

# The Choice of Operative Technique in the Treatment of Anterior Plagiocephaly: Clinical Experience

## Anterior Plajiosefali Tedavisinde Cerrahi Teknik Seçimi: Klinik Deneyim

### ABSTRACT

**OBJECTIVE:** Synostotic plagiocephaly involving the coronal suture has been a matter of surgical debate and interest for pediatric neurosurgeons. In this report, the authors analyze the results of an operative series of anterior synostotic plagiocephaly. They also emphasize their experience on patient selection, timing of the surgery and choice of operative technique with a review of the literature.

**METHODS:** Seven anterior plagiocephaly cases that were operated on between 1989 and 2004 were analyzed. The operative procedures employed were bilateral frontal advancement technique or unilateral canthal advancement technique.

**RESULTS:** In the series, there were no perioperative or long-term surgical complications. None of the patients required reoperation for aesthetic problems. It is remarkable that the outcome scores of the patients treated with unilateral canthal advancement technique were quite satisfactory.

**CONCLUSION:** In the treatment of anterior plagiocephaly, unilateral canthal advancement technique seems to be advantageous in many aspects especially in patients who are under the age of 1 year.

**KEY WORDS:** Anterior plagiocephaly, Craniosynostosis, Outcome, Surgical technique

### ÖZ

**AMAÇ:** Koronal sütün etkilendiği sinostotik plajiosefali, pediatrik nöroşirürjiyenler için ilgi uyandıran bir cerrahi tartışma konusu olagelmıştır. Bu çalışmada, yazarlar cerrahi uygulanmış anterior sinostotik plajiosefali olgularından oluşan serilerinin sonuçlarını analiz etmektedir. Yazarlar ayrıca; hasta seçimi, cerrahi prosedürün zamanlaması ve tercih edilmesi gereken cerrahi tekniğin seçimi konularındaki deneyimlerini ilgili literatür bilgilerini de gözden geçirerek aktarmaktadır.

**YÖNTEM:** 1989 ile 2004 seneleri arasında opere edilmiş olan yedi anterior sinostotik plajiosefali olgusuna ait veriler analiz edilmiştir. Uygulanmış olan cerrahi teknikler, bilateral frontal ilerletme tekniği ve unilateral kantal ilerletme tekniğidir.

**BULGULAR:** Seriyeye ait perioperatif veya geç dönem postoperatif cerrahi komplikasyon yoktur. Olguların hiçbirinde estetik sorunlar nedeniyle tekrar cerrahi gerekmemiştir. Unilateral kantal ilerletme tekniği ile opere edilmiş olan olguların "sonuç skorları"nın oldukça tatmin edici olduğu dikkat çekicidir.

**SONUÇ:** Anterior plajiosefaliye yaklaşımda unilateral kantal ilerletme tekniği, özellikle 1 yaşın altındaki hastalarda bir çok açıdan daha avantajlı olarak gözükmektedir.

**ANAHTAR SÖZCÜKLER:** Anterior plajiosefali, Kraniosinostozis, Sonuç, Cerrahi teknik

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## INTRODUCTION

Since Rudolf Virchow attributed plagiocephaly to unilateral stenosis of the skull sutures, the term has been commonly used in relation to craniosynostosis (8). Synostotic anterior plagiocephaly (coronal synostosis) has been referred to in the literature as "plagiocephaly", "frontal plagiocephaly", "unilateral coronal synostosis" and "anterior plagiocephaly". Numerous studies have been published describing the management and treatment for plagiocephaly and there has been a wide and varied array of management strategies used on infants with plagiocephaly (2, 4, 10, 11, 13, 14, 20, 22, 27).

In this report, we aim to analyze the results of an operative series of 7 patients with synostotic anterior plagiocephaly. We also emphasize our experience on patient selection, timing of the surgery and choice of operative technique. The pertinent literature on anterior plagiocephaly has also been briefly reviewed.

## MATERIALS AND METHODS

We followed-up 7 anterior plagiocephaly cases between 1989 and 2004. The series consisted of 4 girls and 3 boys whose age ranged between 3 months and 9 months. The primary procedures for anterior plagiocephaly were performed at an average age of 5.28 months, with an average postoperative follow-up of 24 months.

A preoperative clinical examination was performed in all patients and physical findings were documented by photographs. Radiological assessment included plain X-ray films, CT scan with bone windows and three-dimensional reconstructed computed tomography (3D-CT) studies.

The operative procedures employed were bilateral frontal advancement technique (27) in 2 cases and unilateral canthal advancement technique (12) in 5 cases. Skeletal fixation for all patients included a combination of silk suture osteosynthesis and/or rigid microfixation.

The mean duration of surgery was  $180.0 \pm 30.0$  minutes ( $\pm$  standard deviation) and the mean volume of intraoperative blood loss was  $11.7\% \pm 6.4\%$  of the estimated total blood volume ( $\pm$  standard deviation).

In attempting to evaluate the surgical results, we used a three-grade classification system: Grade I: unchanged frontonasal angle and poor advancement of frontal bone; Grade II: good advancement of frontal bone and reformed frontonasal angle; Grade

III: satisfactory advancement of frontal bone and normal frontonasal and orbital angles.

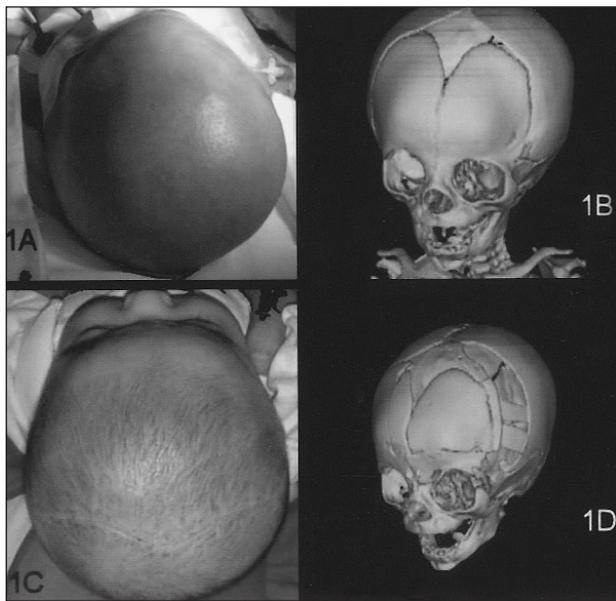
## RESULTS

There were no perioperative or long-term surgical complications in any patient in this study. There were no deaths, infections, or bleeding complications. There were no wound complications and no cases of CSF leakage. All patients underwent only a single surgical procedure for correction of their craniosynostosis. None of the patients in this series required ventriculostomy or ventricular shunting. No fixation hardware required removal during the study period.

The outcome scales of the patients showed that 6 cases were grade III. Postoperative 3D-CT studies and photographic evaluations have shown an immediate aesthetically pleasing change in the contour of the skull (Figure 1A-I). Long-term follow-up postoperative photographic evaluations also revealed that the contour of the skull tended to improve with time (Figure 2). In our series one patient who had been operated with bilateral frontal advancement technique had an outcome score grade II. Outcome scores and the data on the patients and the operative procedures employed are summarized in Table I.

## DISCUSSION

Plagiocephaly is a general descriptive Greek term connoting an oblique or twisted shape of the head not always caused by either basal or calvarial sutural synostosis (8). Cranial anomalies affect the development of all facial bones and plagiocephaly has been suggested to be "the most complete presentation of craniofacial asymmetry" (28). Among these patients those with synostotic plagiocephaly either involving the coronal suture or lambdoidal suture have been a matter of surgical debate and interest for pediatric neurosurgeons and maxillofacial surgeons. The endocranial morphology of this entity has been studied in detail and the physiopathogenic interpretation suggests that the base of the skull plays a predominant role in the genesis and severity of this deformation (6, 9, 15, 18). However, it has become known in recent years that this cranial dysmorphology has a number of etiologies other than craniosynostosis, mainly related to external deformational forces occurring in the uterus or at the time of delivery (3). The term "deformational plagiocephaly" has been first defined



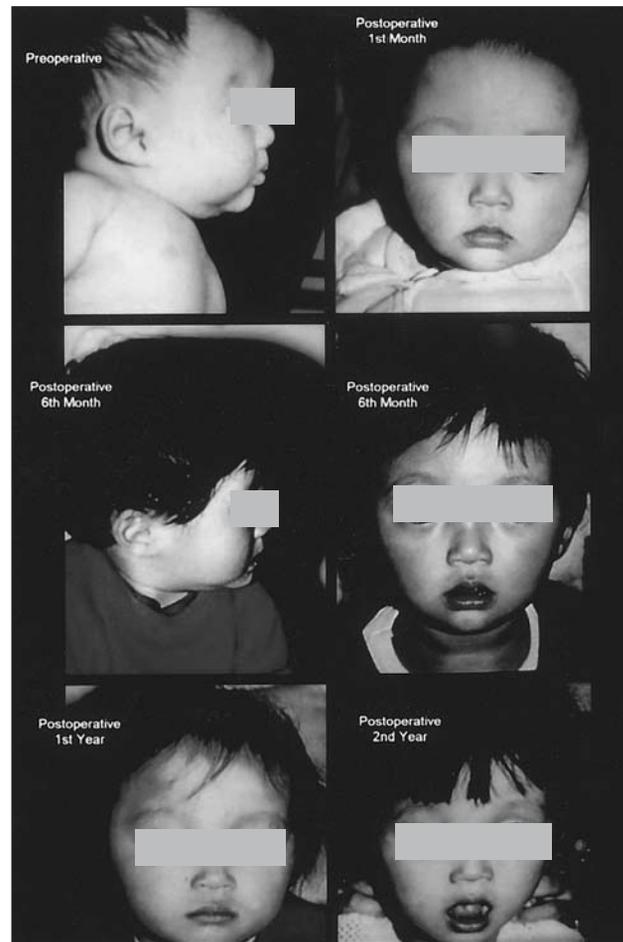
**Figure 1:** Reconstruction of the skull by unilateral canthal advancement technique in a left anterior plagiocephaly case. Preoperative and postoperative radiological assessment included CT scans with bone windows and three-dimensional reconstructed computed tomography (3D-CT) studies. After reshaping by the unilateral canthal advancement technique, the case showed an aesthetically pleasing change in the contour of the skull.

**1A:** Photograph showing left anterior plagiocephaly in a 5-month-old boy. Unilateral flattening of the involved forehead and frontal contralateral bossing are evident.

**1B:** Preoperative three-dimensional CT study of the same patient revealing orbital dysmorphology and the configuration of the face. Synostosis of the left coronal suture is also demonstrated.

**1C:** Photograph showing the same case, 15 days after reshaping by unilateral canthal advancement technique. A satisfactory correction of the deformity of coronal synostosis is achieved. The outcome score of this child was assigned as Grade III (satisfactory advancement of frontal bone and normal frontonasal and orbital angles).

**1D:** Early postoperative three-dimensional CT scans revealing the advanced supraorbital margin and the newly created artificial suture at the base of the skull. Autologous bone grafts which were placed at the lateral extent of the supraorbital rim and at the surgically induced parietal bone defect can also be seen.



**Figure 2:** Follow-up photographic evaluations of another anterior plagiocephaly case showing aesthetically pleasing change in the contour of the skull which tends to improve with time.

**Table I:** Data on the patients, the operative procedures employed and the outcome scores are shown

Patient Age/Sex	Operative Technique	Outcome Scale
3m/F	Unilateral canthal advancement	Grade III
5m/F	Unilateral canthal advancement	Grade III
3m/F	Bifrontal advancement	Grade III
9m/M	Unilateral canthal advancement	Grade III
8m/M	Bifrontal advancement	Grade II
4m/F	Unilateral canthal advancement	Grade III
5m/M	Unilateral canthal advancement	Grade III

M: male, F: female, m: months

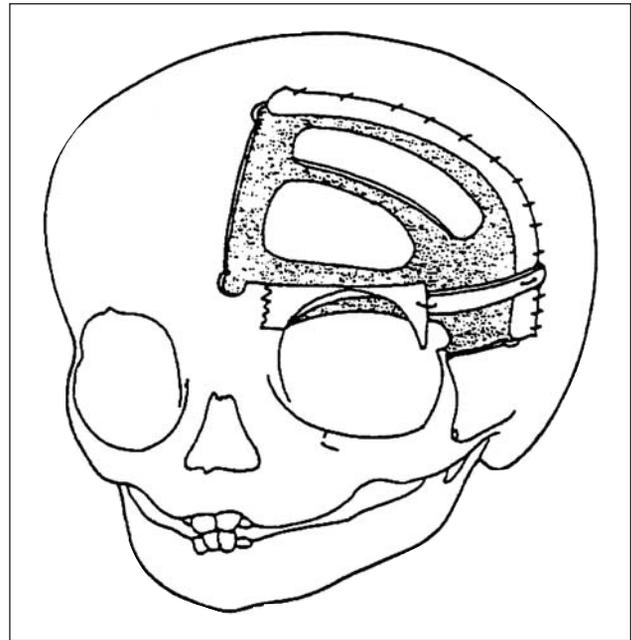
Grade II: good advancement of frontal bone and reformed frontonasal angle

Grade III: satisfactory advancement of frontal bone and normal frontonasal and orbital angles.

by Brunneteau and Mulliken (3) for children who have craniofacial asymmetry without synostosis of the cranial sutures, and this condition has been suggested as a probable result of extrinsic factors such as congenital torticollis (4, 5, 7), aberrant constraint of the fetal head in the intrauterine environment (4), preferential sleeping position in early infancy (1, 29) secondary effects of cranial base abnormalities (19) and others. In 1995, Roddi et al. reported a new clinical classification with six categories of plagiocephaly where children affected by deformational plagiocephaly were grouped in category VI (23). It was possible to demonstrate craniosynostosis in all 7 patients of our series.

The purpose of the surgical treatment in plagiocephaly, is to correct the deformation to provide an aesthetically acceptable skull contour and in many cases to decompress the brain. The historical background of the surgical management of anterior plagiocephaly has been well reviewed by Jane et al. (14). Surgical techniques have evolved considerably from the simple resection of a suture proposed by Lane (1892) and Lannelongue (1890). Finally, in 1967, Tessier (27) and his neurosurgical colleagues (24) initiated a new era of craniofacial surgery. As to anterior plagiocephaly in particular, many surgical techniques have been proposed in the last two decades to treat this condition (11, 12, 13, 20, 22). Hoffman et al. (12) have modified the approach to coronal synostosis and proposed the advancement of the supraorbital margin, creating an artificial suture at the base of the skull that would allow the proper correction of this disorder (Figure 3) and named their technique "lateral canthal advancement procedure". They achieved good results (81% of patients) with this technique (11, 12, 16). Whitaker et al. (30) obtained excellent results in 93% of their cases with unilateral orbital advancement, and Marchac and Renier used bilateral advancement and achieved similar results (17). Bartlett et al. (2) compared the results obtained at two major centers using either a bilateral or a unilateral approach and concluded that both procedures were equally successful, but recommended in their conclusions that a bilateral approach is preferable if contralateral bossing is evident.

Esparza et al. (8) have suggested that anterior plagiocephaly is a bilateral craniofacial disease, and surgical reconstruction of the forehead should also



**Figure 3:** The schematic drawing of the technique described by Hoffman (12). This technique proposes the advancement of the supraorbital margin, creating an artificial suture at the base of the skull that allows the proper correction of anterior plagiocephaly

be bilateral. Debate still exists concerning the extent of frontal reconstruction for the correction of plagiocephaly resulting from unilateral coronal synostosis. In a series of 38 patients, Sgouros et al. (25) have reported that forehead correction with a bilateral frontal bone segment and unilateral supraorbital bar advancement provided better early cosmetic results.

In our series, we preferred to perform unilateral canthal advancement technique (Hoffman's method) in patients who were under the age of 1 year. However, as Bartlett et al. (2) have suggested previously, we carried out bilateral frontal advancement technique in patients who had prominent contralateral bossing. It seems that our series had quite satisfying results with the unilateral canthal advancement technique. We believe that in the operative treatment of isolated anterior plagiocephaly, employing the technique of unilateral canthal advancement is advantageous in many aspects. Compared to the bilateral frontal advancement technique, the unilateral canthal advancement procedure requires a shorter operation time. The amount of blood loss in this operation also seems to be less when compared to the bilateral advancement technique. Another advantage of the

unilateral canthal advancement procedure is the lower amount of brain compression needed during the surgery. Easy remodeling of the bone flap seems to permit immediate correction of the deformity and provide a very satisfactory outcome especially in patients who are under 6 months of age.

Some authors have however reported that unilateral canthal advancement technique has disadvantages when compared to bilateral frontal advancement technique especially in the area of aesthetic outcome (8). However, our series had quite satisfactory outcome scores with the unilateral canthal advancement technique. In all 5 of the cases we have achieved a satisfactory correction of the deformity of coronal synostosis and none of the patients treated with unilateral canthal advancement technique required reoperation for aesthetic problems. We believe that the unilateral canthal advancement technique is ideal in unilateral coronal synostosis where the deformed frontal bone can be lined up with the normal one on the other side.

Accurate methods to document the presenting deformity and postoperative results are limited, and guidelines for the evaluation of the results are few (21). However, there is a common clinical impression that surgical correction during the neonatal period yields superior results because abnormality at a single suture strongly influences the development of other areas in the craniofacial complex (10, 17, 26).

### CONCLUSION

Synostotic plagiocephaly involving the coronal suture has been a subject of surgical debate and interest for pediatric neurosurgeons. Although our series is not big enough to allow a detailed and very effective comparison of the two techniques, our current experience shows that unilateral canthal advancement technique seems to be advantageous in many aspects, especially in patients with anterior plagiocephaly who are under the age of 1 year. A shorter operation time, lower amount of blood loss, less need for brain compression and easy remodeling of the bone flap are the major advantages of this procedure.

### REFERENCES

- Argenta LC, David LR, Wilson JA, Bell WO: An increase in infant cranial deformity with supine sleeping position. *J Craniofac Surg* 7: 5-11, 1996
- Bartlett SP, Whitaker LA, Marchac D: The operative treatment of isolated craniofacial dysostosis (plagiocephaly): a comparison of the unilateral and bilateral techniques. *Plast Reconstr Surg* 67: 677-683, 1990
- Bruneteau RJ, Mulliken JB: Frontal plagiocephaly: synostotic, compensational, or deformational. *Plast Reconstr Surg* 1: 21-31, 1992
- Clarren SK: Plagiocephaly and torticollis: etiology, natural history, and helmet treatment. *J Pediatr* 98: 92-95, 1981
- Coventry MD, Hains LE: Congenital muscular torticollis in infancy. *J Bone Joint Surg* 41A: 815, 1959
- Di Rocco C, Velardi F: Nosographic identification and classification of plagiocephaly. *Child's Nerv Syst* 4: 9-15, 1988
- Dunn PM: Congenital sternomastoid torticollis. An intrauterine postural deformity. *Arch Dis Child* 49: 824, 1974
- Esparza J, Munoz MJ, Hinojosa J, Romance A, Munoz A, Mendez MD: Operative treatment of the anterior synostotic plagiocephaly: analysis of 45 cases. *Childs Nerv Syst* 14: 448-454, 1998
- Genitori L, Zanon N, Denis D, Erdinçler P, Achouri M, Lena G, Choux M: The skull base in plagiocephaly. *Child's Nerv Syst* 10: 217-223, 1994
- Goodrich JT, Hall CD, Argamaso R: Craniofacial Anomalies: Growth and Development From a Surgical Perspective, New York: Thieme, 1995: 33-42
- Hoffman HJ: Procedure of lateral canthal advancement for the treatment of coronal synostosis. *Child's Nerv Syst* 12: 678-682, 1996
- Hoffman HJ, Mohr G: Lateral canthal advancement of the supraorbital margin. A new corrective technique in the treatment of coronal synostosis. *J Neurosurg* 45: 376-381, 1976
- Jackson IT, Costanzo C, Marsh WR: Orbital expansion in plagiocephaly. *Br J Plast Surg* 41: 16-19, 1988
- Jane JA, Park TS, Zide BM, Lambruschi P, Persing JA, Edgerton MT: Alternative techniques in the treatment of unilateral coronal synostosis. *J Neurosurg* 61: 550-556, 1984
- Lun-Jou L, Marsh JL, Pilgram TK, Vannier MW: Plagiocephaly: differential diagnosis based on endocranial morphology. *Plast Reconstr Surg* 2: 282-291, 1996
- Machado HR, Hoffman HJ: Long-term results after lateral canthal advancement for unilateral coronal synostosis. *J Neurosurg* 76: 401-407, 1992
- Marchac D, Renier D, Broumand S: Timing of treatment for craniosynostosis and faciocraniosynostosis: a 20 years experience. *Br J Plast Surg* 47: 211-222, 1994
- Marsh JL, Vannier MW: Three dimensional surface imaging from CT scans for the study of craniofacial dysmorphology. *J Craniofac Genet Dev Biol* 9: 61-75, 1989
- Moss ML: New studies of cranial growth. *Birth Defects* 11: 283-295, 1975
- Persing JA, Jane JA, Delashaw JB: Treatment of bilateral coronal synostosis in infancy: a holistic approach. *J Neurosurg* 72: 171-175, 1990
- Posnick JC: Unilateral coronal synostosis (anterior plagiocephaly): current clinical perspectives. *Ann Plastic Surg* 36: 430-447, 1996
- Raimondi AJ, Gutiérrez FA: A new surgical approach to the treatment of coronal synostosis. *J Neurosurg* 46: 210-214, 1977
- Roddi R, Jansen MA, Vaandrager JM, Van der Meulen JCH: Plagiocephaly - new classification and clinical study of a series of 100 patients. *J Craniomaxillofac Surg* 23: 347-354, 1995
- Rougerie J, Derome P, Anquez L: Craniosténoses et dysmorphies cranio-faciales. Principes d'une nouvelle technique et ses résultats. *Neurochirurgie* 18: 429-440, 1972

25. Sgouros S, Goldin JH, Hockley AD, Wake MJ: Surgery for unilateral coronal synostosis (plagiocephaly): unilateral or bilateral correction? *J Craniofac Surg* 7: 284-289, 1996
26. Shillito J: A plea for early operation for craniosynostosis. *Surg Neurol* 37: 182-188, 1992
27. Tessier P, Guiot G, Rougerie J: Ostéotomies cranio-naso-orbitofaciales. Hypertelorisme. *Ann Chir Plast* 12: 103-118, 1967
28. Tulasne JF, Tessier P: Analysis and late treatment of plagiocephaly. *Scand J Plast Reconstr Surg* 15: 257-263, 1981
29. Turk AE, McCarthy JG, Thorne CH, Wisoff JH: The "back to sleep campaign" and deformational plagiocephaly: is there cause for concern? *J Craniofac Surg* 7: 12-18, 1996
30. Whitaker LA, Salyer KE, Munro IR, Jackson IT: Craniofacial surgery in infancy. Berger K (ed), *Atlas of Craniomaxillofacial Surgery*, St Louis, Mosby, 1982: 457-498