Lateral frontal galeal-cutaneous flap for reconstruction after orbital exenteration for advanced periorbital skin cancer

Abstract

**Background/aim:** Orbital exenteration is one of the most disfiguring procedures leading to significant deformity. Defect reconstruction is challenging, especially in elderly patients. We have reviewed our experience of orbital exenteration and primary reconstruction with lateral frontal galeal-cutaneous flap based on superficial temporal artery.

**Materials and methods:** Data on patients treated for non-melanoma skin cancer invading the orbit during the 10-year period were analyzed. Patients’ demographics, tumor features, reconstructive technique used, complications and survival were recorded with a median follow-up of 27.5 months.

**Results:** 26 patients in whom orbital exenteration was done were included in the study. There were 14 males and 12 females, mean aged 75.29 years (ranged 61-87). The majority of patients were treated for basal cell carcinoma with medial cantus as primary site. All defects were closed by lateral frontal galeal-cutaneous flap based on superficial temporal artery, and in two cases temporalis muscle pedicle flap was used as additional flap for reconstruction of orbital roof in order to separate the brain from empty orbit, and covered with same galeal-cutaneous flap. In 19 cases frontal area was closed primarily, and in 7 cases skin graft was used for secondary defect. There was no flap loss. Tumor related death was registered in three patients (inoperable recurrent tumors) (11.5%), 7 died as tumor unrelated (2 of them were operated from recurrent orbital tumor) and 16 survived.

**Conclusion:** The preferred method for reconstruction after orbital exenteration in our university affiliated center is lateral frontal galeal-cutaneous flap based on superficial...
temporal artery. The flap harvesting is simple, safe and obtains enough tissue for covering defects even after extended exenteration. Complication rate is low. We suggest the simultaneous use of this flap with pedicle temporalis muscle flap only for reconstruction of scull base after anterior cranial fossa resection.

**Key words:** Orbital evisceration, reconstructive surgery, galeal skin island flap

1. **Introduction**

Advanced periorbital skin tumors sometimes have fungating appearance and invade the orbit. In general, clinical presentation of orbital invasion is defined by visible or palpable mass, tumor fixed to orbital wall, limited ocular motility, globe displacement, ptosis and epiphora [1]. Older patient referred to tumor board for larger tumor, multiple previous recurrences and aggressive histologic subtype (basosquamous carcinoma) should be considered for CT imaging [1]. The aim of surgery is to obtain tumor-free state. It could be reached only by orbital exenteration (OE) [1]. Although OE provides quality of life improvement by reduction of pain, this procedure also results in devastating functional, aesthetic, psychological and functional losses. The OE leads to loss of binocular vision (impairment of visual functions) and psychological disturbances [2]. OE is a mutilating and disfiguring procedure which typically involves the removal of the entire content of the orbit, including the periorbita, appendages, and sometimes the eyelids and a variable amount of surrounding skin. Extended OE includes the removal of the adjacent bone [3]. Most frequently the anterior ethmoidectomy and/or suprastructure maxillectomy is described [4]. After extended OE the orbital cavity may communicate with paranasal sinuses, nasal cavity, oral cavity or both. [2]. The defect after OE and maxillectomy is
defined as complex with communication of oral and nasal cavity with exterior. In such cases some authors advise rectus abdominis microvascular flap [4,5]. So far, OE has not been shown to provide a cure in most of the cases. On the other hand, it has been proven to control local disease, and may prolong life, especially when combined with other adjuvant therapy (chemotherapy and radiotherapy).

In general, OE is used to treat tumors and, rarely, inflammation and trauma. The most common indication for OE is periocular malignant tumor invading the orbit and orbital wall. Absolute indications for OE are the invasion of the muscles and the fat tissue of the orbital apex, and infiltration of the conjunctiva and/or sclera. Although basal cell carcinoma is the most common malignancy in periorbital region (90%), only 0.8 to 5.5% of these tumors invade the orbit [1]. The majority of exenterations are performed for tumors originating from orbital structures, and periorbital malignancies such as eyelids or periocular skin. Most of skin tumors invading orbit are squamous cell carcinoma, followed by basal cell carcinomas, sebaceous-gland carcinomas and melanomas [2,6,7]. Meyer and Zaoli classified OE for tumors in relation to the extent of destruction involved in the surgery on four types:

– Type I: palpebral skin and conjunctiva are spared;
– Type II: only the palpebral skin is spared (orbital contents and conjunctiva are removed);
– Type III: both eyelids are removed with orbital contents;
– Type IV: the eyeball, eyelids and appendages of the eye are removed with the involved bone structures [8].
The most important decision after OE is whether to perform primary or secondary reconstruction. Some facts must be kept in mind. Early recurrence can be easily recognized when the cavity is exposed for secondary reconstruction; therefore, spontaneous granulation technique is used in the cases in which complete tumor clearance is not certain. However, some case series have reported a high rate of sino-orbital fistula following spontaneous granulation. Skin graft reconstruction has been shown to speed up the healing process. In order to separate the orbit from the surrounding cavities, and to produce an acceptable aesthetic outcome, several methods are to be considered for lining the orbit (skin grafts or local flaps) or filling it, in order to exclude nasal cavity or protect the brain when orbital roof is resected [2]. Regional flaps (temporalis muscle, midline forehead, frontal, or temporo-parietal fascial flaps, dermis-fat graft) and microsurgical flaps (rectus abdominis, latissimus dorsi, radial forearm, lateral arm flaps) could be used to reconstruct the cavity. Regional muscle only flaps, rather than fascia, has shown better results, by providing better nutrition to the skin graft [2]. When the resection of the dura, and its reconstruction are performed in addition to OE, primary reconstruction is mandatory, in order to avoid the risk of meningitis. The flap used in this study is lateral frontal galeal-cutaneous flap based on superficial temporal artery.

2. Materials and methods

We retrospectively analyzed the data from medical records of 26 consecutive patients in whom orbital exenteration for skin cancer invading the orbit was performed during the period from January 2005 to December 2014. At admission, an informed consent for the treatment and data scientific analysis was obtained from all the patients included in the
Study. Additional informed consent was obtained from all individual participants for whom the photos were included in this article. Institutional Ethical Committee approval was obtained before undertaking the study. Demographic data (gender, age), tumor site and histopathology, previous treatment, type of reconstruction used and complication rate, as well as operative time, hospital stay, recurrence rate and cause of death were recorded. The disease stage for each case was assigned according to American Joint Committee of Cancer (AJCC) as T4a (advanced infiltrative but thought to be resectable). In this study OE were performed as the sole procedure (Meyer and Zaoli Type III) or as extended OE with resection of one or more bony walls (Meyer and Zaoli Type IV). In all patients the reconstructive procedure was performed primarily - immediately after exenteration. The lateral frontal flap was raised during surgery and transferred to defect. Flap consisted of skin, subcutaneous tissue and galea in lateral frontal region based on superficial temporal artery. Only periosteal were left in place. The donor site was closed primarily, or skin grafted. In cases of extended exenteration with the resection of orbital roof, the temporalis muscle pedicle flap was transposed first to separate cranial contents from orbit, followed by galea-cutaneous frontalis flap.

2.1. Statistical analysis

The following statistical parameters are presented by descriptive statistical analysis: arithmetic mean, standard deviation, absolute frequency (N) and structure index (%).

3. Results

Demographic characteristics, primary site of tumors and pathological characteristics of study participants were shown in Table 1.
Fourteen men and 12 women with a mean age 75.69+6.28 (ranged 61 to 87) underwent surgery.

The most common primary origin was the medial canthus region 13 (50%). The orbital roof and lateral part of supraorbital arch (anterior cranial fossa) were removed, reaching the dura, but without dura resection in two cases. In 4 surgeries a suprastructure maxillectomy was performed.

Tumor histopathology included the following: basal cell carcinoma (BCC) in 15 (57.69%) patients and squamous cell carcinoma (SCC) in 11 (42.31%) patients. In BCC group, incidence of infiltrative, basosquamous and nodular BCC was recorded in 8, 4 and 3 patients consecutively, Orbital exenteration extent and reconstruction after exenteration were shown in Table2.

In 11 (42.30%) patients the tumor was primary advanced, without previous treatment, and in 15 (57.7%) patients a recurrent cancer of periorbital skin infiltrating the orbit was diagnosed. Number of previous treatments ranged from one to three. According to Meyer and Zaoli’s classification, in 14 (53.84%) patients the exenteration was performed as type III (both eyelids are removed with orbital contents), and in 12 one or more orbital walls were removed (Type IV- the eyeball, eyelids and appendages of the eye were removed with the involved bone structures). Ethmoidectomy was performed most dominantly. Clear margins after exenteration were recorded in 20 patients (76.92%), while in 6 (23.08%) margins were positive. All defects after exenteration were reconstructed using local flaps.

In all patients the lateral frontal galeal-cutaneous flaps based on superficial temporal arteries were harvested for primary reconstruction. In two cases of anterior cranial fossa
resection, lateral frontal galeal-cutaneous flaps were raised, followed by harvesting and transposition of a pedicle temporalis muscle flaps in orbit through lateral orbital wall in order to separate cranial content from orbit. After temporalis flaps positioning and fixation, the reconstructions were completed by transposition of lateral frontal galeal-cutaneous flaps. Donor regions of lateral frontal flaps were closed primarily in 19 cases (73%) and in 7 cases a partial thickness skin grafts were used. In all cases after resection of orbital floor (maxillectomy), a trans-nasal maxillary sinus tamponade was used for 5 days.

Early postoperative complications were minor, and did not require further surgery. The overall complication rate was 11.53% as following: hematoma formation in orbit was drained spontaneously in one patient (3.85%) and in 2 patients (7.7%) partial loss of skin graft appeared and healed by secondary intention. Mean operative time was 114 ± 15min. The average hospital stay was 7.2 ± 1.1 day. None of the patients stayed in the intensive care unit. The average length of follow up from surgery to the last contact or to death was 27.5 ± 13.2 months (ranged 8 to 78 months). In the long term, the flap molded itself to the orbital cavity. The skin graft over the donor area presented total integration. The aesthetic result was good in all patients. According to decision of oncological board all patients with skin SCC were irradiated, as well as 2 skin BCC patients with R1 resection (microscopically evident residual tumor on resection margin). During the follow up we registered recurrent tumors in 5 (19.23%) patients. In two cases recurrent tumors were detected as resectable, they underwent surgery and in later follow up did not present disease progression. In 3 cases recurrent tumors invaded skull base, and were unresectable (death in those 3 cases was related to tumor progression). In 7 cases death was caused by
another disease. Sixteen patients survived follow up period. Aesthetic result was considered satisfactory in all patients. Clinical cases were shown in Figures 1-7.

4. Discussion

OE is one of the most disfiguring procedures in the head and neck region and some authors define it as one of the most destructive and unpleasant to perform surgeries [8]. Periorbital skin carcinoma is very common, and due to the anatomical features of the eyelids and periorbital region, patients frequently present with advanced tumors. When tumor penetration through orbital septum, and involvement of the orbit bone walls are seen on computed tomography (CT) scans, OE is required. Our study is consistent with other series where the main indication for the exenteration was the skin carcinoma (periorbital or eyelid). Periorbital skin malignancies invading orbit and bony structures could be defined as neglected cases [9]. In our study, the series of 26 patients is presented, dominantly of male gender (M: F=14:12). Male gender is also dominant in other series [8,10-16], but some studies refer the female predominance [9,17]. The average age of patients in our study was 75.69 years. The average age of patients in other studies also refers the elderly population ranging from 60 to 77 years and these results correlate with our data [1,9,11,12,14-16,18]. Primary tumor sites in our study are medial cantus (50%) and lower lid (34.62%). The study of BCC with orbital invasion by Sun shows the same data [1]. Some authors found higher incidence of lower lid cancers invading the orbit [13,19]. Skin BCC is the most common in periorbital region and despite the slow progression it may invade the orbital structures [9]. The most frequent histological type in our series was BCC. BCC most commonly affects the lower eyelid and medial canthus, which is in
correlation with our results [3,10,11,14,20]. However, some authors reported the equal incidence of BCC and SCC [15]. The SCC is associated with additional risk of perineural spread along branches of trigeminal nerve [9]. Some authors found predominance of SCC in their series [15,21]. OE is not reserved only for primary orbital tumors, but is often required for the periorbital skin tumors invading the orbit. Invasion of the fat and muscles of the orbital apex and infiltration of the conjunctiva or sclera are absolute indications for OE [22]. In our study exenteration was performed in 57.7% of the patients for recurrent tumor and secondary orbital spread after primary treatment(s) of skin cancer and in 42.3% of the cases for primary advanced skin cancers with evident orbital invasion at the time of first presentation. The secondary orbital tumors are referred as main indications by other authors [11,15,19]. Although radical surgery is the primary goal, in most of the series the clear margins were not achieved in all cases [12]. In our series in 20 of 26 patients (76.92%) we recorded clear margins, while in other reports clear margins ranged from 33% [9] and 50% [19] to 61% [13,21]. Some authors point out perineural invasion as reason of inadequate radicality and found it in 63% [16]. In our study total OE and extended OE are almost equally performed (53.85% vs. 46.15%). This finding correlates with report of Nasab [14]. In series of Duman total exenteration was required in 75% and extended exenteration in 25% of patients [11], while Croce undertakes 7 extended exenteration and one total exenteration in his series [8].

In our series in only one patient extended OE included ethmoid, maxilla and malar bone, while in 6 patients only medial wall was resected (ethmoidectomy). In 3 cases inferior and lateral orbital walls were resected (superstructure maxillectomy and malar bone resection),
and in 2 cases resection of superior and lateral orbital wall was indicated. The aim of reconstruction is to establish contour symmetry with opposite site of the face and it is important that the flap covers the line of the orbit [9,10]. Our study presents the role of the lateral frontal galeal-cutaneous flap in primary reconstruction after orbital exenteration. Numerous techniques have been described for reconstruction of the exenterated orbit [3]. Spontaneous granulation and epithelization is one of the first techniques reported. In one report with 25 cases in which the orbit was left to granulate, all patients were presented with tumor progression/recurrence on follow-up, and author suggest the orbital granulation approach when the tumor clearance is not certain [17]. However, secondary granulation and epithelization is rarely applicable, making serious discomfort and delaying postoperative irradiation. Primary reconstruction promotes healing and provides better aesthetic appearance [22]. The average healing time for spontaneous granulation is 14 weeks to 6 months [22,23]. Primary closure could be obtained by cheek advancement [24]. Local options include split thickness skin graft [14], or a full thickness skin graft [8]. Skin grafts for reconstruction could be used for defects without bony wall resection [2]. In cases where OE is combined with resection of orbital walls, the usage of flaps is advised for more extensive defects. The aim of the flap is to isolate orbit from the nasal cavity and paranasal sinuses, to prevent fistula, and to protect cranial contents from exposure in extensive defects. Frontal flap provides a good color and texture, similar to the rest of the facial skin and represents an excellent single stage reconstruction. The use of local flaps is recognized as advantageous regarding spontaneous healing of skin grafting especially in anticoagulated patients. Use of local flaps reduces hospital stay and allows earlier social
reintegration of the patient [10]. Other authors describe predominantly usage of temporalis muscle flap with skin graft [13,22]. Temporalis muscle pedicled flap had robust vascular supply and is preferred to transpose in orbit through window in lateral orbital wall (transorbital) [9]. Galeal fascial or pericranial flap based on supratrochlear artery are described [8,25]. Croce used a lateral based frontal fasciocutaneous pedicle flap and full thickness skin graft in the oldest patient in his report [8]. The disadvantage of temporalis muscle flap is a visible hollowness of the temporal area but none of patients had concerns about that [9]. Bilobed forehead flap based on supraorbital and supratrochlear pedicle could be used as a local flap in orbital reconstruction [26]. Some authors describe the use of cervicofacial rotation advancement flap for orbital reconstruction [3]. Other authors refer the use of pedicle muscle flaps as pectoralis major flap [27] or latissimus dorsi muscle flap [8]. In our series we also performed temporalis muscle flap in two cases, where medial half of the orbital roof was resected in order to separate cranial structures with sufficient mass of muscle.

In cases where orbital cavity is not completely filled with transferred tissue, the residual scarring can displace the eyebrow downward and lead to facial asymmetry. Hannasono defines those reconstructions as open cavity reconstructions [2]. Bulky flaps such as rectus abdominis, completely fill the orbital cavity and same author defines them as closed orbital reconstructions [2]. The contracture is less intensive and there is not any displacement of surrounding tissues. However, the patient cannot wear orbital prothesis. In our reconstruction the flap was bigger than orbital defect and we have not encountered the problem of eyebrow displacement. Some authors suggest the use of microvascular flap for
orbitomaxillary defects as the best solution [28]. Microsurgical flaps are time consuming and require good general status of the patient. OE is usually carried out in older patients with significant comorbidities. These increase the surgical risk and may worsen postoperative outcome [29]. Free flaps extend the duration of the surgery and additional team is needed [9,22]. Prolonged surgery with free flap reconstruction may increase the risk of postoperative intensive care unit requirements and complication rates. Free flaps should be reserved for selected cases. For orbital reconstruction some authors use microvascular dorsalis pedis, flap [30] or free myocutaneous gracilis flap [31]. The flap used in our study consists of galea and skin of frontal region avoiding the use of skin graft for orbital walls or for the coverage of previously used galea flap alone. The donor region in frontal area can be closed primary in most of the cases or skin grafted. The transferred flap is resistant enough to radiation therapy and we did not register any radiodermatitis. In 2 cases we additionally used temporalis major muscle in order to separate intracranial content from exterior environment. Advantages of the lateral frontal galeal cutaneous flap is: the easy design and elevation, low donor area morbidity, adequate cutaneous covering of the orbital area, possibility of closure of communication with paranasal sinuses, preservation of the temporal muscle. Donor region was primary closed in 17, but in 7 it was covered using partial thickness skin graft.

Average operative time was 114 minutes compared to reported longer time (up to 500 minutes), using free microvascular flaps [9]. Based on experience from our, and other studies, it could be concluded that the use of local flaps is time saving reconstruction [10]. None of the patients in our study stayed in ICU, which correlates with the results of
Hanasono in case of orbital reconstruction using skin graft and local flaps [2]. Average hospital stay in our report is 7.2 days which is in accordance with some [2] but inconsistent with studies with reported longer length of hospitalization ranging from 7 to 35 days [9,14,15]. From our point of view OE is indicated most predominantly in older patients with serious comorbidities. The intention is to achieve radical tumor ablation and sufficient reconstruction, and surgeon should avoid long surgeries using microsurgical free flaps. Early postoperative complications were minor in our series, and did not require further surgery. The overall complication rate was 11.53% and included: hematoma formation in orbit drained spontaneously in one patient (3.85%) and in two patients (7.7%) partial loss of skin graft in frontal region (donor site) and healed by secondary intention. There were no flap related complications, flap has shown the best results, and therefore came to be preferred method in our unit. In study of Croce [8] all patients recovered satisfactorily, but in series of Rabey 2 of 12 patients required further procedures due to the complications from reconstruction used [3]. Partial necrosis of the flap in three patients is reported in one study [13]. In the literature, sinoorbital fistula is the most common complication of the exenteration, but in our study we did not detect neither sinoorbital fistula, nor fungal infection of the orbital cavity, despite the orbit was left empty in most of the cases. In some reports intraoperative cerebrospinal fluid leak was managed with tissue adhesive without any complication [11]. On the other hand, Shieh reported a case of tension pneumocephalus after OE. This patient was treated with collagen, and engineered dural substitute fat graft, and temporalis muscle flap in order to close the dural tear in the orbital roof [32]. We did not have any cerebrospinal leak nor complicated sinoorbital fistula. The
average length of follow up from surgery to the last contact or to death was 27.5 ± 13.2 months (ranged 8 to 78 months), while Gerring calculated survival after 17.5 mean follow up [24]. Pain and swelling were the most common presenting features of patients with recurrent tumors [15]. The incidence of recurrent tumor in our study was 19.23% (5 patients). In two cases recurrent tumor was detected as resectable, they underwent surgery and in follow up did not present the disease progression. In 3 cases recurrent tumor invaded skull base, and was unresectable (death in those 3 cases was related to tumor progression). The local recurrence was reported 18.7% [11], 25.8% [16] to 28.5% [19]. In one study three cases of recurrence were detected at an average onset of 28 months (range 12 to 60) with contralateral exenteration indicated for one patient [13]. We support the statement that survival rate is acceptable enough to justify the undertaking of such a disfiguring and dysfunctional operative procedure [16].

In conclusion we could point out that the surgical team must be familiar with basic anatomy, as well as to have the adequate surgical skills for the reconstruction. From the authors’ point of view, galeal-cutaneous flap based on temporalis superficialis artery is technique of choice for reconstruction following exenteration and extended orbital exenteration. Temporalis muscle flap reconstruction is indicated only in cases of extended OE with anterior skull base resection (upper orbital wall) in addition with galeal-cutaneous flap described in our study. The lateral frontal flap can be considered an option for patients with contraindication for a microsurgical flap as one of simplest procedure in the elderly population with significant morbidities.
References


7. Deo SV, Nootan KS, Niranjan B, Dinesh K. Vertical rectus abdominis myocutaneous flap cover for lower abdomen, chest wall, groin and thigh defects following


Table 1  Gender and age distribution, primary site of tumors requiring orbital exenteration and tumor histology

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Table 2: Orbital exenteration extent and reconstruction after exenteration and reconstruction after exenteration

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Figure 1: Basal cell skin cancer of lower lid

Figure 2: Operative defect includes orbital exenteration and suprastructure maxillectomy
Figure 3. Definitive result Donor site in frontal region is primarily closed
Figure 4. Basal cell skin cancer of left cheek infiltrating facial massive.
Figure 5. Operative defect includes orbital exenteration, ethmoidectomy, partial maxillectomy and malar bone resection

Figure 6. The extensive galeal-cutaneous flap designed
Figure 7 Definitive result. Donor region in frontal area is skin grafted.