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Management of Sagittal Craniosynostosis in Mansoura University Hospital: Assessment of Two Surgical Techniques

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ABSTRACT

Objective: One of the most common forms of craniosynostosis which leads to scaphocephaly is the isolated sagittal synostosis, it causing scaphocephaly, it accounts for 40% of cases.

The present study is a comparison between the outcomes of two surgical techniques of craniosynostosis; peninsula-shaped extended linear craniectomy and parasagittal biparietal bone remodeling with extended strip craniectomy technique.

Material and Methods: The present study is a prospective study that includs all the non-syndromic scaphocephalic cases. Patients were children less than one year old, admitted to the Pediatric Neurosurgical Department, Mansoura University Hospital, during the period from 2005 to 2015. Cases were divided into two groups into 26 each. Cases of Group 1 were surgically treated by the first surgical technique and cases of Group 2 with the second technique. The following parameters: Age, sex, weight, Cranial Index (CI), amount of blood loss duration of surgery, time of hospital admission, and postoperative complications.

Results: The total number of children admitted with craniosynstosis was 164, only 52 children were with isolated scaphocephaly. The average age of cases was 5.7 months, the median operative time for Group 1 was 55 minutes compared to 130 minutes in Group 2. The post-operative hospital stay in the first group was 3 days and 6 days in the second group. The median intra and post-operative amount of blood transfusion in Group 1 and Group 2 was 60ml and 200ml respectively. There were no complications. As regards CI measurement, it was 65 and 66 preoperative, immediately after operation was 69, and 74. And one year post-operative was 72 and 73 for group one and 2 respectively.

Conclusions: Although early outcome of remodeling group proved statistically superior to extended linear craniectomy group as regards the Cranial Index (CI), yet after one year, there was no statistical significant difference between the two groups. In view of the shorter operative time, shorter hospital stay and less blood loss, authors recommend extended linear craniectomy to be the technique of choice.

Key Words: *Craniosynstosis – Scaphocephaly.*

INTRODUCTION

Scaphocephaly is the most common isolated craniosynostosis in neurosurgical practice. In many series it accounts for 40% of the cases with craniosynostosis **[14]**. Different techniques are described for the surgical correction of sagittal synostosis ranging from the simpler suturectomy **[12]**, extended sagittal craniectomy **[5,19]** to the more extensive total and subtotal cranial vault remodeling **[3,18]**. It is a well known fact that the younger the patient the less extensive the procedure needed to produce a normal Cephalic Index (CI) **[14]**. Sagittal suturectomy received criticism in the literature because of its inability to achieve good results in all cases. Extensive total cranial vault remodeling achieves good results but it is sometimes associated with increased operative and blood transfusion risks.

The purpose of this paper is to compare outcome of two surgical techniques; extended linear craniectomy (peninsula-shaped) and the more invasive parasagittal biparietal bone remodeling with extended strip craniectomy in Neurosurgical Department in Mansoura University. The results are presented with reference to the Cranial Index (CI).

MATERIAL AND METHODS

The present work is a prospective study that includes all the non syndromic scaphocephalic cases referred to the Neurosurgical Department, Mansoura University Hospitals during the period between 2005 to 2015.

The inclusion criteria:

1- Clinical and radiological criteria of non syndromic scaphocephaly as syndromic one needs more complicated staged surgeries.

2- Children below 1 year of age were selected for different reasons, believing that the operation is technically easier due to the plasticity of the calvaria, the osseous defects created by cranial vault reconstruction are liable to rapid healing with earlier treatment, and the morphologic results will be superior.

Sex, age, weight, duration of surgical procedure, blood loss, time of admission to the hospital, and postoperative complications were analysed. Diagnosis of scaphocephaly was determined by clinical examination and confirmed by simple skull X-rays and 3D. CT-scan was done to detect intracranial abnormalities. Preoperative assessment was carried out immediately before surgery together with pediatric clinical evaluation, measurments and cranial index (cranial width/cranial length *100).

Group 1: Twenty six patients were selected for extended strip craniectomy in peninsula shape surgical technique Fig. (1), the children were operated in supine position with anteflexion of the head using a small gel pillow. Shaving and disinfection with solution of xylocain 1% was done then epinephrine (1:200.000) was infiltrated to the operative area. About 2cm behind the coronal suture, a bicoronal skin incision was performed supraperiostally. For exposure of both coronal and lambdoid sutures, skin flaps were evaluated anteriorly and posteriorly. Incision and reflection of the periosteum and enough of the squamal part of the temporalis muscles, a curvilinear bilateral parasagittal craniectomy 1.5-2cm wide was performed and extended towards both coronal and lambdoideal sutures. The ends of both craniectomies were curved postero-and antero-inferiorly, respectively, into the squamous temporal bone below the dissected temporalis muscle. This is followed by the creation of two 'peninsula-shaped' temporo-parietal bone flaps with the neck on the temporal bone. The two 'peninsula-shaped' temporo-parietal bone flaps underwent controlled fracture outward to increase side to side diameter. A linear craniectomy, crossing the superior sagittal sinus and combining right and left curvilinear craniectomies was added at the level of the anterior fontanel. The wound was irrigated and closed in layers after waxing the bone margins, a non-compressing head dressing was applied and left in place for 48 hours. No drains were used.

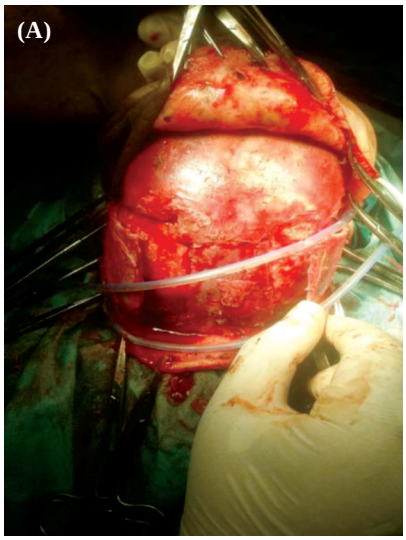
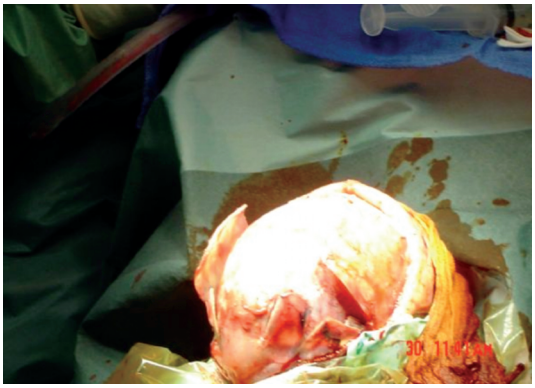


Fig. (1): (A) Peninsula shaped extended craniectomy.

Fig. (1): (B) Preoperative 4 months old girl that was subjected to Peninsula shaped extended craniectomy (C) 3 months and (D) 4 years postoperatively.

Group 2: Twenty six patients were selected for 26 patients who underwent parasagittal biparietal bone remodeling with extended strip craniectomy surgical technique Fig. (2). The children were operated in same position as the previous group. Shaving and disinfection as well as epinephrine infiltration of the operation site was performed the same as in Group 1. Exposure of bothe coronal and lambdoid sutures was done as in Group 1. Through multiple burr hole central part of sagittal bone along with equal bilaterally 4cm. Parietal bone is removed in one mass extending from coronal to lamboid suture. After removal of biparietal bone, it is shortened anteroposterly by removing stip of bone from posterior end, and increased in width by barrel stave osteotomies and outward controlled fracture on both side concomitant barrel stave osteotomies are made in the lateral frontal and parietal bone and fractured outward to increase width of the skull. Also barrel stave osteotomies are made posteriorly in the occipital bone and fractured inward to decrease length of the skull. The wound was irrigated and closed in layers after waxing the bone margins, a non-compressing head dressing was applied and left in place for 48 hours. No drains were used.



(A)

Fig. (2): (A) Group 2 remodeling technique with parasagittal bone remodeling and strip craniectomy with in and out controlled fractures.

(B)

(C)

(D)

Fig. (2): (B) Preoperative 4 months old girl that was subjected to Peninsula shaped extended craniectomy (C) 3 months and (D) 4 years postoperatively.

The studied groups were followed-up by 3D CT. Cranial index of every case (cranial width/ cranial length *100) was determined preoperatively, immediately postoperative and one year postoperative. The cranial width was defined as bitragal distance and the cranial length was defined as nasion-inion distanance. The aim of this work is to compare the outcome of both surgical techniques regarding cranial index (cranial width/cranial length *100). Other differences between both techniques, namely: The time of hospital admission, duration of surgery, blood loss during surgery and postoperative complications.

Statistical analysis: Data were computed with the statistical package for the social science, windows 98 version, USA (SPSS 10 software). Variables with non-normal distribution were expressed as median (range). In these variables, the Mann-Whitney-U test was applied for group differences. Values of $p<0.05$ were considered significant.

RESULTS

Among 164 children admitted to Mansoura University Hospital with craniosynstosis from 2005 to 2015, only (52) child had isolated scaphocephaly. The final average age was 5.7 months (variation 4-11 months). The minimal weight found was 6Kg and the maximum was 8.5 (average, 7Kg). The median operative time was found to be 50 minutes in (Group 1) (range 35-70), compared with 130 minutes in (Group 2) (ranges 100-180) (p 0.0001); while the post-operative hospitalization time was 3 days (ranges 2-6), compared with 6 days (ranges 5-8) in Group 2 (p 0.001). The median intra and post-operative blood substitution in Group 1 and Group 2 was 60 (range 0-70) ml and 200 (range 120-250) ml (p 0.0001), respectively (Table 1). There were no complications.

The median preoperative Cranial Index (CI) was 66 (range 64-68) in both groups (expressed in all population), while the immediate post-operative was 69 (range 67-71), and 74 (range 71-75) (p 0.001), and the 1-year post-operative was 72 (range 70-74) and 73 (range 70-74) (p 0.147), in both groups consequently (Table 2). Although, there were superior outcome of remodeling group statistically in immediately postoperative period, there were no significant difference of CI after 1 year between two groups.

Table (1): Correlations of operative times, hospital stay and blood loss to both groups variables expressed as median (range).

Variables	Group 1	Group 2	*p*-value
Operative time	55 minutes (35-70)	130 minutes (100-180)	0.0001
Hospital stay	3 days (2-6)	6 (5-8)	0.0001
Blood substitutes	60ml (0-70)	200ml (120-250)	0.0001

Table (2): Cranial index outcome in both group variables expressed as median (range). Preoperative CI was expressed in all our cases (52).

Cranial index	Group 1	Group 2	*p*-value
Preoperative	Median 66 (range 64-68)	Median 66 (range 64-68)	
Immediate postoperative	Median 69 (range 67-71)	Median 74 (range 71-75)	0.001
More than 1 year postoperative	Median 72 (rang 70-74)	Median 73 (range 70-74)	0.143

DISCUSSION

Several techniques have been used for the treatment of scaphocephaly, ranging from simple suturectomy, **[18]** extended strip craniectomy, **[15,16]** the Pi procedure, **[1,8]** to total vertex craniotomy, **[3,6]** and calvarial craniotomy, **[17]** together with a number of more recent innovative techniques including the endoscopically-assisted craniectomy **[9]**.

Some authors **[6,9,19]** believe that extended strip craniectomy with large opening of the skull have a good influence on remodeling and further growth of the skull in the future. Erdincler **[4]**, stated that the advantage of wide linear craniectomy [peninsula-shaped]; it is a simple technique that can be applied by most neurosurgeons with minimal blood loss, spare growth of the normal sutures, relaxes brain compression immediately, favors natural growth of the skull by decompression and enabling volume expansion until reossification.

Vague terms were used by many authors to describe the outcome of their operative techniques e.g. “optimal appearance or superior results” **[10,11, 15,18]**. Recently some authors **[7,13,17]** use cephalic index for quantitative aesthetical assessment of the operative outcome. The cranial index is the ratio of maximum calaverial width divided by maximum calaverial length multiplied by 100. It can be obtained either by skull radiograph **[7]**, direct anthropometric measurement **[17]**, or CT scan **[13]**. We documented the change of the aesthetical appearance of our patients by direct anthropometric measurement cephalic index and comparison of the preoperative, perioperative and postoperative (after 1 year) measurements for every patient.

Kaiser **[10]**, Marsh **[15]** and Panshal **[16]** compared the results of total and subtotal calverectomy with less invasive procedures (linear and extended strip craniectomy) in reference to cephalic index. They stated that remodeling produced a more statistically significant change toward normaly in cranial index than extended strip craniectomy. They referred time from 6 months to 1 year post operatively.

We use two techniques; first is Fig. (1) extended strip craniectomy in Peninsula shape with outward controlled fracture of tempro-parietal flap to increase side to side diameter. Although it is safe procedure with minimal blood loss, short operative time and hospital stay it is not associated with good immediate result. Second technique Fig. (2) is vertex remodeling with extended strip craniectomy, it takes advantage of good immediate result but it is associated with significant blood loss and hazard of blood transfusion.

In our study there were statistically significant superiority of remodeling group only in immediate post-operative period but long term follow-up after 1 year, there were no statistical significance between 2 groups. This met with others in immediate postoperative period only but not met with them in long follow-up, we think the cause of this may be that some previous studies **[10,15]** were not done in random way like our one. Also these studies **[10,15,16]** have less number of cases especially in extended craniotomy group, and we did additional step which is controlled outward fracture of temproparietal flap to increase side to side diameter of the skull, this step is not described with all extended linear craniectomies described before in literature.

There were statistically insignificant difference between two groups in long term follow-up regarding aesthetic appearance, together with, statistically significant difference in favor of extended craniectomy group regarding operative time, post-operative hospitalization time and blood loss. That is why the extended linear craniectomy technique is recommended by the authors to be widely applied.

Conclusion:

Although early outcome of remodeling group proved statistically superior to extended linear craniectomy group in term of Cranial Index (CI), the long term outcome after 1 year showed no statistical significance. So in view of the superiority in operative time, hospital stay and blood loss, we recommend extended linear craniectomy to be more widely applied.

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