Dept. of Anatomy & Histology,
Faculty of Vet. Med., Assiut University,
Head of Dept. Prof. Dr. A. Hifny.

ANATOMICAL STUDY ON THE RADIAL NERVE IN DONKEY WITH SPECIAL REFERENCE TO ITS PARALYSIS

(With 3 Figs.)

By

K.E.H. ABDALLA; I.H. AHMED*; SALMA A. MOHAMED** and M.A. SLEIM*

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دراسه تشريحيه على العصب الكعبري في الحمار باشاره خاصه الى شلله

كمال الدين هاشم ؛ ابراهيم حسين ؛ سلمى أحمد ؛ مجدي سليم

أجري هذا البحث على عدد عشرون حمارا . وقد تم دراسة موقع ومسار ونهاية وتوزيع العصب الكعبري. وأوضح البحث أن العصب الكعبري عندما يصل الى الميزاب العضلي الحلزوني لعظم العضد ينتهي بانقسامه الى الفرع السطحي والفرع الغائر . الفرع السطحي يعطي الأعصاب الجلديه العضديه الوحشيه الخلفيه ثم يستمر تحت اسم العصب الجلدي الساعدي الوحشي . الفرع الغائر أكبر من الفرع السطحي ويعتبر التواصل المباشر للعصب الكعبري . ومن الناحيه التشريحيه فقد أوضح البحث بأن الشلل الجزئي للعصب الكعبري أكثر توقعاً في الحمار عن الشلل الكلي لهذا العصب .

SUMMARY

The present work was carried out on a total of 20 adult healthy donkeys. The position, course, termination and distribution of the radial nerve were studied.

*: Dept. of Surgery, Fac. Vet. Med., Assiut University.
**: Animal Health Research Lab. Assiut.

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On reaching the musculospiral groove, the radial nerve terminates by dividing into superficial and deep branches. After detaching the caudal lateral brachial cutaneous nerves the superficial continues as the lateral antebrachial cutaneous nerve.The deep branch is the larger one and considers the direct continuation of the parent nerve. From the anatomical point of view the partial radial paralysis in donkey is more excepted than the total radial paralysis.

INTRODUCTION

The injuries of the nerves of the thoracic limb are an important cause of locomotory dysfunction in large domestic animals especially equine. In this respect VENUGOPALAN (1982) and O'CONNOR (1982) reported that the radial paralysis is more commonly seen in horse and rarely in cattle and dog. Clinically, it is frequently difficult to determine the proportion of the lameness that can be caused by nerve paralysis and the proportion that has resulted from the damage of other diseases. Therefore, the experimental neurectomy of the radial nerve in donkey is performed to give the clinicians a good data about the paralysis of this nerve. In order to make this neurectomy and understand its effect it is necessary to study the anatomy of the radial nerve concerning its course, distribution and suitable site for its resection as well as the layers which are dissected during neurectomy, because the obtained literature lack any information about the anatomy of this nerve in donkey.

MATERIAL and METHODS

The anatomy of the present work was carried out on 13 adult healthy donkeys of both sexes. The animals were anaesthetized by chloroform and bled through the common carotid artery. Thenafter ten of the examined animals were injected by 10% formalin solution and preserved for a week before examination the other three specimens were dissected in fresh state to determine the suitable site for the neurectomy of the radial nerve.

In addition seven clinically healthy adult donkeys were used for surgical approach and neuectomy of the radial nerve. The animal was casted into the lateral recumbency. The skin at the lateral aspect of the operated arm was prepared for aseptic surgery. Neurectomy was performed under effect of chloral hydrate narcosis.

All animals were clinically observed during rest and walk for any changes in limb conformation and gait directly after recovery from anaesthesia till 6 weeks post-operation.

RESULTS

N. radialis:

The radial nerve (Fig. 1/1) originates from the cranial part of the branchial plexus, it can be considered the largest nerve of this plexus. It passes ventrally and slightly caudally caudal to the ulnar nerve and medial to the subscapular artery. About 6cm distal to the level of the shoulder joint it curves laterally between the long and medial heads of the M.triceps brachii as well as the M.teres major to gain the musculospiral groove where the radial nerve divides into smaller R.superficialis and larger R.profundus.

During its course and before entering the musculospiral groove the radial nerve gives off two muscular branches (Fig. 1/2). The first muscular branch is the larger passes ventrally caudal to the parent nerve for about 1.5cm then divides into 3-4 branches which redivides to terminate in the caudal part of the long head of M.triceps brachii. The second branch runs ventrally caudal to the brachial artery to reach the medial head of the M.triceps brachii where it terminates by dividing into two branches one terminates within the latter muscle and the other passes ventrocaudally in the direction of fossa olecrani undercover the lateral head of M.triceps brachii to terminate in the M.anconeus. Before its division the second muscular branch detaches a relatively weak branch to the M.tensor fasciae antebrachii. In five examined cases the latter muscle was innervated by a separate nerve arising directly from the radial nerve.

R. Superficialis:

The superficial branch (Fig. 1/3) of the radial nerve runs ventrolaterally for about 3.5cm between the lateral head of the M.triceps brachii and the M.brachialis then it detaches two small caudal lateral brachial cutaneous nerves and continues its course as the lateral cutaneous antebrachial nerve. After its origin by 1.7cm the superficial branch releases two branches (Fig. 1/4) running distally and slightly cranially for a short distance on the deep aspect of the lateral head of the M.triceps brachii where they terminate.

Nn. Cutanei brachii laterales caudales:

The caudal lateral brachial cutaneous nerves (Fig. 1/5) run craniodistally at first on the deep aspect of the lateral head of the M.triceps brachii to gain the deep aspect of the M.cutaneus omobrachialis where they continue their course in the same direction to reach the fascia and skin of the distal part of the lateral aspect of the arm where they end.

N. Cutaneus antebrachii lateralis:

The lateral antebrachial cutaneous nerve (Fig. 1/6) which is the direct continuation of the superficial branch of the radial nerve is relatively strong nerve emerges between the lateral head of the M.triceps brachii and M.brachialis then it continues distally crossing the lateral aspect of the arm undecover the M.cutaneus omobrachialis to gain the fascia nearly at the level of the elbow joint. After that the lateral antebrachial cutaneous nerve runs distally and slightly cranially on the lateral aspect of the forearm undercover the skin to terminate directly at the level of the carpal joint.

During its course and 1 cm distal to the level of the lateral tuberosity of radius, the lateral antebrachial cutaneous nerve gives off a small distocaudally directed branch which end in the fascia and skin at the proximal part of the forearm. A second branch is also detached from the parent cutaneous nerve at the middle of the forearm it courses distally and slightly caudally to terminate about hand breadth above the carpus. Moreover and about 3cm before its termination the lateral antebrachial cutaneous nerve gives off a small branch terminating in the skin infront of the tendon of the M.extensor carpi radialis.

R. Profundus:

The deep branch (Fig. 1/7) of the radial nerve runs within the musculospiral groove obliquely distocaudally undercover the lateral head of the M.triceps brachii. Here the nerve comes in contact with the lateral aspect of the humerus, this position has a clinical importance. Thenafter the deep brach completes its course distally between the M.extensor carpi radialis and M.brachialis to gain the flexor aspect of the elbow joint. Here the nerve courses distocaudally between the M.extensor digitorum communis and the radius crossing the lateral border of the latter undercover the M.extensor digitorum lateralis to terminate in the M.ulnaris laterlis.

Along its course the deep branch of the radial nerve detaches, on the flexor aspect of elbow joint, three muscular branches to the M.extensor carpi radialis. Two of these branches enter the muscle near its origin, while the third branch passes distally on the deep aspect of the same muscle and enters

it near its middle. Moreover, the deep branch detaches, during its course on the deep aspect of the M.extensor digitorum communis, two branches innervating the latter muscle. Directly after the latter branches, the deep branch of radial nerve gives off a thin branch running distally on the radius undercover the M.extensor digitorum communis to terminate in the M.extensor carpi obliquus.

Lastly the deep branch of radial nerve supplies the M.extensor digitorum lateralis through a small branch arising from it by 1 cm before its termination. From the above mentioned results it is concluded that the collateral muscular branches originating from the deep branch of radial nerve supplying the extensor muscles of the forearm arranging from cranial to caudalwards as fowwlo Mm.extensor carpi radialis, extensor digitorum communis, extensor carpi obliquus and extensor digitorum lateralis.

Site of operation:

For surgical approach of the radial nerve a caudoventrally directed incision about 7cm long is performed on the lateral aspect of the arm at the junction between the middle and the distal third of the humerus. The incision passes through skin and subcutaneous tissue (M.cutaneus omobrachialis). Then the lateral head of the M.triceps brachii is separated bluntly from the underlying M.brachialis. Here the radial nerve is neurectomized as it is located in the musculospiral groove.

Clinical signs:

Directly after recovery from anaesthesia the operated limb shows flexion of the elbow, carpal and phalangeal joints (Fig. 2). The flexion is more pronounced in the carpal and phalangeal joints than in the elbow joint. Therefore the affected limb is held in flexed position. The front of the hoof rests on the ground because the digit can't be extended. Abnormality during gait was observed. The animal advances the affected leg with difficulty. These observations last all over the period of the experiment. Cutaneous desensitization of the lateral aspect of the forearm was also observed. All animals show wear at the toe of the operated limb from the second week of the operation (Fig. 3).

DISCUSSION

The present study shows that in donkey the superficial branch of the radial nerve supplies the lateral head of the M.triceps brachii. In horse (SISSON and GROSSMAN, 1969; GHOSHAL, 1975 and DYCE, et al. 1987) and in

cattle (RAGHAVAN, 1964) as well as in all domestic animals (SEIFERLE and BOHME, 1984) the foregoing head is supplied by the muscular branches of the radial nerve. Corresponding to the aforementioned authors the present results indicates that the long and medial heads of the M.triceps brachii are innervated by the muscular branches of the radial nerve. The site of the origin of these muscular branches is differed; they originate from the radial nerve either before it enters the musculospiral groove as in the present work and as stated by DYCE, et al. (1987) in horse and RAGHAVAN (1964) in cattle, within the musculospiral groove as reported by GHOSHAL (1975) in horse, or at the flexor aspect of the elbow joint as mentioned by FRANK, (1982) in the latter animal.

According to that reported in horse by SEIFERLE and BOHME (1984) and the findings of the examined donkeys, the superficial branch of the radial nerve detaches the caudal lateral brachial cutaneous nerves (lateral brachial cutaneous nerve). However, GHOSHAL (1975) stated that in horse and ruminant these nerves arise from the radial nerve before its termination into superficial and deep branches.

SISSON and GROSSMAN (1969), GHOSHAL (1975) and FRANK (1984) pointed up that the radial nerve gives off one muscular branch to the M.tensor fasciae antebrachii before it reaches the musculospiral groove. According to the current investigation and that stated by RAGHAVAN (1964) in cattle, the radial nerve detaches a number of muscular branches, before it reaches the musculospiral groove, supplying Mm.tensor fasciae antebrachii, anconeus and the long and medial heads of the M.triceps brachii.

Regarding the muscular branches of the radial nerve which supply the extensor muscles of the carpus and digits, the present work indicates that the foregoing muscles in addition to the M.ulnaris lateralis are innervated by muscular branches arising from the deep branch of the radial nerve at the region of the elbow joint, the same result was obtained by SISSON and GROSSMAN (1969) in horse and RAGHAVAN (1964) in cattle. According to DYCE, et al. (1987) the radial nerve in horse detaches branches to the aforementioned muscles where it is covered by the lateral head of the M.triceps brachii. On the other hand LANGER and NICKEL (1953) reported that in cattle these branches arising from the radial nerve before it reaches the lateral aspect of the humerus.

On reaching the musculospiral groove the radial nerve in donkey terminates by dividing into a superficial and deep branches. In this connection GHOSHAL (1975) reported that the radial nerve divides into

superficial and deep branches at a variable distance proximal to the elbow in horse, at a variable level in the arm near the craniodistal border of the lateral head of the M.triceps brachii in ruminant; at the level of the lateral humeral epicondyle in pig, between the M.brachialis and the lateral head of the M.triceps brachii in dog and in the region of the elbow in cat.

DYCE, et al. (1987) classified the radial paralysis in horse into high and low radial paralysis depending upon the origin of the tricipital branches. They added that when the injury proximal to the origin of the tricipital branches causes high radial paralysis and when distal to the origin of the tricipital branches causes low radial paralysis. FIRTH (1986) also used the term of low radial paralysis. MANSMANN, et al.(1982) classified the radial paralysis into total and partial paralysis. In this connection, BHARAT SINGH and MISRA (1978) used the term of complete radial paralysis instead of total radial paralysis.

Concerning the position and the course of the radial nerve in the examined donkeys, as the nerve leaves the brachial plexus and coursing distally on the medial aspect of the shoulder region and the proximal part of the arm, therefore, the injury of the radial nerve in this area is difficult to be occur and if the injury occurs it causes a high radial paralysis. In this respect, DELAHUNTA (1983) stated that contusion of the brachial plexus medial to the shoulder is rarely. On the other hand, as the superficial and deep branches of the radial nerve run in the musculosiral groove of the humerus undercover the lateral head of the M.triceps brachii, therefore the injuries of these branches can be taken place by sever trauma as fracture of the humerus causing low radial paralysis.

Regarding the action of the radial nerve, if the injury of the nerve is taken place before it gives off any muscular branches this causes the denervation of all the muscles supplied by the radial nerve, therefore the signs of paralysis appear on all the joints of the thoracic limb and this case is called total (complete) radial paralysis. WORTHMAN (1957) in dog and MANSMANN, et al. (1982) as well as FRANK (1982) in horse mentioned that in total paralysis the animal is unable to suport weight upon the affected limb and also it is unable to extend the leg and flex the shoulder joints. On the other hand the injury of the superficial and deep branches causes desensitization of the lateral aspect of the forearm (in case of the superficial branch) and denervation of the extensor muscles of the carpus and digits and consequently the carpal and digital joints are flexed (in case of deep branch). This condition is called partial paralysis because not all the joints of the

thoracic limb are affected as observed in the present work.

Finally, from the anatomical point of view it is clear that the classification of the radial paralysis into high and low is logical concerning the position and course of the nerve. Also the classification of the radial paralysis into total and partial is logical regarding the action of the radial nerve.

According to VAUGHAN (1964) in cattle and ADAMS (1974) in horse, the dropped elbow which is the characteristic sign in the radial paralysis is seen when the M.triceps brachii is paralyzed. Therefore this feature can be seen in donkey only in case of total paralysis.

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LEGENDS

Fig. 1: Diagram of the distribution of the radial nerve on the medial aspect of the thoracic limb in donkey.

A) Site of total (high) radial paralysis.

B) Site of partial (low) radial paralysis.

1– N.radialis 2– Rr.musculares of the radial nerve

3– R.Superficialis 4– Rr.musculares of superficial branch

5– Nn.cutanei branchii laterales caudales

6– N.cutaneous antebrachii lateralis

7– R.profundus

Fig. 2: Showing flexion of the carpal and phalangeal joints in an experimental donkey in addition to the site of operation.

Fig. 3: Showing the wear at the toe of the operated limb.