Burdenko's Journal of Neurosurgery
2026, No. 4, pp. 44–49
https://doi.org/10.17116/neiro20269003130

Fat grafting for frontotemporal contour restoration after neurosurgery

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ABSTRACT

Background. Currently, aesthetic assessment becomes important after head and neck surgeries. Anterolateral approaches are common in neurosurgery, and frontotemporal contour deformities with asymmetry are the most common aesthetic defects. In 68% of cases, such sequelae can lead to severe psycho-emotional disorders. Autologous fat grafting (lipofilling) is a minimally invasive method with low risk of complications and stable long-term results. It is widely used in plastic reconstructive surgery but not routine after neurosurgical interventions.

Material and methods. We present 4 cases of autologous fat grafting in patients with frontotemporal deformities after previous craniotomies. A 5-point Likert scale was used for subjective assessment of aesthetic outcomes after lipofilling.

Results. «Complete satisfaction» with results was achieved in three patients; one patient rated the result as «satisfactory». No postoperative complications were registered. Mean volume of injected autologous fat tissue per a procedure was 23.5 ml. The second procedure of lipofilling was required for two patients to achieve satisfactory results.

Conclusion. These cases demonstrate feasibility of autologous fat grafting in patients with frontotemporal deformities after previous craniotomies. This method can be used as one of the options for minimally invasive soft tissue augmentation in temporal region considering graft survival, acceptable aesthetic outcomes and low risk of complications. When planning treatment, it is necessary to account for natural resorption of autologous fat tissue that often necessitates multiple lipofilling procedures.

Keywords: *temporal deformity, lipofilling, cosmetic outcomes, technique overview.*

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TO CITE THIS ARTICLE:
Lukyanchikov VA, Gorozhanin VA, Orlova EV, Kirilenko IA. Fat grafting for frontotemporal contour restoration after neurosurgery. *Burdenko's Journal of Neurosergery*. 2026;90(4):44–49. (In Russ.). https://doi.org/10.17116/neiro20269004144

Introduction

Modern neurosurgery is characterized by implementation of continuous multidisciplinary approach and comprehensive treatment at all stages. An important component of this approach is not only treatment of cerebral pathology and prevention of neurological dysfunction, but also correction of aesthetic defects after craniotomy. This contributes to accelerated social rehabilitation and better quality of life [1]. Aesthetic deformities can cause severe psychoemotional stress and social maladjustment. Sixty-eight percent of patients demonstrate signs of avoidant and compulsive behavior aimed at concealing (camouflaging) scars and postoperative soft tissue deformities of the head or their difficult perception [2].

Frontotemporal region, soft tissues of the upper third of the face and temporal muscle are most often involved in surgical approaches for cerebral diseases in adults. For example, pterional and supraorbital approaches are used for vascular lesions in view of predominant anterior aneurysms (85—95%). All decompressive craniotomies are accompanied by extensive mobilization of the temporal muscle and extended temporal bone resection towards skull base [3]. This leads to malnutrition and atrophy, soft tissue scarring and visually noticeable local deformities. Therefore, such approaches can create a problem for aesthetic rehabilitation even in patients with favorable neurological outcomes [4]. Autologous fat tissue (lipofilling) for correction of soft tissue deformities is currently one of the leading methods in facial reconstructive surgery [5]. Autologous nature, availability and low risks of fat tissue rejection allow for natural and long-term results. Moreover, potential regenerative properties make this method highly valuable and often preferable for correction of complex aesthetic defects of soft tissues [6]. However, unpredictability and relatively high degree of resorption are disadvantages of this method, and many authors remain skeptical of its effectiveness [7].

Table 1. **Characteristics of groups.**

Sex/age, years	Previous neurosurgery	Likert score after the 1st procedure	Likert score after the 2nd procedure	Number of lipofilling procedures to achieve satisfactory result	Volume of fat tissue transplant, ml
M/37	Skull defect closure	5	5	2 (repeated procedure after 5 months)	25+20
M/36	Pterional craniotomy; aneurysm clipping	5	5	2 (repeated procedure after 1.5 months)	22+18
F/39	Skull defect closure	5	–	1	30
M/19	Skull defect closure	4	–	1	26

Table 2. **Likert scale.**

Score	Satisfaction	Description
5	Extremely satisfied	Excellent natural contour, result fully meets expectations
4	Satisfied	Good improvement, result is generally in line with expectations
3	Neutral	Moderate improvement, result only partially meets expectations
2	Dissatisfied	Minimal improvement, results do not meet expectations
1	Extremely dissatisfied	No improvement or deterioration of aesthetic result

Material and methods

We present 4 cases of autologous fat transplantation in patients with frontotemporal deformities following previous craniotomy **(Table 1)**. Patients were followed-up in early postoperative period (after 7 days) and 1 month after surgery. We evaluated aesthetic results of lipofilling in 1 and 6 months after each procedure using standard photographic protocol and assessed patient satisfaction with appearance using a 5-point Likert scale **(Table 2)**. Evaluation criteria included restoration of natural contour, symmetry, actual aesthetic effect and overall psychological comfort.

Lipofilling technique

We used basic technique presented by Coleman S.R. (structural lipofilling) for free autologous fat grafting with some modifications [8]. Autologous fat graft was harvested from the inner thigh. Before the procedure, we performed tumescent anesthesia of appropriate area using a blunt cannula with six 4-mm side holes, 0.5% lidocaine and 1:200.000 adrenaline solution (0.000005 g/ml). After 2-minute exposure, we harvested autologous graft using a blunt 4 mm cannula connected to a 10 ml syringe under minimal negative pressure. Autologous fat is passively rinsed with saline until the fluid runs clear, then allowed to settle. The middle layer (fat tissue) is transferred to a 1 ml syringe connected to a blunt 18-gauge cannula with one hole. Preoperative planning is necessary. In addition to visual assessment of soft tissue defect, palpation is necessary to create a tissue «map» (boundaries and density of scar tissue, areas with preserved elasticity). Markings clearly delineating zones of different rigidity and deformity boundaries are applied to the skin. First, a blunt cannula is used to disrupt scars and create tunnels for autologous fat **(Fig. 1)**. Fat graft is injected into recipient area (tunnels) slowly (no faster than 0.5 ml/sec) in a fan-shaped pattern in deep subcutaneous layer above the aponeurosis **(Fig. 2)**. Surgeon must constantly feel tissue resistance. Upon reaching dense scar, force on syringe plunger increases, and volume of fat injected per pass decreases to literally a drop. The purpose is not to tear the tissue, but to push apart scar fibers and creates the pockets for the graft. In more elastic areas, graft volume may be slightly greater, but remain small. This ensures uniform distribution despite tissue heterogeneity. Injection is stopped when mild slight visual overcorrection is achieved or significant resistance appears. The last one indicates that available volume is completely filled.

Unlike original method by Coleman S.R., our technique implied another size of cannula for fat harvesting (4 mm), no saline in donor area and no centrifugation to reduce the impact of aggressive factors on autologous fat graft.

Postoperative compression dressings should be with minimal compression, so as not to compress weak microcirculation. It is crucial to inform the patient in advance that fat engraftment is significantly reduced under these conditions, and optimal results will likely require 2–3 sessions spaced 4–6 months apart. Final evaluation of results is performed no earlier than 6 months after the last procedure.

Case #1

A 37-year-old man presented 12 months after cranioplasty with titanium plate due to previous decompressive craniotomy for severe traumatic brain injury. Primary cranioplasty was complicated by hematoma that required plate removal. The second cranioplasty was performed 7 months later. Thus, the patient underwent four procedures involv-



Fig. 1. **Patient with frontotemporal deformity after craniotomy.**
a — soft tissue depression and temporalis muscle atrophy; b — intraoperative markings: 1 — cannula entry point, 2 — cannula path lines, 3 — depression area.



Fig. 2. **Patient with frontotemporal deformity after cranioplasty with titanium plate.**
a — soft tissue depression, temporalis muscle atrophy and dislocation; b —retrograde autologous fat graft injection.

ing the right frontotemporal region. The main complaint at presentation was soft tissue depression and asymmetry in the right temporal region **(Fig. 3)**. Examination and palpation revealed soft tissue atrophy in this area due to severe scarring and adhesions. The temporalis muscle was displaced downward but its function was normal.

The patient underwent lipofilling of the right frontotemporal region in two stages with a 5-month interval. At the first procedure, 25 ml of graft were injected with subsequent approximately 50% resorption. This required the second stage of correction. The second procedure implied injection of 20 ml. Postoperative period was unevent-



Fig. 3. **Patient with right-sided frontotemporal deformity after cranioplasty with titanium plate.**
a, b — soft tissue depression, atrophy and dislocation of the temporalis muscle; c, d — image in 6 months after the first procedure.

ful. No additional physical therapy was used for rehabilitation. The patient was completely satisfied with treatment outcome (Likert score 5).

Case #2

A 36-year-old man presented 39 months after craniotomy for the right internal carotid artery aneurysm clipping. Upon admission, the patient complained of soft tissue depression and asymmetry in the right temporal region **(Fig. 4)**. Examination and palpation revealed elastic soft tissues and local areas of rigidity due to cicatricial adhesions. Temporal muscle was displaced downwards but its function was normal.

Following the first lipofilling procedure (22 ml), partial fat graft migration towards inferior margin of temporal fossa was noted. According to the literature, it is a relatively common consequence [9]. Therefore, correction was performed 1.5 months later with liposuction of displaced graft and lipofilling of tissue depression (18 ml). Postoperative period was uneventful. No additional physical therapy was used for rehabilitation. The patient was completely satisfied with treatment outcome (Likert score 5).

Results

Visible soft tissue deficits were eliminated, and contours significantly improved in all patients. There was high patient satisfaction. Three patients were completely satisfied (Likert score 5). One patient reported 4 scores (satisfied), i.e. significant improvement compared to baseline status with minor aesthetic defects. Most patients experienced moderate swelling at the fat harvesting and injection site in early postoperative period (throughout 14 days). Edema regressed without therapy. There were no complications. Mean volume of autologous fat injected per a procedure was ±23.5 ml. Two patients required redo lipofilling to achieve satisfactory results.

Discussion

Lipofilling is effective for correcting contour deformities in reconstructive and aesthetic plastic surgery. However, its success and predictable outcomes are largely determined by surgical technique. According to literature data, aggressive adipose tissue harvesting under high pressure, bolus injection into a small area and multiple tissue trauma within one pocket are associated with higher resorption, unsatisfactory aesthetic results and necessary redo interventions [10, 11].

Hyaluronic acid-based fillers are used as an alternative augmentation technique due to immediate effect and no need for graft harvesting. However, fillers are associated with the risk of vascular complications, unstable results requiring repeated injections and high overall costs in long-term follow-up [12]. There are also limitations regarding volume of augmented defects. More pronounced palpable skin irregularities are possible due to higher viscosity and features of distribution [13]. In this context, lipofilling with autologous biocompatible material provides more stable results and appears to be preferable strategy for reconstruction [9].

Importantly, technique of temporal lipofilling after neurosurgical interventions differs from aesthetic correction of age-related changes. The key difference lies in disrupted anatomy of layered soft tissue structure in this category of patients. Extensive scarring leads to dense fibrous adhe-



Fig. 4. **Patient with right-sided frontotemporal deformity after craniotomy.**
a, b — soft tissue depression, atrophy and dislocation of temporal muscle; c, d —5 months after primary procedure.

sions between skin, subcutaneous fat, temporal aponeurosis, muscle, and often dura mater in projection of burr holes and bone defects [14]. An additional aggravating factor is iatrogenic damage to superficial temporal artery following posteriorly displaced coronal approach. This naturally decreases recipient site vascularization and potential graft engraftment.

Combination of these factors impacts graft engraftment and surgical technique. Tunnels in rigid scar tissue have minimal distraction capacity that significantly limits the volume of fat injected at one time and makes hypercorrection technique difficult or impossible. Potentially reduced vascularization and anatomical limitations of recipient site increase the likelihood of resorption and, consequently, the need for repeat procedures for optimal results compared to correction of aesthetic disorders. Therefore, technique requires significant adaptation. Injection procedure should be extremely careful near bone defects (in superficial layers of scars above the aponeurosis). One should use only blunt cannulas to minimize the risk of iatrogenic perforation of dura mater. High risks of intraoperative damage to dura mater, facial nerve and superficial temporal artery necessitate these procedures in specialized neurosurgical facilities.

Conclusion

Our data demonstrate the feasibility of autologous fat transplantation in patients with frontotemporal deformities following previous craniotomies. Acceptable aesthetic results, no complications and delayed graft survival make this method one of the options for minimally invasive temporal soft tissue augmentation. To achieve optimal results, one should consider natural resorption of autologous fat tissue. This often necessitates multiple procedures. In view of these characteristics, lipofilling is appropriate for correction of moderate defects and minor soft tissue deficit.

Author contribution:
Concept and design of the study — Kirilenko I.A.
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No conflict of interests to declare.

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Received 14.01.2026
Accepted 07.05.2026

COMMENT

Frontotemporal (pterional) craniotomy is still a common surgical approach for various lesions of anterior and middle skull base. Surgical trauma of temporal muscle is an inevitable side effect of this approach. Accurate soft tissue dissection, small craniotomy and some surgical techniques reduce severity of temporal muscle atrophy. However, this approach is not always feasible. Therefore, cosmetic defects resulting from temporal soft tissue depression is a significant factor largely determining quality of life after successful surgery.

Lipofilling is an effective technique in plastic surgery and cosmetology. Injectable lipofilling is the gold standard, but its technology is variable and continues to improve. The authors' technique for fat grafting is not «classical» and has some distinctive features, but it is certainly viable. Whether it will provide significantly better cosmetic outcomes over a long-term follow-up remains to be seen.

Compared to conventional cosmetic correction of temporal contour, aesthetic tissue correction after previous interventions is characterized by possible temporal bone defects following neurosurgery, bone substitute implants of various configurations and materials in lipofilling area and impaired blood supply to frontotemporal skin due to previous surgical trauma. It is valuable that these features are described in the present study. It will be important to continue follow-up of patients regarding possible late complications.

Lipofilling described by the authors is a cosmetic procedure. However, specific features resulting from previous neurosurgeries often lead to refusal of aesthetic correction in clinics for plastic surgery and cosmetology. Acquisition of such competencies in major neurosurgical hospitals is a positive trend that will further improve the quality of life after neurosurgical interventions.

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