Muscle arrangement in the initial portion of the canaliculi lacrimalis

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SUMMARY

The vertical portion of the canaliculi lacrimalis is surrounded by a muscular framework with the morphology of a sphincter. This framework is built from three different components: a first component of vertical direction placed in front, laterally and dorsally to the vertical portion of the canaliculi, which proceeds from the external face of the os lacrimale and belongs to the pars lacrimalis (pars lacrimalis, fasciculus coronalis); a second component of transversal-lateral direction, which derives from the crista lacrimalis posterior and belongs to the pars lacrimalis (pars lacrimalis, fasciculus caudalis); and a third component of transversal-medial direction, which proceeds from the ligamentum palpebrale laterale and belongs to the pars ciliaris of the musculus orbicularis oculi. The synchronized contraction of these muscular fibres performs a collapsible function on the initial portion of the canaliculi lacrimalis.

Key Words: Lacrimal sphincter

INTRODUCTION

In spite of the numerous morphological and functional studies on the ductuli excretorii lacrimarum, the role played by each of its portions in the processes of lacrimal drainage remain unclear. In particular, the sheath of muscular fibres surrounding the canaliculi lacrimalis has not yet been well defined in the anatomical studies, carried on the date.

The existence of a sphincter at the initial portion of the ductuli excretorii lacrimarum has been suggested by some authors (Berres, 1835; Merkel, 1885; Rohen, 1953; Jones, 1958; Williams et al., 1980), without individualizing the fascicles of which it is formed nor the origin, direction or trajectory of its fibres.

By contrast, other authors (Genis-Gálvez, 1955; Brienen and Snell Card, 1967, 1969) failed to report fibre bundles forming a sphincter.

From our interest in finding a firm morphological basis from which to draw a functional interpretation, here we studied the muscular sheath of the ductuli excretorii lacrimarum to explain the existence of the sphincter in addition to the origin, trajectory and ends of the different muscular fascicles forming it.

MATERIALS AND METHODS

Studies were performed in both orbital regions of 12 human fetuses (8 female and 4 male) that ranged from 100 to 210 mm in craneo-caudal length, and in both orbital regions of 10 adult cadavers of both sexes (4 female and 6 male).

Tissue was fixed in 10% formaldehyde for 2-3 weeks and then submerged in Ebner's liquid for 10 days to decalcify before paraffin embedding. The blocks were sectioned serially into 10-(m-thick sections, numbered and stained with Heidenhain's azocarmine and Masson-Goldner trichrome.

RESULTS AND DISCUSSION

Within the eyelid, we found a large number of muscular fibres belonging to the different portions of the musculus orbicularis oculi, some of which showed crossing images at infundibulum

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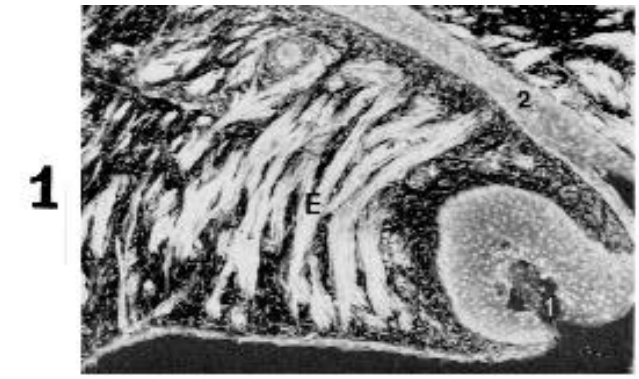
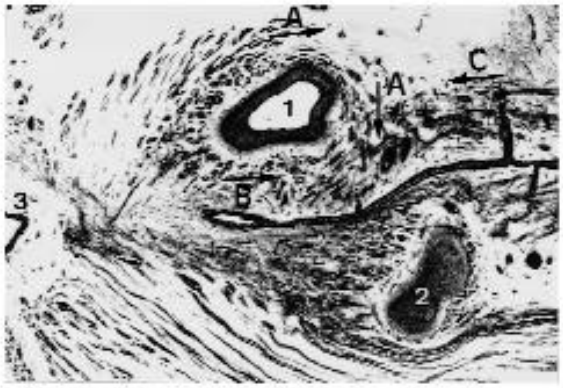
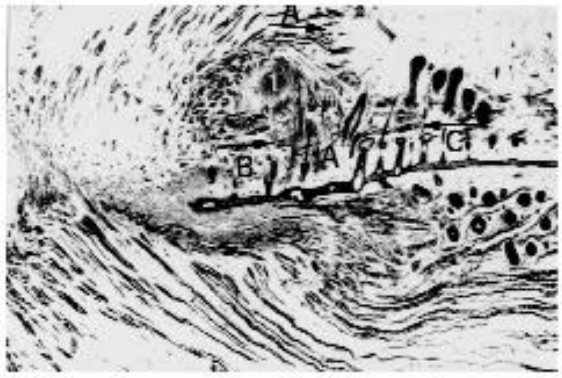
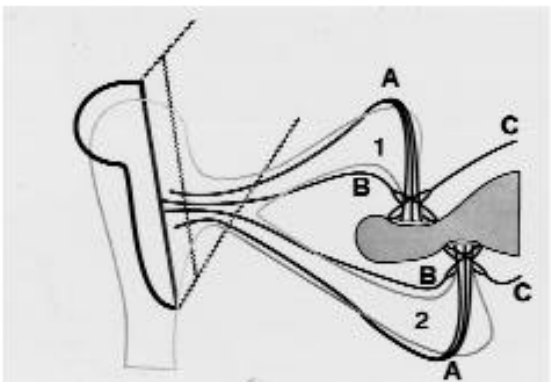








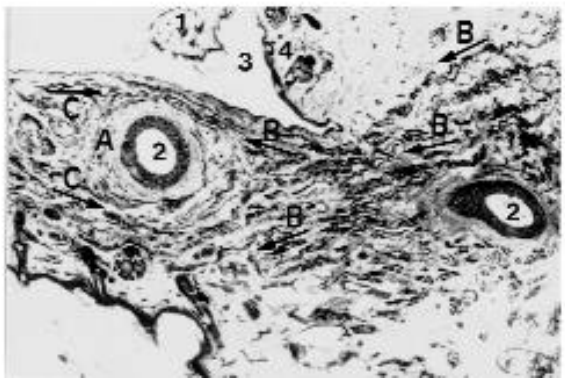


Fig. 1.- Fetus 190 mm. Sectio transversalis. Fluorescence, x400.
1 = Punctum lacrimale.
2 = Rima palpebrarum.
E = Sphincter papillae lacrimalis.

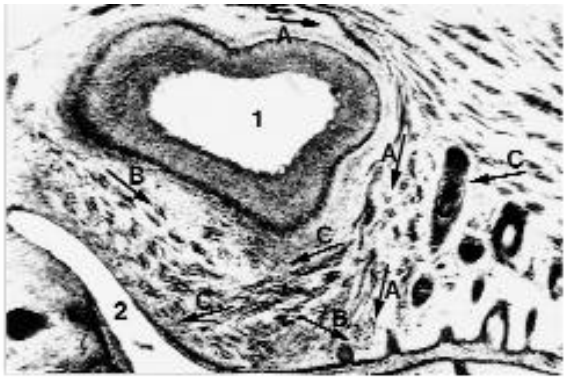
Fig. 2.- Fetus 190 mm. Sectio transversalis. Azocarmin, x2.5.
↓ = Dorsal; ← = Medial.
1 = Canaliculus lacrimale superior
2 = Canaliculus lacrimale inferior
3 = Lacus lacrimale
4 = Plica semilunaris
A = Pars lacrimalis, fasciculus coronalis
B = Pars lacrimalis, fasciculus caudalis
C = Pars ciliaris
E = Sphincter papillae lacrimalis.

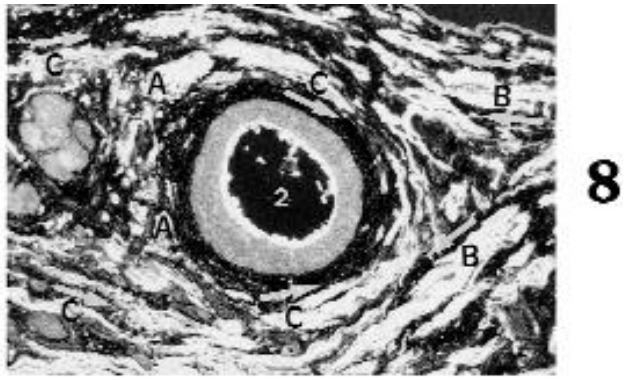
Fig. 3.- Fetus 100 mm. Sectio frontalis. Azocarmin x400.
↑ = Superior; ← = Medial.
1 = Canaliculus lacrimale superior
2 = Canaliculus lacrimale inferior
A = Pars lacrimalis, fasciculus coronalis
B = Pars lacrimalis, fasciculus caudalis
C = Pars ciliaris.

Fig. 4.- Fetus 100 mm. Sectio frontalis. Azocarmin, x40.
↑ = Superior; ← = Medial.
1 = Canaliculus lacrimale superior
2 = Saccus lacrimalis
A = Pars lacrimalis, fasciculus coronalis
B = Pars lacrimalis, fasciculus caudalis
C = Pars ciliaris.

Fig. 5.- Scheme of the lacrimal sphincter.
↑ = Superior; ← = Medial.
1 = Canaliculus lacrimale superior
2 = Canaliculus lacrimale inferior
A = Pars lacrimalis, fasciculus coronalis
B = Pars lacrimalis, fasciculus caudalis
C = Pars ciliaris.

Fig. 6.- Fetus 105 mm. Sectio transversalis. Azocarmin, x2.5.
↑ = Dorsal; → = Medial.
1 = Plica semilunaris
2 = Canaliculus lacrimale inferior
3 = Lacus lacrimalis
4 = Caruncula lacrimalis
A = Pars lacrimalis, fasciculus coronalis
B = Pars lacrimalis, fasciculus caudalis
C = Pars ciliaris.





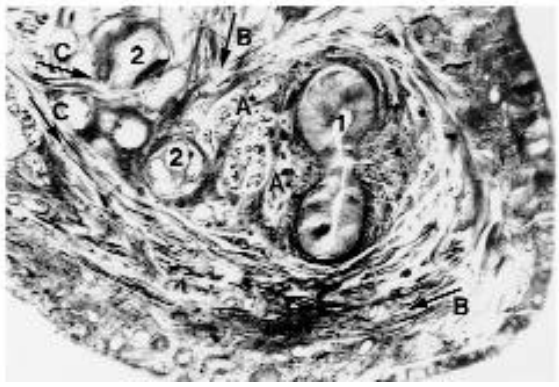


Fig. 7.- Fetus 100mm. Sectio sagittalis. Azocarmin, x400.
← = Dorsal; ↑ = Superior.
1 = Canaliculus lacrimale superior
2 = Lacus lacrimalis
A = Pars lacrimalis, fasciculus coronalis
B = Pars lacrimalis, fasciculus caudalis
C = Pars ciliaris.

Fig. 8.- Fetus 105mm. Sectio transversalis. Fluorescence, x100.
↑ = Dorsal; → = Medial.
1 = Glandulae tarsalis
2 = Canaliculus lacrimale inferior
A = Pars lacrimalis, fasciculus coronalis
B = Pars lacrimalis, fasciculus caudalis
C = Pars ciliaris.

Fig. 9.- Adult. Sectio transversalis. Azocarmin, x2.5.
↑ = Dorsal; → = Medial.
1 = Canaliculus lacrimale inferior
2 = Glandulae tarsalis
A = Pars lacrimalis, fasciculus coronalis
B = Pars lacrimalis, fasciculus caudalis
C = Pars ciliaris.

level at the level of both the canaliculus lacrimalis superior and the inferior one (Figure 1).

We observed the origin, trajectory and ends of these fibres in the serial sections and found that they came from three sites:

A. From the posterior-most (dorsalis) muscular fascicles of the pars lacrimalis, which originate in the external face of the os lacrimale and that, reaching the ampulla region, surround it above in the upper eyelid and underneath in the lower eyelid, then opening into a fan and finishing in the palpebral dermis, around the punctum lacrimale (Figures 2 to 9, fascicle A). Some of these fibres run parallel to the canaliculus axis in its vertical level, whereas others, the greater part, go oblique to that axis. None of the authors studying these aspects has considered the origin of these muscular fascicles, nor their trajectory at the level of the posterior face of the horizontal portion of the canaliculi lacrimalis. Only Murube (1981) indicated the presence of a part of the first component fibres at the level of the vertical portion, although without specifying its origin. Considering the action of the first component of the fibres separately, in view of its direction and its insertions, it would cause a shift towards the sagittal middle plane of the punctum lacrimalis and a shortening of the vertical portion of the canaliculi (Figure 5, fascicle A).

B. From the fascicles of the pars lacrimalis, which originate in the crista lacrimalis posterior and run past the faces of the canaliculi next to the free edge of the eyelids (Figures 2 to 9, fascicle B). These fascicles reach the vertical por-

tion of the canaliculi lacrimalis and divide into several anterior and posterior bundles which surround the canaliculus and surpass it laterally, reaching the free edge of the eyelids, in whose dermis they finish. This insertion occurs immediately out of the punctum lacrimale. Some authors (Calleja Sanchez, 1886; Braus, 1906; Rohen, 1953; Ravetta et al., 1967; Orts-Llorca, 1979) consider the second component of the fascicles as belonging to the pars ciliaris, and propose that they proceed from the ligamentum palpebrale laterale. We followed these fascicles from their origin in the crista lacrimalis posterior to their end in the lateral part of the punctum lacrimale, not reaching the ligamentum palpebrale laterale directly. In view of its trajectory and insertions, the contraction of this second muscular component shifts the punctum lacrimale to the sagittal middle plane and at the same time compresses the vertical portion of the canaliculi.

C. The last muscular component we considered as being part of this sphincter belongs to a fibre bundle which reaches the canaliculus laterally. These are fibres proceeding from the external angle of the rima palpebrarum and belonging to the pars ciliaris of the musculus orbicularis oculi. Their trajectory is horizontal until they reach the canaliculus lacrimale, afterwiich they divide into anterior and posterior bundles which, after surpassing the canaliculus medially, are inserted into the palpebral dermis, medial to the punctum lacrimale and also in the ligamentum palpebrale mediale (Figures 2 to 9, fascicle C).

The third component of the sphincter makes the canaliculus lacrimale shift outside, neutralizing the shifting action of the second component, and likewise compressing the vertical portion of the canaliculi.

Taking into account the above description of the three muscular components, we can affirm that their action is that of closing the lumen of the canaliculus at the level of the infundibulum and thus performing the proposed work of a sphincter.

Considered as a whole, these three components of muscular fibres constitute an important framework which surrounds the canaliculi lacrimalis at infundibulum level. Due to the directional crossing of the different fascicles, it is possible to interpret muscular images as sphincters in both canaliculi lacrimalis. Some authors (Berres, 1835; Merkel, 1885; Rohen, 1953; Jones, 1958; Williams et al., 1980) have stated that the initial portion of the canaliculi lacrimalis has a sphincter that causes a narrowing of the infundibulum, but these authors have not individualized each fascicle nor described their origin, direction and trajectory. Only Rohen (1953) specifies the existence of a double spiral sphincter with two tracts of muscular fibres which cross at the level of the initial portion of the canaliculi lacrimalis. We think that this author refers to the three fascicles explored here.

Contrary to these descriptions, other authors (Brienen and Snell Card, 1967, 1969), have not found any fibre bundle with a spiral form at the level of the vertical portion of both canaliculi, and Genis-Gálvez (1955) failed to find muscular fibres at punctum lacrimale level.

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