Eyebrow Tissue Expansion

An Underappreciated Entity in Thyroid-Associated Orbitopathy

Louis M. Savar, MD; Ravi M. Menghani, MD; Kelvin K. Chong, MD; Helene Chokron Garneau, MPH; Robert A. Goldberg, MD

Objectives: To report photographic evidence of eyebrow tissue expansion in patients with thyroid-associated orbitopathy (TAO) and to demonstrate consistency in grading through the use of standardized photographs.

Methods: A retrospective cohort study of patients referred for evaluation of TAO in an orbitofacial tertiary care center between January 1, 2000, and December 31, 2010. A grading key was produced with representative views of each of 4 grades (0 [no expansion] to 3 [severe expansion]), corresponding to increasing severity of eyebrow tissue expansion. Photographs of each study patient, including both premorbid and morbid photographs, were retrieved from an electronic medical record system and graded by 6 independent, masked observers using this 4-point system.

Results: Seventy-five patients with TAO were identified for inclusion. The average grade was 0.3 for premorbid eyes and 1.1 for morbid eyes. Intraclass correlation coefficients for the premorbid photographs were 0.705 and 0.632 for the right and left eyes, respectively. Intraclass correlation coefficients for the morbid photographs were 0.921 and 0.916 for the right and left eyes, respectively.

Conclusions: Eyebrow tissue expansion is a common manifestation in TAO. Comparison of premorbid and morbid photographs is a useful means to identify and characterize the extent of brow involvement. The use of a grading key improves the consistency of identifying and grading eyebrow tissue expansion. Recognition of the eyebrow tissue as distinct anatomically in TAO may be crucial to rehabilitation of these patients, which may entail multiple surgical procedures.

HYPOID-ASSOCIATED ORBITOPATHY (TAO) is a common disease that affects many of the orbital soft tissues.1 Many of the changes in TAO can be attributed to expansion of orbital adipose tissue and extraocular muscles that lead to proptosis and congestion. The periorbital tissues are also involved in TAO.2,3 Kim and Kazim4 described involvement of the cheek fat. We have also been impressed that the soft tissues of the upper periocular area, specifically the eyebrow fat pad, seem to be clinically involved.3 Eyebrow tissue involvement in TAO may be a useful clinical parameter to identify and characterize the disease in individual patients. We provide photographic evidence of eyebrow tissue expansion in patients with TAO and demonstrate consistency in grading using standardized photographs.

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After obtaining institutional review board approval, the medical records of the UCLA oculoplastic clinic were searched for all the patients with documented Graves disease who had premorbid and morbid photographs available between January 1, 2000, and December 31, 2010. Premorbid photographs were brought in by the patient and had to meet the following criteria: absence of signs of TAO, unobstructed view of both eyebrows, contrast sufficient to delineate the contour of the eyebrow, and resolution sufficient to delineate the pupil. Patients were excluded from the study if they had undergone any orbital or eyelid surgery prior to their morbid photograph or if the photographs were of insufficient quality for assessment.

Baseline variables assessed included age and sex. A grading key for the level of eyebrow tissue expansion was produced with representative front and oblique views of each of the 4 grades, 0 to 3, ranging from no eyebrow changes to severe eyebrow tissue expansion (Figure 1). Standardized clinical photographs were taken of all the patients. Using a digital camera (Olympus C-8080) with zoom lens set at 135 mm, and lighting from a soft box strobe (diagonal measurement 100 cm, located 140 cm from the patient), photographs were taken with the plane of the patient’s face parallel to the film plane, along with oblique and chin-up views. Front-view photographs of each study patient, including premorbid and current photographs, were retrieved from an electronic medical record system and graded by 6 inde-
pendent, masked observers (K.K.C. and R.A.G.) using this 4-point system (Figure 2). The observers were instructed to focus on the area between the upper eyebrow and the upper eyelid crease. All the observers had experience in the management of TAO. The selection of the photographs was done independent of all the observers.

Statistical analysis included calculation of the intraclass correlation coefficient (ICC) using a commercially available software package (SPSS, version 19; SPSS, Inc). Intraclass correlation coefficients were used to quantify interrater reliability. A mean grade was calculated for each side and rounded to the nearest integer.

RESULTS

One hundred fifty eyes of 75 patients with TAO (65 females; mean age, 42 years) were identified for inclusion during the study period. Of the premorbid photographs, 69% were graded 0 and the remaining 31% were graded 1 for right and left eyes. Of the morbid photographs, most were graded 1 with the remaining photographs receiving grades of 0, 2, or 3 (Table 1 and Figure 3). The average grade was 0.3 and 1.1 for premorbid and morbid eyes, respectively. Intraclass correlation coefficients for the premorbid photographs were 0.705 and 0.632 for the right and left eyes, respectively. Intraclass correlation coefficients for the morbid photographs were 0.921 and 0.916 (Table 2) for the right and left eyes, respectively. Scores above 0.50 represent high correlation and, therefore, consistency between graders.

COMMENT

The periorbital tissues seem to be involved in TAO. Presumably related to infiltration of the dermal or subdermal tissues, the eyebrow region becomes thickened and coarse. This can be recognized by change in shape of the eyebrow (lateral flare or “C” shape), by the expansion of the lateral eyebrow tissue creating a rounded bulge of tissue between the lateral eyebrow and the temporal fossa, and accentuation of the glabellar folds (Figure 4). Some of these changes may be clinically indistinguishable from the effects of diffuse periorbital edema, but the specific anatomical patterns of involvement suggest direct tissue effects.

Our data suggest that eyebrow contour changes in TAO can be characterized through the use of standardized photographs by trained observers. We found that in experienced hands, there was a high degree of consistency between each grader. The ICC increased between premorbid and morbid photographs. This increase may be due to the use of standardized clinical photographs for the morbid photographs, while premorbid photographs were nonclinical photographs brought in by the patient at the time.
of examination. This finding emphasizes the importance of standardized, high-quality photographs for clinical evaluation. A possible limitation to the study is that the grades may not be linear, and thus, an average calculation may not be as useful a comparison as the ICC. Additionally, because the premorbid photographs were brought in by the patients whereas the morbid photographs were standardized photographs taken in the clinic, the graders were able to differentiate whether a photograph was premorbid or morbid, creating a potential bias. To minimize the distinction between premorbid and morbid photographs, only front-view photographs were used, which may have limited the observers' ability to fully assess the eyelid contour.

The use of photographic grading has been validated and used within the various subspecialties of ophthalmology, including the grading of diabetic retinopathy and cataracts. It has also been used in other fields of medicine, such as the grading of acne severity by dermatologists. Dickinson and Perros presented a grading system for TAO that included photographic representations. The use of standardized photographs may improve the consistency of identifying and grading eyebrow tissue expansion. Comparison of premorbid and current photographs is a useful means to identify and characterize the extent of eyebrow tissue involvement. In assessing the fullness of the eyebrow, photography is not as objective as 3-dimensional imaging, such as magnetic resonance imaging or computed tomography, but it is readily available, is repeatable, and correlates well with the patient's perception of his or her appearance.

TAO causes significant reduction in the quality of life. Patients describe pain, visual disturbances, and dissatisfaction with their physical appearance. Eyebrow tissue remodeling is among the physical changes that occur in TAO, and it contributes to the disfiguration of the periorbital area. Recognition of eyebrow involvement may not only assist in the diagnosis of TAO but also can provide an additional avenue for surgical rehabilitation of these patients. Also, because the eyebrow fat is sometimes sculpted as part of the surgical rehabilitation, tissue is obtained that can provide another anatomical area for histologic evaluation and characterization. If tissue is needed for research, staging, or clinically classifying patients with thyroid-related orbitopathy, the eyebrow tissue represents a readily accessible area for diagnostic biopsy.

While the anatomical and biologic basis for the stereotyped clinical presentation of eyebrow tissue enlargement is still being elucidated, further studies may provide data that will help us understand this enigmatic disease and perhaps provide tools to help make diagnostic and treatment decisions. Developing a reliable grading system to describe eyebrow tissue changes in TAO is the first step in studying the implications of eyebrow tissue involvement. A consistent grading system is a necessary tool for subsequent studies, for example, to as-

### Table 1. Severity Grades

<table>
<thead>
<tr>
<th>Grade</th>
<th>Premorbid Right Eyes (n = 75)</th>
<th>Premorbid Left Eyes (n = 75)</th>
<th>Morbid Right Eyes (n = 75)</th>
<th>Morbid Left Eyes (n = 75)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>52 (69)</td>
<td>52 (69)</td>
<td>14 (19)</td>
<td>13 (17)</td>
</tr>
<tr>
<td>1</td>
<td>23 (31)</td>
<td>23 (31)</td>
<td>43 (57)</td>
<td>46 (61)</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>15 (20)</td>
<td>12 (16)</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td>3 (4)</td>
<td>4 (5)</td>
</tr>
<tr>
<td>Mean</td>
<td>0.31</td>
<td>0.31</td>
<td>1.10</td>
<td>1.10</td>
</tr>
</tbody>
</table>

*Grade 0 indicates no expansion; grade 1, minimal expansion; grade 2, moderate expansion; and grade 3, severe expansion.

### Table 2. Intraclass Correlation Coefficient

<table>
<thead>
<tr>
<th>Intraclass Correlation (95% CI)</th>
<th>Premorbid right</th>
<th>Premorbid left</th>
<th>Morbid right</th>
<th>Morbid left</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.705 (0.588-0.797)</td>
<td>0.632 (0.487-0.748)</td>
<td>0.921 (0.889-0.945)</td>
<td>0.916 (0.883-0.943)</td>
</tr>
</tbody>
</table>

Figure 3. Severity grades.

Figure 4. Severe eyebrow tissue enlargement with arrows delineating the lateral round shape.
sess whether eyebrow involvement correlates with disease activity, fibrosis (diplopia), or disease severity and, thus, help segregate patients into useful clinical subgroups. We suggest that grading of the eyebrow involvement in patients with TAO be included in the clinical parameters that are monitored. Standardized photographs may prove useful in maintaining consistency among clinicians involved in evaluating patients with eyebrow involvement in TAO.

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Author Contributions: Dr Goldberg had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Conflict of Interest Disclosures: None reported.

REFERENCES