Alexandria Journal of Veterinary Sciences
www.alexjvs.com

AJVS. Vol. 73 (2): 65-74 Apr 2022
DOI: 10.5455/ajvs.46198

Development of Ultrasound-Guided Technique for 4 Points Blockade of Manus in Dromedary Camel: A Cadaveric Investigation

Atef S.A. Abd-Algalil[1], Anwar A. El Shafey[2], Ahmed Sayed-Ahmed[3], Mona A. Nasr[4], Ahmed H. Khalil[5*]

[1] Departments of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Menoufia University, Menoufia, Egypt.
[2] Departments of Anatomy and Embryology, Faculty of Veterinary Medicine, Benha University, Benha, Egypt.
[3] Departments of Anatomy and Embryology, Faculty of Veterinary Medicine, Menoufia University, Menoufia, Egypt.
[4] Departments of Anatomy and Embryology, Faculty of Veterinary Medicine, Sadat City University, Sadat City, Egypt.
[5] Departments of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Benha University, Benha, Egypt.

Key words:
Camelus dromedarius, dromedary, manus, nerve block, ultrasound-guided.

***Correspondence to:**
Ahmedlotfy301@gmail.com

Article History
Received: 10 Feb 2022
Accepted: 10 Apr 2022

ABSTRACT

The purposes of this study were to describe the most applicable approach of manus blockade in camel using ultrasound-guided techniques. The study was performed on 40 forelimbs of 20 apparently healthy mature freshly slaughtered camels. Limbs were randomly allocated into 3 phases of the study. Phase-I (n=8 limbs): dissection of both dorsal and palmar aspects to identify the topographical anatomy of the target nerves. Phase-II (n=8 limbs): dissection after US guided needle insertion to confirm the needle insertion position. Phase-III (n=24 limbs): US-guided methylene blue injection using one of three volumes (3, 5, or 7 mL) to establish the ideal injection volume. Our results revealed that the dorsal aspect of manus received its innervation from dorsal common digital nerves II and III (DCDN-II & III) and dorsal common digital nerve IV (DCDN-IV). The palmar aspect of manus was received its innervation from the palmar common digital nerve IV (PCDN-IV) and the median nerve. Under Ultrasonographic guidance, the most applicable approach for blocking the DCDN-II & III is at the dorsomedial aspect at about 8-10 c.m below the carpometacarpal joint (CMJ) and 2 cm medial to CDET. Blocking of the DCDN-IV is performed at the dorsolateral aspect at about 8-10 c.m below the CMJ and 2 cm lateral to CDET. Blocking the PCDN IV was performed at the lateral and palmar aspect at about 10-12 c.m below the accessory carpal bone (ACB) and 5 cm palmar to the imaginary line bisect the forelimb longitudinally from lateral to medial. Blocking the median nerve was performed at the proximal third of medial and palmar aspect of metacarpal bone at about 10-12 c.m below the ACB and about 5 cm palmar to the same imaginary line. In conclusion, four-point blockade of the manus region in dromedary cadavers can be achieved by US-guided injection of the DCDN-II, III, DCDN-IV, PCDN-IV, and the median nerve.

1. INTRODUCTION

Camel possesses unique qualities which make it superior to other domesticated animals in the hot and arid desert ecosystems including food production, draught, riding, transportation, sports and competition (Schwartz and Dioli 1992, Wernery and Kaaden, 2004, Gerlach, 2008 and Al Haj and Al Kanhal, 2010). The foot affections representing 46.9 % of the surgical affections causing lameness in camels (Mostafa, 1979 and Zabady, 1999). Camel foot affections including traumatic pododermatitis (Ibrahim, 1976), neoplasms (Tagelddin and Omar, 1986), heel ulcer and separation of the cornified digital pad (Mostafa, 1979), sore feet, abscess, sole ulcer and elephant foot (Ramadan et al, 1994), burns (Gahlot et al, 1988), septic diffuse pododermatitis (Soliman et al, 1988), gangrene (Soliman et al, 1993), calcinosis circumscripta, edema of the foot, exuberan granulation and herniation of digital cushions (Singh and Gahlot, 1997), idiopathic skin lesion (Shwartz and Dioli, 1992), and grain founder (Sharma and Sharma, 2006). For manus

desensitization to a accomplish diagnosis and treatment of such affections, general anesthesia still the technique of choice for restraining and desensitization. In camels, general anesthesia represents a great challenge for surgeon due to risk of tympani and respiratory compromise rather than its costs and special equipment required in comparison with regional anesthesia (Hall et al., 2000). Conventional blind nerve block has been considered the gold standard technique for nerve infiltration in regional anesthesia practice (Huichu and Walz, 2014). It represents a challenge for veterinary anesthetist which often requires multiple trial-and-error needle attempts, resulting in procedure time, procedure-related pain, poor in efficiency and complications including hemorrhage, nerve injuries and miss injection (Marhofer and Chan 2007; Rioja et al., 2012). Accurate and efficient identification of nerves is critically important in interventional pain management procedures such as nerve blocks (Osuobeni and Hamidzada, 1999; Helen et al., 2015; El-Shafaey et al., 2017 and Badawy and Eshra 2018). Several methods have been implemented in clinical practice to facilitate nerve identification, among various imaging guidance modalities, ultrasound (US) was widely used for facilitating nerve blocks (Campoy et al., 2010; Echeverry et al., 2012). Despite the dromedary camel's popularity, information regarding various imaging-guided nerve block techniques in this species is little and limited only to the head (El-Shafaey et al., 2017 and Badawy and Eshra 2018). To the best of the authors' knowledge, US-guided nerve block of camel limb has not been described before, and therefore, this study may provide the first description in this species. The purposes of this study were to describe the topographical anatomy of the major nerves of the manus region with filed applicable significant and to describe the most applicable approach of manus blockade in camel using ultrasound-guided techniques.

2. MATERIAL AND METHODS

2.1. Ethics Statement

This study was conducted and approved by the Ethical Committee for Institutional Animal Use and Care of the College of Veterinary Medicine, Menoufia University, Egypt.

2.2. Animals and Study design.

The study included 40 forelimbs of 20 apparently healthy mature male camels (Camelus dromedarius) (4-6 years old). The limbs obtained immediately after slaughter and were studied as rapid as possible. Congenital or acquired abnormalities of the limbs were considered exclusion criteria. All limbs were randomly allocated into 3 phases of the study:

2.2.1. Phase I (n=8 limbs): 8 limbs (4 for dorsal aspect & 4 for palmar aspect) were carefully dissected to identify the topographical anatomy of the target nerves, its course, approach, depth, divisions, and the site of needle placement.

2.2.2. Phase II (n=8 limbs): 8 limbs (4 for dorsal aspect & 4 for palmar aspect) were dissected just after the needle insertion using US guided technique to confirm the needle implantation position and to determine the ultrasonographic guide marks.

2.2.3. Phase III (n=24 limbs): 24 limbs (12 for dorsal aspect & 12 for palmar aspect) subjected to US-guided methylene blue 1.4% injection using one of three volumes of MB (3, 5, or 7 mL). Evaluation achieved by using 4 limbs per one tested volume to establish the ideal injection volume as modified according to Badawy and Eshra (2018). Following that, each limb was dissected carefully until the target nerve was recognized, and the stain distribution was assessed. The injection was regarded successful if the MB solution stained all the target nerves strongly and failed if there was weak or no staining. The US-guided injection technique was carried out using an ultrasonographic machine (Chison ECO3-Expert, Medical-EXPO, China) equipped with a multi-frequency 7-10 MHz linear probe. All examinations and injection trials were carried out by the same operator who had a significant clinical experience in US examinations.

3. RESULTS

3.1. Dorsal aspect innervation of the manus region dromedary camel:

Anatomical dissection of the dorsal surface of camel manus is described in **Figure (1-A).**

3.1.1. The termination of the superficial branch of radial nerve

On manus region the termination of superficial branch of radial nerve forms the dorsal common digital nerves II and III (DCDN-II & III). Both nerves descend distally closely related to each other especially at dorsomedial aspect of the proximal third of the metacarpal bone. The DCDN-II descends distally along the dorsomedial aspect of metacarpus and fetlock joint and along the abaxial surface of third digit where it named dorsal proper abaxial nerve of digit III. The latter nerve terminates in the abaxial surface of 3rd digit and the dorsomedial aspect of the foot bad. On other hand dorsal DCDN-III at the middle of the metacarpus inclines more dorsally and laterally and just proximal to the fetlock joint it divided into two branches each of them descends on the axial surface

of the 3rd and 4th digits forming the dorsal proper axial nerves III and IV for 3rd and 4th digits respectively. The latter nerves innervate the dorsal axial surface of 3rd and 4th digits and the dorsal axial (center) part of the foot bad (Fig. 1-A).

The most applicable approach of needle insertion for blocking the dorsal common digital nerves II and III is performed at the dorsomedial aspect of the proximal third of metacarpal bone where both nerves are descending closely related so we can use one approach for blocking of both nerves (Fig. 1-B). The Ultrasonographic guide marks were the carpometacarpal joint and the subcutaneously located common digital extensor tendon. Under Ultrasonographic guidance of sagittally placed probe directed from medial to lateral, the needle is inserted at about 8-10 c.m below the carpometacarpal joint and at about 2 cm medial to the common extensor tendon. The optimum site of needle placement achieved after directing the needle into dorso-palmar direction and subcutaneously with a depth of 0.5-1 cm (Fig 2-A, B &C).

3.1.2. The dorsal branch of the ulnar nerve:

At the distal third of the forearm the ulnar nerve divided into a dorsal and palmar branch. The dorsal branch descends between the tendon of flexor carpi ulnaris and tendon of extensor carpi ulnaris and cross the lateral surface of the accessory carpal bone and directed dorsally (cranially) then continuous distally on the dorsolateral aspect of the metacarpal bone as dorsal common digital nerve IV (DCDN-IV) that extend distally about 1-2 cm lateral to the common extensor tendon. At the fetlock the latter nerve descends on the dorsal abaxial surface of the fourth digit as dorsal proper abaxial nerve IV where it supplies the dorsal abaxial (outer) surface of the 4th digit and the most dorsolateral part of the foot bad. So, the dorsal branch of ulnar nerve and its continuations innervate the dorsolateral aspect of carpus, metacarpus, fetlock, dorsal abaxial (outer) surface of 4th digit and the dorsolateral part of the foot bad (Fig. 1-A).

The most applicable approach of needle insertion for blocking the DCDN-IV (dorsal branch of ulnar nerve) is performed at the dorsolateral aspect of the proximal third of metacarpal bone (Fig. 1-B). The Ultrasonographic guide marks are the carpo-metacarpal joint and the subcutaneously located common extensor tendon and dorsolateral surface of metacarpal bone. Under Ultrasonographic guidance of sagittally placed probe directed from lateral to medial the needle is inserted at about 8-10 c.m below the carpometacarpal joint and at about 2 cm lateral to the common extensor tendon. The optimum site of needle placement achieved after directing the needle into dorso-palmar direction and subcutaneously with a depth of 0.5-1 cm (Fig 3-A, B &C).

3.2. Palmar aspect Innervation of the manus region of dromedary camel:

Anatomical dissection of the dorsal surface of camel manus is described in Figure (4-A).

3.2.1. Palmar branch of ulnar nerve:

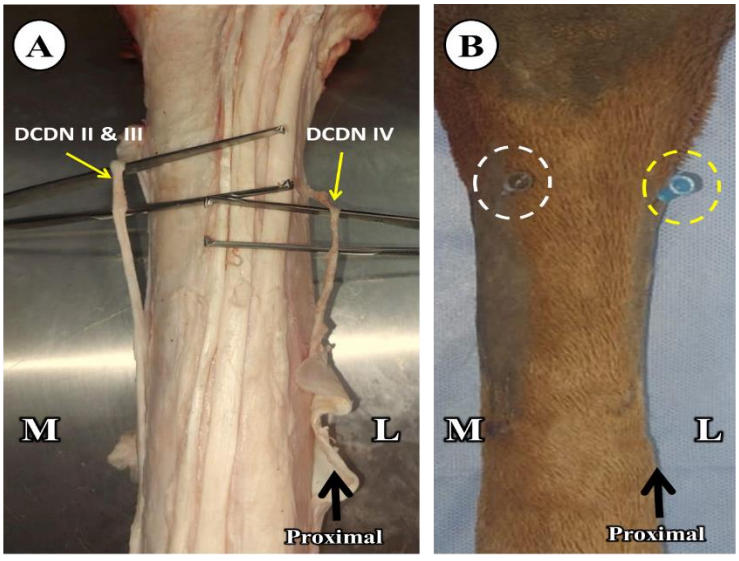

Fig. 1: Panel A; anatomical dissection of the dorsal aspect of camel manus showing the dorsal common digital nerves II and III (DCDN II & III) and the dorsal common digital nerves IV (DCDN IV) which appeared after dissection of the skin just subcutaneously on the dorso-medial and dorso-lateral sides, respectively. Panel B; points of needle placement for desensitization of DCDN II & III (white circle) and DCDN IV (yellow circle). M: medial, L: lateral.

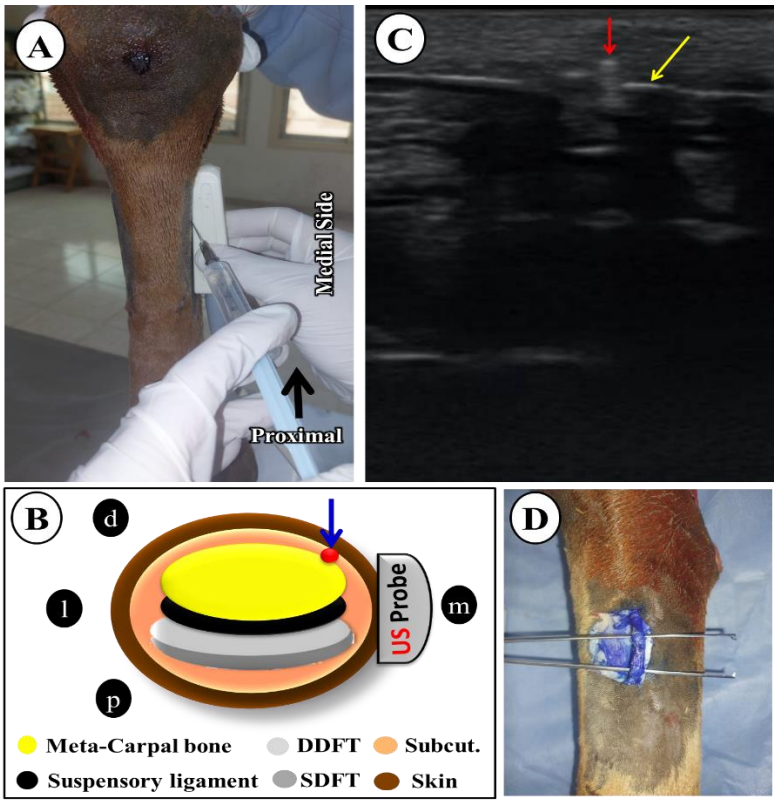

Fig. 2: Panel A; Ultrasonographic guided needle replacement for desensitization of DCDN II & III at 10 cm below the dorsal medial aspect of the carpometacarpal joint. Panel B; diagrammatic illustration of needle direction (l: lateral, m: medial, d: dorsal, p: palmar, red point: the nerve, blue arrow: the needle direction). Panel C; the corresponding sagittal ultrasonographic plane at the site of injection of the DCDN II & III (the nerve: yellow arrow, the needle: red arrow). Panel D; MB stained DCDN II & III at 10 cm below the dorsal medial aspect of the carpometacarpal joint. The nerve was stained with 3mL of 1.4% MB using the Ultrasonographic guided needle replacement.

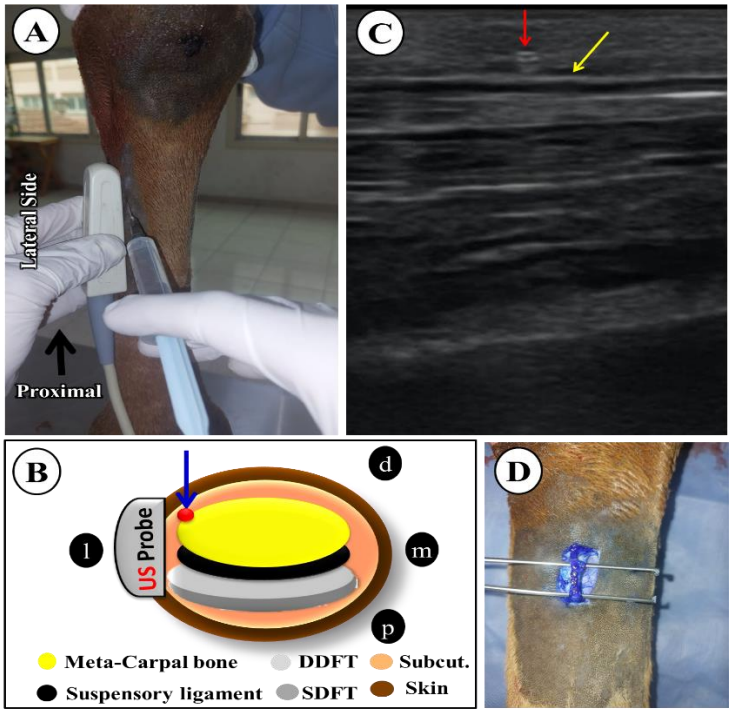

Fig. 3: Panel A; Ultrasonographic guided needle replacement for desensitization of DCDN IV at 10 cm below the dorsal lateral aspect of the carpometacarpal joint. Panel B; diagrammatic illustration of needle direction (l: lateral, m: medial, d: dorsal, p: palmar, red point: the nerve, blue arrow: the needle direction). Panel C; the corresponding sagittal ultrasonographic plane at the site of injection of the DCDN IV (the nerve: yellow arrow, the needle: red arrow). Panel D; MB stained DCDN IV at 10 cm below the dorsal lateral

aspect of the carpometacarpal joint. The nerve was stained with 3 mL of 1.4% MB using the Ultrasonographic guided needle replacement.

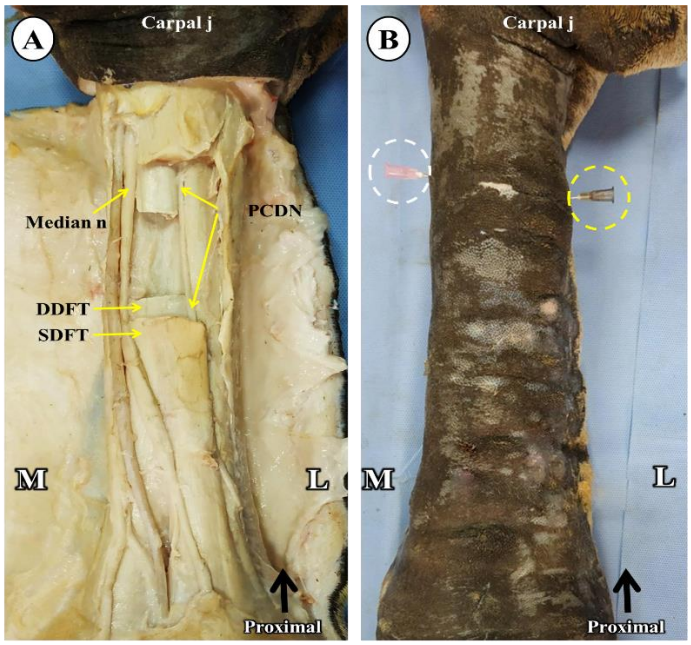

Fig. 4: Panel A; anatomical dissection of the palmar aspect of camel manus showing the palmar common digital nerve IV (PCDN IV) (in the groove between the lateral margins of DDFT and SDFT) and the median nerve (on the medial border of SDFT). Panel B; points of needle placement for desensitization of the PCDN IV nerve (yellow circle) and median nerve (white circle). M: medial and L: lateral.

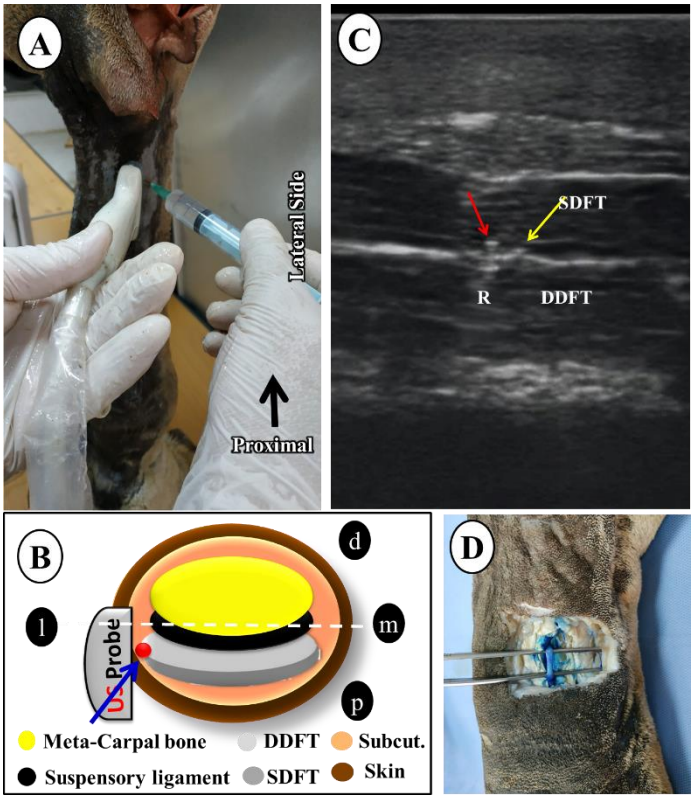

Fig. 5: Panel A; Ultrasonographic guided needle replacement for desensitization of palmar common digital nerve IV of ulnar nerve at 10 cm below the palmar lateral aspect of the carpal joint. Panel B; diagrammatic illustration of needle direction (l: lateral, m: medial, d: dorsal, p: palmar, red point: the nerve, blue arrow: the needle direction, white pointed line: imaginary line bisect the forelimb longitudinally from lateral to medial). Panel C; the corresponding sagittal ultrasonographic plane at the site of injection of the palmar common digital nerve IV of ulnar nerve (the nerve: yellow arrow, the needle: red arrow, R: reverberation artifact of the needle). Panel D; Appearance of the target nerve (palmar common digital nerve IV of ulnar nerve) at 10 cm below the palmar lateral aspect of the carpal joint. The nerve was stained with 5 mL of 1.4% methylene blue using the Ultrasonographic guided needle replacement.

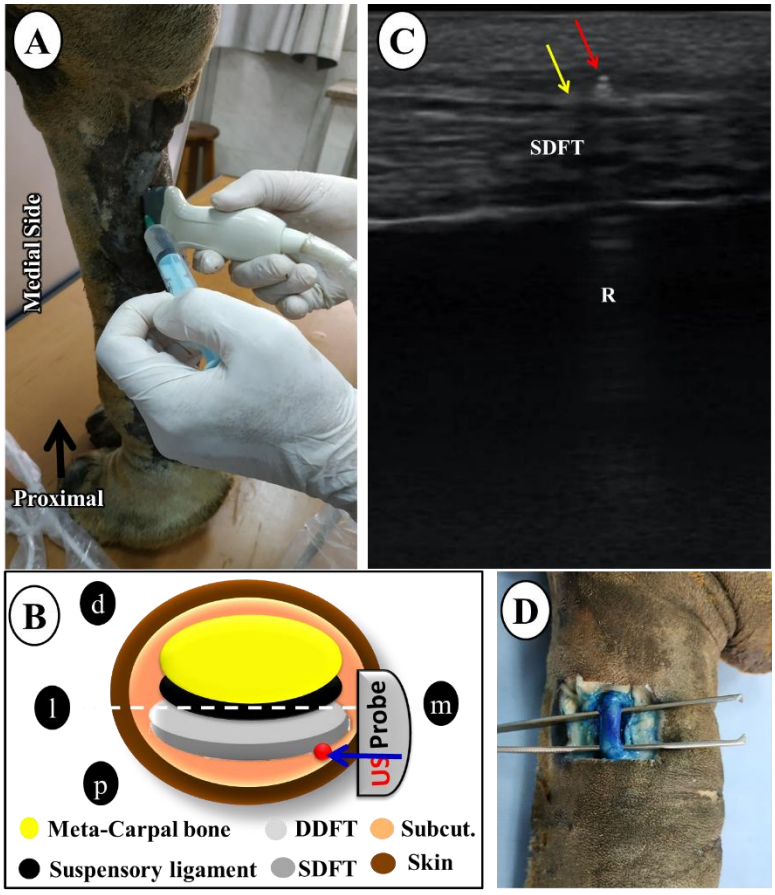

Fig. 6: Panel A; Ultrasonographic guided needle replacement for desensitization of the median nerve at 10 cm below the palmar medial aspect of the carpal joint. Panel B; diagrammatic illustration of needle direction (l: lateral, m: medial, d: dorsal, p: palmar, red point: the nerve, blue arrow: the needle direction, white pointed line: imaginary line bisects the forelimb longitudinally from medial to lateral). Panel C; the corresponding sagittal ultrasonographic plane at the site of injection of the median nerve (the nerve: yellow arrow, the needle: red arrow, R: reverberation artifact of the needle). Panel D; Appearance of the target nerve (median nerve) at 10 cm below the palmar medial aspect of the carpal joint. The nerve was stained with 5 mL of 1.4% methylene blue using the Ultrasonographic guided needle replacement.

The palmar branch of the ulnar nerve is considered the direct continuation of ulnar nerve where it descends on the palmar surface of carpus and medial to accessory carpal bone. It descends within narrow groove that located between the superficial digital flexor tendon and deep digital flexor tendon where it detaches several branches to suspensory ligament and continued as palmar common digital nerve IV (PCDN-IV). Just proximal to fetlock the latter nerve received communicating branch from palmar common digital nerve III of median nerve then it descends on the palmar abaxial surface of the fourth digit as palmar proper abaxial nerve IV where it supplies the palmar abaxial surface of the 4th digit and the most palmar lateral part of the foot bad (Fig. 4-A).

The most applicable approach of needle insertion for blocking the palmar common digital nerve IV was performed at the proximal third of lateral and palmar aspect metacarpal bone **(**Fig. 4-B). The Ultrasonographic guide mark is the groove that located between lateral border of both superficial digital flexor tendon and deep digital flexor tendon. Under Ultrasonographic guidance of sagittally placed probe directed from lateral to medial, the needle is inserted at about 10-12 c.m below the accessory carpal bone and about 5 cm palmar to the imaginary line bisect the forelimb longitudinally from lateral to medial. The optimum site of needle placement achieved after directing the needle into oblique direction from palmar lateral toward dorsal medial direction by an angle about 30° with the imaginary line bisect the forelimb longitudinally from lateral to medial with subcutaneous travelling for a depth of about 1-1.5 to locate the needle in the groove between the lateral borders of both superficial digital flexor tendon and deep digital flexor tendon (Fig 5-A, B & C).

3.2.2. Median nerve:

The median nerve descends on the palmar surface of carpus within the carpal canal where it extends on the medial border of the superficial digital flexor tendon. At the middle of the metacarpus the median

nerve is divided into medial branch (palmar common digital nerve II) and lateral branch (palmar common digital nerve III). The palmar common digital nerve II (medial branch of median) extend distally is dived into two palmar proper abaxial nerve III that extend along palmar abaxial surface of 3rd digits and palmar proper axial nerve III that extend along the palmar axial surface of the 3rd digits. While the palmar common digital nerve III (lateral branch of median) is extended along the palmar axial surface of the 4th digit forming the palmar proper axial nerve IV (Fig. 4-A).

The most applicable approach of needle insertion for blocking the median nerve was performed at the proximal third of medial and palmar aspect metacarpal bone before its detaching the communicating branch to the palmar common digital nerve IV and proximal to its terminal division into palmar common digital nerve II and palmar common digital nerve III (Fig. 4-B). The Ultrasonographic guide mark is the medial border of superficial digital flexor tendon. Under Ultrasonographic guidance of sagittally placed probe directed from medial to lateral, the needle is inserted at about 10-12 c.m below the ACB and about 5 cm palmar to the imaginary line bisect the forelimb longitudinally from medial to lateral. The optimum site of needle placement achieved after directing the needle from medial toward lateral direction and traveling subcutaneously for a depth of about 0.5-1 cm to reach the medial border of superficial digital flexor tendon (Fig 6-A, B & C).

The anatomical dissection process that proceeded the needle insertion using US guided technique (phase II of the study) confirmed accomplishment of needle implantation position in all limbs for all nerves.

Injections of a 3 mL MB under US guidance (phase III of the study) for both 2 nerves on the dorsal aspect (the DCDN-II & III and the DCDN-IV) give satisfy strong staining without spreading of excessive stain (four of four limbs for each nerve) (Fig. 2-D & 3-D). While injection of 5- and 7-ml stain revealed strong staining of both nerves but with excessive stain spreading in all cases (four of four limbs for each nerve and in each volume). Injections of a 3 mL MB under US guidance for both 2 nerves on the palmar aspect (the PCDN-IV and the median nerve) give weak inadequate staining (two of four limbs for each nerve). Injection of 5 ml MB give satisfies strong staining without spreading of excessive stain (four of four limbs for each nerve) (Fig. 5-D & 6-D). While injection of 7 ml stain revealed strong staining of both nerves but with excessive stain spreading in all cases (four of four limbs for each nerve). As a result, a volume of 3 ml and 5 mL of MB 1.4% was deemed sufficient for the dorsal and the palmar aspects, respectively.

4. DISCUSSION

The main aim of this study is to describe the most applicable approach for the nerve blocking of the manus region of one humped camel distal to the carpus. Plane I of the present studies demonstrated the innervation of the manus region distal to carpal joint. The distal continuation of superficial branch of radial nerve (DCDN-II & III) and the dorsal branch of ulnar nerve (DCDN-IV) are responsible for the innervation of the dorsal, dorsomedial, and dorsolateral aspect of the metacarpus and digits and foot pad. The palmar branch of ulnar nerve the (PCDN-IV) and the median nerve are responsible for innervation of the palmar and palmar lateral and palmar medial aspects of metacarpus, digits, and foot pad.

In the same accordance, Allouch (2018) mentioned that several branches of the radial nerve innervate the dorsal surface of the metacarpus and the abaxial aspect of the third digit. While the ulnar nerve innervates the skin of the palmar surface of the metacarpus and the dorso-abaxial and palmar abaxial surfaces of the fourth digit and median nerve give abundant cutaneous twigs to the skin of the medial aspect of the metacarpus and the palmar abaxial and palmar axial of the third digit.

Concerning the dorsomedial aspect of camel manus; anatomical dissection performed during phase I of the study observed that the distal continuation of superficial branch of radial nerve as DCDN II and III innervate the dorsal and dorsomedial aspects of metacarpus and digits also the abaxial surface of the third digit and the dorsal axial surfaces of digits. In the same accordance, anatomical dissection described by (El-Shaieb 1976) and Smuts and Bezuidenhout (1987) in camel showed that both DCDN II and III were originated from the cranial branch of the superficial branch of radial nerve proximal to the carpus and descend distally along the dorsal surface of carpus and metacarpus where the DCDN II descend distally along the dorsomedial aspect of metacarpus and fetlock joint and along the abaxial surface of third digit where it named dorsal proper abaxial nerve of digit III. While DCDN III just proximal to the fetlock joint is divided into two branches each of them descends on the axial surface of the 3rd and 4th digits forming the dorsal proper axial nerves III and IV for 3rd and 4th digits.

On other hand El-Bakary (1989) in camel, (Dellman and McClure 1975, Budras and Habel 2003, Konig

and Liebich 2004 and Mansour et al., 2018) in ruminant mentioned that the terminal branch of the superficial branch of radial nerve extend distally till the middle of the metacarpus where it divided into DCDN II and III. The DCDN II descends as the dorsal proper abaxial nerve of digit III for 3rd digit and the DCDN III descended and divided forming the dorsal proper axial nerves III and IV for 3rd and 4th digits. In horse, the skin innervation of the dorsomedial aspect of carpus and metacarpus is received from the medial cutaneous antebrachial nerve of musculocutaneous nerve (Budras et al., 2009 and Dyce et al 2010).

The current study assessed that; for reaching of the DCDN II and III one injection was satisfy at the dorsomedial aspect of the proximal third of the metacarpal bone. Assessment of those approach depended on the results of anatomical dissection performed during phase I which observed that both nerves DCDN II and III descend distally closely related to each other especially at dorsomedial aspect of the proximal third of the metacarpal bone.

The dorsolateral aspect of manus of camel distal to carpus is innervated by dorsal branch of ulnar where it continuous distally on the dorsolateral aspect of the metacarpal bone as DCDN IV that descends on the dorsal abaxial surface of the fourth digit as dorsal proper abaxial nerve IV. This result is in agreement with El-Shaieb (1976), Smuts and Bezuidenhout (1987) and El-Bakary (1989) in camel and with Dellman and McClure (1975), Budras and Habel (2003), Konig and Liebich (2004) and Mansour et al. (2018) in ruminant. In horse, the dorsolateral aspect of carpus is received its cutaneous innervation from the dorsal branch of the ulnar nerve, while the medial surface of the digit is innervated by the medial digital nerve of median nerve and the lateral surface receives a mixed innervation of median and ulnar nerves through the lateral digital nerve that contains fibers from both median and ulnar nerves (Budras et al., 2009 and Dyce et al 2010).

In present studies the palmar branch of the ulnar nerve is considered the direct continuation of ulnar nerve and continued distally as PCDN IV. Just proximal to fetlock the latter nerve received communicating branch from palmar common digital nerve III of median nerve then it descends on the palmar abaxial surface of the fourth digit as palmar proper abaxial nerve IV where it supplies the palmar abaxial surface of the 4th digit and the most palmar lateral part of the foot bad, so the lateral palmar aspect of the 4th digits has a mixed innervation from ulnar and median nerve. This result is in agreement with El-Shaieb (1976), Smuts and Bezuidenhout (1987) and El-Bakary (1989) in camel and with Dellman and McClure (1975), Budras and Habel (2003), Konig and Liebich (2004) and Mansour et al. (2018) in ruminant. Although the horse has one digit it has also a mixed innervation from both ulnar and median nerves through the lateral digital nerve that contains fibers from both median and ulnar nerves (Budras et al., 2009 and Dyce et al 2010).

The median nerve descends on the palmar surface of carpus within the carpal canal where it extends along the medial border of the superficial digital flexor. At the middle of the metacarpus the median nerve it divided into medial branch (palmar common digital nerve II) and lateral branch (palmar common digital nerve III), the latter branch give a communicating branch to palmar common digital nerve IV of ulnar nerve. This result is in agreement with El-Shaieb (1976), Smuts and Bezuidenhout (1987) and El-Bakary (1989) in camel, and with Dellman and McClure (1975), Budras and Habel (2003), Konig and Liebich (2004) and Mansour et al., (2018) in ruminant. While in equine the median nerve is divided into medial and lateral palmar nerves proximal to the carpus and the later branch join with palmar branch of ulnar nerve Dellman and McClure (1975) Budras et al., (2009) and Dyce et al., (2010).

Several complications may be associated with peripheral nerve blocks such as peripheral nerve injury, intraneural injections, block failure, accidental vascular puncture with haematoma formation, local anesthetic systemic toxicity (Jeng et al., 2010). Ultrasound is becoming increasingly common among anesthesiologists conducting regional blocks (Amini, et al., 2016 and Yoshida, et al., 2017). In the review published by Marhofer et al. (2005), ultrasound guidance has been suggested to provide various potential benefits, including direct observation of nerves, assessment of LA distribution around nerves, direct imaging of anatomical structures, real-time control of needle advancement. Direct imaging of nerves and LA spread around nerves improve block effectiveness, reduce latency, extend duration, reduce LA dose, and reduce the risk of overdose. Direct visualization of anatomical structures (muscles, bones, blood vessels and tendons) and real-time control of needle advancement reduce the number of needle passes, reduce block performance time, and reduce the risk of needle-related complications such as vascular puncture or neuropraxia.

The use of US guided injections of 3 mL MB 1.4% to stain the dorsal aspect nerves (the DCDN-II & III and the DCDN-IV) and 5 mL MB 1.4% to stain the palmar aspect nerves (the PCDN-IV and the median

nerve) of dromedary cadaver manus proven to be a feasible and dependable practice in current study.

The study's limitations include the use of just cadaver samples. Moreover, additional studies are needed to determine the practicality of this method in live and aware animals with and without limb affections, and the onset and duration of the nerve block, as well as any potential postanaesthetic consequences.

In conclusion, this investigation shows that complete nerve blocking (four high nerve blocking) of the manus region in dromedary cadavers can be achieved by US-guided injection of the DCDN-II, III, DCDN-IV, PCDN-IV, and the median nerve. However, more studies on living dromedaries is required to determine the clinical practicality of this approach.

Author's Contribution

Conceptualization by Khalil AH and Abd Al-Galil AS. Data curation by Khalil AH, Ahmed S-A and Abd Al-Galil AS. Formal analysis by Khalil AH, Nasr MA, and El Shafey AA. Methodology by Khalil AH, Abd Al-Galil AS, and Ahmed S-A. Writing – original draft by Khalil AH, Nasr MA Ahmed S-A. Writing - review and editing by Khalil AH, Abd Al-Galil AS and El Shafey AA.

REFERENCES

Al Haj, O. A., Al Kanhal, H. A. 2010. Compositional, technological and nutritional aspects of dromedary camel milk. Inter. Dairy J. 20: 811- 821.

Allouch, J. 2018. Anatomical Study of the Nerve Supply of Camels (Camelus dromedarius) in Distal Forelimb with a Special Reference to the Cutaneous Innervation. Medical and Biological Sciences Oct 8: 2018.

Amini, R., Kartchner, J. Z., Nagdev, A., Adhikari, S. 2016. Ultrasound-guided nerve blocks in emergency medicine practice. Journal of Ultrasound in Medicine, 35(4): 731-736.

Badawy, A.M., Eshra, E. 2018. Development of an ultrasound-guided technique for retrobulbar nerve block in dromedary camels: a cadaveric study. Veterinary Anaesthesia and Analgesia 2018, 45: 175-182

Budras, K., Sack, W.O., Röck, S. Anatomy of the Horse Fifth, revised Edition. Schlütersche Verlagsgesellschaft mbH & Co. KG., Germany; 2009.

Budras, K., Habel, R.E. Bovine Anatomy An Illustrated Text. First edition. Schlütersche GmbH & Co. KG, Verlag und DruckereiHans-Böckler-Allee 7, 30173 Hannover, Germany; 2003.

Campoy, L., Bezuidenhout, A. J., Gleed, R. D., Martin-Flores, M., Raw, R. M., Santare, C. L., Wang, A. L. 2010. Ultrasound-guided approach for axillary brachial plexus, femoral nerve, and sciatic nerve blocks in dogs. Veterinary anaesthesia and analgesia, 37(2): 144-153

Dellman H. D., McClure R.C. Equine nervous system. Ruminant nervous system. In Sisson and Grossman's the anatomy of the domestic animals. Fifth edition. W.B. Saunders company; 1975.

Dyce, K. M., Sack, W.O., Wensing C.J.G. Textbook of veterinary anatomy. 4th ed. Saunders, an imprint of Elsevier Inc; 2010.

Echeverry, D. F., Laredo, F. G., Gil, F., Belda, E., Soler, M., Agut, A. 2012. Ultrasound-guided 'two-in-one'femoral and obturator nerve block in the dog: an anatomical study. Veterinary anaesthesia and analgesia, 39(6): 611-617.

El-Bakary, R.M. 1989. surgical anatomical studies on the nerves of the manus of the camel. Alexandria Journal of Veterinary Sciences [AJVS]. 5 (2): 87-100

El-Shafaey, E. S., Hamed, M., Abdellatif, A., Abo Elfadl, E. 2017. Comparison of blind, ultrasound and computed tomographic-guided injection techniques for nerve block of the head in one-humped camel (Camelus dromedaries) cadavers. Pak Vet J, 37(2): 180-184.

El-Shaieb, M. 1976. The brachial plexus of the camel (Camelus Dromedarius). Assiut Vet. Med. J. 3 (5): 13-25.

Gahlot, T., Chouhan, D., Choudhary, R. 1988. Management of surgical diseases in camel. Indian Journal of Veterinary Surgery 3(2):100-102.

Gerlach F. Kokzidiose beim Dromedar (Camelus dromedarius). [Dissertation med. vet]. Berlin: Freien Universität Berlin; 2008.

Hall, L. W.; Clarke, K. W., Trim, C. M. Wright's Veterinary Anaesthesia and Analgesia. 10th ed. London, ELBS and Baillierre Tindall, 2000.

Helen, L., O'Donnell, B. D., Moore, E. 2015. Nerve localization techniques for peripheral nerve block and possible future directions. Acta Anaesthesiologica Scandinavica, 59(8): 962-974.

HuiChu, L., Walz, P. Farm animal anesthesia: cattle, small ruminants, camelids, and pigs, 1st Ed., John Wiley & Sons, Chichester, UK; 2014.

Ibrahim, A. K. 1976. Studies on the surgical affections of the camel. MV Sc (Doctoral dissertation, Thesis, Fac. Vet. Med., Zagazig University-Egypt).

Konig, H.E., Liebich, H.G. 2004. Veterinary anatomy of the domestic animals, textbook and colour atlas. Schattauer GmbH Germany.

Mansour, M., Wilhite, R., Rowe, J. Guide to Ruminant Anatomy Dissection and Clinical Aspects. John Wiley & Sons, Inc, USA; 2018.

Marhofer, P., Chan, V.W. 2007. Ultrasound-guided regional anesthesia: current concepts and future trends. Anesth Analg 104:1265-9.

Marhofer, P., Greher, M., Kapral, S. 2005. Ultrasound guidance in regional anaesthesia. Br J Anaesth. 94: 7–17.

Moustafa, M. A. 1979. Surgical affections causing lameness in camels. MV Sc (Doctoral dissertation, thesis, Faculty of Veterinary Medicine, Zagazig University).

Osuobeni, E.P., Hamidzada, W.A. 1999. Ultrasonographic determination of the dimensions of ocular components in enucleated eyes of the one-humped camel (Camelus dromedaries). Res Vet Sci. 67:125-9.

Ramadan, R. O. 1994. Surgery and radiology of the dromedary camel. Al-Jawad Printing Press.

Rioja, E., Sinclair, M., Chalmers, H. 2012. Comparison of three techniques for paravertebral brachial plexus blockade in dogs. Vet Anesth Analg 39:190-200.

Schwartz, H.J., Dioli, M. 1992. The one-humped Camel in Eastern Africa. A Pictorial Guide to Diseases, Health Care and Management. Verlag Josef Margraf Scientific Books Editions: Verlag, Weikersceim; 1992. p.282.

Sharma, N.K., Sharma, S. 2006. Grain founder in a male camel (Camelus dromedarius). Journal of Veterinary Science 7(1):91-92.

Singh, G., Gahlot, T.K. 1997. Foot disorders in camels (Camelus dromedarius). J.Camel Pract.Res. 4: 145-154.

Smuts, M.M.S., Bezuidenhout, A.J. 1987. Anatomy of the dromedary. Oxford [Oxfordshire] : Clarendon Press ; New York : Oxford University Press, 1987

Soliman, I., Moustafa, M., Mezyein, A. 1988. Angiographic alterations of some foot affections in camels. Proc. 3rd Cong., Fac. Vet. Med., Assuit Univ. Egypt. pp 13-24.

Soliman, I., Othman, G.M., Kamel, A. 1993. Amputation of the digit in the camel. Journal of Egyptian Veterinary Medical Association. 43:131-137.

Tageldin, M., Omar, F.A. 1986. A note on squamous cell carcinoma in a camel. Indian Veterinary Journal. 63(7):594-595.

Wernery, U., Kaaden, O. R. 2004. Foot-and-mouth disease in camelids: a review. The Veterinary Journal. 168(2), 134-142.

Yoshida, T., Nakamoto, T., Kamibayashi, T. 2017. Ultrasound-guided obturator nerve block: a focused review on anatomy and updated techniques. BioMed research international, 2017.

Zabady, M. K. E. E. 1999. Studies on some Lamb affections in Camels (Camelus dromedarius) (Doctoral dissertation, Cairo University).