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ANATOMIC VARIATIONS

Double-bellied superior rectus muscle

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Abstract
Congenital variations of extraocular muscles are rare. We report a double-bellied superior rectus muscle, observed in an adult male cadaver aged 70 years. The superior rectus muscle had two equal-sized bellies, which took separate origins from the common tendinous ring and united to form a common belly 1 cm before the insertion. Due to the duplication, the muscle extended laterally beyond the levator palpebrae superioris. Both its bellies were supplied by oculomotor nerve. To the best of our knowledge, this is the first report on doubling of the belly of the superior rectus muscle.

Keywords Extraocular · Orbit · Superior rectus muscle · Eye movement · Strabismus

Introduction

Voluntary movements of the eyeball are performed by six extraocular muscles, namely superior rectus muscle, the inferior rectus muscle, medial rectus muscle, lateral rectus muscle, superior oblique muscle, and inferior oblique muscles. Variations of these muscles can result in restrictions of movements of eyeball, causing strabismus. Reported variations of extraocular muscles include congenital absence [3, 16], supernumerary heads [14], and bifurcation of the tendon [13]. von Lüdinghausen et al. [15] and Whitnall [17] have reported some types of variations of other extraocular muscles. These variations have been noted incidentally or during surgical procedures. Bergman et al. have reported a slip connecting superior rectus muscle with the inferior rectus muscle, lateral to the optic nerve; an anomalous slip connecting the inferior rectus muscle to the inferior oblique muscle; absence of lateral and medial recti muscles and doubling of inferior oblique muscle and lateral rectus muscle [1]. We report a unique, to the best of our knowledge, yet unreported variation of superior rectus muscle, and discuss about its clinical relevance here.

Case report

During dissection classes for the first-year medical students, we observed a unique variation in the right orbit of an adult male cadaver aged 70 years. The cadaver was donated to the department for teaching and research purpose. No history of strabismus or visual defects is available. The variation was found for the first time in 25 years of cadaveric dissections of over 250 cadavers in our dissection hall. After the removal of the roof of the orbit, a muscle was observed under the levator palpebrae superioris muscle, projecting beyond its lateral border. Further careful reflection of the levator palpebrae superioris muscle and frontal nerve revealed the doubling of the belly of superior rectus muscle. The superior rectus muscle had two equal-sized fleshy bellies (a medial belly and a lateral belly) (length; 40 mm and breadth 7 mm). Both bellies took origin from the common tendinous ring and united to form a single muscle about 1 cm before the insertion of the muscle. At the origin, there was no much space between the two bellies. The common tendon of the muscle was inserted to the sclera, 6 mm behind the corneal limbus (Figs. 1, 2). Both bellies were supplied by the superior branch of the oculomotor nerve. There were no other variations in the orbit.

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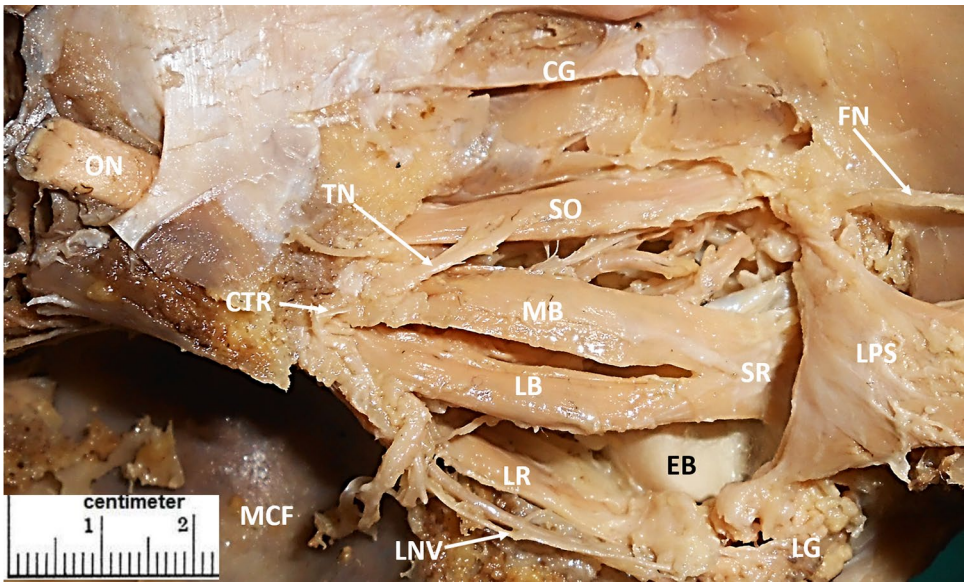

Fig. 1 Dissection of the right orbit showing the variant superior rectus (SR) muscle. *MB* medial belly of superior rectus, *LB* lateral belly of superior rectus, *LPS* levator palpebrae superioris, *EB* eyeball, *FN* frontal nerve, *LG* lacrimal gland, *SO* superior oblique muscle, *LR* lateral rectus muscle, *LNV* lacrimal nerve and vessels, *CG* crista galli, *TN* trochlear nerve, CTR common tendinous ring, *MCF* middle cranial fossa, *ON* optic nerve

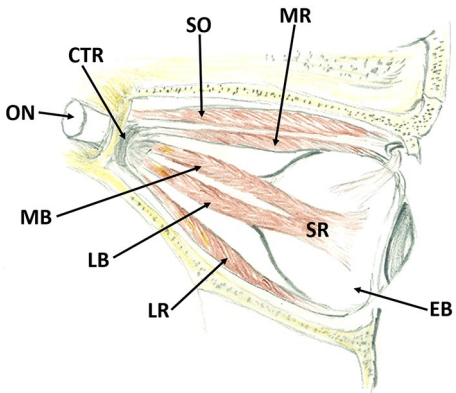

Fig. 2 A simplified schematic drawing of the right orbit showing the variant superior rectus (SR) muscle. *MB* medial belly of superior rectus, *LB* lateral belly of superior rectus, *EB* eyeball, *SO* superior oblique muscle, *MR* medial rectus muscle, *LR* lateral rectus muscle, *CTR* common tendinous ring, *ON* optic nerve

Discussion

According to Brenda et al., the extraocular muscles of vertebrates are derived from two groups of mesenchymal cells namely, the unsegmented paraxial head mesoderm and the prochordal head mesoderm. Among these two sources, the lateral rectus muscle and superior oblique muscle are derived from the paraxial head mesoderm and the rest of the muscles are derived from the prochordal mesoderm. It is believed that the neural crest has a stimulant role in the formation of the extraocular muscles. The neural crest contributes to the formation of the sclera and the choroid coat of eyeball [2]. Variations in the attachments, nerve supply and actions of the muscles of orbit are seldom seen. This could be due to the fact that the variations might impair the visual function drastically. Variations of extraocular muscles could cause exophthalmos, enophthalmos, strabismus, and diplopia. Total absence of a rectus muscle is very rare. However, there is a report on congenital absence of superior rectus muscle [12]. This type of absence or hypoplasia of a muscle might cause monocular elevation deficiency. Duplication of one of the recti muscles is also relatively rare. However, there is report of a case of congenital duplication of the inferior rectus muscle causing entropion and hypotropia [11]. Supernumerary muscles of the orbit are common in monkeys, but they are also in humans occasionally [8]. Von Lüdinghausen [15], has reported the presence of a supernumerary muscle bilaterally between optic nerve and lateral rectus muscle. The muscle was oriented in sagittal plane and merged with the inferior rectus anteriorly. A supernumerary muscle called gracillimus orbitis muscle can be found in 5–14% dissections. It arises from medial side of the levator palpebrae superioris muscle and gets inserted to the fascia around the trochlea [6]. This muscle was also seen by von Lüdinghausen and he is of the opinion that it represents the degenerated nictitating membrane of primates [14]. Some of these additional muscles might cause restrictive strabismus. One such additional muscle that can cause restrictive strabismus has been reported by Molinari et al. [9]. Liao and Hwang [8] have reported the presence of an additional lateral rectus muscle with normal ocular movements. Imaging studies of the orbit can reveal the presence of the supernumerary muscle of the orbit [4, 10]. In addition to supernumerary muscles, reports are also found on linking or bridging muscles which connect two extraocular muscles with each other. Kakizaki et al. [7] and Haładaj et al. [5] have reported a muscle connecting

the superior rectus muscle with the inferior rectus muscle. Recti muscles can show variations in their insertion to the eyeball too. There is a report on bifid tendon of superior rectus muscle [13].

Though there are reports on variant attachments, supernumerary muscles, and symptomatic and harmless muscles, there is no report on double-bellied superior rectus muscle in the literature. The duplication that we have observed might cause mono-ocular elevation of the affected eye. Since the anomaly is congenital, this might not be associated with diplopia. The presence of this muscle can be viewed in MRI procedures and surgical correction of eye can be undertaken. This case could be important to radiologist, ophthalmologists, and craniofacial surgeons.

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Author contributions SBN dissected the cadaver. He also took the photograph and labeled it and drafted the manuscript. SDS, NK, and AA helped in reviewing the literature, proof reading the manuscript, and final approval.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

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