Bone flap resorption in infants

To the Editor: We read with interest the article by Bowers et al.1 (Bowers CA, Riva-Cambrin J, Hertzler DA II, et al: Risk factors and rates of bone flap resorption in pediatric patients after decompressive craniectomy for traumatic brain injury. Clinical article. J Neurosurg Pediatr 11:526–532, May 2013). Their retrospective study reports on 54 patients, ranging in age from 6 months to 16 years, who underwent decompressive craniectomy for traumatic brain injury, thus representing the second largest experience in the pediatric literature to date. Bone resorption was observed in 50% of the patients. Underlying contusion, comminuted skull fractures, a permanent ventriculoperitoneal shunt, and age under 2.5 years were found to be independent risk factors for bone flap resorption on multivariate analysis. The impact of age on the risk of bone resorption may be further highlighted because 10 (71.4%) of 14 patients under 2.5 years old experienced this complication.

In previous papers focusing on pediatric populations, no correlation between age and the risk of bone resorption was found. However, in the article by Piedra et al. we can assume that no patients under 2.5 years old were included because the mean age was 8.03 ± 5.30 years in the group of patients who received early cranioplasty and 10.8 ± 5.46 years in the group of patients who received late cranioplasty. The variable of age was dichotomized as younger or older than 10 years and did not result in statistical significance.4 However, infants were included in the study by Grant et al., who collected data on 40 children and adolescents younger than 20 years (mean 9.3 years, range 6 weeks to 19 years) at time of initial injury. Although age did not correlate with failure of autograft, the number of patients younger than 2.5 years and the type of dichotomization of the variable age for statistical analysis were not clearly stated in the paper.3 These findings could eventually explain why patient age did not result in being a risk factor for bone flap resorption in previous pediatric experiences.

Again, Bowers et al. are to be congratulated on highlighting the impact of young age, in particular age less than 2.5 years. They correctly observed that 83% of intracranial volume expansion is complete by 2 years of age and that the reossification of calvarial defects is more effective at this age, as confirmed by experiences in craniosynostosis surgery. Thus, the authors found the higher rate of bone resorption in patients younger than 2.5 years apparently in contrast to the expected bone healing at this age. Therefore, they hypothesized that the increased metabolic demand of the calvaria at this age would eventually exceed the ability of the extremely large bone flaps to create a fusion. This hypothesis would be confirmed by the higher rate of bone flap resorption observed by Grant et al. for larger bone flap (> 75 cm).3

We have already proposed the crucial role of age-related factors in a paper focusing on the complications of autologous cranioplasty after decompressive craniectomy in patients younger than 1 year.2 Indeed, in our experience the rate of bone resorption increases to 100% in this subgroup of patients.

The intrinsic factors favoring the bone flap resorption at this age are as follows: minor bony reserve, pushing force of the growing brain, loss of a dural layer resulting in the loss of mechanical strain and subsequent decrease of osteogenic growth factors, and impaired CSF dynamics (subdural collections, hydrocephalus). In particular, we have pointed out that “in infants and young toddlers, the cranioplastastic graft is subjected to the ab interno forces resulting from the concomitant brain growth, which, in turn, are attenuated after the second year of age. These forces, which play a positive remodelling role after bilateral cranioplasty (e.g. in the treatment of craniosynostoses), could be critical in the osteointegration of unilateral cranioplasty bone flap.”

The influence of these factors would decrease with age, thereby explaining why the rate of bone resorption is 100% in infants under 1 year of age, as reported in our experience; about 70% in children under 2.5 years of age, as extrapolated from the paper by Bowers et al.; and 50% in the general pediatric population (< 18 years), as already demonstrated by Grant et al.3 and confirmed by Bowers et al.

New solutions and surgical options should be investigated in infants in order to reduce the risk of bone flap resorption or at least decrease the risk component related to young age.

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Disclosure

The authors report no conflict of interest.

References

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RESPONSE: We appreciate the kind comments and important insights contributed by Frassanito et al. regarding the important finding that patient age less than 2.5 years was an independent risk factor for bone flap resorption (BFR). All 3 of their patients under 1 year of age who underwent decompressive craniectomy for traumatic malignant intracranial hypertension experienced BFR.2 As they noted, 71.4%, or 10 of 14, of our patients younger than 2.5 years experienced BFR. Their excellent discussion points regarding the age-related factors predisposing very young children to BFR were published after the preparation of our manuscript. Their article is a great resource for all of those interested in the age-related factors that may predispose the very young to BFR.

Frassanito et al. also note that the 2 previous large pediatric BFR studies by Grant et al.3 and Piedra et al.4 did not identify young age as a risk factor for BFR. Frassanito et al. identify clear reasons from these 2 studies that could explain why very young age was not found to be a risk factor for BFR. These include the fact that Grant et al. did not specify the number of very young patients and that the method of age dichotomization and subsequent statistical analysis in their study are unclear, and that Piedra et al. apparently did not include very young patients in their cohort. We would also stress that both of these studies included nontrauma patients in their study groups, and we believe that the trauma patients should be analyzed separately from other groups of patients who underwent decompressive craniectomy procedures. Indeed, we found 2 independent risk factors for BFR that are unique to trauma patients: 1) the presence of an underlying parenchymal contusion, and 2) the presence of comminuted skull fractures.

It is important to note that it is difficult to make any definitive conclusions or clear recommendations regarding the different risk factors for pediatric BFR based upon the current literature. This is highlighted in the article by Rocque et al.2 that appeared in the Journal of Neurosurgery: Pediatrics last month, which reported the findings of their systematic review on cranioplasty outcomes in pediatric patients after decompressive craniectomy. They included 441 cranioplasty patients from 11 studies in their study group, and their study variables included craniectomy size, time to cranioplasty, bone flap storage method, complication rates, skull defect size, and cranioplasty material used. They concluded that no specific risk factors for BFR have been identified in pediatric patients. These same authors noted that a multicenter retrospective study is currently underway to try to identify risk factors for BFR in a much larger group of patients.

Nevertheless, 2 extremely large recent BFR studies with more than 600 patients identified risk factors for BFR that support what we found in our study. These studies, by Schuss et al.6 and Dünisch et al.,1 consisted primarily, but not exclusively, of adult patients. Dünisch et al. had almost identical results to ours, with the independent risk factors for BFR consisting of bone flaps broken into multiple fragments, younger patient age, and shunt-dependent hydrocephalus. Schuss et al. also identified multiple bone flap fragments as an independent risk factor for BFR. Additionally, they found that an early replacement of the native bone flap (autologous cranioplasty) less than 8 weeks after the decompressive craniectomy was an independent risk factor predisposing to BFR.

Unfortunately, the literature is scant and conflicting regarding the different risk factors for BFR in pediatric decompressive craniectomy patients. The literature is also extremely heterogeneous with respect to patient population and methodology. Although we encourage and look forward to further studies clarifying the current state of the literature, we reiterate that, based upon our institutional experience in pediatric patients undergoing autologous cranioplasty with their native bone flap after decompressive craniectomy, age less than 2.5 years, underlying parenchymal contusion, comminuted skull fractures, and the presence of a permanent ventriculoperitoneal shunt are all independently associated with increased BFR.

References

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