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Original Article

Echographic study of extraocular muscle thickness in normal Indian population

Priyangshu Chandra, B. Optom; Aditya Sudhalkar, MS; Subhadra Jalali, MS; Veerendranath Pesala, B. Optom; Raja Narayanan, MS; Chinmaya Sahu, MS; Jay Chhablani, MS *

Abstract

Purpose: To establish normative data of extraocular muscle (EOM) dimensions, both vertically and horizontally, using a reproducible echographic method in various age groups.
Methods: Two hundred eyes of 100 healthy subjects (50 males and rest females) were included in this prospective observational study. All subjects were divided into 5 groups with an interval of 10 years from 10 to 60 years. Each group contained 10 male and 10 female healthy subjects. A single operator took measurements at 4 mm distance from the globe plane after drawing a perpendicular line on the globe to the muscle belly.
Results: The average age of subjects was 37.28 ± 17.14 years. Intraobserver reproducibility was very high (intersession concordance correlation co-efficient = 0.995). Mean horizontal and vertical diameters of recti were 3.0775 and 8.26 mm, respectively. Mean muscle thickness of superior rectus/levator palpebral superioris (LPS) muscle complex and LPS was 4.56 and 1.45 mm, respectively. Extraocular muscle diameter increases up to the middle age, then it starts decreasing. There was no statistically significant correlation between diameter of each EOM, both eye and gender ($p \geqslant 0.05$). There was a non-significant change in extraocular muscle thickness with age.
Conclusion: The study provides normative data for extraocular muscle thickness in both genders of various age groups in Indian population. Muscle dimensions do not change significantly with age, between the eyes and gender.

Keywords: EOM, Extraocular muscle, Grave's ophthalmopathy

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Introduction

The accurate assessment of the dimensions of extraocular muscles is of vital clinical importance in the management of patients with orbital, extraocular muscular and neuro-ophthalmologic disorders. Subjective assessment of these structures may be controversial and inaccurate to diagnose or assess the changes during the follow up. There are several diseases that can affect the morphology of extraocular muscles such as primary neoplasm, vascular malformation, acromegaly, orbital myositis, muscle hematoma, orbital apex syndrome, pansinusitis, as well as Graves' ophthalmopathy,[1] the most common cause of muscle thickening.[2,3] In differentiating and diagnosing several of such diseases and to analyze pathologic changes quantitatively it is important to determine normal ranges of dimensions of the muscles first.

There are different imaging techniques to evaluate and measure the dimensions of the extraocular muscles and optic nerve-sheath complex such as ultrasound echography, computed tomography (CT) and magnetic resonance imaging

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Smt. Kanuri Santhamma Retina Vitreous Centre, L.V. Prasad Eye Institute, Kallam Anji Reddy Campus, L.V. Prasad Marg, Banjara Hills, Hyderabad 500 034, India

* Corresponding author. Tel.: +91 40 30612607.
e-mail address: jay.chhablani@gmail.com (J. Chhablani).

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(MRI). Of these, echography is the safest and most cost-effective method and appears to be the best option for a baseline quantitative evaluation of a muscle over other imaging techniques. Echography is useful in detecting the change in extraocular muscle thickness when associated with orbital abnormalities during the therapy. The technique of an extraocular muscle evaluation including dimensions using ultrasound was developed by McNutt and Ossoining.[4,5] However the reproducibility of the technique is questionable.

Normal muscle diameters have been reported earlier in different races with very high variation in measurements. A study was reported on normal extraocular muscle measurements in Indian population in 1990 by Arora et al.[6] with a relatively small sample size without uniform age-distribution. Thus there is a need for extraocular muscle thickness database in Indian population with a larger sample size.

The objective of the present study was to assess the reproducibility of a new technique for muscle thickness measurements and establish a normative database of measurements of the extraocular muscles using ultrasound across different age groups in Indian population and to assess the relationship between the muscle thickness and various other variables.

Material and methods

This prospective study included 100 healthy subjects at L.V. Prasad Eye Institute, Hyderabad, India from July to October 2012. Prior approval from the institutional review board of L.V. Prasad Eye Institute, Hyderabad was taken and informed written consent was obtained from each subject. All participants underwent a comprehensive ocular examination including best-corrected visual acuity (BCVA), slit-lamp biomicroscopy and dilated fundus examination. Subjects with any evidence of orbital or ocular disease, extraocular muscle disorder and history of extraocular or intraocular surgery were excluded. Images with poor quality or inability to measure were excluded.

Extra ocular muscle thickness measurement protocol

Extraocular muscle is surrounded by a smooth sheath *called Tenons' capsule*, that produces distinct, highly reflective interface between the muscle and soft tissue on ultrasound examination. Muscle fibers are relatively compact and homogeneous than the surrounding area. Therefore, normal extraocular muscles produce low to medium homogeneous reflectivity internally on A scan and relatively less echo dense on B scan than the surrounding fat soft tissue.

Echographic evaluation of the extraocular muscle was done for all subjects in both eyes with closed lid by an experienced optometrist following a comprehensive eye checkup. All echographic measurements were performed using OTI 3000 (OPKO instrumentation, USA) instrument, which has an advanced noise reduction algorithm, using a 10 MHz probe of 0.20 mm lateral resolution. The muscle diameter was measured at a low tissue sensitivity of 60 Decibel, which was maintained throughout the study. The ''Narrow Scanning Field'' of 35° was used to image the extraocular muscle. This narrow scanning angle maintains the same number of scanning lines which are packed at a narrower scanning angle over ''Wide Scanning Field'' of 50° and therefore it provides a higher lateral resolution of each image. Measurements were taken using in-built calipers in the instruments.

The examination techniques used in measuring the extraocular muscles with standardized echography were the same as described by McNutt[4] and Ossoining.[5] This includes evaluation of the Inferior rectus, medial rectus and the superior rectus muscles and levator palpebrae muscle in the primary gaze position and lateral rectus muscle in the 10 degrees abducted eye position.

Both transverse and longitudinal approaches were used for morphological evaluation of the muscles. Transverse orientation provides cross sectional view and the muscle appears rectangular or oval shaped. Longitudinal orientation provides a long-axis (anteroposterior) view and the muscle appears fusiform in shape. The echographic probe located in the transbulbar position was aimed at the equator. Measurements in both longitudinal and transverse scans were taken at the level where distance between the globe and the muscle was 4 mm. A perpendicular line was drawn on the globe to the muscle belly and measurements were taken at 4 mm distance from the globe plane for all subjects at the muscle belly in all images (Figure 1).

The longitudinal scan provided the horizontal diameter for the medial and the lateral rectus. Transverse scan provided both the vertical and the horizontal diameter of all recti. The vertical diameters of the inferior, superior rectus and levator palpebrae muscle complex were obtained in the longitudinal scan.

The levator palpebrae muscle appears as a thin, umbrella shaped less echo lucent area above the superior rectus in echography, which is quite difficult to measure virtually.[3,4] Hence, first the superior rectus and the levator palpebrae muscles were measured together in the longitudinal scan as a combined or complex structure. Next the superior rectus muscle thickness was evaluated separately using a transverse scan. Finally these two values were deducted from each other to find out the levator muscle thickness.

Statistical analysis

The distribution of muscle diameters was tested for deviation from a Gaussian distribution using the Shapiro–Wilks test. However, the absolute values often do not follow a Gaussian distribution. The effect of demographic variables like gender, the contralateral difference of muscle measurement, and the thickness values obtained from two different orientations of each muscle were evaluated using a non-parametric Mann Whitney test. Pearson's correlation was used to evaluate correlations between muscle thicknesses with continuous demographic variable. The muscle thickness values were statistically elaborated; the mean, median, range, the standard deviation and the 5th and 95th percentiles were calculated. A p-value of less than 0.05 was considered statistically significant. All statistics in the present study were done using version SPSS 15.0 (SPSS Inc., Delaware).

Results

Two-hundred eyes of 100 subjects were enrolled in the study of which 50 were female. Subjects were divided into 5 groups based on their age starting from 10 to 60 years at 10 year interval and each group contained 10 males and 10

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