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Surgery

Ultrasound Guided Tibial and Common Peroneal Nerve Block in Donkey

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ABSTRACT

The aim of this study was to evaluate the use of ultrasound as a guiding tool for efficient desensitization of tibial and common peroneal nerves in donkeys. Six clinically normal donkey cadavers' hind limbs and eight clinically normal mature donkeys were included in this study. Two of the cadaver's hind limbs were dissected for anatomical investigation while the remaining four limbs and the live animals were used for the ultrasonographic study. The tibial and common peroneal nerves of cadaveric limbs were injected with 1ml of methylene blue 1% under ultrasound guidance and dissected to evaluate the accuracy of injection. In live animals the nerves were blocked under ultrasonographic guidance using 10 ml of lidocaine 2% (Debocaine 2%) for each nerve. The Onset time, and duration of analgesia and nerve depth from skin surface were calculated. Our results revealed complete staining of the nerves after methylene blue injection with a success rate of 100%. The study on live animals showed complete desensitization of limb distal to the tarsal joint which started 5±0.5 and4.5±1 minutes and lasts for 48±6and 64±6 minutes after tibial and common peroneal nerves block respectively. Statistical analysis showed that the meanskin nerve depth of tibial nerve was 9.777±0.455mm while in common peroneal nerve, it was 3.621±0.631mm. Our study concluded that ultrasound is considered safe, economic, and accurate tools in blocking tibial and common peroneal nerves. Moreover, blocking of these nerves is sufficient for complete distal hind limb desensitization.

Keywords: Donkey, Nerve block, Peroneal, Tibial, and Ultrasound-guided

INTRODUCTION

Although nerve blocks are regularly used in lameness diagnosis in horses, it is occasionally difficult to achieve ideal analgesia of the objective areas when blocking big nerves (Doherty, et al, 2021). Blocking of tibial and common peroneal nerves was usually done using conventional blind technique, however effective analgesia is sometimes difficult to be achieved (Dyson, 1984; Denoix, 1991; Denoix & Trapprest, 1992).

Ultrasound guided injection is considered one of the important tools in veterinary medicine, especially in equine. It is currently used for treating neck, pelvic and back affections (Denoix & Heitzmann, 2005) and joint disease in horses (Denoix, 2006;

Carnicer et al., 2008; Davidet al., 2007) Even though, ultrasound guided injection in nerve blockage is rarely reported in equine medicine (Denoix et al., 2020; van der Laan et al., 2021), there is no reports about ultrasound guided nerve block of tibial and common peroneal nerve in donkeys.

Ultrasound guided nerve block has been reported in different animal species (Shilo et al., 2010; Campoy et al., 2010; Echeverry et al., 2010; Denoix et al., 2020). It provides the operator with a real time image of the nerve and associated blood vessels and follow up of accurate needle direction and distribution of the local anesthetic drug. It is also characterized by rapid onset of blockage for long time using a low volume of local anesthetic drug (Casati et al., 2007; Ali et al., 2019).

The present study was aimed to describe the anatomical features of tibial and common peroneal nervein donkey, evaluation of ultrasound guided tibial and common peroneal nerve block in live donkey.

MATERIAL AND METHODS

Animal model:

The study was carried out according to the regulation of the Institutional Animal Care and Use Committee (IACUC) Protocol number: VUSC-040-1-20 at Faculty of Veterinary Medicine, University of Sadat City, Egypt. It was conducted in three aspects including anatomical, ex-vivo, and in-vivo ultrasonographic studies. The anatomical and the ex-vivo parts of this study were carried out on six fresh hind limbs obtained from mature donkey cadavers of both sexes prepared for anatomy sessions. The in-vivo part of this study was conducted on 8 adult clinically normal donkeysof both sex aging (2-4years), weighting from 200-250 kgs. The animals were housed in a clean dry place at veterinary clinical hospital of Surgery, Anesthesiology and Radiology department, Faculty of Veterinary Medicine University of Sadat city. All donkeys were dewormed and fed on proper diet and water during the whole study.

Study design:

1- Anatomical study

Two hind limbswere dissected. The relationship between the tibial and common peroneal nerves and its surrounding structures were determined and photographed.

2- Ex-vivo ultrasonographic study.

Four cadaveric hind limbs were used in this part. The lateral thigh region extending from the stifle to the hock joints was prepared for ultrasound examination via hair clipping, cleansing the skin with ethyl alcohol, and application of ultrasonographic gel. Esaote my lab one ultrasound unit equipped with multi frequency linear array probe (10-18 MHz) was used to identify the tibial and the common peroneal nerves including its ultrasonographic shape, and its related structures. Each nerve was injected with 1ml of methylene blue 1% under ultrasonographic guidance. In case of tibial nerve injection (Figure 2A), the probe was applied in transverse plane at the middle of the lateral aspect of the thigh just cranial to Achilles tendon.24-gaugeneedlewas inserted at the cranial or the caudal pole of probe and directed to the nearest point of the nerve and 1 cm of methylene blue 1% was injected. In case of common peroneal injection (Figure 2B), the probe was applied in transverse plane at the proximal lateral aspect of the thigh just distal to the lateral collateral ligament of femorotibial joint and caudal to the level of the proximal aspect of lateral digital extensor muscle. A 24-gauge needle was inserted subcutaneously at the cranial or caudal pole of probe and directed to the nearest point of the nerve and1 cm of methylene blue 1% was injected. The nerve was dissected after 30 minutes to ascertain the accuracy of fluid deposition around the nerves (van der Laan et al., 2021).

3- In-vivo ultrasonographic study.

8 donkeys were controlled in a stanchion and a twitch was placed on the upper lip. Animal preparation and nerve blocking was performed as previously described in the ex-vivo part of this study. The tibial nerve and common peroneal were blocked via injection of 10-ml lidocaine (Debocaine 2% Al-Debeiky Pharmaceutical Industries Co., Egypt) around nerve sheath.

Evaluation of analgesia was accomplished via pin-prick test which was applied to the skin at the lateral aspect of the thigh and anterio-lateral aspect of the tarsal and metatarsal regions in case of common peroneal nerve block and to that of the caudal aspect of the hock in case of tibial nerve block and skin. Skin nerve depth, onset time, and duration of analgesia were evaluated. All donkeys were followed up for 3 days after nerve blockage for detection of any complications.

Statistical analysis:

The obtained values were reported as mean, and standard deviations. All values were analyzed using Graph Pad Prism software (version 5.0; San Diego, California).

RESULTS

1-Anatomical findings (Figure 1)

At the caudal aspect of the stifle, the tibial nerve interspersed between the gastrocnemius and soleus muscle and proceeds distally besides the superficial digital flexor tendon and the lateral common saphenous vein within a groove bounded by the gastrocnemius and superficial digital flexor tendon and lateral digital flexor muscle. At the distal third just proximal to the hock, it divides into two plantar nerves to innervate distal limb.

The common peroneal nerve descends from the caudal aspect of stifle. Distal to the stifle the nerve passes cranially along the lateral surface of lateral digital flexor and lateral digital extensor muscle. Then split into two branches (superficial and deep) at the level of lateral digital extensor muscle. The superficial branch propagates superficially just under the skin and fascia along the junction point between lateral digital extensor and long digital extensor muscle. The deep branch passes deeply caudal to tibialis cranialis muscle.

2- Ex-vivo ultrasonographic findings

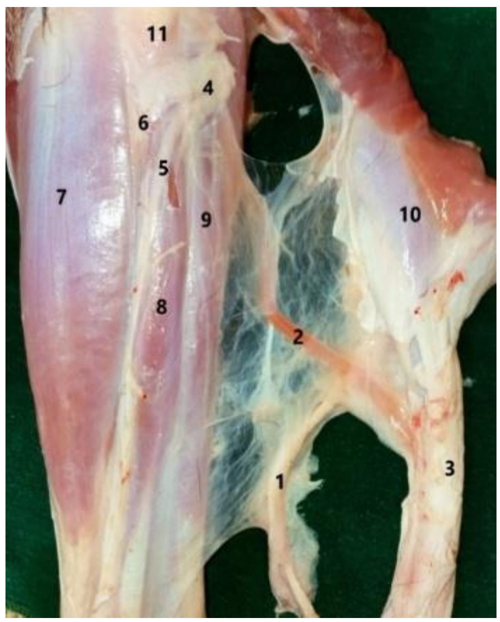
The tibial nerve was best imaged using high frequency linear probe (14-18mhz) and low depth from 1-3cm from both medial and lateral aspect of the thigh 5-8cm proximal to the hock and 5cm distal to stifle. It appeared as hyperechogenic half moon like structure with mottled center cranial to round anecoic lateral common saphenous vein and superfecial digital flexor tendon and caudal to lateral digital flexor muscle (Figure 3A) .

The common proneal nerve was best imaged using high frequency linear probe (14-18mhz) and low depth at 1-2cm from proximal part of thelateral aspect of the thigh just one finger distal to the level of lateral collateral ligament of femorotibial joint. Ultrasonographically, It appeared in transverse scanjust under skin and S/C as two structure , the 1stone appeared as multple parallel hyper and hypoechogenic layers surrounded by hyperechogenic wall and the 2nd structure appear as hypoechogenic honey comb like structure surrounded by hyperechogenic wall ventral to the 1ststructure (Figure 3B).

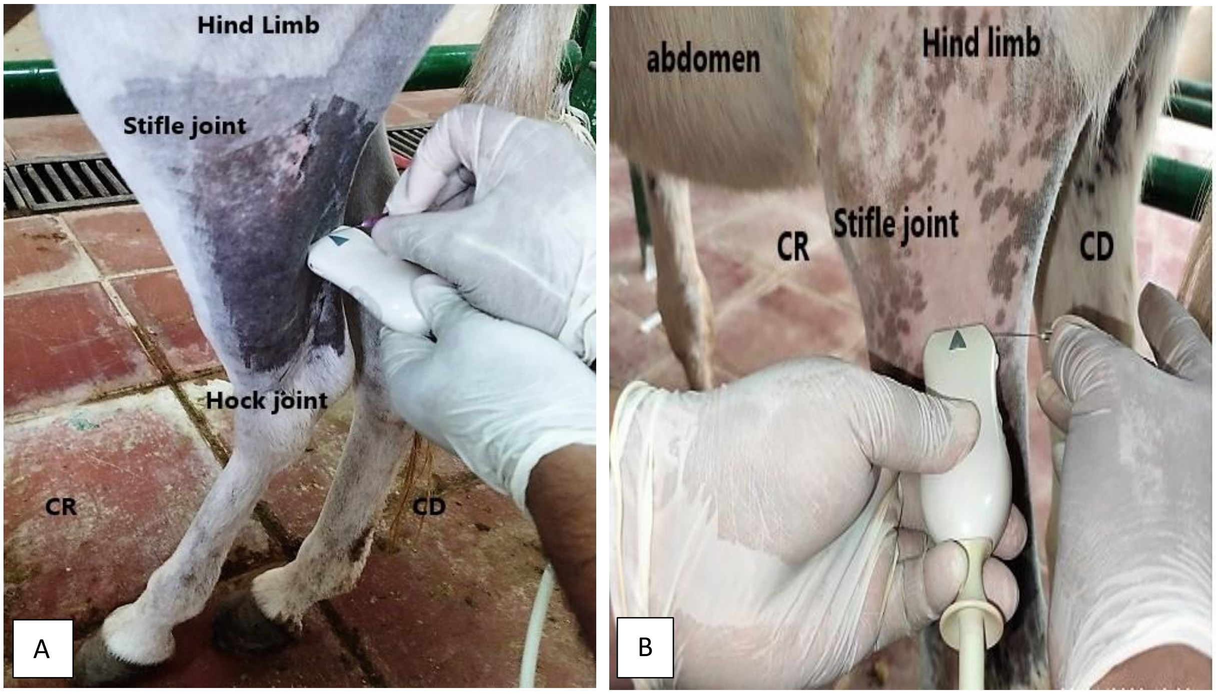
Dissection of each nerve after methylene blue injection showed complete staining of each nerve and its surrounding tissue (Figure 5).

3- In-vivo ultrasonographic findings.

Successful blocking of tibial and common peroneal nerves under ultrasonographic guidance was accomplished in all animals (Figure 4). In case of tibial nerve block, pin prick test to the caudal aspect of the hock showed complete desensitization which manifested with limb dragging. It started after 5±0.5 minutes and lasts for 48±6 minutes, skin nerve depth was recorded with mean±SD (9.777±0.455) mm from lateral side No complications have been reported in any of the examined animals. In case of common peroneal nerve block, pin prick test to the skin of the lateral aspect of the thigh, anterio-lateral aspect of the tarsal and metatarsal regions showed complete desensitization which started after 4.5±1 minutes and lasts for 64±6minutes.In all cases, skin nerve depth was recorded with mean±SD3.621± 0.631 mm.



(**Figure1)**: Showing dissection of the lateral thigh region (**1-** Tibial nerve,**2-**lateral common saphenous vein,**3-** superficial digital flexor tendon and gastrocnemius tendon, 4- common peroneal nerve **5-** superficial peroneal branch **6-** deep peroneal branch,**7-** long digital extensor muscle,**8-** lateral digital extensor muscle,**9-** lateral digital flexor muscle,**10-**Gastrocnemius muscle,**11-** lateral collateral ligament of femorotibial joint).



(**Figure2)**: Showing ultrasound guided injection **(**probe and needle orientation) of **A:** tibial nerve from lateral side **B:** common peroneal nerve. **CR:** cranial, **CD:** caudal

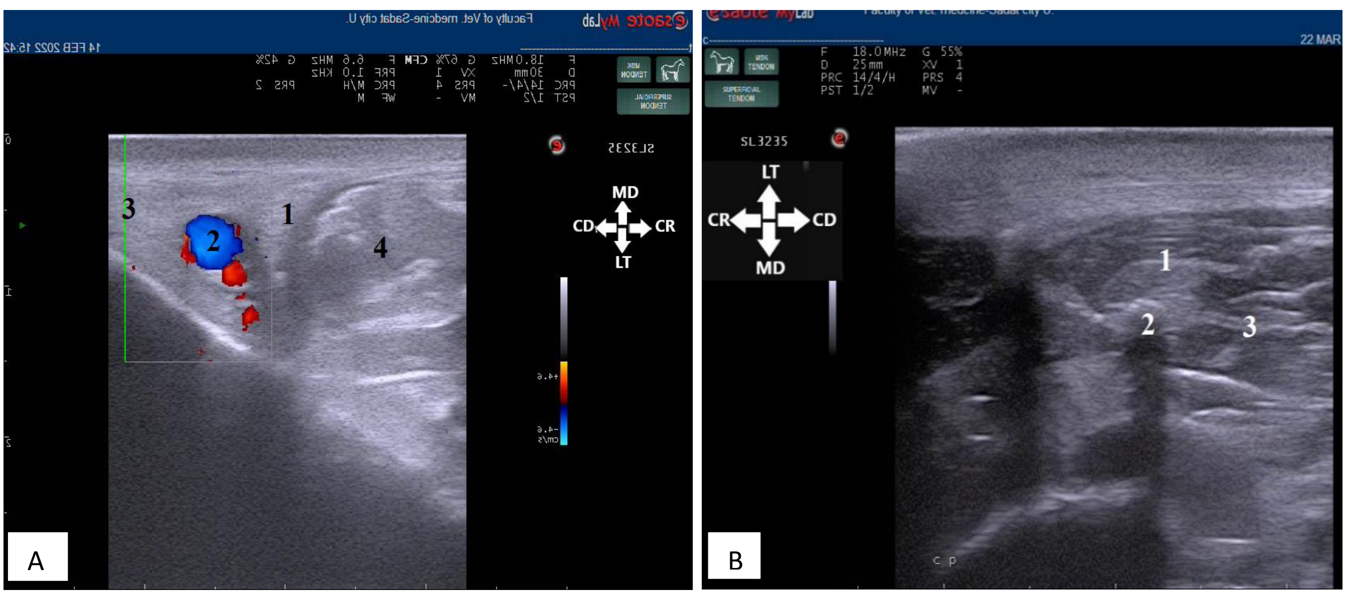


Figure 3: Showing ultrasonographic imaging of **A:** Tibial nerve (**1-**Tibial nerve **2-** Lateral common saphenous vein **3-**Superficial digital flexor tendon and gastrocanemus muscle tendon (Achilles tendon) **4-** Lateral digital flexor muscle. **B:** Common peroneal nerve (**1-**common peroneal nerve, **2-**tibia, **3-** lateral digital extensor muscle).

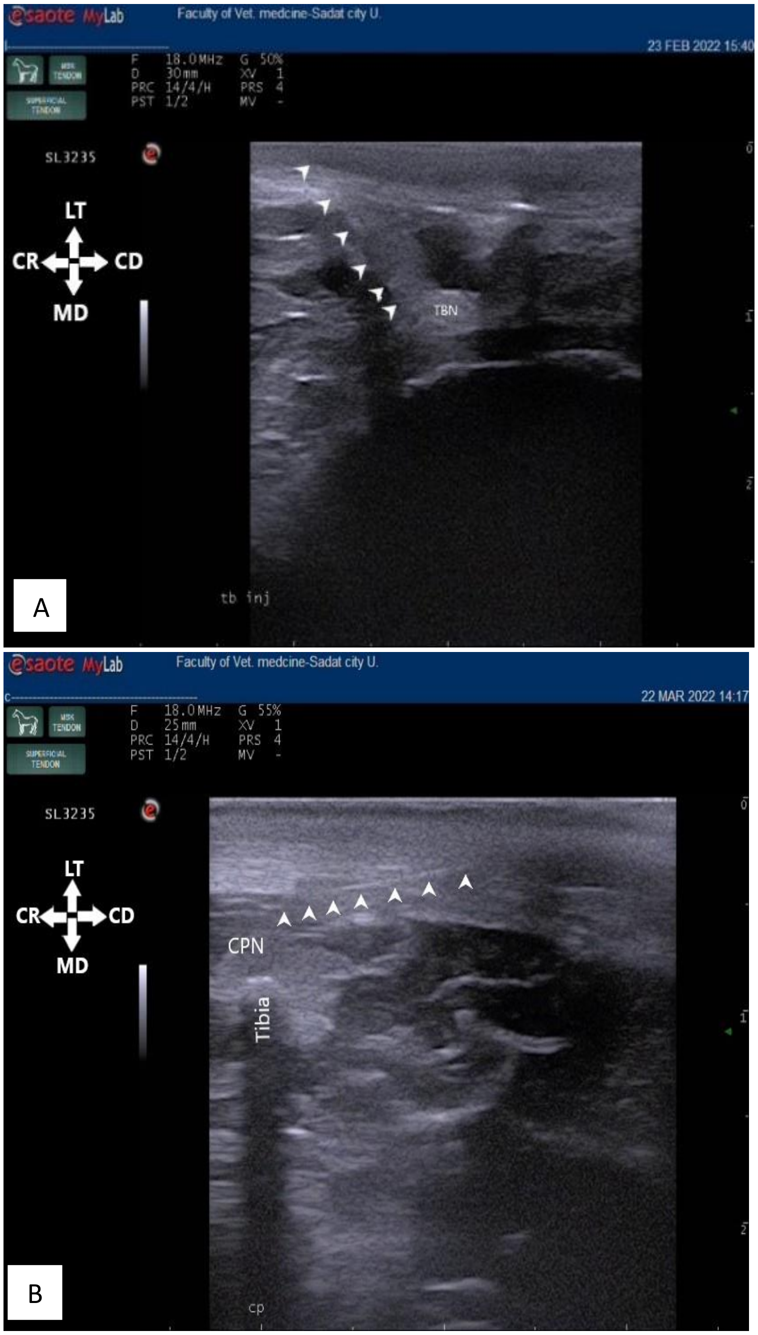


Figure 4: Showing ultrasound guided injection (ultrasound image) of **A-**Tibial nerve (**TBN:** tibial nerve, **Arrow heads,** indicated theneedle pathway toward the nerve). **B:** Common peroneal nerve. **(CPN:** common peroneal nerve, **Arrow heads,** indicated theneedle pathway toward the nerve).

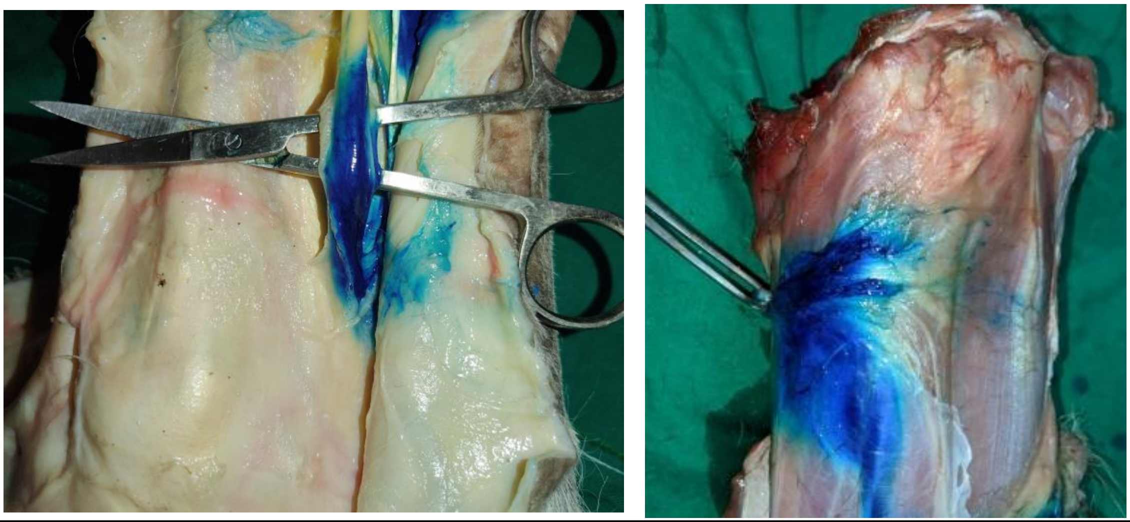


Figure 5: Showing stained nerves after methylene blue injection **A:**Tibial nerve **B-**common peroneal nerve.

DISCUSSION

There are several difficulties reported in blind tibial and common peroneal nerve blocks including in ability to detect nerve precisely, needle malposition and vascular injection that led to blockage failure (Denoix et al., 2020; Colla et al., 2023). So that present study was designed to evaluate the use of ultrasound as a guiding tool for tibial and common peroneal nerve block in cadavers and live donkeys. To our knowledge, this may be the first report that described the ultrasound guided technique for tibial and common peroneal nerve block in donkeys.

In this study the selected ultrasound frequency, probe type and depth provided better details of these superficial nerves. This was found in accordance with (Alexander & Dobson, 2003; Helen et al., 2015) and confirm the recommendation of (Van der Laan et al., 2021). Who used 7.5 MHz linear probe and recommend using high frequency probe for better resolution.

Our anatomical results for tibial and common peroneal nerve anatomy were the same as reported by (Dyson, 1984; Budras et al., 2012; Denoix, 2019; Denoixet al., 2020).

The tibial nerve appeared as hyperechogenic leaf like structure with mottled center contain hyperechogenic round dots dispersed in hypoechogenic background and hyperechogenic wall. Theses results was found in agreement with with previous reports by (Beukers et al., 2016; Denoix et al., 2020). This may be the first report that described the common proneal nerve, which appeared as two adjacent structure , 1st structure appear as multple parallel hyper and hypoechogenic layers surrounded by hyperechogenic wall and the 2nd structure appear as hypoechogenic honey comb like structure surrounded by hyperechogenic wall ventral to the 1st structure.

Our study was the first to measure the depth of tibial and common peroneal nerves from skin surface ultrasonographically. It was 9.777±0.455 mm for the tibial nerveand 3.621± 0.631 mm for the common peroneal nerve depth. These parameters can be used as reference range in future studies and clinical application. Methylene blue 1% stain was used as indicator of successful nerve injection after guidance with ultrasound as mentioned by (Alexander & Dobson, 2003; Hagag & Tawfiek, 2018; Denoix et al., 2020), which was successful by 100% and make staining of the nerves. in our study we used only 1 ml of methylene blue 1% which make nerve staining that indicate that low volume of local anesthetic can produce successful nerve block. This was found in accordance agreed with (Van der Laan et al., 2021).

In live animal study, 10 ml of local anesthetic drug were used for tibial and common peroneal nerves block under ultrasound guidance. This volume was considered sufficient for complete blockage of each nerve with rapid onset of analgesia which started after 5±0.5 minutes and lasts for 48±6 minutes in tibial nerve block and started after 4.5±1 minutes and lasts for 64±6 minutes in common peroneal nerve block, unlike blind technique which used 15-20 ml for tibial nerve block and used two injection with total dose (10-15 cm) for common peroneal nerve block (Dyson, 1984; Skarda et al., 2009; Bassage & Ross, 2011). While in our study we used only one injection for common peroneal nerve block.

In this study we used lateral approach technique for tibial nerve block, comparing to previous reports in which the authors used medial approach (Muir & Hubbell 2008; Denoix et al., 2020; Doherty et al., 2021). In our opinion, although this approach requires deeper needle penetration, its more superior comparing to the medial one in terms of easy approach from free side and kicking avoidance.

Tibial nerve block and common peroneal nerve block was performed and pinprick test to all parts of distal hind limb showed no response with sign of hind toe dragging which indicate complete distal limb desensitization. This agrees with (Denoix et al., 2020) who reported that the obtained results aid in clinical application of tibial and common peroneal nerves block in distal hind limb desensitization. Follow up of live donkeys revealed no complication which is comparable to the conventional blind technique (Denoix & Tapprest, 1992; Robertson, 2004; Gerard, 2007; Nagy et al., 2009; Labelle & Clark-Price, 2013; Davidson, 2018).

CONCLUSION

Our study concluded that ultrasound is an important tool in limb desensitization. It provides real time imaging of drug distribution around suspected nerves, decrease volume of drug, rapid onset, and prolonged time of analgesia. It also helps to avoid side effect of blind technique such as nerve trauma, hemorrhage, and faulty injection. Moreover, tibial, and common peroneal nerve block provide complete desensitization of distal hind limb for standing surgical procedure.

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