A Retrospective Review of Patients Undergoing Lateral Canthoplasty Techniques to Manage Existing or Potential Lower Eyelid Malposition: Identification of Seven Key Preoperative Findings

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Background: Lateral canthal procedures are often indicated to correct or prevent lower eyelid malposition. When determining an appropriate lateral canthal procedure, planning is essential and includes proper analysis and identification of any contributory anatomical factors.
Methods: A 12-month retrospective review was performed on patients undergoing lateral canthal procedures. Important components of the preoperative examination were studied to relate patient anatomy and results. Outcomes were followed for a minimum of 5 years.
Results: Of 288 consecutive lower eyelid canthal procedures, a total of 146 met the inclusion criteria. Common designated abnormal preoperative findings included a negative vector (62 percent), lid margin eversion (12 percent), scleral show (21 percent), neutral or negative canthal tilt (49 percent and 18 percent, respectively), and lateral canthus -to -orbital rim distance of more than 1 cm (11 percent). The distribution of lateral canthal procedures performed in our study population included inferior retinacular lateral canthopexy ($n = 36$), inferior retinacular lateral canthoplasty ($n = 88$), tarsal strip lateral canthoplasty ($n = 15$), and dermal-orbicular pennant lateral canthoplasty ($n = 7$). Successful outcomes were noted to be 86 percent and 91 percent according to surgeons and patients, respectively.
Conclusions: Specific findings on the preoperative physical examination identify when simple or more complex lateral canthal procedures should be performed. The authors report seven key physical findings that should be documented to effectively determine a lateral canthal procedure that is appropriate for prevention and management of lower eyelid malposition. (*Plast. Reconstr. Surg.* 136: 40, 2015.)
CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, IV.

The lower eyelids undergo characteristic malposition changes with aging. These include inferior migration of the lower eyelid associated with lid margin eversion, scleral show, and horizontal lid laxity.[1–6] Lower eyelid malposition may also develop following lower eyelid surgery that did not address specific preoperative anatomical findings. Lateral canthal procedures have been described to avoid lower eyelid malposition in the blepharoplasty patient and to address an existing lower eyelid deformity.[4,7–16] There remains uncertainty in choosing the most appropriate lateral canthal procedure.[17–19] Contributing factors to this uncertainty are a lack of understanding of the complex functional anatomy of the lower eyelid and an inadequate documentation of patient specific morphologic and anatomical physical

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findings necessary to choose a lateral canthal procedure.

Previously, we identified subsets of patients with specific preoperative anatomical findings who underwent lateral canthoplasty procedures designed to address the anatomy.[20] The following study sets out to further characterize preoperative anatomical findings that may contribute to postoperative malposition. This large series of surgical patients over a 12-month period were used to define key preoperative considerations that could ultimately be used to choose the most appropriate lateral canthoplasty.

PATIENTS AND METHODS

All patients undergoing lower eyelid lateral canthal procedures in 2005 were considered for this study. Preoperative evaluations and procedures were performed by a single surgical team.[21] Standard physical examination findings relevant for lower eyelid malposition were evaluated. The following features were documented: vector analysis (Fig. 1), lid margin eversion, lid snap-back and distraction test (Fig. 2), scleral show, canthal tilt (Fig. 3), and lateral canthus–to–orbital rim soft-tissue distance (Fig. 4).

Vector analysis is determined in the lateral view and relates the most anterior projection point of the globe to the most anterior projection point of the lower eyelid and malar eminence. When the globe is posterior to the most anterior projection of the malar eminence, the vector is deemed positive (Fig. 1, *left*). In contrast, negative vector is defined when the globe is anterior to the most anterior projection of the malar eminence (Fig. 1, *right*). If the anterior projection of the globe and malar eminence form a vertical line, the vector is considered neutral.

Lid margin eversion was evaluated with a snap-back and distraction test to determine the presence of horizontal lid laxity and graded on a scale of 0 to 4. The distraction test is performed by pulling the lower eyelid away from the globe and the space created is measured in millimeters. When there is greater than 8 mm of distraction, significant lower eyelid laxity is present and must be addressed at the time of surgery. The snap-back test is performed by pulling the lower eyelid caudally and looking for a rapid or slow return to its original position. If the snap back is delayed or requires a blink to reset the lower eyelid, significant lower eyelid laxity is present (grade 0, no lid margin eversion and no detectable deformity; grade I, scleral show with intact lower eyelid tarsal ligamentous tone; grade II, mild lower eyelid laxity; grade III, moderate lower lid eversion; and grade IV, frank ectropion). Grades II to IV show increasing amounts of horizontal eyelid laxity with the snap-back and distraction testing.

Scleral show is measured in millimeters of sclera visible below the inferior corneal scleral limbus and above the lower lid (range, 0 to 4 mm). Canthal tilt is determined by measuring the horizontal position of the lateral canthus in relationship to the medial canthus (in millimeters). Values were positive, negative, or neutral (Fig. 3).

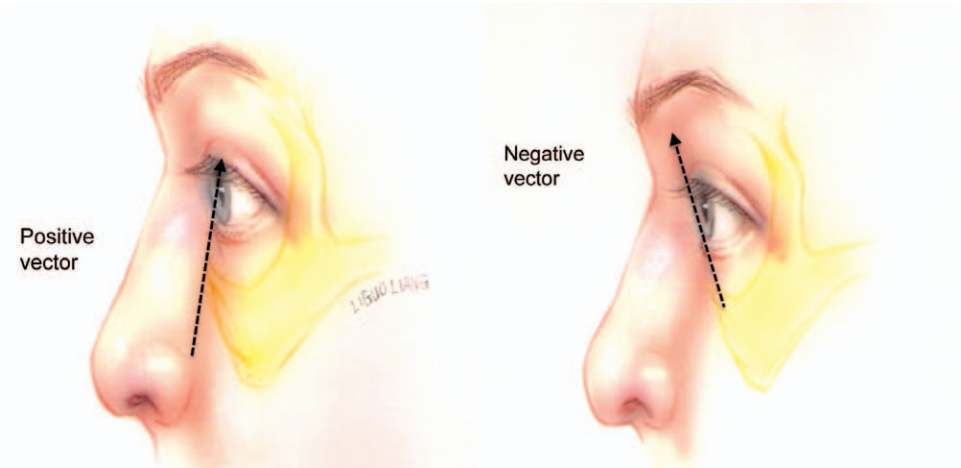

Fig. 1. Diagram showing vector analysis. Vector analysis is determined by the linear relationship of the most anterior projection of the globe to the most anterior projection of the malar eminence. When the globe is posterior to the most anterior projection of the malar eminence, the vector is positive (*left*). When the globe is anterior to the most anterior projection of the malar eminence, the vector is negative (*right*).

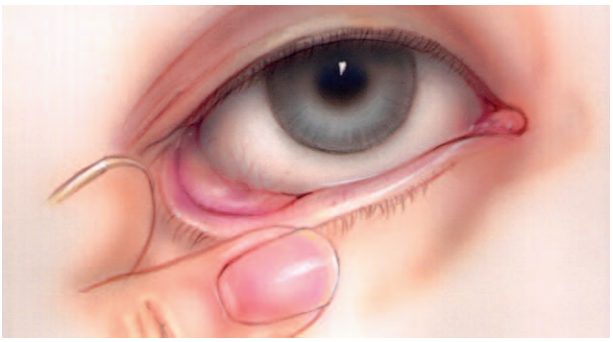

Fig. 2. Lid distraction measures the distance the lower eyelid pulls away from the globe. If distraction measures greater than 8 mm, horizontal lid shortening is usually required at the time of lower eyelid blepharoplasty.

Lateral canthus–to–orbital rim soft-tissue distance was defined as either less than 1 cm or greater than or equal to 1 cm (Fig. 4). This distance can vary greatly among patients and is an important measurement for understanding periorbital anatomy and stratifying high-risk patients in need of lateral canthal manipulation. We have previously reported the value of the dermal orbicular pennant canthoplasty in patients with a lateral canthus–to–orbital rim distance of more than 1 cm.

The type of lower eyelid lateral canthal procedure performed was documented and included inferior retinacular lateral canthopexy, inferior retinacular lateral canthoplasty, tarsal strip lateral canthoplasty, and dermal-orbicular pennant lateral canthoplasty. Postoperative assessments by patient and surgeon were recorded and additional surgical procedures were noted. Patients were then subdivided according to their surgical procedure and similar analyses were performed. To be included in this study, all of the above data points needed to be documented in the chart, and a minimum follow-up of 5 years was required.

RESULTS

The senior authors (E.B.J., G.W.J.) performed 288 consecutive lower eyelid canthal procedures over 12 months in 2005. Of these, a total of 146 procedures met the inclusion criteria of complete data sets and at least 5-year follow-up (72 left eyes and 74 right eyes).

Preoperative Anatomy

The overall distribution of the preoperative anatomy for the 146 lower eyelids included in this study is shown in Figure 5. Vector analysis was negative in the majority of cases [62 percent ($n = 91$)] compared with positive vector [21 percent ($n = 29$)] or neutral [17 percent ($n = 26$)]. Preoperative lid margin eversion was noted to be grade 0 (no deformity) in 88 percent (129 cases), with the remainder being grade I [8 percent ($n = 12$)], grade II [1 percent ($n = 2$)], grade III [1 percent ($n = 1$)], and grade IV [1 percent ($n = 2$)]. The majority of patients evaluated had no scleral show [$n = 116$ (79 percent)], and a minimal degree of scleral show of 1 mm [10 percent ($n = 14$)] and 2 mm [9 percent ($n = 13$)] was found. Extreme scleral show

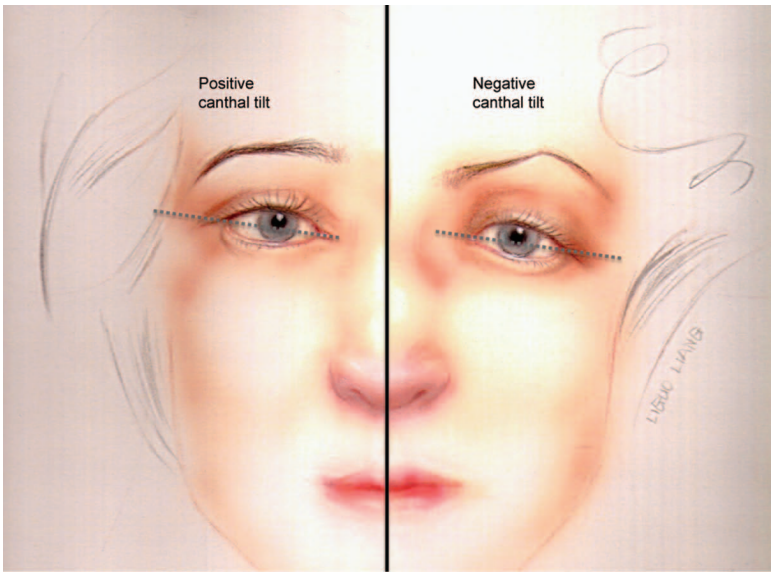

Fig. 3. Canthal tilt relates the horizontal position of the lateral canthus to the medial canthus. This can be determined to be positive (*reader's left, patient's right*). neutral, or negative (*reader's right, patient's left*).

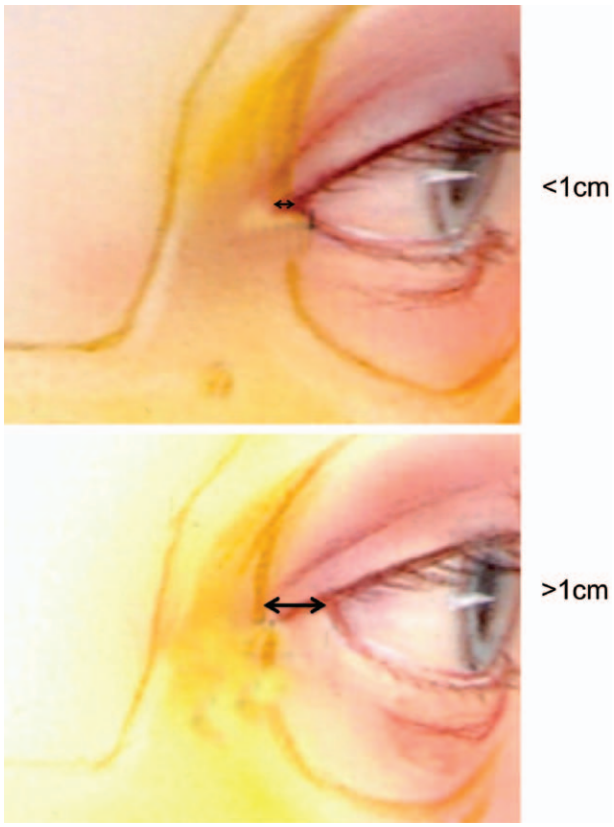

Fig. 4. *LC-OR* represents the distance of the lateral canthus to the orbital rim, and can be defined as either less than 1 cm or greater than or equal to 1 cm.

of greater than or equal to 3 mm was seen in only 3 percent ($n = 3$). The values of canthal tilt ranged from +3 mm to −3 mm. A positive canthal tilt was noted in 33 percent ($n = 47$), neutral canthal tilt was noted in 49 percent ($n = 71$), and negative canthal tilt was noted in 18 percent of patients ($n = 28$). The lateral canthus–to–orbital rim distance was less than 1 cm in 89 percent of patients ($n = 129$) and greater than or equal to 1 cm in 11 percent of patients ($n = 17$).

Procedures and Surgical Outcomes

The distribution of procedures performed in our total study population included inferior retinacular lateral canthopexy ($n = 36$), inferior retinacular lateral canthoplasty ($n = 88$), tarsal strip lateral canthoplasty ($n = 15$), and dermal-orbicular pennant lateral canthoplasty ($n = 7$) (Fig. 6). Surgeon evaluations reported that lower lid malposition had been corrected in 127 lower lids (88 percent), which closely matched complete patient satisfaction in a total of 133 lids (91 percent) at 1 year postoperatively. Additional lateral canthal procedures were performed on 10 percent of cases ($n = 15$) over the 5-year follow-up period.

Evaluation by Surgery Type

Patients were further stratified according to their surgical procedure: inferior retinacular lateral canthopexy (group I), inferior retinacular lateral canthoplasty (group II), tarsal strip lateral canthoplasty (group III), and dermal-orbicular pennant lateral canthoplasty (group IV).

Group I: Inferior Retinacular Lateral Canthopexy

The preoperative anatomy for patients undergoing inferior retinacular lateral canthopexy is shown in Figure 7, *above*. Vector analysis showed that 30.6 percent ($n = 11$) of the patients had a positive vector, 8.3 percent ($n = 3$) had a neutral vector, and 61.1 percent ($n = 22$) had a negative vector. Lid margin eversion was grade 0 in 88.9 percent ($n = 32$), and 11.1 percent ($n = 4$) were in the setting of grade I. Regarding the lateral canthus–to–orbital rim distance measurement, 88.9 percent ($n = 32$) of cases had a distance that was less than 1 cm and 11.1 percent ($n = 4$) of cases had a distance of greater than or equal to 1 cm. When the horizontal relationship of the lateral canthus was measured with respect to the medial canthus, canthal tilt was found to be positive in 41.7 percent ($n = 15$), neutral in 47.2 percent ($n = 17$), and negative in 11.1 percent of cases ($n = 4$). Scleral show evaluation yielded no scleral show in 86.1 percent ($n = 31$), 1 mm of scleral show in 11.1 percent ($n = 4$), and 3 mm of scleral show in 2.8 percent of cases ($n = 1$). Return-to-surgery rate in this group was 5.6 percent ($n = 2$). Patient satisfaction and surgeon satisfaction with postoperative results were 88 percent and 94 percent of cases, respectively.

Group II: Inferior Retinacular Lateral Canthoplasty

The preoperative anatomy for patients undergoing inferior retinacular lateral canthoplasty is shown in Figure 7, *second row*. Vector analysis showed that 15.9 percent of the patients ($n = 14$) had a positive vector, 21.6 percent ($n = 19$) had a neutral vector, and 62.5 percent ($n = 55$) had a negative vector. Lid margin eversion was grade 0 in 93 percent of procedures ($n = 82$), grade I in 4.5 percent ($n = 4$), and grade II in 2.3 percent ($n = 2$). The lateral canthus–to–orbital rim distance was less than 1 cm in 11.4 percent of cases ($n = 10$) and greater than or equal to 1 cm in 88.6 percent of cases ($n = 78$). Canthal tilt was found to be positive in 22.7 percent ($n = 25$), neutral in

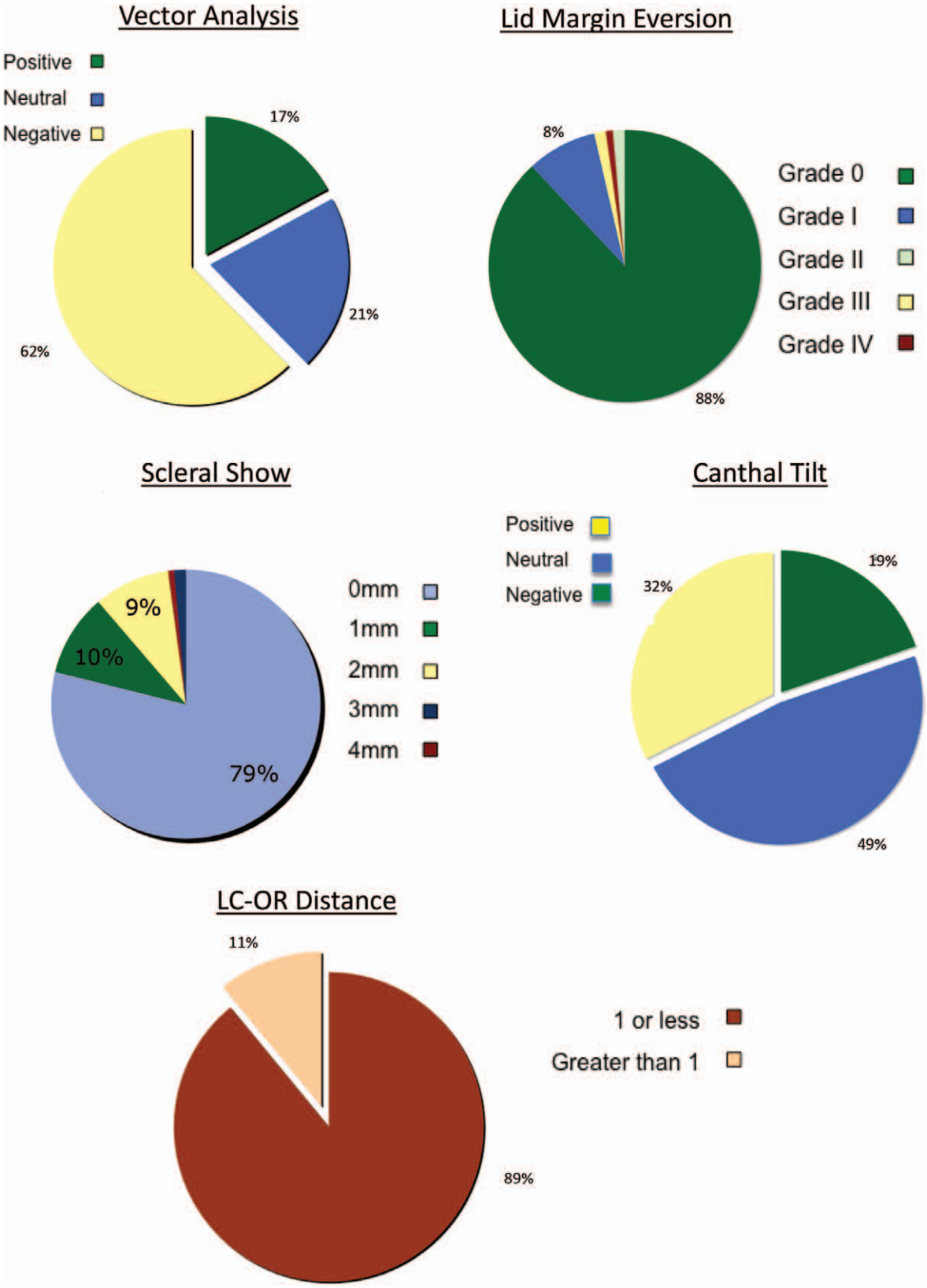

Fig. 5. Preoperative anatomy of the 146 lower eyelids was analyzed, and the distribution of the following features is shown: vector analysis, lower eyelid margin eversion, scleral show, canthal tilt, and lateral canthus–to–orbital rim *(LC-OR)* distance.

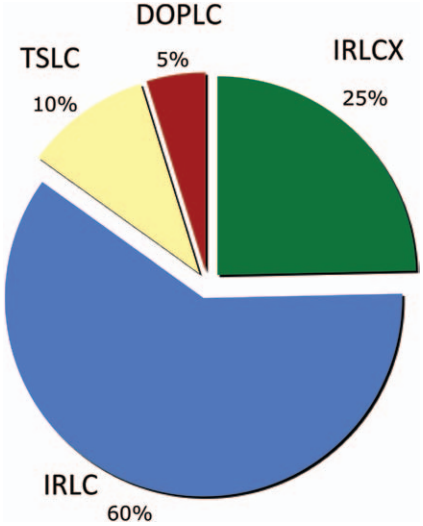

Fig. 6. Breakdown of procedures performed on lower eyelids ($n = 146$). The majority of patients underwent inferior retinacular lateral canthopexy or inferior retinacular lateral canthoplasty (25 percent and 60 percent, respectively). *IRLCx*, inferior retinacular lateral canthopexy; *IRLC*, inferior retinacular lateral canthoplasty; *TSLC*, tarsal strip lateral canthoplasty; *DOPLC*, dermal-orbicular pennant lateral canthoplasty.

48.9 percent ($n = 43$), and negative in 28.4 percent of cases ($n = 20$). Scleral show evaluation yielded no scleral show in 82.9 percent ($n = 73$), 1 mm of scleral show in 11.4 percent ($n = 10$), and 2 mm of scleral show in 5.7 percent of cases ($n = 5$). Additional procedures were required in 4.4 percent of patients ($n = 4$). Patient satisfaction and surgeon satisfaction with postoperative results were 93 percent and 95 percent, respectively.

Group III: Tarsal Strip Lateral Canthoplasty

The preoperative anatomy for patients undergoing tarsal strip lateral canthoplasty is shown in Figure 7, *third row*. Vector analysis showed that no patients in this surgical population had a positive vector, 46.6 percent ($n = 7$) had a neutral vector, and 53.3 percent ($n = 8$) had a negative vector. Lid margin eversion for this surgical procedure showed that 86.6 percent of cases ($n = 13$) were grade 0 and 13.3 percent ($n = 2$) were grade I. The lateral canthus–to–orbital rim distance was less than 1 cm in 86.6 percent ($n = 13$) and greater than or equal to 1 cm in 13.3 percent of cases ($n = 2$). Canthal tilt was found to be positive in 13 percent ($n = 2$), neutral in 60 percent ($n = 9$), and negative in 27 percent of cases ($n = 4$). Scleral show evaluation yielded no scleral show in 53 percent ($n = 8$) and 2 mm of scleral show in 46 percent of cases ($n = 7$). The reoperation rate in this group was 46 percent. Patient satisfaction and surgeon satisfaction with postoperative results were met in 53 percent and 60.0 percent of cases, respectively.

Group IV: Dermal-Orbicular Pennant Lateral Canthoplasty

The preoperative anatomy for patients undergoing dermal-orbicular pennant lateral canthoplasty is shown in Figure 7, *below*. Vector analysis showed that no patients in this surgical population had a positive vector, 14.3 percent ($n = 1$) had a neutral vector, and 85.7 percent ($n = 6$) had a negative vector. Lid margin eversion was grade 0 in 28.6 percent ($n = 2$), grade I in 28.6 percent ($n = 2$), grade III in 14.3 percent ($n = 1$), and grade IV in 28.6 percent ($n = 2$). The lateral canthus–to–orbital rim distance was greater than or equal to 1 cm in 100 percent of cases ($n = 7$). Canthal tilt was found to be positive in 42.8 percent ($n = 3$), neutral in 28.6 percent ($n = 2$), and negative in 28.6 percent of cases ($n = 2$). Scleral show evaluation yielded no scleral show in 28.6 percent ($n = 2$), 2 mm of scleral show in 42.9 percent ($n = 3$), 3 mm of scleral show in 14.3 percent ($n = 1$), and 4 mm of scleral show in 14.3 percent of cases ($n = 1$). A total of 28.6 percent of patients required additional lower lid canthal procedures in the subsequent years. Patient satisfaction and surgeon satisfaction with postoperative results were 100 percent and 71 percent, respectively.

DISCUSSION

When performing lower eyelid surgery, a systematic approach to identify morphologic- and anatomic-specific findings should be performed to correct existing lower eyelid malposition and to avoid lower eyelid deformities. Rohrich et al. recently offered a standardized approach to lower eyelid blepharoplasty in which five surgical steps were consistently applied: malar support/augmentation, orbicularis oculi muscle preservation, release of retaining ligaments, lateral canthal support, and minimal skin removal.[22] Although various reports such as this focus on surgical technique, there is a paucity of literature where the importance of preoperative findings is highlighted to avoid lower eyelid malposition. The goal of this retrospective review was to design an effective and systematic preoperative checklist of anatomical findings to aid in the choice of the most appropriate surgical technique to prevent or correct lower eyelid malposition.

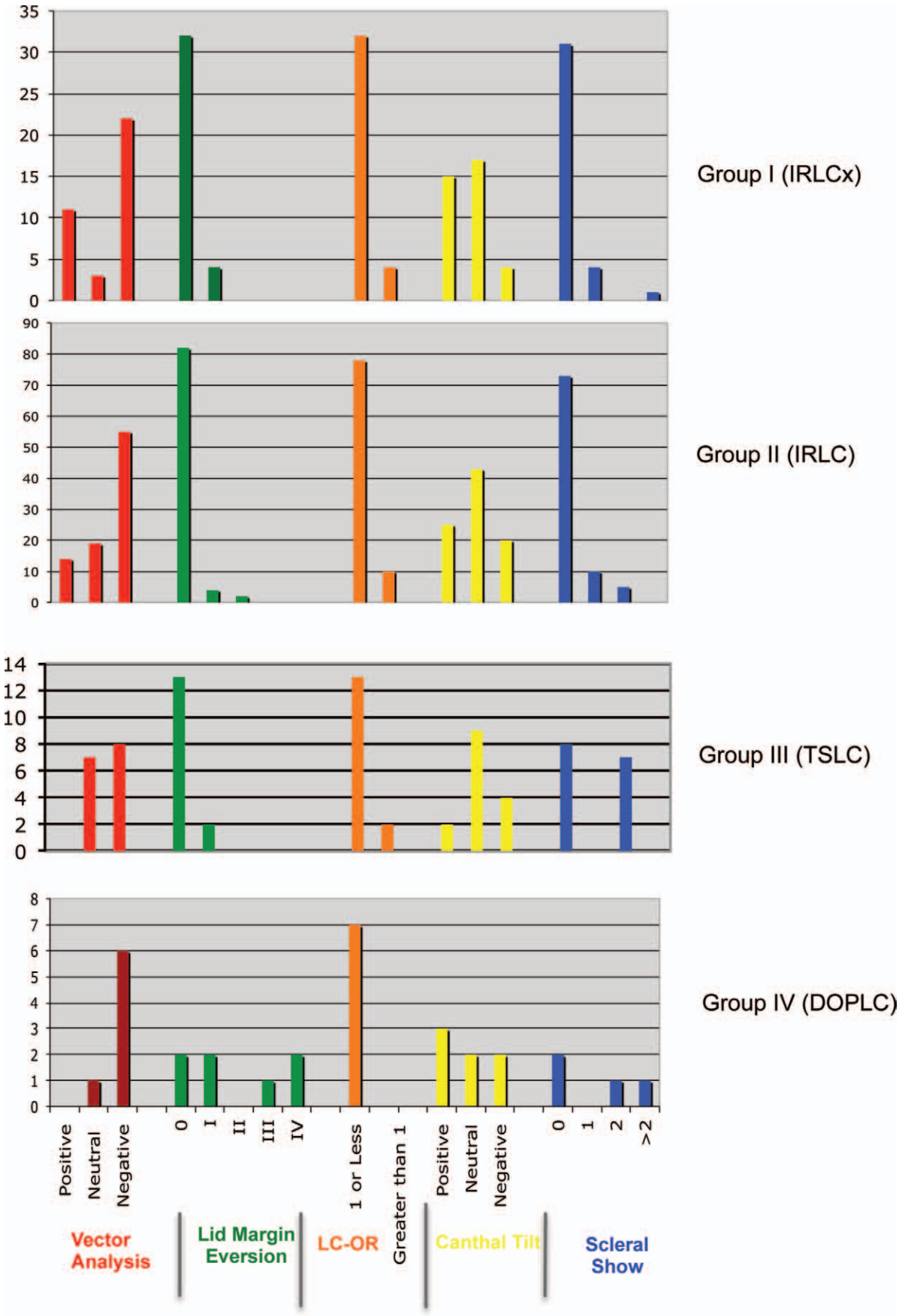

Fig. 8. Schematic representation of normal malar position (*reader's left, patient's right*) versus malar descent (*reader's right, patient's left*).

In the year 2005, when the analysis was performed, the senior authors were consistently documenting the following five anatomical findings: (1) vector analysis, (2) tarsoligamentous integrity, (3) scleral show, (4) canthal tilt, and (5) lateral canthus–to–orbital rim soft-tissue distance. The presence of midfacial descent and lower eyelid retraction secondary to cicatrix (vertical restriction) were also documented with those patients with existing lower eyelid malposition (Fig. 8). These two additional physical findings assisted in choosing the best lateral canthal procedures and ancillary techniques to use.

Based on these findings and continued experience, the authors recommend that the preoperative evaluation for all lower eyelid blepharoplasty patients include a checklist of seven key physical anatomical findings: (1) vector analysis, (2) tarsoligamentous integrity, (3) scleral show, (4) canthal tilt, (5) lateral canthus–to–orbital rim soft-tissue distance, (6) midface position, and (7) vertical restriction. A data sheet was developed for inclusion in the recorded preoperative examination (Fig. 9).

Negative vector anatomy has been documented to be a risk factor for postoperative complications such as scleral show and lower eyelid malposition.[20] In our study population, the number of patients who were defined as having negative vector anatomy was 62 percent ($n = 91$). To our knowledge, there have been no studies to date looking at the vector distribution in patients seeking lower blepharoplasty procedures. This finding suggests that negative vector anatomy may increase the likelihood of patients seeking a primary lower eyelid blepharoplasty.

In our total study population, 13 percent of patients required additional canthal tightening/reconstruction over a 5-year period. The reoperation rate may be higher in groups III and IV because of the unique referral pattern of the senior authors. Their patient population included a significant percentage of patients with preexisting lower eyelid deformities. Analysis of the patient population requiring reoperation implicated midface descent as one of the most important findings to be noted in the preoperative evaluation. Descent of the midface was defined as the inferior migration of the lower eyelid-cheek junction associated with lower eyelid laxity and scleral show. When mechanical (finger) elevation of the midface corrects the midface descent, it suggests an anchoring procedure of the midface as an appropriate ancillary technique.[23] If there is vertical restriction of movement, release of cicatrix and possible use of a lower eyelid spacer graft is a consideration. Recently, the authors have also supplemented additional support of the lower eyelid with autologous fat grafting to volume-deficient compartments of the face.

The authors chose to include only those patients with a follow-up period of at least 5 years. To confirm that the inclusion criteria did not skew the data, they also reviewed the distribution of patients in the excluded group with incomplete data sets ($n = 142$). The breakdown of this patient group was as follows: 35 eyelids underwent inferior retinacular lateral canthopexy, 88 eyelids had inferior retinacular lateral canthoplasty, seven eyelids had tarsal strip lateral canthoplasty, and 12 had dermal-orbicular pennant lateral canthoplasty procedures performed. The distribution of this exclusion group closely mimics that of the study population. Thus, the authors do not feel that there are any significant confounding variables in their patient population. Moreover, the authors believe that the seven key physical findings that were identified provide a standardized preoperative examination that is applicable to all patients undergoing lower lid blepharoplasty regardless of race or ethnicity.

Fig. 7. Graphs show distribution of preoperative anatomy for the four different surgical groups. *IRLCx*, inferior retinacular lateral canthopexy; *IRLC*, inferior retinacular lateral canthoplasty; *TSLC*, tarsal strip lateral canthoplasty; *DOPLC*, dermal-orbicular pennant lateral canthoplasty; *LC-OR*, lateral canthus–to–orbital rim distance.

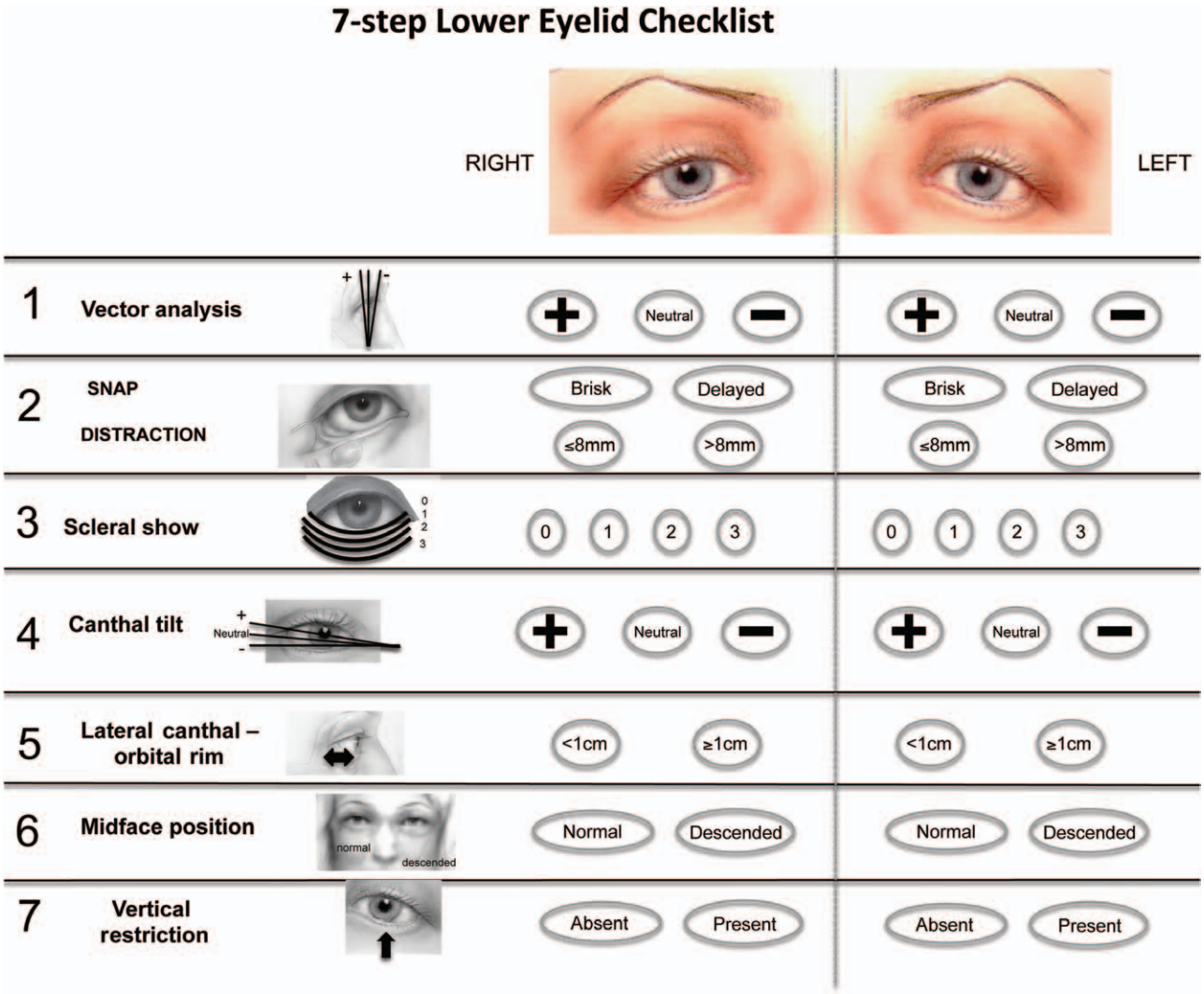

Fig. 9. The seven-step checklist is provided to assist surgeons approach lower eyelid procedures in a standardized fashion.

CONCLUSIONS

This study provides a stepwise approach to identify patients with morphology- and anatomy-specific physical findings that determine the need for a lateral canthal procedure. The seven steps of the preoperative checklist for patients undergoing lower eyelid blepharoplasty are as follows: (1) vector analysis, (2) tarsoligamentous integrity, (3) scleral show, (4) canthal tilt, (5) lateral canthus–to–orbital rim soft-tissue distance, (6) midface position, and (7) vertical restriction. This standardized evaluation assists in determining the most appropriate lateral canthal and ancillary procedures to perform for existing lower eyelid deformities or for patients considered at risk for postoperative lower eyelid malposition.

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