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Experience of Ruptured Thoracolumbar Myelomeningocele Repair Under Local Anesthesia in Neonates

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ABSTRACT

Objective: To see the efficacy of surgical repair of ruptured thoracolumbar myelomeningocele under local anesthesia.
Study Design: Quasi experimental study.
Place and Duration of Study: Neurosurgery center, CMH Rawalpindi, Pakistan from Jun 2022 to Jan 2024.
Methodology: All the patients were operated within 24 hours of presentation to the hospital. All the patients were neonates, having ruptured Thoracolumbar Myelomeningocele sac, with established complete or incomplete neurological deficit. The cases with intact neurology, cervical and upper thoracic vertebral levels, severe or un-diagnosed coagulopathy were excluded from the study. Parents were counselled in detail about the purpose of the surgical procedure being to prevent future complications of ruptured myelomeningocele; and established neurological deficit shall not be reversed.
Results: Out of the 50 children, with male pre-ponderance, 17 were paraplegic and 33 were paraparetic. Surgical site infection, post repair hydrocephalus, cerebrospinal fluid leak and meningitis were seen in 8%, 38%, 10% and 4 % of the participants, respectively. No patients developed any local anesthesia systemic toxicity. 6% patients developed wound dehiscence resulting in re-admission. The mean hospitalization stay was 3.5±2.0 days, while mean operative time was approximately 40 minutes. Mean blood loss was 35.8±7.04 ml, while mean transfusion was 21.38±6.49ml. Mean follow-up time was 6.7±1.6 days. 2(4%) patients lost to follow-up. One patient died before discharge.
Conclusion: The repair of ruptured Thoracolumbar Myelomeningocele under local anesthesia, is an efficient, convenient, cost effective and feasible surgical approach for resource constrained settings with high patient burden.

Keywords: Myelomeningocele. Spinal dysraphism. Thoracolumbar. Hydrocephalus.

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INTRODUCTION

Myelomeningocele is the severe form of spinal dysraphism, compatible with life. It presents in a newborn as a lump containing malformed neural placode fused to the skin or a thin easily ruptured membrane, anywhere along the vertebral column, due to herniation of meninges and spinal cord through the deficient vertebral arches.[1,2] It accounts for 38.6% of all Nervous system abnormalities, owing to multi-factorial etiology like poor antenatal care, maternal malnutrition and folic acid deficiency.[6,7] In about 80% cases myelomeningocele is associated with Chiari type II malformation, characterized by cerebellar tonsillar herniation; downward displacement of the brainstem, leading to hydrocephalus.[3,18] Furthermore, a majority of these cases present with concurrent genetic abnormalities under the spectrum of trisomy 13 or 188,17; a major poor prognostic factor. If left untreated, mortality has been reported to be 90% within six months.[11]

Myelomeningocele requires expedited surgical repair, preferably within 24 hours of birth, to prevent complications like meningitis, wound sepsis, and progression of neurological damage.[4,5] In low and middle income countries timings to Myelomeningocele repair are not optimal, due to limited resources, late presentation and lack of awareness, which leads to undesirable outcome.

Surgical repair under local anesthesia is a relatively novel approach, which has shown considerable improvement in the management of Myelomeningocele; is more feasible, less costly and equally safer, as would be in general anesthesia. The purpose of this prospective study is to assess the effectiveness of repairing Myelomeningocele under local anesthesia.

METHODOLOGY

A Quasi experimental , single-center study was conducted at our Neurosurgical center between June

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2022 and January 2024, with a sample of 50 patients. Data were collected after obtaining permission from the institutional ethical review board (ERC Number 586) All the patients were operated within 24 of presentation to the hospital.

Inclusion Criteria: All the patients of ruptured thoracolumbar Myelomeningocele presenting within <28 days of birth, having an established neurological deficit paraplegia/paraparesis were included in this study. Neonates with concurrent systemic abnormalities precluding general anesthesia (GA) were also included in the study.

Exclusion Criteria: The subjects excluded from this study were infants beyond 28 days age, unruptured myelomeningocele sac, and a broad-base sac (preventing direct primary closure), and the children with intact neurology.

Demographic data was collected prospectively from the patient files and admission record. Body weights of the neonates were measured in grams before surgery. Operative time was measured in minutes; from the beginning of skin incision to the closure of the surgical wound. Blood loss was measured as the weight of blood soaked surgical gauze/sponges subtracted from their dry weight and measured as milligrams; whereas the transfusion volumes were separately recorded in milliliters. Hospitalization period was recorded as a measure of cost effectiveness. All the patients were followed up for six months.

The goals of surgical management include preservation of functional neural tissues, reconstruction of the dural tube, securing sound myofascial and skin closure, and minimizing the chances of future tethering of the cord.

Patients who presented from center's indigenous neonatal unit were operated within 24-48 hours of birth, while those referred from other hospitals were also operated no later than 24 hours of the arrival. Parents were counselled in detail that neurological status of the already paraplegic/Para paretic will not be improved patients, and procedure was being done to prevent further complications of MMC like meningitis, sepsis, progression of neurological deficit. Blood products were arranged in-hand during surgery, with precautions to achieve adequate hemostasis. Additionally, pre-operative Hb was build-up by blood transfusion at 10ml per kg body weight. Careful airway monitoring with neck control was provided by anesthetists, throughout the procedures. Additionally, meningitic dose of Ceftriaxone and Vancomycin were used intra-venously during surgery. The operation theater's temperature was maintained at 28^{o}C. Patients were proned onto a warm pad, with pressure point management. The neurologically intact patients were restrained (strapped with adhesive surgical tape) to avoid movement during surgery. The membranous portion of the sac, containing the exposed neural placode, was irrigated profusely with antibiotic-reinforced saline, and the surrounding skin scrubbed with the Povidone-iodine solution. Lignocaine 1% with a dose not exceeding 4-4.5mg/kg was percutaneously infiltrated on the surrounding skin of the myelomeningocele sac, according to body weight in semi-prone position. Throughout surgery non-latex powder-free gloves were used. Under loupe magnification 3.5x , the sac was initially mobilized by undermining around the MMC sac halfway from the margin of placode and healthy skin, until dura-mater is seen to enter the skin defect. The zona epitheliosa was preserved while the redundant skin around sac was excised and separated. The pinkish neural placode was identified with its nerve roots and differentiated from neurulated cord tissue, and carefully handled, trimmed/excised and reduced back to its origin. The caudal end of placode was carefully checked for neurulated cord, to exclude a rare case of segmental placode. The dura was sharply incised from the lumbar fascia and cranio-caudal ends of the dura were exposed dural flaps were created, to reconstruct new neural tube. Furthermore, the newly reconstructed dural tube was reinforced by lumbar fascia flaps. The skin defects were closed primarily, with undermining carried out sufficiently in all directions to avoid tension on the suture lines. Closure was done in 2 layers with 5.0 Vicryl in the subcutaneous tissue and 5.0 Prolene interrupted mattress sutures for the skin. The surgical wound was dressed with paraffin and bacitracin based ointments, followed by a gauze dressing and Tegaderm. No drains were placed in the wounds. Those patients who sought discharge on the same day basis post-operatively, were given oral antibiotics with advice for nursing in lateral (right or left) position till removal of stitches on 10th day, with change of first dressing on third day, and regular wound assessment for any CSF leak, seroma or wound breakdown. Care givers were also advised to report to hospital, in the event of CSF leakage, increased head circumference or symptoms suggesting hydrocephalus.

Data Analysis

Data was analyzed by using Statistical Package for Social Sciences (SPSS) 22.00. Normality of data was checked by Shapiro-Wilk test that showed that data were normally distributed. Quantitative data was represented using Mean±SD. Qualitative data was represented by using percentage and frequency. Student t-test was applied and *p*-value of ≤0.05 was considered as statistically significant

RESULTS

A total of two hundred and fifty (n=250) cases of Myelomeningocele were presented to the hospital, of which 50 patients had ruptured Thoracolumbar Myelomeningocele, who were included in the final analysis. Out of 50 Patients, 28(56.0%) patients were male and 22(44.0%) were females. Mean age and weight were 3.44±2.13 years (Range: 1.00 to 9.00 years) and 2620.00±330.85 grams (Range 2200.00 to 2620.00 grams). The mean blood loss was 35.78±7.04 ml, while the mean transfusion volume of blood was 21.38±6.49 ml. The mean duration of hospitalization was 3.54±1.98 days, and 5 patients were discharged on the same day. The mean surgical/operative time was 41.00±4.84 minutes. The mean follow-up time was 6.76±1.63 days). One patient died before discharge from the hospital. Of the total,46(92.0%) patients had the radiological Arnold Chiari Type II malformation (Table I).

Table-I: Demographic and Clinical Characteristics of the Thoracolumbar Myelomeningocele Patients (n=50)

Parameters	Values
Age in Years	3.44±2.13
Gender	
Male	28 (56.0%)
Female	22(44.0%)
Weight in Grams	2620.00±330.85
Blood Loss (ml)	35.78±7.04
Transfusion Volume of Blood (ml)	21.38±6.49
Surgical/Operative Time (Minutes)	41.00±4.84
Follow-Up Time (Days)	6.76±1.63
Radiological Arnold Chiari Type II Malformation.	46(92.0%)

Prenatal diagnosis of NTD was made in only 9(18%) cases. 9(18%) had associated sepsis. 17(34%) of the participants were paraplegic with bowel and bladder incontinence, and 33(66.6%) were paraparesis. Surgical site infection was seen in 4(8.0%) of the participants. 5(10.0%) patients reported CSF leak from the wound resulting in a soaked suture line and delayed wound healing. This coincided with a development of hydrocephalus in 19(38.0%), manifested as marked increase in head circumference (Table-II). These patients underwent cerebrospinal fluid diversion procedure : Ventriculo-peritoneal shunt. No patients developed hindbrain herniation, requiring chiari decompression procedures. 3(6%) patients reported on follow-up with wound dehiscence, which were managed with daily dressings, intravenous anti-biotics. Two patients presented with wound dehiscence on follow-up and were managed with a rhombic flap reconstruction under GA, making use of the nearby skin laxity by Plastic surgeons14. Both gender had almost same average of blood loss (*p*–value =0.382) while mean of Transfusion Volume of Blood (ml) was seen more in female as compare to male as *p*-value=0.005 shown in Table-III.

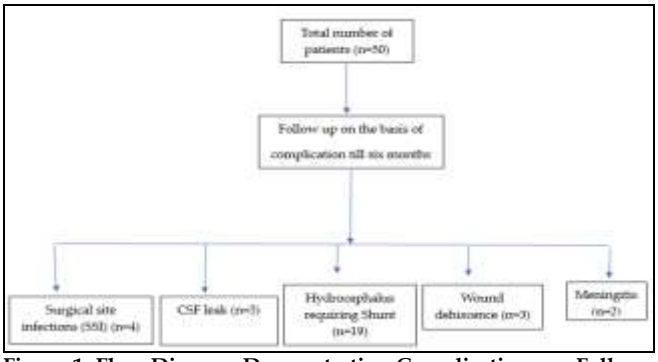

Figure-1: Flow Diagram Demonstrating Complications on Follow-up

Table-II: Percentage of Complications presented in the Patients (n=50)

Surgical site infections (SSI)	4 (8.0%)
CSF leak	5(10.0%)
Hydrocephalus requiring Shunt	19(38.0%)
Wound dehiscence	3(6.0%)
Meningitis	2(4.0%)

Figure-II: Images from the Subjects with Ruptured Myelomeningocele. All Iamges Have Been Taken with the Permission of the Patient families, and Identification Detail Have Been kept Anonymous

Table-III: Comparison of Blood Loss (ml), Transfusion Volume of Blood (ml) Among Gender (n=50)

	Male (n=28)	Female (n=22)	*p*-value
Blood Loss (ml)	35.00±7.34	36.77±6.70	0.382
Transfusion Volume of Blood (ml)	19.14±7.12	24.22±4.25	0.005

2(4%) patients had meningitis on follow-up confirmed on trans-coronal ventricular tap. No patients developed local anesthesia related systemic toxicities. No dural substitutes or fibrin glue were used in any of the patients. One patient died before discharge from hospital.

DISCUSSION

The traditional surgical approach of myelomeningocele repair under general anesthesia brings is time consuming, due to induction time, limited OT space and anesthesia drugs usually being administered at a very strict margin of dosage. Furthermore, intubation and peri-operative airway management in neonates is generally challenging and requires a high amount of expertise.[16,19] For some of these patients who are especially unfit for general anesthesia due to birth-related or VACTREL anomalies, and several inherent factors, the repair under local anesthesia is more feasible in preventing morbidity of this disease.[17] Approximately 300 cases of Thoracolumbar myelomeningocele are annually managed at our center and a majority of the cases are usually managed within 24–48 hours of birth, as an emergency. This is generally in keeping with the literature which recommends surgery within 48 hours, and just two sources which allow up to 72 hours.[9] This enormous burden of cases amid other neurosurgical emergencies and elective cases poses a backlog of cases in a limited OT space and human resource-constrained setting. Surgical repair under local anesthesia is an alternate management strategy for ruptured myelomeningocele cases in high volume centers like ours.

Complications associated with post-natal Myelomeningocele repair are variable, more commonly wound breakdown and superficial skin infections (1-2%), CSF leak (17%), usually preventable with good wound care. These complications usually occur in the first week of the surgery.[10,15,21] In this study, surgical site infection were seen in 8% cases, while CSF leak was seen in 10% patients, and 38% patients required Ventriculo-peritoneal shunting for hydrocephalus. Enrique *et al*., showed results of post-natal Myelomeningocele repair for a sample of 50 patients as well, demonstrating the percentage of skin infection, CSF leak and hydrocephalus to be 8%,2% and 42%, respectively; consistent with our results.[12] A retrospective cross-sectional study by Hagemann *et al.*, with a sample of 36 , showed Hydrocephalus in 58% patients of which 41% required Ventriculo-peritoneal shunt, also comparable to our results. Hagemann *et al.*, reported only one patient(3.2%) required retethering surgery for tethered cord.[13,20]

LIMITATIONS OF STUDY

A major limitation of our study is a short follow-up of nearly 7 days on average, and long-term outcome and quality of life could not be recorded and assessed on our subjects. Another limitation is a small sample size. There is a need for a more randomized, multi-centered study to be designed in order to determine significant long-term outcomes of ruptured thoracolumbar myelomeningocele repair.

CONCLUSION

Repair of ruptured Thoracolumbar Myelomeningocele under local anesthesia is relatively safe, less time consuming and an inexpensive alternate to repair under general anesthesia and it avoids complications associated with general anesthesia. Moreover, it is convenient and feasible for resource constrained settings with high patient burden, where availability of operation theaters and GA is usually delayed.

Informed Consent

Informed consent was obtained from the attendants of all the patients who were included as a part of this study.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

AR & ZH: Data acquisition, data analysis, critical review, approval of the final version to be published.

SAQ & B: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

IA & ARA: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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