



Review Article

Pharmacology for better Drug screening

## Local anesthetic drugs in popliteal sciatic nerve blocks for patients with established diabetic neuropathy - Do no harm!

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**Abstract:** Diabetes mellitus is a commonest endocrine disease with India leading the world in prevalence of the disease. Patients with Diabetes Mellitus present with foot surgeries with proven neuropathies. A complete search of the Pubmed, Cochrane and Scopus databases was done for the articles on the safety of the local anaesthetic drugs inside the nerve with established neuropathy. Relevant articles with their methodologies were analysed. Patients with long term diabetes mellitus have multiple other comorbidities; administration of either General or neuraxial technique of anaesthesia may not be favoured. Autonomic imbalance and hemodynamic instability in central neuraxial blockade happen in such cases. The problem of airway control, presence of organ dysfunction may make general anaesthesia an unfriendly choice. Hence, blocking the sciatic nerve in the popliteal site is very popular in these patients. The advent of ultrasound and a better knowledge of extra neural injections is advantageous in these patients with known neuropathy. It has also made the action to be more definite with decreased dosage of drugs. The concept of double crush phenomenon of additional damage caused by local anaesthetics is not clinically very significant. Local anaesthetics as plain solutions seem to be better than mixing with additives with unknown toxic potential. Given the pros and cons, the targeted ultrasound guided nerve blocks seem to be advantageous with negligible side effects.

**Keywords:** diabetes mellitus, neuropathy, nerve block, drugs, local aesthetics

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## 1. INTRODUCTION

Diabetes mellitus is one of the commonest endocrine diseases affecting the population worldwide. India is the diabetic capital of the world with the maximum number of reported cases. People affected with diabetes mellitus often develop foot ulcers (which mean open sores on the feet going through the skin to the deeper layers). They may worsen to make interventions like amputations necessary. The procedure of removing dead tissue and the unhealthy callus from the ulcers is a common procedure done which is also known as "debridement". This procedure can be done in multiple ways, which includes surgical and application of special dressings and gels. The prevalence of diabetic foot syndrome is approximately 6.3% and is found higher in males than females. Recently a greater number of cases are presenting to us with bad infections and sepsis<sup>1</sup>. Administration of peripheral nerve blocks is the cornerstone of successful surgical management of such infections. Usually such foot infections are associated with peripheral neuropathy. The pathogenesis of diabetic neuropathy has always been disputed and described as having a metabolic or ischemic insult. Axonal degeneration of varied types followed by demyelination have been reported. Despite disagreement about the primary role of a particular lesion or the etiology of diabetic neuropathy, it is clear that diabetes mellitus has the potential to induce pathologic changes in most cellular and noncellular components of the peripheral nerve<sup>2</sup>. There are many drugs like chloroquine, dapson when administered systemically can cause neuropathy<sup>3</sup>. Blocking a nerve with local anaesthetics in the presence of neuropathy creates a doubt in the minds of anaesthesiologists. Placement of local anaesthetics on these nerves exacerbates neuropathy is a matter of debate and still unproven. But many such patients can also have concomitant autonomic neuropathy which may prove detrimental when administering neuraxial anaesthesia<sup>2</sup>. Many numbers of patients present with clinical features of frank sepsis. In all cases of diabetic foot syndrome seeking and eliciting the clinical features of autonomic neuropathy is crucial. A minimal interference of the internal milieu without affecting the imbalanced autonomic system assumes importance in these cases. It can be derived that peripheral targets of anaesthesia are useful. Hence in such cases, a local anaesthetic injection especially in the site of an infective focus may not prove useful. This emphasizes the need of popliteal sciatic nerve blocks. In this short review, we will try to outline the advantages and disadvantages of administering sciatic nerve blocks in diabetic foot syndromes.

## METHODS

A complete search of the Pubmed, Cochrane and Scopus databases were done for the articles on the safety of the local anaesthetic drugs inside the nerve with established neuropathy. Relevant articles with their methodology were analysed.

## DIABETIC FOOT SYNDROME

Diabetic foot syndrome (DFS), as defined by the World Health Organization (WHO), is an "ulceration of the foot (ankle and below) associated with neuropathy and different grades of ischemia and infection. We can derive from the above definition that there are three inciting factors in its development in patients with diabetes mellitus. They are neuropathy, vasculopathy and infection. Hence its clear from

the evidence that neuropathy is an essential accompaniment of DFS. Peripheral neuropathy represents the vital path in the journey of DFS and foot ulceration. Diabetic peripheral neuropathy (DPN) significantly impedes neuronal function throughout the body. These nerves include autonomic, motor, and sensory nerves<sup>4</sup>. The diminished sensation of the foot exposes the foot to traumatic damage from immoderate mechanical or thermal injury. In this fragile foot background, an exposure to infection, especially unnoticed due to diminished pain, the foot disease can be severe enough to warrant debridement. There are innumerable and multidisciplinary methods of tackling the disease like, glycaemic control, antibiotics, management of vasculopathy, adjuvants like oxygen and wound healers<sup>5</sup>. The WHO recommends<sup>6</sup> sharp debridement rather than just superficial excision of unhealthy tissues. This demands satisfactory anaesthesia to proceed unhindered to achieve the target of complete healing. Hence such a complete denervation is possible with nerve blocks or neuraxial anaesthesia only. As peripheral nerve blocks have established superiority with regard to haemodynamics and safety, they are the preferred ones in these patients. As vasculopathy may be coexistent, surgeons don't prefer to use the tourniquet which makes it suitable for such peripheral nerve blocks.

## TECHNIQUES OF SCIATIC NERVE BLOCKS

The sciatic nerve arises from the ventral rami of L4 through S3, which forms most of the sacral plexus (L4-S4). The sciatic nerve is actually two nerves in close apposition, the tibial nerve and the common peroneal nerve. The sciatic nerve supplies motor and sensory innervation to the posterior aspect of the thigh as well as the entire lower leg, except for the medial lower part of the leg, which is supplied by the saphenous nerve<sup>7</sup>. This sciatic nerve can be blocked from the hip, upper thigh and the popliteal region. Before even the advent of peripheral nerve stimulators, the block was administered in the upper thigh and the back of the knee for many years. The elicitation of paraesthesia was the endpoint for injection of the local drug then. Victor Pauchet, a French surgeon, described the sciatic nerve block in 1920: "the site of needle insertion for blocking the sciatic nerve at the level of hip: 3 cm along the perpendicular that bisects a line drawn between the greater trochanter and the posterior superior iliac spine." This technique was now known as Labat's method because he popularized in English as a student of Faucet, It was practiced for decades. Beck's anterior approach and Prithviraj's lithotomy approach were described later in the 1960s<sup>8</sup>. After the invention of peripheral nerve stimulators, the nerve was located with their help, giving a small current of 0.5mA. This led to the visible contraction of the muscles usually hamstring in the higher approaches and great toe movements in the lower approaches. The successful elicitation of such a twitch with a minimal amperage was followed by drug injection<sup>9</sup>. The invention of ultrasound has revolutionised the practice of nerve block with the visualisation of the nerve. The simultaneous imaging of the needle tip and the drug deposition was fascinating with real time pictures. This led to the significant use of such blocks in sick cases leading on to enhanced quality of anaesthesia services. The use of ultrasound is proved in all the approaches of the sciatic nerve but the popliteal approach is easier than others. This is possible because the nerve is superficial and close to vessels which form the easily identifiable nearby anatomical structure.

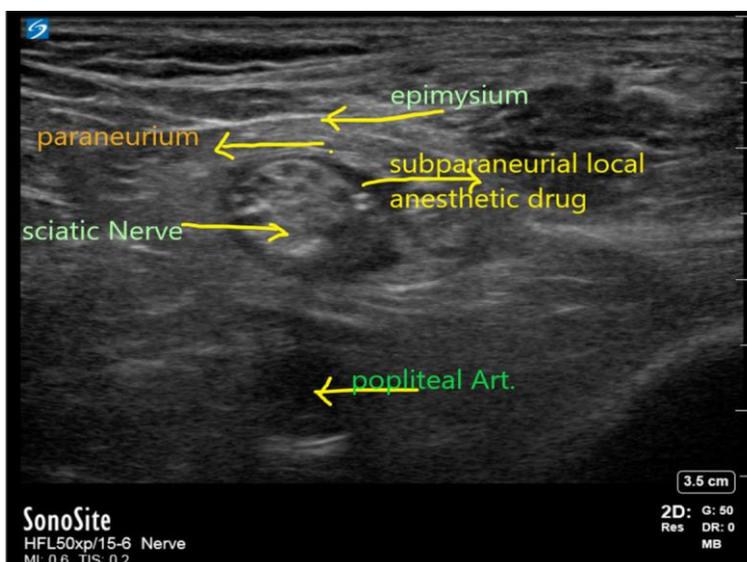
**ADVANTAGES OF POPLITEAL SCIATIC NERVE BLOCK**

The popliteal sciatic nerve block is usually administered in the prone position with ultrasound guidance for analgesia and anaesthesia of below knee surgeries. The sciatic nerve can be imaged using a 6 - 13 -MHz (HFL) probe up to the popliteal fossa, where it divides into the common peroneal and the tibial nerves Here, the nerve often appears round and hyperechoic and is located posterior to the femur, lateral / posterolateral to the popliteal artery. The semitendinosus

and semimembranosus (SM and ST) muscles are medial and the biceps femoris muscle is lateral (figure 1) More distally, the peroneal nerve can be traced laterally as the head of the fibula. The visualisation of the nerve with its divisions are so clear in the scan that precise administration of the drug into the place is possible. The onset of action is fast and the failure rate is extremely less. The anaesthesia is very intense and duration is prolonged according to the drug used<sup>9</sup>. The various common drugs which are used in the block are tabled (Table 1) below<sup>10</sup>.

Table 1. Showing the dosage of local anaesthetic drugs and duration.			
Drug	Onset (minutes)	Analgesia Duration (hours)	Duration of anaesthesia (hours)
2 % lignocaine with Epinephrine	10 - 20	3 - 8	2 - 5
0.5 % ropivacaine	15 - 30	5 - 12	4 - 8
0.5 % bupivacaine	15 - 30	6 - 30	5 - 15

The advent of ultrasound in this block has revolutionised the sono-anatomy with the description of the paraneural sheath and the deposition of drugs (Figure 1).



**Fig 1. Showing sciatic nerve and its relations**

This has basically changed the concept of intraneural injections. The possibility of an intraneural injection can be avoided with a clear description of the sono-anatomy of the sciatic nerve in the popliteal fossa. This scientific understanding of the sub para neural space can stave off an additional damage to the diseased nerve. Usually 20 ml of the local anaesthetic is injected to get the result. The direct visualisation of the drug spread makes it possible to decrease the quantity to 12-15 ml. Many destructive histopathological changes are noted on the deposition of the local anaesthetic. But changes are due to a multifactorial cause, which includes a genetic predisposition. Hence the exact component of the damage caused by the drug is not so far known. A decrease in both drug concentration and volume may decrease the additional damage caused by local anaesthetics. All these subtle changes are not so far projected to have clinical significance. The biggest advantage of such peripheral targets for anaesthesia is that it obviates the need for neuraxial blocks<sup>11</sup>. The neuraxial blocks are mostly associated with hemodynamic imbalance and this complication is not well tolerated by diabetic patients with established neuropathy. The logical reason is that there may be an associated definite

autonomic component in all these patients. The second advantage is that the superficial block like ultrasound guided popliteal sciatic block is feasible in patients on anticoagulants. Many of the patients with DFS present usually with some other micro vascular or macro vascular disease and may be on dual anti coagulants. This precludes the use of neuraxial technique<sup>12</sup>. A general anaesthesia with airway manipulation on any day has more disadvantages than the block. The need for polypharmacy, airway control, autonomic imbalance, associated renal, cardiovascular problems. being common accompaniments of a long-standing Type 2 DM are going to be definite impediments in proceeding with General anaesthesia<sup>13</sup>.

**DISADVANTAGES OF POPLITEAL SCIATIC NERVE BLOCK**

The major disadvantage of this block is the need for an ultrasound machine 24 hours. This may become a reality even in small centres in due course. The availability of personnel trained in such blocks on an emergency basis will be available in the coming years. The medial side of the ankle

is supplied by the femoral nerve through its saphenous branch. Hence any surgical nociception in the area is not tackled by sciatic nerve block alone. The use of tourniquets is not possible with popliteal blocks. In surgeries where the surgeon opts to have a tourniquet, the anaesthetic technique needs to be given a second thought as the tourniquet is usually wrapped in the thigh. Upton et al. described an entity called double crush phenomenon<sup>15</sup> in 1973. Axons can have disturbed axoplasmic flow due any ischemic or a metabolic disease like Diabetes Mellitus. In the setting of such a disturbed flow, any added insult is likely to stop the flow and conduction of the nerve. It may produce distal denervation. Hence in the backdrop of diabetic neuropathy, “can an added insult of local anaesthetic drugs cause distal denervation?” is a staggering question in the minds of the attending anaesthesiologists. In acute hyperglycemic nerve injuries in rats<sup>15</sup>, a few studies have established the additive damage produced by the local anaesthetic drug. One such study clearly dissociates itself with its findings to be extrapolated to chronic nerve injuries. Cuvillon P et al. in their study have described the prolonged effect of Ropivacaine<sup>16</sup> as a local anaesthetic in sciatic nerve block in diabetics when compared with non-diabetic patients. Baeriswyl, M. et al.<sup>17</sup> have proved that the onset of action of a mixture of lignocaine-bupivacaine administered in ultrasound guided sciatic nerve blocks to be shorter in diabetic patients than in non-diabetics. The exact reason, even though not clearly established, can be construed that a pathological nerve is more sensitive than a normal nerve<sup>18</sup>. The addition of any additive to local anaesthetics changes the milieu including the pH and hence probing the safety of cocktails in a morbid nerve is unwarranted<sup>19</sup>. Baeriswyl et al. in their prospective study of patients<sup>17</sup> with diabetic neuropathy have demonstrated a hastened onset and an additional extended duration of block than non-diabetics in popliteal sciatic

blocks. From these findings, we can derive the inveterate truth that any additional drug administration in a damaged nerve is likely to act faster and better.

## 2. CONCLUSION

Diabetic foot syndrome posted for foot surgeries is becoming a day to day affair. These patients usually have many comorbid illnesses. This indicts hesitancy in us to administer either general or central neuraxial blockade. Peripheral sciatic nerve block with ultrasound guidance can be very useful as definite anaesthesia is established. Use of tourniquet is rare in these patients and a distal block is usually enough. Even though the administration of local anaesthetics in the nerve of long-standing diabetes mellitus can theoretically cause more damage, such instances of any excess permanent damage in clinical practice are rare. The clarity in understanding the nerve sheaths and the subtle ultrasound guided deposition of the lesser volume of drug has almost eliminated the intraneural injections. Even though the double crush phenomenon is well known, the risk benefit ratio of a sciatic nerve block Vs other forms of anaesthesia is clearly in favour of distal blocks. It's prudent to use plain local anaesthetic drugs rather than any combinations or additives.

## 3. AUTHOR CONTRIBUTION STATEMENT

Dr. Avijit Chanda has devised the concept, Dr. Balachandar has done the critical review and database search, Dr. Parthasarathy has done the write up and communication.

## 4. CONFLICT OF INTEREST

Conflict of interest declared none.

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