CLINICAL ARTICLE

Early Treatment of Craniosynostosis by Using Endoscopic – Assisted Minimally Invasive Techniques

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ABSTRACT

Object: *The conventional calvarial remodeling procedures are being replaced by minimally invasive endoscopic-assisted suturectomies across the globe. The object of the study was to evaluate the efficacy of these minimally invasive techniques of strip craniectomies in our population.*

Material and Methods: *A total of 70 patients, below 4 months of age, with metopic, coronal or sagittal suture premature fusion were treated during a period of three years from Nov. 2009 – Nov. 2012, using minimally invasive endoscopic-assisted techniques.*

Results: *The sagittal suture synostosis group consisted of 28 patients, 19 males and 9 females with a mean age of 3 months. The group with coronal synostosis consisted of 17 patients, 8 males and 9 females with a mean age of 3.2 months. Metopic group consisted of 25 patients, 17 males and 8 females with a mean age of 2.3months. All these patient were chosen for minimally invasive strip craniectomies with the help of rigid neuroendoscope instead of conventional suturectomy. There were 4 intra-operative and 3 post-operative blood transfusions (10%). The mean surgical time was 55mins. All but 3 patients were discharged on 1st post-operative day (96%).*

Complications *included 3 dural tears, 2 sagittal sinus injuries and 2 pseudo-meningoceles (10%). 2 cases had superficial wound infection of the skin and there was no mortality. Using anthropometric measurements and photographic assessment, excellent results were obtained in 78%, good results in 14% and poor in 8%.*

Conclusion: *Coronal, metopic and sagittal synostosis can be treated at a very early age satisfactorily with minimally invasive endoscopic-assisted technique with good cosmetic results and limited blood loss.*

Key Words*: Suturectomy, Endoscopic – assisted minimally invasive, Infants, Metopic, Coronal, Sagittal, Cranio-synostosis.*

INTRODUCTION

The average weight of the brain of a newborn varies from 300 – 350 grams and within 1 year it will become 1000grams (300% increase). Now it will grow slowly till the age of 7 years when the adult weight of the brain, 1400 – 1500 grams, will be reached. It is essential that during the neonatal period, brain should have freedom to grow and when premature closure of any of the sutures ensues, it is likely to effect the anatomical and functional growth of the brain which will have cosmetic effects on the shape of the skull as well in addition to intellect. As the primary deformational force in a single suture synostosis is the fused suture itself, the early suturectomy during the rapid brain growth phase would stop the progression of the deformation. Surgical procedures have developed from simple suturectomies to complete calvarial vault remodeling using high speed drills.[10] Major remodeling procedures have shown good cosmetic results but are time consuming, have extensive incisions and there is considerable blood loss. These extensive procedures of bifrontal craniotomies and orbital bandeau remodeling carry a certain morbidity and mortality.[6] Moreover, there are chances of loosening of hardware and migration of screws into the brain parenchyma. On the other hand, the endoscopic – assisted minimally invasive procedures over the last decade have also proven their usefulness and provided acceptable cosmetic

correction of the deformation of skull. Short hospital stay, minimal blood loss, less post-surgical swelling and discomfort, lower rate of complications are the benefits of these minimally invasive endoscopic – assisted procedures.[5] The metopic synostosis when treated by conventional methods at 6 – 9 months of age will require bi-frontal craniotomies and orbital bandeau remodeling but even then the orbital dystopia cannot be addressed. Similarly, the sagittal synostosis, when treated at a later stage, may require Barrel – Stave Osteotomies or Pie Procedure in addition to the removal of the bone. In 1800, von Sömmering first described the structure of cranial sutures and observed that premature suture fusion could alter the head shape.[3,11] Three decades later, Otto and in 1851, Virchow contributed greatly in understanding the nature of mechanism of deformation of skull. Initially, the only treatment available for craniosynostosis was strip craniectomy. But, with the advancement of anesthesia and per-operative monitoring, more and more complex procedures were devised to get best cosmetic appearances. But all these extensive procedures were attended by a certain morbidity and mortality.

In 1999, Baron and Jimenez published the endoscopic approach for suturectomy followed by helmet therapy, for the first time.[1,7] Some surgeons question the need for adjuvant helmet therapy in addition to endoscopically assisted strip craniectomy but probably the historical failure of strip operations alone does support the need for external device like helmet.

MATERIAL AND METHODS

Between November, 2009 – November, 2012, all the patients below 4 months of age (range 40 days – 4 months) who were suffering from sagittal, coronal or metopic synostosis were included in the study. All the patients were examined, head circumference was documented, cranial index measured in sagittal synostosis group. Clinical details recorded the duration of surgery, hospital stay, complications and need for blood transfusion.

SURGICAL TECHNIQUE

Position

For metopic and coronal synostosis, supine position was used and for sagittal suturectomy, modified prone position using chest rolls and U-shaped chin support was used.

Surgical Steps

In cases of **sagittal synostosis**, two parallel incisions were made, each 1.5 – 2 cm long, one behind the posterior border of the anterior fontanelle and second was placed at the junction of lambdoid and sagittal sutures. Burr holes were made over midline at each incision. Supra-periosteal dissections were then performed between lambda and anterior fontanelle. Epidural dissection was performed by using rigid neuroendoscope with 6 degree angle along with suction tip and bipolar diathermy was used to coagulate the emissary veins and sever the dural attachments. 1 cm wide strip of bone was removed using special, thin bone rongeurs, bone cutting scissors and long artery forceps. The spongoston was placed over craniectomy site and incision was closed in two layers by using 3/0 vicryl. For **metopic synostosis**, incision was made in hairline in the midline, 2 – 3 cm anterior to the anterior fontanelle and strip craniectomy of 8 mm – 1 cm was done from anterior fontanelle to glabella. In cases **of unilateral coronal synostosis**, 2 – 2 .5 m long incision was made midway between the ipisilateral ear and the anterior fontanelle. A 10 – 11 cm long and 1cm wide coronal suturectomy was done. These patients were followed up from 3 months – 2 years.

Post-operative Care

All the patients had crepe bandage dressing for the first 24 hours to minimize the blood accumulation below the incision. After removal of stitches, the parents were advised to contact the orthopedic workshop for fitting of a cranial molding helmet according to the requirement of the patient. The helmet costs about 3500/- Rs and may need to be replaced once in the next 6 – 8 months. Almost 50% of parents did not agree to the idea of wearing helmet for some or the other reason, post-operatively and requested for instructions of manual molding of skull at home. As most of the mothers in our society are not the working women, so they have ample time to concentrate on manual molding of skull and hence were advised accordingly. Those parents, who agreed to helmet therapy, were advised to make the child wear it for minimum of 8hrs each day for 6months after surgery, though the general recommendation of helmet therapy is till the age of one year. Most of the parents did not meticulously follow the helmet therapy instructions, even then the majority of the parents were satisfied with the outcome of the surgery.

RESULTS

Sex Incidence

Out of 70 cases, 44 (63%) were male and 26 (27%) were female patients Table 1.

Table 1: *Sex Incidence.*

Sex	No.	Percentage
Male	44	63
Female	26	27
Total	70	100

Table 2: *Suture Involved, Sex, Mean age.*

Fused Suture	Sub-total	Sex		Mean Age
		Male	Female	
Sagittal	28	19	9	3 months
Coronal	17	8	9	3.2 months
Metopic	25	17	8	2.3 months
Total	70	44	26	

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The mean surgical time was 55 mins (25 – 90 mins). The **complication** rate was 10% (3 dural tears, 2 anterior sagittal sinus injuries and 2 pseudo meningoceles). Only 10% patients needed blood transfusions. There was no post-operative CSF leak or mortality. In cases of sagittal synostosis, the cranial index increased from mean 0.63 to 0.75. On follow-up, 92% parents showed their satisfaction at the outcome of surgery.

DISCUSSION

Over the last four decades, simple suturectomy or Barrel – Stave Osteotomies gave way to larger, open remodeling techniques, largely because of dissatisfaction with the outcome of former operations. Open cranial remodeling procedures have a significant associated morbidity and mortality, with operation time ranging from 1.5 – 7 hrs.[7] Large centers have reported 84 – 100% rates of blood transfusions.[8] The minimally invasive endoscopic-assisted techniques have ushered a new era in the management of early suture closure. Although, one might suppose that a smaller operation would result in less morbidity, some surgeons question whether limited exposure might actually increase the risk of serious injury or death. This concern is not supported by the literature because many reports of minimally invasive endoscopic craniectomy techniques and post-operative helmet therapy have shown extremely

Table 3: *Meta – analysis of studies reviewing endoscopic strip craniectomy.*

Authors and Year	No. of Patients	Mean Operative Duration (min)	% EBL	Transfusions (%)	Mean Hospital POS (days)
Barone and Jimenez, 1999	9	93.6 min	12 ml	NA	1.16
Johnson and Jimenez, 2000	59	50.0 min	NA	10	1.07
Jimenez et al, 2002	61	52.7 min	6.1 ml	NA	1.10
Clayman et al, 2007	11	97.0 min	NA	25	Majority on postop Day 1
Barone and Jimenez, 2004	139	59.6 min	NA	9	1.07
Ridgway et al, 2011	56	45.0 min	NA	3.3	1.30
Current Study	70	55.0 min	--	10	1

Abbreviations: EBL= estimated blood loss, NA= not available. POS = Post-operatively.

low morbidity, short hospital stay, short operation time and low incidence of blood transfusions. In addition to being safe, endoscopic – assisted strip craniotomy and post-operative helmet therapy yields short – term improvement in the cranial index comparable to those obtained by larger open procedures. Heller et al. reported an improvement in the cranial index from 67.9 to 78.5 with open calvarial vault remodeling[4]. The modified pi-plasty was associated with an improvement in the cranial index from 65 to 72. Barone and Jimenez and colleagues in 2004 reviewed 139 patients of minimally invasive endoscopic – assisted sagittal synostosis suturectomies and described an improvement in 96% patients so far as cranial index is concerned.[2] It shows that the results of extensive calvarial remodeling and early minimally invasive endoscopic – assisted procedures are comparable. Sandeep Sood and Arlene Rozzelle have demonstrated that molding helmets improve head shape even without a suturectomy in patients with sagittal craniosynostosis, challenging the traditional view.[9] This study also demonstrates that early suturectomy my not offer any advantage over molding helmets alone. This furthermore raises the controversy regarding whether surgery should be deferred until the full benefit from the helmet is achieved and whether surgery maybe unnecessary in some patients if molding helmets are just as effective.

CONCLUSION

Improvements in cranial index and head circumference percentile are comparable to larger open remodeling procedures. And cosmetic results are equally acceptable by the parents. Though these minimally invasive endoscopic – assisted suturectomies are very beneficial for early months of infantile age, but the major interventions will continue to have their place for patients who present late and for those who have failed to get improvement from minimally invasive neuroendoscopic – assisted procedures.

DISCLOSURE

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper. Author contributions to the study and manuscript preparation include the following: Conception and design: Malik Muhammad Nadeem. Drafting the article: all authors. Statistical analysis: Uzair. Study Supervision: Nadeem.

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