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CLINICAL STUDY

Reconstructive techniques for lower eyelid and canthal defects after tumor resection

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ABSTRACT
BACKGROUND: This prospective study aims to evaluate the demographic and histopathological characteristics of patients who underwent resection of malignant skin tumors of the lower eyelid. It also seeks to assess the size of the defect and outline the management strategies for reconstructing anterior and posterior lamellae.
METHODS: The study enrolled 87 patients treated between January 1, 2018, and December 31, 2022. The article outlines a reconstructive strategy based on the defect characteristics.
RESULTS: The most prevalent type of tumor was basal cell carcinoma (86%), followed by squamous cell carcinoma (8%), malignant melanoma (5%), and Merkel cell carcinoma (1%). There was a slight male preponderance (52%). No significant difference was found in the incidence of lower eyelid malignant tumor between the sex subgroups (p=0.97). The mean age of the patients was 73.52 years (SD=10.582; range 37-92 years). No statistically significant difference in laterality (p=0.108) was observed. A larger tumor size was significantly associated with a higher tumor grade (p=0.008; r=0.926). A significant correlation was identified between the tumor location and the size of the excision (p<0.001). Furthermore, a significant correlation was identified between the histopathological types of tumors and the excision area (p=0.016). Reconstruction of the anterior lamella in small- and medium-sized defects was achieved by using local randomized flaps (61%), primary closure (29%), and skin grafts (10%). For large-sized defects, the anterior lamella was reconstructed by flap (88%) or skin graft (22%). Altogether, posterior lamella was replaced in 25 cases (29%) of all defects using nasal chondromucosa (40%), conchal cartilage (28%), buccal mucosa (8%), periosteal flap (12%), Hewes flap (8%) and Hughes flap (4%).
CONCLUSION: Advanced techniques are necessary when reconstructing a larger lower lid area. In such cases, various subunits must be reconstructed separately to achieve optimal functional and aesthetic outcomes. However, the choice of reconstructive technique mainly depends on the extent of the lid resection *(Fig. 9, Ref. 44)*. Text in PDF www.elis.sk
KEY WORDS: defects, eyelid, malignant neoplasms, reconstructive surgical procedures, resection.

Introduction

The lower eyelid is a complex structure that provides support and protects the eye. The skin of the eyelid is susceptible to numerous periocular malignancies that may be more aggressive and pose more significant treatment and repair challenges compared to other cutaneous sites (1, 2).

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Basal cell carcinoma (BCC) is the most common skin malignancy of the periorbital area (3). The various subtypes of BCC are divided into low-risk and high-risk forms. The United Kingdom National Multidisciplinary Guidelines recommend that non-infiltrative BCCs measuring <2 cm should be excised with a margin of 4–5 mm. However, smaller margins (2–3 mm) may be used in cases with limited reconstructive options (4).

Squamous cell carcinoma (SCC) is the second most common cancer of the eyelids (5). High-risk features of SCC include the depth of invasion >2 mm, poor histological differentiation, high-risk anatomic location, perineural involvement, recurrence, multiple cSCC tumors, and immunosuppression. The 2020 guidelines for cutaneous malignancies recommend wide local excision (WLE) with safety margins of 5–10 mm, depending on risk factors (6).

Merkel cell carcinoma (MCC) is a rare, highly malignant neuroendocrine tumor originating from sensory Merkel cells. In 50% of cases, MCCs occur in the head and neck area, with 5–10% of these cases involving the eyelids. Although there is no universal management protocol, current consensus indicates that WLE with disease-free margins up to 5 mm should be combined with sentinel lymph node biopsy, adjuvant chemotherapy, and/or radiotherapy (7).

Periocular malignant melanoma (MM) is a relatively rare tumor accounting for <1% of malignant eyelid neoplasms. The European Society for Medical Oncology (ESMO) suggests WLE of primary tumors with safety margins of 5 mm for *in situ* MMs, 1 cm for MMs up to 2 mm in thickness, and 2 cm for thicker MMs (8). Although prospective randomized trials are unavailable, modifications with reduced safety margins are deemed acceptable to preserve eyelid function (9).

The surgical management of a malignant tumor is contingent on its biological behavior. The current standard of care often entails WLE with tumor-free margins to minimize recurrence and mortality rates. Regardless of the reconstruction method used, an approach centered on the defect is crucial, focusing on restoring the aesthetic and functional aspects of the eyelid. The reconstruction prioritizes achieving symmetry, both with the eyes open and closed. The findings of this study provide a comprehensive understanding of lower eyelid and canthal tumors, linking guidelines, histopathological parameters, defect characteristics, and available treatment strategies based on the principles of the reconstructive ladder.

Methods

Study design and subjects

This prospective study examined the demographic and histopathologic features of 87 patients within the Slovak Caucasian population diagnosed with lower eyelid malignant skin tumors between January 1, 2018, and December 31, 2022. The patients were treated at the Department of Plastic, Reconstructive, and Aesthetic Surgery, Louis Pasteur University Hospital, Košice, Slovakia. The

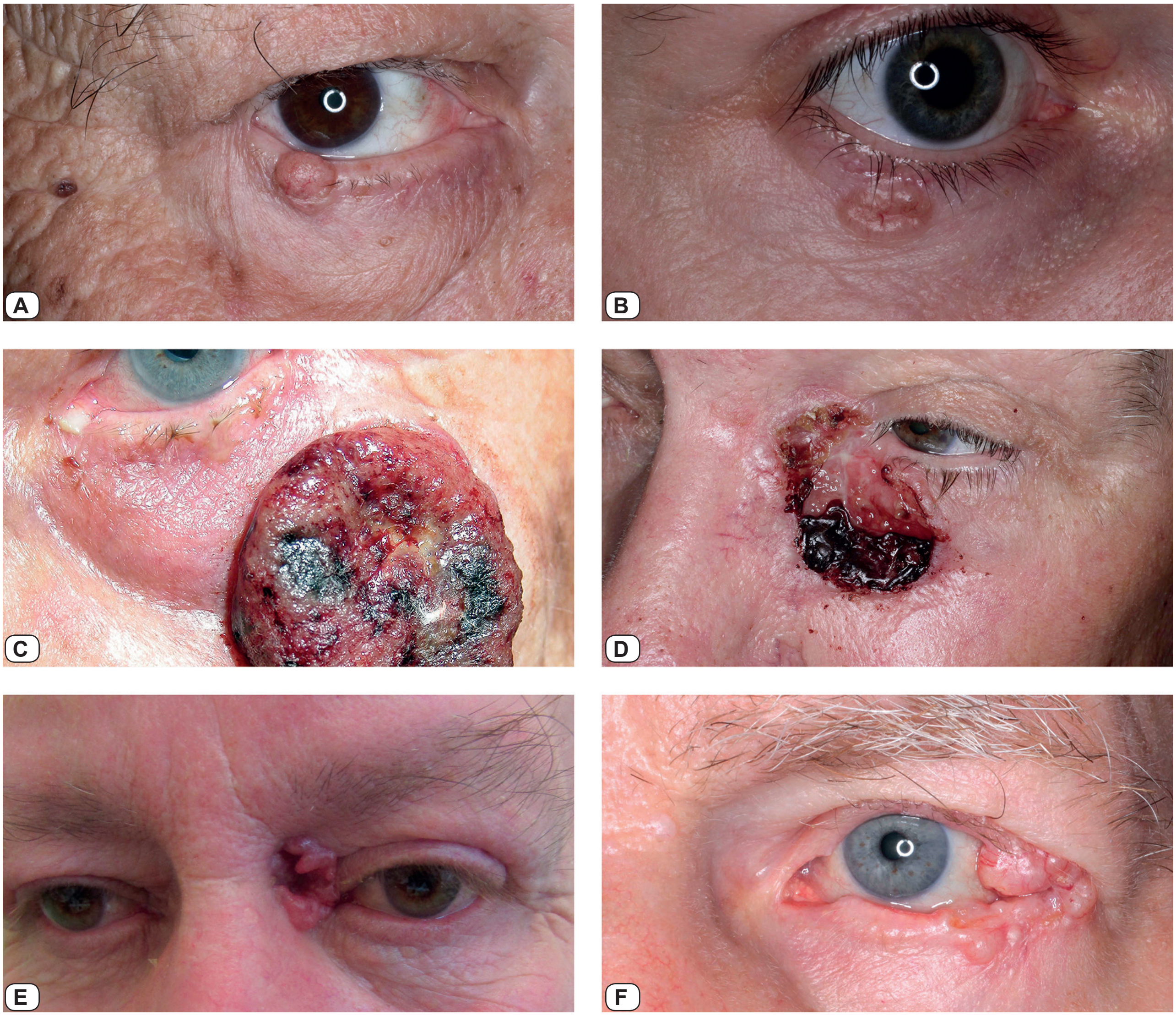

Fig. 1. Location of the lower eyelid malignant tumors. A, Pretarsal (Type I). B, Preseptal (Type II). C, Eyelid-cheek junction (Type III). D, Multiple lower lid subunits (Type IV). E, Medial canthus. F, Lateral canthus.

reconstructive strategies were determined based on the defect etiology and characteristics of the defects, including size and location. Patient medical records were analyzed for age, sex, indication for surgery, symptoms, repair methods, histopathological diagnosis, complications, and functional and cosmetic outcomes.

The inclusion criteria encompassed patients with histopathologically confirmed malignant tumors of the lower eyelid who consented to reconstruction and were deemed suitable for either local or general anesthesia. The exclusion criteria comprised conditions such as benign tumors, or extensive tumors indicated for radiotherapy or palliative treatment, patients unfit for local or general anesthesia, or those who declined subsequent reconstruction of defects. Prior to the surgery, patients were informed about the reconstructive options and provided informed consent. The study was conducted in accordance with the tenets of the Declaration of Helsinki and received approval by the hospital's Ethics Committee (protocol number EK/01005).

All samples were obtained through WLE and processed as formalin-fixed paraffin-embedded (FFPE) specimens using a standard method (10). The 8th edition of the American Joint Committee on Cancer (AJCC) staging manual was used to classify the tumors. The histopathologic report included histopathological subtype, macroscopic description, location, laterality, size, resection margins, ulceration, lymphovascular and perineural spread of the tumor, and immunochemistry. All cases were grouped according to the histopathologic subtypes of the tumors, area to be reconstructed (mm^2), and type of anterior and posterior lamellar reconstruction. Standardized follow-up photographs were captured 3 months postoperatively to evaluate the surgical outcome.

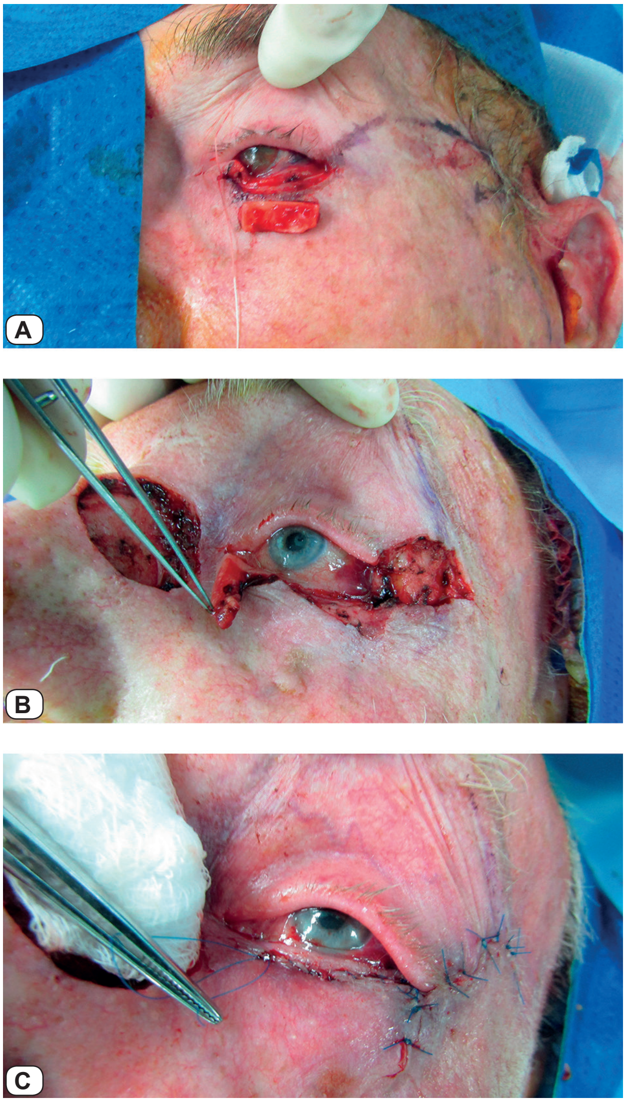

Fig. 2. Tenzel semicircular rotational flap. A, Patient with a full-thickness horizontal eyelid defect (90%). The planned flap incision and reconstruction of the posterior lamella by an auricular conchal graft. B, Another patient with a full-thickness pretarsal and preseptal defect (types I and II) involving the lateral canthus (50%). Incisions are performed, and the tarsal strip is separated. C, The tarsal strip is secured to the lateral orbital rim, and the flap is rotated medially to the defect without tension.

Classification of defects and reconstruction methods

The classification of lower eyelid defects focuses on the missing full-thickness horizontal percentage of eyelid length: small defects (up to 25–50%), medium defects (50–75%), and large defects (>75%). However, this classification is unsuitable for planning the reconstruction of complex defects and does not address postoperative malposition of the lower eyelid. A recent study by Alghoul et al. (2019) showed that, in addition to the defect's size and width, vertical subunits are essential in predicting functional and aesthetic outcomes. Therefore, to classify defects and plan reconstruction, we used the new classification system of vertical subunits (11) (Fig. 1).

Pretarsal defects

Isolated defects in the pretarsal area have a low risk of postoperative malposition with proper planning and adequate tension of the tarsoligamentous sling. The approximation of the tarsus is necessary to avoid misalignment or notching. For horizontal defects, the wound is closed directly in 20% of younger patients and up to 30% in older patients (12). Anterior lamellar defects can be reconstructed using a full-thickness skin graft (FTSG). Two free grafts were previously not used to reconstruct both lamellae. However, a recent study by Tenland et al (2021) reported that free bilamellar grafts also achieved good perfusion and survival (13). Currently, a vascularized layer is usually transposed between two non-vascularized layers (the sandwich flap/technique). Defects of the pretarsal region with a total width of 33–50% of the eyelid can be closed using lateral canthotomy and inferior cantholysis (14). If a canthotomy is insufficient, a Tenzel flap can be used (Fig. 2). For better fixation, the periosteal flap can be transposed from the orbital rim (15).

For full-thickness defects (25–75% of the eyelid), a tarsomarginal composite graft can be harvested. Tarsoconjunctival flaps (bridging or eyelid-sharing techniques) are an excellent choice for restoring posterior lamella and tarsus continuity for up to 75% of the defect width (16). The Hewes tarsoconjunctival flap is ideal for reconstructing isolated lateral canthal defects and is transposed from the upper eyelid with its base laterally (17). The Hughes tarsoconjunctival flap is a two-stage eyelid-sharing procedure that is suitable for full-thickness defects involving 50–100% of the lower eyelid. Depending on operator preference, the Hughes flap can be harvested with or without Müller's muscle. Dissection of the Müller's muscle in the first stage facilitates detachment of the flap during the subsequent phase. However, this approach may compromise the graft's vascularity (18).

Preseptal defects

For preseptal defect reconstruction, it is essential to change the vertical vector to a horizontal one. In defects with intact muscles, skin grafting is sufficient. However, for smaller defects affecting the muscles, locally randomized flaps without mobilizing the septum are suitable. A Tripier flap, which is double-pedicled, is often used as the standard approach. Resuspension of the canthus is not required for isolated preseptal defects that are not close to the lateral canthus. The Tripier flap can be combined with the Hewes tarsoconjunctival flap, providing excellent skin-muscle coverage in elderly patients (19). Another option for reconstructing defects across the entire width of the lower eyelid is the temporal forehead transposition flap, or Fricke flap. For better transposition, it is used as a skin-subcutaneous flap with its base at the lateral canthal area (20). Furthermore, the McGregor flap operates on a similar concept to the Tenzel flap, but it is based on the principle of Z-plasty rather than a semicircle design (21) (Fig. 3).

Eyelid-cheek junction defects

For eyelid-cheek junction defects, the morphology of this area and the gradual changes that occur from the palpebral to the malar area must be recognized (22). It is crucial to replicate the natural convexity of the malar eminence and thus preserve the volume to maintain the structural support of the eyelid. FTSGs, or locally randomized flaps, are used for smaller defects. However, the donor site with the greatest tissue reserve is appropriate when local tissue is unavailable.

Reconstruction in the eyelid-cheek junction and lateral canthus also involves lateral canthal fixation, which aims to achieve adequate apposition of the eyelid to the globe. The orbital rim provides an anchorage point for grafts, making its reconstruction crucial after extensive resections. Flaps and grafts can be fixed to the orbital periosteum using suture or through periosteal flaps. If the periosteum is resected, drilled holes and non-absorbable graft sutures can also be used (23).

Combined defects of the multiple lower lid subunits

The reconstruction of complex defects should address the subunits of the lower eyelid separately. Defects involving the medial canthus often carry a high risk of postoperative malposition of the lacrimal drainage system. Alghoul et al reported using the Hughes flap in the pretarsal area for posterior lamella reconstruction, lateral anchoring for the reconstruction of the tarsoligamentous sling, and FTSG to further cover the defects (10). For preseptal and eyelid-cheek junction defects, a Mustardé flap with a spacer

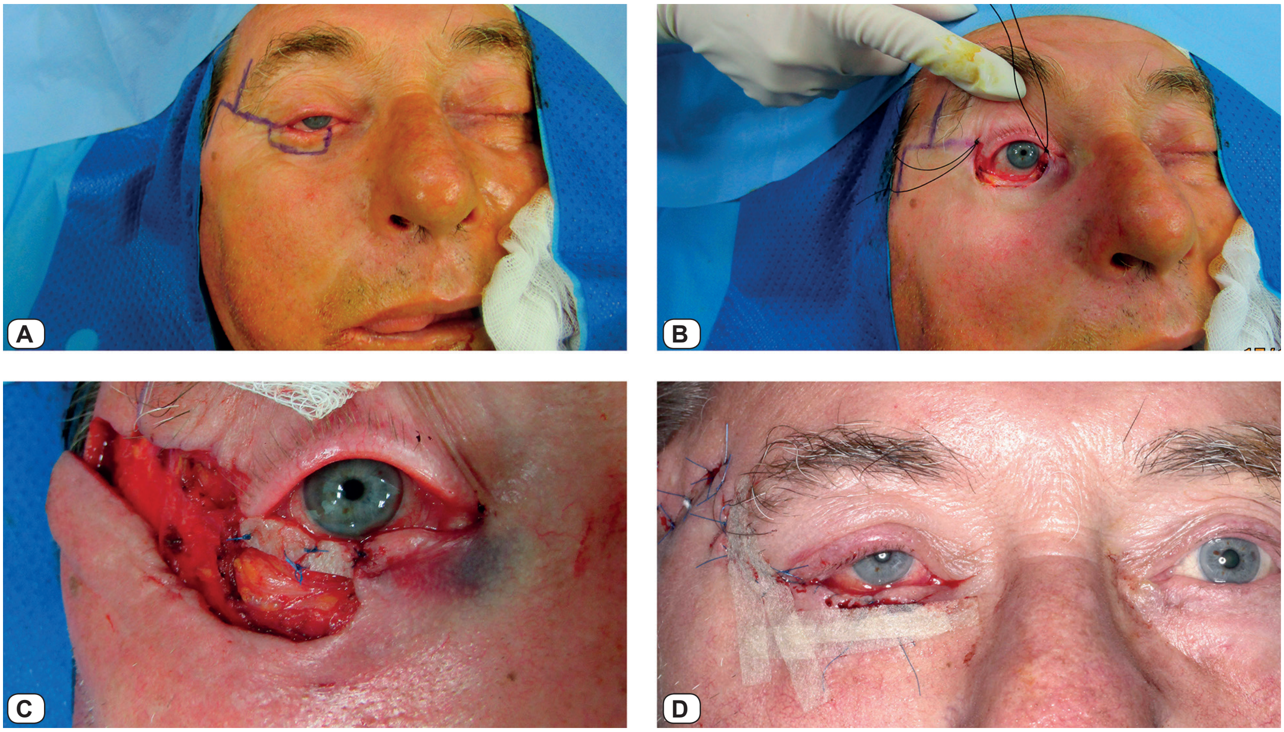

Fig. 3. The McGregor flap. A, The planned lower eyelid tumor excision and flap incision. McGregor flap is based on the principle of Z-plasty by transposing two triangular flaps. B, Full-thickness eyelid defect (80%). C, The arms of the Z-plasty form 60° angles, which extend the central arm by 70%. The flap is mobilized in the submuscular layer, reducing tension and improving the scar's final appearance. Reconstruction of the posterior lamella is done using a nasal septum chondromucous graft. D, Final appearance 48 h post-surgery.

can be used to reconstruct the anterior lamella and reduce the risk of scar retraction (24) (Fig. 4).

If the full-thickness defect reaches 50–100%, spacer grafts are used to reconstruct the posterior lamella and manage lower eyelid retraction (25). The most common autologous grafts are hard palate mucoperiosteal grafts (HPMG), nasal septum chondromucous grafts, and auricle cartilage grafts. HPMG is histologically similar to the tarsus; however, its disadvantages include donor-site discomfort, a high incidence of complications, and ineffective reconstituting of volume. When harvesting an auricular cartilage graft, replacing the conjunctival component with buccal mucosa is necessary. A dermis fat graft can also be used for larger defects with volume loss. However, as dermal fat has unstable absorption rates, potential size changes due to weight loss are unpredictable (26).

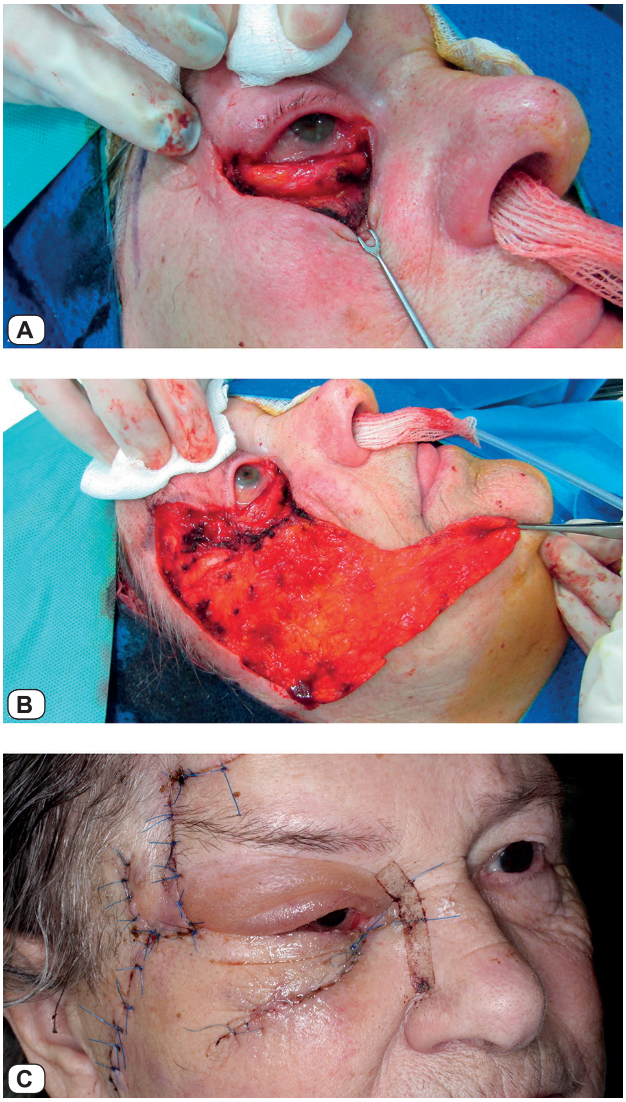

Fig. 4. The Mustardé cheek rotation flap. A, Full-thickness lower eyelid defect (100%) (Type IV) after the excision of a spindle cell malignant melanoma. B, Dissection under the superficial musculoaponeurotic system (SMAS), which provides a strong fascial layer to anchor the flap to the periosteum of the orbit or zygomatic bone. Reconstruction of the posterior lamella using a nasal septum chondromucous graft. C, The final appearance 48 h post-surgery. A transposition myocutaneous forehead flap was used to close the lateral periorbital area.

Statistical analysis

The study's data were compiled and statistically analyzed to assess the differential distribution, arithmetic means and standard deviations of variables. Appropriate tests of significance were used for the statistical analysis. The chi-square goodness of fit test was used to analyze the difference in laterality between the left and right eye in all cases. Spearman's rank correlation was used to analyze the relationship between the tumor's grading and size. Kruskal-Wallis analysis of variance was used to analyze the differences in the excision area (mm^2) among different histopathological types of tumors and defects. SPSS version 21.0 (IBM Corp. Armonk, NY, USA) was used for statistical analysis. P values <0.05 were considered statistically significant, and values <0.001 were considered highly significant.

Results

Patients' characteristics

There was a slight male preponderance, with 45 male (52%) and 42 (48%) female patients. No significant difference in the incidence of lower eyelid malignant tumor was found between sex subgroups (p=0.97). The mean age of the patients was 73.52 years (SD=10.582; range 37–92 years) (Fig. 5). The mean age values in the male and female patients were similar (57.8 years and 57.07 years, respectively). The right and left eyes were affected in 49 (56%) and 38 cases (44%), respectively, with no statistically significant difference in laterality (p=0.108).

The most prevalent histopathologically confirmed lower eyelid malignancy included 75 cases (86%) of BCC, 7 cases (8%) of SCC, 4 cases (5%) of MM, and 1 case (1%) of MCC (Fig. 6). A larger tumor size was significantly associated with a higher tumor grade (p=0.008; r=0.926). Furthermore, a significant correlation was identified between the histopathological types of tumors and the excision area (p=0.016). Specifically, MM cases required significantly larger excision areas (AM=763.67 mm^2; SD=469.964), while BCC cases required significantly smaller excision areas (AM=238.04 mm^2; SD=206.927). SCC cases required a medium-sized excision area compared to those of other types (AM=398.71 mm^2; SD=274.498) (Fig. 7).

Techniques

For small-to-medium-sized defects, reconstruction was performed immediately after excising well-defined primary tumors. However, in cases of recurrent tumors, large tumors with poor demarcation, or suspected high-risk tumors resulting in subsequent large defects, the reconstruction was deferred until the definitive histopathologic finding was obtained in the second stage.

Regarding the system of horizontal eyelid length defect size, 41 cases (47%) were classified as small defects, 21 cases (24%) as medium defects, and 25 cases (29%) as large defects. In 56 patients (64%) with small-to-medium-sized defects, surgery was performed

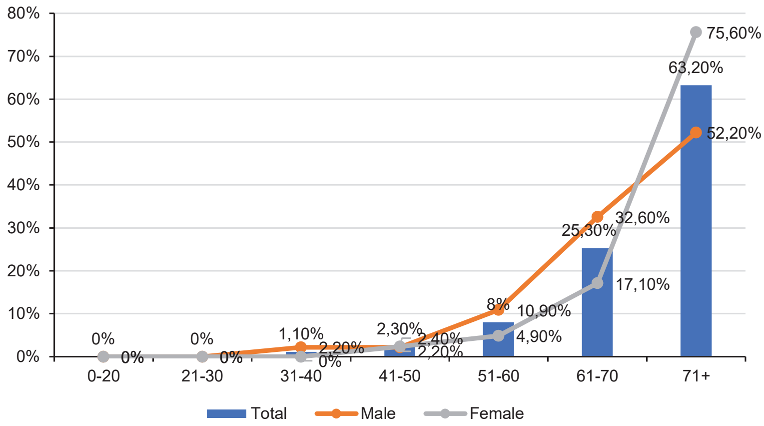

Fig. 5. Distribution by age in the group of malignant lower eyelid tumors. The mean age of the patients was 73.52 years (SD=10.582; range 37–92 years). The mean age in sex subgroups was similar (male, 57.8 years; female, 57.07 years). The highest percentage of malignant tumors was in the group aged 71+ years. Patients over 60 years of age exhibited a three-fold increase in malignant tumors, those over 70 years yielded an eight-fold increase compared to the age group 50+ years. Age and malignancy were significantly positively correlated.

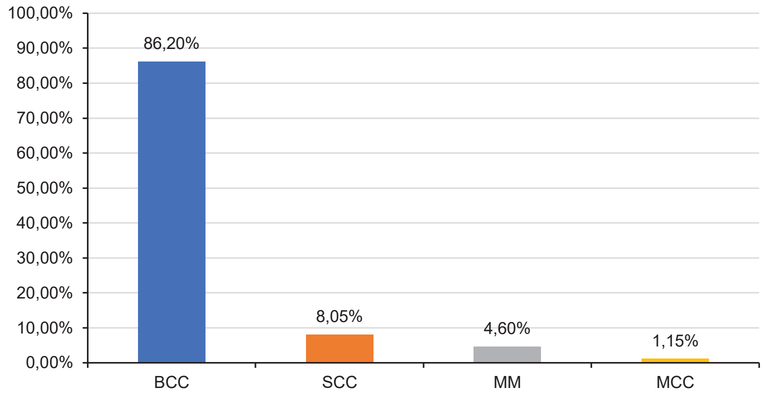

Fig. 6. Percentage distribution of lower eyelid malignant tumors.

under local anesthesia, while for 31 patients (36%) with large-sized defects and those who could not undergo local anesthesia, a combination of local anesthesia and analgosedation or general anesthesia was used.

The tumors were localized in the lower eyelid in 56 patients (64%): 14 (16%) cases in the pretarsal subunit, 16 (18%) in the preseptal subunit, 8 (9%) in the eyelid-cheek junction, and 18 (21%) cases classified as combined defects with multiple subunits affected. Further localizations were in the medial canthal region (28 cases; 32%), and lateral canthal region (3cases; 3%).

A significant correlation was identified between the tumor location and excision size ($p<0.001$). Tumors located in the combined and eyelid-cheek regions required larger excision areas (AM=463.61 mm^2, SD=227.621 and AM=354.75 mm^2, SD=350.493, respectively), while those in the pretarsal and preseptal regions required smaller excision areas (AM=145.29 mm^2, SD=133.858 and AM=103.06 mm^2, SD=51.132, respectively). Tumors located in the canthal region required a medium-sized excision area compared to those in other regions (AM=272.94 mm^2, SD=229.800) (Fig. 8).

In 12 out of 41 cases (13%), primary closure was used to reconstruct the anterior lamella in small-sized defects. Sliding flap was used in eight cases (9%), followed by the Limberg flap in five cases (6%), FTSG in four cases (5%), rotation flap in four cases (5%), Dufourmental flap in three cases (4%), bilobed flap in two cases (2%), and V-Y advancement flap in two cases (2%). For the anterior lamella of medium-sized defects, the blepharoplasty flap was used in eight cases (9%), the Tenzel flap with lateral canthotomy and inferior cantholysis in seven cases (8%), the Tripier flap in four cases (5%), and the Blasius flap in two cases (2%).

The following techniques were used for the reconstruction of the anterior lamella in large-sized combined defects: the Mustardé flap was performed in eight cases (9%), the Fricke flap in five cases (6%), the Tripier flap in four cases (5%), the McGregor flap in three cases (4%), FTSG in three cases (4%), and the paramedian forehead flap in two cases (2%). Posterior lamellar replacement was performed in 25 cases (29%) in one-stage surgery by composite graft. This included chondromucous septal graft in 10 cases (40%), auricular conchal graft in seven cases (28%), buccal mucosa in two cases (8%), periostal flap in three cases (12%), and Hewes flap in two cases (8%). Two-stage surgery was done using the Hughes flap in one case (4%).

After comparing the different techniques of posterior lamellar repair, the chondromucous septal graft emerged as the most preferred method. Although two cases of auricular chondral graft failure were observed, attributed to suboptimal cartilage's shape, no failure of the composite graft harvested from the nasal septum occurred, and no septum perforation was observed in this study. Notably, the impact of the total area of the eyelid defect on the surgical success rate was found to be nonsignificant ($p=0.468$).

After reconstruction, postoperative follow-up was scheduled at weeks 1 and 2, months 3 and 6, and semiannually thereafter. The mean follow-up duration was 462 days, which is approximately 15 months. The hospitalization duration ranged from 2 to 10 days. Eyelid sutures were removed 7 days following small defect repair after primary skin closure. In contrast, tarsal sutures were kept in place for up to 10 days and for up to 2 weeks after extensive periorbital reconstructions with large flaps. Each case underwent examination for functional outcomes and postoperative complications during the follow-up period. Preoperative photographs were taken to document lesion progression and for medico-legal purposes.

Postoperative complications

Postoperative complications were observed in six cases. These complications were more common in patients who had a history of

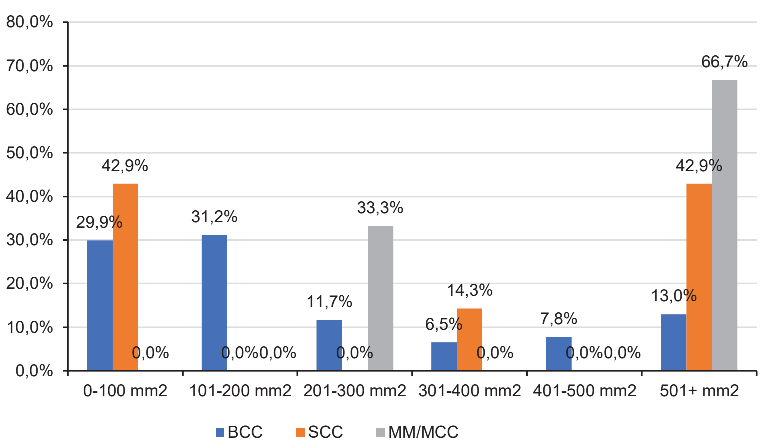

Fig. 7. Distribution by size of excision (mm^2) and histopathological type of lower eyelid malignant tumors. A larger tumor size was significantly associated with a higher tumor grade ($p=0.008$; $r=0.926$). Furthermore, a significant correlation was identified between the histopathological types of tumors and the excision area ($p=0.016$). Specifically, MMs required significantly larger excision areas (AM=763.67 mm^2, SD=469.964), while BCCs required significantly smaller excision areas (AM=238.04 mm^2, SD=206.927). SCCs required a medium-sized excision area compared to those of other types (AM=398.71 mm^2, SD=274.498).

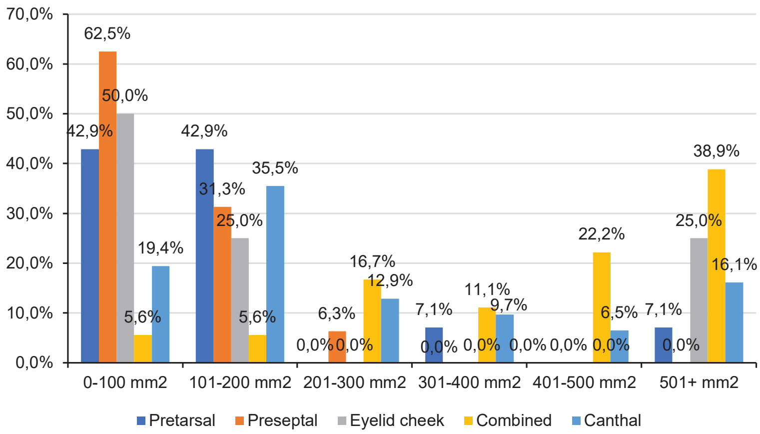

Fig. 8. Distribution by location of the lower eyelid malignant tumor and size of excision. A significant correlation was identified between the tumor location and the size of excision ($p<0.001$). Tumors located in the combined and eyelid-cheek regions required larger excision areas (AM=463.61 mm^2, SD=227.621 and AM=354.75 mm^2, SD=350.493, respectively), while tumors in the pretarsal and preseptal regions required smaller excision areas (AM=145.29 mm^2, SD=133.858 and AM=103.06 mm^2, SD=51.132, respectively). Tumors located in the canthal region required a medium-sized excision area compared to those in other regions (AM=272.94 mm^2, SD=229.800).

prior radiation, smoking, vascular disease, and diabetes mellitus, particularly those who were treated with insulin. One patient experienced complete wound breakdown 3 days postoperatively and required re-suturing of both lamellae. Histopathological analysis revealed chronic stromal reactive inflammatory cellularization and xenogenic giant cell granulomas in the conjunctiva. Another patient had suture dehiscence, requiring re-suturing of the anterior lamella. Partial FTSG necrosis occurred in a different patient after excising an infiltrative BCC in the medial canthal region, which was managed with secondary granulation. No cases of flap dehiscence or flap necrosis were observed. However, three patients developed ectropion, which was treated with a lateral tarsal strip fixation and periosteal flap 2–4 months later. Tumor recurrence was observed in six patients, requiring further treatment with extensive reconstruction and adjuvant therapy.

Discussion

This study summarizes the clinicopathological variants of malignant lower eyelid tumors and outlines available treatment strategies based on reconstructive ladder principles. The study included 87 patients with histologically verified lower eyelid malignancy who underwent reconstructive surgery tailored to the thickness and size of the defects. The results of this study reflect the general pathological and clinical characteristics of the most common lower eyelid cutaneous malignancies among the Caucasian population.

The primary objective of any oncologic surgery is to eradicate the tumor and minimize the potential for recurrence. Our in-house gold standard is to defer definitive reconstruction after excision of a high-risk tumor that results in a large defect until a permanent pathological examination using FFPE sections is completed, typically requiring up to 1 week while the patient remains hospitalized. In most countries, Mohs micrographic surgery (MMS) and the frozen section technique (FS) are widely employed. With FS, reconstruction typically occurs concurrently with tumor removal, although there is a significant risk of false-negative results. Conversely, MMS, while highly effective, may be too expensive and time-consuming for all periocular BCCs and is not usually recommended for deep orbital invasion due to non-orientable nature of specimens from orbital soft tissues (27).

Immediate histological monitoring for clear margins is not available in our department. However, to achieve R0 resection and mitigate the risk of recurrence, it is generally advised to maintain a clinical safety margin of at least 4 mm. A wide clinical safety margin of 7–10 mm is applied when a high-risk or recurrent tumor is suspected.

In a similar study by Ho et al, the largest series of BCC excisions using the non-Mohs rapid-turnaround paraffin technique was conducted on 270 patients. Initially, a 3-mm safety margin was applied, and the reconstruction was performed a few days after confirming clear margins histologically. If the margins were involved, further excision was performed using FS or paraffin examination until clear margins were obtained (28).

A prospective Australian study by Malhotra et al reported the outcomes after a 5-year follow-up period of 819 patients with periocular BCCs treated with MMS. The most common locations

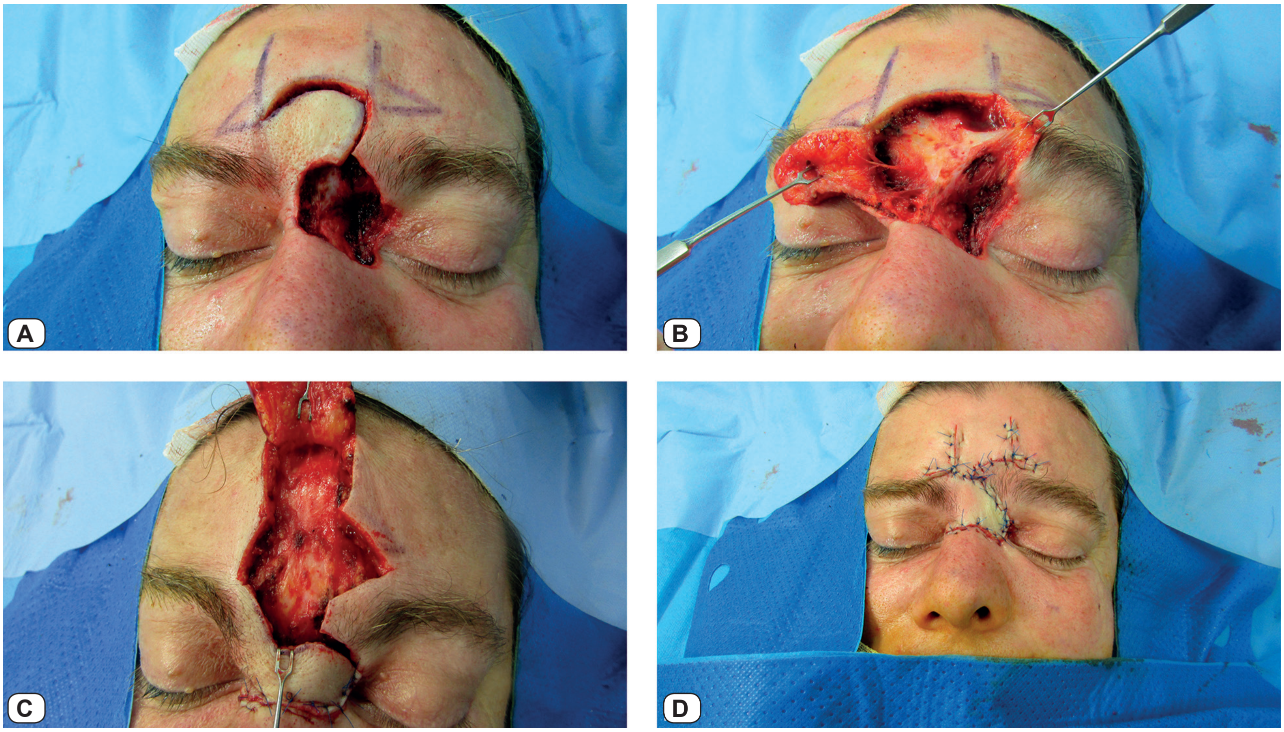

Fig. 9. Rotation and advancement flap in the medial canthus. A, The medial canthal area is a unique part of the face where multiple subunits overlap. This area includes the upper eyelid, lower eyelid, eyebrows, and the sidewall of the nose. Large defect of the medial canthus after the excision of a nodular BCC. A rotation flap incision is made. B, Raising and undermining the flap. C, Raising of the frontal advancement flap with excision of the Burrow triangles. D, Final appearance after suturing the wound without tension. To achieve the best aesthetic outcome, it is essential to replicate the natural depression in the center. Tumors located in the medial canthus pose unique challenges due to their propensity for deep penetration.

were the lower eyelid (54%) and medial canthus (41%), with nodulocystic (43%) and infiltrating (30%) histologic subtypes being predominantly identified (29). However, in our study, we observed a higher incidence of tumors in the lower eyelid (64%) compared to the medial canthal region (32%).

In the United States and Europe, BCC constitutes the majority of eyelid carcinoma (85–95%), with other eyelid malignancies accounting for only 5–15% of cases (30). This is consistent with our study's findings, where the most prevalent histopathologic type, according to the WHO classification, was BCC (86%), followed by SCC (8%), MM (5%), and MCC (1%). Within BCC subtypes, our study revealed nodular (60%), not otherwise specified (NOS) (16%), infiltrative (11%), superficial (3%), and other variants such as micronodular, basosquamous, and adenoid BCC (13%), which are also referred to as high-risk subtypes. Notably, basosquamous carcinoma, an aggressive tumor representing a combination of BCC and SCC with or without a transition zone (30) was found in 3.5% of cases in our study.

The incidence of tumors in Asian countries is slightly different. In East Asia, the dominant type of periocular tumor is BCC (42% to 82%) (32). Conversely, in South Asia, SCG exhibits a higher prevalence compared to BCC. For instance, a study by Kadir et al (2022) conducted in Bangladesh, comprising 332 eyelid malignancies, reported SGC as the most prevalent (42%), followed by BCC (38%), SCC (18%), and MM (2%) (33). Notably, our study did not encounter a single case of SGC. Instead, SCC emerged as the second most common tumor in our study, with an incidence of 8%. Within SCC cases, we observed SCC *in situ* (Bowen's disease) in 14% of cases, SCC NOS Grade 1 in 43% of cases, and SCC NOS Grade 2 in 29% of cases. Additionally, we found a significant association between the tumor size and grading, ($p=0.008$; $r=0.926$).

We observed only one case of MCC in this study, which clinically presented as a fast-growing subdermal nodule in the eyelid-cheek junction fixated to the SMAS with telangiectasia on the skin surface. Histopathological examination showed a pT1 stage, tumor thickness of 6 mm, and infiltrative growth pattern. Initially, a disease-free margin of 5 mm with primary closure was applied. However, after 1 month, the patient developed a recurrence, necessitating an additional 15-mm safety margin with FTSG coverage. This case aligns with findings from other studies indicating that MCC exhibits rapid and aggressive growth with a high incidence of local recurrence, as reported in 21% of cases in one series (34). We also found that patients diagnosed with MM predominantly had the nodular type, accounting for 80% of cases.

Adequate surgical margins are a reliable predictor of local recurrence. Higher recurrence rates were found with tumor-free margins <2 mm, recurrent lesions, medial canthus location, and aggressive histologic subtypes (35). For periocular BCCs resected without histological monitoring, recurrence rates were as high as 67%. In contrast, a similar study by Pfeifer et al from Spain reported a recurrence rate of only 5% after surgery with histologically clear resection margins (36, 37).

A previous study reported a recurrence rate of 6.9% for all high-risk tumors exhibiting aggressive behavior. The most severe recurrence was observed in a female patient diagnosed with spindle cell melanoma. She underwent complete lower lid removal with negative margins and reconstruction with a chondromucous septal graft and Mustardé flap. Despite these measures, the patient later required enucleation due to an intraorbital recurrence. Genetic testing subsequently ruled out a mutation in codon 600 of the BRAF gene.

According to the literature, perineural invasion (PNI) indicates aggressive behavior and poor prognosis, with a prevalence of 3–14% in SCC and 0.18–10% in BCC (38). The likelihood of PNI increases with tumor size, mid-face location, high histological grade, or history of recurrence. In our study, we found PNI in three cases (3.45%), namely in two morpheaform BCCs and one nodular MM located in the eyelid-cheek junction. If significant PNI is encountered, consultation with a radiation oncologist is appropriate.

The lower eyelid is one of the most challenging areas of the face to reconstruct due to its dynamic complexity. Our department's standard treatment for periorbital defects does not involve healing by secondary intention (*laissez-faire*). Compared to other methods, such as local flaps or FTSG, secondary intention healing requires frequent follow-ups and changing of dressings, sometimes for 6 to 8 weeks. Furthermore, predicting the quality and formation of scars, particularly in the medial canthus, is challenging (39). In our study, we used this method after partial necrosis of FTSG in the medial canthal region. Fox and Beard initially suggested leaving a small defect (measuring 1 cm in diameter) for spontaneous granulation, primarily in the medial canthal area, since the nasal bones effectively resist the formation of contracting scars (40).

In the study of NMSC patients, Choi et al reported that primary closure was the most common method for repairing any surgical defect (38.9%), followed by a local flap (35.5%). Specifically, the defects after BCC excision were reconstructed using primary closure (39.5%) followed by local flaps (34.2%). In contrast, the coverage after SCC removal was most commonly repaired using a local flap (39.5%), followed by primary closure (34.2%) (41).

In a recent study, small-to-medium-sized anterior lamellar defects in the pretarsal area were managed through primary closure, local advancement flaps, or FTSGs under local anesthesia. Preseptal and eyelid-cheek junction defects were primarily reconstructed with FTSGs and local randomized flaps, such as the V-Y advancement flap, the Limberg flap, and the rotation flap. A canthotomy with inferior cantholysis was performed if needed. Following surgery, FTSGs were bolstered in the defect until the fourth postoperative day, and stitches were removed seven days after surgery. A recent study reported that 93% of BCCs were located in the medial canthus, with the nodular subtype being the most common. SCC and basosquamous carcinoma were also encountered, accounting for 4% and 3%, respectively. Reconstruction of the medial canthal region was primarily performed using the glabellar flap, followed by the Limberg flap, and the A-to-T flap. For larger and shallower defects or recurrent tumors where the periosteum of the nasal bone is not invaded, using FTSG is considered ideal (42) (Fig. 9).

Patients with larger full-thickness defects did not exhibit a preference against the utilization of local anesthesia combined with analgosedation or general anesthesia. For anterior lamella reconstruction, we used the Fricke flap, McGregor flap, or Mustardé cheek rotation flap. Our team has substantial experience with nasal chondromucous grafts for posterior lamellar reconstructions, which are harvested from the nasal septum without complications at the donor or recipient site. Minor rhinorrhea can occur, but typically subsides within a week postoperatively. One disadvantage of using a nasal chondromucous graft is the necessity for coverage with a relatively large flap, which increases the risk of ectropion. In comparison, the Hughes flap provides a vascularized layer. Although it requires a two-stage reconstruction technique, using an FTSG is sufficient for reconstructing the anterior lamella, making it advantageous.

Most lower eyelid reconstructive procedures are associated with a high incidence of ectropion (43). In the presented study, three patients (3.5%) developed ectropion. The first case of ectropion occurred after using the Fricke flap for anterior lamellar reconstruction. The second case was due to cicatricial mechanisms of FTSG after restoring the anterior lamella in the preseptal region. In both cases, the posterior lamella remained intact. The third case of ectropion occurred after anterior lamellar reconstruction using a Mustardé flap and posterior lamellar reconstruction using an auricular conchal graft. The ectropion was likely caused by inadequate fixation of the posterior lamella graft to the orbit's periosteum, insufficiently high fixation of the flap on the periosteum of the zygomatic bone, or owing to gravitational pull of the anterior lamella. To prevent ectropion in certain cases, a dermal-orbicularis oculi suspension (DOS) flap is effective (44).

While our study provides valuable insights, it is essential to acknowledge its limitations. Firstly, all patients included in the study were recruited from a single center, which may limit the generalizability of our findings to broader populations. Multicenter studies with larger and more diverse patient cohorts would be beneficial to validate our results across different settings and demographics. Additionally, single-center recruitment may introduce potential biases related to patient selection, healthcare practices, and institutional protocols. Future research involving multiple centers can help mitigate these biases and provide a more comprehensive understanding of the topic. However, our prospective study provides a thorough analysis of lower eyelid tumors that occurred in the eastern region of the Slovak Republic over five years, a dataset that has not been previously presented in our country. Additionally, we outline a wide range of reconstructive techniques used in specific cases of lower eyelid defects, highlighting the versatility and adaptability required in this complex field of reconstructive surgery.

In conclusion, accurate diagnosis, staging, and treatment planning are crucial before initiating interventions for eyelid tumors. While standard-wide excision is the preferred option, implementing guidelines for high-risk and invasive tumors in the periocular region can be challenging. Balancing the need for effective treatment with minimizing cosmetic disfigurement or functional impairment is essential in achieving optimal outcomes for patients.

Learning points

The classification system based on vertical subunits is beneficial in effectively categorizing lower eyelid defects, facilitating accurate planning for reconstruction. Tailoring surgical approaches based on individual patient requirements and tumor characteristics optimizes treatment outcomes and reduces the risk of complications. Understanding the histological type of the tumor is crucial as more aggressive types carry a higher risk of relapse. Reconstruction should aim to restore a three-layer eyelid structure, ensuring a stable margin and good apposition to the globe. While flaps typically provide the best tissue match and cosmetic outcome, careful planning is necessary to minimize secondary deformities. Larger lower eyelid defects require advanced reconstruction techniques to achieve optimal functional and cosmetic outcomes.

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