Original Article

Comparison of Craniosynostosis Surgery Outcomes Using Resorbable Plates and Screws versus Absorbable Sutures in Children with Craniosynostosis

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Received: 2022/07/16
Accepted: 2023/01/01

ABSTRACT

Background: Previously, absorbable screw and plate systems were widely used in craniosynostosis surgery in Iran, but now, due to the establishment of economic sanctions, the importation of these tools into the country has become difficult. In this study, we compared the short-term complications of cranioplasty surgery in craniosynostosis using absorbable plate screws with absorbable sutures.

Methods: In this cross-sectional study, 47 patients with a history of craniosynostosis who underwent cranioplasty at Tehran Mofid Hospital, Tehran, Iran from 2018 to 2021 were divided into two groups. For first group (31 patients) we used absorbable plate and screws, and for the second group (16 patients) absorbable sutures (PDS). All operations in both groups were performed by the identical surgical team. Patients followed up for consecutive post-operative examinations in the first and second weeks and 1, 3, and 6 months. Data were analyzed using SPSS software version 25.

Results: The results did not show any short-term or medium-term complications in either group. No recurrences were observed. In Whittaker classification, 63.8% were Class I, 29.8% were Class II, 6.4% were Class III, and 0% were Class IV. There was no statistically significant relationship between the type of treatment (screw and plate or absorbable suture) and higher Whitaker. There was also no statistically significant relationship between type of craniosynostosis and higher Whittaker.

Conclusion: The absorbable sutures can be considered as valuable and cost-effective tools in the fixation of bone fragments in craniosynostosis surgeries by surgeons.

KEYWORDS
Craniosynostosis; Absorbable suture; Resorbable plates and screw

Please cite this paper as:
Nobakht M, Hasanpour SE.. Comparison of Craniosynostosis Surgery Outcomes Using Resorbable Plates and Screws versus Absorbable Sutures in Children with Craniosynostosis. World J Plast Surg. 2023;12(1):37-42.
doi: 10.52547/wjps.12.1.37

INTRODUCTION

The premature closure of one or more cranial sutures is known as craniosynostosis, which causes typical forms in the baby's head, depending on the anatomic position of the suture involved. Its incidence is 1 case in 2000-2500 live births. However, several genetic disorders have been identified in the cases of syndromic craniosynostosis, the cause of single-suture craniosynostosis is largely unknown[1, 2]. Although

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[DOI: 10.52547/wjps.12.1.37]

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craniosynostosis is generally associated with defined syndromes, more than 70% of cases appear non-syndromic. In the syndromic type, abnormalities of the limbs, heart, and central nervous system are commonly observed[3].

Craniosynostosis was recognized in 1830 by Otto. In 1851, Virshu stated that cranial growth is limited in fused sutures, which led to increased development along healthy sutures to compensate for brain growth (a concept known as Virshu law)[4]. Depending on the closed sutures, the shape of the baby's skull will be different. The most frequent manifestation of this condition is the abnormal shape of the head during the first year of life. The shape of the skull is varied from long and narrow (scaphocephaly,dolichocephaly). Triangular (trigonocephaly) in front, broad and flat (brachycephaly), or oblique (plagiocephaly)[5].

Although a surgical operation is carried out primarily for aesthetic purposes, critical clinical reasons are more important to avoid increasing intracranial pressure (ICP) and its consequences, such as neurological and cognitive disorders. Lannelongue introduced craniosynostosis surgery in 1890[6]. Over time, all kinds of partial or complete reconstructions of the cranial arch were replaced by a relatively simple strip craniectomy[7]. Like other surgical procedures, complications may occur following cranioplasty. It includes bleeding and the need for blood transfusions, complications of anesthesia, infection, damage to intracranial structures such as the sagittal sinus, dural tears, subcutaneous hematoma, cerebrospinal fluid (CSF) leakage, and the need for further surgery[8, 9].

The use of titanium screws and plates to correct craniosynostosis deformities in young children is associated with abnormalities such as local growth restriction and visible subcutaneous appearance. It may also interfere with diagnostic procedures such as MRI. Infection and palpability are other problems in using titanium screws. Another complication is the migration of screws and plates into the intracranial space, and the need for reoperation to remove them[10, 11].

Thus, with the introduction of resorbable plate-screw systems on the market, they have been widely used in craniosynostosis surgery[12, 13]. These systems also have disadvantages like the visible plate through the skin, skin lesions on the plate, bone changes, and the capsules formation around the plate[14, 15]. Resorbable plate-screw systems are made of materials such as polyglycolide (PGA) and polylactic acid (PLA). They have bio-absorb properties with absorption between 12 and 36 months into the body[16]. One of the ordinary and conventional methods in craniotomy surgeries is connecting the skull parts with wire sutures[17]. Previously, resorbable plate-screw systems were widely used in craniosynostosis surgery in Iran. They overcome the drawbacks of non-resorbable plate systems. But now due to Iran's economic sanctions, the price of these resorbable plate-screw systems has become more expensive, and it is not easy to provide.

Therefore, we aimed to compare short-term outcome of resorbable plate-screw and absorbable sutures cranioplasty surgery in craniosynostosis.

METHODS

This cross-sectional study was conducted based on information in patients' clinical records. This study was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran with ethical code IR.SBMU.MSP.REC.1400.146. All patients under two years of age who underwent surgery for craniosynostosis repair in Mofid Hospital, Tehran, Iran between 2018 and 2021 were enrolled. Patients whose skull fixation was done by non-absorbable materials or combined techniques were used for skull repair were excluded from the study.

A total of 47 children with the above characteristics were included. They were divided into two groups. Surgical fixation in the first group was performed with resorbable plates and screws (31 patients). In the second group (16 patients), long lasting absorbable polydioxanone was used for fixation. After providing the necessary explanations about the procedure and the type of equipment used and subsequent follow-up to the patient's parents and obtaining their consent, the patients underwent surgery. Preoperative evaluations include clinical examinations, photography, 3D scanning, and counseling in pediatrics, ophthalmology, neurology, and anesthesia. All procedures were performed under general anesthesia by the same surgical team. After a zigzag coronal incision subgaleal forehead dissection was performed up to 4 cm above the superior orbital rim. Subperiosteal dissection was performed in the upper region of the orbit with preservation of the supraorbital nerves. The

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[DOI: 10.52547/wjps.12.1.37]

posteriorly based periosteal flaps were released in the forehead before the craniotomy. After completion of appropriate craniotomies and osteotomies to correct skull abnormalities, one of the two above methods (resorbable plates and screws or absorbable sutures (PDS)) was used to reconstruct and fix the bony parts of the modified skull. All patients had consecutive examinations in the first and second weeks and 1, 3, and 6 months post-operative. The results of these examinations were documented in defined forms.

Statistical analysis

Data were analyzed using SPSS software version 25 (IBM Corp., Armonk, NY, USA). A significance level of 0.05 was considered for all statistical tests. In the first step, the Kolmogorov Smirnov test was used to check the normal distribution of data for each variable. The chi-square test was used to analyze qualitative variables and independent *t* test, Mann Whitney U test or Kruskal-Wallis test were used for analyze the quantitative variables, depending on the normality of the data.

RESULTS

Overall, 47 young children with craniosynostosis who underwent cranioplasty were enrolled. The sex distribution of the subjects was almost equal (23 females and 24 males) (Table 1). The samples included 31 patients with a mean age of 11.87 ± 6.26 months in the resorbable plate-screw group and 16 patients with a mean age of 11.75 ± 5.41 months in the absorbable suture group (Table 2). 61.7% of the patients were younger than 1 year of age (Table 1). The results of the Chi-square test and independent *t*-test showed that there was no statistically significant difference between the two groups in terms of gender distribution ($P = 0.081$) and age ($P = 0.948$) (Table 2).

The outcomes of craniosynostosis surgeries were evaluated by Whitaker classification. There was no significant difference between the two groups

Table 1: Demographic and baseline characteristics of patients

Variable	No.	Percent
Operation year		
2018	16	34
2019	9	19.1
2020	20	42.6
2021	2	4.3
Age		
< 6 month	6	12.8
7-12 month	23	48.9
13-18 month	14	29.8
> 18 month	4	8.5
Gender		
Male	24	51.1
Female	23	48.9
Surgery technique		
Plates and screws	31	65.9
PDS suture	16	34.1

Table 2: Gender, age and surgical outcomes in the two study groups

Variable	Plates and screws	PDS suture	*P*
Gender			
Male	13	11	0.081†
Female	18	5	
Age (mean (SD))	11.87 (6.26)	11.75 (5.41)	0.948*
Whitaker classification n(%)			
I	21(67.7)	9(56.3)	0.703†
II	8(25.8)	6(37.5)	
III	2(6.5)	1(6.3)	
IV	0(0)	0(0)	

* independent t-test
† chi-squared test

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Table 3: Outcomes of craniosynostosis surgery in relation to other variables

Variable			Whitaker classification I	II	III	P
Types of craniosynostosis n(%)						
Anterior plagiocephaly			8(50)	7(43.8)	1(6.2)	0.555*
Trigonocephaly			12(70.6)	3(17.6)	2(11.8)	
Multiple-suture synostosis			3(75)	1(25)	0(0)	
Brachycephaly			2(40)	3(60)	0(0)	
Scaphocephaly			2(100)	0(0)	0(0)	
Posterior plagiocephaly			3(100)	0(0)	0(0)	
Age (mean (SD))			11.6(6.35)	12.21(5.40)	12.33(5.50)	0.844‡
Surgical technique (by gender) n(%)						
Gender	Male	Plates and screws	10(76.9)	2(15.4)	1(7.7)	0.357†
		PDS suture	7(63.6)	4(36.4)	0(0)	
	Female	Plates and screws	11(61.1)	6(33.3)	1(5.6)	0.456†
		PDS suture	2(40)	2(40)	1(20)	
Types of craniosynostosis (by gender) n(%)						
Gender	Male	Anterior plagiocephaly	3(75)	1(25)	0(0)	0.820*
		Trigonocephaly	9(69.2)	3(23.1)	1(7.7)	
		Multiple-suture synostosis	1(50)	1(50)	0(0)	
		Brachycephaly	0(00)	1(100)	0(0)	
		Scaphocephaly	2(100)	0(0)	0(0)	
		Posterior plagiocephaly	2(100)	0(0)	0(0)	
	Female	Anterior plagiocephaly	5(41.7)	6(50)	1(8.3)	0.528*
		Trigonocephaly	3(75)	0(0)	1(25)	
		Multiple-suture synostosis	2(100)	0(0)	0(0)	
		Brachycephaly	2(50)	2(50)	0(0)	
		Posterior plagiocephaly	1(100)	0(0)	0(0)	
Surgical technique (by age) n(%)						
Age	<1 year	Plates and screws	12(70.6)	4(32.5)	1(5.9)	0.567†
		PDS suture	4(50)	4(50)	0(0)	
	≥1 year	Plates and screws	9(64.3)	4(28.6)	1(7.1)	1.00†
		PDS suture	5(62.5)	2(25)	1(12.5)	
Types of craniosynostosis (by age) n(%)						
Age	<1 year	Anterior plagiocephaly	4(44.4)	5(55.6)	0(0)	0.683*
		Trigonocephaly	7(70)	2(20)	1(10)	
		Multiple-suture synostosis	2(100)	0(0)	0(0)	
		Brachycephaly	2(66.7)	1(33.3)	0(0)	
		Posterior plagiocephaly	1(100)	0(0)	0(0)	
	≥1 year	Anterior plagiocephaly	4(57.1)	2(28.6)	1(14.3)	0.513*
		Trigonocephaly	5(71.4)	1(14.3)	1(14.3)	
		Multiple-suture synostosis	1(50)	1(50)	0(0)	
		Brachycephaly	0(0)	2(100)	0(0)	
		Scaphocephaly	2(100)	0(0)	0(0)	
		Posterior plagiocephaly	2(100)	0(0)	0(0)	

* chi-squared test
† fisher's exact test
‡ Kruskal-Wallis test

in terms of Whitaker classification (Table 2). The analyses also showed that the type of craniosynostosis and age did not make any significant difference in the outcome of the surgeries. Outcomes were compared between the two groups by gender and age mediation, and there were no statistically significant differences reported (Table 3).

DISCUSSION

The findings showed no statistically significant difference in the outcomes obtained after craniosynostosis surgery with the two fixation methods. Previous studies have reported various complications for using resorbable plate-screw

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[DOI: 10.52547/wjps.12.1.37]

systems including inflammatory foreign body reactions, soft tissue swelling, osteolysis, sterile fistulas, fractures and decreasing stability of resorbable plate-screws, when the bone thickness is insufficient[12, 18].

In addition, studies have shown that during follow-up, the number of palpable or visible plates increases over the first months to a maximum of 12 months[19]. The thickness of the resorbable plates would rise to 300% during the degradation process. This initial thickening of the resorbable plates, which results in a significant bulge before destruction, has been described by various researchers[20]. Despite the favorable results of using resorbable screws and plates, in some cases, complications such as protrusion of the plate surface and exposure of the plate from the site of the surgical incision may be observed[21]. In the present study, no complications or recurrences were observed during the patient's follow-up.

In the current study, the Whitaker classification system was used, a system for classifying the outcomes of craniofacial surgeries proposed by a person of the same name in 1987[22]. This classification is a four-level scale that has been used in various studies for more than three decades to evaluate the results of craniosynostosis surgery despite its simplicity in design[23-25]. Whitaker classification criteria are as follows: I) No corrections or revisions are necessary or suggested to the patient by the surgeon; II) Soft tissue or lesser bone revisions is desirable whether performed or not; III) Extensive osteotomies or bone grafting procedures performed or required; IV) Requires a similar or superior surgical procedure than the initial surgery. In our study, children had Whitaker class I in 63.8%, Whitaker class II in 29.8%, Whitaker class III in 6.4% and Whitaker class IV in 0% of cases.

After craniosynostosis surgery and fixation of bone fragments with absorbable sutures, no complications and reactions to foreign bodies were observed after 36 month and favorable outcomes were obtained after surgery[26]. These findings were consistent with the results of the present study. Linz et al. also reported in a conducted survey on 124 children, no complications in the fixation of bone fragments in pediatric craniofacial surgeries with absorbable sutures and observed a stable condition in all patients[27]. This study was in line with the present findings.

As the result, based on our findings, the use of absorbable screws usually does not cause postoperative problems, and no postoperative complications were reported compared to resorbable plates and screws fixation.

Absorbable sutures have more advantages such as high speed for operation, lower cost, no displacement, acceptable aesthetic results and providing the necessary strength. Also, these materials cause no deformation of the skull. A 6-month follow-up of patients shows that fixation with the absorbable suture is an efficient, low-complication, safe and low-cost method.

Due to the problems caused by international sanctions in Iran and restrictions on the import of some medical devices into the country, using absorbable sutures can be a good alternative for cranioplasty and front-orbital remodeling in patients with craniosynostosis. We suggest a more extensive double blind clinical trial with a long period of follow-up for a better results.

CONCLUSION

The use of absorbable sutures could be considered by plastic and craniofacial surgeons as a valuable and cost-effective tool in the fixation of bone fragments in craniosynostosis surgeries. This method usually does not cause any significant complications, and its clinical results are the same as the approach of using absorbable screws and plates.

ACKNOWLEDGMENTS

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

DECLARATIONS OF INTEREST

The authors have no competing interests to declare that are relevant to the content of this article.

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