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Case Report

Minimally invasive pericranial incisions as an alternative for fronto-orbital advancement in a pediatric patient with craniosynostosis: Case report

Nicolás Solano[a,b], Manuel Linares[a,b,*], Gabriel Hernández[c], Jondalys López[a,b]

[a] Craniofacial Surgery Unit, University Hospital of Maracaibo, Venezuela
[b] Oral Surgery Post-graduated Program, School of Dentistry, Zulia's University, Venezuela
[c] Neurosurgery Service, University Hospital of Maracaibo, Venezuela

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ABSTRACT

The coronal approach is a viable alternative for the treatment of problems related to the craniomaxillofacial complex. It can be used for fronto-orbital advancement procedures. The aim was to propose minimally invasive pericranial incisions as an alternative in the conventional coronal approach for fronto-orbital advancement to reduce blood loss and operative times, through a case report. In this study, the authors have focused on developing an alternative within the protocol of the conventional coronal approach through minimally invasive pericranial incisions at osteotomy sites for both the craniotomy and the fronto-orbital band in a pediatric patient with syndromic craniosynostosis. The use of minimally invasive incisions in the pericranium for the coronal approach represents an excellent alternative that allows to significantly reduce blood loss and surgical times.

1. Introduction

The selection of a surgical approach is important in the treatment plan for problems involving the craniomaxillofacial complex. In such situations, the coronal approach is a viable alternative, described by Hartley and Kenyon in 1907. This approach has gained popularity among craniomaxillofacial surgeons, after Tessier, Henderson and Jackson used it for craniofacial deformities, trauma and pathology [1–3]. It has been described as an incision behind the hairline and two lateral components located in the preauricular areas, with some variants such as endaural and postauricular. It is important to note that the amount of exposure of the frontoorbital region will be directly proportional to the lower extent of the incision and not to the most anterior position of the incision. The execution of this approach implies careful attention regarding hemostasis, which is especially important in the pediatric population, due to the potential loss of blood volume. However, for fronto-orbital advancement (FOA) techniques, the creation of wide subperiosteal flaps has been well described and can increase blood loss [4,5]. In our study, we have focused on the development of a pericranial flap with minimally invasive incisions with the aim to describe them as an alternative in the conventional coronal approach for FOA to reduce blood loss and operative times.

2. Case report

As previously mentioned, the coronal approach is the gold standard for achieving good access to the upper facial third and the anterior cranial segment. On the other hand, to address the bony component of these craniofacial areas, it is necessary to raise a pericranial flap. In pediatric craniofacial surgeries, we must take into account two premises to reduce intraoperative risks, such as: controlling bleeding and being efficient and effective in the shortest surgical time, with the aim of maintaining stable hemodynamic parameters in these patients and thus, ensuring better postoperative evolutions. For this reason, we have implemented certain strategies to meet these objectives, through minimally invasive pericranial incisions.

A 25-months-old male patient with crouzon syndrome and turricephaly secondary to bicoronal and lambdoid synostosis and exophtalmia attended our service. Increased intracranial pressure was noted along with epilepsy and psychomotor development retardation. The technique was performed under general hypotensive anesthesia in association with the neurosurgery service at our institution. Perioperative antibiotics and steroids were used, as well as infiltration of the scalp with local anesthetic (0.5 % lidocaine and 1:100,000 parts epinephrine) before incision, which began with a conventional bicoronal approach, exposing the anterior cranial segment and the upper third of the face (Fig. 1).

At this time, we started our anterior craniotomy in a standardized

* Corresponding author at: Virrey Olaguer y Feliu 3350, Colegiales, Autonomous City of Buenos Aires, Argentina.
E-mail address: manuellinarescano@gmail.com (M. Linares).

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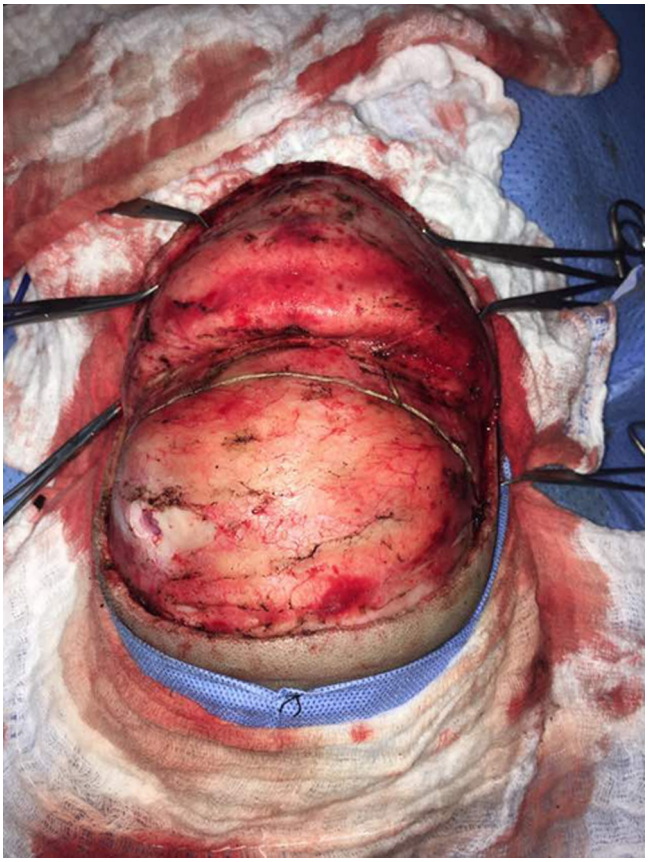

Fig. 1. Pericranial incisions.

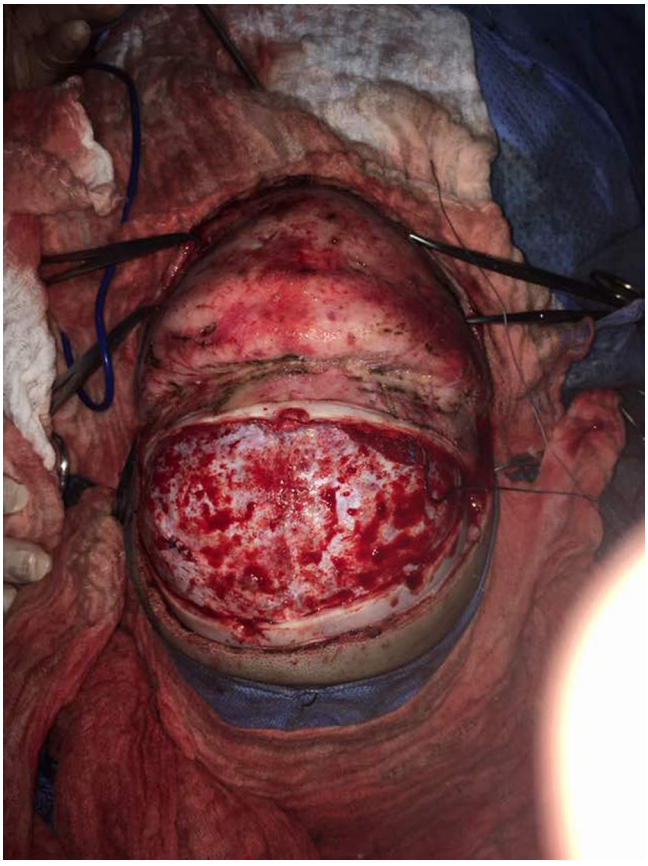

Fig. 2. Frontal craniotomy.

Fig. 3. Fronto-orbital osteotomy.

Fig. 4. Fronto-orbital band.

manner, except that we only made periosteal incisions in the sites to be osteotomized (Fig. 2), likewise, under the same protocol, the release of the supraorbital band was initiated (Fig. 3). Subsequently, once the bony component that involved the fronto-orbital region was modified, it was advanced and fixed using 3 − 0 silk suture with the clear objective of creating a new open coronal suture that allows the brain to grow without mechanical restrictions (Fig. 4). During surgery, 250 mL of erythrocyte concentrate of 60 % was administered according to the amount of bleeding from the osteotomy sites in the suction bottle and the number of saturated sponges. The bicoronal incision was closed in layers with resorbable sutures. Drains were placed for 2 days and the head was covered with a sterile head wrap dressing.

Table 1
Clinical data of the case.

	Patient's Data
Gender	Male
Age (Months)	25
Weight (kg)	12.4
Diagnosis	Crouzon Syndrome (Turricephaly)
Specific affected suture	Coronal and Lambdoid
Treatment	Fronto-orbital advancement
Total blood loss	184.02 mL
Operation time	3h15m
Hb intraoperative	11.2 g/dl
Hb Postoperative	8.8 g/dl
iRCT (volume of red blood cells transfused intraoperatively)	180 mL

Antibiotics were given for 48 h postoperatively. After the procedure, the surgery data was provided by the anesthesia records (Table 1): operative time (duration from incision to closure), administered red blood cells and the calculated blood loss (determined using the formula described by Faberowski et al. [6].)

3. Discussion

The treatment of craniosynostosis is essentially surgical, aiming to improve form and function as well as address the risks of raised intracranial pressure (ICP). Normally, in this kind of surgery a coronal flap incision is needed [7]. Intraoperative complications related to the bicoronal flap and FOA performed on young children may be present, associated with potential risks like significant blood loss. Several studies have been published describing approaches to minimize blood loss and manage blood replacement during craniofacial surgery for anomalies, trauma and pathology [8,9]. For this reason, the authors proposed an alternative to the standard coronal approach through minimally invasive pericranial incisions only in the sites of osteotomies for the craniotomy and the fronto-orbital band unlike the original technique, which proposes the entire flap to be raised along with the periosteum [10]. In this way, we managed to reduce blood loss and even surgical time significantly, based on Moss' proposal to leave the periosteum attached to the advanced bone, in order to prevent insidious blood loss [11].

Our results are close with the ones found in the study of Hönig et al. [12], which performed subgaleal dissections and compared it with subperiosteal approaches in 29 children who underwent surgery (fronto-orbital advancement for craniosynostosis). They observed that subgaleal dissections caused a mean blood loss of less than 163 mL, compared with the subperiosteal group, which had a mean blood loss of 266 mL.

Some other authors such as White et al. [9], Seruya et al. [13] and Howe et al. [14] have reported higher numbers of blood loss compared to our case and the study described by Hönig et al. [12]. This could be due to the inclusion of vascularized layers of intact subgaleal fascia with the flap, which increases blood supply since the large perforating vessels are preserved; avoiding the rupture of these vessels and reducing bleeding [15].

Therefore, a standardized surgical approach should be able to reduce surgical time and blood loss with the clear objective of creating a new coronal suture that allows the brain to grow without mechanical restrictions and, thus, avoidance of permanent neurological sequelae as well as the increase the depth of the orbital cavity, giving greater protection to the eyeball. Likewise, by not completely de-periostizing the bony segments, a better locoregional regenerative capacity is guaranteed due to the osteogenic potential of the pericranium, as explained by Moss et al. [11] and Snyderman et al. [16].

A long surgical time is an important factor that influences bleeding. Therefore, the experience of the surgical team can reduce the duration of the surgery and also indirectly reduce bleeding. White et al. [9], concluded that there was significantly greater blood loss in those patients with craniofacial syndromes, younger than 18 months and / or with an operation time greater than 5 h. Although, Howe et al. [14] and Kucuk et al. [17] have described that shorter surgical times were associated with a decrease in blood loss in fronto-orbital advancement with subgaleal dissection, with results similar to ours with operating times of approximately 3h20 m; supporting the results of our study. However, these results are not comparable with those of our study, because only one case is being reported.

Several studies have shown the presence of variables such as blood loss and the operating time in fronto-orbital advancement with conventional technique (Table 2) [9,12–14,18,19]. As a matter of fact, Ali et al. [18] and Chang et al. [19] reported operative times around 3h20 m but blood loss higher than 260 mL. This may be due to the fact that the galeal flap can be prepared when the skin flap is elevated at the first stage of surgery, thus offering substantial advantages in terms of shorter operative time and reduced invasiveness. Also, the use of pericranial flaps in the site of osteotomy such in our case, reduces the risk associated with vascular anastomosis, making them a safer choice for reconstruction [20]. Therefore, our findings suggest that improved operative efficiency, through the use of minimally invasive pericranial incisions, will reduce blood loss and operative time in the surgical approach of severe craniosynostosis in pediatric patients such as the case.

The management protocol for craniosynostosis applied by the authors in their Craniofacial surgery unit begins with the aforementioned procedure during the first years of life of the patient in order to address the upper facial third. Subsequently, at the age of 7–9 years, a middle facial third correction is performed. Finally, during adolescence, the patients are submitted to orthognathic surgery with the purpose of giving harmony, symmetry and balance to the craniofacial complex.

4. Conclusion

Blood loss is a central concern in craniosynostosis surgery and thus, meticulous and continuous control of hemostasis is paramount. The use of minimally invasive incisions in the pericranium for the coronal

Table 2
Studies included of blood loss and operative time for fronto-orbital advancement with conventional technique.

Authors	Epidemiological Characteristic				Blood Loss (ml)	Operative Time
	Total Cases (n)	Total Syndromic Cases (%)	Median Age (Months)	Weight (kg)		
White N, et al. [9]	116	18.1	18		220	5h 11m
Hönig J, et al. [12]	29	37.9	5.8	6.3 ± 0.7	266	3h20m
Seruya M, et al. [13]	90	13.3	10.7 ± 12.9	9.0 ± 7.0	259.3	4h20m
Howe PW, et al. [14]	65	23.7	11.5	9.4	256	3h20m
Alí A, et al. [18]	42	23.8	9.2 ± 3.2	9.3 ± 2.0	310	3h20m
Park C, et al. [19]	58	5.17	9.5 ± 15.6	10.3 ± 3.9	309	3h44m

approach represents an excellent alternative that allows to significantly reduce blood loss and surgical times, details of utmost importance in hemodynamic homeostasis in pediatric patients with syndromic craniosynostosis. Despite of this, given the low frequency described in the literature and several limitations of this study, further clinical studies are required to assess advantages and/or limitations of this technique.

Ethical approval

All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

Informed consent

The manuscript does not contain clinical studies or patient data.

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Declaration of Competing Interest

The authors declare that they have no conflicts of interest.

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