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ORIGINAL ARTICLE

Aesthetic issues in neurosurgery: a protocol to improve cosmetic outcome in cranial surgery

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Abstract Nowadays, surgical interventions must treat with care the aesthetic impact on the patient, even when a malignant pathology or an patient's advanced age could give the aesthetic issue lower priority. The cranio-facial area is probably the most important anatomical region with regard to the harmony of the human body. Consequently, a step-by-step procedure, applicable regardless of the site and the nature of the lesion, is advisable to minimize the aesthetic impact. We prospectively analyzed 65 patients during a period of 2 years. At 1-year follow-up, all patients were invited to undergo a 3D-multislice CT and to complete a questionnaire with a subjective rating scale about aesthetic impact. The 3D-multislice CT scan didn't show dislocations, depressions or gaps of the bone flap. Nevertheless, five patients complained of some degree of aesthetic injury, or reported a psychological suffering from the aesthetic consequences of surgery. As a control group, we retrospectively reviewed 223 patients. The authors describe their surgical protocol and discuss it in the light of the results of their series.

Keywords Neurosurgery · Aesthetic impact · Temporal muscle · Titanium plates · Neuronavigation

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Introduction

Nowadays, surgical interventions must treat with care the aesthetic impact on the patient. The cranio-facial area is probably the most important anatomical region with regard to the harmony of the human body. Modern neurosurgery must incorporate precautions and surgical techniques aimed at minimizing aesthetic consequences on patients [1–21]. Even if the aesthetic problem is felt more by young people, by women and by bald people, the adoption of a common protocol of treatment for all patients seems to be absolutely necessary. This way, neurosurgeons should become used to considering the aesthetic aspect as a must for all patients, even those with unfavourable pathologies.

A surgical protocol is consequently advisable to minimize the aesthetic impact with a step-by-step procedure which is feasible regardless of the site and the nature of the lesion.

We describe a series of precautions and tips concerning the following surgical steps: (1) skin and muscle incision, (2) periosteum dissection, (3) craniotomy and subsequent bone flap repositioning, and (4) closure. The objective is to perform those procedures which allow preservation of vascular structures (above all, the superficial temporal and the occipital arteries which are responsible for the vascularization of both cutaneous and muscular flaps), and reconstruction of the surgically approached structures without leaving dead spaces and bone gaps, and avoiding

muscular atrophy or paralysis which are responsible for both functional and psychosomatic damage to the patient.

The frontal branch of the facial nerve innervates the musculi frontalis and orbicularis oculi [5]. A traction of the temporal musculo-cutaneous flaps can produce damage to this nervous branch due to an excessive stretching in the orbito-zygomatic approach or in approaches such as those concerning the exposure of the temporal pole or the sub-temporal route. In those cases, we apply a variation of the interfascial approach described by Yasargil—the dissection technique drawn by Ammirati, Coscarella, Sekhar [1, 2, 5, 16, 20]. Both superficial and deep temporal fascias are incised and dissected fron the temporal muscle at the level of their anterior third. The muscle is then separately dissected from the bone and reversed downward. This technique avoids traction or direct damage to the frontal branch of the facial nerve, and it is of paramount importance to maintain unchanged the patient's aesthetics [1–3, 5, 7, 13, 14, 16].

Fig. 1 Skin incision can be performed following a thin binary among the hairs. In this case, we completely avoided any hair cut. Alternatively, the shaving of a thin line of hair is sufficent to perform the incision in a sterile way. Closure of cutaneous layer is made with reabsorbable materials. Even if, as in this case, we work very near to the hairline, the procedure is easily performed if the surgeon pays attention not to take any hair below the suture thread

Materials and methods

We prospectively followed patients during a period of 2 years (Group A). As control group (Group B), we retrospectively analyzed patients operated between 1985 and 1990, when, in our department, standardized techniques concerning the surgical procedures we describe in this paper were absent.

Patients who underwent an emergency craniotomy, who had a previous neurosurgical procedure or who had infiltrative bone disease have been excluded from the study. Only patients with a pre-operative Karnofsky Performance Scale (KPS) greater than 79 were considered suitable for enrollment.

Group A

Patients have been treated according to the following protocol, regardless of both pathology and site of the lesion:

- Opening
- Hair shaving was done according to the patient's request (reducing the shave to a thin line along the skin incision or, on the contrary, extending it to the whole scalp) (Fig. 1). Nevertheless, patients with a preoperative imaging showing malignant pathologies which needed adjuvant radiotherapy were informed about the risk of a post-actinic alopecia.
- After infiltration of the cutaneous flap with marcain 2% combined with epinephrin (1:200,000) (in the absence of anaesthesiological contraindications), skin incision was performed behind the hairline. In the case of contraindications to epinephrin, local anesthesia was always performed in order to help the dissection of the pericranium from the skull.
- Hemostatic forceps were used for the hemostasis of the subcutaneous tissue much more frequently than hemostatic Raney clips. The latter clips were used when the forceps could hamper the surgeon during the subsequent steps, or when infiltration with local anaesthetic could not be done. The use of bipolar coagulation was reduced to the minimum possible, to avoid problems such as hairloss or cutaneous necrosis. Monopolar coagulation was never used.
- In addition to the previous steps, the following procedures were applied in frontal, temporal, fronto-temporal, orbito-zygomatic approaches and their respective modifications and extensions:
- Preservation of the superficial temporal artery was obtained, dissecting it from the derm with blunt scissors during skin incision, coagulating its posterior collateral branch and mobilizing the artery forward. This procedure is easily performed if the incision of the skin begins a few centimeters superiorly from the artery, at the level of a horizontal plane passing through the superior edge of the auricula, and subsequently it is carried out with dissecting scissors. The superficial temporal artery can also be felt and subsequently drawn on the skin with a dermographic pencil. In cases where artery pulsation is difficult to feel or when it is mandatory to preserve the vessel (by-pass procedures, for example) it is possible to point out clearly the course of the artery with the aid of the neuronavigator probe (Fig. 2). Maximum intensity projection (MIP) was used

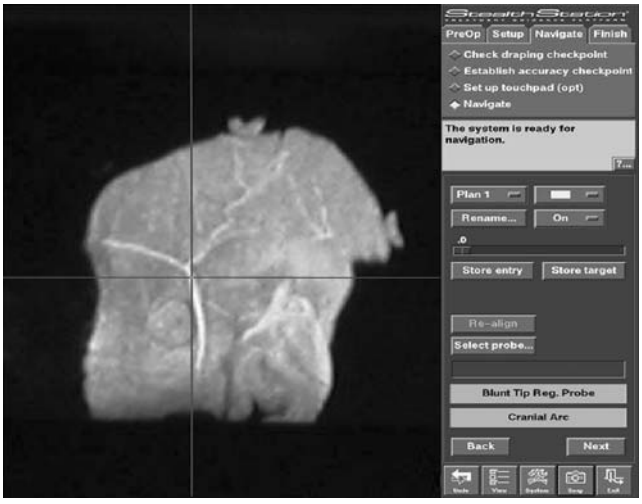

Fig. 2 Loading the maximum intensity projection sequence of MRI inside the neuronavigator, we can clearly see vascular structures of particular interest (the *grey cross* represents the neuronavigator probe pointing the superficial temporal artery)

in these cases because it clearly highlights vascular structures.

- The inferior limit of the skin incision ends about 1 cm before the tragus and on the upper edge of the zygomatic arch. The skin flap is cut away from the superficial fascia of the temporal muscle by means of a smooth or sharp dissection up to 2–3 cm posteriorly to the orbit, in order not to damage the facial nerve.
- Afterwards, as mentioned in the introduction, we use the subfascial dissection of the fascia temporalis [5]. According to this technique, an incision and dissection of both the superficial and deep temporal fascias from the temporal muscle at level of their anterior third is carried out, and the muscle is then separately dissected from the bone and reversed downward.
- Instead of using monopolar coagulation for the incision of the muscle or of its fascias, a 15 blade knife is used.
- Periosteum of temporal muscle is dissected from the temporal bone with the aid of a Penfield dissector.
- When there was the need to perform a transzygomatic approach, a pre-plating was done, and the masseter muscle was never disinserted by its origin on the bone. The zygomatic bone was then reversed downward together with the temporalis and masseter muscles.
- Craniotomy
- The number of holes on the skull is reduced to the minimum. Possibly, only one hole is drilled for frontal, fronto-temporal, occipital, posterior temporal and parietal craniotomies, compatibly with the site of pathology and the degree of adhesion of the dura mater to the bone flap. In the case of approaches to the posterior cranial fossa or to the midline (such as the interhemispheric transcallosal approach), the number of holes on the skull will depend essentially on the need to preserve important venous structures such as the superior longitudinal, the transverse and the sigmoid sinuses.
- The dimensions of craniotomy and of the cutaneous flap can be reduced through neuronavigation which allows us to perform procedures perfectly aimed at the lesion.
- Every time a hole is drilled, bone powder is accurately harvested and preserved.
- Once holes and part of the craniotomy have been performed, a plating is carried out before completing the procedure, in order to allow a perfect repositioning of the bone flap on closure. A small track is dug in the bone at the site of the plate lodging, in order to avoid the plates sticking out from the bone (according to the technique already reported by Di Lorenzo et al. [6]) (Fig. 3a). Very low profile miniplates are now available

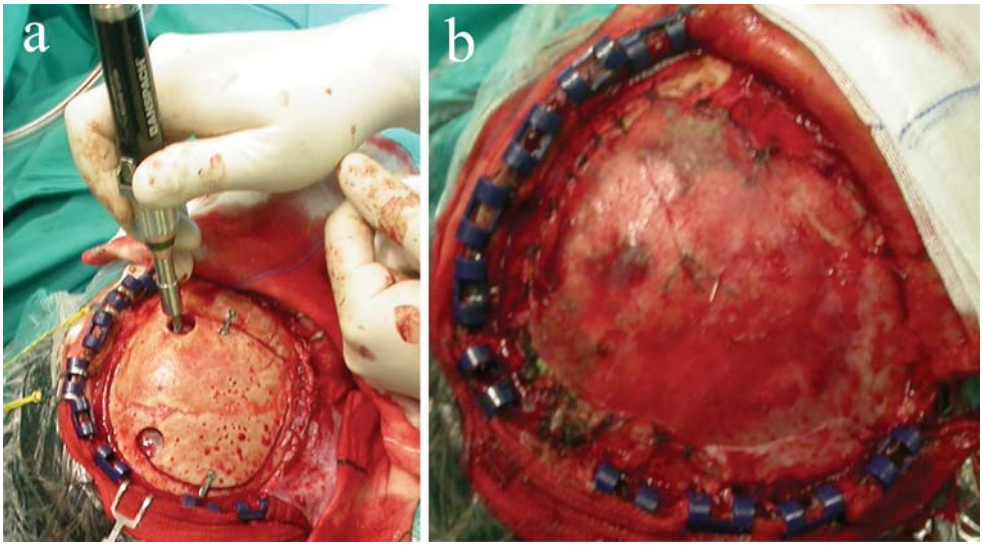

Fig. 3 **a** Once holes and part of the craniotomy have been performed, a plating is carried out before completing the procedure, in order to allow a perfect repositioning of the bone flap on closure. A small track is dug in the bone at the site of the plate lodging, in order to avoid the plates sticking out from the bone. **b** The pericranium is sutured in order to cover plates and screws, to help to keep the bone dust inside the gaps and to provide vascularization of the bone flap, hence helping osteosynthesis

on the market. They do not need to be embedded in the bone. We used in two cases 0.3 thick miniplates and screws for neurosurgery of the new titanium osteosynthesis system provided by Lorenz (Fig. 4a).

– When performing a pterional craniotomy, a thin oscillating saw can be used to drill the sphenoid ridge in order to make a cranioectomy as small as possible. Any incidental gap will be filled up on closure with bone cementum or with Spongostan and bone dust.

– Closure

– Once the bone has been repositioned according to the above-mentioned plating, the drill holes are filled with bone dust and covered by circular titanium or absorbable plates, in order to avoid a gap and depression of the scalp which clearly impair the aesthetic outcome. If the autologous bone powder is unavailable, bone cementum may be used to fill up bone gaps. We used in two cases Mimix bone replacement, a fully synthetic hydroxyapatite tetra-tri-calcium phosphate material (Fig. 4b).

– The pericranium is sutured in order to cover plates and screws, which also helps to keep the bone dust inside the gaps. Moreover, pericranium must be preserved because it provides a barrier between subcutaneous tissue and bone, and could revascularize the bone flap, hence helping osteosynthesis (Fig. 3b).

– If a paranasal sinus or the mastoid cells have been violated, pericranium, muscle, fascia or fat is used to exclude communications among extracranial and intracranial spaces, thus reducing the occurrence of infections to bone, soft tissues and nervous system.

– The temporal muscle and its fascia are sutured separately. The skin is sutured with reabsorbable 3-0 vicryl threads, as already reported by Missori et al. (Fig. 1).

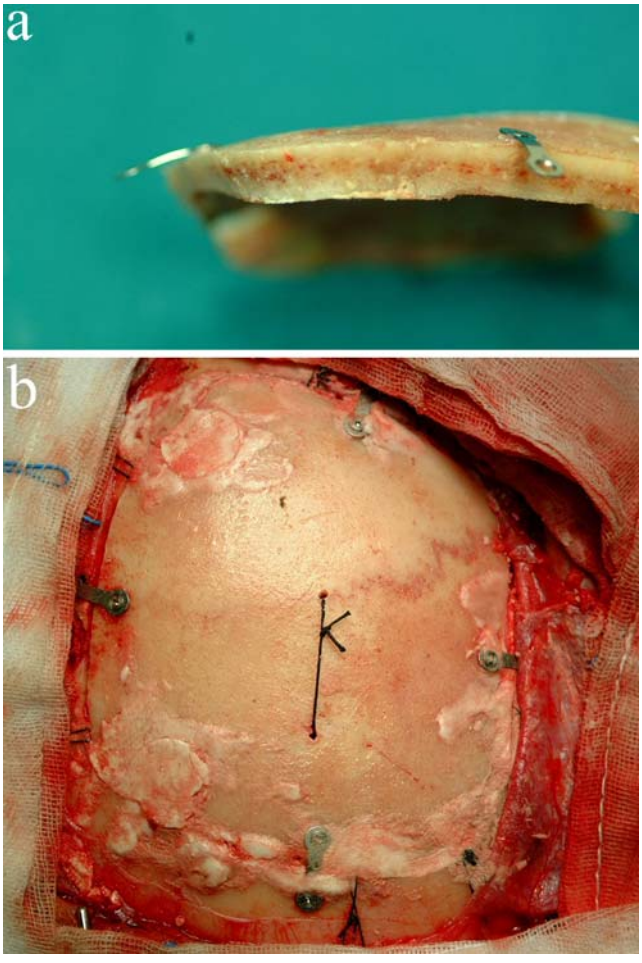

Fig. 4 **a** For the repositioning of the bone flap on closure, 0.3 thick miniplates and screws are now available on the market. They do not need to be embedded in the bone. The system depicted in the photo was provided by Lorenz. **b** The drill holes can be filled with bone dust and covered by circular titanium plates or, alternatively and with better results, bone cementum may be used to fill up bone gaps. The material showed in the photo is the Mimix bone replacement, a fully synthetic hydroxyapatite tetra-tri-calcium phosphate material

A 3D-multislice CT scan was performed at 1-year and 2-year follow-up to evaluate the outcome of craniotomy, the trophism of the temporal muscle, and the patency of the superficial temporal and/or occipital arteries (Fig. 5). Patients werr checked every 6 months for 2 years after surgery to evaluate their clinical outcome. All patients have been invited to complete a questionnaire 18 months after surgery with a subjective rating scale about aesthetic impact. Judgement parameters were the following: nil (0), mild (1), medium (2), high (3), severe (4) aesthetic impact.

(0) Nil: No aesthetic changes in comparison with preoperative situation.

(1) Mild: patient notices small changes, but none of these is experienced as an aesthetic problem (no requirement to change patient's hairstyle, absence of visible scar).

(2) Medium: patient notices a degree of discomfort as to the scar or to the hairstyle. Patient feels a certain swelling of subcutaneous and muscular tissues. On the whole he/she feels different, and isn't completely satisfied from the cosmetic aspect.

(3) High: patient refers to a significant degree of dissatisfaction about his/her aesthetic aspect. Depressions on the skin, visible or hairless scars, asymmetry between the two sides of the head. Alopecia.

(4) Severe: aesthetic aspect heavily disfigured by the surgery. Facial deficit. Significant temporal muscle atrophy. Visible burr holes, depressions of skin and bone gaps. Major alopecia. Scar on forehead or on face.

The psychological impact was evaluated with a questionnaire of 50 questions about personal and social changes in the life of the patient in the immediate post-operative period and in the following months. A score was attributed

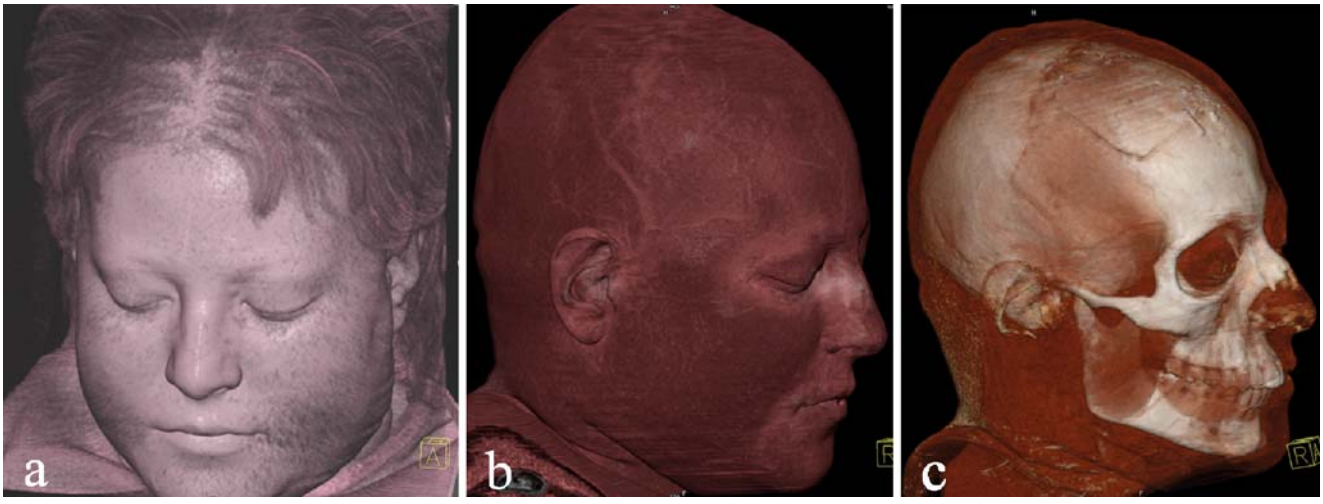

Fig. 5 Postoperative 3D-CT scan at 1-year follow-up of three patients, showing the correct consolidation of bone flap (**c**) and the absence of depressions and reliefs of the surrounding tissues (**a**, **b**). On reconstruction of the derm, the scar on the head is recognizable only for the thin track produced by the scalpel during incision (**a**). Also note the temporal muscle trophism and the perviety of the superficial temporal artery are preserved (**b**)

to every question. The assignment to class 0–4 was settled by the sum of the points.

Group B

Only patients who agreed to be interviewed by direct clinical evaluation, by telephone or by email have been included in the control. We also chose patients who were operated under elective surgery, and tried to create a group with similar male/female ratio, age and KPS in comparision with Group A. Patients were evaluated at a follow-up that ranged between 15 and 20 years. They have all been invited to complete the same questionnaires as the first group of patients. We also asked them how much time passed before the scarring processes stabilized.

The Chi square test was used to compare the two groups.

Results

Group A

Sixty-five patients with a 1-year follow-up 3D-multislice-CT scan have joined the study. Thirty patients were males; 35 patients were females (53.9%), of whom 14 (40%) were under 40 years old.

Nine patients (eight men and one woman) (13.9%) presented at our observation with a level of baldness that didn't permit them to entirely cover the scar with hair.

Thirty-one patients (22 of whom were female) (47.7%) out of 65 asked not to be completely shaved.

With the exception of six cases, neuronavigator was used for all patients.

Post-operative complications were present in five patients (7.7%). In one case, there was a triventricular hydrocephalus due to cerebral edema and subsequent compression of the IV ventricle: it was successfully treated with an external ventricular shunt. In another case, an ischemia referrable to vasospasm induced a hemiparesis and an aphasia recovered 3 months after the intervention. One case concerned a patient who underwent a VIII cranial nerve schwannoma excision, and presented a transient deficit of the VII cranial nerve which recovered almost fully within 6 months. One case of postoperative hygroma with moderate symptomatology was treated with cortico-steroids. The fifth case had a hemiparesis and underwent a second operation for the evacuation of a hematoma in the surgical cavity: 6 months after the intervention he had an improvement of the hemiparesis. Only the last two patients didn't complete the two questionnaires, while the other three responded to only one questionnaire.

The 60 remaining patients didn't experience significant complications, and were all subjected to the questions.

The main characteristics of the treated cases are showed in Table 1.

The results of the questions are summarized in Table 2.

None of the treated patients presented relevant aesthetic deficits (gap or depression of cutaneous flap, muscolar atrophy, infections, complication of surgical scar, VIIth cranial nerve paresis) at 6-month follow-up .

Neither 1- nor 2-year 3D-multislice-CT follow-up scans showed dislocations, depressions or gaps of bone flap. Titanium plates and screws were used in 51 cases (78.5%), while reabsorbable plates were applied in 14 patients. We saw no case of granuloma, or any other kind of infection or inflammatory reactions.

Table 1 In the following table, sex and age of the patients in the series have been summarized

Age	Female	Male	Total
15–20	2	1	3
21–30	5	3*[1]	8
31–40	7	6*[1]	13
41–50	10	5*[2]	15
51–60	6	7*[2]	13
61–70	3*[1]	6*[2]	9
>71	2	2	4
Total	35	30	65

*[n] Number of patients affected preoperatively by various degree of baldness.

Table 3 In the following table, sex and age of the patients retrospectively analyzed are summarized

Age	Female	Male	Total
15–20	6	4	10
21–30	23	21*[4]	44
31–40	35	26*[5]	61
41–50	22	12*[9]	34
51–60	18*[2]	24*[13]	42
61–70	9*[2]	17*[7]	26
>71	4*[1]	2*[2]	6
Total	117	106	223

*[n] Number of patients affected preoperatively by various degree of baldness.

The subjective feeling of depressions or small protrusions of the bone flap was referred to by two patients. One patient complained about an aggravation of baldness; no-one referred to a "de novo" onset of baldness. Two patients were dissatisfied with the visible scar on the head.

Eighteen patients underwent whole brain radiotherapy (WBRT). This type of treatment started at least 4 weeks after surgical intervention. Complications referrable to cutaneous flap, such as necrosis and infections, were absent.

Group B

Two hundred and twenty three patients were clinically reviewed. Of these, 106 were males and 117 were females (52.4%); of the latter, 64 (54.7%) were under 40 years old at the time of surgery.

The main characteristics of the treated cases are shown in Table 3. The results of the questions are summarized in Table 4.

As expected, intervention descriptions were very variable with regard to opening and closure. Across all the cases, so many different devices were used that an attempt to group patients according to homogeneous procedures has been fruitless. In 32% of cases, the craniotomy plate has been fixed with steel wires.

Two hundred and four patients felt (on sight or with touch) changes of skin and of the tissues below for the first 8–10 months after the intervention. After this period, the majority of the patients do not refer to any relevant change in aesthetic appearance. Nineteen patients referred to subjective perception of the scarring processes continuing until the 18th month after intervention.

Chi square statistical analysis suggested a significant difference beetween the groups for both the aesthetical (χ^2=58.8, p<0.01) and psychological aspect of the surgery (χ^2=111.9, p<0.01).

Discussion

Aesthetic impact of surgery is an increasingly important topic for both patient and neurosurgeon, even in those cases in which a malignant pathology or an advanced age could give the aesthetic issue lower priority. So, in our department we felt the need to adopt a surgical protocol, in which we summarize the decennial experience and skills of our "senior" surgeons, as well as those of other authors, in order to create standard techniques for younger surgeons [3, 4, 6–9, 12–15, 17, 19–21].

A surgeon can potentially inflict some important aesthetic damage during surgery: visible cutaneous scars, alopecia, temporal muscle atrophy with facial asymmetry and depressions or loss of soft tissue, roughness of skin above the craniotomy line (from the drill holes, or from an incorrect positioning of the bone flap), facial nerve deficit, presence of subcutaneous reliefs due to the screws and plates below [3, 7, 13, 20]. Aesthetic damage may also depend on complications of surgery such as skin and bone

Table 2 At 2-year follow-up, all patients were invited to complete two questionnaires with a subjective rating scale: one about aesthetic impact and the other about psychological impact

	Severe	High	Medium	Mild	Nil	Total
Aesthetic impact	0	2*[2] 3.2%	5*[1] 7.9%	13*[6] 20.6%	43 68.3%	63
Psychological impact	1*[1] 1.6%	1*[1] 1.6%	3*[3] 5%	8*[4] 13.3%	47 78.3%	60

*[n] Number of patients affected preoperatively by various degree of baldness.
Judgement parameters were the following: nil (0), mild impact (1), medium impact (2), high impact (3), severe impact (4).

Table 4 At a follow-up that ranged from 15 to 20 years, all patients were invited to complete two questionnaires with a subjective rating scale: one about aesthetic impact and the other about psychological impact

	Severe	High	Medium	Mild	Nil	Total
Aesthetic impact	5*[3] 2.2%	16*[16] 7.2%	96*[25] 43%	62*[1] 27.8%	44 19.7%	223
Psychological impact	17*[15] 7.6%	32*[21] 14.3%	90*[6] 40.4%	58*[3] 26%	26 11.7%	223

*[n] Number of patients affected preoperatively by various degree of baldness.
Judgement parameters were the following: nil (0), mild impact (1), medium impact (2), high impact (3), and severe impact (4).

infections, granulomas, inflammatory reactions which can occur regardless of the adoption of an aesthetic protocol in cranial surgery.

The neuronavigator allows us to perform a skin incision and a bone flap accurately aimed at the lesion, and permits the identification of the exact course of the superficial temporal artery (Fig. 2). This is possible if the MRI sequence loaded into the navigator workstation is the T1-plus gadolinium-MIP (maximum intensity projection).

An infiltration of local anaesthetic combined with epinephrine 1:200,000 should come before the cutaneous incision, permitting the surgeon to minimize the use of bipolar coagulation and to dissect more easily both the periosteum and the galea away from the skull. Hemostatic forceps are less traumatic for the skin than Raney clips. These should be applied only in proximity to the origin of the bleeding, avoiding covering the entire cutaneous flap because, in the case of a long operation, this can impair skin-flap vascularization, hence favouring successive necrosis and also alopecia. It is mandatory to preserve the vascular supply to the flap with the technique described in the section "Materials and methods". Of particular relevance is the main trunk of the superficial temporal artery, which provides the vascular supply of the temporal muscle and the skin of the anterior part of the skull, and may also be used as a graft in procedures such as the construction of a slow-flow bypass [5, 7, 11, 13, 18]. In order to preserve trophism and consistence of temporal muscle, we cut both the muscle and its fascia with the scalpel, leaving aside the bovie, which produces muscular and fascial retractions due to burning, with loss of functional tissue and risk of necrosis or atrophy. It is also necessary to keep the periosteum tied to the deep temporal muscle fascia, because it contains nerves which are very important for its trophism [5, 7, 13]. It should be cut away with a Penfield dissector using linear movements, remaining very adherent to the skull and going from the squamous part of the temporal bone to the superior temporal line. A preservation of muscular trophism prevents post-operative aesthetic damage [3, 5, 7, 13, 14, 20, 21]. It is equally important to preserve and not to shrink the pericranium of the frontal bone, because it may be used to cover osteosynthetic items, avoiding the risk of decubitus ulcers or of cutaneous roughness.

When a zygomotomy is necessary, the technique which foresees the preservation of the integrity of masseter muscle (see "Materials and methods") can help to reduce the risks of masticatory defects. Another critical point for the balance of the temporomandibular joint is to preserve the trophism of the temporalis muscle.

Before the craniotomy is completed, a pre-plating of the bone flap is performed. This procedure permits a perfect repositioning of the flap to be obtained, and avoids the plates bulging from the skull plane [6] (Fig. 3a).

The number of the drill holes has been limited to the minimum required in relation to surgical issues such as the degree of adherence of the dura mater to the skull and the need to preserve important vascular structures (as already described in Materials and methods) during the approach. During closure, we completely covered these holes with burr holes, to avoid skin depressions. We inserted the bone powder previously harvested all along the binary of the craniotomy in order to completely fill the interstice between the flap and the adjacent skull. Though more expensive, bone cementum leads to a nearly perfect reconstruction of the bone surface.

Muscle and fascia are sutured separately and the pericranium is disposed to cover the bone flap completely with its contention items (Fig. 3b). It is important to suture the temporal fascia of temporal bone apart from the muscle, because its complete closure could correct a gap or a loss of muscular tissue. The latter condition could occur if muscle has been excessively cauterized during opening.

Several authors have described other fixation systems for the bone flap [3, 4, 6, 14, 16, 17, 19, 21]: Spetzler [17] applied a system in which external hardware can be avoided on one side by inserting pins on one edge of the scalp flap into the medullary portion of the skull. Thus, the author avoids the use of external hardware under the hairless portion of the scalp. This is an interesting technique that could be used in cases in which the bone flap involves the forehead. The author thought this system up to avoid the elevation of the skin caused by screws and plates, but we have been able to avoid this situation without dedicated instrumentation, simply digging small lodging grooves for the plates, as already described by other authors [6]. Spetzler proposes this system also in patients with normal

scalps, because they can palpate their skull hardware and cause skin irritation. However, the procedure does not remove completely the use of miniplates and screws, and also increases the space between the opposite side of the bone flap and the skull, making it more difficult to fill up and cover perfectly the enlarged binary on that side. Furthermore, the use of pins inside the spongiosa excludes the possibility of a pre-plating and then of its advantages. Moreover, the ultra-low profile plates now currently on the market can be placed without any digging, and reduce the possibility of a subjective perception of a foreign body.

The use of absorbable sutures offers some aesthetic advantages, as Missori et al. previously described, but it doesn't appear to be a conclusive issue [10] (Fig. 1).

We interviewed Group A patients at 18-month follow-up to allow the scarring processes to stabilize, and to be sure not to neglect any late development of aesthetic impairment. No patient of ours presented bad positioning of the bone flap, visible gaps due to the drill holes or to the bone binaries of craniotomy. But, even if in radiological (3D-multislice-CT scan) and clinical evaluation we didn't find cosmetic problems and irregularities in any case, five patients in our series complained of some degree of aesthetic injury, or reported psychological suffering resulting from the aesthetic consequences of surgery: four were bald and three were female, two of them under the age of 40. Two out of these five dissatisfied patients suffered both from complete shaving of the hair and the visible scar on the head, two complained of the roughness of the skin at the touch (due to the plates). It is likely that in this case the lodging grooves for the plate were not accurately prepared.

In the light of surgical results of Group B, we can consider the protocol useful to reduce aesthetical impact of surgery.

Patients who will face radiotherapy and chemotherapy need to feel cured and to live as naturally as possible. Cutting the hair completely or causing a visible scar reminds the patient of his/her condition, with all the psychological sequelae. In the same way, when surgical treatments succeed fully in recovering patients' health, the need to return to a normal life increases, after the trauma of undergoing brain surgery. For this purpose, recovery of the pre-operative aesthetic aspect is often absolutely necessary in order to reach both physical and mental recovery.

Therefore, surgeons cannot disregard the tips on how to reduce risks of permanent, but also temporary (e.g., complete shaving of the hair) aesthetic stigmata of their actions.

References

1. Ammirati M, Spallone A, Ma J, Cheatham M, Becker D (1993) An anatomicosurgical study of the temporal branch of the facial nerve. Neurosurgery 33(6):1038–1043, discussion 1044
2. Ammirati M, Spallone A, Ma J, Cheatham M, Becker D (1994) Preservation of the temporal branch of the facial nerve in pterional-transzygomatic craniotomy. Acta Neurochir (Wien) 128 (1–4):163–165
3. Bogaev CA (2002) Cosmetic considerations in cranial base surgery. Neurosurg Clin N Am 13(4):421–441
4. Broaddus WC, Holloway KL, Winters CJ et al (2002) Titanium miniplates or stainless steel wire for cranial fixation: a prospectiverandomized comparison. J Neurosurg 96:244–247
5. Coscarella E, Vishteh AG, Spetzler RF, Seoane E, Zabramski JM (2000) Subfascial and submuscular methods of temporal muscle dissection and their relationship to the frontal branch of the facial nerve. Technical note. J Neurosurg 92(5):877–880
6. Di Lorenzo N, Mouchaty H, Shamsaldin M et al (2004) Cranial bone flap fixation with microplates and screws: a new application technique. Technical note. J Neurosurg Sciences 48(1):55–56
7. Kadri P, Al-Mefty O (2004) The anatomical basis for surgical preservation of temporal muscle. J Neurosurg 100:517–522
8. Lerch KD (1999) Reliability of cranial flap fixation techniques: comparative experimental evaluation of suturing, titanium miniplates, anda new rivet-like titanium clamp (CranioFix): technical note. Neurosurgery 44:902–905
9. Matsumoto K, Akagi K, Abekura M et al (2001) Cosmetic and functional reconstruction achieved using asplit myofascial bone flap for pterional craniotomy. Technical note. J Neurosurg 94 (4):667–670
10. Missori P, Polli FM, Fontana E, Delfini R (2003) Closure of skin or scalp with absorbable sutures. Plast Reconstr Surg 112(3):924–925
11. Newell DW, Vilela MD (2004) Superficial temporal artery to middle cerebral cerebral artery bypass. Neurosurgery 54(6):1441–1449
12. Ochiai C, Okuhata S, Yoshimoto Y et al (1996) Bridged craniotomy for stable fixation of a bone flap. Technical note. J Neurosurg 85:518–519
13. Oikawa S, Mizuno M, Muraoka S, Kobayashi S (1996) Retrograde dissection of the temporalis muscle preventing muscleatrophy for pterional craniotomy. J Neurosurg 84:297–299
14. Park J, Hamm IS (2005) Cortical osteotomy technique for mobilizing the temporal muscle in pterional craniotomies. J Neurosurg 102:174–178
15. Sato S, Sato M, Nishizawa M et al (2001) Method to improve cosmeticoutcome following craniotomy. J Neurosurg 23:339–342
16. Sekhar LN (2002) The cosmetic aspects of neurosurgery. Neurosurg Clin N Am 13(4):401–403
17. Spetzler RF (1997) Bone flap fixation: a new technique: technical note. J Neurosurg 87:475–476
18. Wanebo JE, Zabramski JM, Spetzler RF (2004) Superficial temporal artery-to-middle cerebral artery bypass grafting for cerebral revascularization. Neurosurgery 55(2):395–398, discussion 398–399
19. Winston KR, Wang MC (2003) Cranial bone fixation: review of the literature and description of a new procedure. J Neurosurg 99:484–488
20. Yasargil MG, Reichman MV, Kubik S (1987) Preservation of the frontotemporal branch of the facial nerve using the interfascial temporalisflap for pterional craniotomy. Technical article. J Neurosurg 67:463–466
21. Zager EL, Del Vecchio DA, Bartlett SP (1993) Temporal muscle microfixation in pterional craniotomies. Technical note. J Neurosurg 79:946–947

Comments

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In this paper, Frati and colleagues present a surgical protocol to improve cosmetic outcome followed by craniotomy. Step by step

procedures during skin and muscle incision, periosteum dissection, craniotomy and subsequent bone flap repositioning, and closure, have been described in detail. Finally, improvements in both aesthetic and psychological impacts were shown at 2-year follow up.

It would be interesting if the neuronavigation system was applied routinely to confirm not only ideal skin incision and bone flap but also the exact course of the superficial temporal artery. Further studies for clinical impact in preserving the superficial temporal artery during skin incision are expected. Procedures during craniotomy are not new; however, clinical importance of preoperative evaluation and each appropriate procedure were statistically shown in the present study.

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The Authors address a topic that is emerging with increasing importance in everyday neurosurgical work: the impact of the surgical procedure on the "functional aesthetics" of the face and the skull. They describe in every detail the procedure used to perform a craniotomy and to close the operculum, with the aid of all the modern technology (neuronavigation, low profile plating, high speed drill, 3-dimensional CT, etc). They compare the results obtained in a group of patients operated upon using this technique with a second group that had been treated previously with no such care; they conclude that this careful technique can definitely avoid, or significantly reduce, both the functional and the psychological problems related to a neurosurgical procedure. Most of these precious suggestions are well known, and are recognized and used routinely in several schools. However, it is important to demonstrate that these variants of surgical technique are indeed useful to reduce postoperative aesthetic and functional complications. Concerning the "pure aesthetics", the pre-plating technique that we derived from our maxillo-facial colleagues, is very useful to obtain a correct repositioning of the bone flap. Besides, as the authors point out, there are now on the market very low profile miniplates that do not require to be embedded in the bone. The same holds true for bone cementum, that can be used to fill up bone gaps, with better aesthetic results than bone dust in the long run. One of the critical points is the true incidence of chewing difficulties between the two groups, or the percentage of patients reporting headache as a consequence of an misbalancing of the temporomandibular joint, because this is one of the most frequent complaint of patients even several years after surgery. It surprising why a small but not negligible number of patients, a good cosmetic and functional result notwithstanding, are so deeply affected in their psychology; personality bias obviously plays a major role in this regard. In summary, I think that most young neurosurgeons, and some older ones as well, will take advantage from the careful reading of this very instructive paper.