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Assessment of extraocular muscle thickness and correlation study using optical coherence tomography☆

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ABSTRACT

Objective: To report reference values for the horizontal rectus muscles thickness using Spectral Domain optical coherence tomography (SD-OCT), and to evaluate whether there are any correlations between the muscle thickness and gender, age, or axial length (AL).

Materials and methods: A cross-sectional study was conducted on 131 right eyes of healthy subjects. The gender and age were recorded, and axial length was measured using an optical biometer. The medial rectus (MR) muscle thickness was measured at 7.2 and 9.2 mm from the limbus, and the lateral rectus (LR) at 8.5 and 10.5 mm from the limbus using OCT. A multivariate model was adjusted to determine whether gender, age, and axial length could have an impact on the muscle thickness.

Results: Mean age was 43.3 ± 20.9 years (range 6–86), and 59% were women. Mean AL was 24.9 ± 2.7 mm (range: 20.4–33.8). Mean thickness was 188.5 ± 51.2 μm (range 69–342) for the LR at 8.5 and 186.5 ± 45.9 μm (range 75–269) at 10.5 mm, and for the MR, 158.1 ± 39.1 μm (range 69–273) at 7.2 mm and 193.7 ± 55.9 μm (range 105–386) at 9.2 mm. A correlation was observed between the AL and MR thickness ($R = -0.255$; $p = 0.023$) while no correlation was observed for the LR ($p \geq 0.203$). No correlations were found between thickness and gender or thickness and age ($p \geq 0.125$).

Conclusions: The reference ranges of the horizontal rectus muscles thickness was described using SD-OCT, observing an association between the AL and the MR thickness.

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Evaluación del grosor de los músculos extraoculares y estudio de correlación mediante tomografía de coherencia óptica

Palabras clave:
Músculos extraoculares
Grosor muscular
Tomografía de coherencia óptica
Tendón muscular
Longitud axial ocular

RESUMEN

Objetivo: Describir los valores de normalidad del grosor de los músculos rectos horizontales mediante tomografía de coherencia óptica de dominio espectral (SD-OCT) y valorar si existe correlación entre el grosor muscular y el sexo, la edad o la longitud axial (LA).

Material y métodos: Estudio transversal de 131 ojos derechos de pacientes sin enfermedad oftalmológica. Se recogieron el sexo y la edad y se midió la LA utilizando un biómetro óptico Lenstar LS 900 (Haag-Streit AG, Koeniz, Suiza). El grosor del recto medio (RM) se midió a 7,2 y 9,2 mm desde el limbo y el recto lateral (RL) a 8,5 y 10,5 mm utilizando la OCT. Se ajustó un modelo multivariable para analizar si el sexo, la edad y la LA podrían influir sobre el grosor muscular.

Resultados: La edad media fue 43,3 ± 20,9 años (rango 6-86), siendo 59% mujeres. La LA media fue 24,9 ± 2,7 mm (rango: 20,4-33,8). El grosor medio del RL a 8,5 mm fue 188,5 ± 51,2 μm (rango 69-342) y 186,5 ± 45,9 μm (rango 75-269) a 10,5 mm. El grosor del RM fue 158,1 ± 39,1 μm (rango 69-273) a 7,2 mm y 193,7 ± 55,9 μm (rango 105-386) a 9,2 mm. Se observó correlación entre el grosor del RM y la LA ($R = -0,255$; $p = 0,023$), no hallándose correlación para el RL ($p \geq 0,203$). Tampoco se encontró asociación entre el grosor y el sexo o la edad ($p \geq 0,125$).

Conclusiones: La OCT permite medir el grosor de los músculos rectos horizontales, observándose una asociación entre el grosor del RM y la LA.

Introduction

Extraocular muscles (EOM) could be compromised in numerous diseases, changing their volume and thickness as in Graves' ophthalmopathy, myositis, vascular malformations or neoplasia, all of which produce thickening,[1] or in oculomotor palsy where the muscle could lose thickness.[2] On other occasions, muscular fibrosis occurs as in the congenital fibrosis syndrome[3] or the Duane syndrome,[4] or alterations in the muscle position that produce strabismus as in the case of age-related esotropia, also known as age-related distance esotropia,[5] or myopic acquired progressive esotropia.[6]

At present, nuclear magnetic resonance (NMR) and computerized tomography (CT) are the most extended devices for assessing the position and measuring the size of EOM [7]as they allow the visualization of all extraocular muscles at the same time. However, said devices are not immediately available and involve high cost, in addition to CT been limited due to radiation. Echography also enables EOM evaluations and is more accessible but exhibits lower resolution and large inter-and intra-observer variability.[8]

To date, several authors have analyzed factors like age, sex or axial length (AL) to determine their influence on muscular thickness through the above described imaging devices, although said association is the subject of debate.[9–14]

In recent years, optical coherence tomography (OCT) has emerged as an option for visualizing the anterior part of rectus muscles with high resolution. The first studies described as measured the distance of muscular insertion.[15–21] However, very few authors have focused on analyzing muscular thickness with OCT. One of the first was Salcedo-Villanueva et al. who measured said muscles at the level of the muscle-tendon join.[22] Subsequently, Häner et al.[23] annualized muscular thickness in controls and patients with Graves' ophthalmopathy. Lastly, a study carried out by the authors' group observed good reproducibility when measuring horizontal rectus muscle thickness utilizing 3 different OCT devices.[24] However, to date there are no OCT studies that aimed at resolving the current controversy about the possible influence of parameters such as age, sex and AL in EOM thickness.

Accordingly, the purpose of the present study is to describe normal thickness values of horizontal rectus muscles by means of OCT as well as to carry out a correlation study to analyze whether sex, age or AL play a role in muscular thickness.

Methods

An observational, transversal study with a sample of 131 right eyes of 131 healthy subjects in the San Carlos Clinic Hospital, Madrid (Spain). The study complied with the principles of the Helsinki declaration and was approved by the ethics committee of the hospital. Informed consents of all participants were obtained.

A completed clinical history was performed as well as an extended ophthalmological examination of EOM and the anterior and posterior pole in order to discard any type of disorder.

Axial length was measured utilizing a Lenstar LS 900 (Haag-Streit AG, Koeniz, Switzerland) optical biometer. Sex and age of participants were registered.