Regional Reconstruction of Orbital Exenteration Defects

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Abstract

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Aggressive disease such as invasive fungal infections or malignancies may necessitate orbital exenteration. The defects of orbital exenteration are often complex involving adjacent structures. Rehabilitation of the orbital exenteration defect poses unique challenges to the reconstructive surgeon. Various options have been described ranging from secondary intention to microvascular free tissue reconstruction. Here the authors review local/regional options for reconstruction of orbital exenteration defects.

Pathology involving the orbit and eye has long provided a challenge to the reconstructive surgeon. Aggressive disease such as invasive fungal infections or malignancy often necessitates radical resections, including orbital exenteration. Exenteration involves removing the entire orbit including eyelids, eye, retrobulbar tissues, and surrounding periosteum. Often the resection can involve other surrounding structures such as the nose, paranasal sinuses, or maxilla.^{1–3} A common classification separates the defect into types I, II, III, and IV, with type I defined a simple exenteration. Type IIa defines an extended orbital exenteration with loss of a single orbital wall or rim, while type IIb involves the loss of several orbital walls. Types III and IV involve additional defects as a result of the resection.³

Various strategies have been employed for orbital reconstruction and rehabilitation. Healing by secondary intention has been described as one option. However, this represents a lengthy process that can delay planned adjuvant therapies such as radiation.¹ Moreover, this is associated with a high rate of sinonasal fistulae.⁴ Given such complications, the vast majority of patients who undergo orbital exenteration require reconstruction.⁵ The goals of reconstruction are to maintain separation between the orbit, the nasal cavity and sinuses, and the intact skull base. Additionally reconstruction also aims to provide an optimal cosmetic outcome by restoring facial contours and to enable potential use of prosthetic implants.

Various reconstructive techniques have been employed ranging from split thickness skin grafts (STSGs), to regional flaps, and to free tissue reconstruction.^{3,5–11} Free tissue transfer is reserved primarily for advanced orbital exenteration defects, usually types III and IV. Here we review several regional reconstructive options utilized primarily for type I and II orbital exenteration defects.

Skin Grafts

Skin grafting, full thickness skin graft (FTSG) or STSG, has long been a mainstay of reconstructive surgery. FTSGs include the epidermis and the entire thickness of the dermis. Conversely STSGs include only part of the dermis. FTSGs provide for better pigmentation and less contracture when compared to STSG. While FTSGs are a good reconstructive option for many facial defects due to their excellent color match and limited contracture, they do require more robust underlying tissue in order to take.

Type I orbital exenteration defects can heal by secondary intention over the course of several months. Skin grafting was championed as a means of rapidly re-epithelializing an orbital exenteration cavity. An STSG can be inlaid over an orbital exenteration cavity either at the time of resection or after granulation tissue has formed. Skin grafting alone should be reserved for type I exenterations without a history of radiation or planned adjuvant radiation. The risk of

sinonasal fistulas and additional wound complications in irradiated patients is too great without underlying vascularized tissues. In these patients, STSGs are often used as an adjunct over other soft tissue flaps such as temporalis or pericranium.

Temporalis Flaps

Type IIa and IIb defects require vascularized tissue within the wound bed due to the more extensive defect. The temporal region provides the reconstructive surgeons with several options including the temporoparietal fascia (TPF) flap and the temporalis muscle flap (TMF). The TPF lies just deep to the skin and subcutaneous tissues. The TPF is continuous inferiorly with the superficial musculoaponeurotic system and superiorly with the galea aponeurotica. Deep to the TPF lies loose areolar tissue and then the fascia of the temporalis muscle itself. The TPF flap is based on the superficial temporal artery that runs just deep to the TPF. The TPF represents a thin and pliable flap that can readily receive a skin graft or be harvested with the overlying skin. It can be used as a pedicled flap or as a free flap. The arc of rotation for the TPF flap makes it a great candidate for orbital reconstruction.

The temporalis flap or TMF represents a versatile and robust regional option for head and neck reconstruction. The temporalis muscle is a fan-shaped muscle that originates and sits in the temporal fossa on the cranium. It inserts onto the coronoid process of the mandible. The flap is supplied by the anterior and posterior deep temporal arteries. These vessels lie deep to the muscle belly and superficial to the pericranium. As such the flap can be raised in a subperiosteal plane in order to protect the vasculature. Care must be taken to preserve the frontal branches of the facial nerve when raising a temporalis flap. The frontal branches of the facial nerve run across the superficial temporal fat pad.

Various techniques have been employed utilizing the TMF for orbital reconstruction.^{6,8,12} The temporalis flap can be inlaid into the orbital defect either over an intact lateral orbital wall, or after an orbitectomy when the lateral orbital wall is removed. Alternatively the temporalis flap can be transferred into the orbit via the creation of an ostium in the lateral orbital wall. Torroni et al describe a novel approach using such a lateral orbital ostium. They describe an anterior retrograde approach that spares a hemicoronal incision and utilizes long curved retractors to raise the flap through an anterior incision.⁶ The flap is then brought into the orbital exenteration defect by means of a window created in the lateral orbital wall. Ultimately TPF and TMF represent robust and reliable regional options for reconstruction of type IIa and IIb orbital exenteration defects (– Fig. 1).

Pericranial Flaps

The soft tissues of the scalp are composed of five distinct layers: the skin, subcutaneous tissues, galea aponeurotica, the subgaleal loose alveolar tissues, and finally the periosteum. The pericranium refers to the periosteum and subgaleal loose connective tissue. The pericranium can be raised

as a thin, pliable, and well vascularized flap. Anteriorly based pericranial flaps are fed by the supraorbital and supratrochlear vessels. The flap can be rotated and tunneled through incisions and used for a variety of reconstruction. As such pericranial flaps have become a workhorse flap for skull base and orbital reconstruction.^{2,9,13,14}

The pericranium is fed anteriorly by the supratrochlear and supraorbital arteries. Lateral portions of the pericranium are supplied by branches off the superficial temporal system. A pericranial flap can be raised with a standard bicoronal incision. The skin flap should be dissected in the subgaleal plane leaving the loose areolar tissue and periosteum below. The pericranium can then be released off of the calvarium. Care should be taken anteriorly to preserve the blood supply from the supraorbital/supratrochlear arteries. Once raised the pericranial flap can then be rotated into an orbital defect. A frontoethmoidal incision can be used to inlay the flap into the orbital defect. The well vascularized surface of a pericranial flap is also an excellent recipient for skin grafts (– Fig. 2).

Other Local Flaps for Orbital Exenteration Repair

As discussed previously, in those patients whose orbital exenteration defects involve bony exposure with loss of orbital walls or rims, soft tissue coverage is needed. A STSG often is not adequate for these defects. While temporal muscle flaps or free tissue transfer provide excellent vascularized tissue, in a select group of patients other local flaps may be an appropriate option.

In previously irradiated patients or in those undergoing neoadjuvant therapy, the general consensus is to proceed with a pedicled flap or free tissue transfer. However, in those with no history of radiation and no plans for postoperative radiation therapy, local flaps may be a simpler yet effective option.

Cervicofacial Advancement Flap

The cervicofacial advancement flap is a rotational flap with a random blood supply. The flap is raised in a subcutaneous plane and recruits skin laxity from the posterior superior neck. This local flap is commonly used for reconstruction of the medial cheek, and thus with minimal modification it can easily reconstruct an orbital exenteration defect.^{7,15}

An ideal design takes advantage of the subunits of the face to allow for more cosmetic outcomes. The medial incision can be made along the nasofacial sulcus and carried down the melolabial fold to camouflage the resulting scar. In order to allow for more superior rotation to cover the orbital defect, this medial limb often extends down into the neck. The inferior aspect of the incision often requires a back cut or Z-plasty to help achieve the necessary rotation. The superior/lateral incision runs horizontally along the temple. This modification may also be referred to as a pivotal advancement cheek flap.

As previously stated this flap relies on a random blood supply, and is elevated in a subcutaneous plane. A slight modification has also been described, in which the platysma is raised with the flap inferiorly prior to transitioning to a

Fig. 1 (A) Illustration showing the temporalis muscle to be raised/rotation for orbital reconstruction. (B) Supraorbital transfer of the temporalis muscle over an intact lateral orbital rim. (C) Transorbital inset where the temporalis muscle is transferred into the orbit via an opening created in the lateral orbital wall. (D) Transorbitectomy inset shown where the temporalis muscle is transferred into the orbit via a defect created by partial resection of the lateral orbital rim.

Fig. 2 Illustration demonstrating the blood supply and layers of the scalp in a raised pericranial flap.

subcutaneous plane in the face to preserve facial nerve branches. This is thought to provide a more robust blood supply for coverage of slightly larger defects (►Fig. 3).

Frontal Island Flap

The frontal island flap is a pedicled flap based off the frontal branch of the superficial temporal artery. Its use has also been described for reconstruction of exenteration defects in a single-stage procedure. The frontal artery branch diverges from the superficial temporal artery approximately 2 cm superior to the zygomatic arch and courses within the superficial temporal fascia. The perforators supplying the skin are myocutaneous, so frontalis muscle must be harvested with overlying skin.

The incision is made in a preauricular crease carried superiorly to the inferior aspect of the designed flap. The designed skin paddle is incised circumferentially, but must be left attached to the superficial temporal fascia laterally. Laterally, skin flaps are elevated superiorly and inferiorly to expose the superficial temporal fascia and the frontal arterial

Fig. 3 The planned tissue to be advanced can be seen demarcated in *blue* on the left. The illustration on the left shows the cervicofacial advancement flap after it has been advanced and sutured in place.

branch. After dissection of the pedicle and elevation of the flap, these skin flaps may be closed primarily. A subcutaneous tunnel is made to connect to the orbital defect. After tunneling the flap, inset is performed. Some authors propose inseting a TMF into the orbital defect for volume restoration prior to the inset of the frontal island flap (► **Fig. 4**).

Paramedian Forehead Flap

An interpolated, axial flap based on the supratrochlear artery, the paramedian forehead flap, has a robust arterial blood supply. Commonly used for repair of nasal defects, this flap can reach as far as the columella, and thus can easily reach

Fig. 4 Illustration of frontal island flap based on frontal branch of the superficial temporal artery. Myocutaneous perforators from the frontalis supply the skin paddle.

orbital exenteration defects. Its main limitation is that it must be performed as a two-stage procedure, unlike the single-stage flaps previously described.

Its use is still relevant in the discussion of orbital exenteration, however. One of the complications of reconstruction with STSGs is a sinonasal fistula. Particularly in those cases near the nasal sidewall, the paramedian forehead flap can provide vascularized tissue for closure. In cases where STSGs fail, this remains a viable option.^{10,16}

Conclusion

The reconstructive surgeon faces unique challenges when faced with orbital exenteration defects. Orbital exenteration results in a disfiguring defect with significant morbidity. The aggressive pathologies that necessitate orbital exenteration can also result in associated defects of surrounding structures including the nose, paranasal sinuses, skull base, or maxilla. The reconstructive surgeon must restore form and function by reconstructing facial contours and appearance while simultaneously ensuring separation of orbit and adjacent structures.

A wide variety of approaches have been described for orbital reconstruction ranging from healing by secondary intention to microvascular free tissue reconstruction. Regional and local flaps remain a great option for a select group of patients, primarily those with type I and II defects. Skin grafting and local flaps such as the cervicofacial flap are simple solutions for the nonradiated patient. In patients whose tissue has been previously irradiated, it may be better to rely on more robust flaps such as the TMF. Many surgeons also prefer more robust tissue (i.e., pedicled muscle flaps, free tissue transfer) in those undergoing neoadjuvant radiation. In the right patient, the approaches described can offer a simple and reasonable cosmetic outcome to a challenging defect.

Financial Disclosures

None.

Conflicts of Interest

None declared.

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