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Original contributions

Use of computed tomography to assess volume change after endoscopic orbital decompression for Graves' ophthalmopathy☆,☆☆,★

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ABSTRACT

Background: Orbital decompression is frequently performed in the management of patients with sight-threatening and disfiguring Graves' ophthalmopathy. The quantitative measurements of the change in orbital volume after orbital decompression procedures are not definitively known. Furthermore, the quantitative effect of septal deviation on volume change has not been previously analyzed.

Objectives: To provide quantitative measurement of orbital volume change after medial and inferior endoscopic decompression and describe a straightforward method of measuring this change using open-source technologies. A secondary objective was to assess the effect of septal deviation on orbital volume change.

Methods: A retrospective review was performed on all patients undergoing medial and inferior endoscopic orbital decompression for Graves' ophthalmopathy at a tertiary care academic medical center. Pre-operative and post-operative orbital volumes were calculated from computed tomography (CT) data using a semi-automated segmenting technique and Osirix™, an open-source DICOM reader. Data were collected for pre-operative and post-operative orbital volumes, degree of septal deviation, time to follow-up scan, and individual patient Hertel scores.

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Results: Nine patients (12 orbits) were imaged before and after decompression. Mean pre-operative orbital volume was 26.99 cm^3 (SD = 2.86 cm^3). Mean post-operative volume was 33.07 cm^3 (SD = 3.96 cm^3). The mean change in volume was 6.08 cm^3 (SD = 2.31 cm^3). The mean change in Hertel score was 4.83 (SD = 0.75). Regression analysis of change in volume versus follow-up time to imaging indicates that follow-up time to imaging has little effect on change in volume (R = −0.2), and overall mean maximal septal deviation toward the operative side was −0.5 mm. Negative values were attributed to deviation away form the operative site. A significant correlation was demonstrated between change in orbital volume and septal deviation distance site (R = 0.66), as well as between change in orbital volume and septal deviation angle (R = 0.67). Greater volume changes were associated with greater degree of septal deviation away from the surgical site, whereas smaller volume changes were associated with greater degree of septal deviation toward the surgical site.

Conclusion: A straightforward, semi-automated segmenting technique for measuring change in volume following endoscopic orbital decompression is described. This method proved useful in determining that a mean increase of approximately 6 cm in volume was achieved in this group of patients undergoing medial and inferior orbital decompression. Septal deviation appears to have an effect on the surgical outcome and should be considered during operative planning.

1. Introduction

Surgical decompression is a common treatment for many patients with cosmetic or functional complications of Graves' ophthalmopathy. In 1956 Drs. Walsh and Ogura first performed the transantral Caldwell–Luc inferior and medial wall decompression that remained the mainstay of decompression surgery for many years [1]. However, the high incidences of postoperative diplopia and infraorbital paresthesia associated with the Walsh–Ogura technique prompted the search for more effective and less morbid treatments [2]. Numerous advances in technology and surgical techniques have subsequently increased the options available to surgeons and patients with Graves' disease [3].

Surgical decompression for Graves' ophthalmopathy involves the removal or remodeling of any combination of one or more of the medial, lateral and inferior orbital walls, and/or the removal of intraorbital fat [2–9]. A number of different surgical techniques are utilized for orbital decompression. The surgical approaches can be open, through a variety of different incisions, or endoscopic transnasally. Historically, the type of decompression offered to patients is often based upon surgeon or institutional preference rather than on individual patient characteristics. As a result, decompression surgery is rarely tailored to an individual patient's anatomy and pathology, which can be quite variable. The degree of exophthalmos can vary greatly from patient to patient, and each patient's osseous anatomy is unique. Therefore, applying the identical surgical technique to all patients may yield vastly different results. The body of literature surrounding customized orbital decompression, tailored to particular patient anatomical and clinical characteristics, is growing [5,9–11]. However, quantitative volumetric analysis of the change in orbital volume achieved with these tailored techniques is lacking.

Orbital volumes calculated using CT have been reported on patients with known Graves' ophthalmopathy, and quantitative measurements correlate with clinical findings [12,13]. It has been demonstrated that the increase in orbital volume correlates with the reduction in proptosis, and subsequently the patient's cosmetic deformity, after orbital decompression [14]. Despite the usefulness of these data, definitive measurement of the change in orbital volume following orbital decompression is lacking in the literature.

Quantitative data regarding the change in orbital volume as a result of a particular surgical technique may be useful in informing the surgical decision-making process for each patient. There exists a need for a no-cost technique that is accessible to physicians who may not necessarily have training in the manipulation and analysis of radiographic films. Osirix™ is available freely for download and provides a straightforward method to analyze orbital volumes. Its accuracy in measuring orbital volume has been demonstrated in the orbital trauma literature [15,16]. Information regarding the change in orbital volume might also be useful to document the definitive outcomes achieved by the surgical procedure. Knowing the change in orbital volume after orbital decompression informs the surgeon's decision-making process for the individual patient's care.

While the mean change in Hertel measurement has been well document for medial and inferior orbital decompression [17], and while CT has been used in patients with zygomatic fractures to measure proptosis [18], to the best of our knowledge the mean change in orbital volume following medial and inferior endoscopic orbital decompression has never been reported. Additionally, significant septal deviation is a known challenge for any form of endoscopic nasal surgery, but the effect of septal deviation on orbital decompression outcomes has not been studied.

The purpose of this study is to describe an accessible technique for the measurement of change in orbital volumes, document the approximate change in orbital volume and analyze the effects of septal deviation on outcomes following medial and inferior endoscopic orbital decompression.