Technical notes

□ Skin-sparing Neurosurgery

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SUMMARY: *With the exception of neuroradiosurgical treatment with Gamma Knife or other radiogenic sources, the surgical approach to the skull always involves skin damage. As the focus is intracranial, the post-surgical condition of the skin may not be a priority, but it is the most visible sign of neurosurgical intervention after healing. Furthermore, inadequate surgical planning and poor skin management can also compromise wound healing and lead to infectious, functional and/or aesthetic complications that can significantly affect the future life of the patient. This short communication highlights the use of the "Simpson" technique in the incision, with a view to maximising preservation of the vascular and lymphatic skin bed.*

KEY WORDS: *Craniotomy, Neurosurgery, Skin, Skin incision.*

The skin is what separates our insides from the outside. It is the visible part of us. The skin is an indispensable organ for both life and social wellbeing. It is at the nexus between medical science and sociology. This is fitting, since the skin originates from the ectoderm, the same embryonic germ layer that gives rise to both the central nervous system and the sense organs.

In fact, the skin can provide visual signal of nervous system alterations; think of Sturge-Weber syndrome, a rare congenital neurocutaneous disease characterized by capillary malformations on the face associated with neurological disease of varying degrees. Think also of von Recklinghausen's disease, with its different manifestations involving the skin, eye and nervous system. The list of such conditions would be long, and difficult to complete. Indeed, even common pathologies of the nervous system such as Parkinson's disease has implications for the skin, such as seborrhoea, accompanied by very particular odorous secretions.

In the modern world, the skin is a major source of social stigma, with discrimination based on fundamental skin functions such as melanin hyperpigmentation, which counteracts damage from solar radiation, and thermoregulation, which "civilized" people seek to disrupt via hair removal and antiperspirants.

The skin is also now a canvas for painting with makeup, piercings and tattoos, intended to display a state of mind (however fleeting), or to signal belonging to a particular social group, to instil respect or fear. In other latitudes and eras, skin modifications were markers of tribal identity-the context may change, but the substance does not.

Finally, the skin is the mirror of age. So much so, that people will do anything to stop the signs of aging; we invest far more energy and resources to appear younger than we do to counteract or slow down the decay of the mind and its substrate, the brain.

That being said, it is precisely in the field of human endeavour that seeks to restore the function of the latter, i.e., neurosurgery, that tends to ignore the importance of the skin. However, treating intracranial

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pathologies often requires access through skin incision in cosmetic regions of the head and neck. Surgical success is typically measured in terms of the central part of the intervention, but the vast majority of complications tend to occur towards the end of the operation, that is, during closure of the incision(s) at the surgical site.

Some of the most difficult issues that a surgeon has to deal with are post-surgical wound complications, which will often involve the patient having to undergo further surgery; major complications such as infections of the meninges or central nervous system can even undermine all the positive outcomes of the primary intervention.

After surgery, tissue healing does not take place if the tissue flap does not receive an adequate supply of oxygen and nutrients necessary for tissue reconstruction. Hence, an adequate blood supply is essential for the optimal healing process, as are proper venous and lymphatic drainage. If the patient has already undergone previous cranial surgery, the surgeon should re-trace the old scars in order not to cause further aesthetic and/or functional tissue damage. In addition, he or she must be aware of what drugs the patient is taking, especially corticosteroids, and whether they have previously been subjected to radiotherapy, are suffering from a metabolic disease, such as diabetes, or practise habits that can negatively influence the healing process, like smoking.

When planning the intervention, the surgeon must place the utmost importance on the underlying arterial network; this, as well as the natural folds of the skin, must be considered when designing the incision. The scalp is one of the most highly vascularized tissues of the human body. It receives blood supply from both the internal and the external branches of the carotid artery. The four main branches of the external carotid artery are: the superficial temporal artery, the angular, occipital and posterior auricular arteries, and the supraorbital and supratrochlear arteries, which are terminal branches of the ophthalmic artery. The anterior portion of the scalp is supplied by the supratrochlear artery (also known as the frontal artery) and the supraorbital arteries. These vessels extend towards the vertex of the skull, and provide one of the anastomotic points between the internal and the external branches of the carotid system, joining the frontal sections of the superficial temporal artery. The superficial temporal artery replenishes the middle portion of the scalp, ascending anterior to the ear, and then dividing into the frontal branch, mentioned above, and the parietal branch, which supplies the temporal muscle and the parietal muscle of the scalp. There are anastomoses from the parietal branch of the superficial temporal artery to its counterpart on the opposite side, and to the homolateral occipital arteries, which supply the posterior portion of the scalp.

The scalp's venous drainage is divided into three components: the superficial, diploic and emissary. The superficial veins run along their arterial counterparts, while the diploic veins are located inside the diploe, the space between the internal and external layers of the skull. In the diploe, the veins are connected to the intracranial venous sinuses by means of the valveless emissary veins, which pass through tiny foramina in the skull. The four main groups of emissary veins are the posterior condyloid, mastoid, occipital, and parietal emissary veins. These veins provide bidirectional flow, typically from the outside to inside, but the direction can change in abnormal pathological states such as increased intracranial pressure. However, having veins without valves allows infections to spread from extracranial to intracranial sites, leading to septic thrombi.

Incisions that intersect a larger surface area can suffer from delayed wound healing, as such approaches carry a greater risk of compromising vascular supply. However, in large craniotomies, such as the pterional (frontotemporoparietal), this can be avoided by making an incision about 1 cm before the tragus, to avoid severing the main proximal trunk of the superficial temporal artery and the emerging branches of the facial nerve. A linear or "zig-zag", aka "Simpson", incision can then be made in order to allow tension to be dispersed through the incision. In this technique, the surgeon can also align the incision with the hairline, minimizing trauma to the follicle and thereby reducing the amount of hair loss at the site. The Simpson incision enables the surgeon to achieve excellent aesthetic results, not only in those with thick hair, but also on bald skulls. Especially in pterional flaps, it seems to represent an improvement as regards both the aesthetic outcome and patient satisfaction, as compared to the conventional curvilinear incision.

Then, while the intracranial surgery is underway, care must be taken to preserve the flap vitality, avoiding crushing or excessive traction, both possible causes of ischemia. Subgaleal drainage, if used, should also be as atraumatic as possible, and not create an obstacle to blood circulation. Direct visualization of

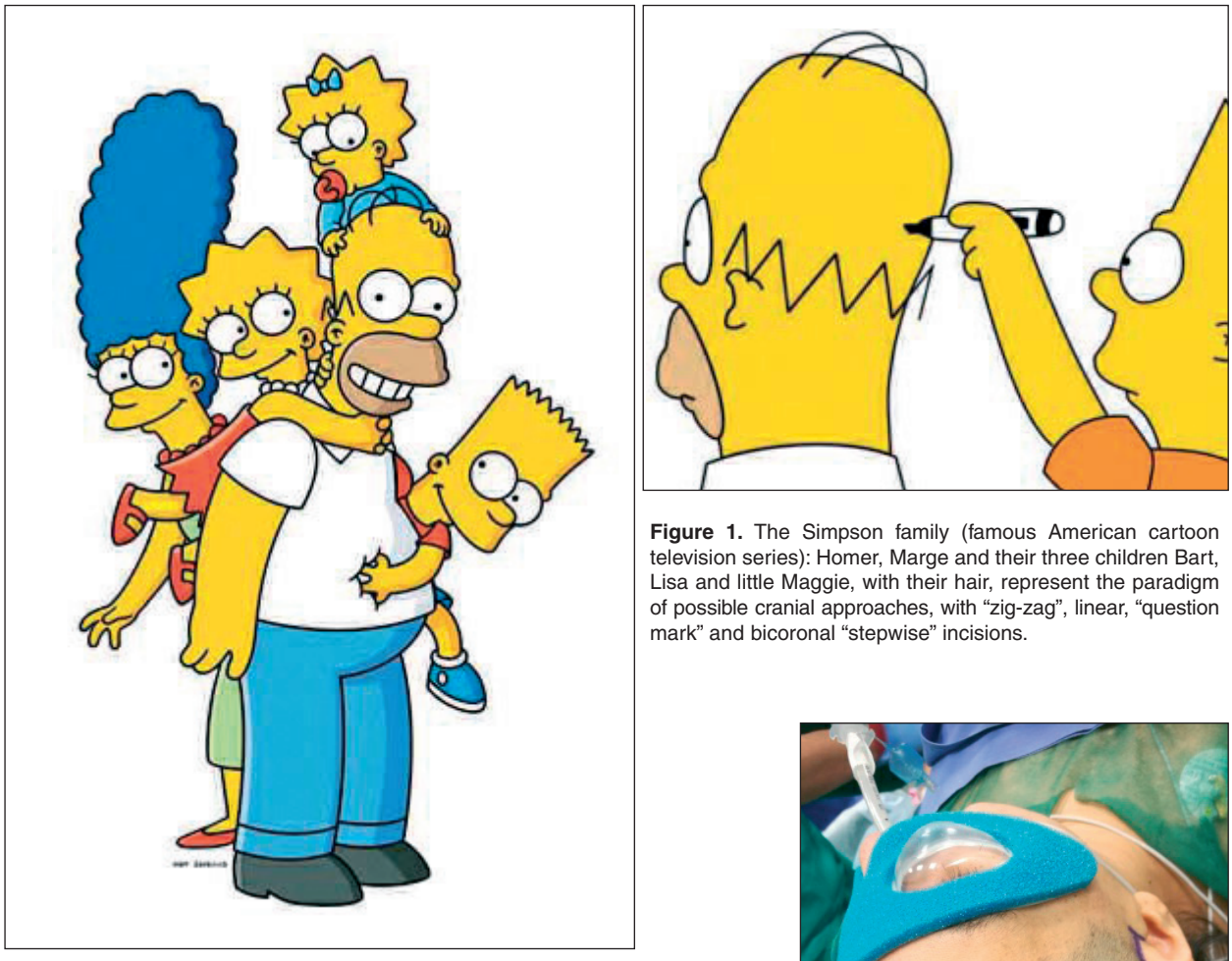

Figure 1. The Simpson family (famous American cartoon television series): Homer, Marge and their three children Bart, Lisa and little Maggie, with their hair, represent the paradigm of possible cranial approaches, with "zig-zag", linear, "question mark" and bicoronal "stepwise" incisions.

Figure 2. Pterional incision via the "Simpson" technique.

the surgical flap and its complexion must be constant, and closely monitored in the days after surgery.

In order to optimize the outcome, the wound should be closed using intradermal sutures or staples. It is vital to use appropriate bandages, avoiding excessive pressure on the flaps, in order to contain and eliminate possible complications such as infections, ischemia and/or skin decubitus. Indeed, superficial infections that invade the central nervous system, among which meningitis, cerebritis, encephalitis, ventriculitis, abscess and empyema, may be fatal if not detected and treated quickly.

Neurosurgical wound healing competes with cerebral and systemic energy consumption, and can deprive the skin wound of the nutrition it needs for healing. While the human brain accounts for only 2% of the total body weight, it consumes more than 20% of its energy requirements, even in the absence of pathological lesions. After neurosurgery, particularly in patients with head trauma, the energy requirement is significantly greater, up to 32% or even 200%, depending on the severity of the injury.

Water supply must also be sufficient: dehydrated skin loses much of its elasticity, blood flow is compromised, and healing processes are interrupted. Another factor that surgeons do not always pay due attention to is the role of vitamins and minerals; vitamin C has long been known to be of fundamental importance in the formation of collagen, and also

plays a role in bone healing; selenium is used by fibroblasts; zinc aids in the debridement of devitalized tissue by macrophages; and copper is also essential for healing surgical wounds in tissues. However, nutrition is not only vital for surgical wound healing, it is also of fundamental importance for the area of the brain affected by surgery to treat the underlying pathology.

It is important to bear in mind, too, that wound healing can also be compromised by the pharmacological effects of some antibiotics, such as tetracycline and erythromycin, which inhibit leukocyte chemotaxis, and gentamicin, which delays wound re-epithelialization. Aspirin, ibuprofen and other non-steroidal anti-inflammatory drugs inhibit the inflammatory phase of wound healing and are platelet anti-aggregants. As a result, these medications can predispose patients to postoperative bleeding. In addition to inhibiting wound healing, non-steroidal anti-inflammatory drugs impede osteosynthesis by counteracting bone arthrodesis in spinal fusion procedures.

In the post-operative period, chemotherapy, radiotherapy and monoclonal antibodies can all inhibit and/or delay surgical wound healing, and, last but not least, the surgeon should also counsel the patient against the use of shampoos and cosmetics that can adversely affect the healing phase.

In short, although the neurosurgeon's target is undoubtedly the treatment of intracranial injury, a good neurosurgeon will try to "save the skin" of their patient, in the most literal sense of the term.

REFERENCES

1. Berry JAD, Miulli DE, Lam B, Elia C, Minasian J, Podkovik S, Wacker MRS. The neurosurgical wound and factors that can affect cosmetic, functional, and neurological outcomes. Int Wound J 2019; 16 (1): 71-78.
2. Minami N, Kimura T, Uda T, Ochiai C, Kohmura E, Morita A. Effectiveness of zigzag Incision and 1.5-Layer method for frontotemporal craniotomy. Surg Neurol Int 2014; 5: 69. doi: 10.4103/2152-7806.132562.
3. Zanotti B, Verlicchi A. Craniectomie decompressive. In: B. Zanotti, A. Verlicchi, P.C. Parodi (editors): Cranioplastica terapeutica. Proceedings SNO: Master sulle Cranioplastiche terapeutiche custom made - LII Congresso Nazionale SNO, 11 maggio 2012, Roma. new Magazine edizioni, Trento: 37-46.