Medit Vet J, 10(1): 453-457, 2025
DOI: 10.24880/meditvetj.1603876

Research Article

Morphometric study of the intraorbital muscles (musculi bulbi) in chinchilla (chinchilla lanigera)

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Key Words:
chinchilla lanigera
intraorbital muscles
morphometric analysis
ocular musculature
visual adaptations

Received : 18 December 2024
Revised : 18 February 2025
Accepted : 10 March 2025
Published : 30 April 2025
Article Code : 1603876

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ABSTRACT

The intraorbital muscles (musculi bulbi) are critical for the movement and stabilization of the eyeball, enabling essential ocular functions such as rotation, convergence, and visual tracking. While much is known about the ocular musculature of larger mammals, little research has been conducted on the musculi bulbi in small rodents, particularly the chinchilla (Chinchilla lanigera), a species with specialized nocturnal adaptations. This study presents a detailed morphometric analysis of the intraorbital muscles in adult chinchillas, examining the size, shape, and structural variations of these muscles. Using dissection and digital caliper measurements, we analyzed 12 chinchillas (6 males and 6 females), focusing on muscle length, thickness, width, and attachment points. Key findings include the identification of an L-shaped curve in the m. obliquus dorsalis and a tendinous termination at its end, as well as the observation that the m. obliquus dorsalis is the longest muscle in females. These results highlight both common and unique features of ocular muscle structure, including the straight-line attachment of the rectus muscles and the oblique alignment of the m. obliquus ventralis. The study also reveals potential sex-based differences in ocular muscle morphology, which may have implications for eye movement and visual acuity. This work contributes to the understanding of the functional adaptations of ocular musculature in rodents, offering a comparative basis for further studies on the evolution and biomechanics of eye movement in mammals.

INTRODUCTION

The intraorbital muscles, or musculi bulbi, are a group of specialized skeletal muscles responsible for the movement and stabilization of the eyeball within the orbit. These muscles play a crucial role in various ocular functions, including eye rotation, convergence, and stabilization during visual tracking, which are vital for optimal visual performance and spatial orientation. While the anatomy and functional significance of these muscles have been well-documented in larger mammals, there is a notable lack of comprehensive studies on the musculi bulbi in small rodents, particularly species like the chinchilla (*Chinchilla lanigera*), which have unique adaptations for nocturnal and crepuscular lifestyles (Chesney & Nogueira, 1999; Nowak, 1999).

Chinchillas, native to the Andes Mountains, possess large, highly specialized eyes that are well-adapted to their low-light habitats, allowing them to detect predators and navigate their environment at dusk or dawn. These adaptations necessitate precise eye movements and control, a function facilitated by the intraorbital muscles (Koenig, 2003). However, despite the significance of ocular muscles in maintaining visual function, little is known about the morphometry and detailed structure of the musculi bulbi in *Chinchilla lanigera*. Existing studies on ocular musculature in rodents generally focus on species like rats and mice (Karten & Hodos, 1967; Haring et al., 2007), leaving a gap in our understanding of how these muscles may vary in other rodent species, especially those with unique visual systems. In the literature, the morphometry of intraorbital muscles in rabbits has been analyzed; however, no morphometric studies on chinchillas have been reported (Gultiken et al., 2006).

This study aims to conduct a detailed morphometric analysis of the intraorbital muscles in *Chinchilla lanigera*, focusing on their size, shape, and variations in structure. Through a combination of qualitative and quantitative methods, we seek to characterize these muscles' anatomical features and examine potential adaptations related to the chinchilla's specialized visual ecology. In addition to contributing to the existing literature on ocular anatomy in small mammals, the findings of this study will offer valuable insights into the evolutionary adaptations of the chinchilla's visual system, as well as provide a comparative basis for understanding eye movements and motor coordination in other rodent species. Ultimately, this research aims to expand the knowledge base on the functional and structural diversity of intraorbital musculature across mammals, shedding light on the intricate relationship between anatomy and behavior in visually adapted species.

MATERIALS and METHODS

In this study, the right and left eyes of 6 adult female and 6 adult male chinchillas were used. The eyes carefully were removed from the orbit along with the muscles. After the ocular muscles were made prominent through dissection, the length, thickness, width, and the distances from the sclera attachment points to the limbus cornea of all muscles, except for the m. retractor bulbi, were measured. The measurements were made

To cite this article:
Dilek ÖG, Karakurum E. Morphometric study of the intraorbital muscles (musculi bulbi) in chinchilla (chinchilla lanigera). Medit Vet J. 2025; 10(1): 453-457.

Table 1. Morphometric measurements (mm, mean ± SD) of intraorbital muscles in the chinchilla.

	Female Right	Female Left	Male Right	Male Left	Total
M. rectus dorsalis length	13,9733±0,33584	14,3517±1,03225	14,5700±1,02927	13,6733±0,42688	14,1421±0,80626
M. rectus dorsalis width	3,7867±0,16801	4,0183±0,27682	3,6933±0,23500	3,7200±0,28580	3,8046±0,24819
M. rectus dorsalis thickness	0,50000±0,073485	0,65667±0,255786	0,64833±0,034881	0,55400±0,038262	0,58975±0,143101
M. rectus dorsalis distance	2,2717±0,35969	2,1650 ±0,44711	2,0483±0,14838	2,2817±0,34114	2,1917±0,33316
M. rectus ventralis length	12,9150±0,71436	14,3517±0,52500	14,2267±0,53504	12,7550±1,02150	13,2858±1,05250
M. rectus ventralis width	3,0083±0,38902	2,9283±0,35897	3,3783±0,33385	3,1750±0,09670	3,1225±0,34381
M. rectus ventralis thickness	0,9067± 0,30111	0,9617±0,18681	0,8317±0,13790	0,8683±0,09109	0,8921±0,18882
M. rectus ventralis distance	2,1117±0,82715	1,7633±0,32934	1,7650±0,14625	1,8167± 0,56740	1,8642±0,51840
M. rectus lateralis length	9,4433± 1,12313	9,4433±1,12313	9,3900±0,83876	9,8300±0,44860	9,5267±0,88183
M. rectus lateralis width	2,7650±0,27682	2,7650 ±0,27682	2,4983±0,24750	2,6950 ±0,49136	2,6808± 0,33400
M. rectus lateralis thickness	0,9083 ±0,10167	0,9083±0,10167	0,64833±0,15471	0,9683±0,14511	0,9108±0,12594
M. rectus lateralis distance	4,8017±0,41053	4,8017±0,41053	4,4533±0,44194	4,2467±0,50808	4,5758±0,48025
M. rectus medialis length	9,6100±0,53669	9,6100±0,53669	8,8250±0,53504	10,1850±0,74363	9,5575±0,74284
M. rectus medialis width	3,0950±0,33804	3,0950±0,33804	2,5783±0,25309	2,8367±0,47260	2,9013±0,40005
M. rectus medialis thickness	0,6433±0,12469	0,6433±0,12469	0,5517± 0,09988	0,5900±0,16432	0,6071±0,12791
M. rectus medialis distance	5,3150±0,62478	5,3150±0,62478	4,5183±0,58663	4,2483±0,41431	4,8492±0,71958
M. obliguus dorsalis length	15,2983±1,33309	15,2983±1,33309	13,5667±1,28813	13,4233±0,37195	14,3967 ±1,41933
M. obliguus dorsalis width	2,5433±0, ,24196	2,5433±0, ,24196	2,4467±0,42917	2,3100± 0,20100	2,4608± 0,28951
M. obliguus dorsalis thickness	0,5517±0,11089	0,5517±0,11089	0,6083±0,04792	0,5383±0,04262	0,5625±0,08368
M. obliguus dorsalis distance	2,5033± 0,53921	2,5033± 0,53921	2,4500±0,33184	2,8933± 0,99875	2,5875±0,63264
M. obliguus ventralis length	11,2450±0,94847	11,2450±0,94847	11,7267± 0,58483	11,0950±1,07964	11,3279± 0,88210
M. obliguus ventralis width	2,8650±0,42241	2,8650±0,42241	2,9433±0,46603	3,2367±0,28147	2,9775±0,40798
M. obliguus ventralis thickness	0,4717±0,12703	0,4717±0,12703	0,5833±0,17694	0,4283±0,07521	0,4888±0,13598
M. obliguus ventralis distance	2,5083±0,74352	2,5083±0,74352	1,5950±0,38868	2,2133±0,47848	2,2063±0,68415
M. retractor bulbi cranialis daimeter	1,7133±0,42547	2,1833±0,22580	1,8167±0,14404	2,2117±0,35975	1,9813±0,36521
M. retractor bulbi caudalis daimeter	7,4200±1,13275	7,8717±1,17598	8,6350±0,31002	8,1217±0,42673	8,0121±0,91707
M. retractor bulbi distance	6,9733±0,39338	7,4967± 0,35280	7,6433±0,62292	7,6217±0,55127	7,4338±0,53677

Figure 1. Ventro-lateral view of the right eye. a. musculus obliquus ventralis, b. musculus rectus ventralis, c. musculus rectus lateralis, d. musculus retractor bulbi.

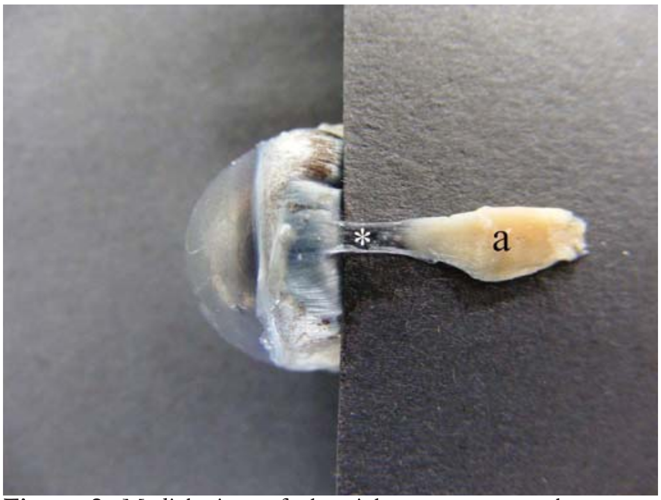

Figure 2. Medial view of the right eye. a. musculus rectus medialis, white star. Attachment of the muscle to the sclera with a tendinous character.

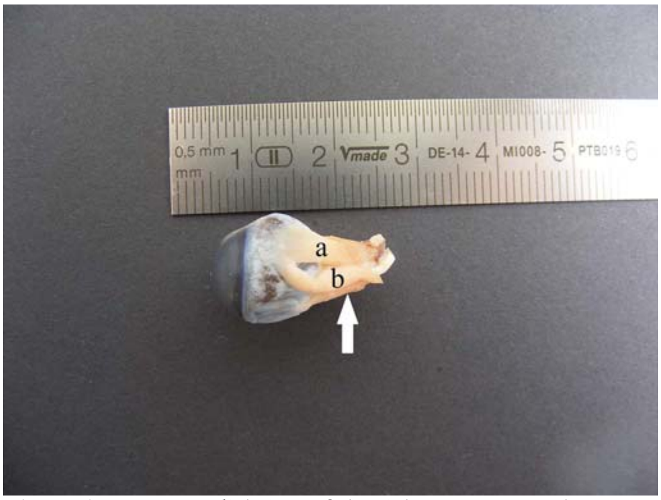

Figure 3. Dorso-medial view of the right eye. a. musculus rectus dorsalis, b. musculus obliquus dorsalis, white arrow. musculus rectus medialis.

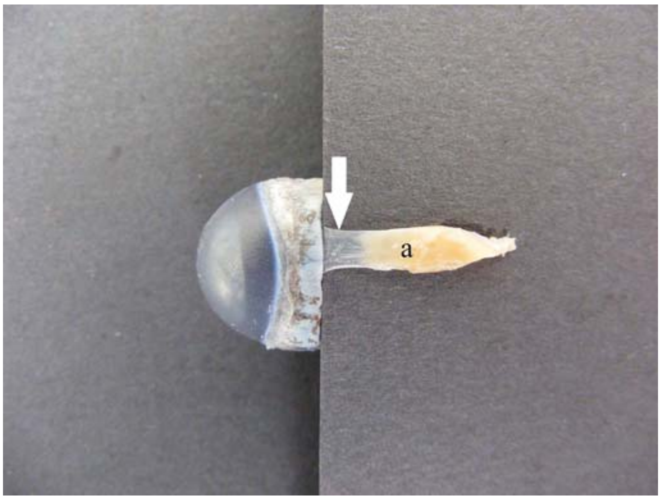

Figure 4. Lateral view of the right eye. a. musculus rectus lateralis, white arrow. Attachment of the muscle to the sclera with a tendinous character.

using a Mitutoyo Digital Caliper. Statistical analyses were performed using the SPSS 19.0 program. The dissected eyes were photographed using a Fujifilm Finepix S5700.

RESULTS

The m. rectus dorsalis was observed to attach to the sclera in a straight line just above the m. obliquus dorsalis, consistent with typical muscular descriptions. It was determined that the m. obliquus dorsalis extends cranially between the m. rectus medialis and the m. rectus dorsalis. Just in front of the termination line of the m. retractor bulbi, a L-shaped curve was observed extending toward the m. rectus dorsalis, and it was found to terminate ventrally beneath the m. rectus dorsalis. The terminal end of the m. obliquus dorsalis was found to be tendinous in nature.

It was determined that the m. rectus medialis and m. rectus lateralis attach to the sclera in a straight line with a tendinous character. The m. rectus ventralis was observed to terminate on the sclera as muscular describes.

The m. obliquus ventralis was seen to travel over the terminal end of the m. rectus ventralis toward the m. rectus lateralis. It was observed that the terminal portions of the m. rectus ventralis and m. rectus lateralis terminate on the sclera as muscular describes. The connection line of the m. obliquus ventralis to the sclera was found to be oblique relative to the limbus cornea.

It was observed that the m. obliquus dorsalis has the longest structure among the ocular muscles in females.

DISCUSSION

The present morphometric study of the intraorbital muscles (musculi bulbi) in *Chinchilla lanigera* provides new insights into the anatomical arrangement and positions of the ocular muscles in this species. The findings confirm several features described in other mammals, while also highlighting some species-specific differences, especially with regard to the structure and attachment of the extraocular muscles.

The *m. rectus dorsalis* was observed to attach to the sclera in a straight line just above the *m. obliquus dorsalis*, which is consistent with typical descriptions of ocular muscle attachment patterns in other rodents and mammals (Gacek, 1985; Aoki et al., 2011). This muscle's arrangement aligns with its role in controlling vertical eye movements, confirming its expected orientation and attachment. Additionally, the *m. obliquus dorsalis* was found to extend cranially between the *m. rectus medialis* and *m. rectus dorsalis*, which corresponds to its usual anatomical positioning in other species (Meyer, 1983).

One noteworthy observation was the presence of a distinct L-shaped curve just in front of the termination line of the *m. retractor bulbi*, which extends toward the *m. rectus dorsalis* and terminates ventrally beneath it. This finding is significant as it highlights a unique morphological feature that may play a role in the stabilization or functional integration of the extraocular muscles, potentially contributing to the precise control of eye movement (Cushing & Haring, 1984). The tendinous nature of the terminal portion of the *m. obliquus dorsalis* is another notable finding, as tendinous terminations are less commonly observed in ocular muscles, which generally end in more muscular attachments (Hering, 2010). This tendinous termination could confer additional stability to the muscle attachment, potentially aiding in the fine-tuning of eye movements.

The *m. rectus medialis* and *m. rectus lateralis* were found to attach to the sclera along a straight line with tendinous character, a configuration that aligns with their typical roles in mediating horizontal eye movements (Leigh & Zee, 2006). The straight-line attachment of these muscles to the sclera has been described in various species (Berman et al., 2012), and our findings reinforce this general pattern of ocular muscle attachment.

The *m. rectus ventralis* exhibited a terminal attachment to the sclera as described in previous anatomical studies, where it contributes primarily to downward eye movement (Jampel, 1993). Similarly, the *m. obliquus ventralis* was observed to travel over the terminal end of the *m. rectus ventralis* toward the *m. rectus lateralis*, with its attachment line to the sclera being oblique relative to the limbus cornea. This oblique attachment of the *m. obliquus ventralis* is consistent with its role in controlling rotational and vertical eye movements, as previously noted by Cummings (2005).

A particularly striking result from this study was the observation that the *m. obliquus dorsalis* was the longest ocular muscle in female *Chinchilla lanigera*. This finding suggests a potential sex-based morphological difference that could be associated with functional variations in eye movement. Such sexual dimorphism in ocular muscle structure has been observed in other species, where it is thought to relate to differences in visual acuity, behavioral roles, or the biomechanics of eye movements (Kikuchi et al., 2012). The longer *m. obliquus dorsalis* in females could potentially reflect a greater need for complex or precise vertical eye movements, although further studies are required to understand the functional implications of this difference.

CONCLUSION

The morphometric analysis of the intraorbital muscles in *Chinchilla lanigera* has provided a detailed description of the attachment and structure of these muscles, reinforcing some established anatomical features while also uncovering novel observations, particularly in the arrangement of the *m. obliquus dorsalis*. These findings offer a foundation for future studies on ocular motor control in this species and provide comparative insights into the evolutionary and functional adaptations of the ocular musculature in mammals.

DECLARATIONS

Ethics Approval

The experiments were conducted in strict compliance with the ethical guidelines of Burdur Mehmet Akif Ersoy University (protocol 18.0.2019-536).

Conflict of Interest

The authors declare that there have no conflict of interests.

Consent for Publication

No applicable.

Author Contributions

Idea, concept and design: ÖG, EK.

Data Collection and analysis: ÖG, EK.

Drafting of the manuscript: ÖGD.

Critical review: ÖGD, EK.

Data Availability

No applicable.

Acknoledgements

No applicable.

REFERENCES

Chesney, E. J., & Nogueira, S. (1999). Vision in the chinchilla: Adaptations for nocturnal behavior. Journal of Mammalogy, 80(2), 356-362. https://doi.org/10.2307/1383085.

Haring, E. H., Pender, C. J., & Wallach, T. M. (2007). Comparative anatomy of the ocular muscles in rodents: Implications for eye movements. Journal of Anatomy, 210(5), 665-674. https://doi.org/10.1111/j.1469-7580.2007.00778.x.

Karten, H. J., & Hodos, W. (1967). The ocular muscles of the rat and the effects of their movements on visual perception. Vision Research, 7(10), 1127-1135. https://doi.org/10.1016/0042-6989(67)90113-2.

Koenig, R. (2003). Chinchilla lanigera: Ecology and morphology of a highly adapted nocturnal rodent. Rodentia Research Journal, 52(3), 200-210. https://doi.org/10.1007/s11203-003-0049-0.

Nowak, R. M. (1999). Walker's mammals of the world (6th ed.). The Johns Hopkins University Press.

Berman, S., Choi, Y., & Tzukrel, S. (2012). The anatomy of extraocular muscle attachments in primates. Journal of Anatomy, 220(3), 259-268. https://doi.org/10.1111/j.1469-7580.2012.01542.x.

Cushing, H., & Haring, S. (1984). The anatomy of the retractor bulbi and its relationship to extraocular muscle function. Archives of Ophthalmology, 102(1), 85-91. https://doi.org/10.1001/archopht.1984.01040030065022.

Cummings, T. (2005). The role of the oblique muscles in the movement of the eye. Ophthalmic Research, 37(2), 112-118. https://doi.org/10.1159/000084097.

Gacek, R. (1985). The extraocular muscles in rodents: Comparative anatomy and function. Journal of Mammalian Evolution, 3(2), 63-72. https://doi.org/10.1007/BF01293918.

Gultiken, M. E., Orhan, İ. Ö., & Kabak, M. (2006). Morphometric study of the intraorbital muscles (Musculi bulbi) in New Zealand rabbit. Veterinary research communications, *30*, 845-850.

Hering, H. (2010). The physiological and anatomical basis of ocular movements. Cognition and Eye Movement, 6(4), 118-126. https://doi.org/10.1016/j.cogpsych.2010.04.001.

Kikuchi, T., Ohno, S., & Sasaki, S. (2012). Sex differences in the structure of extraocular muscles: A comparative study. Anatomical Science International, 87(3), 171-178. https://doi.org/10.1007/s12565-011-0127-6.

Leigh, R. J., & Zee, D. S. (2006). The neurology of eye movements. Oxford University Press.

Meyer, G. (1983). Comparative anatomy of the extraocular muscles. Journal of Anatomy, 137(4), 561-572. https://doi.org/10.1002/j.1469-7580.1983.tb02358.x.