

Gross Anatomical Description of the Scalenus Muscle of the Egyptian Baladi Goat (*Capra hircus*) with Emphasis to Some Morphological Variations

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ABSTRACT

Introduction: the present investigation was prepared to give a full anatomical description of the origin, insertion, relations, and some variations of the scalenus muscle of the Egyptian Baladi goat (*Capra hircus*). This work was carried out on seven adult health goats. The scalenus muscle was subdivided into three muscles; dorsalis, ventralis, and medius muscles, which were located on the lower one-third of the cervical region. The *scalenus dorsalis* muscle originated from the transverse processes of the fifth and sixth cervical vertebrae and was inserted on the lateral surface of the lower one-third of the third rib. The *scalenus ventralis* muscle was the more developed muscle and originated from the transverse processes of the fifth, sixth and seventh cervical vertebrae and was inserted in the distal one-third of the first rib and distal part. The *scalenus medius* consisted of two parts; superficial and deep part. The superficial part originated from the transverse process of the 6th cervical vertebrae and was inserted on the lateral surface of the proximal one-third of the 1st rib while the deep part originated from the transverse process of the seventh cervical vertebrae and was inserted into the middle 1/3 of the first rib. The deep was the smallest muscle of the scalenus group.

Keywords: Egyptian Baladi goat; Scalenus muscle; Anatomic variation.

Introduction

Goats have been widely distributed in all parts of the world country with the increase in the demand for their milk, meat, and skins (ANAE TO et al., 2010). The meat of the goat is highly produced in many subtropical countries as Egypt (EL-HANAFY et al., 2010). Generally, there is little attention to the anatomy of the small ruminants and most of the articles were focused on the large ruminants, except for some comparative references with the small ruminants. Later, the goat had a special interest as they were used as biomedical models and for surgical teaching and some morphological descriptions (FATHI et al., 2016, MADKOUR, 2016).

Generally, the scalenus muscle was subdivided into *scalenus dorsalis*, *ventralis*, and *medius* (NICKELSCHUMMER and SEIFERLI, 1981, SMUTS and LE ROUX, 1975, OMAR, 1980, KOSTOV and CANDEV, 2008) while, (STARCK, 1982) reported that in many mammals, the scalenus muscle was divided into ventral and dorsal parts in corresponding to the brachial plexus. (BARONE, 2000) in the domestic animals and (KOSTOV and CANDEV, 2008) in the goat reported that the ventral scalenus was the more developed muscle if compared to the other two.

in the ox (SMUTS and LE ROUX, 1975) recorded that the *scalenus ventralis* muscle was occupied the triangular area that bordered by the cranial aspect of the 1st rib and the ventrolateral aspects of the third to

the seventh cervical vertebrae. Moreover, (KOSTOV and CANDEV, 2008) in the goat reported that the *scalenus medius* muscle was poorly developed and occupied the space between the fifth cervical vertebrae and the 1st rib.

Finally, the available data about the scalenus muscle of the Egyptian Baladi goats is not enough. So, in the current study, we turn to give a full gross morphological description of the scalenus muscle with emphasis on its origin, insertion, and relations. Then, compare the obtained anatomical data with those previous reported in other animal species.

Material and Methods

Animal Collections

The current investigation was performed on seven adults normal healthy Egyptian Baladi goats of both sexes (sex males and sex females) weighing about (25-35kg) and aging (1-3 years). The collected goats must be free from any abnormalities. The examined goats were collected from the slaughterhouse in Behera Governorate then transferred to the anatomical lab of the Faculty of Veterinary Medicine, Alexandria University. The examined samples were carefully dissected and preserved in a formalin solution of 10%. The measurements were carried out by utilizing digital calipers, in which "ml" means millimeter while "cm" means centimeter. The Quantitative results were expressed as mean \pm SD. This study followed the

guidelines for the care and use of laboratory animals and the animal welfare and Ethics Committee of the Faculty of Veterinary Medicine, Alexandria University according to the Egyptian's laws, approved it, in which adequate measures were taken to minimize pain or discomfort.

Animal Dissections

The anatomical dissection was carried out on both sides (right and left) to illustrate the topographical origin, insertion, position, shape, and its relations with the surrounding structures. The dissected portion including the scalenus muscle of both sides was photographed using a digital camera (Canon IXY 325, Japan).

Results

The scalenus muscle was described as a complex muscle as it divided into three muscles; the scalenus *dorsalis*, the scalenus *ventralis*, and the scalenus *medius* muscles, which were located on the lower one-third of the cervical region.

The M. Scalenus Dorsalis

It was a fine small muscle that originated from the transverse processes of the fifth and sixth cervical vertebrae and was inserted on the lateral surface of the lower one-third of the third rib by fascia at the lateral surface of the m. serratus ventralis thoracis (Figs. 1, 2/8, 3/1, 4/2, 5A/1). It measured 13 ± 0.32 cm in the length and 1.5 ± 0.12 cm in the width in the thoracic part and 0.8 ± 0.11 cm in the cervical part and passed over the origin of the brachial plexus. The scalenus *dorsalis* muscles was related superficially; to the superficial cervical lymph node (pre-scapular lymph node) and the omotransverse muscle while deeply, it was related to nerves of the brachial plexus and the m. serratus ventralis and the longus colli muscle. Dorsally, it was related to the scalenus *medius* superficial part (Fig. 1, 2/8).

Anatomical Variations of the M. Scalenus Dorsalis

1. In one case, the scalenus *dorsalis* muscle was ended by two branches at the level of the second rib over the lateral surface of the m. serratus ventralis thoracis; the dorsal branch was long and inserted into the lower one-third of the lateral surface of the fourth rib while, while the ventral branch was inserted into the lower one-third of the lateral surface of the third rib (Fig. 5A/1, 2, 3).

2. In one case, the m. scalenus *dorsalis* was triangular in shape; its base at its insertion (thoracic part) while, its apex at its origin (cervical part) as described in (Fig. 1B/10).

3. In one case, the m. scalenus *dorsalis* was inserted at the lower one-third of the fourth rib (at the cranial part of the rib) as described in (Fig. 2B/4).

4. In one case, the m. scalenus *dorsalis* was ended by two branches at the level of the second external intercostal muscle over the lateral surface of the m.

serratus ventralis thoracis; the dorsal branch was inserted into the lower one-third of the caudal border of the third rib, while the ventral branch was inserted into the lower one-third of the cranial border of the third rib (Fig. 4A/2, a, b).

5. In one case, the scalenus *dorsalis* muscle was divided into two branches after its origin by 3 cm and at the level of the cranial border of the brachial plexus, over the lateral surface of the serratus ventralis cervical muscle; the dorsal branch was short and inserted into the upper one-third of the lateral surface of the first rib and cover the scalenus *medius* superficial muscle, while the ventral branch was inserted into the middle one-third of the lateral surface of the second rib and the longus thoracic nerve pass between the dorsal and ventral branch of the m. scalenus *dorsalis* (Fig. 4B/2, 3, 4).

The M. Scalenus Ventralis

It was the more developed muscle compared to the other two scalenus muscles. It was originated from the transverse processes of the fifth, sixth, and seventh cervical vertebrae and inserted in the distal one-third of the first rib, in which the muscle was divided into three parts at its middle; the proximal part was the short one and originated from the transverse process of the seventh cervical vertebrae, while the middle part originated from the transverse process of the sixth cervical vertebrae but, the distal part was the longest and arisen from the transverse process of the fifth cervical vertebrae. Moreover, the insertion of the m. scalenus *ventralis* was proximal to the origin of the rectus thoracic muscle by about 1 ± 0.01 cm and distal to the insertion of the m. scalenus *medius* superficial part by about 3.5 ± 0.05 cm, in which the brachial plexus was inserted immediately above the m. scalenus *ventralis* muscle and pass between it and scalenus *dorsalis* (Figs. 1A/11, 1B/9, 2A/10, 2B/5, 3A/3, 3B/2, 4A/8, 4B/1, 5A/6, 5B/3, and 6/4).

The scalenus *ventralis* reached about 12.5 ± 0.51 cm in length and 2 ± 0.05 cm in the wide at the insertion and before the division into the three parts while, the width of three parts were 1 ± 0.01 cm in the proximal part, 0.9 ± 0.02 cm in the middle part and 0.8 ± 0.012 cm in the distal part. Moreover, the length of each part after the division was 6.2 ± 0.47 cm in the proximal part, 7.6 ± 0.51 cm in the middle part, and 10 ± 0.5 cm in the distal part. It was related laterally, to the brachiocephalic muscle, omotransverse and supraspinatus muscles and fat around the superficial cervical lymph node, and branches of the brachial plexus and phrenic nerve while, medially it related to the vertebrae, longus colli and intertransversi cervicis muscles, esophagus (on the left side) and trachea (on the right side), vagus and sympathetic nerve (Figs. 1A/11, 3B/2)

The Scalenus Medius

It consisted of two parts: the superficial and the deep part. The superficial part was originated from the transverse process of the 6th cervical vertebrae and inserted on the lateral surface of the proximal

one-third of the 1st rib, proximal to the insertion of the *scalenus ventralis* muscle by 3.5 ± 0.12 cm and cover the initial part of the brachial plexus, in which this clear after removing the *scalenus dorsalis*. It was about 5.5 ± 0.2 cm in the length and 1 ± 0.01 cm in the wide at its middle part (Figs. 2B/11; 3A/2; 4A/9; 5A/2, 4; 6/2, 3). It was related superficially, to the *scalenus dorsalis*, *subscapular* and *supraspinatus* muscles while, deeply to the *scalenus medius* deep part and the brachial plexus.

Furthermore, the deep part was the smallest muscle of the *scalenus* group, about 4.8 ± 0.13 cm in the length and $0.9-1 \pm 0.001$ cm in the width. It was originated

from the transverse process of the seventh cervical vertebrae and inserted into the middle one-third of the first rib, directly above the insertion of the *scalenus ventralis* muscle. The initial part of this muscle after its origin appeared between the two last cervical nerves of the brachial plexus (7th and 8th cervical nerves) then, this muscle disappeared completely under the brachial plexus and the *m. scalenus dorsalis* (Fig.5A/4) then, become clear completely after removal of the brachial plexus (Fig.6/3). It was related superficially to the *scalenus medius* superficial part muscle and the brachial plexus, while ventrally, it was related to the *scalenus ventralis* muscle.

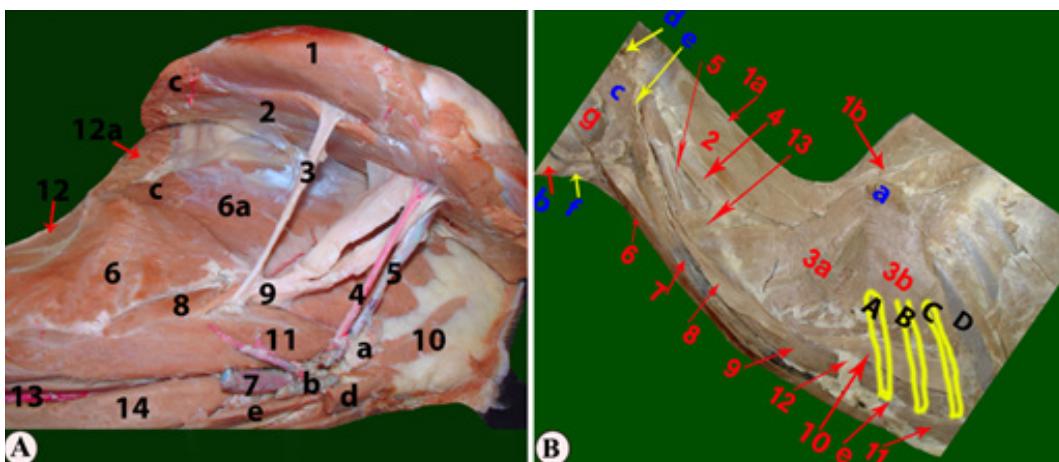


Figure 1. Gross anatomical lateral view of the goat neck.

(View A) after removal of the brachiocephalic and omotransverse muscles and the elevation of the forelimb to show; 1- Supraspinatus muscle, 2- Subscapular muscle, 3- Suprascapular nerve, 4- Axillary artery, 5- Axillary vein, 6- Serratus ventralis cervical part muscle, 6a- Serratus ventralis thoracic part muscle, 7- External jugular vein (cutted), 8- *Scalenus dorsalis* muscle, 9- Brachial plexus, 10- Rectus thoracic muscle, 11- *Scalenus ventralis* muscle, 12- Rhomboideus cervical part, 12a- Rhomboideus thoracic part, 13- Common carotid artery, 14- Cervical esophagus, a- Costocervical lymph node, b- Caudal deep cervical lymph node, c- Subscapular attachment area with the medial surface of the scapula, d- Sternomandibularis muscle (cutted), e- Sternomastoides muscle.

(View B) after removal of the forelimb, brachiocephalic and omotransverse muscles to show; 1a- Rhomboideus cervical part muscle, 1b- Rhomboideus thoracic part muscle, 2- Splenius muscle, 3a- Serratus ventralis cervical part muscle, 3b- Serratus ventralis thoracic part muscle, 4- Longissimus capitis muscle, 5- Longus capitis muscle, 6- Sternomandibularis muscle, 7- External Jugular vein, 8- Cleidomastoides muscle, 9- *Scalenus ventralis* muscle, 10- *Scalenus dorsalis* muscle, 11- Rectus thoracic muscle, 12- Brachial plexus, 13- Omohyoid muscle, a- Subscapular attachment area with the medial surface of the scapula, b- Mandible, c- Parotid salivary gland, d- External ear opening, e- Great auricular nerve, f- Mandibular lymph node.

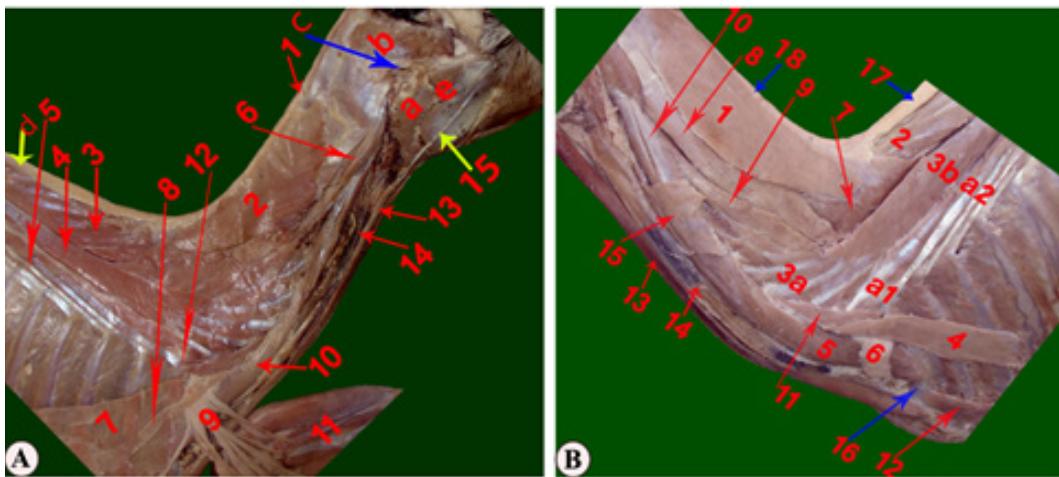


Figure 2. Gross anatomical lateral view of the goat neck.

(View A) after removal of the superficial layer and the 2nd cervical muscular layer to show; 1- Funicular part of the nickel ligament, 2- Semispinalis capitis muscle, 3- Spinalis muscle, 4- Longissimus dorsi muscle, 5- Iliocostalis muscle, 6- Longissimus capitis muscle, 7- Cutted serratus ventralis muscle, 8- *Scalenus dorsalis* muscle, 9- Brachial plexus, 10- *Scalenus ventralis* muscle, 11- Subscapularis muscle, 12- 1st rib, 13- Common carotid artery, 15- Tendon of insertion of the sternomandibularis, a- parotid salivary gland, b- Temporalis muscle, c- External ear opening, d- Supraspinous ligament, e- Masseter muscle.

(View B) after removal of the superficial layer to show 2nd and 3rd layers of the lateral cervical muscles to show; 1- Splenius muscle, 2- Spinalis muscle, 3a- Longissimus dorsi cervical part muscle, 3b- Longissimus dorsi thoracic part muscle, 4- *Scalenus dorsalis* muscle, 5- *Scalenus ventralis* muscle, 6- Brachial plexus, 7- Semispinalis capitis muscle, 8- Longissimus capitis muscle, 9- Longissimus atlanti muscle, 10- Longus capitis muscle, 11- *Scalenus medius* superficial part muscle, 12- Rectus thoracic muscle, 13- Sternomandibularis muscle, 14- External jugular vein, 15- Omohyoid muscle, 16- 1st rib, 17- Supraspinous ligament, 18- Funicular part of nickel ligament, a1- Iliocostalis cervical part muscle, a2- Iliocostalis thoracic part muscle.

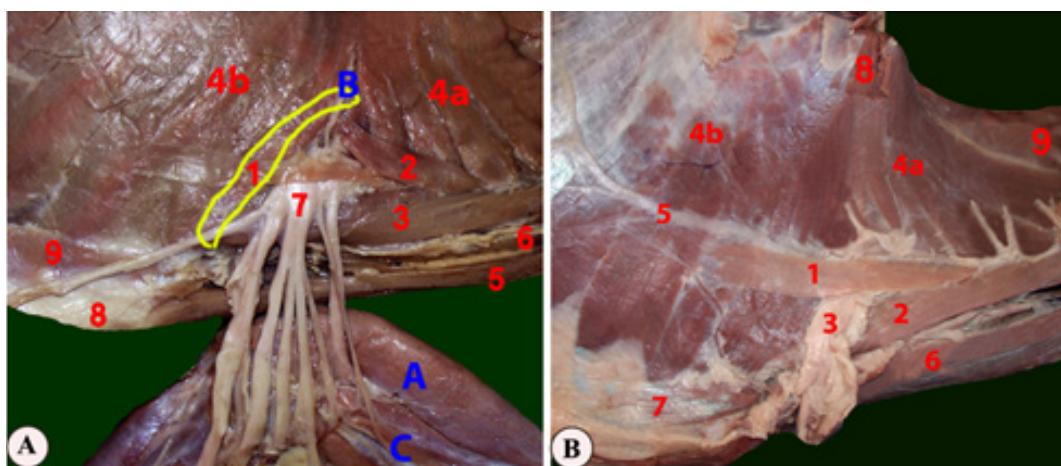


Figure 3. Gross anatomical lateral view of the caudal part of the goat neck.

(View A) after the elevation of the forelimb to show the scalenus muscle group to show; 1- *Scalenus dorsalis* muscle, 2- *Scalenus medius* superficial part, 3- *Scalenus ventralis*, 4a- *Serratus ventralis cervical* part, 4b- *Serratus ventralis thoracic* part, 5- *Sternomandibularis*, 6- External jugular vein, 7- Brachial plexus, 8- *Sternum*, 9- *Rectus thoracic* muscle, A- *Suprascapular* muscle, B- Line to show 1st rib, C- *Subscapular* muscle.

(View B) after removal of the forelimb to show the *scalenus dorsalis* and ventralis; 1-*Scalenus dorsalis* muscle, 2-*Scalenus ventralis*, 3-Brachial plexus, 4a- *Serratus ventralis cervical* part, 4b- *Serratus ventralis thoracic* part, 5- *Longus thoracic nerve*, 6- *Sternomandibularis* muscle, 7- *Rectus thoracic* muscle, 8- *Subscapular* attachment area with the medial surface of the scapula, 9- *Splenius* muscle.

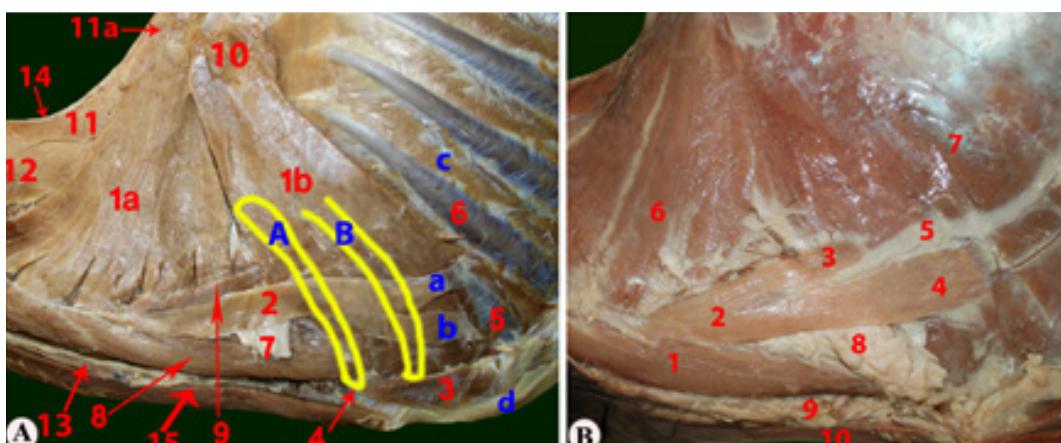


Figure 4. Gross anatomical lateral view of the caudal part of the goat neck to show the variation of the *scalenus dorsalis* muscle insertion:

(View A) to show A- Indicated the position of the 1st rib, B- Indicated the position of the 2nd rib, 1a- *Serratus ventralis cervical* part, 1b- *Serratus ventralis thoracic* part, 2- *Scalenus dorsalis* muscle, 3- *Rectus thoracic* muscle, 4-1st rib, 5-3rd rib, 6-4th rib, 7- Brachial plexus, 8- *Scalenus medius* superficial part, 10- *Subscapular* attachment area with the medial surface of the scapula, 11a- *Rhomboideus cervical* part, 11b- *Rhomboideus thoracic* part, 12- *Splenius* muscle, 13- External jugular vein, 14- Funicular part of the nickel ligament, 15- *Sternothyroid* muscle, a- Dorsal branch of *Scalenus dorsalis*, b- Ventral branch of *Scalenus dorsalis*, c- External intercostals muscle, d- *Sternum*

(View B) to show the variation of the *scalenus dorsalis* muscle; 1- *Scalenus ventralis* muscle, 2- *Scalenus dorsalis* muscle, 3- Dorsal part of the *scalenus dorsalis* muscle, 4- Ventral part of the *scalenus dorsalis* muscle, 5- *Longus thoracic nerve*, 6- *Serratus ventralis cervical* part, 7- *Serratus ventralis thoracic* part, 8- Brachial plexus, 9- External jugular vein, 10- *Sternomandibularis* muscle.

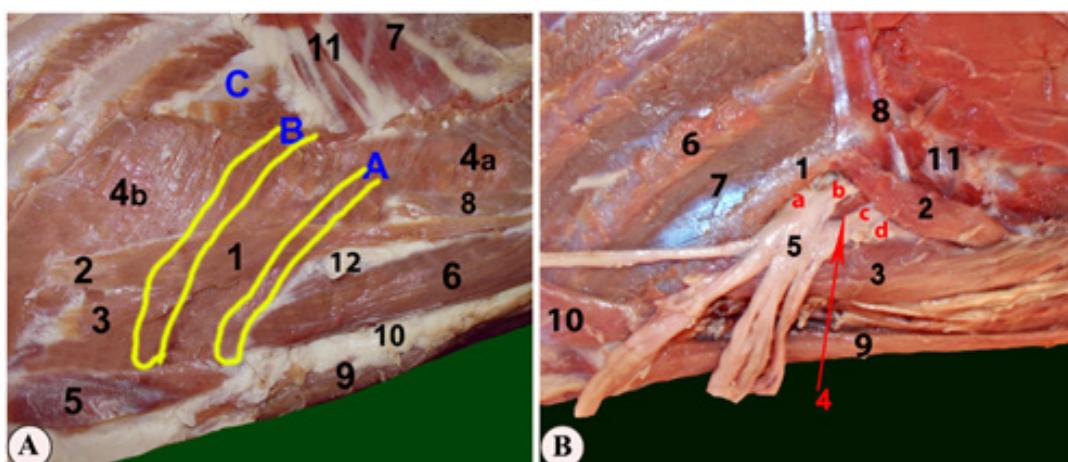


Figure 5. Gross anatomical Lateral view of the caudal part of the goat neck.

(View A) to show the variation of the *scalenus dorsalis* muscle: A- Indicated the position of the 1st rib, B- Indicated the position of the 2nd rib, C- 3rd rib, 1- *Scalenus dorsalis* muscle, 2- Dorsal part of the *scalenus dorsalis* muscle, 3- Ventral part of the *scalenus dorsalis* muscle, 4a- *Serratus ventralis cervical* muscle, 4b- *Serratus*

ventralis thoracic muscle, 5- Rectus thoracic muscle, 7- Longissimus dorsi thoracic muscle, 8- *Scalenus medius* superficial part, 9- Sternomandibularis muscle, 10- Fat cover external jugular vein, 11- Iliocostalis muscle, 12- Brachial plexus. (View B) to show the *scalenus medius* and ventralis after the removal of the *scalenus dorsalis*: 1- 1st rib, 2- *Scalenus medius* superficial part, 3- *Scalenus ventralis* muscle, 4- *Scalenus medius* deep part, 5- Brachial plexus, 6- 2nd rib, 7- External intercostals muscle, 8- Iliocostalis muscle, 9- Sternothyroid muscle, 10- Rectus thoracic muscle, 11- 7th cervical vertebrae, a- 1st thoracic nerve, b- 8th cervical nerve, c- 7th cervical nerve, d- 6th cervical nerve.

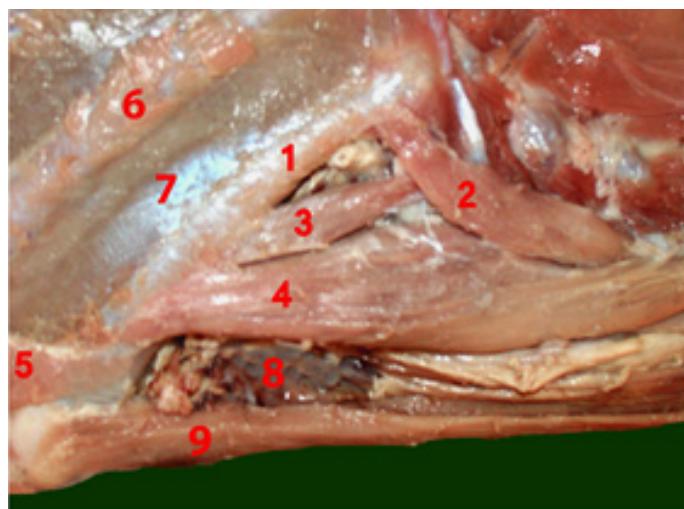


Figure 6. Gross anatomical Lateral view of the caudal part of the goat neck after removal of the brachial plexus and *scalenus dorsalis* to show *scalenus medius* and ventralis; 1- 1st rib, 2- *Scalenus medius* superficial part, 3- *Scalenus medius* deep part, 4- *Scalenus ventralis* muscle, 5- Rectus thoracic muscle, 6- 2nd rib, 7- External intercostals muscle, 8- External jugular vein, 9- Sternothyroid muscle

Discussion

The present study described that the scalenus muscle was subdivided into three muscles; the *scalenus dorsalis*, *ventralis*, and *medius*, which are located on the lower one-third of the cervical region. The same results were obtained by (SMUTS and LE ROUX, 1975, NICKELSCHUMMER and SEIFERLE, 1977) in the ox, (OMAR, 1980) in the camel, and (KOSTOV and CANDEV, 2008) in the goat. However, the scalenus muscle was represented only by the well-developed one part named the *m. scalenus medius* that was divided by the passage of the brachial plexus into the dorsal and ventral parts as reported by (GETTY, 1975) in ruminants and (POPESCU, 1980) in the horse. While, (KOSTOV and CANDEV, 2008, CONSTANTINESCU, 2001) reported that *scalenus dorsalis* was generally absent in the small ruminants, but usually found in the goat. Meanwhile, (TOKIYOSHI et al., 2004) reported that the scalenus muscle was divided into the *scalenus ventralis* and *dorsalis* and the *scalenus dorsalis* was subdivided into the short and the long part in the monkey.

Our findings clarify that the *m. scalenus dorsalis* was observed as a fine small muscle that originated from the transverse processes of the 5th and 6th cervical vertebrae and inserted on the lateral surface of the lower one-third of the 3rd rib at the lateral surface of the *m. serratus ventralis thoracis*, these observations agreed with that reported in the goat (KOSTOV and CANDEV, 2008), but vary in their connection with the transverse process of the fifth cervical vertebrae to the second rib, while (GETTY, 1975) stated that *m. scalenus dorsalis* in the goat was arisen from the transverse processes of the 4th to 6th cervical vertebrae

and terminated on the 2nd to 3rd ribs. However, in ox (GETTY, 1975, NICKELSCHUMMER and SEIFERLE, 1954, ELLENBERGER and BAUM, 1906) observed that *m. scalenus dorsalis* was arisen from the transverse processes of the 3rd to 6th cervical vertebrae and terminated on the 2nd to 4th ribs, while (SMUTS and LE ROUX, 1975) in ox reported that, the *m. scalenus dorsalis* was triangular flattened with craniocaudally direction and the base present on the 4th rib and inserted on the transverse process of the 4th or 5th cervical vertebra by a tendon, either in common with or ventral to the tendon of the *m. scalenus ventralis*. (BARONE, 2000) described that this muscle was originated from the 4th to 6th cervical vertebrae and inserted on the third to the fourth rib. In the camel, (OMAR, 1980, LESBRE, 1903) revealed that the *m. scalenus dorsalis* was arisen from the proximal extremity of the 1st rib to reach the transverse processes of the 7th and 6th cervical vertebrae while, the *m. scalenus ventralis* was originated from the ventral part of the 1st rib to be inserted into the 6th and 5th cervical vertebrae. In contrast to our results, the *m. scalenus dorsalis* muscle was absent in the sheep (GETTY, 1975, ATOJISUZUKI and SUGIMURA, 1984) meanwhile, (VÁZQUEZPEDRANA and PÉREZ, 2010) recorded that 29.5% of the examined sheep had this muscle either bilaterally or unilaterally in Corriedale sheep.

The current study described the presence of some anatomical variation in the position, origin, insertion, and shape of the *m. scalenus dorsalis*. In one case, we found that the *m. scalenus dorsalis* was ended by two branches at the level of the 2nd rib over the lateral surface of *m. serratus ventralis thoracis*; the dorsal long branch inserted into lower one-third of the lateral surface of 4th rib, while the ventral branch was inserted into lower one-third of the lateral surface of 3rd rib. In other case, the *m. scalenus dorsalis* was triangular in shape; its base at its insertion (thoracic part) while its apex at its origin (cervical part). Moreover, in other one case, the *m. scalenus dorsalis* was inserted at the lower one-third of the 4th rib (in the cranial part of the rib)

The present work described that the *m. scalenus ventralis* was the most developed scalenus muscles as described by (BARONE, 2000) in the domestic animals and (KOSTOV and CANDEV, 2008) in the goat. The present study noted that, the *m. scalenus ventralis* was originated from the transverse processes of the 5th, 6th, and 7th cervical vertebrae and inserted into the distal 1/3 of the 1st rib, but (KOSTOV and CANDEV, 2008) in the goat noted that it was originated from the transverse processes of the 3rd, 4th, and 5th cervical vertebrae and inserted on the lower 1/3 of the 1st rib. However, in the horse and cattle, it was originated from the 3rd, 4th and 5th cervical vertebrae and inserted

on the distal surface of the 1st rib (BARONE, 2000) and (GETTY, 1975) added that its end part was divided into three from the branches of the brachial plexus. in ox, the *m. scalenus ventralis* arose from the cranial border of the 1st rib (SMUTS and LE ROUX, 1975). Our results clarify that the *m. scalenus ventralis* was divided into three parts at its middle; proximal, middle, and distal part. The proximal short part was originated from the transverse process of the 7th cervical vertebrae but, the middle part originated from the transverse process of the 6th cervical vertebrae while the longest distal part arose from the transverse process of the 5th cervical vertebrae. Furthermore, (SMUTS and LE ROUX, 1975) noted that there were five muscular divisions observed in the ox.

The current study reported that, the *m. scalenus medius* consisted of two parts; the superficial and the deep part as noted by (SMUTS and LE ROUX, 1975, CONSTANTINESCU, 2001, STEFANOV and ZARKOVA, 2005) in the ruminant while, (KOSTOV and CANDEV, 2008) in the goat observed that it consisted of two parts; superficial and deep in the right side, but in the left side the deep part was absent. The present work reported that the superficial part was originated from the transverse process of the 6th cervical vertebrae and inserted on the proximal one-third of the 1st rib while, the deep part was originated from

the transverse process of the 7th cervical vertebrae and inserted into the middle one-third of the 1st rib, while (CONSTANTINESCU, 2001, STEFANOV and ZARKOVA, 2005) in the ruminant noted that the deep and superficial part of the *m. scalenus medius* was inserted together on the proximal part of the 1st rib. However, the superficial was originated at the fifth cervical vertebrae and the deep part originated at the 7th cervical vertebrae and was inserted on the middle one-third of the 1st rib (KOSTOV and CANDEV, 2008) in the goat. While the *m. scalenus medius* was originated from the proximal part of the 1st rib and inserted on the caudomedial aspect of the transverse process of the seventh cervical vertebrae (SMUTS and LE ROUX, 1975) in ox, but (SMUTS and LE ROUX, 1975) in the ox recorded that the deep part was extended from the 1st rib to the transverse process of the seventh cervical vertebrae, and the superficial part was extended from the 1st rib to the transverse process of the third cervical vertebrae and the fourth cervical vertebrae.

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