



Abhijit S Nair*

Department of Anaesthesia and Pain Medicine, Basavatarakam Indo-American Cancer Hospital and Research Centre, Hyderabad- 500034, India

Dates: Received: 09 January, 2017; Accepted: 17 January, 2017; Published: 23 January, 2017

*Corresponding author: Dr. Abhijit S Nair, Consultant Anesthesiologist, Department of Anesthesia and Pain Medicine, Basavatarakam Indo-American Cancer Hospital and Research Centre, Hyderabad-500034, India, E-mail: abhijitnair95@gmail.com

Keywords: Local anesthetics; Myotoxicity; Ultrasonography; Regional anesthesia; Nerve block

<https://www.peertechz.com>

Review Article

Local Anaesthetic Myotoxicity Due to Fascial Plane Blocks: A Brief Review

Abstract

Fascial plane blocks have become quite popular in the present practice of regional anaesthesia. Transverses abdominal plane (TAP) block, quadratus lumborum (QL), serratus anterior plane (SAP) block, pectoralis block (PECS 1/ 2), rectus sheath and adductor canal block are quite easy to perform with ultrasonographic (USG) guidance. The anaesthesiologist identifies the muscles and the relevant fascial plane to inject the local anaesthetic (LA) in the desired plane under USG guidance. Current prospective and observational studies have shown that these are quite effective as a single injection and can be used for continuous analgesia with an indwelling catheter in the fascial plane. All fascial plane blocks are transmuscular injections i.e. the needle has to reach the target plane by piercing the adjoining muscles. There are high chances of LA injection in the muscle or spillage of LA in the substance of muscle especially after high volume LA injections. The possibility is more when an anaesthesiologist has recently learnt a fascial plane block and is applying it in clinical practice. The myotoxicity could be more profound in continuous LA infusions where the muscle will get continuously exposed to LA.

Introduction

Local anaesthetic induced myotoxicity (LAMT) is terminology which is known and described as early as in 1959 in experimental animals and was documented in case reports [1]. Case reports and series are still published which describes the morbidity and undesirable consequences due to a confirmed LAMT. The present brief communication offers a revision on the mechanism of these injections. Another aim is to discuss the myotoxic potential of the currently used fascial plane blocks which are high volume injections and are performed via transmuscular approach using ultrasonography.

LAMT revisited

All local anaesthetics (LA) are myotoxic at the concentration used in clinical practice. After an LA injection into the muscle, the myofibrils become hypercontracted followed by degeneration of sarcoplasmic reticulum of the striated muscle with myocyte edema and necrosis. These are the findings on histopathological examination. The myoblasts, basal laminae and connective tissues are preserved after a single injection. Subsequently the muscle regenerates provided the ongoing insult with further exposure of LA is stopped [2]. This reversibility is affected after a continuous catheter based infusion or after a high volume, concentrated single shot LA injection.

The branches of nerves supplying the muscle and the blood supply to the muscle is not affected after these injections.

Once injected into the substance of the muscle, the LA leads to increased myoplasmic levels of free calcium which is responsible for muscle tissue necrosis [3]. Thus the LA injection causes toxicity in 3 ways: volu-trauma (by the volume of injected LA), baro-trauma (by the pressure of injection), chemical trauma (due to disruption in intracellular calcium homeostasis).

LAMT in the form of myonecrosis and muscle weakness are commonly seen after peripheral nerve blocks, wound infiltration, trigger point injections and ophthalmic injections like peribulbar and retrobulbar blocks. There is a dose dependent increase in LA induced muscle injury which was demonstrated by Cherng et al. [4]. The study was conducted on rats who were injected different concentrations of bupivacaine on the right tibialis anterior muscle and was compared with saline injections. Intramuscular glutamate which is a marker of muscle injury was more in LA group with more injury in the rats who were subjected to a more concentrated LA injection.

Many clinicians use adjuvants in the LA like epinephrine, alpha-2 agonists, dexamethasone, and opioids in the LA solution for prolonging the duration of analgesia after a block. The effect of these adjuvants on the myotoxicity conferred by LA is not known and not studied in detail till now.

Comparative toxicity

Among the LA commonly used clinically for regional anaesthesia, bupivacaine and chlorprocaine produces severe

myotoxicity with procaine and tetracaine having the least toxicity profile [5]. Ropivacaine appears to be less myotoxic compared to bupivacaine but it is not clear whether the lesser myotoxicity is due to the pure optical isomer structure of ropivacaine. One possible explanation of this could be the more lipophilic nature of bupivacaine which leads to faster entry into the myoplasm leading to more calcium release [6]. In an experimental study by Yildiz et al on rats, the investigators found the myotoxicity of levobupivacaine after intramuscular injections of LA was qualitatively similar and quantitatively less than bupivacaine and ropivacaine [7].

USG guided peripheral nerve block, fascial plane block and myotoxicity:

With the increasing use of ultrasound in the practice of regional anaesthesia and pain medicine; the blocks have become safe, success rate has increased and the volume of drug required for an optimal block is reduced. This has reduced the chances of local anaesthesia systemic toxicity (LAST) as injections are given under direct vision and in real time with an overall lesser volume of LA. The plexus blocks (interscalene, supraclavicular, infraclavicular, axillary) and femoral nerve blocks are given by direct visualization of neural structures on USG [8]. The volume of LA required for these blocks with the use of USG has reduced significantly. Blocks like popliteal, sciatic, obturator, ilioinguinal-iliohypogastric are administered after identification of the nerves on USG but the target area of injection is reached by a transmuscular route.

Therefore chances of LAMT is again a possibility in these injections. The commonly used nerve blocks and fascial plane blocks with the muscles related to the block is shown in Table 1.

The chances of LAMT is theoretically more in the fascial plane blocks like transverses abdominal plane (TAP) block,

quadratus lumborum (QL), serratus anterior plane (SAP) block, pectoralis block (PECS 1/2), rectus sheath as the injection is trans-muscular [9-12]. The local anaesthetic is deposited in the fascial plane under USG guidance after identifying the relevant muscles and the target fascial plane. The nerves or the plexuses are not visualised in the above mentioned blocks unlike the brachial plexus and individual nerve blocks where the nerve/plexus is visualised and targeted in real time. Adductor canal block is a similar block where the nerve is not visualised out of the times and the injection is given in a fascial plane involving muscles of thigh by a trans-muscular approach [13].

The chances of myotoxicity increases if catheters are placed in the fascial plane as there is continuous infusion of LA, the drug might either get spilled in the substance of muscle if catheters get displaced or there can be direct intramuscular deposition of local anaesthetic. Neal et al., reported 3 cases who had LA induced myotoxicity following adductor canal block for total knee arthroplasty [14]. The patients developed progressive, profound quadriceps weakness from postoperative day 1 onwards. On clinical examination, MRI and after neurophysiologic studies, the impression was consistent with myositis. Complete recovery of these patients took several weeks to months.

The muscles of abdomen and chest are not directly associated weight bearing joints unlike the muscles of lower limbs. However in situations where the injection is through a weight bearing muscle like an adductor canal block (sartorius , adductor longus and vastus medialis muscle), popliteal nerve block (biceps femoris muscle), sciatic nerve block(through gluteus muscles); the resultant myotoxicity could be a cause of concern in rehabilitation of the patient in the postoperative period.

Conclusion

The incidence of LAMT is not known. A high volume block can increase the chances of myotoxicity. Similarly, continuous LA infusions can lead to a continuous muscle insult which can have undesirable consequences in certain situations. Fascial plane are high volume blocks hence could lead to myotoxicity which may get revealed only when weight bearing joint muscles are affected. The patients should be prospectively followed and evaluated to have a definitive number which can tell us which particular block can lead to myotoxicity. Further animal studies needs to be done to know maximum concentration or maximum volume of LA which can be safely injected in order to minimise myotoxicity after certain blocks.

References

- Hogan Q, Dotson R, Erickson S, Kettler R, Hogan K (1994) Local anesthetic myotoxicity: a case and review. *Anesthesiology* 80: 942-947. [Link: https://goo.gl/rhaf84](https://goo.gl/rhaf84)
- Zink W, Sinner B, Zausig Y, Graf BM (2007) Myotoxicity of local anaesthetics: experimental myth or clinical truth? *Anaesthesist* 56: 118-127. [Link: https://goo.gl/eVh5ap](https://goo.gl/eVh5ap)
- Zink W, Bohl JR, Hacke N, Sinner B, Martin E, et al. (2005) The long term myotoxic effects of bupivacaine and ropivacaine after continuous peripheral nerve blocks. *Anesth Analg* 101: 548-554. [Link: https://goo.gl/IFXRov](https://goo.gl/IFXRov)

Table 1: Frequently performed ultrasound guided blocks and the muscles around the target neural structures or the target fascial plane.

S.no.	BLOCK	MUSCLES
1	Transversus abdominis plane block	External oblique, internal oblique, transversus abdominis
2	Serratus anterior plane block	Serratus anterior, teres major, latissimus dorsi
3	PECS 2 block	Pectoralis major and minor, serratus anterior
4	Adductor canal block	Sartorius, vastus medialis, adductor longus
5	Rectus sheath block	External oblique, internal oblique, transversus abdominis
6	Ilioinguinal-iliohypogastric nerve block	External oblique, internal oblique, transversus abdominis
7	Quadratus lumborum block	External oblique and internal oblique(aponeurosis), quadrates lumborum, psoas major
8	Popliteal nerve block	Biceps femoris, semitendinosus, semimembranosus
9	Sciatic nerve block	Anterior approach: Adductor muscles (longus, brevis, magnus), pectineus Gluteal approach: Gluteus maximus, quadratus femoris
10	Obturator block	Pectineus, adductor muscles(longus, brevis, magnus)

4. Cherg CH, Wong CS, Wu CT, Yeh CC (2010) Intramuscular bupivacaine injection dose-dependently increases glutamate release and muscle injury in rats. *Acta Anaesthesiol Taiwan* 48: 8-14. [Link: https://goo.gl/zTuRtV](https://goo.gl/zTuRtV)
5. Zink W, Graf BM (2004) Local anesthetic myotoxicity. *Reg Anesth Pain Med* 29: 333-340. [Link: https://goo.gl/ioW3BM](https://goo.gl/ioW3BM)
6. Zink W, Seif C, Bohl JR, Hacke N, Braun PM, et al. (2003) The acute myotoxic effects of bupivacaine and ropivacaine after continuous peripheral nerve blockades. *Anesth Analg* 97: 1173-1179. [Link: https://goo.gl/nz3cVS](https://goo.gl/nz3cVS)
7. Yildiz K, Efesoy SN, Ozdamar S, Yay A, Bicer C, et al. (2011) Myotoxic effects of levobupivacaine, bupivacaine and ropivacaine in a rat model. *Clin Invest Med* 34: E273. [Link: https://goo.gl/HjRbnL](https://goo.gl/HjRbnL)
8. Warman P, Nicholls B (2009) Ultrasound-guided nerve blocks: efficacy and safety. *Best Pract Res Clin Anaesthesiol* 23: 313-326. [Link: https://goo.gl/QZ5pw2](https://goo.gl/QZ5pw2)
9. Blanco R, Fajardo M, Parras Maldonado T (2012) Ultrasound description of Pecs II (modified Pecs I): a novel approach to breast surgery. *Rev Esp Anesthesiol Reanim* 59: 470-475. [Link: https://goo.gl/vwmkZ0](https://goo.gl/vwmkZ0)
10. Young MJ, Gorlin AW, Modest VE, Quraishi SA (2012) Clinical implications of the transversus abdominis plane block in adults. *Anesthesiol Res Pract* 2012: 731645. [Link: https://goo.gl/C6RB7p](https://goo.gl/C6RB7p)
11. Khalil AE, Abdallah NM, Bashandy GM, Kaddah TA (2016) Ultrasound-Guided Serratus Anterior Plane Block Versus Thoracic Epidural Analgesia for Thoracotomy Pain. *J Cardiothorac Vasc Anesth* pii: S1053-0770(16)30359-7. [Link: https://goo.gl/Xsvxac](https://goo.gl/Xsvxac)
12. Abdelsalam K, Mohamdin OW (2016) Ultrasound-guided rectus sheath and transversus abdominis plane blocks for perioperative analgesia in upper abdominal surgery: A randomized controlled study. *Saudi J Anaesth* 10: 25-28. [Link: https://goo.gl/uwYieN](https://goo.gl/uwYieN)
13. Vora MU, Nicholas TA, Kassel CA, Grant SA (2016) Adductor canal block for knee surgical procedures: review article. *J Clin Anesth* 35: 295-303. [Link: https://goo.gl/Hs22nM](https://goo.gl/Hs22nM)
14. Neal JM, Salinas FV, Choi DS (2016) Local Anesthetic-Induced Myotoxicity after Continuous Adductor Canal Block. *Reg Anesth Pain Med* 41: 723-727. [Link: https://goo.gl/FmfF3S](https://goo.gl/FmfF3S)

Copyright: © 2017 Nair AS. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.