Transformation, Transmission, and Transgression in Craniofacial Surgery "Autarchy"

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"We only possess what we have received and transformed, what we have become thanks to others or against them."

André Comte-Sponville

For most readers of the *Journal of Craniofacial Surgery*, Paul Tessier (1917–2008) is known not only as the great pioneer of the specialty but also as an elephant hunter, an amateur of rapid cars, Cuban cigars, and good wines, a workaholic, and a strong character. However, very few are aware of his interest in French grammar and his quests for the right words, the right expressions to describe such or such anatomical structure, surgical technical movement, or procedure, and above all, for his endeavor to transmit his ideas, his methods and innovations in the most precise way. We are indebted to his pupil Anthony Wolf (1940–2023), for having collected many personal writings of Paul, some of which have never been published before.[1] Tessier's concern for the words led him to propose a narrative of the evolution and of the circumstances which presided to the development of what he called craniofacial surgery "autarchy."

"Even before writing concisely, concretely and compactly one must write accurately, ie, in the terms and with the words appropriate for a given subject. But to speak accurately to write accurately supposes an extended vocabulary to cover not just the French language but an entire specialty. However, craniofacial surgery involves 7 specialties: plastic surgery, neurology and neurosurgery, ophthalmology, ENT, stomatology and even dermatology; one must therefore verify the meaning of many words in the dictionary of medical terms and among the synonyms. Happily, today this verification is done by an electric tower."

Inspired by this narrative, we propose to analyze the history of CF surgery specialty in the following 3 phases:

Transformation refers to the changes of methods and the innovations, which Paul Tessier and others introduced in the treatment of major CF malformations.

Transmission recalls the way facial surgery has been transmitted from generation to generation and from surgeon to surgeon, to reach our actual state of the art in craniofacial surgery.

Transgression reminds us of the boundaries of new procedures, but also sometimes the possibility to solve a particular problem, which has not been treated properly before.

TRANSFORMATION

Although several surgeons participated in the development of CF Surgery as an "autarchic" field, the leading contribution of Paul Tessier, cannot be contested.

In most scientific domains and technologies, innovation, novelty, or transformation are broad terms defined as the act of introducing something new or the use of new ideas or methods. For the philosopher Thomas S. Kuhn, normal science progresses by gradual, incremental changes in a particular discipline's practice and knowledge. However, the phase of normal science can be brought to an end by a sudden paradigm shift caused by a scientific breakthrough that drastically alters the status quo. Science is then seen as entering a revolutionary phase, a new paradigm.[2] Inspired by Kuhn's theory Riskin et al[3] recalled that in surgery, no technology or its application is ever entirely new as no inventor works within a vacuum. "The process by which surgical innovation applies new ideas to "hands on" clinical needs is analogous to the process in which translational research applies basic research to clinical problems." For these authors, innovation may be enabling or incremental. An enabling or a disruptive procedure supports the development of new procedures within a field. For example, vascular anastomosis was an enabling procedure promoting a series of advances in surgical technique and innovation, from vascular repair to organ transplantation, or free flaps. On the other hand, an incremental technology change is an innovation that marginally improves upon currently available technology and does not lead to a significant technology shift, like the miniplates replacing the wires with a better holding. Moreover, some innovations, leading to transformation in a particular field, may improve technologies without replacing them, whereas others render previous technologies obsolete.

Tessier himself wrote several notes on the question of innovation, creation, and transformation in surgery.[1] For him, "creation is the formation 'de-novo' starting from nothing. It does not exist, except in biblical terms, and only God would have created the world starting from nothing. Creativity is the aptitude to produce something new which often is nothing more than a renovation. Invention is less pretentious than creativity: perhaps because an invention often leads to material products. Discoveries arise often from fortunate incidents that the observer did not allow to fly away. Major discoverers, like thousands of others, they have seen and then experimented. The rest came by itself. As an example, on December 78 on an Apert, there was a rupture of the palate during a monoblock: it was an accident; the next day on another Apert, it became *the bi-partition- bending* procedure which became a standard procedure including in hypertelorism."

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Tessier also reviewed the transformation introduced in CF surgery from a chronological point of view. For him, after a "paleolithic period," lasting a century, with procedures accidentally used for unanticipated circumstances, CF surgery has evolved in 6 stages, as summarized below:

(1) "Proto-CFS period (1953-1958) made-up of disparate experiences carried out on orbito-maxillofacial clefts, cranial synostosis, tumors, and trauma involving cranium and face.
(2) The initiation or gestation period (1958-1962) with the advancement of the mid-face by osteotomies of "Le Fort III" type for correction of facial retrusion in Crouzon and Apert.
(3) The extension period (1962-1967). Correction of monstruous interorbital separation clefts led to the intracranial approach. This was the act of birth of craniofacial surgery, and this is still its distinction.
(4) The development in France (1967–1972), with courses on orbito-cranial surgery.
(5) Diffusion abroad and other developments (1971–1980). England, Sweden, USA.1976 classification of facial clefts, Ortiz Monasterio: monoblock fronto-facial advancement. 1988 Facial bipartition in Apert.
(6) Help and transformation (1980–1993). Miniplates. 3D imagery. Marchac and Renier: mastery in the treatment of craniosynostosis. Widespread use of cranial bone grafts. 1982: the osteocutaneous free flap of Taylor. 1992: Distraction-osteogenesis by McCarthy, on mandible, maxilla, and mid-face."

Undoubtedly this very simplified summary representing numerous patient observations, anatomical research, and thousands of operations, does not fully reflect the main disruptive innovation introduced by Tessier: the intracranial-extradural approach of complex craniofacial malformations and the circumferential dissection of the orbits. These combined procedures, which permit all kinds of osteotomies to be carried out without endangering the orbital content were a real breakthrough and a disruptive innovation. In addition, the specialty of CF surgery could not have evolved without a series of incremental innovations which were sometimes borrowed from other fields of surgery.

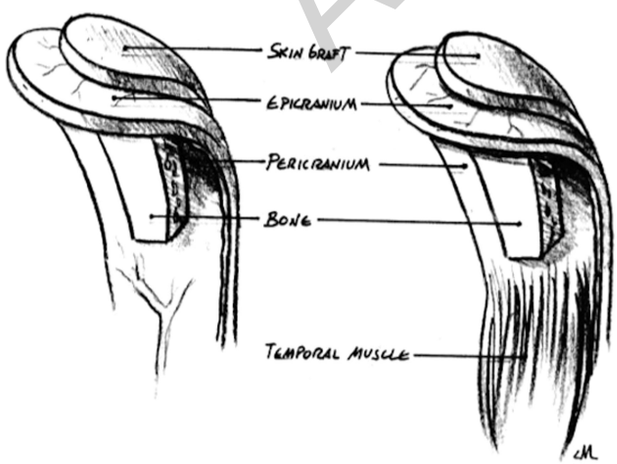

FIGURE 1. Drawing of the prefabricated calvarial bone flap, lined with full-thickness skin graft. The addition of the temporal muscle in the pedicle provides better vascularization.

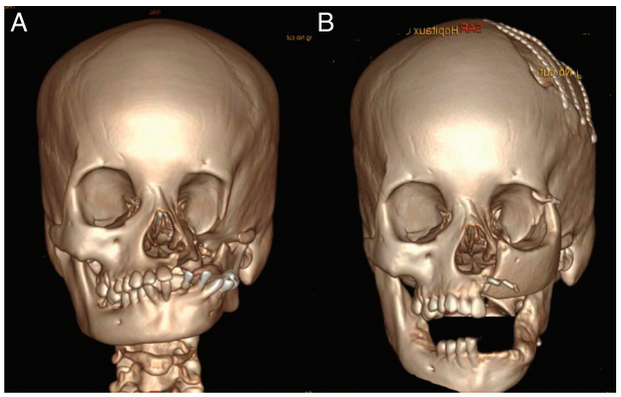

FIGURE 2. (A) Preoperative CT scan of a 6-year-old girl with noma sequelae, with complete destruction of the right malar and maxillary bone and severe constriction of the mandible. (B) Postoperative CT scan, 5 years later. Note: perfect integration and growth of the cranial bone, reproducing the malar bone. The mandibular constriction has been released.

EXAMPLE OF AN INCREMENTAL PROCEDURE IN CF SURGERY: THE PREFABRICATED VASCULARIZED CALVARIUM FLAP

Noma disease often results in devastating full-thickness cheek defects with destruction of the maxilla and malar bones.[4] In many cases, the primary stage of repair should include a vascularized bone flap lined with skin and soft tissue on both sides to protect the bone. For this, we have devised a prefabricated temporocranial flap, requiring a 2 stages procedure (Fig. 1). The details of the method and a retrospective review of 50 patients who underwent 52 maxillary, malar, and mandibular reconstructions, are given in detail in the quoted references.[5,6] The main advantages of this method over free flaps are the following: it can be performed at any age and is particularly suitable for small children, it does not require microsurgical anastomosis, the growth of the cranial bone flap follows the facial growth, the donor site is barely visible. Radiological and clinical long-term results demonstrated excellent integration of the flaps to the adjacent facial skeleton (Fig. 2A, B).

TRANSMISSION

The history of surgery, and plastic surgery in particular, has been marked by pioneers who have passed on their knowledge and, above all, their skills to succeeding generations. Prior to the 19th century, some of these pioneers did not bear the title of Doctor, as they had not studied at a university and did not speak Latin; they were, however, often given the title of *Master Surgeon*. Surgery was learned from a renowned master, in small establishments where barbers and therapists rubbed shoulders. Although for the past 2 centuries, all surgeons have been university-educated physicians, learning the practice of surgery requires a personal relationship between master and pupil, which lasts several years. Every trained surgeon learned his trade from tutors. Looking back, we can all remember the men and women who taught us not only surgical techniques but also how to deal with patients and the ethics of the profession.

Knowledge sharing (KS) and knowledge transfer (KT) are at the root of the transmission of knowledge in enterprises and in scientific fields.[7] KS is used more frequently on the individual level, while KT is used mostly when groups, departments, and organizations are in focus. If we consider the development of surgery, KS has been originally the main way of progressing in the specialty. Since the development of specific journals and the

FIGURE 3. Five-year-old Nigerian girl presenting a hyperteleorbitism (IOD) of 12 cm, complete absence of the nose, median cleft of the upper lip, and complete coloboma of the left upper lid.

internet, KT has greatly improved the transmission of knowledge in a field like CF surgery, widening its scope to several domains like anatomy, embryology, or radiology, that could not be reached by personal KS of surgeons.

KNOWLEDGE SHARING IN CF SURGERY

During the 19th century, several new methods, particularly skin flaps, were developed to reconstruct local defects of the face;

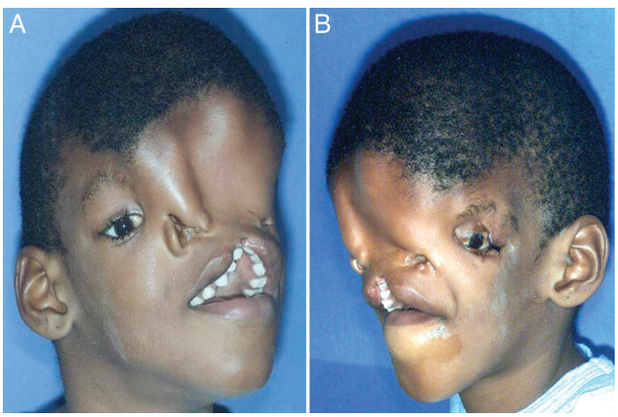

FIGURE 4. (A, B) Oblique views of the patient showing the multiple malformations

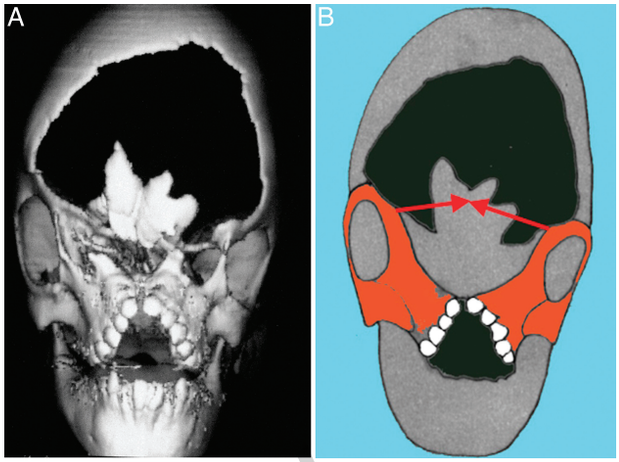

FIGURE 5. (A) CT scan showing complete absence of the frontal bone, very arched palate with reverse V deformity of the maxilla, multiple encephaloceles, or bulging of the brain tissue in the forehead and mid-facial region. (B) Planning of the facial bipartition according to Tessier.

however, it was mostly during the First World War that a new generation of surgeons, coming from a variety of backgrounds (general surgery, orthopedics, otolaryngology, and dentistry) had to apply these methods to the reconstruction of a huge number of facially disfigured soldiers and design treatments for these devastating facial wounds. Among them, Hippolyte Morestin (1869–1919) was an important figure, not only for his achievements but also for the heritage he left behind him.[8] As soon as the Great War broke out, Morestin volunteered for the French Army. A few months after the start of the war, he was called upon to work at the refurbished and enlarged Val-de-Grâce military hospital. As early as 1915, he organized the center for reconstructive surgery for facial injuries. During the 4 years of war, he and his colleagues, in collaboration with dentists, operated on hundreds of mutilated soldiers known as the "Gueules cassées" (broken faces). During his whole career, Morestin published numerous articles on surgical

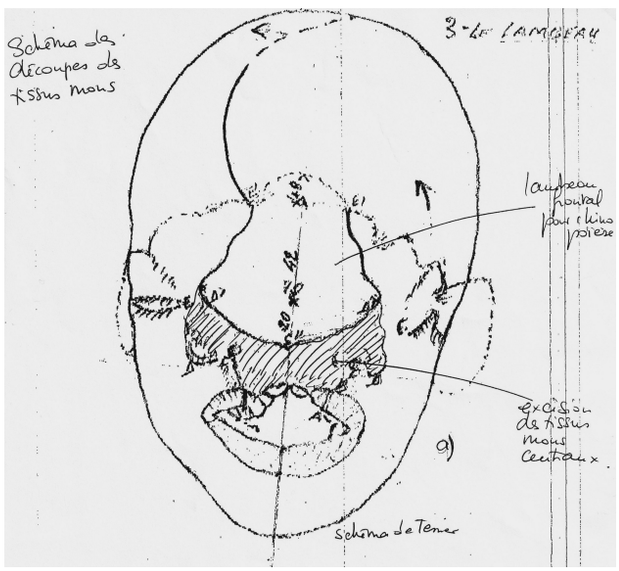

FIGURE 6. Drawing, measurements, and manuscript notes by Tessier for the rhinopoiesis skin flap planning.

FIGURE 7. Postoperative result on the operating table, after mobilization of the orbits, closure of the cleft lip, and nasal reconstruction

FIGURE 8. Postoperative result at 3 months after division of the forehead flap pedicle.

anatomy, abdominal and head and neck surgery, but also on plastic surgery, such as skin expansion to correct extended facial naevi, application of Z-plasty for the treatment of contractures, and the use of costal cartilage grafts for the restauration of the skeletal support of the nose. By his operative skills and his dedication to his profession and his patients, he is known to have influenced deeply several of his pupils, or surgeons who assisted or watched him operating, like Harold D. Gillies (1882–1960), Johannes Frederik Esser (1877–1946), Suzanne Noël (1878–1954), Léon Dufourmentel (1884-1957), Raymond Passot (1866–1933), and the neurosurgeon Thierry de Martel (1875–1940). This KS of Morestin was then adopted by the younger surgeons and opened the ground to modern reconstructive and esthetic surgery of the face and skull. Similar KS happened during and after WW II, with the examples of Gillies, Mc Indoe, Kazanjian, Converse, to quote among many other surgeons who had to deal with wounded soldiers and develop new methods of treatment. Paul Tessier wrote many notes on transformation and innovation, but he also spent a fair amount of time to transmit his ideas and methods to his peers and to younger surgeons, organizing teaching symposia, visiting and operating in several countries, and at times helping personally surgeons confronted with difficult problems.

KNOWLEDGE TRANSFER IN CF SURGERY

If KS with personal contact between tutor and pupil is essential in learning a surgical specialty, CF surgery, like every medical field, requires permanently a fair amount of reading books and articles, which, besides congresses, is the only way to keep in touch with the state of the art of a specialty and the latest adjoining research. Today, with the explosion of printed and numeric medical literature, young surgeons are overwhelmed by publications, obliging them to screen and make difficult choices. For those whose main interest is the field of reconstructive craniofacial surgery, the creation, 40 years ago, of a journal entirely dedicated to this domain—at the time of the first major facial and orbital translocations had just been introduced by Tessier—was a surprise and became a necessity soon. We know now that this Journal has not only drastically increased his audience and his impact factor but has also survived among the numerous difficulties linked to the competition between the major publishing companies and scientific journals. *The Journal of Craniofacial Surgery* has also offered a platform for exchanging new methods and new discoveries in the vast domain of the craniofacial sphere, which is the center of interest for plastic, maxillafacial, head and neck surgeons, ophthalmic and neurosurgeons. It is not easy to explain how could a single surgeon create and run almost alone, for 40 years, such an international medical journal? The question should probably be asked to the protagonist. But I suspect that Mutaz Habal succeeded, not only because of his specific knowledge in the field of CF surgery and his business ability to manage a company, but also because of his open-mind-

FIGURE 9. Dr Tessier examines the operated patient for the first time in the Geneva Hospital (D. Montandon and B. Pittet on the side).

edness to many modern debates as well as his wide-ranging classical culture.

A HISTORICAL CASE OF SHARING TRANSMISSION: THE OPERATION OF A 5-YEAR-OLD GIRL WITH THE WIDEST HYPERTELORISM EVER RECORDED

In an era of robotic, computer-assisted surgery and electronic communications, Paul Tessier has proved that it was possible to conduct at a distance one of the most complex reconstructive sequences of operations ever performed for a craniofacial malformation, using only a fax, and in his own words a kind of "telepathy."

When a 5-year-old girl named Queen arrived from Nigeria at our medical center in Geneva in 2001, the question arose: how to handle such a malformation involving the brain and the whole face without endangering her life and her sight. After meeting Paul Tessier in Paris, we decided that I would send him the pictures and the x-rays, and he would write and draw the various operative steps to be achieved.

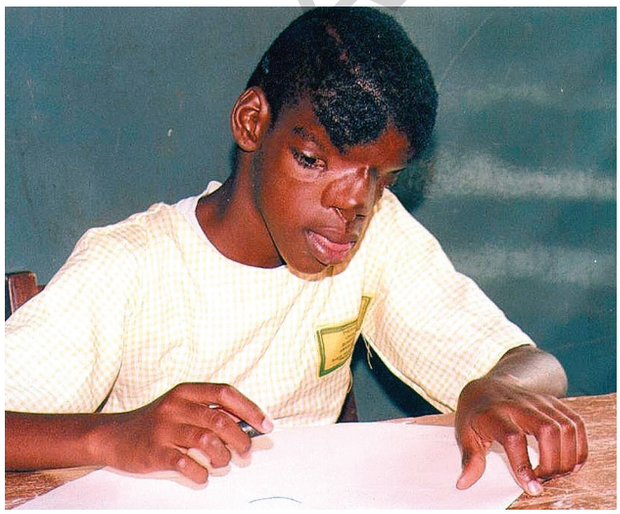

FIGURE 10. Same patient at school in Nigeria, age 16.

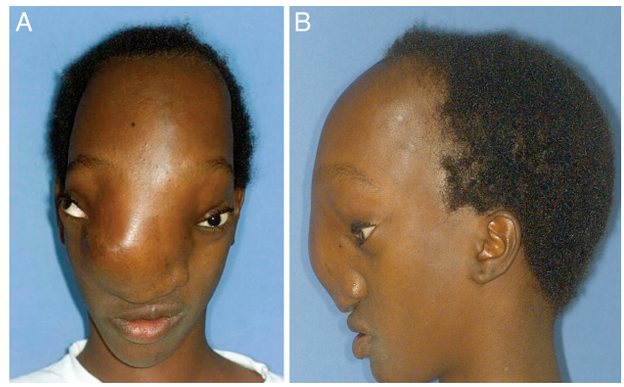

FIGURE 11. (A, B) 16 y. old female with cystic fibrous dysplasia invading the fronto-nasal region. Hyperteleorbitism with IOD of 11 cm.

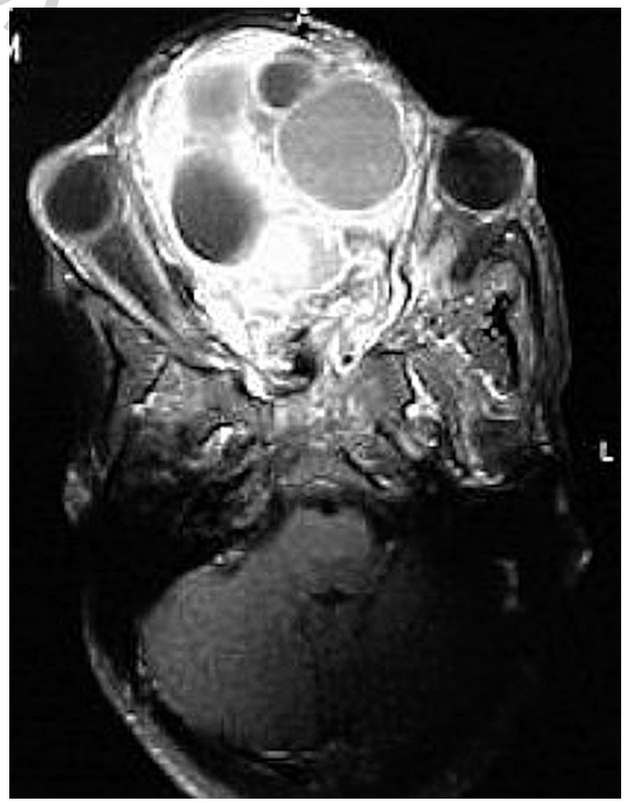

FIGURE 12. Preoperative IRM, showing the extend of the tumor and the displacement of eyes and optic nerves. The brain is compressed and pushed back into the occipital region.

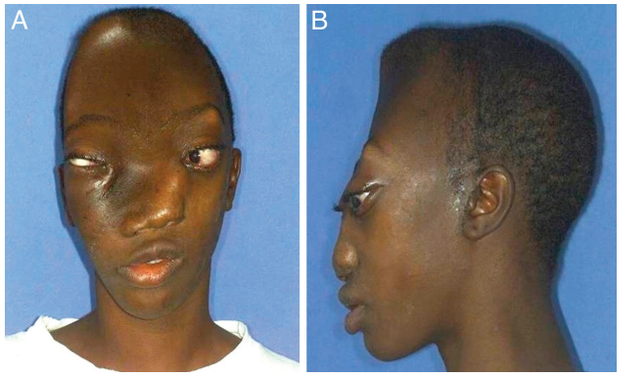

FIGURE 13. A, B, Intermediate phase after removal of the tumor with neuronavigation to localize the optic nerves and storage of the frontal bone in the refrigerator for 6 weeks.

Queen presented the following malformations: severe hyperteleorbitism with an interorbital distance of approximately 12 cm, complete absence of the frontal bone, very arched palate with reverse V deformity of the maxilla, multiple encephaloceles or bulging of the brain tissue in the forehead and mid-facial region, complete absence of the nose, median cleft of the upper lip, complete coloboma of the left upper lid which had led to corneal opacity and blindness of left eye. The patient couldn't eat by herself or walk alone because her seeing eye could only focus at 90 degrees (Figs. 3, 4A, B).

On the basis of Tessier's plan of treatment, with 28 observations and several faxes, where he had drawn the lines of the osteotomies and the skin flaps to reconstruct the nose (Figs. 5A, B, 6), we operated Queen in several stages. As it was reported in an article a year later, and in Volume II of Tony Wolf book,[1] the sequences of operations were carried out according to the plan and predictions of "the Master" (Figs. 7, 8), who came seeing the patient for the first time in Geneva, when she had fully recovered from the operations (Fig. 9). For the first time, she could see in front of herself with the right eye, and therefore eat and walk alone. The patient returned to Geneva for correction of her nasal pyramid with a rib graft 8 years later. She is now back home in Nigeria (Fig. 10).

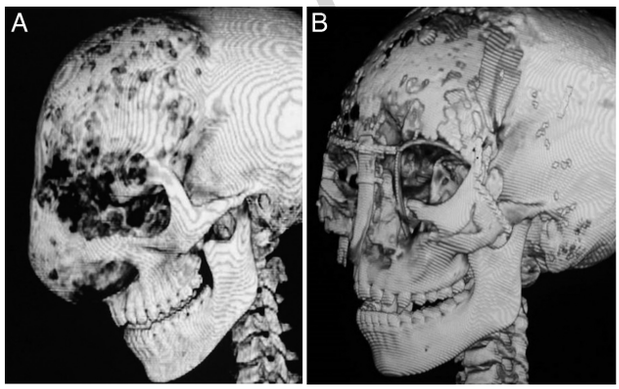

FIGURE 14. (A) Preoperative CT scan showing the extend of the tumor and the hollows in the frontal bone. (B) Post-op CT scan showing the reconstructed orbits and nose with multiple bone grafts. The original forehead bone has been replaced in its position. Two latissimus dorsi muscle flaps filled the anterior cerebral cavity, providing good vascularization for the frontal bone.

FIGURE 15. Early postoperative result (A, B).

TRANSGRESSION

Transgression refers to the act of crossing boundaries, pushing beyond established norms, and venturing into uncharted territories. Transgression may also fuel progress. Creativity thrives on transgression. It challenges dogmas, encourages risk-taking, and fosters breakthroughs. It may, however, also lead to severe

FIGURE 16. Post-op photograph 3 years after the operations. The patient has no sight and no mental impairment.

complications and legal problems, that will be entirely accomptable to the transgressor. Crossing boundaries should not harm others or violate ethical principles.

The practice of medicine and surgery obeys certain rules established by decades of try and errors and research. The transgression of these rules may be sanctioned by the law unless it has been previously approved by an ethical committee or medical authority. However, surgeons are often faced with an unexpected anatomical or pathological situation, which obliges them to innovate and potentially transgress the established procedures. The unsolved problems or the repetitive failures of existing therapies also stimulate surgeons to find a better way and sometimes break the linear pattern of progress in their domain.

Undoubtedly, the intracranial approach of facial malformations was a transgression of the principle "never put in contact the sterile intracranial cavity with the septic nasopharyngeal space, unless forced by a trauma or a tumor." It took years to confirm that, thanks to judicious antibiotherapy, the infection rate after such operations, although present in some cases, was relatively low. When a surgeon faces a situation never encountered before by anyone, he might be forced to find a solution, which might transgress rules established before.

EXAMPLE OF A UNIQUE TRANSGRESSIVE THERAPY: 2 LATISSIMUS DORSI FLAPS TO FILL THE CRANIAL CAVITY

In 1998, the Geneva craniofacial team was confronted with a 16-year-old girl from Burkina Faso, presenting a very particular case of fibrous dysplasia with aneurysmal cysts, which had filled progressively more than half of the cranial cavity, resulting in a monstrous projection of the frontal bone and a hypertelorism with IOD of 11 cm (Figs. 11A, B, 12). The patient presented no mental abnormality. After a full neurological, ophthalmic, and 3D radiological analysis, the decision was made to operate in several stages.

First operation: Through a coronal approach and removal of the frontal bone, the tumoral tissue was nearly completely excised after the identification of the chiasma and the optic nerves by neuronavigation. The remaining bony orbits and the eyes were moved medially, and the skin closed to cover the brain tissue (Fig. 13A, B). The frontal bone was kept in the refrigerator until the next operation

Second operation 3 weeks later: removal of remnant tumoral tissue and anterior coverage of the brain with a latissimus dorsi flap revascularized by the left temporal artery.

Third operation. Second free muscular flapbranched on the right temporal vessels. Reposition of the original frontal bone on top of the 2 muscular flaps. Reconstruction of the orbits with bone grafts and miniplates and reconstruction of the nose with a rib bone and cartilage graft (Fig. 14A).

The follow-up of these 3 operations was uneventful. Three years later, there was no recurrence of the tumor. The frontal bone had revascularized with minimal resorption (Fig. 15A, B). The patient returned to Burkina Faso and had no further surgery (Fig. 16).

Although the bone work of the reconstructive procedures had been planned with a 3D wax model of the patient's skull, the enormous dead space left by the removal of the tumor, which had impeded the brain to develop anteriorly, had not been fully anticipated. It was evident that the frontal bone, already impaired by fibrous dysplasia, would never survive if not adjacent to a well-vascularized tissue. Moreover, the dead space would soon be replaced by cerebrospinal fluid or other serositis prone to infection. Thus, transgressing Tessier's concept to replace "like with like": bone, fat, skin, cartilage, we replaced brain tissue with dorsal muscles!

FUTURE OUTCOMES

Craniofacial surgery as an "autarchic" specialty is now well established. The basic concepts promoted by Paul Tessier's teaching have not only revolutionized the correction of major craniofacial malformations, but they have also improved the treatment of post-traumatic mutilations and the reconstruction after tumor resection. If only a few medical centers can afford to have a team of physicians and surgeons entirely dedicated to this domain, enabling them to treat complex cases of Crouzon, Apert, or multiple facial clefts, many plastic and maxillofacial surgeons, as well as neurosurgeons, ENT, and eye surgeons may also benefit from these innovations for a few cases of their practice. As it happened following Morestin's example, thanks to the teaching of Tessier and to his pupils, who have established training centers in various countries, the transmission of knowledge and savoir-faire in CF surgery has reached nowadays the whole world. Besides Tessier, several surgeons of the same generation, like John Marquis Converse (1909–1981), Fernando Ortiz Monasterio (1923–2012), and others, have also greatly contributed to the diffusion of the specialty through their personal contributions and by their extensive writings in this domain. Thanks to the Journal of Craniofacial surgery in particular, surgeons have been able to follow the progress of the specialty during the last 40 years. It has become an indispensable tool for everyone interested in this field.

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REFERENCES

1. Wolf A. *A Man of Héric, the Life and Work of Paul Tessier MD, Father of Craniofacial Surgery*. Publisher: Lulu.com; 2011. Volume I and II – July 15
2. Marcum JA. *Thomas Kuhn's Revolutions: A Historical and an Evolutionary Philosophy of Science?*. Bloomsbury Publishing; 2015
3. Riskin DJ, Longaker NT, Gertner M, et al. Innovation in surgery. *Ann Surg* 2006;244:686–693
4. Montandon D. The progress on noma disease and its surgical treatment. *J Craniofac Surg* 2018;29:539–542
5. Montandon D, Gumener R, Pittet B. The sandwich epicranial flaps. *Plast Rec Surg* 1996;97:302–311
6. Rüegg EM, Gniadek P, Modarressi A, et al. Facial bone reconstruction with prefabricated vascularized calvarium flaps in children and young adults: advantages and long-term results. *J Craniomaxillofac Surg* 2016;44:1880–1888
7. Paulin D, Suneson K. knowledge transfer, knowledge sharing and knowledge barriers – three blurry terms in KM. *Electron. J. Knowl. Manag* 2019;10:81–91
8. Pittet B, Jaquinet A, Rilliet B, et al. Simultaneous correction of major hypertelorism, frontal bone defect, nasal aplasia, and cleft of the upper lip (Tessier 0-14). *Plast Rec Surg* 2004;113:299–303

