The Effect of Opening Injection Pressure Monitoring Device to Detect Needle Nerve Contact During Ultrasound Guided Popleatial Approach in Diabetic Patients for Below Knee Amputation

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ABSTRACT:

BACKGROUND:

Ultrasound-guided popliteal sciatic nerve blocks is a useful approach for below- knee surgery. Using the injection pressure monitoring device.

OBJECTIVE:

This study to assess the role of opening Injection Pressure monitoring device in providing and avoid nerve injury in patients who underwent, popliteal sciatic nerve block under ultrasound-guided.

METHODS:

This study involve fifty patients underwent unilateral below knee amputation were randomly assigned under ultrasound-guided popliteal sciatic nerve block and femoral nerve block have been done, with use opening Injection Pressure monitoring device and additional ultrasound guided.

RESULTS: :

Regarding the pressure of the injections monitoring , we noticed that in this study, the highest proportion of study patients recorded needle nerve contact (44%) ,needed low pressure <15 psi (38%) , while all Intrafascular injection (18%). Sensory Block three points scale of pin prick sensation to check sensory block before and after nerve block. In this study, we noticed that all patients were normal in both pre nerve block and 5 minutes after nerve block, (74%) of patients were normal and 26% was decrease pain after 10 minutes from nerve block, at 15 minutes from nerve block, most patients were showed decreased pain (86%). The highest proportion of study patients after 20 minutes from nerve block was showed decreased pain (70%), then after 25 minutes of nerve block, the highest proportion of patients didn't show pain (88%). All patients were completely free from pain after 30 minutes of nerve block. Motor block duration lasted for ≥ 20 minutes in (68.1%) of study.

CONCLUSION:

There is high incidence of intraneural needle placement or needle neve contact of nerve under ultrasound guide.

KEYWORDS: Injection pressure monitoring, ultrasound guided popliteal sciatic nerve block.

INTRODUCTION:

Amputation of Diabetic foot:

Diabetes mellitus (DM) is one of the most important and common metabolic disorders affecting about 2–5% of the population in Europe and about 20% of the population in various other parts of the world [1]. It is estimated that around 347 million people in the world are diagnosed with diabetes mellitus .The incidence of diabetes mellitus is increasing worldwide; by 2030, it will grow up to 415 million [2] One of the studies by Jain et al, around 51.09% of the patients admitted with diabetic foot problems, will require amputation [3].

Popliteal sciatic nerve blocks:

The union of the first three sacral spinal nerves and the fourth and fifth lumbar. It separates into its terminal branches about 6 cm proximal to the popliteal crease into the tibial nerve (TN) and the common peroneal nerve (CPN). Lumbar nerves form the sciatic nerve. It is the largest nerve supplying the leg [4]. The main sciatic nerve lies between the biceps femora's (lateral side) and semimembranosus (medial side) muscles, lateral to the popliteal vessels [5].

Ultrasound guidance technique:

Recommend use Ultrasound machine with linear transducer (8–12 MHz) for adult patients. Sterile ultrasound probe cover and gel for all procedure, 50- to 100-mm, 21- to 22-gauge, short-bevel,

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needle required for in-plane technique, 20 ml syringe containing local anesthetic for block and Injection pressure monitor. . The tibial nerve is position superficial and lateral to the vein and is seeing as a hyperechoic, oval. The CPN is visualizing slightly more superficial and lateral to the tibial nerve. The transducer should be slid proximally until the tibial and peroneal nerves are visualized coming together to form the sciatic nerve before its division is recommended for performing the block at the level where TN and CPN start division but are still in the common sciatic nerve[6, 7, 8]. With the ultrasound, the common peroneal nerve and the tibial nerve can be injected separately, making sure to get the local anesthetic circumferentially around each nerve. A single injection can cover both nerves if they are close enough together [9]

Injection Pressure Monitor:

Monitoring injection pressure can help distinguish needle-tip location in the perineural tissue versus the needle-nerve contact or intrafascicular needle placement. recent study demonstrated that high opening injection pressure (≥15 psi) might be indicative of intraneural needle placement, it is important to monitor injection pressure carefully during local anesthetic injection. It has been suggested that opening injection pressure should be kept (<15 psi) to improve safety Opening pressure is not dependent on needle size, needle type, injection speed, and syringe size [10] . Results of several studies suggest that high-pressure injection into the intraneural space, even with small volumes, can be a major contributor to mechanical injury of neurological tissue during peripheral nerve blocks[11,12]

PATIENTS AND METHODS:

This study is a cross sectional study clinical trial, was conducted at Baghdad teaching hospital, medical city, Baghdad, Iraq, which started in period 1ts September 2017 to 15th August 2018 .The study was approved by the Iraqi/scientific council of anesthesia and intensive care, and the consent was obtained from all patients, Inclusive criteria: includes fifty patients, ASA class III_IV, age (30_80)years, Weight 60_100 Kg, Height 150_ 180 cm, scheduled for elective surgery unilateral below knee amputation .Exclusion criteria: Patient refusal, hypersensitivity or allergic to local anesthesia, Infection in the region of the puncture site ,History of coagulation disorder and Bilateral below knee surgeries.

All the patients prepared properly to the operation room, wide bore IV cannula inserted (18G), connecting to the monitoring (pulse rate (PR), noninvasive BP, SPO2&ECG). And receiving infusion of Ringer lactated or normal saline solution at begin of surgery about 10_15 ml/kg , under aseptic condition. Ultrasound with linear probe, gel with gloves, 20 ml syringe contain local anesthesia,10cm long bevel needle,22-gauge (Stimuplex, BBraun medical) connect to injection pressure monitoring device. The popliteal sciatic nerve block was performed after premedication consisting of midazolam (0.02mg/kg) IV. The premedication was adjusted for individual patients to decrease their anxiety and discomfort from the procedure, while maintaining meaningful patient contact. The patient In a lateral position and ultrasound probe (sonosite) position over popliteal fossa the ultrasound probe should be slid proximally until tibial and common peroneal nerve are visualize coming together to form sciatic nerve before its division, The skin puncture site 1_2 cm lateral to ultrasound probe to improve the visualization of needle. The needle is inserted in plane and advance to sciatic nerve once the needle tip is adjacent to the nerve and use 20ml syringes connect to an in-line injection pressure monitoring (BSmart, concert medical), the injection of local anesthesia was an incremental fashion after careful negative aspiration every 2_3ml and (1_2ml) local anesthesia is injected to conform proper injection site. When the initial injection pressure was recorded according the result , If the pressure >20psi that mean red color , while the pressure between 15_20psi that mean yellow color and the pressure <15psi that mean white color. The needle slightly withdrawn (1mm) from the nerve,and injection was reattempted when pressure <15psi and there is no any paresthesia or numbness during procdure. The injection should distribution of local anesthesia surround the sciatic nerve, the total local anesthesia injection 20 ml about (0.375%) of bupivacaine not excessed 2mg/kg ,the maximum dose more than 2mg/kg, the patient was turned to the supine position for femoral nerve block, under aseptic condition ultrasound probe position place transversely on the inguinal crease followed by slow movement laterally and medially to identify the femoral artery the nerve immediately lateral to artery and underneath to the fascia iliaca, which is typically hyperechoic and visualized at a depth (2_4cm),the skin puncture site 1_2cm lateral to ultrasound probe. The needle is inserted in plain and advanced to femoral nerve ,the passage of the needle through the fascia iliaca and the injection of local

anesthesia was an incremental fashion after carful negative aspiration every 2_3ml and(1_2ml) local anesthesia is injected to conform proper injection site. The total local anesthesia injection 12_15 ml (0.375%) of bupivacaine (not excessed2mg/kg).

Sensory block: was assessed by using the loss pin-prick sensation according the scale (normal sensation 0, decrease pain sensation 1, no pain sensation 2). Sensory test were performed for popliteal sciatic nerve block (pinprick to sole of foot) while femoral never block was define as complete loss of pinprick sensation on the medial aspect of leg.

Motor block: was monitoring for popliteal sciatic nerve block was defined by (dorsiflexion, plantar flexion foot and toes), and for femoral never block was defined as the inability to extend the leg of the operated limb against gravity with the hip passively flexed at 90 degree Readiness for surgery was defined as complete loss of pinpricks sensation with motor assessment. after readiness for surgery was achieved, the patient were continues observed for any unexpected and unwanted events. Stander monitoring was used throughout the procedure, include electrocardiogram (ECG) 5 or 3 leads, Heart rate (HR) Noninvasive Blood pressure (NIBP), Respiratory rate (RR) and puls oximetry (SpO2) ,and the duration of block between 20_30 mim and there is no any complication occure during nerve block

Statistical Analysis The data analyzed using Statistical Package for Social Sciences (SPSS) version 25. The data presented as mean, standard deviation and ranges Categorical data presented by frequencies and percentages.

RESULTS:

3.1. General Characteristics.

The distribution of study patients by general characteristics is showing in figures (3.1, 3.2) and table (3.1). Study patient's age was ranging from (40 to 76) years with a mean of (59.26) years and standard deviation (SD) of (± 8.94) years. The highest proportion of study patients was aged (≥ 60) years (58%) .Regarding gender, proportion of males was higher than females (52% versus 48%) with a male to female ratio of (1.08:1).Concerning side, amputation below knee joint in the left side was (54%) of cases By American Society of Anesthesiologists (ASA) classification system, the highest proportion of study patients was classified as grade IV (56.2%) .Concerning BMI level, thehighest proportion of study patients was normal (60%)

Table 3.1: Distribution of study patients by gender and BMI level.

Variable	No. (n= 50)	Percentage (%)
Gender		
Male	26	52.0
Female	24	48.0
BMI		
Normal	30	60.0
Over weight	17	34.0
Obese	3	6.0

Table 3.2: Distribution of study patients by side , ASA and duration.

Variable	No. (n= 50)	Percentage (%)
Side		
Right	23	46.0
Left	27	54.0
ASA classification		
Grade III	22	44.0
Grade IV	28	56.0
onset of Motor Block	n= 50	
< 20 Min	15	30.0
≥ 20 Min	35	70.0

3.2. Motor Block

Motor block duration lasted for ≥ 20 mints in (70 %) of study patients. The mean duration of achievement complete motor block was (20.21 ± 2.43) mints.

3.3. Sensory block

Table 3.2 shows the distribution of study patients by three point's scale of pinprick sensation to check sensory block before and after nerve block. In this study, we noticed that all patients were normal in both pre nerve block and 5 minutes after nerve block, (74%) of patients were normal and (26%) was decrease pain after 10 minutes from nerve block, at 15 minutes from nerve block, most patients were showing decreased pain (86%).

The highest proportion of study patients after 20 minutes from nerve block were showing decreased pain (70%), then after 25 minutes of nerve block, the highest proportion of patients did not show pain (88%). All patients were completely free from pain after 30 minutes of nerve block (100%).

Table 3.3: Assessment of sensory block before and after nerve block.

Three points scale	No. (n= 50)	Percentage (%)
Pre Nerve Block		
Normal	50	100.0
5 Mints after Nerve Block		
Normal	50	100.0
10 Mints after Nerve Block		
Normal	37	74.0
Decrease Pain	13	26.0
15 Mints after Nerve Block		
Normal	7	14.0
Decrease Pain	42	86.0
20 Mints after Nerve Block		
Normal	1	2.0
Decrease Pain	35	70.0
No Pain	14	28.0
25 Mints after Nerve Block		
Decrease Pain	6	12.0
No Pain	44	88.0
30 Mints after Nerve Block		
No Pain	50	100.0

3.3. Pressure Monitoring Record

The distribution of study patients by pressure monitoring record is show in table (3.3). In this study, the highest proportion of study patients recorded needle nerve contact (44%)

Table 3.4: Distribution of study patients by pressure monitoring record according needle position

	No. (n=50)	Percentage (%)
Pressure Monitoring Record		
Low Pressure	19	38.0
Needle Nerve Contact	22	44.0
Intrafasicular injection	9	18.0

DISCUSSION:

In this study, popliteal sciatic nerve blocks has been applied, and it is performed under ultrasound guided technique with close monitoring of injection pressure while the passage of the needle toward the plane.In our study, needle–nerve contact was associated with high opening injection pressure (>15 psi).

In contrast, extraneural (1-mm distant) needle placements were associated with low opening injection pressure (<15 psi).

Moreover, opening injection pressure and pressure throughout the injection procedure remained below 15 psi during administration of the 20-ml local anesthetic used for the surgical blockade for popliteal sciatic nerve blocks. So we need low pressure <15psi in a target (Perineural injection) site of the block ,The study findings have important clinical implications, most importantly monitoring the opening injection pressure prevented the initiation of injection in all. the injection process when opening injection pressure reached less than 15 psi , commencement of injection was possible only when the needle tip was withdrawn from the nerve root. Therefore, limiting opening injection pressure to 15 psi reliably detected needle–nerve contact and prevented injection when the needle tip was positioned too close to vulnerable neural structures. This is particularly to clinical practice because the ultrasound guidance alone does not appear to be a fail-safe monitor to prevent neurologic injury. Ultrasonography requires technical skill, adequate sono-anatomy, high-quality ultrasonography equipment and ultrasound technology lack the resolution to differentiate epineurium from perineurium. For these reasons, inadvertent placement of the needle tip against the nerve before injection can occur undetected by ultrasound,particularly with multiple injection techniques that are common in clinical practice. Subsequent forceful injection, especially with a beveled needle tip that may be partially lodged in the epineurium may result in nerve inflammation or structural nerve damage. . Results of several studies suggest that high opening injection pressure >15psi the pressure that must be overcome before injection can commence may be indicative of intraneural needle placement, even with small volumes, can be a major contributor to mechanical injury of neurological tissue during peripheral nerve blocks. While high injection pressure >20psi can result in persistent neurological damage indicate of intrafascicula injection.[11]. Several authors have reported that intraneural injections may not always lead to nerve injury and some even injecting intraneurally, safety of intraneural injections is highly controversial[13]

Jeff C. Gadsden et al,[14] .

demonstrates High OIP (≥15 psi) consistently detected NNC, suggesting that injection pressure monitoring its useful in prevent injection against nerve roots during interscalene block.

Orebaugh *et al,*[15] Have reported that injections within the root of the human brachial plexus in fresh cadavers can result injection pressures > 15 psi and intrafascicular injury.

Andrzej Krol et al,(16) Demonstrate significant differences between intraneural and perineural injection pressures in the median, ulnar, and radial nerves. Intraneural injection pressures show low specificity but high sensitivity suggesting that pressure monitoring might be a improving the safety and efficacy of peripheral nerve block .

Steinfeldt et al. [17] Have established that forceful needle–nerve contact alone in porcine models of axillary brachial plexus block results in significant neural inflammation, even without injection Therefore, it is possible that a forceful injection during needle nerve contact in patients could cause nerve inflammation and neurologic symptoms. In addition forceful injection at the point of needle–nerve contact may increased risk for intraneural or partial intrafascicular injection

By comparing with the 4 above listed studies, the conducted study is a first study that use the injection pressure monitoring in popliteal sciatic nerve block, and this study shows that the required low injection pressure <15psi to inject the local anesthetic drug into a target site of popliteal sciatic nerve block, while the other 4 listed studies and through the peripheral nerves block we should avoid the pressure > 15 psi to prevent the intraneural injection.

CONCLUSION:

About High injection pressures >20psi (red color) was 9 patient and 23 patients were > 15psi (yellow color).the injection pressure device provide more safety with ultrasound to avoided needle nerve contact or nerve damage

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