	Myotomes and Dermatomes	Myotomes and Dermatomes are the constituents of the muscle and skin groups. Spinal nerves offer superior access to block Myotomes and Dermatomes.
2	Differential blockade	Different nerve fibres exhibit different sensitivity toward local anaesthetic agents. The quantum of local anaesthetic agent is the maximum for motor nerve fibres, followed by nerve fibres associated with touch and pain. The lowest sensitivity of local anaesthetic agent is for sympathetic nerve.
3	Neurovascular bundle	The most common sites for peripheral nerve block mechanism involve the peripheral nerves that are placed in close proximity with veins and arteries.

**Table 2: Tabulated overview of the standard dosage and length of period of local anaesthetic agents with adjunct medications used in blockage of peripheral nerves of patients admitted in the emergency department.<sup>[7]</sup>**

Local anaesthetic agent	Recommended dose with epinephrine	Duration of effect (hours)	Local anaesthetic additives	Effect of Local anaesthetic agents
Prilocaine	7mg/kg	0.5-3	Bicarbonate	Slightly hasten time to onset and shorten the duration of effect
Mepivacaine	7mg/kg	2-4	Epinephrine	Prolongs duration of effect
Lidocaine	5mg/kg	1-3	Buprenephrine	Prolongs duration of effect
Bupivacaine	3mg/kg	4-16	Dexamethasone	Prolongs duration of effect
LevoBupivacaine	2mg/kg	14-17	Clonidine	Prolongs duration of effect
Ropivacaine	3mg/kg	5-8	Magnesium	Prolongs duration of effect

**Table 3: List of studies involving application of peripheral nerve blocks toward different procedures in emergency department or other than OT**

Study	Procedure type	Type of PNB	Complication related to PNB
Cheung Ning et al, China, 2011, <sup>[8]</sup>	RFA for Liver Tumours	Paravertebral block	No major complications reported.
Chatterjee et al, India, 2015, <sup>[9]</sup>	Chest and abdomen case	Transverse abdominis plane block	No major complications reported.
Dzieciuchowicz et al, Spain, 2010, <sup>[10]</sup>	Lower limb case	(Femoral nerve block) Ablation of the greater saphenous vein	No major complications reported.
Yilmaz et al, Turkey, 2013, <sup>[11]</sup>	Lower limb case	(Femoral nerve block) Ablation of the greater saphenous vein	No major complications reported.
Marcus et al, United Kingdom, 2006, <sup>[12]</sup>	Lower limb	Angioplasty of the lower limb	No major complications reported.

**Trauma Cases**

In the Greek terminology, the word ‘trauma’ stands for ‘wound’. Trauma constitutes for the majority of global health burden involving significant morbidity, substantial mortality, and negative impact on socioeconomic parameters. According to the updated statistics of World Health Organization, the cases of burns, violence, falls and road traffic accidents are one of the most significant causes of trauma. In such trauma-affected patients, the injury kicks-off considerable inflammatory, endocrine and metabolic assaults.<sup>[13]</sup>

It is important to note that the intensity of pain correlated with trauma is mostly relentless and on long-term basis. Therefore, peripheral nerve block provides several advantages in emergency conditions like improved analgesia, enhanced cooperation and support from the patient, and safeguarding from chronic pain. Overall, peripheral nerve blocks display site-specific and high-quality analgesia without any systemic side effects, thereby making PNBs an

ideal analgesic.<sup>[14]</sup>

**Potential advantages of pnbs over systemic analgesia in trauma cases are enlisted below.<sup>[15]</sup>**

- Severely reduced systemic side effects as compared to sedation techniques,
- Substantial reduced dependence on local anaesthetic agents or sedatives,
- Significantly decreased duration of length of hospital stay.

Considerable reduction in the healthcare cost for patient when compared with other conventional sedation techniques.

**Block on Arrival**

One of the advances in regional anaesthesia is the continuous peripheral nerve blocks (CPNBs) also known as continuous perineural blocks. It helps to provide immediate pain relief in major trauma just after the initial stabilization of the patient.<sup>[16]</sup> This could be termed as "on arrival block". It is also becoming evident that it not only provides immediate

pain relief to the trauma victim but also considerably attenuates the stress response to tissue trauma. The on arrival block is readily made available in the hospital emergency setting. The most widespread usage of on arrival block involve both during the operation and after the operative period. The 'on arrival blocks' are site specific and offer superior analgesia than parenteral opioid analgesia. The on arrival blocks do not present with general side effects of conventional anaesthesia. The on arrival blocks are of superior use in treating patients with chronic pain syndromes and those requiring palliation for terminal illness.<sup>[17]</sup>

### **Upper Limb**

Upper extremity digit injuries are amongst the most common orthopaedic grievances warranting emergency interventions. Peripheral nerve blocks under ultra-sound guidance have been routinely applied on the forearm of emergency patient suffering from metacarpal fracture reductions, carpal fracture reductions and complex volar lacerations of the hand.<sup>[18]</sup> They are indicated for analgesia for acute injuries (burns, fractures, etc.) and before painful procedures (e.g., laceration repair, fracture reduction, foreign body removal). They do not provide anaesthesia to the forearm or wrist. Along with adults, the ultrasound-assisted peripheral nerve blocks on forearms of children have also been successfully investigated. The technique of applying ultrasound-guided peripheral nerve block over the forearm is comparatively uncomplicated and attains early blockade of the target nerve in forearm. Further, from the patient's point of view, ultrasound-guided peripheral nerve blocks over the forearm are nominally painful and offer long prolonged anaesthetic effects.<sup>[19]</sup> Intrascapular, supraclavicular nerve blocks are used for fracture or trauma of arm and below elbow respectively.

### **Lower Limb**

Since over half a century, the femoral shaft and hip fractures have been successfully managed by application of femoral nerve block both in outpatient department and emergency situations. Another block, the 3 in 1 block (also called the inguinal perivascular block) helps block the lateral, femoral and obturator femoral cutaneous nerves with the help of a single injection of minimal local anaesthetics. Anatomically; the femoral nerve progresses downward in the thigh within a fascial sheath. This sheath is running incessantly along with the nerve sheath that encloses all three nerves. The 3 in 1 block demands injecting considerable volume of local anaesthetic within the nerve sheath. The successful injection manages to block all the three target nerves.<sup>[20]</sup> In ankle blocks, all the five peripheral nerve branches (superficial peroneal, deep peroneal, saphenous nerve, posterior tibial and sural nerves) that supply sensation to the foot are blocked. Out of the five, the saphenous nerves, deep peroneal, and superficial peroneal nerves are anteriorly located and function to provide sensation to the dorsum of the foot. On the contrary, the sural nerves and posterior tibial nerves are posteriorly located where they provide sensation to the volar portions of the foot.<sup>[21]</sup>

From the patients' comfort point of view, the digital toe blocks or digital nerve blocks in the foot are preferred over local, painful and sometimes ineffective penetration of anaesthetic agent into the toes. The web space block is the

most common method to attain the digital block of the toe. In this method, a bigger 27-gauge and 3.75-cm long needle with one millilitre of local anaesthetic is introduced at the base of the toe.<sup>[22]</sup>

PENG block effectively provides analgesia for hip fractures in the emergency department. PENG block can be given easily with the help of Ultrasound. Also Erector Spinae Plane block at Lumbar level provides adequate pain relief to the patients with injuries involving L1-L4 distribution.

The management of pain in foot and ankle injuries are controlled by distal sciatic nerve blocks in the popliteal fossa.<sup>[23]</sup>

### **Chest and Abdomen**

One of the most common medical challenges within the emergency settings is the painful abdominal wall events including open wounds and soft tissue lacerations. These events warrant urgent medical interventions. Such emergency patients cannot be solely directed for local anaesthetic for the simple reason that they are painful, require large amount of time to begin its action, and cannot be used in patients with multiple comorbid conditions. Under such medical challenges, peripheral nerve blocks under the assistance of ultrasound technique provide excellent alternative in the emergency settings. Literatures have reported that such techniques have proved to be a valuable tool in several major abdominal and gynaecological challenges. The abdominal wall is composed of two most popular peripheral nerve blocks termed as the transversus abdominis plane, or "TAP" block, and the ilioinguinal/iliohypogastric (IL/IH) nerve block. Both these abdominal blocks are engaged in the infusing appropriate volume of local anaesthetic agents into the transversus abdominis muscles. The peripheral nerve block technique under the guidance of ultrasound for the TAP block offers multiple benefits over the conventional techniques.<sup>[24]</sup> Chest injuries with multiple rib fractures is greatly benefited with Erector Spinae Plane blocks at thoracic level. Even thoracic paravertebral blocks helps in reducing the pain in patients with chest trauma.

### **Head Injury**

Patients with acute traumatic head injury necessitate expert medical surveillance at both the peri-operative and post-operative stage in the emergency settings. The peripheral nerve block under the assistance of ultrasound technique offers secure option which exposes negligible volume of local anaesthetic into the nervous system of critically damaged patient. Among the several blocks, the motor point blocks and the nerve blocks are the focal techniques used to target localized areas of spasticity.<sup>[25]</sup> The supraorbital nerve block is a procedure performed to provide immediate localized anaesthesia for a multitude of injuries such as complex lacerations to the forehead, upper eyelid laceration repair, debridement of abrasions or burns to the forehead, removal of foreign bodies from the forehead, or pain relief from acute herpes zoster. Indications for supraorbital nerve block include Debridement of burns or abrasions, Repair of complex lacerations and Removal of foreign bodies. Complications of the supraorbital nerve block may include nerve injury including neurapraxia or neurolysis, local

anaesthetic systemic toxicity (LAST), bleeding and infection.<sup>[26]</sup>

### **Maxillofacial Injuries**

The local anaesthetic agent named 'Bupivacaine' is termed as the best agent for local anaesthesia in oral blocks and facial blocks. As compared to another local anaesthetic agent lidocaine, bupivacaine offers long term duration of action. Apart from bupivacaine and lidocaine, addition of epinephrine can also serve as better alternative during the dental blocks because of its increased vascularity within the oral cavity. Another local anaesthetic agent, benzocaine proves to be superior over lidocaine, bupivacaine and epinephrine due to its prompt onset of action, and minimal absorption in the local system.<sup>[27]</sup>

As far as the emergency cases within the dental settings is concerned, the most popular block termed as the supraperiosteal block is valuable to sedate a single tooth. The supraperiosteal block involves injecting one to two millilitre of local anaesthetics into the apex of the tooth, in the vicinity of the periosteum.<sup>[28]</sup> On the similar lines, the anterior superior alveolar nerve block sedates one half of the upper lip, the lateral incisors, the central incisors and the maxillary canine. In this block, around two milliliters of local anaesthetic is injected at the apex of the canine tooth to block the target tooth. The middle superior alveolar nerve block sedates the first molar and the maxillary premolars. In this block, around two milliliters of local anaesthetic is injected at the apex of the second premolar tooth. In this block, around two to three millilitre of local anaesthetic is injected at the buccal root of the upper second molar. The Inferior alveolar nerve block blocks the lower lip, chin and ipsilateral mandibular teeth through managing the mental nerve. In this block, around one to two millilitre of local anaesthetic is injected into the molar surface.

In the ophthalmic emergency cases, the infraorbital nerve block, blocks the infraorbital nerve, the superior alveolar nerve and the middle alveolar nerves. Overall, the infraorbital nerve block sedates the skin of the lower eyelid, most parts of the nose, most parts of the upper lip and the entire interior oral regions areas as well as the skin of the lower eyelid, nose, and upper lip. In order to perform the infraorbital nerve block, around one to three millilitre of local anaesthetic agent is injected in the close vicinity to the supraorbital notch.

### **Central Vein Canulations**

Central venous cannulation (CVC) is a fairly regular procedure in anaesthesia-demanding medical interventions and intensive care medicine situations. CVC assists in providing long-term vascular access and nutritional support to the emergency requiring patients. Enlisted are the major medical symptoms that warrant CVC: a) challenges in estimating the central venous pressure, b) complicated peripheral vascular access, c) increased amount of haemofiltration, d) challenges in monitoring of vascular oxygen saturations, and e) difficulty in maintaining long-term intravenous treatment.<sup>[29]</sup> Superficial cervical plexus block helps in relieving the pain during canulation.

### **Recurrent ventricular tachycardia and other uses:**

The challenging medical conditions like the peripheral

vascular disease, complex regional pain syndrome and the recurrent ventricular tachycardia have been effectively tackled by the stellate ganglion block (SGB). This stellate ganglion block sedates the voice box in the neck region by injecting local anaesthetic agent into the sympathetic nerves of the neck. This block relieves complications like swelling and pain in the neck. As mentioned above, this stellate ganglion block ensures smooth blood circulation in the patients suffering from peripheral vascular disease. As it can be evidenced, the role of sympathetic nerve is enormous in the stellate ganglion block and there exists an uncharacteristic linkage between sympathetic and sensory nervous systems. In view of this, the kind of pain ameliorated by sympathetic block is termed as sympathetically-mediated pain (SMP). The therapeutic effects of SGB are due to the block in neural connections in its region of innervations, the improvement in the blood supply of the region, the reduction of adrenal hormones plasma concentration. SGB can be used in medical conditions like post-traumatic stress disorder.<sup>[31]</sup>

### **Interventional Radiology**

In the emergency department, the patients' requiring interventional radiological treatment have immensely benefitted from the superior features of peripheral nerve blocks. As per the published literature, the most common categories of peripheral nerve blocks employed in interventional radiological treatment methods include stellate ganglion block, intercostal nerve block, phrenic nerve block, paravertebral block (PVB), femoral and sciatic nerve block, hypogastric plexus block, brachial plexus block and, transverse abdominis plane block.

The challenging medical conditions like the peripheral vascular disease, complex regional pain syndrome and the recurrent ventricular tachycardia have been effectively tackled by the stellate ganglion block (SGB). Paravertebral block (PVB) engages an injecting the pre-determined volume of injection with local anaesthetic agents within the paravertebral space. This causes effective blockage of sensory, sympathetic and motor nerves. The paravertebral block applied in the thoracic region provides immense assistance for the treatment of hepatic tumors.

The transversus abdominis plane, or "TAP" block is the most popular fascial plane blocks of the abdominal wall. This block is engaged in the infusing appropriate volume of local anaesthetic agents into the plane between internal oblique and transversus abdominis.

Patients suffering from the chronic pelvic pain post uterine arterial embolization benefit tremendously from the superior hypogastric plexus block. The overall performance of the superior hypogastric plexus block is quite similar to the outcomes of epidural analgesia observed during the treatment of uterine artery embolization. This block involves injection of twenty millilitre of local anaesthetic agent applied on the target nerve thereby offering rapid pain control.

The phrenic nerve block constitutes local anaesthetic injection on the nerve located at the anterior surface of the anterior scalene muscle. This particular block minimizes the post-operative shoulder pain and influences the motor response of the diaphragm.

The pain in cases of interventional radiology procedures in



the upper extremity limbs including the arm, forearm, shoulder, digits, wrist, and hand can be effectively subverted by brachial plexus block. This block involves injecting predetermined volume of local anaesthetic agents at around the brachial plexus region. This block can be undertaken at the infraclavicular, interscalene, axillary and supraclavicular regions as well.

The pain in the lower extremity limbs during interventional radiology can be sufficiently managed by the sciatic nerve block and the femoral nerve block. This block involves injecting predetermined volume of local anaesthetic agents at the posterior or anterior regions of the thigh. Ultrasound-guided femoral nerve block and sciatic nerve block have been used to control pain during endovenous laser ablation for lower extremity venous insufficiency. Both these blocks provide significant anaesthesia prior to the angioplasty of the lower extremity surgeries or interventions.<sup>[32]</sup>

### **Chronic Pains with Acute Presentation**

In the orthopaedic field, the patients' experiencing chronic pains as acute presentation within the emergency situations have immensely benefitted from the superior features of peripheral nerve blocks. Peripheral nerve blocks provide both the control measures against acute pain in patients experiencing major limb surgeries, and, offer superior analgesia during the surgery for patients enduring urological, trauma, and gynaecological, abdominal and thoracic surgeries. In the above mentioned surgeries, peripheral nerve blocks have established in secure and successful reduction of chronic pains, thereby effectively diminishing the intake of analgesics/opioid/sedatives. This effect has caused substantial reduction of opioid-related side-effects and shortened the length of hospital stay for several pain-afflicted patients. Additionally, peripheral nerve blocks under ultrasound guidance offer secure and effective option over epidural analgesia.<sup>[4]</sup>

### **Gangrene of Limbs and Blocks**

Sympathetic Nerve blocks helps in reducing the gangrene due to vascular compromise of the extrimities. The gangrene patients in emergency department requiring urgent limb amputation serve as a particular challenge to anaesthesiologists. These patients are most commonly presented with poor blood circulation, thereby afflicted with sepsis, cellulitis, comorbid conditions and in extreme cases, with multiple organ malfunction. In emergency ward patients suffering from gangrene of limbs, neuraxial blocks are dissuaded due to patients' hemodynamic instability, coagulopathy and higher risk of systemic infection. Under such medical circumstances, usage of peripheral nerve blocks for below knee amputation (BKA) and above knee amputation (AKA) can be implemented. Although, the usage of both these blocks are rare but they offer superior cardiovascular stability and better intra-operative and postoperative pain management. Both the blocks are particularly useful in extremely sick patients. Peripheral nerve blocks with the assistance of ultrasound technology provide convenient, secure and highly successful method to alleviate pain in the patients requiring emergency surgical interventions. Recent case report recorded successful and complete management of methicillin-resistant

staphylococcus aureus positive right lower limb cellulitis for above knee amputation under combined nerve blocks. Additionally, the combined femoral-sciatic nerve block with the technical assistance from ultrasound proved to be secure and effective option for the cases involving lower limb amputation within the high-risk patients.<sup>[33]</sup>

## **Discussion**

Peripheral nerve blocks in guidance with ultrasound technique are relatively novel concept for anaesthesiologists emergency physicians. The patients undergoing emergency intervention procedures immensely benefited from this new development. This procedure completely circumvented the procedural sedation and significantly decreased the duration of length of hospital stay. Peripheral nerve blocks in the emergency department include a) interscalene nerve block for humerus fracture, shoulder dislocation, and elbow fracture/dislocation, b) axillary nerve block for deltoid abscess incision and drainage; c) supracondylar radial nerve block for distal radius fracture and reduction; d) popliteal sciatic nerve block for injuries below the knee; e) intercostal blocks, praverterbral or ESP blocks for rib fractures, chest tube placement, and thoracotomy; f) Transversus abdominis plane blocks for abdominal wall procedures (e.g., abscess incision and drainage), pelvic ring fractures, and pancreatitis; and g) dorsal penile block for paraphimosis and priapism.

## **Conclusion**

Pain management is an essential aspect of emergency care. However, in many circumstances, systemic analgesics are contraindicated or inadequate at controlling pain. Peripheral nerve blocks with the assistance of ultrasound technology provide convenient, secure and highly successful method to alleviate pain in the patients requiring emergency surgical interventions. While some hospitals already have instituted pain management protocols that include peripheral nerve blocks with ultrasound assistance for specific injuries including hip fractures and hand blast injuries, some providers may be hesitant to perform blocks because they are unfamiliar with ultrasound or have misconceptions about the efficacy of blocks. This article attempted to collate several utilities of peripheral nerve blocks in trauma cases, block on arrival, upper limb, lower limb, chest and abdomen, head injury, macillofacial injuries, central vein canulations, recurrent ventricular tachycardia, interventional radiology, chronic pains as acute presentation and gangrene of limbs. It is important to remember that peripheral nerve block is easy to learn, quickly to perform, and successful at managing pain, and, therefore, should be adopted into routine clinical use in the emergency department.

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**How to cite this article:** Prasad GVK. Utilities of Peripheral Nerve Blocks beyond the Operating Room: A Narrative Review. *Acad. Anesthesiol. Int*. 2020;5(1):120-125.

DOI: [dx.doi.org/10.21276/aan.2020.5.1.24](https://doi.org/10.21276/aan.2020.5.1.24)

**Source of Support:** Nil, **Conflict of Interest:** None declared.