

Repair of Head and Face Defects with the Use of Pericranial Flap

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Abstract

Introduction:

The pericranial flaps' benefits have been described in many otolaryngologic, maxillofacial and plastic surgery literature. The benefits are due to the pericranial flaps unique characteristics including good flexibility and mobility, very rich blood supply from several arterial sources and access to sufficient bulk of the flap without any need for distant surgical sites. Using pericranial flaps to repair the local defects of the head and face region in several cases has been reported in this study.

Materials and Methods:

A follow up study was carried out on 12 patients who had undergone frontal sinus obliteration; auriculoplasty and repair of the orbital walls and scalp's defects. Pericranial flap had been used for all these patients. Demographic specifications, surgical indications, imaging evaluations and early and late complications were recorded as well. The functional and cosmetic results and also the satisfaction level of patients were also assessed.

Results:

According to the average follow up period which lasted about 4 years, none of the patients suffered early or late significant complications. No disease relapse or need for revision surgery was reported. Almost all patients were completely satisfied with the procedure and its cosmetic results.

Conclusion:

The use of a pericranial flap is a simple, quick, cost-effective and safe method for repair of head and face defects. Although, a longer follow up time is required, but this uncomplicated method has been considered as an ideal method to repair sinonasal, ear and scalp defects.

Keywords:

Face, Head, Neck, Surgical flap

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Introduction

A quick, easy and reliable method is needed to repair head and neck deformities caused by congenital or traumatic defects and also tumor removal. However, this method should provide the minimal side effects in the graft donor site. Due to the relative lack of flexibility of the scalp, it is necessary to make larger local flaps for large scalp defects. Repair of scalp defects has been considered as a difficult procedure by plastic surgeons, because usually there is not adequate tissue source for this purpose. Although plastic surgeons use skin grafts with full or relative thickness to repair scalp defects; but surgery of tumor lesions or traumatic injuries in many cases has led to the removal of skull bone's periosteum. Meanwhile the bare bone which is considered as a non vascular bed for the graft may not provide the required blood supply.

Different autogenic materials (e.g. bone, cartilage, muscle, fat, dermis and omentum) and alloplastic materials have been used to repair deformities and tissue defects. Despite the relatively good results, potential side effects and morbidities have been reported in these methods. None of them have been approved as ideal methods; so plastic surgeons put more effort in to discovering new techniques to repair the mentioned defects. Due to uncertainty of the adequate local blood supply, infection or extrusion of alloplastic materials are more common in repairing methods of neck and head defects (particularly while the overlying skin is thin or damaged). On the other hand, the structure and color of flaps or skin grafts provided from other parts of the body are different from the head and neck skin. Side effects and morbidities of the graft donor site are also considerable.

Frontal sinus obliteration was performed for the first time by Runge in 1970s. Since that time, the applied methods and also the

used materials have been widely changed (1-4). Although there are variable techniques and materials used for frontal sinus obliteration, no ideal method has been introduced in this regard up to now.

Use of pericranial flaps in order to repair the defects of the anterior part of the skull base was more common in the late 1970s and in the early 1980s. This method is quick and easy without any need for a separate site to provide a graft. Through this method surgeons are able to successfully separate extradural space from the intranasal space and paranasal sinuses (5-6). The main purposes of using pericranial flap to repair the mentioned defects are as follow:

Creating a safe barrier between the brain, nasal cavity and sinuses, removing the dead space as a result of the lesions removal, providing a vascular coating to cover bone grafts and prevent CSF leakage. Regarding the individual specifications of flaps, their indications have also increased. Today, flap applications are as follows:

Treatment of hydrocephalus in children (7), closure of dural defects (8-10), frontal sinus obliteration (11), reinforcement of soft tissue (12-14), covering the bared bones and oropharynx repair (15) and also repair of the ear, nose, orbit, forehead and cheeks (16-20).

The scalp is made from 5 separate layers including the skin, subcutaneous tissue, galea (aponeurosis), loose areolar tissue and pericranium (periosteum which covers the skull bone). Pericranial flap is a well vascularized flap which is used for covering or obliteration of face or skull defects.

Regarding the individual capabilities of pericranial flaps in frontal sinus cranialization as well as repair of the defects in the paramedian anterior skull base, they are used to separate intracranial spaces from extracranial ones and also to prevent some complications such as

meningitis, epidural abscess, CSF leakage and brain tissue herniation.

Pericranial flap is a compound flap consisting of skull bone's periosteum and loose areolar tissue known as subgaleal fascia. The anatomy of pericranial flap has been described by Potparic and his colleagues (21). It is possible to provide an axial pericranial flap pattern (based on its defined blood supply) or a random pericranial flap pattern (based on random blood supply). There are two axial blood supply patterns for pericranial flaps:

-Blood supply pattern to anteriorly based flaps.

-Blood supply pattern to laterally based flaps.

Perforating branches of supraorbital and supratrochlear arteries provide blood supply for anteriorly based flaps whereas branches of the superficial temporal artery provide blood supply for laterally based flaps. The vascularized nature of a pericranial flap has made it feasible to design many random flaps which are successfully used in the repair of local skull defects.

The effective applications of pericranial flaps in frontal sinus obliteration and also repair of oncologic, congenital and traumatic defects of the skull have been reported in this study.

Materials and Methods

This retrospective study was conducted on the following patients:

5 patients, aged 23-39, having undergone frontal sinus obliteration using bilateral based pericranial flaps.

2 patients undergone repair of orbit wall defects due to sinus tumor removal.

1 patient, aged 61, having undergone repair of a frontotemporal scalp defect due to its tumor removal.

1 patient, aged 10, undergone repair of occipitoparietal scalp defect due to traumatic avulsion

3 patients, aged 8-15, undergone auriculoplasty

A single surgeon (main author of the article) performed all the surgeries.

Patients' demographic specifications, surgical indications, imaging evaluations, early and late complications, functional and cosmetic results and also their degree of satisfaction were assessed (Table 1).

Surgical Technique

Using bilateral coronal incision, dissection of the subgaleal plane is continued to the upper orbital edge (taking care to preserve the neurovascular supraorbital and supratrochlear bundles) and the forehead flap is elevated in all patients with frontal sinus obliteration (Fig 1). Frontal sinus area is detected and the involved periosteum is removed.

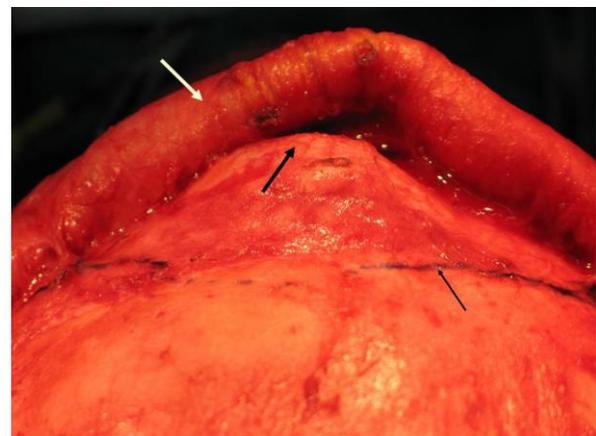


Fig 1: Osteoma of the frontal sinus with involvement of the anterior wall (thick arrow). Bicoronal flap (white arrow), marking sinus area with Blue methylene (thin arrow)

Using a drill specialized for osteotomy, the sinus area is cut and the involved anterior wall of the sinus is removed.

The pathology within the sinus is then fully removed.

Table 1: Demographic specifications of the patients who underwent surgery using a pericranial flap

Patient	Age	Sex	History of sinus surgery	Pathology	Surgery	Follow up duration (year)	Early complications	late complications	Functional results	Cosmetic results
۱	۲۵	M	Yes	Frontoethmoid anaplastic carcinoma	Laterally based pericranial flap to repair the defects in the orbital roof as well as posterior and anterior walls of the frontal sinus	۳	-	D/C	-	Almost satisfactory
۲	۴۹	M	Yes	Maxillary sinus SCC	Laterally based pericranial flap to repair the defects in the orbital floor after hemimaxillectomy	۴	-	-	satisfactory	satisfactory
۳	۳۸	F	No	Mucoperiosteal frontal sinus	bilaterally based pericranial flap on posterior and anterior sinus walls	۷	-	Mild deformity	satisfactory	Almost satisfactory
۴	۲۳	M	Yes	Congenital teratoma of frontal sinus	bilaterally based pericranial flap on posterior and anterior sinus walls	۶	-	-	satisfactory	Almost satisfactory
۵	۲۴	M	No	Osteomyelitis of frontal sinus	bilaterally based pericranial flap on anterior sinus walls	۴	-	-	satisfactory	satisfactory
۶	۳۱	F	No	Osteoma frontal sinus	bilaterally based pericranial flap on the anterior sinus walls	1.5	-	-	satisfactory	satisfactory
۷	۱۶	M	No	Osteoma frontal sinus	bilaterally based pericranial flap on the anterior sinus walls	0.5	-	Mild deformity	satisfactory	satisfactory
۸	۶۱	M	No	Frontotemporal tumor	Posteriorly and inferiorly based temporoparietal pericranial flap	۶	-	-	satisfactory	satisfactory
۹	۱۰	M	No	Traumatic avulsion of the scalp	Posteriorly and inferiorly based occipitoparietal pericranial flap	۴	-	-	satisfactory	satisfactory
۱۰	۸	M	No	Microtia	Auriculoplasty	۵	-	-	satisfactory	satisfactory
۱۱	۱۲	F	No	Anotia	Auriculoplasty	۳	-	-	satisfactory	satisfactory
۱۲	۱۵	M	No	Microtia	Auriculoplasty	۴	-	-	satisfactory	satisfactory

Nasofrontal duct is blocked with a facial or muscular graft; sinus space is filled with abdominal fat graft. The released bipediced pericranial flap is continued downward up to the defective anterior wall of the sinus (Fig 2) and fixed to the upper edge of the nasal root's periosteum and also the orbital edge (Fig 3) and finally the forehead flap is returned in place. After fixing two Pen Rose drains on both sides of the incision, absorbent stitch is used for subcutaneous repair and non absorbent stitch for the skin repair. In order to prevent the occurrence of hematoma, a compressive dressing should be applied to protect the flap.

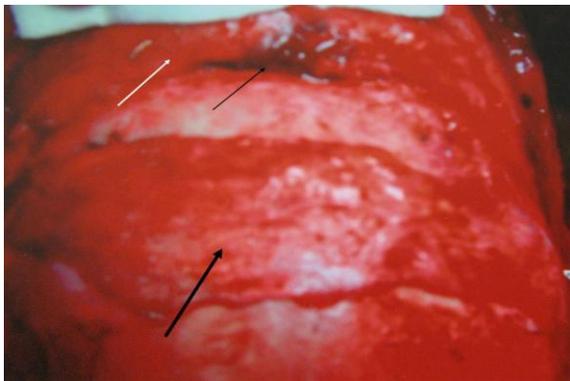


Fig 2: Bilaterally based pericranial flap (thick arrow) used to repair the defective anterior wall of the frontal sinus (thin arrow); bicronal flap (white arrow)

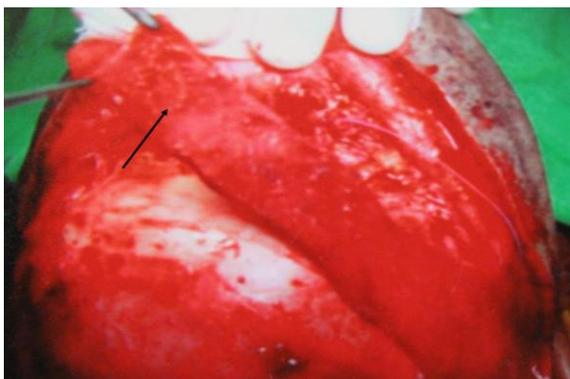


Fig 3: Unilaterally based pericranial flap (arrow) used to repair the defective posterior wall

A separate layer of a one-pedicled pericranial flap was used in order to repair the defective posterior wall of the sinus in two patients.

A separate layer of a laterally based pericranial flap was used to repair the defects in the posterior wall of the frontal sinus and also the orbital roof in a patient with frontoethmoid anaplastic carcinoma (Fig 5). The sinus space was then filled with fat graft and it was also covered by another layer of bipediced pericranial flap. And the cosmetic result of this surgery shown in Fig 4.



Fig 4: A patient with frontal sinus osteoma, one and a half year after surgery.

A laterally based pericranial flap was used to repair the defective orbital floor and also to preserve the orbital contents in a patient with maxillary sinus SCC tumor whom underwent hemimaxillectomy.

In order to use a unilaterally based pericranial flap, it is possible to use mid forehead incision rather than a bicronal incision to access the galea and to pull the flap through a subcutaneous tunnel in to the orbital area (Fig 5).



Fig 5: Unilaterally based pericranial flap (thin arrow) used to repair the defective left orbital floor caused by removing the maxillary sinus tumor (thick arrow)

A posteriorly and inferiorly based pericranial flap elevated from the parietal region was used to repair full thickness scalp defect in 2 patients with a temporal defect (one due to frontotemporal tumor removal and the other due to traumatic avulsion). A skin graft with split thickness was then applied to cover the mentioned flap (Fig 6,7).



Fig 6: Posteriorly and inferiorly based pericranial flap used to repair an oncologic defect in the temporoparietal region



Fig 7: Posteriorly and inferiorly based pericranial flap used to repair a traumatic defect in the occipitoparietal region

A one-pedicled pericranial flap was used to cover Medpor prosthesis in 3 children with congenital ear deformity (microtia or anotia) (Fig 8).

Prophylactic antibiotic therapy was usually given intravenously to all patients 24-48 hours before and after the surgery. It was also administered for a longer duration in patients with an infectious sinus

(mucoperiosteal, osteomyelitis). In addition to Prophylactic antibiotics, oral antiobiotic was prescribed for 7-10 days. Pen Rose drains were removed 2-3 days after the surgery and patients were usually discharged 3 to 4 days later.



Fig 8: One pedicled pericranial flap for Medpore prosthesis 3 years after surgery

Results

Pericranial flap was used for 12 patients from 2000 to 2009. The patients' demographic specifications have been shown in table 1. Our cases were 9 males and 3 females, 8-61 years old with the mean age of 26 yrs. Surgical indications included frontoethmoid anaplastic carcinoma, SCC tumor of the Maxillary sinus, mucoperiosteal frontal sinus, congenital teratoma of the frontal sinus, osteomyelitis of the frontal sinus, frontal sinus osteoma (2 cases), scalp defect due to frontotemporal tumor, traumatic avulsion of scalp in the occipitoparietal region and congenital ear deformity (microtia or anotia).

Biopsy was performed on only 3 patients (endoscopic biopsy for frontoethmoid anaplastic carcinoma and congenital teratoma of the frontal sinus - direct nasal biopsy for SCC tumor of the Maxillary sinus). No history of open surgery or sinus endoscopy was reported in other patients. The average follow up period lasted about 4 years (6 months to 7 years). No significant and early postoperative complication was observed in these

patients. Transient and short lived headaches in the frontal region disappeared after a few days through conservative therapy.

The mean hospitalization duration was 3 to 4 days. No infectious recurrence (Sinusitis, osteomyelitis and mucoperiosteal) or significant and prolonged complication (except mild deformity in the anterior frontal sinus in 3 cases) was reported.

The patient with frontoethmoid anaplastic carcinoma did not show any problem related to the repaired sinus during the three-year follow up period; but unfortunately a few years after the last doctor's visit, he died due to the lesion recurrence and intracranial tumor development. Pericranial flap was used to repair a temporal defect in 2 patients as well as auriculoplasty in 3 patients where no significant complication was observed. Meanwhile, these patients were satisfied with the cosmetic results as well.

Discussion

Due to the lack of scalp flexibility, it is impossible to repair its large defects primarily. So alternative methods should be applied, particularly when there is a full thickness scalp defect and the underlying bone is bare. Skin grafts with full or relative thickness are used to repair scalp defects. A high probability of failure exists while putting these skin grafts directly on the bare bones without any blood supply. In order to provide a vascularized bed for the skin graft, we have successfully used the superficial temporal artery or occipitoparietal artery based pericranial flap.

Halpern and his colleagues (22) applied full thickness skin grafts to repair full thickness scalp defects and they obtained good results (23); whereas Hussain and his colleagues have shown that the metabolic needs of a full thickness graft are more than the metabolic needs of a relative

thickness graft (23). They have used relative thickness grafts and obtained good results. To repair full thickness scalp defects, we also have successfully used skin grafts with relative thickness on laterally based pericranial flaps (Fig 6,7).

Pericranial flap is a vascularized flap based on supraorbital, supratrochlear or superficial temporal arteries. Due to the rich blood supply of pericranial flaps, they can be designed as different types: unilateral, bilateral, laterally based or anteriorly based pericranial flaps.

The design and separation of pericranial flaps are easy. It is available at the surgical site and no additional surgical site or incision is required. While reparing the defects of the anterior part of skull base, pericranial flaps have been used commonly to separate intracranial spaces from extracranial ones (10, 14, 24). Considering the pericranial flap's rich blood supply, it can be safely used on every infected site and can provide a suitable bed for repairing the defects.

Various methods have been used to repair head and neck deformities resulting from congenital, traumatic and neoplastic conditions. Poor wound healing (such as radionecrosis or insufficient blood supply) or weaknesses of the current repairing methods have caused some problems in repairing surgery. These problems may be solved by pericranial flaps. Early experiences on the use of pericranial flaps in the repair of congenital ear deformities have proved the effectiveness of this type of flap. The made incisions yield a very good cosmetic outcome and they are well hidden in the hair or in the line of hair growth. This local flap rotates well. Regarding good flexibility and mobility, local flaps may be successfully used to repair local defects or to cover alloplastic and autogenic materials.

Considering the rich blood supply of pericranial flaps, they can directly feed the

skin or mucosal grafts without any reliance on the impaired blood supply in the graft donor site. We have employed pericranial flaps to repair skin defects and also the skull bone's defective periosteum in occipitoparietal and temporal regions. This method yields optimal functional and cosmetic results. In spite of the large defective site, lower based pericranial flaps have fed and supported skin grafts on the bared bone. The required blood supply for the mentioned flap has been provided by occipitoparietal and superficial temporal arteries. The defective site having been repaired successfully, no complication has been reported.

Sinus malignant lesions particularly frontoethmoid ones are rare (25). These lesions appear at late stages and immediately develop into the surrounding vital structures. Their common therapeutic method includes radical surgery and then radiotherapy (26). Formation of nasocutaneous fistula in the upper nasal cavity and medial orbit is one of the known side effects of this applied therapeutic method. Meanwhile, rupture of the skin flap occurred as a result of fistula formation. It is resistant to treatment and also it is difficult to control the discharges (27). According to several studies, separation of the defective site from the intranasal space through creation of a safe barrier and using pericranial flap has been considered as one of the preventive methods for this complication (13,28,29).

We have employed pericranial flaps to repair defects of the orbital roof as well as the frontal and ethmoidal sinus walls in patients with Frontoethmoid anaplastic carcinoma. Using this flap, we have successfully separated orbital and brain spaces from external and intranasal ones. Applying a pericranial flap, we have also separated the orbital space from nasal space in a patient with maxillary sinus SCC.

In the study conducted by Michel et al, the effect of frontal sinus obliteration was evaluated on cats. According to their study, full removal of sinus mucosa, complete closure of the nasofrontal recess and also complete frontal sinus obliteration have been regarded as main factors in successful obliteration, rather than just using a material to fill in the sinus (30). Kennedy et al also believe that the above mentioned factors especially full removal of sinus mucus, are the most important factors in successful frontal sinus obliteration in the long term (4).

Autogenic fat grafts have been vastly employed in frontal sinus obliteration. They can even be named as the most common grafts applied up to now. In spite of the common and successful usage of autogenic fat grafts, some of the following side effects have been reported:

Fat absorption over time, likely mucosal formation, fat infection in the infected sinus, need to secondary surgical site, associated morbidities and increased operation time (3).

According to the study performed by Weber and his colleagues on 86 patients using fat grafts, a 9.8% rate of mucosal formation and considerable fat absorption over time was reported (3). Meanwhile, 2 of the 12 cases under study by Moshaver et al have shown infection of the fat graft. Reoperation has been suggested for them (31).

We used a rich blood supplied pericranial flap adjacent to the fat graft instead of an osteoplastic flap or exogenic prosthesis and a significant decrease in the risk of complications was the outcome. No recurrent lesion or significant complication was observed in our patients.

Due to the easy access to exogenic implants, lack of morbidities in the graft donor site and also low probability of rejection; the use of exogenic implants such as hydroxyapatite, cement have become common. Since these materials

cannot be vascularized, applying them to the infected sinus will cause a high probability of infection. Furthermore, these materials are so hard and firm that reoperation may cause some problems (1, 32).

No need for reoperation due to the frontal sinus obliteration using a pericranial flap has been reported in our study and other similar studies. In case of any need to do reoperation in patients whom a percranial flap has been used for, you can easily access the surgical site; in such situations hydroxyapatite cement makes it difficult to access the surgical site though.

Achieving a desired size of a pericranial flap to repair or fill the defect is another advantage of these flaps.

Since some of our patients suffered from disorder in the periosteum of the anterior wall of the frontal sinus, fat graft was employed to fill the defective frontal sinus. In order to prevent infection and other related complications, the fat graft was also covered by a pericranial flap.

In order to provide a cover with suitable blood supply to prevent complications such as infection, ruptured wound and prosthesis rejection, a pericranial flap was used in auriculoplasty to cover the Medpor prosthesis. Just like other previous studies (33, 34), three cases revealed good results without any complication.

No significant complication was observed due to the use of pericranial flaps for frontal sinus obliteration in 5 cases undergoing this study. Almost all patients were completely satisfied with the results. There is no report about recurrence of the

disease, need for reoperation, postoperative infection and significant absorption or deformity of the sinus over time.

The mean of the follow-up period in our study was 4 years. Longer follow-up periods such as about 10-20 years are required to fully make sure that long term complications including recurrence of the disease, fat absorption or mucosal formation do not occur.

Conclusion

According to our experience, the use of a pericranial flap is a simple, quick, cost-effective and safe method for repair of local defects in the head and face region, including traumatic and neoplastic scalp and skull defects and also congenital ear defects. This graft is also effective in frontal sinus obliteration with simultaneous use of fat grafts. In comparison to just applying a fat graft, this kind of frontal sinus obliteration results in less morbidities and complications. The vascularized nature of pericranial flaps has made them possible to be used safely in tumoral and infected sites without causing any complications.

More prolonged follow-up periods are needed in on this basis. No significant complication regarding the use of a pericranial flap has been observed up to now; therefore, it can be considered as an ideal alternative to repair the local head and neck defects and also frontal sinus obliterations.

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