Comparative Anatomical Study on the Muscles of Mastication in the Rabbit (Oryctolagus cuniculus) and Cat (Felis domestica)

By

Samah.H. Elbably

Department of Anatomy and Embryology, Faculty of Veterinary Medicine, Cairo University

Abstract

The present work is an attempt to give detailed anatomical studies on the muscles of mastication in rabbit and cat, which may be helpful for anatomists in comparative studies as well as in surgical operations. Fresh and formalized heads of twenty four, apparently healthy, adult domestic rabbit and cats of both sexes were used for manual dissection and bony preparation. The muscles of mastication of the rabbit and cat were dissected, described, weighed and the areas of their origin and insertion were determined. The obtained results were photographed using Nikon digital camera 20 mega pixel, 16X and discussed with their corresponding features of authors who performed earlier studies in other species. The muscles of mastication showed a variation in relative size, attachments and lamination between the rabbit and cat.

Key words: Anatomy, Mastication, Muscles, Rabbit, Cat.
Email: drsamah.elbably@yahoo.com

Introduction

Ten cats and ten rabbits of apparently healthy, adult of both sexes were used in the present study. The animals were anesthetized by using cotton soaked in chloroform in closed glass box. Five of each species were formalized and the remaining five were used in fresh state. The animal was dissected to expose the heart and the left ventricle was cannulated and injected with formalin solution (10% formalin, 4% phenol, 1% glycerin), followed by immersion in formalin solution for 2 -3 days **(Tompsett** and **Wakelly, 1965)**.

The individual muscles were weighed in the fresh state by using the 4 Digit balance and their attachments noted. Comparisons between muscles masses between the two species under investigation, one head of each species were sagittaly cut by using manual bone saw to demonstrate the muscles on the medial surface of the mandible.

one head of each species were used for preparing bony specimens according to the technique adopted by **(Nawrocki; 1997, Moser et. al., 2002 and Margaret, 2007)**.

Degreasing, bleaching and dryness of the prepared bony specimens were applied in accordance with the techniques of **(NPS museum handbook, 1999, Moser et. al., 2002 and Van Gestel, 2005)**.

The data were identified using the nomenclature according to **Nomina Anatomica Veterinaria Nomina Anatomica Veterinaria (2005)** and **Turnbull (1970)**.

Results

The masticatory or jaw muscles comprised the masseter, temporalis, pterygoid and digastric muscles

The muscles of mastication varied in its size and complexity in different mammals especially between herbivore and carnivore. The jaw muscles occupy most parts of the head region and have a broadly distributed origins and insertions on the skull and mandible, but the main factor that contributes to functional complexity is the fact that most muscle fibers attached to internal aponeuroses rather than to the bones directly **Herring (2007)**. The masticatory muscles in mammals defined as the jaw musculature, which formed of jaw-closing muscles as: masseter, temporalis and medial pterygoid muscles and a single jaw-opening muscle as: digastric muscle. The lateral pterygoid muscle is to pull the head of the condyle out of the mandibular fossa to protracts the mandible and help to stabilize the tempromandibular joint **(Turnbull, 1970)** and **Warburton, 2009)**.

The importance of the masticatory muscles, fortified many investigators to give an attention to these muscles. In this connection, these muscles were early described by **Toldt (1905)** in human and domestic animals. **Turnbull (1970)**, **Yoshikawa. et. al. (1961)** and **Yoshikawa** and **Suzuki (1965)** in mammals, **Sasaki. et. al. (2001)** in the giraffe, **Wally** and **Farag (2008)** in the donkey and **Kalifa** and **Daghash (2010)** in the camel. Moreover, the correlation between the diet and jaw musculature was also studied by many authors **(Sanson, 1979, 1980, 1989; Hume, 1982; McArthur and Sanson, 1988; Lentle et al., 1998, 2003; Warburton, 2009 and Vineyard et. al., 2011)** in Kangaroos, Wallabies, Rat-Kangaroos and new world monkeys respectively.

The current investigation is therefore a trial to continue the efforts of the previous authors who studied the muscles of mastication in cat and rabbit

Results

The masticatory or jaw muscles comprised the masseter, temporalis, pterygoid and digastric muscles

M. Masseter

The masseter muscle was the largest and more complex of all the musticatory muscles. It was divided into two main groups, superficial and deep. groups were arranged in two layers in the rabbit and in three ones in the cat.

Pars superficialis

In the rabbit; the superficial masseter was divided into four parts, the lateral superficial masseter part1A, the reflected superficial masseter, the medial superficial masseter part 1B and the superficial masseter part 2.

The lateral superficial masseter part1A (fig. 1A, B /1), was a fan shaped muscle, with rounded ventral border at the ventral margin of the mandible. It was originated from the ventral and lateral aspects of the rostral part of the zygomatic arch (fig. 6A/M3). Its fibers fan out towards their insertion along the length of the caudolateral edge of the angular process. A thick sheet of fascia invested upon the proximal portion of the masseter muscle (fig. 6C/M8).

The reflected portion of the superficial masseter (fig. 1A, B, 3C, D/2), was a small cord like muscular band. It arose from the rostral part of the zygomatic arch, just rostral to the origin of the superficial masseter part1A (fig. 6A/ M3). Its initial portion extended downward in a vertical direction till reaching the ventral edge of the mandibular angle around which it curved caudally and its fibers extended in an almost horizontal direction along the length of the ventromedial edge of the angular process and inserted all over this region (fig. 6C/M10).

The medial superficial masseter part1B (fig. 1A, B/3), was formed of a parallel fibers that almost entirely overlapped by the superficial masseter part 1A, except only a small part appeared superficially, caudal to the latter muscle. It was originated from the lateral face of the zygomatic arch (fig. 6A/M4) and inserted by an aponeurosis at the caudal rim of the angular process, just caudal to the insertion of the superficial masseter part 1A (fig. 6C/M8).

The superficial masseter part2 (fig. 1B, C/4), Represented the fleshy portion of the masseter that originated from the ventral margin of the zygomatic arch (fig. 6A/M5) and inserted into the masseteric fossa and mandibular angle (fig. 6C/M9).

In the cat; The superficial masseter muscle (fig. 2A, B, C/MS), Was represented by a bulky mass that originated from the maxillary process of the zygomatic arch (fig. 7A, B/M1), and its fibers extended caudally towards the ventral edge of the mandible around which it was rolled to be inserted into the medial face of the angular process (fig. 7C/M6).

Pars profunda

In the rabbit; the deep masseter muscle was represented by **zygomaticomandibularis** and composed of rostral and caudal parts.

The rostral masseter muscle (fig. 1B, C/5), was situated rostral and deep to the superficial masseter part2. It was originated from the medial and ventral aspects of zygomatic arch (fig. 6A/M5). Its fibers extended vertically, to be inserted in the ascending ramus of mandible (fig. 6C/M11).

The caudal deep masseter (fig. 1A, B, C/6), was attached to the ventral and medial aspects of the caudal portion of the zygomatic arch. It extended rostroventrally, caudal to the rostral deep masseter and the superficial masseter part2 (fig. 6A/M5). Its fibers converge to be inserted just under the lateral edge of the condyloid process of the mandible (fig. 6C/M12).

In the cat; The deep masseter muscle (fig. 2B, C/ MD) arose from the ventral edge of the zygomatic arch (fig. 7A, B/M2) and was arranged into two layers; an outer and an inner layer. The outer layer was in the form of bundles of fleshy parallel fibers passing slightly caudally and had several delicate tendinous sheets. It was inserted on the lateral surface of the mandibular ramus near the angular process as well as the adjacent ventral border of the masseteric fossa (fig. 7C/M7).

The inner layer represented the M. **zygomaticomandibularis** which composed a small rostral (fig. 2C/7) and a larger caudal portion (fig. 2C/8) which arose from the rostral and caudal portions of the medial face of the zygomatic arch respectively. The two portion extended in an oblique downward direction and blended together to be inserted in the masseteric fossa, (fig. 7C/Z2)

M. Temporalis

The temporalis was the largest muscle of the mastication in the cat, equal in bulk to all the rest of the masticatory muscles and its weight larger three times than the weight of the same muscle in the rabbit (table1). It consisted of two portions; superficial and deep.

Pars superficialis

In the rabbit; the superficial temporal muscle (fig. 3A, B/ 9), originated from the dorsolateral surface of the skull, along the border of the parietal and temporal bones (fig. 6A/ T1). The fibers converged to a rounded tendon that passed through a sort of canal, at the caudal edge of the orbit. Its tendon inserted at the rostral edge of the coronoid process of the mandible (fig. 6C/ T2).

In the cat; the superficial temporal muscle was covered by the thick temporal fascia and was formed two parts; the medial parts was defined as the **Pars superficialis** (fig. 4A/ 9) which arose from the temporal line and zygomatic process of the frontal bone

while the lateral part was defined as the **Pars zygomaticus** (fig. 4A, C/10) that originated from the dorsal edge of the zygomatic process of the temporal bones. The two portions converge in a V-shaped manner overlapping the deep temporal muscle to be inserted by a short thick tendon in the rostral border of the coronoid process (fig. 7C/T2)

Pars profunda

In the rabbit; the deep temporal muscle (fig. 3C, D/11), composed of two parts; lateral and medial deep temporal, it occupied the caudal wall of the orbit (fig. 6A/T1). **The lateral deep temporal muscle** (fig. 3B/13), was in the form of a large mass which was formed of a small dorsal head and a large ventral head. The ventral head inserted in a depression on the medial surface of the neck of the coronoid process, its insertion covered by the medial pterygoid muscle. **The medial deep temporalis** (fig. 3B/12), originated from a small depression, rostral to the origin of the lateral deep temporalis. Its fibers converged to a small tendon, which inserted on the rostromedial surface of the neck of the coronoid process (fig. 6C/T3).

In the cat; the deep temporal muscle (fig. 4A, B, C/11) was a large, pear-shaped muscle, it originated from the wall of temporal bone in its caudal part and sagittal, lambdoidal crests in its rostral part (fig. 7A, B/T1) and passed forward to be inserted by the temporal tendon in the inner surface of the coronoid process. (fig. 7C/T3).

M. Pterygoideus

The medial pterygoid muscle was a large muscle, had a characteristic weight and shape in the rabbit (table 1).

M. Pterygoideus medialis

In the rabbit; the medial pterygoid muscle (fig. 3C, D/14), was a thick, fan-shaped muscle, covered the most medial surface of the mandibular angle; It consisted of two layers, superficial and deep layers, differing in its fibers orientation, the **superfacial layer** (fig. 3C/14'), had an oblique caudoventrally directed fibers and **the deep one** (fig.3C/14"), had a vertical fibers direction. These originated from the pterygoid process of the alisphenoid and the pterygoid fossa (fig. 6A, B/MP1) and inserted over the medial face of the angular process (fig. 6C/MP2).

In the cat; it (fig. 4D/14), was a thick fleshy mass, covered the most medial surface of the mandibular angle; it composed of two layers, superficial and deep, the deep was smaller than the superficial one and completely covered it. These originated from the lower edge of the infratemporal fossa (fig. 7B/MP1) and inserted into the lower edge of the caudal half of ascending ramus and caudal edge of angular process (fig. 7C/MP2).

M. Pterygoideus lateralis

In the rabbit; the lateral pterygoid muscle (fig. 3C /15), located at the ventral wall of the orbit after removal the anterior temporal mass. It composed of two heads, superior head and inferior one. **The superior head** (fig. 3D/16) was a small head originating at the junction between the alisphenoid, palatine and pterygoid bones (fig. 6B/LP1) and passed caudodorsally medial to the deep temporal mass to be inserted in a small depression just below the condyle on the medial surface of the condyloid process (fig. 6C/LP2). **The larger inferior head** (fig. 3D/17) arose from the dorsal surface and caudolateral edge of the pterygoid bone (fig. 6B/LP1) and followed the superior head and inserted in a larger depression surrounding the tendon of insertion of the medial pterygoid muscle (fig. 6C/LP2).

In the cat; it was a slender bundle, smaller in diameter, it originated near in the vicinity of the foramen rotundum, from pterygoid process (fig. 7B/LP1), passed horizontally in backward direction towards the medial edge of the condyloid process of the jaw (fig. 7C/LP2).

M. Digastricus

In the rabbit; the digastric muscle (fig. 5A/18), was in the form of a spindle shaped muscle, which consisted of a single rostral belly. The Venter rostralis (fig. 5A/18') and ended with a tendon, the Tendo intermedia (fig. 5A/18"). It was originated from the occipital bone, just caudal to Bulla tympanica (fig. 6B/D1), passed parallel to the mandible and inserted into the medial surface of the mandibular ramus close to the mandibular symphsis (fig. 6C/D2).

In the cat; the digastric muscle (fig. 5B/18) consisted of a two bellies separated by tendenous inscription; **Venter rostralis** (fig. 5B/18') and **Venter caudalis** (fig. 5B/18"), they passed under the lower edge of the masseter. It originated just caudal to the Bulla tympanica (fig. 7B/D1), its fiber was a straight and parallel passed in a forward direction under the edge of the ascending ramus until reach to be inserted in the mandibular symphsis (fig. 7C/D2).

Statistical studies:

The table 1 showed the differences in weights of the muscles of mastication between the rabbit and cat; the dominant muscle in each animal determined according to the weight of the muscle, in relation to the skull weight, so the table showed that; the temporal muscle weighted 3.63 gm that three times larger than the similar muscle in the rabbit that weighted 0.56 gm. The medial pterygoid in the rabbit weighted 1.98 gm larger two times than the medial pterygoid that weighted in cat 0.62 gm. The masseter considered one of the voluminous muscles in the cat and rabbit, in the cat weighted 1.65 gm and in the rabbit weighted 1.64 gm. The table also showed that the lateral pterygoid in the cat nearly neglicable, it weighted 0.04 gm while, in the rabbit weighted 0.28 gm. From the previous data; the largest muscles in the rabbit were the masseter then the medial pterygoid while in the cat; the temporalis then the masseter muscles.

Muscle	Average weights in (R) grams	%	Average weights in (C) grams	%
1- Masseter superfacialis	0.95	19.8	0.72	10.2
2- Masseter profundus	0.69	14.4	0.93	13.2
3- Zygomaticomandibularis	0.00	0.00	0.54	7.7
4- Temporalis	0.56	11.6	3.63	51.6
5- Pterygoideus medialis	1.98	41	0.62	8.8
6- Ptergoideus lateralis	0.28	5.8	0.04	0.6
7- Digastricus	0.36	7.4	0.56	8
Total	**4.82 gm**		7.04 gm	

Table 1: Average weights of the Masticatory Muscles in Rabbits (R) and Cats (C)

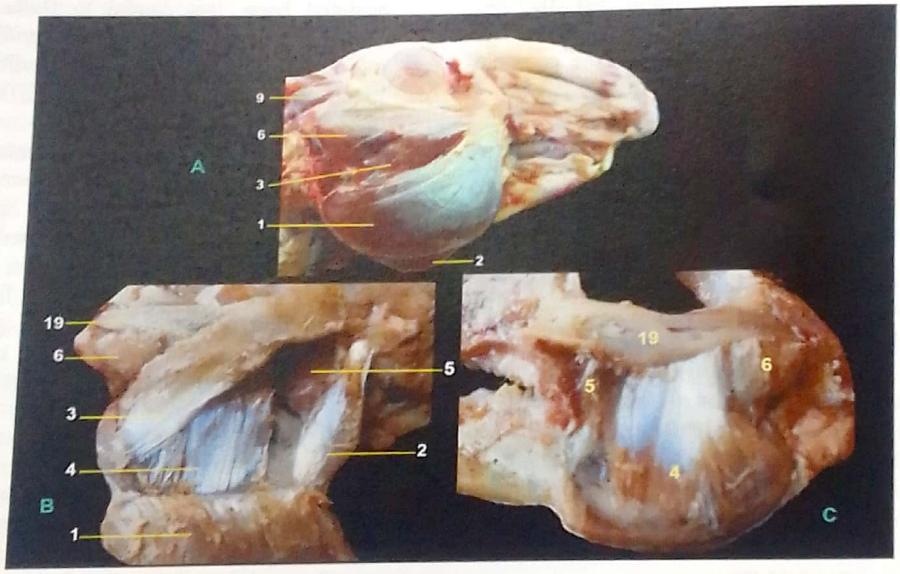

Fig.1: A photograph showing layers ofthe masseter muscle in the rabbit (lateral view) A- superficial layer: B, C- Deep layer.

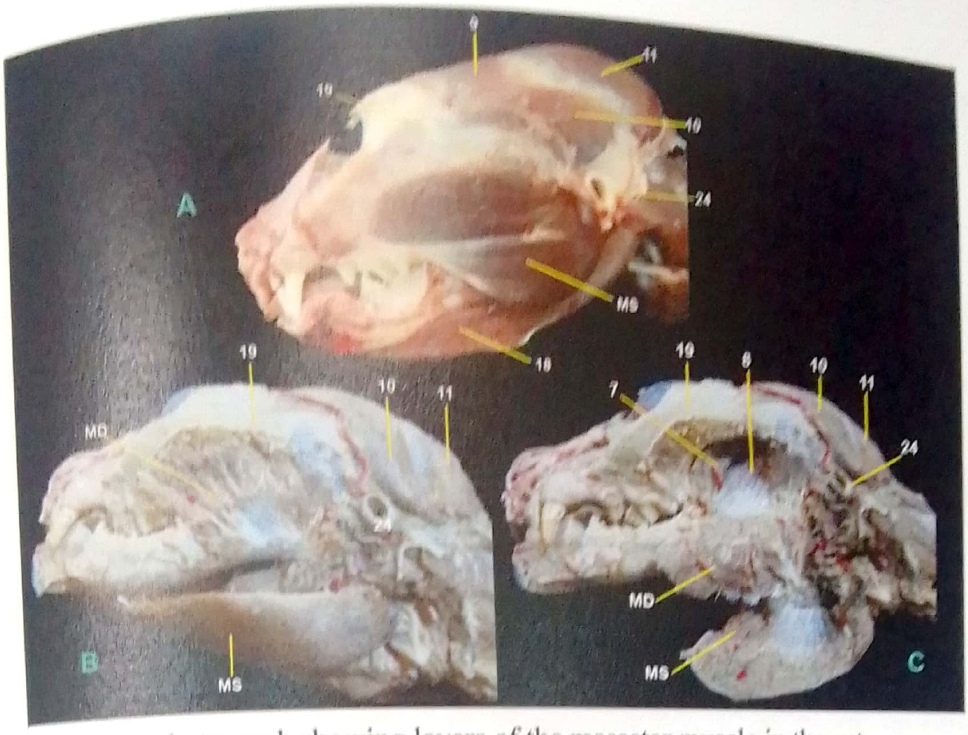

Fig.2: A photograph showing layers of the masseter muscle in the cat (Lateral View). Superficial layer: B- Intermediate layer: C- Deep layer

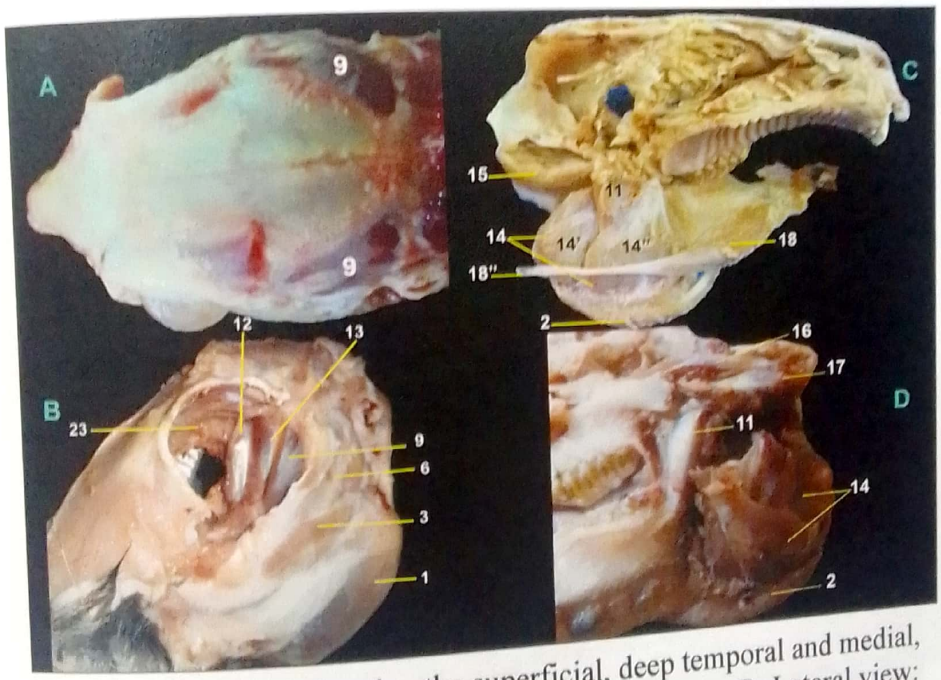

Fig.3: A photograph showing the superficial, deep temporal and medial, lateral pterygoid muscles in the rabbit. A- Dorsal view: B- Lateral view: C, D- Medial view.

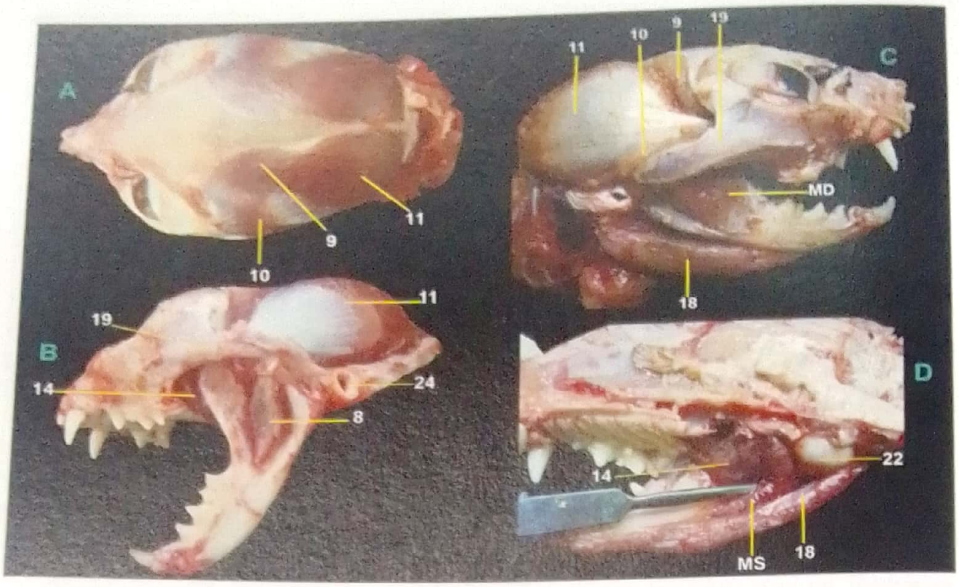

Fig.4: A photograph showing the superficial, deep temporal and medial, lateral pterygoid muscles in the cat. A- Dorsal view: B, C- Lateral view: D- Medial view.

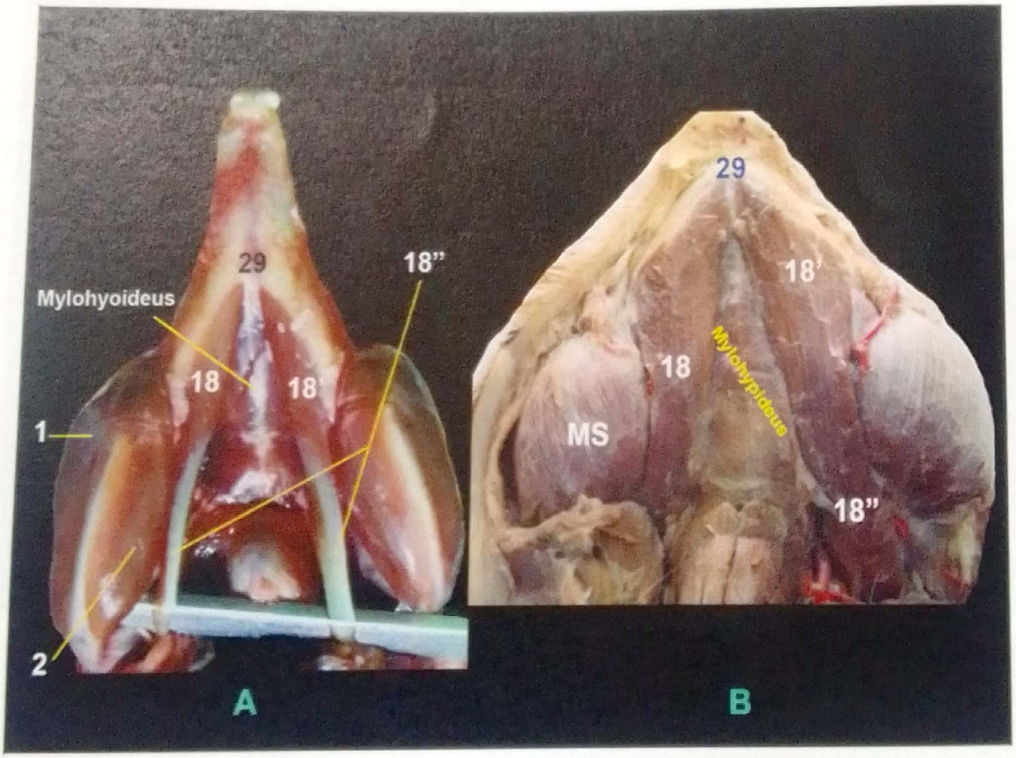

Fig.5: A photograph showing the digastric muscle (Ventral view). A- Rabbit. B- Cat.

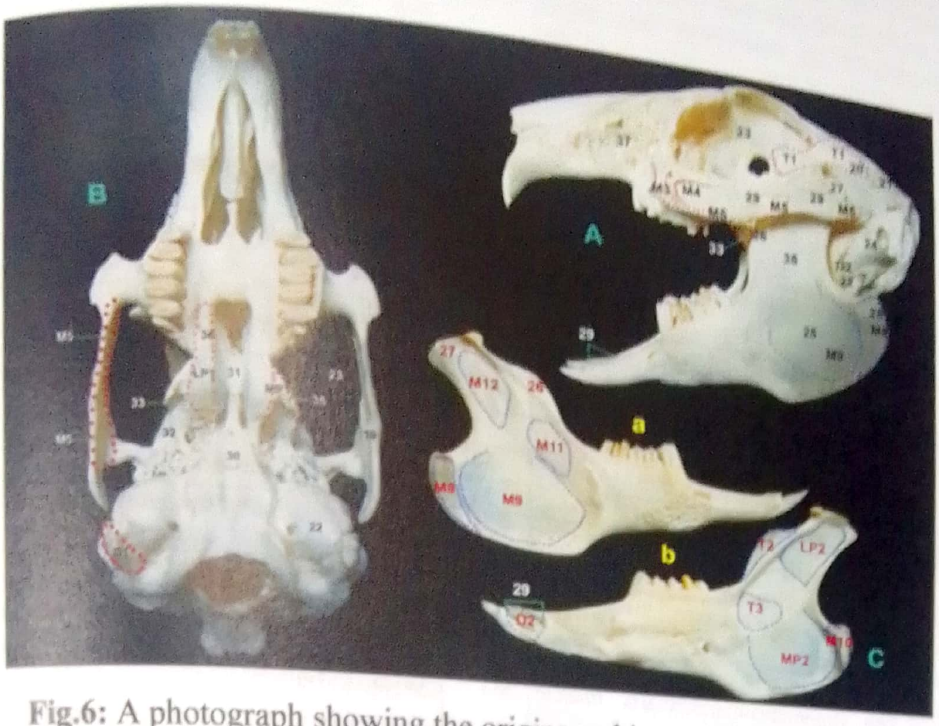

Fig.6: A photograph showing the origins and insertions on the skull of rabbit. A- Lateral view. B- Ventral view. C- Mandible (a- Lateral view ; b- Medial view).

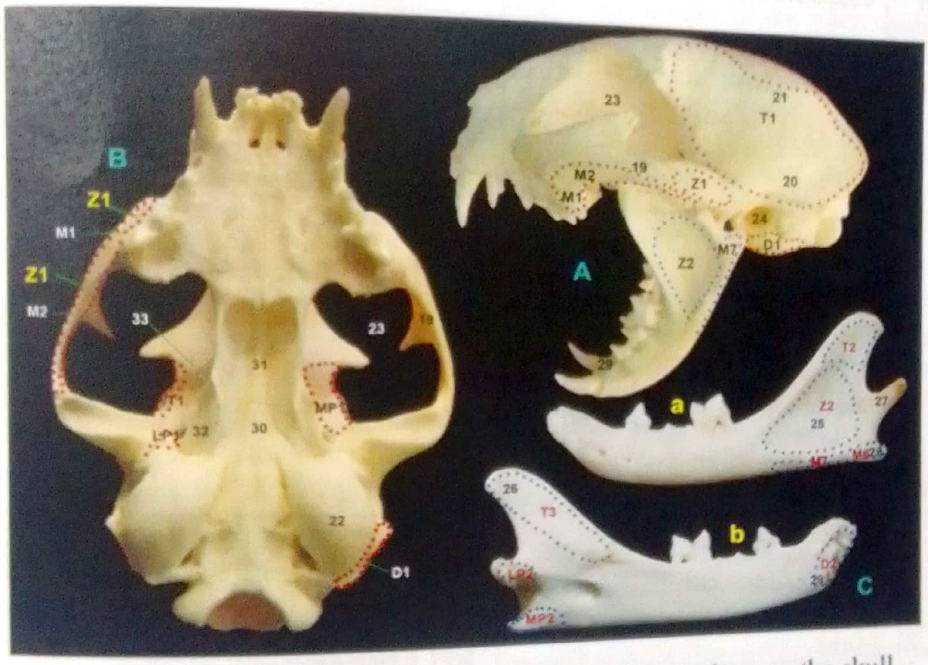

Fig.7: A photograph showing the origins and insertions on the skull of cat. A- Lateral view. B- Ventral view. C- Mandible (a- Lateral view ; b- Medial view).

Legends for figures (1-7)			
M	Masseter muscle	29	Region of mandibular symphysis
MS	Superficial masseter	30	basisphenoid
1	The superfacial masseter part 1A	31	Presphenoid
2	The reflected portion	32	alisphenoid
3	The superfacial masseter part1B	33	Hamulus of pterygoid process
4	The superfacial masseter part2	34	Pterygoid process of alisphenoid
MD	Deep masseter	35	Pterygoid fossa
5	The rostral deep masseter muscle (rabbit)	36	Prependicular part of palatine bone
6	The caudal deep masseter muscle (rabbit)	37	Fenestrated region of rostrum
Z	Zygomaticomandibularis muscle	38	Ascending ramus of mandible
7	The zygomaticomandibularis muscle (anterior part) (cat)	M1	Origin of superfacial masseter (cat)
8	The zygomaticomandibularis muscle (posterior part) (cat)	M2	Origin of deep masseter muscle (cat)
T	Temporal muscle	M3	Origin of superfacial masseter part 1A & reflected part
9	The superfacial temporalis	M4	Origin of superfacial masseter part 1B
10	Zygomatic part of temporal	M5	Origin of superfacial part 2 & deep rostral & caudal masseter muscle
11	The deep temporalis	M6	Insertion of superfacial masseter (cat)
12	Medial Head	M7	Insertion of deep masseter (cat)
13	lateral Head	M8	Insertion of superfacial masseter part 1A & 1B
14 14' 14"	Medial pterygoid muscle Superfacial layer Deep layer	M9	Insertion of superfacial masseter part2
15	lateral pterygoid muscle	M10	Insertion of reflected part
16	Superior Head	M11	Insertion of rostral deep masseter
17	Inferior Head	M12	Insertion of caudal deep masseter
18 18' 18" 18'"	Digastric muscle Anterior belly Intermediate tendon Posterior belly	Z1	Origin of zygomaticomandibularis muscle (cat)
19	Zygomatic arch	Z2	Insertion of zygomaticomandibularis muscle (cat)
20	Temporal bone	T1	Origin of superfacial & deep temporal
21	Parietal bone	T2	Insertion of superfacial temporal
22	Bulla tympanica	T3	Insertion of deep temporal
23	Orbit	MP1	Origin of medial pterygoid
24	External auditory meatus	MP2	Insertion of medial pterygoid
25	Masseteric fossa	LP1	Origin of lateral pterygoid
26	Coronoid process	LP2	Insertion of lateral pterygoid
27	Condyloid process	D1	Origin of digastric muscle
28	Angular process	D2	Insertion of digastric muscle

In this study, [illegible] description of the masticatory muscles as well as the relative size, represented by the weight in both rabbit and cat and it concluded that, the masticatory apparatus was dominated by the temporalis muscle in cats, while the masseter and medial pterygoid had a voluminous size in rabbits, similar findings were also reported by

(Herring, 2007; Weijs and Dantuma, 1981; Russell,

1998) in rabbit, **(Herring, 2007)** in cat and **Miller et. al., (1996)** in the dog. **Dyce and Sack (2010)** gave similar observation in the dog and explained that, the masseter muscle was better developed in herbivorous species that make lateral and rotational movements when chewing, while, the temporalis was especially large in carnivores species, in which the chief jaw movement is scissor like. It is to add that the dominant of the masticatory muscles were the masseter and medial pterygoid **(Smith and Savage, 1959; Schumacher, 1961; Turnbull, 1970; and Koppe, et al., 1987)** in the mammals, **(Wally and Farag, 2008)** in the donkey, **(Khalifa and Daghash, 2010), (Vinyard. et. al., 2011)** in new world monkeys and **(Sharp and Trusler, 2015)** in common wambat.

In agreement with; **Yoshikawa et al. (1961, 1962)** in mammals and ruminants, the masseter divided was divided into superficial and deep masseter. It is to add that the superficial masseter in the rabbit was divided into four parts in accordance to what recorded by **Russell (1998)**, while that of the cat the superficial masseter was formed of only one mass similar to that recorded by **Turnbull (1970)**. While **Toldt (1905)** description reported a union between the superficial masseter and medial pterygoid.

In accordance to the observation of **Russell (1998)** in rabbit, **Turnbull (1970)** in cat, the superficial masseter muscle arose from the zygomatic arch and inserted into the angular process, masseteric fossa and angle of mandible in rabbit and only into the angular process in cat. In this connection it was originated from the facial crest and zygomatic process of the zygomatic bone and inserted in the ventral and distal part of the caudal borders of the mandible as mentioned by **Sisson and Grossman (1975)** in horse, **Wally and Farag, (2008)** in the donkey and **Khalifa and Daghash (2010)** in camel.

In agreement with, **Turnbull (1970)** in the cat, the deep masseter was arranged into two layers; an outer and an inner layer, the inner layer represented the zygomaticomandibularis muscle, which composed of a small rostral and a larger caudal portion. These finding disagreement with **Toldt (1905)** description ensure the fusion between the deep layer of the masseter and zygomatic portion of the temporal forming zygomaticomandibularis muscle.

[illegible] of **Russell (1998)** in deep masseter muscle occupied the deep layer and called zygomaticomandibularis, the deep masseter muscle occupied the dorsal part of the masseteric fossa and also divided into rostral part and caudal part mentioned by **Yoshikawa and Suzuki (1965)** in mammals and **Wally and Farag, (2008)** in the donkey, **Khalifa and Daghash (2010)** in camel.

In accordance to the observation of **Turnbull (1970)** in cat, the outer layer of deep masseter muscle arose from the zygomatic arch and inserted into the lateral surface of the mandibular ramus near the angular process, while the inner layer represented the M. **zygomaticomandibularis** arose from the the zygomatic arch and inserted into the masseteric fossa. Similar to the observation of **Russell (1998)** in rabbit, the deep masseter muscle originated from the zygomatic arch and inserted into the ascending ramus and condyloid process of mandible.

In agreement with, **Turnbull (1970)** in cat and **(Miller et. al., 1996 and Dyce and Sack, 2010)** in the dog, the temporalis muscle is divided into; superfacial part and deep part, the superfacial part divided superficial part and zygomatic part. It arose from the temporal line, zygomatic process of the frontal and temporal bones and inserted into the coronoid process.

In accordance with, **Russell (1998)**, the deep temporalis muscle, in the rabbit, composed of two parts, lateral and medial deep temporal, it occupied the caudal wall of the orbit, it arose from the temporal fossa and inserted into the neck of the coronoid process. While according to **turnbull (1970)** in cat, it is a large, pear-shaped muscle, originates from the wall of temporal bone and sagittal, lambdoidal crests and inserts in the inner face the coronoid process.

In agreement with **Russell (1998)** in the rabbit, The medial pterygoideus muscle coverd the most medial surface of the mandibular angle; superficial and deep layers, in this study, the two layers can be easily separated from each other, differing in its fiber orientation in the rabbit, the superficial layer had an oblique caudoventrally directed fibers and the deep layer had a vertical directed fibers. While a very difficult to separate the two layers in the cat, these results disagreement with **Turnbull (1970)** in cat and **Miller et. al., (1996)** in the dog which divided the medial pterygoid into superficial and deep layers and it divided the superficial into anterior and posterior parts but **Sharp and Trusler (2015)** in common wambat also can not separate the superficial from the deep layer.

In this study, the medial pterygoid muscle originated from the pterygoid process of the alisphenoid and the pterygoid fossa and inserted over the medial face of the angular process similar to **Russell (1998)** in rabbit and **Miller et. al., (1996)** in the dog. According to **Turnbull (1970)** in cat, it originated from the lower edge of the infratemporal

fossa and the superfacial layer divided into anterior and posterior portion, inserted into the of posterior edge ascending ramus and angular process.

Similar to **Russell (1998)** in rabbit, the lateral pterygoideus composed of two heads superior and inferior heads, it originated from the alisphenoid, palatine and pterygoid bones, and inserted in a small depression just below the condyle on the medial surface of the condyloid process. It had a characteristic size in rabbit than cat which was neglacable as stasted by **Tolds (1905)** due to the movement of the jaw during the mastication process need only the powerfull closure action of the temporalis against upper jaw with the action of the masseter and medial pterygoid, in addition to the powerfull molars in cutting process, but this results disagreement with **turnbull (1970)** in cat which recorded that, the lateral pterygoid muscle divided into two portion, fleshy portion and tendenous one.

In this study, the digastric muscle was a spindle shape muscle, end with a tendon, it arose from the occipital bone and inserted into mandibular symphsis at the lower jaw, **(Baisden et. al., 1985, 1988) and Tsuruyama. et. al., (2002)**, while it composed of a single anterior belly in rabbit and composed of two bellies separated by tendenous inscription and a powerfull opening muscle in cat. It originated just caudal to the bulla tympanica and inserted in the body of mandibular these finding similar to **turnbull (1970)** in cat. **Miller et. al., (1996)** in the dog added that, it originated from the paraoccipital process and inserted into the mandible body.

Acknowledgment

I wish to express my sincere thanks to **Prof. Dr. Fouad. M. Farag,** Professor and Head of Anatomy and Embryology, Faculty of Veterinary Medicine, Cairo University for his great help, supervision, interest and wrathful advice in this study.

References

Baisden, R. H.; Woodruff, M. L.; Whittington, D. L.; and Benson, A. E.; (1985): The moto innervation of the single-bellied digastric muscle in the rabbit: a retrograde horseradish peroxidase study. Neurosci Lett. 1985 May 14;56(2):129-36.

Baisden, R. H.; Woodruff, M. L.; Whittington, D. L.; and Benson, A. E.; (1988): Muscle Spindles in the Digastric Muscle of the Rabbit. J DENT RES September 1988 67: 1243-1245.

Dyce K, WO Sack and CJG Wensing, (2010): Textbook of veterinary anatomy. The Musticatory system, pp: 107-115.

Herring, S. W.; (2007): Musticatory Muscles and the Skull. Arch Oral Biol. April; 52(4):296-299.

Hildebrand, M. (1968): Anatomical preparation, Berkelely and Los Angeles: University of California press.

Hume, I. D. (1982): Digestive physiology and nutrition of marsupials.Great Britain: Cambridge University Press.

Khalifa and **Daghash (2010):** The Lamination and Arterial Blood Supply of the Masseter Muscle of Camel (Camelus dromedarius). .Vet.Anat. Vol. 3 No. 1.

Koppe, T., B. Schumacher, and K,-U, Schumacher, 1987: Funkitionelle Morphologie des maxillo-mandibularen Apparates beim Miniaturschwein Mini-Lewe. Anat. Anz. 164:181-188.

Lentle, R. G.; Hume, I. D.; Stafford, K. J.; Kennedy, M.; Haslett, S.; and Springett, B. P.; (2003): Comparison of tooth morphology and wearpatterns in four species of wallabies. Aust J Zool 51:61–79.

Lentle, R. G.; Stafford, K. J.; Potter, M. A.; Springett, B. P.; and Haslett, S.; (1998): Incisor and molar wear in the tammar wallaby (Macropuseugenii Desmarest). Aust J Zool 46:509–527.

Mackey, W, J. (1991): Prepration of skeletal display of animals, United states patent.

Margaret Cox. (2007): Ambikaflavel, Lan Hanson, Joanna Laver, Roland Wessling. The Scientific Inveinstigation of Mass Graves.

McArthur C, Sanson GD. (1988): Tooth wear in Eastern Grey Kangaroos (Macropus giganteus) and Western Grey Kangaroos (Macropus fuliginosus), and its potential influence on diet selection, digestion and population parameters. J Zool (Lond) 215:491–504

Miller ME, GC Christensen and HE Evans, (1996): Anatomy of the dog. WB Saunders Co, Philadelphia.

Moser, D., Duerr, R., and Hawkes, J. (2002): Marine mammal Skeletal Preparation and Articulation. November 28-December 3, 2002. poster presentation at the Biennial Conference on the Biology of marine mammals.

Nomina Anatomica Veterinaria (2005): 5th edition. Prepared by the international Committee on Veterinary Gross Anatomical Nomenclature (I.C.V.G.A.N) and authorized by the General Assembly of the World Association of Veterinary Anatomists (W.A.V.A.), Knoxville,TN (USA). Puoxblished by the Editorial Committee, Hannover, MaColumbia, Gent, and Sapporo

Nowrocki, S. (1997): Cleaning Bones. University of

Indianapolis Archaeological Laboratory (http:// archlab. Uindy,edu).

NPS Museum Handbook (1999k): Part1. Appendix T, Biological collections, 1999.

Russell, A. P. (1998): The mammalian masticatory apparatus: An introductory comparative exercise. Pages 271-286.

Sanson, G. D. (1979): The evolution and significance of mastication inthe Macropodidae. Aust Mammal 2:23–28.

Sanson, G. D. (1980):. The morphology and occlusion of the molariformcheek teeth in some Macropodinae (Marsupialia; Macropodidae).Aust J Zool 28:341–365.

Sanson, G. D. (1989): Morphological adaptations of teeth to diets and feeding in the Macropodoidea. In: Grigg G, Jarman P, Hume I,editors. Kangaroos, wallabies and rat-kangaroos, NSW Australia: Surrey Beatty and Sons. p 151–168.

Sasaki, M.; Endo, H.; Kogiku, H.; Kitamura, N.; Yamada, J.; Yamamoto, M,; Arishima, K. and Hayashi, Y. (2001): The structure of the masseter muscle in the Giraffe (Giraffa camelopardalis). Anat. Histol. Embryol., Vol. 30, Pp. 313-319.

Schumacher, R. J. G., 1961: Funktionelle Morphologie der Kaumuskulatur. Jena: VEB Gustav Fischer-Verlag, pp. 1-202.

Sharp. A. C., and Trusler. P. W., (2015): Morphology of the jaw closing musculature in the common wambat (Vombatus urisinus) using digital dissection and magnetic resonance imaging. School of Earth, Atmosphere and Environment, Monash University, Clayton, Victoria, Australia.

Sisson and Grossmans (1975): The anatomy of the domestic animals- 5th ed.W.B. Saunders comp., Philadelphia London. Toronto.

Smith, J. M., and R. J. G. Savage, 1959: The mechanics of mammalian jaws, School Sci, Rev, 40, 289-301.

Tomsett, D. H. and C. W. Wakeley (1965): Anatomical Techniques. 1st Edition. E & Living Stone Ltd. Edinburgh and London.

Toldot, C. (1905): Der Winkelfortasaz des Unterkiefers beim Mansschen und bei den Saugetieren und die Beziehung der Kaumuskulatur zu demselben. Teil. II. Sitz. K. Akad. Wiss. Wien. Math. Nat. K1. 114, 315-476.

Turnbull, W.D. (1970): Mammalian masticatory apparatus. Fieldiana Geol. 18, 149-356.

Tsuruyama, K.[a,b]; Scott G.[a]; Widmer C.G.[c]; and Lund J.P; (2002): Evidence for Functional Partitioning of the Rabbit Digastric Muscle. [a]Faculty of Dentistry, McGill University, Montreal, Quebec, Canada; [b]Nihon University School of Dentistry at Matsudo, Chiba, Japan; [c]University of Florida, Gainesville, Fla., USA; [d]Centre de Recherche en Sciences Neurologiques, Université de Montréal, Montreal, Quebec, Canada. Cells Tissue Organs 170: 179-182..

Van Gestel, W. (2005): Cleaning Skulls and Skeletons by Maceration. http://www. Skullsite. Com/misc/macerationmanual.htm.

Vinyard, C. J.; Taylor, A. B.; Teaford, M. F.; Glander, K. E.; Ravosa, M. J.; Rossie, J. B.; Rayan, T. M.; and Williams, S. H.; (2011): AreWe Looking for Loads in All the RightPlaces? New Research Directions forStudying the Masticatory Apparatus ofNew World Monkeys. The Anatomical Record 294:2140–2157.

Yoshikawa, T., Suzuki, T., Kiuchi, R. and Matsuura, H. 1961: The comparative anatomy of the musculus masseter of the mammals. Acta Anat. Nippon. 36:53-71.

Yoshikawa, T., Suzuki, T., Kiuchi, R. and Matsuura, H. 1962: The lamination of the masseter of the ruminantia. Acta Anat. Nippon. 37:430-442.

Yoshikawa, T., Suzuki, T. (1965): The comparative anatomical study of the masseter of the mammal II. Okajimas Fol. Anat. Jpn. 40:339-363.

Wally,Y.R. and F.M. Farag (2008): The lamination and arterial blood supply of the masseter muscle in the donkey. J.Vet.Anat. Vol. 1 No. 1. 38-47.

Warburton, N. M.; (2009): Comparative Jaw Muscle Anatomy inKangaroos, Wallabies,and Rat-Kangaroos (Marsupialia: Macropodoidea). The Anatomical Record 292:875–884.

Weijs, W. A. and Dantuma, R. (1981): Functional anatomy of the masticatory apparatus of the rabbit (Oryctolagus cunuculus L.) Netherlands journal of Zoology, 31:99-147.

دراسة تشريحية مقارنة على عضلات المضغ فى الأرنب و القط

سماح البابلي - مدرس التشريح والأجنه – كلية الطب البيطري- جامعة القاهرة

أجريت الدراسة على عضلات المضغ فى اربعة و عشرون من الأرانب و القطط البالغة من الجنسين وتزن الواحدة مابين 2.5 -4.5 كيلوجرام لأجل الدراسة التشريحية . عولجت العينات التي إستخدمت للدراسة التشريحية، بعد ذبحها وإستنزافها للتخلص من بقايا الدم فى أوعيتها الدموية, بحقنها بمادة الفورمالين ثم حفظت فى خليط من الفورمالين 10%, الفينول 4% والجليسرين 1% وتم تشريحها بدقة بعد ثلاث ايام و تم عمل الوصف التشريحي و الاحصائى على عضلات المضغ و هى العضله الماضغة، الصدغية، الجناحيةالأنسية، الجناحية الوحشية و ذات البطنين . و قد تبين: ان عضلات المضغ تختلف فى اشكالها, احجامها و اتجاه الالياف بين كل من الارانب و القطط نظرا لطبيعة غذاء كل منهما. و قد تم إعتماد المسميات واستخدام المصطلحات التشريحية البيطرية الدولية للحيوانات المستانسة لسنة 2005 في تسمية العضلات.وقد تم تزويد الدراسة بسبع صور للعينات بعد تشريحها ، وذلك لتوضيح النتائج. كما نوقشت النتائج المتاحة في الدراسة مع ما تم الحصول علية في الاعمال السابقة في الحيوانات المستانسة.