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Stable fixation with absorbable sutures in craniofacial surgery

C. Linz [a, *], F. Kunz [b], J. Krauß [c], H. Böhm [a], C. Wirth [d], S. Hartmann [a], J. Wirbelauer [e], T. Schweitzer [c]

[a] Department of Oral and Maxillofacial Plastic Surgery, University Hospital of Würzburg, Würzburg, Germany
[b] Department of Orthodontics, University Hospital of Würzburg, Würzburg, Germany
[c] Department of Neurosurgery, Section of Pediatric Neurosurgery, University Hospital of Würzburg, Würzburg, Germany
[d] Department of Pediatric Radiology, Institute of Diagnostic and Interventional Radiology, University Hospital of Würzburg, Würzburg, Germany
[e] Department of Pediatrics, University Hospital of Würzburg, Würzburg, Germany

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ABSTRACT

The present study analyses the exclusive use of absorbable suture material (Vicryl®, Ethicon, Germany) in the fixation of transposed bone segments in craniofacial surgery without modification of the osteotomy design.

Among 129 children up to 24 months of age, osteosynthesis was conducted exclusively with Vicryl® sutures. The stability of postoperative results was evaluated and possible foreign body reactions were examined within the framework of clinical and radiological routine checks.

All examined children exhibited stable postoperative conditions while the length of hospital stay was not affected. X-ray examinations of the skull in two planes demonstrated good bony union in all cases. Relevant foreign body reactions were not observed.

The exclusive application of absorbable suture material enables stable and cost effective osteosynthesis. Significant foreign body reactions were not observed. The exclusive use of absorbable sutures did not alter the osteotomy design.

1. Introduction

The surgical treatment of craniofacial malformation consists of osteotomy and repositioning of the affected region (Pagnoni et al., 2014). Stable osteosynthesis is dependent on immobile fixation of the communicating osteotomy edges, which plays a decisive role in the successful treatment of afflicted children (Whitaker et al., 1987). Historically, wire ligatures were among the first materials to be implemented in osteosynthesis (Striker et al., 1990; Lerch, 1999). They enabled relatively stable as well as cost effective fixation of the translocated bone segments (Striker et al., 1990). Drawbacks of this method included cumbersome handling, transposition with regard to transosseous migration of the osteosynthesis materials, as well as danger of an injury to the overlying scalp (Kosaka et al., 2003). Later developments in osteosynthesis materials include titan micro plates which enable simple, well defined and stable fixation (Smith and Pelofsky, 1991; Ohata et al., 1998). Disadvantages of the implementation of these non-absorbable plates were artefacts in radiological examinations and potential transosseous migration (Goldberg et al., 1995; Papay et al., 1995; Barone and Jimenez, 1996; Duke et al., 1996). These problems were seemingly solved at the end of the 1990s with the introduction of absorbable osteosynthesis plates and screws composed of absorbable polymers (Kumar et al., 1997; Montag et al., 1997; Tharanon et al., 1998; Wiltfang et al., 1999; Eppley and Li, 2003; Eppley et al., 2004; Sauerhammer et al., 2014; Salokorpi et al., 2015). It must be noted, however, that not only hydrolytic foreign body reaction, but also a loss of tensile strength right up to increased rates of material breaches have been observed through the implementation of this method (Bos et al., 1989; Bergsma et al., 1993; Losken et al., 2001; Dorri et al., 2009; Ballard et al., 2010; Wood et al., 2012). Similar to the aforementioned methods, absorbable plates also demonstrate the problem of palpability of the implant (Yaremchuk, 1994; Tharanon et al., 1998). A simple, stable and cost effective osteosynthesis method is offered through the correct fixation of displaced bone segments with absorbable sutures (Fearon, 2003). In our craniofacial centre, absorbable sutures have been used to fixate transposed bone

* Corresponding author. Department of Oral and Maxillofacial Plastic Surgery, University Hospital of Würzburg, Pleicherwall 2, 97070 Würzburg, Germany. Tel.: +49 931 201 74200.
E-mail address: linz_c@ukw.de (C. Linz).

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segments for over 15 years. Specifically, Vicryl® sutures (Ethicon, Germany) are implemented in the treatment of children up to two years of age. In the treatment of children over two years of age Polydioxanone sutures (PDS, Ethicon, Germany) are used in order to exploit the extended time of resorption. In this study we included craniofacial operations in which the fixation of bone segments was performed exclusively with absorbable Vicryl® sutures. The surgical procedure remained consistent with that of plate osteosynthesis.

2. Material and methods

2.1. Patients

A total of 129 children (86 male, 43 female) with premature closure of at least one cranial suture were included in this study (Table 1). We investigated children with monosutural non-syndromic craniosynostosis, among sagittal (n = 62), metopic (n = 22), uni- (n = 10) or bilateral coronal (n = 6), unilateral lambdoid (n = 3) affected sutures. Moreover, 21 children with syndromic premature craniosynostosis were investigated (5 children diagnosed with Apert syndrome, 9 with Morbus Crouzon, 3 with Saethre–Chotzen syndrome, 3 children with Muenke syndrome and 1 with Pfeiffer syndrome). 5 children in this study were operated because of a non-syndromic plurisutural craniosynostosis.

The mean age at first referral to our craniofacial centre was 4.6 months (SD 3.2, ages between 0 and 17.6 months). Depending on the affected suture or individual situation, surgery was performed at different time-points, with a mean age of 10.0 months (SD 4.3, ages between 3.5 and 20.7 months). Children were discharged from the clinic an average of 7.5 days (SD 1.5) following surgery. All children attended all follow-up examinations that were already part of our existing clinical routine.

2.2. Surgery and follow-up

Within the scope of clinical routine, the performed surgical care was adapted with regard to respective age and diagnosis. The application of absorbable sutures was the only technical change in this study. Stable fixation of the transposed bone segments was achieved through the implementation of absorbable Vicryl® sutures, sizes 1-0 and 2-0 (Ethicon, Germany). At least one of three experienced craniofacial surgeons (T.S., H.B., J.K.) took part in every surgery.

The operations were performed between March 2007 and June 2014.

Follow-up ensued within the context of interdisciplinary doctors' consultation visits. During these consultations, postoperative clinical results were evaluated by a paediatric neurosurgeon as well as by a neuropaediatrician. Consistency of intraoperatively achieved stability was assessed through subjective evaluation and palpation. Additionally, children were examined for possible signs of foreign body reaction specifically manifested through local redness, rejection or systemic reaction. Routine postoperative cranial X-ray images were conducted in two planes. Follow-up radiographic imaging allowed for evaluation of the degree of ossification as well as the stability of the intraoperative bone relocation or transposition. Specifically, possible postoperative dislocations, resulting from a loosening or tear of the applied suture material, were evaluated.

3. Results

62 children with premature monosutural sagittal synostosis initially presented in our centre at a mean age of 3.6 months (SD 1.6, ages between 0.2 and 7.4 months). Surgical care through broad median craniectomy including an active tilting of the forehead was executed at the age of 6.5 months (SD 1.2, ages between 3.5 and 10 months). The children were discharged from the clinic at a mean of 7.2 days (SD 1.5) postoperatively. In one case the child was discharged four days after surgery, as requested by the parents. Two children experienced a delayed discharge at 11 and 14 days, respectively, due to reasons that were not directly related with surgery. The follow-up timeframe for this subgroup, including radiographic examination performed as a skull X-ray in frontal and lateral projection, averaged 9.7 months (SD 6.0). These radiographs demonstrated stable postoperative results, detected through preserved angle of tilting in all cases. Relevant complications were not observed in this group and further interventions were not necessary.

The 22 children enrolled in this study with premature closure of the metopic suture had a median age of 5.4 months (SD 2.1, ages between 1.0 and 9.4 months). Fronto-orbital advancement (FOA, Fig. 1) was performed at a mean age of 12.6 months (SD 1.6, ages between 10.6 and 18.4 months). The children in this subgroup were also discharged from the clinic at an average of 7.5 days (SD 1.2)

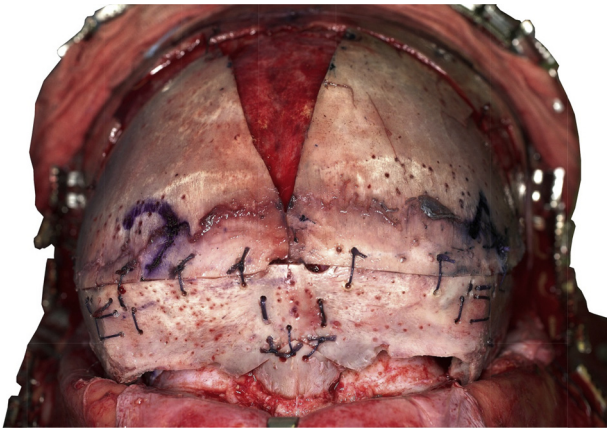

Fig. 1. Intraoperative situs of a fronto-orbital advancement with Vicryl® sutures used for stable fixation, frontal view.

Table 1
Patients investigated in the study and detailed information to time points and timeframes.

	Sagittal synostosis	Metopic synostosis	Unilateral coronal synostosis	Bilateral coronal synostosis	Lambdoid synostosis	Plurisutural synostosis	Syndromic children
Children	62	22	10	6	3	5	21
Sex, male/female, *n*	47/15	14/8	4/6	2/4	2/1	4/1	13/8
Mean age at first referral, *years* (SD)	3.6 (1.6)	5.4 (2.1)	8.4 (4.4)	3.7 (2.9)	2.9 (0.7)	7.2 (5.8)	4.9 (5.3)
Mean age at surgery, *years* (SD)	6.5 (1.2)	12.6 (1.6)	15.0 (3.1)	15.6 (2.6)	10.8 (2.8)	13.8 (3.2)	12.3 (4.9)
Mean postoperative hospitalization, *days* (SD)	7.2 (1.5)	7.5 (1.2)	7.2 (0.6)	7.5 (0.5)	7 (0.0)	8.2 (1.5)	8.9 (2.3)
Mean follow-up time, *month* (SD)	9.7 (6.0)	17.5 (13.0)	13.0 (10.5)	22.3 (21.6)	29.8 (13.5)	3.3 (4.1)	12.5 (7.0)
Mean age at last follow-up examination [including skull X-ray], *month* (SD)	16.2 (6.2)	30.1 (13.4)	28.0 (10.9)	38.0 (22.1)	40.5 (15.2)	17.1 (5.3)	24.8 (9.5)
Surgical and material related complications, *n*	0	0	0	0	0	0	0