

Anatomy of Temporalis in Old World Hamsters

KAZUHIKO SATOH and FUMIHIKO IWAKU

Department of Oral Anatomy, Asahi University School of Dentistry

[Chief : Prof. Fumihiko Iwaku]

Summary The anatomy of the temporalis is described in Old World hamsters (cricetine murids), *Mesocricetus auratus*, *Cricetulus griseus*, *Phodopus sungorus*, and *Tscherskia triton*. In *Mesocricetus*, the temporalis is much larger than in the other genera and its origin nearly extends to the mid-sagittal line. On the basis of fiber direction and attachment site, the anterior part directed vertically, and posterior and deep parts running horizontally are recognized. The anterior part consists of three subdivisions, the orbital, lateral, medial portions. The first two portions have aponeurotic insertions and dominate the latter portion, which has a fleshy insertion, in mass. In contrast to cricetine species, previous reports on murine murids and sciurids indicate that the portion of the anterior temporalis with a fleshy insertion is richer than its aponeurotically inserting portion. Similar chewing patterns between cricetine murids and sciurids suggest that the relative mass of each subdivision is not determined by chewing pattern alone and that other functional factors are also involved.

Key words : Temporalis, Cricetine murids, Aponeurosis, Site of insertion

INTRODUCTION

The temporalis is the only masticatory muscle pulling the jaw backward. In rodents, although the masseter is much larger than the other masticatory muscles¹⁻⁴, the temporalis also plays important roles such as controlling chewing motion⁵⁻⁷, producing occlusal forces^{7,8}, and stabilizing the condylar position⁹.

The temporalis is a fan-shaped muscle, thus its fiber directions are not uniform. In addition, the insertion of this muscle has an aponeurosis that gathers fiber bundles on a narrow strip of the coronoid process^{8,10-21}. Thus, to compare the functional property of the temporalis among rodents, several subdivisions, each of which acts as a unit, must be recog-

nized.

Old World hamsters, murid rodents classified into the subfamily cricetinae, is an interesting group for anatomical studies on feeding apparatuses, because of its primitive cuspal arrangement and the unspecialized chewing pattern accompanied by a transverse jaw shift. However, the temporalis of this group has been briefly described only in *Mesocricetus*⁵. In the present study, the internal architecture of the temporalis was examined and the origin-insertion sites of each subdivision were illustrated in four cricetine genera.

MATERIALS AND METHODS

Four adult specimens of each species (*Mesocricetus auratus*, 115.3-141.0g; *Phodopus sungorus*, 22.2-33.6g; *Cricetulus griseus*, 26.8-32.7g; and *Tscherskia triton*, 101.4-118.9g) were dissected. These specimens were donated from the Experimental Ani-

mal Center, Miyazaki Medical College. Heads of the specimens were preserved in 10% formalin fluid, then the attachment site and architecture of the muscle were observed.

RESULTS

The temporalis takes origin from the squamosal and its adjacent area on the parietal and frontal, and inserts on the coronoid process. The coronoid process of Old World hamsters exceeds the condylar process in height (Fig. 1). In *Mesocricetus*, *Cricetulus*, and *Phodopus*, the coronoid process is strongly inflected posterodorsally, and its tip reaches the notch formed by the angular and condylar processes (Fig. 1a-c). In *Tscherskia*, however, the coronoid process is not excessively curved, and its tip lies anterior to the notch (Fig. 1d).

The temporalis is much larger in *Mesocricetus* than in the other three genera. In *Mesocricetus*, the origin of the temporalis extends nearly to the mid-sagittal line (Fig. 2a), and the interparietal, on which the temporalis never attaches, is very narrow. The other three genera have wide interparietal, and the origin of their temporalis is restricted to the lateral side of the brain case (Fig. 2b).

On the basis of fiber direction the anterior part directed vertically, and the posterior and deep parts running horizontally are recognized within the temporalis. The anterior part (Fig. 2a-c) originates from the area anterodorsal to the line connecting the middle point of the dorsal boundary of the squamosal and the most anteromedial point of the posterior zygomatic root. Most of the fibers in the anterior part have a fleshy origin. The fibers near the dorsomedial border of origin arise from the fascia covering the muscle, with the exception of that of *Cricetulus*. In

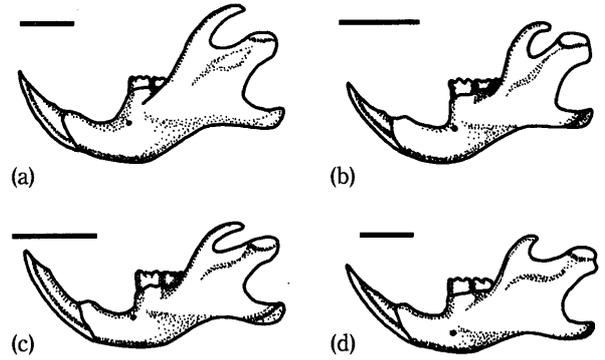


Figure 1. Mandible of cricetine murids. a : *Mesocricetus*, b : *Phodopus*, c : *Cricetulus*, d : *Tscherskia*. Scale bars are all 5 mm.

the anterior part of cricetine murids, the fibers with aponeurotic insertions dominate those with fleshy insertions in mass.

The anterior part consists of three subdivisions, the orbital, lateral, and medial portions. The orbital portion originates from the posterior wall of the orbit mainly formed by the frontal (Fig. 3a), and inserts with a thick tendon on the anterior limit of the retromolar fossa (i. e., the longitudinal groove between the molar row and the coronoid process) (Fig. 3b). The tendon of insertion also adheres along the anterior base of the coronoid process. Although this tendon is continuous with the aponeuroses for the lateral portion of the anterior temporalis (see below) and the medial layer of the masseter, the orbital portion is distinct from these two muscles.

The lateral portion arises from the anterodorsal

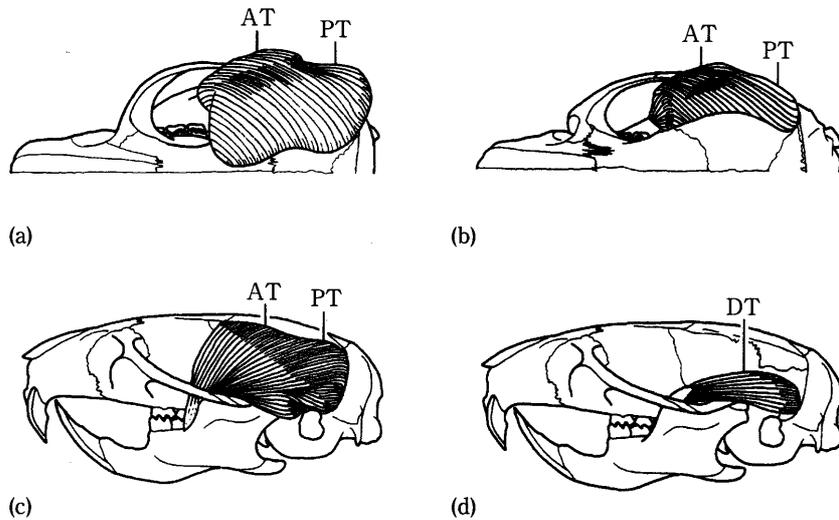


Figure 2. Temporalis of *Mesocricetus* (a) and *Tscherskia* (b-d). a and b : superficial and dorsal view, c : superficial and lateral view, d : lateral view after removal of the anterior and posterior parts. AT, anterior part ; DT, deep part ; PT, posterior part.

area of the squamosal and the inner side of the fascia covering the temporalis (Fig. 3a). For its insertion, an aponeurosis lies along the anterior edge of the coronoid process (Fig. 3b). The medial portion originates from the area just ventral to the origin of the lateral portion (Fig. 3a) and fleshly inserts to the medial aspect of the coronoid process (Fig. 3b).

The posterior part (Fig. 2a-c) fleshly arises from the area adjacent to the posterior half of the suture between the squamosal and parietal. This part also originates from the nuchal crest, which borders the origin of the temporalis posteriorly, and vertically runs from the outer limit of the interparietal to the external auditory meatus (Fig. 3a). The nuchal crest is more prominent in *Mesocricetus* than in the other genera. The posterior part of the temporalis inserts on the lateral aspect of the coronoid tip with a thick tendon (Fig. 3b).

The deep part (Fig. 2d) lies beneath the posterior part. This part of the temporalis is much thinner than the other two parts and has a fleshy origin and insertion. The deep part originates from the posterior area of the squamosal (Fig. 3a). Its insertion is located on the medial side of the coronoid tip (Fig. 3b).

In addition to the above three parts, the suprazygomatic head, which runs from the anterior edge of the glenoid fossa to the lateral side of the coronoid tip just below the tendon of the posterior part, was described in a previous study of *Mesocricetus auratus*⁵. This quite small muscle is also recognized in

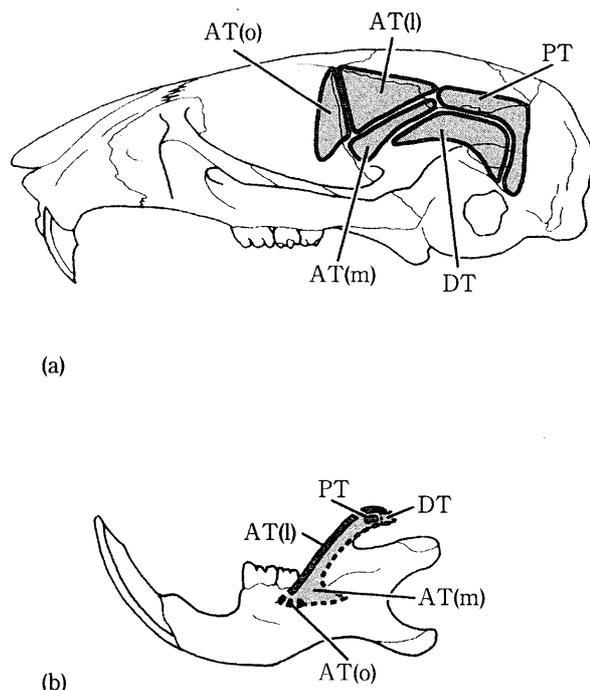


Figure 3. Origin (a) and insertion (b) of each part or portion. A solid or broken line indicates fiber attachment on lateral or medial side, respectively. A heavy line corresponds to an aponeurosis. A hatched area encircled by a thin line shows a fleshy attachment. AT (l) : lateral portion of anterior part, AT (m) : medial portion of anterior part, AT (o) : orbital portion of anterior part, DT : deep part, PT : posterior part.

Tscherskia. In *Phodopus* and *Cricetulus*, however, it is difficult to find the suprazygomatic head, because of their small cranial size.

DISCUSSION

In previous studies on the temporalis of rodents subdivisions have not been standardized. In many families, however, this muscle is commonly divided into four fiber groups running as follow: 1) from the posterior wall of the orbit to the retromolar fossa, 2) from the temporal ridge to the anterior margin of the coronoid process, 3) from the anterolateral aspect of the brain case to the medial side of the coronoid process, and 4) the posterolateral side of the brain case and the nuchal ridge to the tip of the coronoid process^{5,11,14~21}. In cricetine murids, the origin-insertion relation is the same as above for each fiber group. As in *Mesocricetus* and *Tscherskia*, the suprazygomatic part is also present in sciurids²¹ and hystricognath rodents¹⁶, but has not been reported in other murid subfamilies. In murid species, this part may be difficult to find due to its

quite small size.

In a previous study on *Mesocricetus*⁵, the portion of the anterior part with a fleshy insertion (i. e., termed the medial portion in the present study) is referred to be absent. In the present study, this portion was recognized for all cricetine genera examined, although it is much smaller than the portion with an aponeurotic insertion (i. e., the orbital and lateral portions). Unlike cricetine species, a murine murid, *Rattus norvegicus*, possesses the medial portion of the anterior temporalis richer than the orbital and lateral portions¹⁵. In sciurids, the portion fleshly ending on the medial aspect of the coronoid process is also the largest among subdivisions of the temporalis¹¹. The transversely directed chewing motion of this group resembles that of cricetines^{5,22~24}. Nonetheless, sciurids share a well-developed medial por-

tion of the anterior part with murine murids, which process food with a forward jaw movement²⁵. This finding suggests that the relative mass of each subdivision is not determined by the chewing pattern

alone and that other functional factors are also involved. To clarify these factors, quantitative information on the muscle should be accumulated in various rodent groups.

CONCLUSION

In cricetine murids, the internal structure of the temporalis is basically identical with that in other rodents previously studied. Unlike murine murids and sciurids, however, the fibers of the anterior part that inserts on an aponeurosis are much richer than fi-

bers with fleshy insertions on the coronoid process.

We thank Dr. Kimiyuki Tsuchiya of the Miyazaki Medical College for providing the specimens dissected in this study.

REFERENCES

- 1) Turnbull, W. D. : Mammalian masticatory apparatus. *Fieldiana Geol.*, **18** : 149~356, 1970.
- 2) Becht, G. : Comparative biologic-anatomical researches on mastication in some mammals I and II. *Koninkl. Neder. Akad. van Wet. Proc.*, **56** : 508~527, 1953.
- 3) Fabian, H. : Studien zur Kaufunktion. *Deutsche Zahnheilkunde*, **65** : 5~73, 1925.
- 4) Schumacher, G. H. : Funktionelle morphologie der kaumuskelatur., Gustav Fischer Verlag, (Jena), 1~292, 1961.
- 5) Gorniak, G. C. : Feeding in golden hamsters. *Mesocricetus auratus*. *J. Morphol.*, **154** : 427~458, 1977.
- 6) Byrd, K. E. : Mandibular movement and muscle activity during mastication in the guinea pig (*Cavia porcellus*). *J. Morphol.*, **170** : 147~169, 1981.
- 7) Satoh, K. : Comparative functional morphology of mandibular forward movement during mastication of two murid rodents, *Apodemus speciosus* (Murinae) and *Clethrionomys rufocanus* (Arvicolinae). *J. Morphol.*, **231** : 131~142, 1997.
- 8) Kesner, M. H. : Functional morphology of the masticatory musculature of the rodent subfamily Microtinae. *J. Morphol.*, **165** : 205~222, 1980.
- 9) Satoh, K. : Balancing function of the masticatory muscles during incisal biting in two murid rodents, *Apodemus speciosus* and *Clethrionomys rufocanus*. *J. Morphol.*, **236** : 49~56, 1998.
- 10) Orcutt, E. E. : Studies on the muscles of the head, neck, and pectoral appendages of *Geomys bursarius*. *J. Mammal.*, **21** : 37~52, 1940.
- 11) Bryant, M. D. : Phylogeny of Nearctic Sciuridae. *Am. Midland Nat.*, **33** : 257~390, 1945.
- 12) Van Vendeloo, N. H. : On the correlation between the masticatory muscles and the skull structure in the musk rat, *Ondatra zibethica* (L.). *K. Acad. Wet. Amsterdam, Proc.*, **56** : 116~127, 265~277, 1952.
- 13) Rinker, G. C. : The comparative myology of the mammalian genera *Sigmodon*, *Oryzomys*, *Neotoma* and *Peromyscus* (Cricetidae) with remarks on their intergeneric relationships. *Misc. Publ. Mus. Zool. Univ. Michigan*, **83** : 1~124, 1954.
- 14) Repenning, C. A. : Mandibular musculature and the origin of the subfamily Arvicolinae (Rodentia). *Acta Zool. Cracow.*, **13** : 29~72, 1968.
- 15) Hiimae, K. and Houston, W. J. B. : The structure and function of the jaw muscles in the rat (*Rattus norvegicus* L.) I. Their anatomy and internal architecture. *Zool. J. Linn. Soc.*, **50** : 75~99, 1971.
- 16) Woods, C. A. : Comparative myology of jaw, hyoid, and pectoral appendicular region of New and Old World hystricomorph rodents. *Bull. Amer. Mus. Nat. Hist.*, **147** : 115~198, 1972.
- 17) Weijs, W. A. : Morphology of the muscles of mastication in the albino rat, *Rattus norvegicus* (Berkenhout 1769). *Acta Morphol. Neerl. Scand.*, **11** : 321~340, 1973.
- 18) Ohno, N. : The comparative anatomy on the muscles of mastication of the mammals (in Japanese). *Aichi-Gakuin J. Dent. Sci.*, **10** : 319~335, 1973.
- 19) Woods, C. A. and Howland, E. B. : Adaptive radiation of capromyid rodents : anatomy of the masticatory apparatus. *J. Mammal.*, **60** : 95~116, 1979.
- 20) Ball, S. S. and Roth, V. L. : Jaw muscles of New World squirrels. *J. Morphol.*, **224** : 265~291, 1995.
- 21) Thorington, Jr. R. W. and Darrow, K. : Jaw muscles of Old World squirrels. *J. Morphol.*, **230** : 145~165, 1996.
- 22) Offermans, M. and de Vree, F. : Mastication in springhare : A cineradiographic study. *J. Morphol.*, **205** : 353~367, 1990.
- 23) Wahlert, J. H. : Relationships of the extinct rodents *Cricetops* to *Lophiomys* and the cricetinae (Rodentia, Cricetidae). *Amer. Mus. Novitates*, **2784** : 1~15, 1984.
- 24) Druzinsky, R. E. : Incisal biting in the mountain beaver (*Aplodontia rufa*) and woodchuck (*Marmota monax*). *J. Morphol.*, **226** : 79~101, 1995.
- 25) Weijs, W. A. and Dantuma, R. : Electromyography and mechanics of mastication in the albino rat. *J. Morphol.*, **146** : 1~34, 1975.

旧世界ハムスター類の側頭筋形態

佐藤和彦 岩久文彦

朝日大学歯学部口腔解剖学講座（主任：岩久文彦教授）

501-0296 岐阜県本巣郡穂積町穂積1851

キーワード：キヌゲネズミ亜科，側頭筋，腱膜，停止部

抄録 旧世界ハムスター類(齧歯目ネズミ科キヌゲネズミ亜科)に分類される *Mesocricetus*, *Tscherskia*, *Phodopus*, および *Cricetulus* 属の側頭筋の肉眼解剖学的形態について検索をおこなった。この筋はで特に発達し、その起始部背側縁は正中部付近まで拡がっているのが観察された。側頭筋は筋繊維の走行および起始・停止領域に基づいて前部，後部，深部に大別され，前部にはさらに眼窩部，外側部，内側部が認められた。筋突起前縁に沿う腱膜上に停止する眼窩部，外側部は筋質の停止をもつ内側部に比べてより発達していた。一方，これまでに報告のあるネズミ科ネズミ亜科およびリス科では，キヌゲネズミ亜科とは逆に内側部がより発達する。キヌゲネズミ亜科とリス科の咀嚼様式が類似することを考慮すると，側頭筋各部の相対的な筋量は顎運動のみならず複数の機能的要因によって決まるものと思われる。