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Muhammet Arif Ozbek,
Naci Emre Aksehirli,
Alican Tahta,
Nejat Akalan

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Double curve linear incision approach in cases of sagittal craniosynostosis

Muhammet Arif Ozbek, Naci Emre Aksehirli, Alican Tahta, Nejat Akalan

Department of Neurosurgery, Istanbul Medipol University, Istanbul, TURKEY

ABSTRACT

Craniosynostosis is the premature fusion of one or more sutures in the cranial dome or anterior skull base, resulting in an abnormal head shape. This pathological process is observed less frequently in Eastern geography and approximately one in 2000 to 2500 births in Western countries. Isolated sagittal synostosis accounts for more than half of craniosynostosis cases. In our study, the duration of surgery, duration of anaesthesia, duration of hospital stay, estimated amount of bleeding during surgery and the months of surgery were examined in 16 patients. The performed craniotomy is not different from the four different craniotomies described in the literature. Strip craniectomy and barrel osteotomy were performed on each patient. According to the incisions described in the literature, the incision type and location are different. As the described incision provides less skin dissection, less bleeding and less dead space formation allows surgery in earlier months.

Keywords
sagittal,
craniosynostosis,
double curve linear incision

Corresponding author:
Muhammet Arif Özbek

Department of Neurosurgery,
Istanbul Medipol University,
Istanbul, Turkey

m_a_ozbek@yahoo.com

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INTRODUCTION

Craniosynostosis is the premature fusion of one or more sutures at the cranial dome or anterior skull base, resulting in an abnormal head shape. Reconstruction of craniofacial structure is typically required when physical or mental well-being becomes affected. This pathological process is observed less frequently in the Eastern geography, at about 2000 to 2500 births in Western countries (1). The first surgical treatment was reported with linear craniectomy to open fused sutures in the 1890s, and this method was used for a long time until the 1960s (2,3). Craniofacial surgical techniques were described in the 1960s with the repositioning of the frontal bone to enlarge the cranial volume. Since this revolutionary medical event, the surgical procedure for craniosynostosis has been developed in various ways based on various ideas through trial-and-error methods.

A recent study found that 84% of the patients had isolated craniosynostosis, 7% had other clinical symptoms, and 9% had suspected syndromic craniosynostosis. This is consistent with a frequency of 0.4 to 1.0 per 1000 live births for nonsyndromic craniosynostosis.

Sagittal and unicoronal synostosis patients are predisposed differently based on their gender, with sagittal synostosis happening more frequently in males at a rate of 4:1 and unicoronal synostosis occurring more frequently in females at a rate of 3:2.2. (4) In a review of 519 subjects, the sagittal suture was affected in 56 percent, the coronal suture in 25 percent, the metopic suture in 4 percent, and the lambdoid suture in 2 percent of cases (5).

Although many families with craniosynostosis children present to the craniofacial surgeon with the goal of restoring normal head shape for purely cosmetic reasons. The fundamental reason for intervention is to avoid the consequences of intracranial hypertension (defined as more than 15 mm Hg). Although the exact prevalence of intracranial hypertension is unknown, it can cause neurodevelopmental delay. According to the most recent research, cerebral hypertension affects 15% of the population(6). However, the resulting neurodevelopmental delay is more difficult to predict and is likely multifaceted, with factors such as hydrocephalus, anatomical alterations in the brain, preterm, and family history all playing a role. Some studies have shown indications of neurodevelopmental delay in patients with single suture craniosynostosis as high as 37%(7).

Another much debated question is the timing of surgical intervention. Surgery is normally postponed for nonsyndromic children until they are at least 3 months old, which is considered to help the child to better adjust for the physiologic stress of bleeding. Although the amount of blood lost after surgery is typically non-substantial, it accounts for a bigger proportion of the baby's growing total blood pool than in older patients.

In addition to the effect of brain growth on head shape, proponents of an early surgery for open repair point to the advantages of avoiding further advancement of secondary craniofacial alterations and having more readily shaped bone stock. Furthermore, children who get early care are more likely to spontaneously correct any lingering calvaria problems. Late intervention supporters point to the greater rate of revision necessary in early intervention children.

In practice, most surgeons intervene in between 3 and 12 months of age, and this decision is affected by technique and surgeon bias. In our clinic, we will talk about a method that will shorten the surgical time and reduce the complications and eliminate the deformity.

Patient and Methods

Patients who underwent craniosynostosis surgery between 2016-2021 were retrospectively reviewed. Between these dates, due to sagittal synostosis; 16 patients who underwent the front-to-back double-curved method were identified in our clinic. The duration of their surgery, duration of anesthesia, amount of bleeding, length of hospital stay and preoperative weights of the patients were examined. Patients who will undergo cranial synostosis surgery; It was expected to exceed six kilos in order to reduce the risks of anesthesia and surgery. It was decided to perform a surgical procedure with preoperative physical examination and 3D computed tomography.

Surgical Procedure

The same surgical technique was applied to all patients discussed in our study. In cases where the sagittal suture was closed, the patient was positioned in the prone position and the sagittal suture, coronal suture and lambdoid sutures were exposed using a front to back double-curved anterior to posterior incision starting from the front of the coronal suture and progressing until past the lambdoid suture at the back. (Figure 1)

Figure 1. Sagittal synostosis and cranium are seen after skin incision.

Two bilateral burr holes were opened 2 cm in front of the coronal suture, one cm lateral to the midline. Two burr holes were opened at the rear, one cm lateral to the midline at the lambda level. Craniectomy was performed along the 2 cm wide suture centered on the sagittal suture. The suture spacing was expanded by excising the lambdoid suture with a kerrison. Barrel osteotomies were performed 2 cm apart on the parietal bone. (Figure 2) A drain was placed under the skin and the operation was terminated. (Figure 3)

Figure 2. Strip craniectomy parietal and occipital barrel osteotomies.

Figure 3. Postop skin incision.

STATISTICAL ANALYSIS

Statistical analysis was performed using the TURCOSA (Cloud-based statistical software) program using the Student's t test, p-value of less than 0.05 ($p < 0.05$). was considered statistically significant.

Table 1. Demographic information of patients

No	Age	Closed suture	Length of stay in hospital	Amount of bleeding (ml)	Preop Hgb	Weight (Kg)	Polideks (ml)	Surgery Time (min)	Anaesthesia Time (min)
1	6 months	Sagittal posterior	3	20	12	6,1	100	75	145
2	5 months	Sagittal	2	35	12,3	5	80	100	160
3	5 months	Sagittal posterior	4	50	10,7	8	140	95	175
4	6 months	Sagittal	4	60	10,2	8	300	102	175
5	4 months	Sagittal	3	55	10,7	6,5	160	75	150
6	4 months	Sagittal	3	20	11	7	85	95	170
7	4 months 11 days	Sagittal	3	30	12,3	8	200	102	150
8	5 months 7 days	Sagittal	3	40	11,1	7	80	80	130
9	5 months 8 days	Sagittal	3	80	11,3	8,5	250	80	145
10	4 months 18 days	Sagittal	3	30	10,6	7	200	77	143
11	5 months 1 days	Sagittal	3	20	11,7	7	130	85	138
12	4 months 26 days	Sagittal	3	30	12,2	8	125	100	160
13	5 months 11 days	Sagittal	2	30	12,1	6	120	93	140
14	4 month 20 days	Sagittal	2	30	12,4	7,1	300	72	120
15	4 months	Sagittal	3	30	9	7	100	78	128
16	6 months	Sagittal, lambdoid	3	50	10,7	8	150	70	140

Table 2. Statistical results are shown in the table

	n	Mean and Standard Seviation	p
Duration of surgery group A Our data	50 16	174.9±400 86.1±11.6 (min)	<0,001
Duration of surgery group B Our data	22 16	136.1±30.4 86.1±11.6 (min)	<0,001
Amount of bleeding group A Our data	50 16	113.3±100.3 38.1±16.7(ml)	<0,001
Amount of bleeding group B Our data	22 16	168.1±50.6 38.1±16.7(ml)	0,004
Volume of crystalloid in group B Our data	22 16	329.4±70.8 157.5±73.1(ml)	<0,001

RESULTS

Of the 16 patients who were operated in the examined date range, 3 were female patients and 13 were male patients. The mean age of the patients was 4.9±0.6 months (min 4 months, max 6 months), preop weight was 7.14±0.9 any developmental delay was observed in any of the patients. No examination finding suggestive of increased intracranial pressure was detected in any of the patients. The mean hospital stay of the patients was 2.94±0.5 days, the mean amount of bleeding was 38.1ml±16.7ml. Mean surgery time is 86.1±11.6 mins, mean anesthesia time is 148±16.3 mins. (Table 1)

As the control group in the study of Christopher M. Runyan et al. named 'Long-Term Outcomes of Spring-Assisted Surgery for Sagittal Craniosynostosis'(8) defined as group A and Paul J. Escher et al.'s 'Minimizing transfusion in sagittal craniosynostosis surgery: the Children's Hospital of Minnesota Protocol'(9) The craniotomy group in the study was defined as group B. When the means and standard deviation values in articles A and B were compared with the means and standart deviation in our study. (Table 2)

DISCUSSION

The main finding in patients with craniosynostosis is premature closure of the cranial sutures; The malformations that occur in the anatomical regions it affects are proportional to the extent of closure of which sutures. Malformations are usually prominent in the vertical direction of the affected joint. Since the aim of surgery is to prevent head deformity by recreating the closed suture line, the application of surgical intervention in the first six months after birth, when head development is rapid, prevents the occurrence of secondary effects on head shape development. A smoother head shape result can be obtained in surgeries performed in the first six months. In infants, low weight and fragile hemodynamics cause many risks related to anesthesia as well as surgical difficulties. Although surgeries for craniosynostosis have been performed since 1890, today the development of anesthesia and the development of surgical techniques allow for a decrease in morbidity, mortality and better surgical results.

Because of the myriad risks of allogeneic transfusions such as infection, hemolytic reactions, allergic reactions, and transfusion-induced acute lung injury (TRALI), strategies to reduce the need for transfusions in patients with craniosynostosis are a subject of ongoing research. Preoperative EPO use and iron replacement therapies have been described in the literature(10–12). Although replacement therapy was not applied to our patients, none of the patients required blood transfusion therapy.

The aim of the described surgical techniques is to correct the head deformity. The success of the surgery directly affects the success of the surgery. In surgery, it is necessary to perform the procedure to reveal the largest suture line of the cranium. Although it is not related to the intracranial area, it should not be forgotten that the superior sagittal sinus is under the suture. Since minimal bleeding in the surgical procedure enables early intervention, it indirectly affects the success of the surgery.

From the 1960s to the 1990s, the evolution of operative intervention for sagittal craniosynostosis involved increasingly extensive cranial dome reshaping(13). These techniques included wide stripe craniectomy with bilateral parietal wedges, extended vertex craniectomy, and complete calvarial remodeling via the pi procedure(14–16). Such operations were associated with long operative time, high blood loss, and prolonged hospital stays(13,17). In the early 1990s, surgical techniques reduced the morbidity of these operations. During this time, surgeons also began to explore the use of force therapy to counter the cranial vault's tendency to relapse after surgery and realized that surgical intervention provides a unique opportunity for cranial molding early in life.(13,18,19) A more minimally invasive approach, Jimenez and Barone

1990 showed that endoscopic strip craniectomy has low morbidity and that the cephalic index can be normalized when combined with postoperative helmet therapy.(18)

Basically, four different craniotomy have been defined; strip craniectomy alone, strip craniectomy with wedges, strip craniectomy with parietal barrel staves and midline osteotomy with separate burr holes for spring placement. The technique we use is strip craniectomy with parietal barrel staves. Although the width of the osteotomy performed in the literature varies inversely with the age at which the surgical intervention was performed(20–22), we used the same width of craniectomy for each patient regardless of age. With the help of barrel osteotomies, it was observed that the head took its normal shape and expanded the craniectomy area. In our surgical procedure, in addition to strip craniectomy with parietal barrel staves, occipital barrel states were added to provide a wider area for remodeling. The most important difference from the literature is our double curved incision, which remains completely at the vertex. Considering the area where the scalp is stripped from the calvarium and the area being worked on, the more unnecessary calvarium area in the classically applied bicoronal incision causes more bleeding and a longer operation time. It is not possible to create occipital barrel staves by reaching as far back as we reached with a bicoranal incision.

In the study of Runyan et al. (8) with 50 patients and in the study of 22 patients by Paul J. Escher's friends(9), the mean operative time was stated as 174 and 136 minutes, respectively. Again, the mean amount of bleeding is indicated as 113 and 168 milliliters. In the study of Paul J. Escher with his friends, the average use of crystalloids during surgery was found to be 329 milliliters. In our technique, the amount of crystolloid used during surgery was found to be statistically less. In this case, it can be associated with direct bleeding and less volume loss. Considering that the same craniotomy model was applied, where our only technical difference with these studies is the incision difference, we can say that our incision statistically reduces the operation time and the amount of bleeding compared to the bicoronal incision.

As a result of our study, none of the patients needed intensive care and no complications were encountered, suggesting that our surgical method was successful. In one study(23), 26 pediatric neurosurgeons reported an average hospital stay of 1 to 4 days after surgery. In our patient group, the mean hospital stay was 2.9 days.

Our study has important limitations. This study is a retrospective study of a single center surgical team. The small sample size is the limitation of this study. For more reliable data, the study should be developed as a multicenter and control group.

Conclusion

The purpose of the incision in sagittal craniosynostosis operations is to reveal the largest line of the cranium. In our study, one of the four different craniotomy methods defined basically was used. In the literature, strip craniectomy and parietal barrel osteotomies, which are generally performed with bicoronal incision, reduce surgical time and surgical damage with a new incision with a smaller and less dead space component. The earliest surgical intervention in surgical surgery had a positive effect on the success of the surgery in terms of results. The benefits of this technique will be more visible with the children of patient visits and follow-up periods. This incision is prominent in sagittal synostosis treatments.

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