



# Piezosurgical Suturectomy and Sutural Distraction Osteogenesis for the Treatment of Unilateral Coronal Synostosis

Weiming Shen, MD\*

Jie Cui, MD\*

Jianbin Chen, PhD\*

Barbara Buffoli, PhD†

Luigi Fabrizio Rodella, MD†

Jijun Zou, MD\*

Yi Ji, MD\*

Haini Chen, PhD\*

**Summary:** Different surgical procedures are used for the treatment of synostosis. Among them, suturectomy and sutural distraction osteogenesis (SDO) are suitable for young infant patients. In this report, we present the case of a young infant patient with a clear synostosis of the left coronal suture, which was treated by piezoelectric suturectomy combined with SDO and 2 internal distractors. One-year follow-up showed good results. Thirty-six months after surgery, normal skull growth and shape were observed by 3D computed tomographic examination. No infection, bleeding, fistula, and other complications were observed. The results suggested that the treatment of unilateral coronal synostosis in young infant patient by piezosurgical suturectomy and SDO is to be preferred because of its simplicity and relatively minimal invasiveness. (*Plast Reconstr Surg Glob Open* 2015;3:e475; doi: 10.1097/GOX.0000000000000382; Published online 3 August 2015.)

**C**raniosynostosis is a relatively rare congenital deformity in which one or more of the cranial sutures have closed prematurely. Premature fusion of one of the coronal sutures results in plagiocephaly, which is a common deformity in craniomaxillofacial surgery that can be associated with many complications affecting sensory, respiratory, and neurological function.<sup>1</sup>

Different surgical procedures have been considered in the treatment of synostosis. Suturectomy (strip craniectomy) and sutural distraction osteogenesis (SDO) are widely used.<sup>2-5</sup> In particular, during suturectomy,

the prematurely fused suture line is reopened, permitting brain growth and cerebral decompression but not the reshaping of the dysmorphic skull; on the other hand, gradual SDO helps in reshaping the skull without leaving any subcranial dead space.<sup>5</sup>

Distraction methods include both external and internal devices. The external devices require a frame that is attached to the skull and permit to control and modify the vectors and forces during activation. They are easier to apply and simpler to remove, but its bulk can result in physical and psychosocial discomfort for the patient. On the contrary, internal devices are smaller with better patient acceptance but require an additional surgical access for removal. So, internal devices have a specific indication in patients under school age, whereas external devices should probably be preferred in adolescents and adult patients because they offer easier implantation and better control of the vectors and assure more predictable and effective results.<sup>3,6,7</sup>

Here, we present the case of a young infant patient with a clear synostosis of the left coronal suture, which was treated by piezoelectric suturectomy combined with SDO.

**Disclosure:** Dr. Rodella received financial support from Silfradent for research of tissue regeneration but not for Surgybone use. None of the other authors has any financial disclosures. The Article Processing Charge was paid for by the authors.

From the \*Department of Plastic Surgery, Nanjing Children's Hospital Affiliated to Nanjing Medical University, Nanjing, China; and †Section of Anatomy and Physiopathology, Department of Clinical and Experimental Sciences, University of Brescia, Brescia, Italy.

Received for publication December 23, 2014; accepted April 15, 2015.

Copyright © 2015 The Authors. Published by Wolters Kluwer Health, Inc. on behalf of The American Society of Plastic Surgeons. All rights reserved. This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially.

DOI: 10.1097/GOX.0000000000000382

### CASE REPORT

A 6-month-old male infant was referred to Nanjing Children's Hospital with deformities of the skull and face. Clinical examination revealed left frontal flattening, slight nasal tip deviation toward the flattening, and depression at the frontotemporal junction; Harlequin eye was not observed. Cranial perimeter was normal (Table 1).

Three-dimensional computed tomography (3D CT, Philips, the Netherlands) scans showed a slightly smaller size of the left orbit and a thickening of the pterion with a retrusion of the greater sphenoid wing; moreover, synostosis of the left coronal suture was evident (Fig. 1).

The parents were informed about the cosmetic aspect of the surgery and the progressive deformations and their informed consent was obtained. Suturectomy and SDO were planned. Surgery was performed with the patient in a supine position. A half coronal incision was made and the scalp was dissected. The dissection plane was extended subperiosteally to expose the frontal bone, the superior part of the orbit, the left fused coronal suture, and the temporal fossa behind the zygomatic process of the left frontal bone. Piezoelectric suturectomy (2-cm strip of bone) of the left coronal suture was performed without dura mater dissection by piezoelectric surgery (Surgybone, Silfradent Srl, Italy). Two internal distraction devices (Ningbo Cibe Medical Treatment Appliance, Ningbo, China) were applied across the osteotomized

fused coronal suture (Fig. 2). From the second day after surgery, distraction was started at 1.2mm per day for 15 days. The postoperative clinical course was uneventful. Three months after surgery, 3D CT scan was performed (Fig. 3). The internal device was removed, and the distraction-resulted skull defect was filled with Medpor (Porex, Atlanta, Ga.) to prevent skull growth and craniosynostosis again. One-year follow-up showed good results (Table 1), even if the left orbit was smaller. Thirty-six months after surgery, normal skull growth and shape were observed by 3D CT examination (Fig. 4). No infection, bleeding, fistula, and other complications were observed.

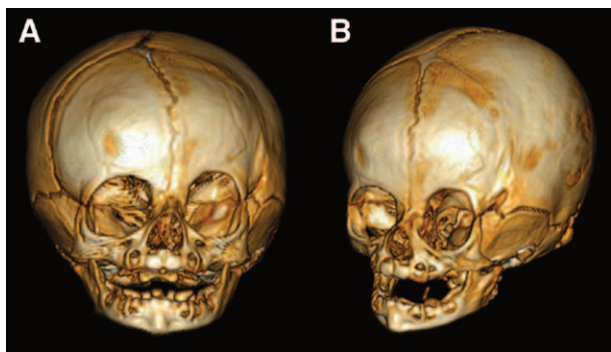
### DISCUSSION

Unilateral coronal synostosis is a premature fusion of one of the coronal sutures occurring in 1 in 10,000 live births.<sup>8</sup> Multiple procedures have been described for its treatment, highlighting the

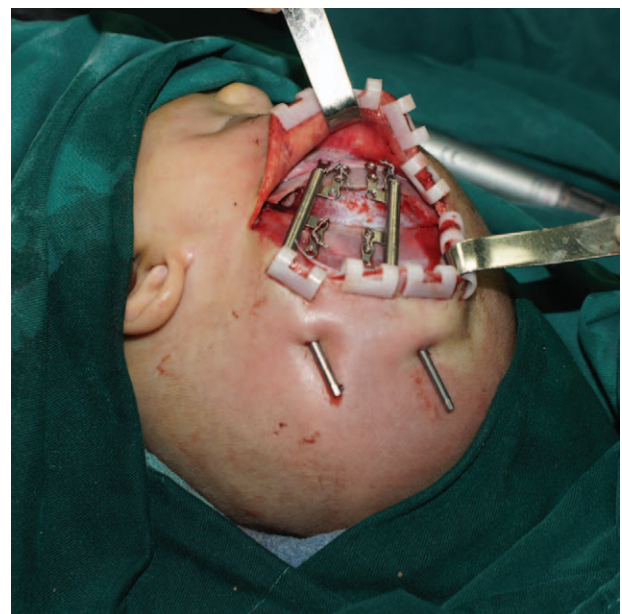
**Table 1. Measurement of Preoperation and Postoperation**

	Preoperation	Postoperation (1-year Follow-up)
Cranial perimeter	43	48
CVAI	3.8%	1%
CI	76	78

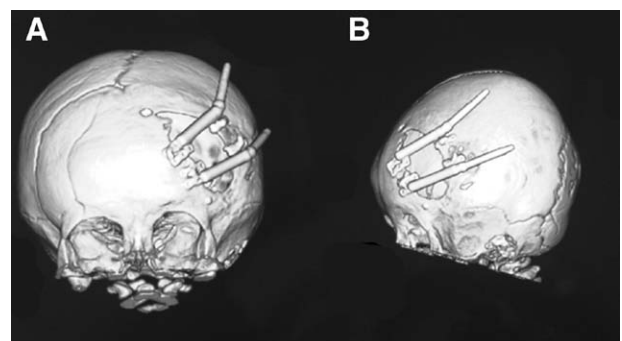
CI, cephalic index; CVAI, cranial vault asymmetry index.



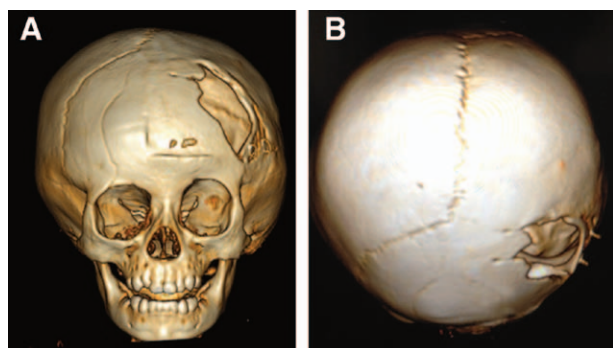
**Fig. 1.** A, Preoperative frontal view by 3D CT. B, Preoperative oblique view by 3D CT showing a clear synostosis of the left coronal suture.



**Fig. 2.** Intraoperative view of 2 internal distraction devices.



**Fig. 3.** Postoperative view 3 months after surgery. A, Frontal view by 3D CT. B, Lateral view by 3D CT.



**Fig. 4.** Postoperative view 36 months after surgery. A, Frontal view by 3D CT. B, Vertex view by 3D CT.

fact that no single approach seems to alleviate all functional and aesthetic problems. Among them, craniotomy and SDO are used for the treatment of cranial synostosis.<sup>4,8-14</sup>

McCarthy et al<sup>15</sup> first introduced distractors for lengthening the mandible. In 1998, Sugawara et al<sup>12</sup> pioneered the use of distractors for the treatment of cranial synostosis and, in particular, to expand gradually vascularized cranial bone together with the intracranial content, keeping the dura-cranium connection intact. Then, the use of distractors has been widely employed, allowing safer and more controlled advancement of the midface, without the need for internal plating and graft site morbidity.<sup>3</sup> Nevertheless, one difficulty with the distractor frame is the need to anchor it securely to the cranium. In very young patients, the bone may be too thin for its safe application; consequently, the timing of surgical intervention has to be considered. Some authors believed that it should be as early as 6 months of age because it takes advantage of rapid brain growth that occurs within first years. Other authors believe in delaying until ninth or 12th month because the bones are better developed and the surgical results are better maintained.<sup>3,8,16</sup>

Here, we presented a surgical approach for the treatment of unilateral coronal synostosis in young infant patient: piezosurgical suturectomy combined with SDO.

Piezosurgery is mainly used in oral surgery<sup>17,18</sup>; however, it has been used for osteotomies in cranial vault and orbital walls with minimal undermining of the dura mater and periorbital soft tissue, reducing the postoperative swelling.<sup>19</sup> In particular, it is adequate in the case of osteotomies involving thin bone (eg, infant skull), whereas in the case of osteotomies involving thick bone, the procedure requires more time and could be performed initially with the drill and eventually completed with the piezoelectric device. Furthermore, with piezoelectric surgery, it has been possible to perform precise osteotomy

in close proximity of vessels, nerves, and other important structures, such as dura mater, with minimal bleeding.<sup>17,18,20</sup>

The pro-osteogenic properties of the dura are well known and are thought to result from the production of osteoinductive factors.<sup>14,21</sup> Therefore, in our surgical design, the intact dura mater permitted bone regeneration from islands of bone within the dura mater, as suggested by other authors.<sup>21,22</sup>

Here, we decided to combine piezosurgical suturectomy with SDO. SDO technique, in fact, is suitable for young infant patients (under 6 months), with several advantages. In particular, bone is expanded gradually without subcranial dead space postoperatively, and the cranial bone remains vascularized.<sup>12</sup> However, some disadvantages include the limited possibility of initial reshaping and the necessity of one more operation for distractor removal.<sup>16</sup>

Our experience of combining piezosurgical suturectomy with SDO for the management of unilateral coronal synostosis in a young infant patient is promising. In particular, this surgical approach permitted to obtain both the correction of the underlying bony deformity associated with the synostotic suture and the management of the overlying soft-tissue envelope, avoiding long-term surgical relapse.<sup>23</sup>

## CONCLUSION

Treatment of unilateral coronal synostosis by piezosurgical suturectomy combined with SDO permitted the expansion of cranial bone with overlying skin and underlying dura mater. A long-term follow-up in more cases will be required to validate our results.

*Weiming Shen, MD*

Department of Plastic Surgery  
Nanjing Children's Hospital  
Affiliated to Nanjing Medical University  
72 Guangzhou Road  
Nanjing 210008, China  
E-mail: shenweiminchina@hotmail.com

## PATIENT CONSENT

*Parents provided written consent for the use of the patient's image.*

## REFERENCES

1. Johnson D, Wilkie AO. Craniosynostosis. *Eur J Hum Genet.* 2011;19:369-376.
2. Bonfield CM, Lee PS, Adamo MA, et al. Surgical treatment of sagittal synostosis by extended strip craniectomy: cranial index, nasofrontal angle, reoperation rate, and a review of the literature. *J Craniomaxillofac Surg.* 2014;42:1095-1101.
3. Dobbs TD, Wall SA, Richards PG, et al. A novel technique to secure the Rigid External Distraction (RED) frame in a thin skull allowing sutural mid-face distraction. *J Craniomaxillofac Surg.* 2014;42:1048-1051.

4. Komuro Y, Hashizume K, Koizumi T, et al. Cranial expansion with distraction osteogenesis for multiple-suture synostosis in school-aged children. *J Craniofac Surg*. 2009;20:457–460.
5. Sahoo N, Roy ID, Gupta V, et al. Role of intraoral distractors in management of cranial synostosis: an initial experience. *Ann Maxillofac Surg*. 2014;4:24–29.
6. Meling TR, Høgevold HE, Due-Tønnessen BJ, et al. Midface distraction osteogenesis: internal vs. external devices. *Int J Oral Maxillofac Surg*. 2011;40:139–145.
7. Pelo S, Gasparini G, Di Petrillo A, et al. Distraction osteogenesis in the surgical treatment of craniostenosis: a comparison of internal and external craniofacial distractor devices. *Childs Nerv Syst*. 2007;23:1447–1453.
8. Khorasani M, Barzi MH, Derakhshan B. Correction of maxillofacial deformities in a patient with unilateral coronal craniosynostosis (plagiocephaly): a case report and a review of literatures. *J Dent (Tehran)*. 2013;10:478–486.
9. Hirabayashi S, Sugawara Y, Sakurai A, et al. Frontoorbital advancement by gradual distraction. Technical note. *J Neurosurg*. 1998;89:1058–1061.
10. Lauritzen C, Sugawara Y, Kocabalkan O, et al. Spring mediated dynamic craniofacial reshaping. Case report. *Scand J Plast Reconstr Surg Hand Surg*. 1998;32:331–338.
11. Matsumoto K, Nakanishi H, Seike T, et al. Application of the distraction technique to scaphocephaly. *J Craniofac Surg*. 2000;11:172–176.
12. Sugawara Y, Hirabayashi S, Sakurai A, et al. Gradual cranial vault expansion for the treatment of craniofacial synostosis: a preliminary report. *Ann Plast Surg*. 1998;40:554–565.
13. Uemura T, Hayashi T, Satoh K, et al. Three-dimensional cranial expansion using distraction osteogenesis for oxycephaly. *J Craniofac Surg*. 2003;14:29–36.
14. Wiberg A, Magdum S, Richards PG, et al. Posterior calvarial distraction in craniosynostosis—an evolving technique. *J Craniomaxillofac Surg*. 2012;40:799–806.
15. McCarthy JG, Schreiber J, Karp N, et al. Lengthening the human mandible by gradual distraction. *Plast Reconstr Surg*. 1992;89:1–8; discussion 9–10.
16. Cho BC, Hwang SK, Uhm KI. Distraction osteogenesis of the cranial vault for the treatment of craniofacial synostosis. *J Craniofac Surg*. 2004;15:135–144.
17. Gao Y, Lin Z, Rodella LF, et al. Piezoelectric ultrasonic bone surgery system in the extraction surgery of supernumerary teeth. *J Craniomaxillofac Surg*. 2014;42:1577–1582.
18. Labanca M, Azzola F, Vinci R, et al. Piezoelectric surgery: twenty years of use. *Br J Oral Maxillofac Surg*. 2008;46:265–269.
19. Nordera P, Spanio di Spilimbergo S, Stenico A, et al. The cutting-edge technique for safe osteotomies in craniofacial surgery: the piezosurgery bone scalpel. *Plast Reconstr Surg*. 2007;120:1989–1995.
20. Crosetti E, Battiston B, Succo G. Piezosurgery in head and neck oncological and reconstructive surgery: personal experience on 127 cases. *Acta Otorhinolaryngol Ital*. 2009;29:1–9.
21. Greenwald JA, Mehrara BJ, Spector JA, et al. Biomolecular mechanisms of calvarial bone induction: immature versus mature dura mater. *Plast Reconstr Surg*. 2000;105:1382–1392.
22. Sohn JY, Park JC, Um YJ, et al. Spontaneous healing capacity of rabbit cranial defects of various sizes. *J Periodontal Implant Sci*. 2010;40:180–187.
23. Mesa JM, Fang F, Muraszko KM, et al. Reconstruction of unicoronal plagiocephaly with a hypercorrection surgical technique. *Neurosurg Focus* 2011;31:E4.