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Surgical anatomy and histology of the *levator palpebrae superioris* muscle for blepharoptosis correction

Hirurška anatomija i histologija mišića podizača gornjeg kapka u korekciji blefaroptoze

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Abstract

Background/Aim. The detailed knowledge of the architecture of the upper eyelid is very important in numerous upper eyelid corrective surgeries. The article deals with the detailed anatomy of the major components of the upper lid, which are commonly seen in surgical practice. **Methods.** This study was conducted on 19 human cadavers (12 adults and 7 infants) without pathologic changes in the orbital region and eyelids. Anatomic microdissection of the contents of the orbita was performed bilaterally on 12 orbits from 6 unfixed cadavers (3 male and 3 female). Micromorphologic investigations of the orbital tissue were performed on 8 *en bloc* excised and formalin-fixed orbits of infant cadavers. Specimens were fixed according to the Duvernoy method. An intra-arterial injection of 5% mixture of melt formalin and black ink was administered into the carotid arterial system. Using routine fixation, decalcination, dehydration, illumination, impregnation and molding procedures in paraplast, specimens were prepared for cross-sections. **Results.** The measurement of the muscle length and diameter *in situ* in 6 nonfixed cadavers (12 orbits) showed an average length of the *levator palpbrae superioris* (LPS) muscle body of the 42.0 ± 1.41 mm on the right, and 40.3 ± 1.63 mm on the left side. In all the cases, the LPS had blood supply from 4 different arterial systems: the lacrimal, supratrochlear, and supraorbital artery and muscle branches of the ophthalmic artery. The LPS muscle in all the specimens was supplied by the superior medial branch of the oculomotor nerve. The connective tissue associated with the LPS muscle contains two transverse ligaments: the superior (Whitnall's) and intermuscular transverse ligaments (ITL). The orbital septum in all the specimens originated from the arcus marginalis of the frontal bone, and consisted of two layers – the superficial and the inner layer. In addition, a detailed histological analysis revealed that the upper eyelid's crease was formed by the conjoined fascia including the fascia of the orbicularis muscle, the superficial layer of the orbital septum, and the aponeurosis of the LPS muscle, as well as the pretarsal fascia. **Conclusion.** The conducted study provided a valuable morphological basis for biomechanical and clinical considerations regarding blepharoptosis surgery.

Key words:
oculomotor muscles; blepharoptosis; microdissection; oculomotor nerve.

Apstrakt

Uvod/Cilj. Detaljno poznavanje građe gornjeg kapka veoma je važno za mnogobrojne korektivne hirurške zahvate na gornjem kapku. Ovaj članak bavi se detaljnom anatomijom glavnih struktura gornjeg kapka koji se obično susreću u hirurškoj praksi. **Metode.** Studija je sprovedena na 19 ljudskih kadavera (12 odraslih i 7 odojčadi) bez patoloških promena u orbitalnoj regiji i kapcima. Anatomska mikrodisekcija sadržaja orbite sprovedena je na 12 orbita, obostrano na 6 svežih kadavera odraslih (3 muška i 3 ženska). Mikromorfološka ispitivanja struktura orbite izvedena su na 8 *en bloc* orbita kadavera odojčadi fiksiranih formalinom. Preparati su fiksirani Duvernoy metodom. U karotidni sistem intraarterijski je ubrizgavana mešavina 5% rastvora formalina i crnog tuša. Rutinskom procedurom, koja obuhvata fiksaciju, dekalcifikaciju, dehidrataciju, prosvetljavanje, impregnaciju i kalupljenje u paraplastu, uzorci su pripremani za pravljenje preseka. **Rezultati.** Merenje dužine i širine mišića na šest svežih kadavera (12 orbita) pokazalo je prosečnu dužinu tela mišića *levator palpebrae superioris* (LPS) od 42,0 ± 1,41 mm na desnoj strani, a 40,3 ± 1,63 mm na levoj strani. U svim slučajevima, LPS je bio vaskularizovan iz četiri različita arterijska sistema: *a. lacrimalis*, *a. supratrochlearis*, *a. supraorbitalis* i mi-

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šićnih grana *a. ophthalmicae*. Mišić LPS u svim slučajevima inervisala je gornja medijalna grana *n. oculomotoriusa*. Ustanovljeno je da je vezivno tkivo povezano sa LPS mišićem, sastavljeno od dva poprečna ligamenta: gornjeg (Whitnallovog) i intermuskularnog poprečnog ligamenta (ITL). Orbitalni septum je u svim slučajevima polazio od supraorbitalne ivice čeone kosti i sastojao se od dva sloja – površnog i dubokog. Osim toga, detaljna histološka analiza pokazala je da gornji kapačni žleb formira fascija mišića *orbicularis oculi*, površni sloj orbitalnog septuma, aponeuroza mišića *levator palpebrae superioris* i pretarzalna fascija. **Zaključak.** Istraživanjem je obezbeđena važna morfološka osnova za biomehanička i klinička ispitivanja u hirurgiji blefaroptoza.

Ključne reči:
mišići, okulomotorni; blefaroptoza; mikrodisekcija; n. oculomotorius.

Introduction

A wider knowledge of the *levator palpebrae superioris* (LPS) muscle and the suspensory fibrous tissue related to the LPS muscle is essential for the eyelid surgery, especially for the blepharoptosis correction. Even though, there are several papers providing the description of the eyelid anatomy, anatomic features of the *orbicularis oculi* and the LPS muscle, there are various anatomical details that are still controversial. In particular, the importance of the orbital connective tissue and the role they play in pathogenesis or the blepharoptosis treatment are still unclear.

In most patients with congenital and acquired blepharoptosis, palpebral creases are not so distinctive. In addition, Anderson et al. [1] described an atrophic and dehiscent superior transverse ligament (Whitnall's ligament-WL [2]) in those patients. Fink et al. [3] first reported the presence of the connective tissue which underlines the LPS muscle, the tissue that was called the intermuscular transverse ligament (ITL) by Lukas et al. [4]. However, the functional role of these ligaments in the LPS muscle is still unclear.

The aim of this study was to reinvestigate the detailed anatomy of the connective tissues related to the LPS muscle, and to establish their role in the suspension and creation of normal upper eyelid contours in the occidental race.

Methods

The anatomic microdissection study and histological analysis were conducted on 19 human cadavers (12 adults and 7 infants). We used microdissection techniques for the orbits from formalin-unfixed/fixed cadavers, as well as micromorphologic investigation methods.

The anatomic microdissection of the contents of the orbita through the anterior cranial fossa (transcranial approach) was performed bilaterally on 12 orbits from six unfixed cadavers (3 male and 3 female). The cadavers, aged 42–75 years (the mean age was 60 years) had no pathologic changes in the orbital region and eyelids. We used the standard technique for the brain extraction, and the customary abduction technique to remove the orbital bony roof. The periorbita was then incised, and turned laterally so that the levator muscle of the upper eyelid could be seen. Anteriorly, we found the transverse fibrous strands of Whitnall's ligament, and, after cutting the LPS muscle proximally, an intramuscular transverse ligament with connections to the bone of the orbital roof. The space under the aponeurosis of the LPS muscle was dissected to expose the tarsal plate. Microdissection of the orbital subject was performed using a stereo magnifying glass (4×).

The method of standard dissection of 12 orbits from 6 formalin fixed cadavers (3 male and 3 female) was performed by the combined transcutaneous and transcranial approach. Incisions were made on the skin, the orbicularis oculi muscle was exposed, and a strip of *orbicularis oculi* muscle was turned aside. After the junction of the orbital septum and levator aponeurosis was observed, a blunt dissection was carried out through the outer layer of the orbital septum, and continued to the Whitnall's ligament between the levator aponeurosis and the inner layer of the orbital septum, which covers the posterior surface of the orbital fat.

All the specimens were photographed by a Sony Cyber Shot DCS P8 digital camera.

Micromorphologic investigations of the orbital tissue were performed on 8 *en bloc* excised and formalin-fixed orbits of infant cadavers with no pathologic changes in the orbital region and eyelids. An intra-arterial injection of 5% mixture of melt formalin and black ink was administered in the carotid arterial system, and rinsed out using a saline solution and 4% neutral buffered solution of formaldehyde. The specimens were fixed according to the method of Duvernoy. We used the standard technique for the brain removal, and the specific transcranial approach. Microdissections (using micro instruments) of injected orbital blood vessels, nerves and muscles were analyzed under the Leica MZ6 stereomicroscope.

All the specimens were photographed by Sony Cyber Shot DCS P8 digital camera. To get more easily visible details, we used the Leica DC 300 digital camera (magnifications 6.3×, 10× and 20×).

Histological analysis was carried out on 6 *en bloc* excised and formalin-fixed infant orbits. We used the material from the Anatomic Institute of the Faculty of Medicine, Belgrade. The aim was to establish the exact micromorphologic architecture of the upper eyelid. Orbital and frontal region specimens were perfunded with the saline solution through a cannula placed in one of the carotid arteries, and the 4% neutral buffered formaldehyde solution was used afterwards for the same purpose. All the specimens were fixed in the 4% neutral buffered formaldehyde solution in volume 20 times larger than the tissue volume prepared for fixation. Using routine fixation, decalcination, dehydration, illumination, impregnation and molding procedures (Bio-Plas plus, Bio-Optica, Italy), paraplast specimens were prepared for sections At the distance of 15 μm, we cut off a series of tissue midsagital sections of 4–5 μm in thickness using a Reichert-Jung microtome. Sections were placed on special high-adhesive glass plates (Super Frost Plus, DAKO, Denmark), dried for 60 minutes in thermostat (56°C), and dyed afterwards. Out of standard hematoxilin-eosin (H&E) dyeing procedures, we used advanced histochemical dyeing methods: periodic acid-Schiff (PAS), Masson trichrome and elastica Martius scarlet blue (MSB).

This study was conducted in accordance with the Serbian laws and regulations. The methods for securing the human tissue were humane, proper consents and approvals were obtained, and the tenets of the Declaration of Helsinki were followed.

Results

Anatomic investigations

Levator palpebrae superioris (LPS) muscle

The measurement of the muscle length and diameter *in situ* on 6 nonfixed cadavers (12 orbits) showed the average length of the LPS muscle body to be 42.0 ± 1.41 mm on the right, and 40.3 ± 1.63 mm on the left side. In its origin part, the muscle width was 3.93 ± 0.37 mm on the right, and 3.60 ± 0.40 on the left side, while at the point of the muscle transition to aponeurosis (LPS tendon), it was 4.97 ± 0.29 mm and 4.78 ± 0.27 mm, respectively. The transition of the LPS muscle body to its aponeurosis was 14–17 mm [15.83 ± 0.75 mm (right side), and 14.83 ± 0.75 mm (left side)] from the superior edge of the tarsus (Table 1).

Blood supply of levator palpebrae superioris (LPS) muscle

Our anatomical investigation of the LPS muscle blood supply revealed that the muscle got the blood from four different arterial systems: the lacrimal, supratrochlear, and supraorbital artery and muscle branches of the ophthalmic artery (fellows of *n. oculomotorius* and its branches), in all our cases. The anterior half of the LPS muscle had the blood supply from the lacrimal artery branches (the lateral part) and branches of the supratrochlear and supraorbital artery (the medial part), while the blood into the posterior half of the LPS muscle came from the muscle branch of the ophthalmic artery (a fellow artery of the superior branch of the oculomotor nerve). All the arterial branches entered the muscle from its superior surface (Figures 1 a–c).

Distribution of the oculomotor nerve terminal branches in the m. levator palpebrae superioris (LPS)

The *levator palpebrae superioris* muscle in all dissections (8 orbits) was supplied by the upper medial branch of the oculomotor nerve. In one case, the LPS muscle was supplied by 2 divided branches of the upper medial branch. After excising the lateral wall of the cavernous sinus and entering the orbit through its upper medial part, just behind the annulus of Zinn, the oculomotor nerve divided into two branches: the superior and the inferior one. The upper branch (*ramus superior*) was directed upward, and after the short travel was divided into two divisions: the lateral division that supplied the superior rectus muscle, and the medial division for inervation of the LPS muscle. Medial division ran continuously to the LPS muscle along the medial border of the superior rectus in 7 of 8 specimens (87.5 %), while in 1 specimen, it passed through the rectus (12.5%) and entered the inferior surface of the LPS muscle. The number of terminal branches of the medial division in the LPS muscle was 2.93 ± 0.45 (mean ± standard deviation) (Figure 1d).

The terminal branches of the upper medial division traveling to the LPS muscle were traced. We classified the pattern of distribution of the superior division of the oculomotor nerve course as follows: type I – terminal branches extending to the proximal third of the LPS; type II – terminal branches extending to the middle third of the LPS; type III – terminal branches extending to the distal third of the LPS.

In our investigation, the type I distribution of terminal branches was seen in 1 of 8 (12.5%) specimens, type II in 1 (12.5%) specimen, and type III in 5 (62.5%) specimens. There were 2 separate medial branches in 1 dissection, 1 ending in the proximal third, and the other terminating in distal third of the LPS muscle.

Type III was further reclassified as follows: type IIIa – terminal braches running along the medial third of the LPS; type IIIb – terminal braches running along the central third of the LPS; type IIIc – terminal braches running along the lateral third of the LPS.

In our study, the type IIIa was seen in 1 of 5 (20%), type IIIb in 3 of 5 (60%) specimens, while 1 of 5 (20%) dissections showed the type IIIc.

Table 1

Measurements of the *levator palpebrae superioris* muscle (LMS)

Parameter		Values						$\bar{x}$	SD
The length of muscle bodies LPS	Right (mm)	42	44	40	41	43	42	42.00	1.41
	Left (mm)	41	42	38	39	42	40	40.33	1.63
The width of origin part muscle bodies LPS	Right (mm)	4.0	4.4	3.4	3.6	4.2	4.0	3.93	0.37
	Left (mm)	3.7	4.1	3.0	3.3	3.9	3.6	3.60	0.40
The width of LPS at the place of the muscle transition to aponeurosis	Right (mm)	5.0	5.4	4.6	4.7	5.1	5.0	4.97	0.29
	Left (mm)	4.8	5.2	4.4	4.6	4.9	4.8	4.78	0.27
The length of aponeurosis LPS	Right (mm)	16	17	15	15	16	16	15.83	0.75
	Left (mm)	15	16	14	14	15	15	14.83	0.75

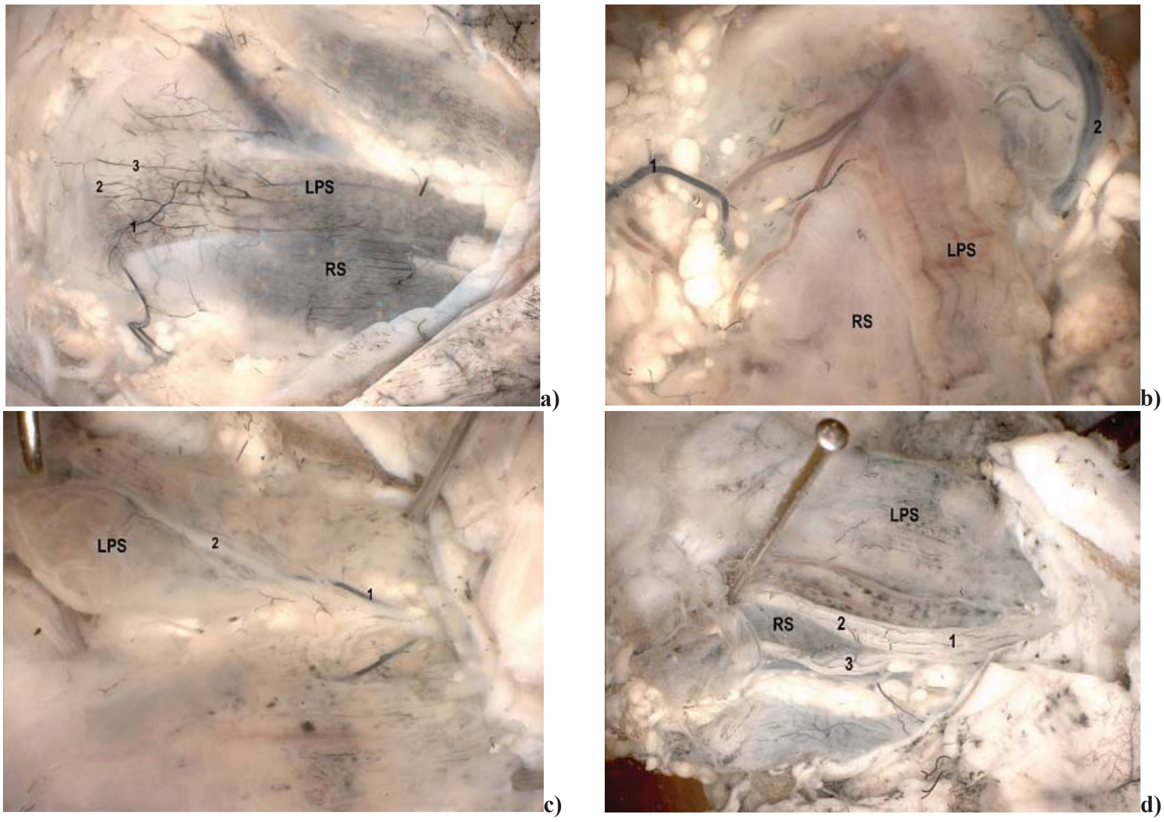


Fig. 1 – Microdissection – intraarterial injection of 5% mixture of melt formalin and black ink

a) 1 – branches of the lacrimal artery; 2 – branches of the supratrochlear artery; 3 – branches of the supraorbital artery, the *levator palpebrae superioris* (LPS), the *rectus superior* (RS) muscle; b) 1 – the lacrimal artery; 2 – the supraorbital artery of the *levator palpebrae superioris* (LPS) muscle the *rectus superior* (RS) muscle; c) 1 – branches of the ophthalmic artery; 2 – the upper medial branch of the oculomotor nerve of the *levator palpebrae superioris* (LPS) muscle; d) 1 – the upper medial branch of the oculomotor nerve; 2 – the branch of the upper medial branch of the oculomotor nerve for the *levator palpebrae superioris* (LPS) muscle; 3 – the branch of the upper medial branch of the oculomotor nerve for the *rectus superior* (RS) muscle and *levator palpebrae superioris* (LPS) muscle.

Transverse ligaments related to the levator palpebrae superioris (LPS) muscle

In our study we found 2 transverse ligaments (thickening of the muscle sheath) related to the LPS muscle: the superior transverse ligament (Figure 2) and the intermuscular transverse ligament (ITL) (Figure 3).

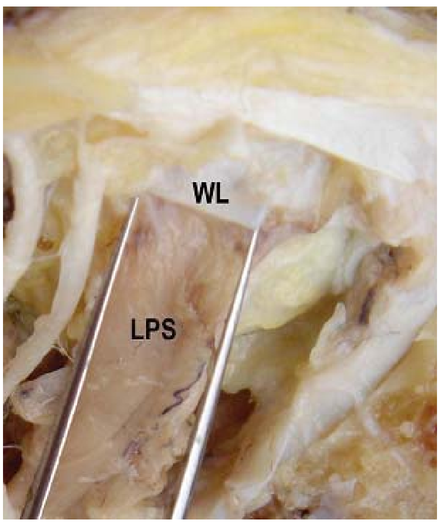


Fig. 2 – The Whitnall's (WL) ligament.
LPS – *levator palpebrae superioris*.

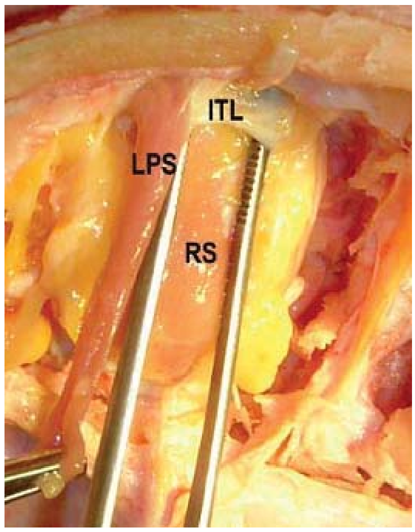


Fig. 3 – The intermuscular transverse ligament (ITL).
LPS – *levator palpebrae superioris* muscle;
RS – *rectus superior* muscle.

As it could be seen from the above said, the Whitnall's ligament (Table 2) assumed spindle shape showing its maximum anterior-posterior extension over the LPS muscle. The 60% of specimens in our study showed the WL bundles fused with the medial and lateral horn of the LPS muscle.

Table 2

Measurements of the Whitnall's (WL) ligament and the intermuscular transverse ligament (ITL) (n = 20)

Parameter	WL (x̄ ± SD)		ITL (x̄ ± SD)	
	right orbit	left orbit	right orbit	left orbit
Anterio-posterior extension (mm)	11.4 ± 4.2	11.5 ± 4.0	15.7 ± 4.8	15.4 ± 4.7
Mediolateral extension (mm)	36.6 ± 5.6	36.4 ± 5.1	34.6 ± 7.2	35.0 ± 6.2
Thickness (mm)	1.4 ± 0.4	1.6 ± 0.5	1.2 ± 0.3	1.4 ± 0.4
Angle with the LPS muscle (°)	84.4 ± 5.4	83.3 ± 4.8	84.7 ± 9.6	83.8 ± 8.9
Distance from the superior posterior tarsal border (mm)	12.1 ± 2.7	11.9 ± 3.2	15.7 ± 4.1	15.6 ± 4.8

LPS – *levator palpebrae superioris*

Fine connective tissue fibers occurred between the orbital roof periost and the WL. Due to this connective tissue was consistently observed between the LPS muscle and the superior rectus (SR) muscle, this ligament was named ITL by Lucas et al. [4] (Table 2) to ensure clear differentation from the WL. As already mentioned, the trapezoidal-shaped ITL with a nearly transverse anterior border continued posteriorly as a thin transparent layer (the intermuscular septum). A sleeve for the LPS muscle was formed by the fusion of the WL and the ITL near their medial and lateral insertions. Originating from the outer and, mainly, from the inner fascia of the lacrimal gland or the lateral orbital wall, the ITL extended transversally below the LPS muscle to insert at the superomedial orbital notch, and continued posteriorly to the trochlea and the connective tissue around the superior oblique. The main ligament insertions were slightly lower in the orbit than in the middle of both ligaments connected with the LPS muscle. The connections of the ITL with the upper conjunctival fornix, and the presence of the sagittal connective tissue strands between the ITL and the SR and its pulley were revealed by microscopic preparations.

Orbital septum

In all the specimens, the orbital septum originated from the *arcus marginalis* of the frontal bone, and consisted of two layers (Figure 4). The outer (superficial) whitish layer, aponeurosis and deep aponeurosis of the *orbicularis oculi* muscle reflecting downward without the attachment of the surrounding connective tissue, and ending in the deep layer of the pretarsal skin. The inner (deep) layer ran closely abreast, reflected at the levator aponeurosis and continued superiorly and posteriorly to the levator sheath. Tracing of the deep layer led to the superior transverse ligament of Withnall above the levator aponeurosis. In the space between the palpebral part of the *orbicularis oculi* muscle and the orbital septum, we found the (loose) areolar tissue. Most commonly, this space contains the preseptal fatty tissue.

Our study of orbits and the upper eyelid revealed 3 different compartments of the fatty tissue: lateral, medial and pre-aponeurotic fatty pads. The lateral fatty pad (light yellow) was placed between the lateralis rectus and the SR muscle, based anteriorly-superiorly to the orbital part of the lacrimal gland. It did not reach the upper eyelid in any of the specimens. The medial fatty pad (light yellow, too), between the medial rectus and the oblique superior muscle reached the orbital septum at the level of the medial part of the eyelid. The pre-aponeurotic fat is a cephalic portion of the orbital fat. It is located below the orbital roof, behind the orbital septum, and in front of the LPS muscle aponeurosis. The pre-aponeurotic fat, light yellow in color, extended laterally behind the lacrimal gland, and medially, to the oblique

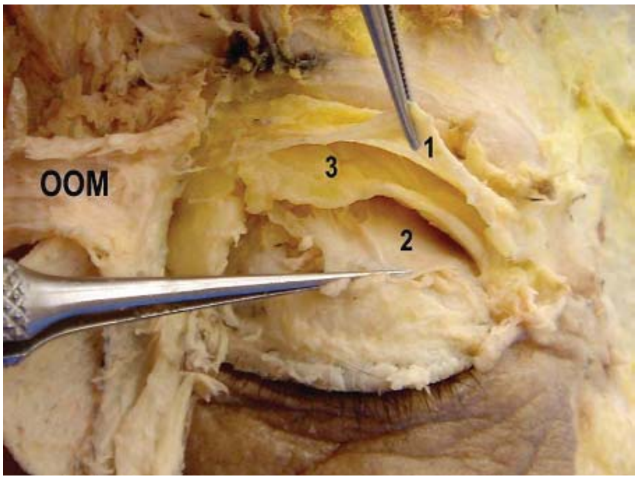


Fig. 4 – Microdissection of the orbital septum.

1 – the superficial layer; 2 – the submuscular fibrofatty layer; 3 – the pre-aponeurotic fatty pad; OOM – *orbicularis oculi* muscles.

containing vertically running vessels, descended just posteriorly to the *orbicularis oculi* muscle and the submuscular fibrofatty layer. Slightly above the tarsal upper edge (3 to 5 mm), there was a junction of the orbital septum, the levator superior tendon, which separated it from the medial fat. Fat formations of the upper eyelid were separated by fascial extensions from the WL. Medial and central fatty pads were completely separated in few cases (16.7%), while, in most cases, they were connected partially. The blood supply and the innervation of fatty pads came from terminal branches of the supraorbital artery and nerve.

Histological analysis

In our upper eyelid investigation, we identified a formation that creates the palpebral crease called the conjoined fascia by Siegel. In all the cases, it was placed in front of the tarsus at the level of the upper palpebral crease, and consisted of *orbicularis oculi fascia*, the superficial layer of the orbital septum, the LPS muscle aponeurosis and the pretarsal fascia. At the level of the upper palpebral crease, the LPS muscle aponeurosis showed a junction to the orbital septum and the orbicularis oculi fascia. These fibers proceeded downward, and met the pretarsal fascia. The conjoined fascia was firmly attached to the tarsus and the pretarsalis part of the orbicularis oculi muscle. Some fibers of the LPS muscle aponeurosis continued forward and was inserted in the deep surface of the skin. Behind the *orbicularis oculi* muscle, as well as in the front of the orbital septum, we found the lose fibrofat layer, mostly avascular, and called it the suborbicular fascial plan (Figure 5a).

The dense, thick collagen fibers of both layers of the orbital septum enclosed the pre-aponeurotic fat in the midsagital line. Collagen fibers of the deep layer proceeded to the WL and sheath of the LPS muscle. At the level of the upper palpebral crease, the deep layer of the orbital septum was intimate with and directly adjacent to the LPS muscle aponeurosis. The deep layer of the orbital septum near the supraorbital edge terminated in the periorbital periostium, without a connection to the superficial layer (Figure 5b).

In addition, we found that the superficial layer of the orbital septum ran cephalad as a galeal layer, without a direct or indirect connection to the frontal muscle. We identified fibrous connections between the orbital septum and the suborbicular fascial layer near the eyebrow. These connections indirectly limited the frontal muscle in the eyebrow elevation (Figure 5c).

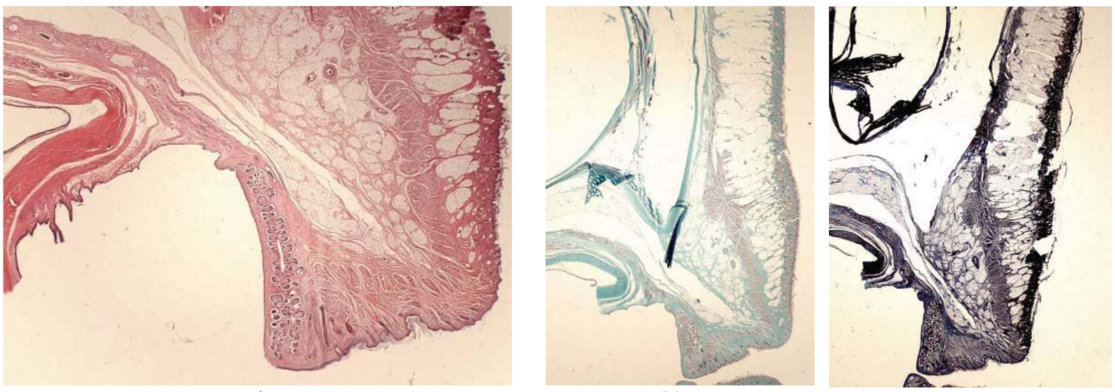
In all the cases, the anterior half of the LPS muscle was supplied by the branches of the lacrimal, the supratrochlear, and the supraorbital arteries, while the posterior half was supplied by the muscular branch of the ophthalmic artery (fellow artery of the superior division of the oculomotor nerve). George [9] found that the posterior half of the LPS muscle had the blood supply by the posterior ethmoid artery that we did not find in any case.

We consider that injuries to the blood vessels supplying the anterior part of the muscle might be indirectly involved in muscle activity, that is the inadequate hemostasis of these vessels, especially in surgical procedures involving the LPS muscle, might result in hematoma, and interfere with postoperative results.

The LPS muscle in all the specimens was supplied by the superior medial branch of the oculomotor nerve. The upper medial branch of the oculomotor nerve extended to the middle third of the LPS muscle (Type III distribution according to the study of Hwang et al. [10]).

These nerve endings were exposed and vulnerable, so their injuries could cause permanent postoperative blepharoptosis. They were also sensitive to local anesthetics, and could be disturbed during the eyelid surgery under local anesthesia. Due to that, exceptional care should be taken during the infiltration of anesthetic near the LPS muscle in order to avoid its transient paralysis postoperatively.

The microarchitecture of the orbital connective tissue system has a significant role in extraorbicular muscles functioning [11–15]. The connective tissue associated to the LPS muscle contains two transverse ligaments: the superior transverse (Whitnall's) ligament and the intermuscular transverse ligament. The Whitnall's ligament has been described as a condensed sheet of fascia underlying the LPS on the superior surface of the muscle, localized in the transitional zone between the muscle body and the aponeurosis. In spite of several descriptions, the function of the WL is still controversial. Whitnall has considered its function as a check ligament. Lemke et al. [16] have mentioned that the WL shows no tension with the open eyelid, while Dutton [17] believes that the WL plays no role in the suspensory activity of the LPS. Anderson and Dixon [18] think that the WL has the role in



a) b) c)

Fig. 5 – Phistological analysis of the orbital septum.

a) Van Gieson's methods (×15); b) Masson trichrome methods (×15); c) Martius scarlet blue (MSB) methods (×15).

Discussion

Our analysis of anatomical and topographic features of the LPS muscle has not shown any statistically significant differences compared to previous studies [5–8].

changing the anterior-posterior traction power of the LPS into vertical one, relieving the eyebrow elevation. In addition, they have found the WL dehiscence and atrophy in some patients with congenital blepharoptosis.

Our study revealed that the superior transverse ligament (WL) and the intermuscular transverse ligament surrounding the LPS muscle in all cases were located at the junction of the muscle body and its aponeurosis. Both transverse ligaments had their origin from the medial and lateral orbital wall. The Withnall's ligament had firm attachments to the LPS on the outer parts of the muscle. The main and dominant origin of the WL was the lateral one, under the LPS muscle, thus, it could be of a great importance for the suspensory activity of the LPS. Under the upper surface of the WL, there were brands of the loose connective tissue reaching periostium of the orbital roof. The ITL is the condensed fascia of the LPS muscle, between the LPS and the rectus superior muscle, connected by brands to the superior conjunctival fornix. This ligament showed a greater anterior-posterior extension than the WL. The main insertion was placed under the middle of both transverse ligaments. We assume that the LPS muscle runs freely over the ITL thanks to condensing of the connective tissue in the anterior parts of the ligament.

According to the conclusions of a separate examination, we think that these two ligaments could be inadequate. Anatomically, both ligaments create an annular formation containing the fibroelastic and fibromuscular tissue surrounding the LPS muscle near its musculoaponeurotic junction. We consider that, despite the fact that the dominant origin of both ligaments is lower, it could be the morphological substratum of suspension action of the LPS muscle during the passive lowering of the eyelid with the upward view.

In the Gray's anatomy, the upper eyelid elevation is to be checked by the orbital septum [19]. In 1910 Whitnall described how the superficial part of the levator sheath forms a conspicuous band above the LPS muscle in a vertical section through the orbit, just behind the aponeurosis. Moreover, he recognized a delicate layer of the connective tissue running over the aponeurosis and posteriorly to the orbital septum. Fink [3] reported that the fascial sheath of the LPS muscle continued anteriorly from the WL as a continuous membrane that could be traced up to the supraorbital rim, where it blends with the orbital septum.

Conclusion

Our study showed that the superficial layer of the orbital septum, 3 to 5 mm above the superior tarsal edge, had its origin from the LPS fascia, and continued upward as a deep galeal layer in the frontal region, without connections to the frontal muscle, and exhibited no blending with the superficial layer of the orbital septum. Behind and above the origin of the superficial layer of the orbital septum, the aponeurosis of the LPS muscle deep layer of the orbital septum exhibited, the junction to aponeurosis by the connection to an undefined integrity. We consider that the junction of the orbital septum, fascia of the LPS muscle, and the deep fascia of the *orbicularis oculi* muscle plays a supporting role for the periorbital fat, and is placed more medially than laterally in the upper eyelid [16, 20–22].

In addition, this detailed histological analysis revealed that the upper eyelid's crease was formed by the conjoined fascia containing the fascia of the *orbicularis* muscle, the superficial layer of the orbital septum, and the aponeurosis of the LPS muscle, as well as the pretarsal fascia. These findings suggest that in creating the upper eyelid's crease, the skin suture should be placed through the aponeurosis and the superficial layer of the orbital septum, as to protect the integrity of the crease (levator-dermal fixation).

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