Technical Notes

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Hydroxiapatite morceau at fronto-orbital advancement: Technical note.

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Introduction: In this work, we demonstrate a modification in the frontal advancement technique, using a hydroxyapatite "morceau", through a series of cases.

Technical note: The technical improvement consists of applying a piece of solid hydroxyapatite, freely cut and molded, under the fronto-orbital band, ensuring the advancement of the band itself, as well as facilitating early reossification. The service's experience, through a series of 20 cases, reflected good outcomes, guaranteed by frontal reossification in all cases. There were no complications associated with the new technical stage in any of the cases in the series.

Conclusion: Therefore, the results favor the use of hydroxyapatite Morceaux as an advantageous strategy for the treatment of craniostenosis with frontal advancement.

Keywords: Fronto-orbital advancement, Craniostenosis, Hydroxyapatite Morceaux.

INTRODUCTION

Fronto-orbital advancement in the treatment of craniostenosis involving the skull base is a fundamental step. It consists of causing osteotomies, translocations of bone flaps and planned greenstick fractures in trigonocephaly, plagiocephaly and brachycephaly, allowing volumetric correction of the anterior fossa and orbits, alignment of the nasal bone and orbital rhymes. Consisting of two pieces obtained in one or two segments: frontal and the supraorbital bar, the latter defining the orbital part of the frontal bone, pars orbitalis, horizontal bony portion of the frontal bone that extends from the supraorbital margin. Formed by two thin triangular plates, they create the roof of each orbit, separated in the middle deeply by a median gap (ethmoidal notch) – the orbital bandeau[1].

Variations in the technique of advancement of the fronto-orbital portion have been described and vary according to its proponents in terms of better aesthetic, three-dimensional results, preservation of blood supply and reduction of bone resorption risk[2-11].

The objective of this work is to describe the technique of using hydroxyapatite morceau in fronto-orbital advancements at craniostenosis treatment, as support for the reconstructed orbital bandeau as so as present the series of cases in wich it was used by a pediatric neurosurgery service.

MATERIAL AND METHODS

This work consists of a technical note supported by a series of cases, in a public-private multicenter service, based on the technique applied by the author of the Pediatric Neurosurgery service of Marseilles – Hôpital la Timone, over the last 7 years. Trigonocephaly, anterior plagiocephaly and brachycephaly patients were included, whether syndromic or not, isolated or combined, as long as the surgery included anterior frontobasal advancement with reconstruction of the orbital bandeau and the use of a block apatite hydroxide formulation - maintaining similar brand characteristics, dimensions, weight, porosity, resistance (Table 1).

TECHNICAL NOTE

Begin with posterior bicoronal incision, then routine orbital-fronto-parietal supraperiosteal dissection. Craniotomies are directed on a case-by-case. Obtaining the orbital bandeau: osteotomy 1.5 cm above the orbital rim, 5 cm in a bilateral posterior direction. Deeply, with delicate chisels or piezotome, the orbital fossae, ethmoid, and zygomatic processes are separated from the frontal ones. The remodeling of the pieces is carried out with the aim of symmetrical correction of the bone defect, with

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Table 1 - Clinical and epidemiological presentation of cases

Id.	Age	Sex	Suture	Reconstruction Techinique
1.	9M	M	Right coronal	Right fronto-orbital advancement + Frontosphenoidal bilateral release / Frontoethmoidal release
2.	24M	M	Bilateral Coronal (Crouzon)	Bilateral fronto-orbital advancement + Frontosphenoidal bilateral release / Frontoethmoidal release
3.	7M	F	Metopic	Bilateral frontal expansion + Frontosphenoidal bilateral release
4.	24M	F	Bilateral coronal	Floating bilateral fronto-orbital advancement + Frontosphenoidal bilateral release / Frontoethmoidal release
5.	8M	M	Right coronal	Right fronto-orbital advancement + Frontosphenoidal bilateral release
6.	24M	M	Bilateral coronal + metopic	Floating bilateral fronto-orbital advancement + Frontosphenoidal bilateral release / Frontoethmoidal release

advancements, expansions, repositionings according to the nature of the craniofacial defect, and then repositioning the new frontal flap using absorbable plates and nylon threads. Just posterior to the gap between the zygomatic processes of the frontal bone and the sphenoid bone, an apatite hydroxide block, specifically modeled for the function, is interposed as a chock for immobilization and support of the temporal/frontonasal support points – figure 1. Then, the supraorbital bandeau is accommodated, so that it is supported on the surface of the morceau from the zygomatic process of the frontal bone, to the frontotemporal point.

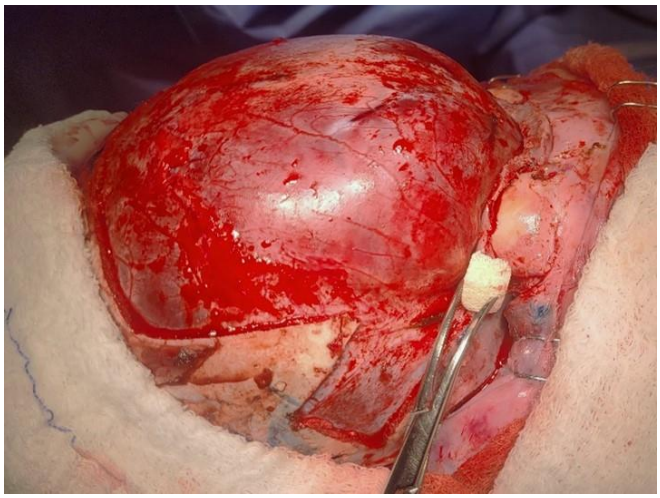

Figure 1 - Correct position of morceau. Lateral view.

It is extremely important to ensure the fit of the morceaux in the bone flaps, as well as its symmetry with the contralateral advancement, when applicable – figure 2. Excess of material can be removed after correct positioning, avoiding subdermal projections and unfavorable cosmetic results.

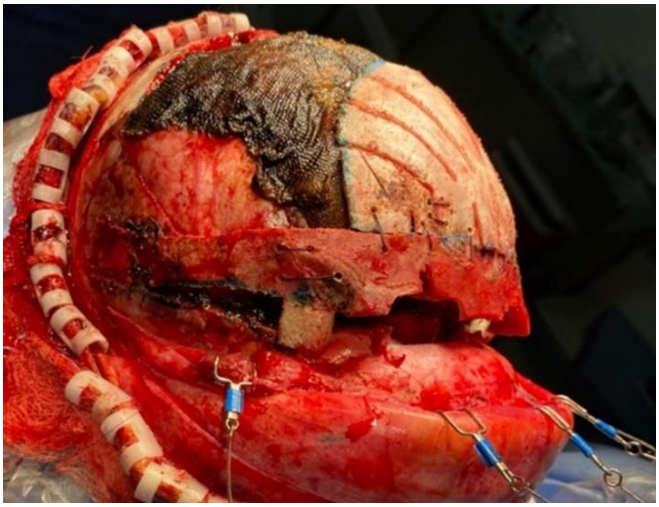

Figure 2 - Hydroxyapatite morceaux supporting fronto-orbital bandeau. Lateral view.

RESULTS

The sample group comprised 20 patients aged between 7 and 96 months at the time of surgical treatment. There was a slight male predominance (11:9) and a higher prevalence of coronal suture disease – 58%. In the present study, there was a predominance of bilateral disease, compared to either side alone. Syndromic patients represented 15% of cases and, in 55% of the population, the disease affected two or more sutures. In all cases, fronto-orbital advancement and frontosphenoidal release were performed.

DISCUSSION

Hydroxyapatite is a molecule that is the most stable and insoluble phosphate under environmental conditions12. It has great biocompatibility, favoring bonds with organic molecules, especially water and collagen, favoring high rates of cell adhesion in the first 7 days for implantation in bone tissues, given its osteoinductive capacity13. Besides, it has low toxicity that allows the formation of a long-lasting carbon bond with living tissues13 and, therefore, offering ideal conditions for early osteosynthesis. It can be manipulated into different forms for in vivo use: powder, paste, blocks.

The position and configuration of the supraorbital bandeau are of crucial importance in reconstruction techniques. Marchac and Renier advocate in seminal works that the most physiological dimensions, angles and projections possible should be sought: 1) in the sagittal plane a frontonasal angle is formed that varies from 90 to 120 degrees; 2) the superior orbital rim located forward of the eyeball and tangentially to the pupillary line, transverse and

slightly convex in the central region, until proximally the middle part of the orbits and then describing an arc of 90 degrees towards the temporal regions14. Recessed and excessively wide in brachycephaly, tilted in oxycephaly, asymmetrically deformed in plagiocephaly and symmetrically in trigonocephaly, the search for physiological position must be sought, a goal shared by the author's pediatric neurosurgery group.

Given its resistance in the form of blocks, it has been used in recent years in all cases of the group as a shim to preserve the conformity of the reconstructed orbital bandeau, distributing the force vectors applied on it, more evenly, reducing the risk of displacements or fractures in more fragile portions. Furthermore, it ensures that the craniofacial conformation applied intra-operatively is maintained exactly as desired by the surgeon – figure 3. Despite the need for additional studies, the author discusses the role of the existence of a fixation point and less antero-posterior mobility of the bar reinstalled, for a more uniform, faster reossification with consequent revascularization and less tendency for bone reabsorption. No patient showed signs of

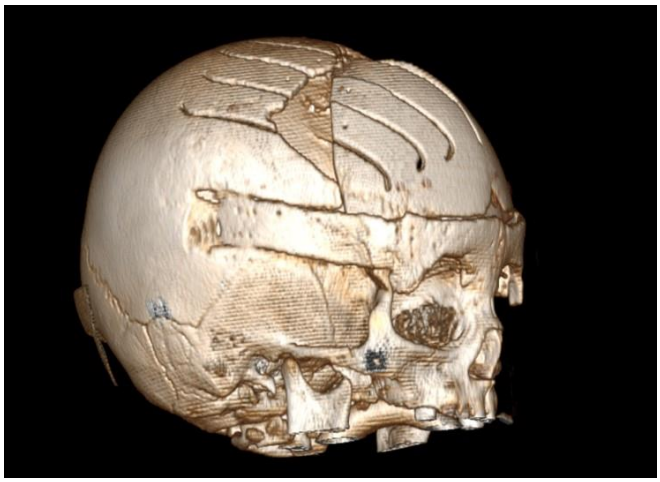

Figure 3 - Skull tomography with bone phase reconstruction in 3D aspect after 10 days.

rejection of the material, hyperthermia or inflammation. Displacement of the material and the technique was the same as that used despite of different types of craniostenosis, age and sex. Over time, it is possible to observe in tomographic series the complete osteointegration of apatite hydroxide into the bone – figure 4.

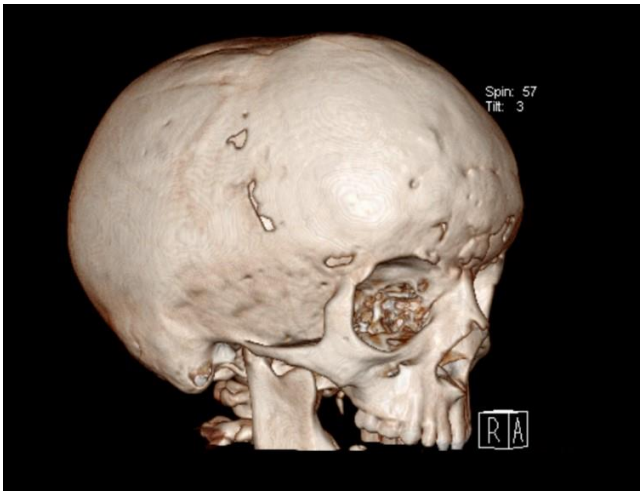

Figure 4 - Skull tomography with bone phase reconstruction in 3D aspect after 2 years.

It is possible to show that the technique is easily reproducible, even in specific remodeling objectives without changing the mode of fixation of the orbital bandeau, bringing greater early safety to frontal and orbital multidimensional remodeling.

CONCLUSION

The present paper confirms that the use of the apatite hydroxide bandeau is a fundamental technical variation in fronto-orbital advancement. The use of the bandeau mechanically redistributes bone pressure vectors on the cranial diploic surface and, in addition, the osteo-inductive properties of apatite hydroxide favor early reossification without associated infectious complications.

DISCLOSURES

Ethical approval

This study was performed in line with the principles of the Declaration of Helsinki. Research with databases, whose information is aggregated, without the possibility of individual identification

Conflict of interest

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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Artificial intelligence

No.

CONTRIBUTIONS

-**Tiago de Paiva Cavalcante**: Conceptualization, Investigation, Methodology, Project administration, Supervision, Writing – review & editing
-**João Victor de Souza Santos**: Data curation, Methodology, Writing – original draft
-**Carlos Alberto Miranda Lyra**: Data curation, Formal Analysis, Visualization
-Rilton Marcus Morais: Supervision

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