

Gross morphology of *Musculi bulbi* of the ostrich (*Struthio camelus*) and emu (*Dromaius novaehollandiae*)

Ellené Kleyn and Martina R. Crole

Department of Anatomy and Physiology, Faculty of Veterinary Science, University of Pretoria, Pretoria, South Africa. ellene.kleyn@up.ac.za

Introduction

The avian eye is uniquely adapted to the habitat and feeding strategies of the bird and reflects some structural peculiarities in comparison to the mammalian eye [1, 4]. The *M. bulbi* or *M. bulbi oculi* is composed of four rectus and two oblique muscles and two muscles of the nictitating membrane [1, 2, 4]. These muscles have been described in several avian species, including the ostrich [3], however, little information is available on the emu. Both the ostrich and emu are commercially farmed in South Africa [3, 5]. Both birds have large eyes [3] and a deeper understanding of the morphology of the *M. bulbi* would aid veterinarians in diagnostics and surgery.

Materials and methods

Heads from three sub-adult ostrich and three sub-adult emu were collected from the anatomy department specimen bank. They were immersion fixed in 10% neutral-buffered formalin for at least 48 hours. Enucleation was performed by removing extra-ocular tissues and incising the origins of the *M. bulbi* in half the specimens and by incising the insertions in the remaining half. The *M. bulbi* was described and compared.

Results and discussion

In both species *M. bulbi* was composed of eight thin, sheet-like muscles; with the two nictitating membrane muscles being more robust (Fig. 1). The straight and oblique muscles inserted near the equator. Minor differences in the attachments (Fig. 2 and 3) of these muscles were noted between the species (Table 1). The pyramidal muscle inserted on the ventral free margin of the nictitating membrane via a long tendon. The quadratus muscle inserted onto the tendon of the pyramidal muscle via a muscular loop, namely the *Vagina fibrosa tendinis* (Fig. 1).

Table 1. Comparison of the attachments of the *M. bulbi oculi* of the ostrich and emu.

Musculi bulbi oculi	Species	Origin	Insertion
<i>M. rectus dorsalis</i>	Ostrich	Dorso-lateral margin of the For. n. optici.	Dorsally on the equator margin.
	Emu	Dorso-lateral margin of the For. n. optici.	Dorsally, posterior to the equator margin.
<i>M. rectus ventralis</i>	Ostrich	Ventral margin of the For. n. optici.	Ventro-medially, anterior to the equator margin. Deep to the <i>M. obliquus ventralis</i> .
	Emu	Ventro-medial margin of the For. n. optici.	Ventro-medially on the equator margin.
<i>M. rectus lateralis</i>	Ostrich	Lateral margin of the For. n. optici.	Laterally, anterior to the equator margin.
	Emu	Ventro-lateral margin of the For. n. optici.	Laterally, anterior to the equator margin.
<i>M. rectus medialis</i>	Ostrich	Septum interorbitale, dorso-medially to the For. n. optici.	Medially, posterior to the equator margin.
	Emu	Septum interorbitale, dorso-medially to the For. n. optici.	Medially, posterior to the equator margin.
<i>M. obliquus dorsalis</i>	Ostrich	Os ectethmoidale, caudo-ventrally to the For. orbitonasale mediale.	Dorsally on the equator margin, between the <i>M. rectus dorsalis</i> and <i>M. quadratus membranae nictitantis</i> .
	Emu	Os ectethmoidale, caudo-ventrally to the For. orbitonasale mediale.	Oblique. Dorsally, posterior to the equator margin.
<i>M. obliquus ventralis</i>	Ostrich	Os ectethmoidale, dorsal aspect of the Depressio glandularis.	Ventrally, anterior to the equator margin.
	Emu	Os ectethmoidale, dorsal aspect of the Depressio glandularis.	Ventro-medially on the equator margin.
<i>M. quadratus membranae nictitantis</i>	Ostrich	Dorsally, posterior to the equator margin. Deep to <i>M. rectus / obliquus dorsalis</i> .	Proximal tendon of insertion of <i>M. pyramidalis membranae nictitantis</i> via a muscular loop, dorsal to the <i>N. optici</i> .
	Emu	Dorsally, posterior to the equator margin. Deep to <i>M. rectus / obliquus dorsalis</i> .	Proximal tendon of insertion of <i>M. pyramidalis membranae nictitantis</i> via a muscular loop, dorsal to the <i>N. optici</i> .
<i>M. pyramidalis membranae nictitantis</i>	Ostrich	Ventrally, posterior to the equator margin. Deep to <i>M. rectus ventralis</i> .	Ventral free margin of the nictitating membrane
	Emu	Ventrally, posterior to the equator margin. Deep to <i>M. rectus ventralis</i> .	Ventral free margin of the nictitating membrane

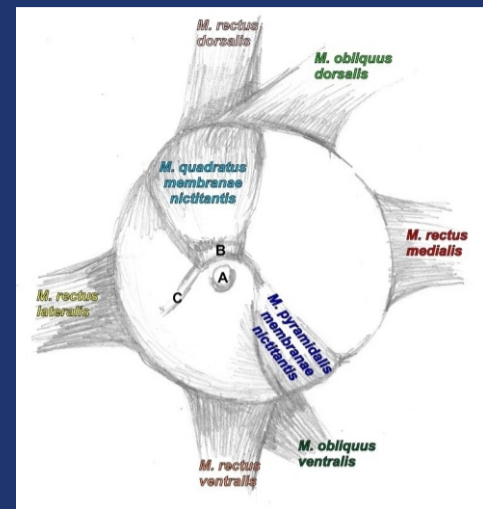


Figure 1. Sketch of the left emu eye demonstrating the *M. bulbi*. Posterior view. The extrinsic muscles have been reflected. *N. optici* (cut) (A), *Vagina fibrosa tendinis* (B) and *Tendo pyramidalis* (cut) (C).

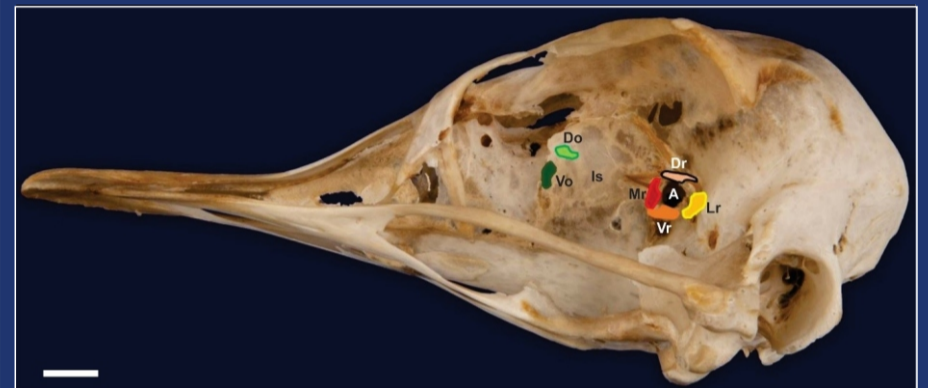


Figure 2. Ostrich skull. Left lateral view. Origins of the extrinsic muscles of the eye. Dorsal oblique (Do), Ventral oblique (Vo), Dorsal rectus (Dr), Lateral rectus (Lr), Ventral rectus (Vr) and Medial rectus (Mr) muscles. Interorbital septum (Is), For. n. optici (A). Scale bar = 1 cm.

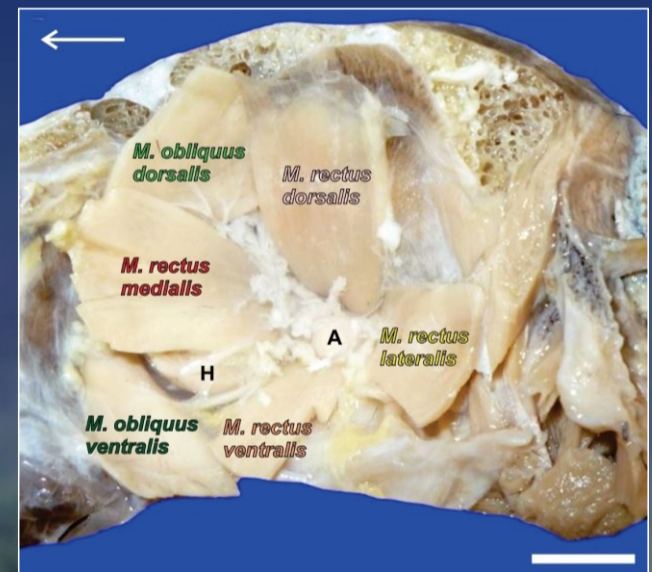


Figure 3. Emu. Left lateral view. Extrinsic muscles of the eye have been transected near their insertions and the globe removed. Optic nerve (A) and Harderian gland (H). Arrow indicates rostral. Scale bar = 1 cm.

Conclusion

The *M. bulbi* was similar in the ostrich and emu. Minor differences were noted with respect to the relative insertions and dimensions of the muscles and need to be morphometrically quantified. However, the functions of the muscles was comparable in both species. A similar surgical procedure for enucleation is recommended in the ostrich and emu.

References

- Baumel, J.J., King, A.S., Breazile, A.E., Evans, H.E., & Van den Berge, J.C. (1993) *Handbook of Avian Anatomy: Nomina Anatomica Avium*, 2nd ed. Cambridge, Massachusetts: Nuttall Ornithological Club.
- Chard, R.D., Gundlach, R.H. (1938) The structure of the eye of the homing pigeon. *Journal of comparative psychology*, 25, 2, 249 – 272.
- Deeming, D.C. (1999) *The ostrich: Biology, Production and health*. London: CAB International.
- King, A.S., Mc Lelland, J. (ed) (1985) *Farm and Function in Birds*. Volume 3. London: Academic Press.
- Sales, J. (2007) The emu (*Dromaius novaehollandiae*): a review of its biology and commercial products. *Avian and Poultry Biology Reviews*, 18, 1, 1 – 20.

