Journal of Cranio-Maxillo-Facial Surgery 42 (2014) e148–e151

Contents lists available at ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

Long-term incidence of sensory disturbance in the forehead after fronto-orbital advancement in isolated nonsyndromic craniosynostosis

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ARTICLE INFO

Article history:
Paper received 7 March 2013
Accepted 17 July 2013

Keywords:
Fronto-orbital advancement
Trigonocephaly
Supraorbital nerve
Craniosynostosis

ABSTRACT

In the majority of the craniofacial literature, preservation of the supraorbital nerve during fronto-orbital advancement (FOA) is recommended. However, only a few studies have evaluated the incidence of sensory disturbance in the forehead after FOA during long-term follow-up.

57 children who underwent FOA in their first year of life because of isolated nonsyndromic craniosynostosis including trigonocephaly, anterior plagiocephaly or oxycephaly, were evaluated for sensory disturbance in the frontal region with a minimum follow-up of 27 months.

An objective and repeatable measurement using the Semmes–Weinstein test was possible in 36 children older than 5 years at last follow-up. We revealed no sensory deficits in all patients, even in 3 patients, where one of the supraorbital nerves was transected during FOA.

As previous reports have suggested a full recovery of sensation after transection of the supraorbital nerve during FOA I seen, the need to preserve the nerve has to be evaluated. However, as release of the nerve from the supraorbital rim is possible, we generally recommend preserving this structure, to minimize the risk of sensory deficits in the forehead region.

1. Introduction

In craniofacial surgery, open surgical procedures including fronto-orbital advancement (FOA) are considered to be the "gold standard" to correct malformations like trigonocephaly, anterior plagiocephaly and oxycephaly in isolated craniosynostosis (Engel et al., 2013, 2012; Freudlsperger et al., 2013; Mesa et al., 2011; Selber et al., 2008). FOA is a standardized and well-established surgical technique, which allows opening the abnormally closed suture, increasing the intracranial volume, correcting the position of the bone segments and inducing cranial growth in the desired direction. The operation consists of removing, shaping and repositioning the fronto-orbital skull segments (Aryan et al., 2005; Collmann et al., 1996; Engel et al., 2012; Fearon et al., 2009; Whitaker et al., 1987).

An inherent step during the surgical procedure is the release of the supraorbital nerves from the supraorbital rim. The supraorbital nerve is a branch of the frontal nerve, which originates from the ophthalmic branch of the trigeminal nerve and supplies sensation to parts of the forehead skin (Knize, 1995). The supraorbital nerve trunk exits the superior orbital rim through its foramen or notch (Fig. 1), forming a superficial (medial) and a deep (lateral) division both innervating the ipsilateral skin from the midline scalp laterally to the level of the superior temporal line of the skull (Knize, 1995). Generally, identification and isolation of the supraorbital nerve is recommended (Wiewrodt and Wagner, 2009), however, this risks damage to the nerve due to intra-operative manipulation. If the nerve runs through a notch, it can be separated by subperiosteal dissection from the bone, however, if the nerve runs through a canal, the canal must be opened which is usually accompanied by a higher risk of nerve damage (Mühling, 1991). Several studies have already been published about the successful esthetic outcome after FOA (Aryan et al., 2005; Engel et al., 2012; Fearon et al., 2009; Selber et al., 2008; Whitaker et al., 1987), but very few reports have paid particular attention to the affection of the supraorbital nerve during the surgical procedure (Wiewrodt and Wagner, 2009).

As recent reports have indicated a full sensory compensation after transection of the supraorbital nerve during FOA, and that partial preservation might result in dysesthesias in the forehead, this study evaluated the incidence of injuring to the supraorbital

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1010-5182/$ – see front matter
http://dx.doi.org/10.1016/j.jcms.2013.07.012

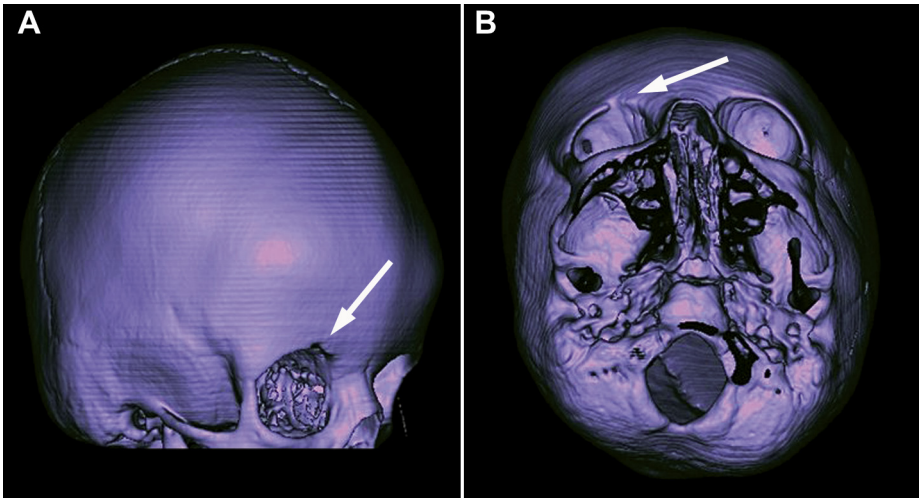

Fig. 1. 3D-computertomographic scans of a patient with isolated coronal synostosis and anterior plagiocephaly. The typical fissure in the course of the supraorbital nerve can be identified in the middle of the orbital roof. (A) Lateral view, (B) sagittal view.

nerve after FOA in single suture craniosynostosis, in a long-term follow-up of 6 years.

2. Material and methods

This retrospective study used a standardized measurement protocol, examined and approved by the local Ethics Committee (Ethics number S-237/2009). The study was carried out according to the Declaration of Helsinki and written informed consent was obtained from the parents. The database of the Department of Oral and Maxillofacial Surgery at the University Hospital of Heidelberg was searched to identify children who underwent surgery with open FOA in isolated nonsyndromic craniosynostosis between January 2004 and December 2009. The following data were retrospectively collected: name, date of birth, sex, age at point of operative correction and last date of follow-up examination. In order to create a homogenous study population we only included patients with (1) isolated nonsyndromic craniosynostosis, (2) a single cranial vault remodeling procedure with FOA, (3) no second surgical approach in the follow-up, (4) age at the time of surgery under 1 year of age, (5) a follow-up after surgery of at least 27 month.

To evaluate sensory disturbance in the forehead region, we used the Semmes–Weinstein monofilaments. This non-invasive sensitivity test consists of 5 standardized monofilaments with different diameter, which allows an objective and repeatable measurement (Bell-Krotoski and Tomancik, 1987). As the supraorbital nerve consists of a superficial (medial) and a deep (lateral) division (Knize, 1995), we evaluated each side of the forehead with regard to both parts of the nerve: (I) From the forehead midline laterally to a vertical line drawn through the supraorbital foramen and (II) laterally from the supraorbital foramen to the superior temporal line of the skull.

3. Results

We identified 57 children (36 male, 21 female) who were eligible for our study (Table 1). 40 children suffered from trigonocephaly, 14 from anterior plagiocephaly and 3 from oxycephaly. The average age at referral was 5.3 months (±2.9). The surgical procedure was performed at an average age of 10.4 months (±1.5). All operations were performed by the same craniofacial team, consisting of two senior staff surgeons. According to our

Table 1
Patient data in chronological order. In children below the age of 5 (21), a reliable and repeatable measurement of sensory disturbance in the frontal region was not possible. In children older than 5 years of age (36), no sensory deficits or irritations in the region of interest could be noted in our examination results using the Semmes–Weinstein test.

Initials	Gender	Diagnosis	Age at surgery (months)	Follow-up (months)	Age at last clinical examination (years)	Sensory at the forehead
H.J.	m	Trigonocephaly	12.9	24.8	3.1	n.a.
F.M.	m	Anterior plagiocephaly (left side)	12.9	24.0	3.1	n.a.
H.T.	m	Trigonocephaly	11.5	24.2	3.0	n.a.
W.M.	w	Trigonocephaly	12.5	26.2	3.2	n.a.
D.R.	w	Trigonocephaly	12.4	26.8	3.3	n.a.
B.E.	w	Plagiocephalus	6.8	29.5	3.0	n.a.
H.L.	m	Trigonocephaly	10.3	30.1	3.4	n.a.
T.J.	m	Trigonocephaly	11.4	31.8	3.6	n.a.
R.A.	w	Trigonocephaly	11.3	33.9	3.8	n.a.
D.C.	m	Trigonocephaly	9.7	34.0	3.6	n.a.
D.L.	m	Trigonocephaly	9.1	34.6	3.6	n.a.
R.S.	m	Anterior plagiocephaly (right side)	12.0	35.7	4.0	n.a.
N.D.	m	Trigonocephaly	9.6	36.6	3.9	n.a.[a]
F.J.	m	Trigonocephaly	12.0	36.6	4.1	n.a.
L.M.	m	Trigonocephaly	12.0	37.4	4.1	n.a.
H.J.	w	Trigonocephaly	5.4	38.1	3.6	n.a.
Z.S.	w	Trigonocephaly	10.7	38.8	4.1	n.a.
P.P.	m	Trigonocephaly	11.5	44.2	4.6	n.a.
K.H.	m	Trigonocephaly	11.1	45.4	4.7	n.a.
L.Y.	m	Trigonocephaly	10.1	47.0	4.8	n.a.
M.D.	w	Oxycephaly	11.0	47.7	4.9	n.a.
L.N.	m	Anterior plagiocephaly (right side)	11.6	50.4	5.2	No deficits[a]
Z.K.	m	Trigonocephaly	11.1	53.0	5.3	No deficits
K.M.	m	Trigonocephaly	10.6	53.2	5.3	No deficits
F.M.	m	Trigonocephaly	11.9	54.4	5.5	No deficits
A.C.	w	Trigonocephaly	10.6	55.0	5.5	No deficits
D.C.	m	Trigonocephaly	11.7	55.0	5.6	No deficits
S.R.	m	Trigonocephaly	10.1	55.8	5.5	No deficits[a]

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