Scientific Research Publishing

Open Journal of Modern Neurosurgery, 2024, 14, 137-148
https://www.scirp.org/journal/ojmn
ISSN Online: 2163-0585
ISSN Print: 2163-0569

The Timing of Primary Neurosurgical Repair and Wound-Site Infection in Children with Myelomeningocele

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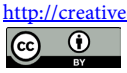
How to cite this paper: Obande, J.O., Bitrus, P.T. and Obande, E.I. (2024) The Timing of Primary Neurosurgical Repair and Wound-Site Infection in Children with Myelomeningocele. *Open Journal of Modern Neurosurgery*, **14**, 137-148.
https://doi.org/10.4236/ojmn.2024.142015

Received: February 5, 2024
Accepted: April 15, 2024
Published: April 18, 2024



Abstract

Background: The optimal time to closure of a newborn with a myelomeningocele has been the focus of a number of evaluations. The Timing of primary surgery has received significant attention due to its relationship to repair-site infection that can lead to increased morbidity and prolonged hospital stays. It is on this basis that recommendations have utilized 48 - 72 hours post birth as ideal time of closure. This is not only prevent infection at the site but also prevent ventriculitis and neural structure damage. We therefore, hypothesized an increase in wound infection rates in those patients with delays in myelomeningocele repair. *Methods*: We retrospectively reviewed the records of 103 children with myelomeningocele treated between 2016 and 2023. At discharge the patients were followed up at the post-operative clinic visit 2 weeks later. Children were assigned to 1 of 2 groups, those who underwent primary neurosurgical repair within 72 hours of delivery (Group 1) and those undergoing repair after 72 hours (Group 2). We compared the infection rates. *Results*: 103 children who underwent myelomeningocele repair were identified, with a median time from birth to treatment of 1 day. Eight (7.8 %) patients were noted to have post-repair surgical site complications. There was no significant difference in rates of infection between Group 1 and Group 2 repair times. The presence of infection was associated increased length of stay when compared to neonates without infection. *Conclusion*: In children with myelomeningocele, the timing of primary neurosurgical repair appears not to have a significant impact on surgical site infection. Closure of the spinal lesion within the first 72 hours of life may be more favorable for neural damage prevention. These results suggest that early myelomeningocele repair may not impart significantly on the rate of wound-site infection.

Keywords

Spina Bifida, Surgical Timing, Excision and Repair, Surgical Site Infection, Myelomeningocele

1. Introduction

Spina bifida is a congenital malformation in which the spinal column is split (bifid) as a result of failed closure or formation of the embryonic neural tube. The most common and severe form is open type of spina bifida known as myelomeningocele, MM [1] [2]. In myelomeningocele, the spinal cord is open dorsally, forming a placode on the back of the fetus or newborn baby; this placode frequently rests on a meningeal sac [3] [4]. The vertebrae at the level of the lesion lack neural arches and are incomplete dorsally [4]. Individuals with myelomeningocele often exhibit neurological deficits below the level of the lesion, involving both motor and sensory functions. Urinary and fecal incontinence also occurs frequently [1] [3] [4] [6]. Treatment is surgical, Myelomeningocele excision and repair. This achieves closure of the back defect to provide protection to neural structures as well as minimize the risk of ascending infection [2] [3] [4] [6].

Background

The timing of primary myelomeningocele repair has received significant attention due to its relationship to repair-site infection which can lead to increased morbidity and prolonged hospital stays. Multiple studies have confirmed that early surgery (before 36 hours) likely has no effect on the level of lower extremity paralysis [4] [5]. However some studies have shown that in as much as there is no significant improvement of paralysis following primary repair within 72 hours, there is no worsening of paralysis as seen when repair is done after 72 hours [7].

Current neurosurgical practice dictates that the optimal timing for repair is within 36 - 72 hrs as this reduces the incidence of infection (incidence of ventriculitis reduces from 37% to 7% when done within 48 hours) and positively impacts on neurogenic bladder prognosis [8]. Surgical site infections following repair within this time frame has a prevalence of 7% - 11.7% [1].

It is hypothesized that delayed surgical repair of myelomeningocele is associated with an increased rate of infection due to bacterial colonization of an open neural tube defect, NTD [3] [4] [6], leading to wound infections or meningitis/ventriculitis following repair [5] [6]. Hence the practice has been that for patients who present beyond 72 hours of life, their myelomeningoceles, MMs, will undergo surgical dressing until epithelization of the neural placode, when primary repair can then be undertaken. Despite this, due to logistics of late presentation, out-of-pocket payment for services and significant financial constraints

on the part of the patients, a significant number of patients in our environment have had repairs done beyond this optimal period of timing of surgery. Hence the need to inquire to ascertain the significance of the timing of myelomeningocele repair on infection-related complications.

2. Methods

This is a retrospective cohort study in which, we reviewed the records of 103 children with myelomeningocele treated over 7 years, between 2016 and 2023 at our Centre. Following the procedure of excision and repair of the myelomeningoceles, the patients were kept on admission till stitches were removed. At discharge the patients were followed up at the post-operative clinic visit 2 weeks later. For the purpose of this study, the children's records were assigned to 1 of 2 groups, those who underwent primary neurosurgical repair within 72 hours of delivery (Group 1) and those who underwent repair after 72 hours (Group 2).

2.1. Surgical Technique

General anaesthesia is induced with endotracheal intubation. The baby is placed in the prone position on the operating table. The operative site is cleaned with povidone iodine or chlorhexidine solution. The myelomeningocele sac is cleaned well with warm sterile saline. The drapes are applied to keep in mind that skin flaps can be mobilized. Midline longitudinal skin incisions are made, usually in an elliptical to achieve a midline closure. The skin is incised immediately adjacent to the exposed meninges. The incision is carried down and often into the meningeal sac and the skin edges are retracted laterally. The dura margins and the neural elements are now clearly encountered. The edges of the neural placode are gently dissected off the sac and then tubularized and sutured with interrupted 4 - 0 absorbable polyglactin 910 suture to restore the configuration of the spinal cord. The dura is then dissected from the subcutaneous tissue and lumbosacral fascia. We watertight dura closure utilizing 3 - 0 nonabsorbable nylon suture in an interrupted fashion. The nylon used to suture the skin is left in place for 10 days. Sterile surgical dressing is applied and the wound and dressing is isolated from faeces. Postoperatively, the child is nursed prone or lateral 3 days after surgery to avoid undue pressure on the fresh surgical wound and to allow dependent drainage of urine and feces.

2.2. Data Analysis

Data were gathered on these patients and analyzed using SPSS version 22.0. Chi-test and was used to determine the significance of surgical site infection when repair was done within 72 hours and when done beyond 72 hours; this was meant to examine whether the observed results are in order with the expected values. Pearson's correlation coefficient was used to determine the relationship between surgical site infection and time to presentation, and this was to test if there was a linear relationship between variables.

3. Results

Data were gathered on 103 patients. A summary of the age distribution is provided in Table 1. The mean age of the study sample was 108 days, Majority of patients (64.1%) were <28 days with only one patient being above 2 years. Table 2, a summary of patients' clinical characteristics, shows that only 3.9% of patients presented within 36 hours of life, whereas 96.1% presented at or beyond 36 hours of life. Table 2 and Figure 1 showed a male to female preponderance of 5.3:4.6. Table 2 and Figure 2 expressed the similarity of incidence of hydrocephalus across the time spectrum of the condition. Table 2 and Figure 3 showed that hydrocephalus has the highest occurrence with the lumbosacral subtype. From Table 2 and Figure 4, surgical site infection was noted in 6.8% (7 patients) of the studied population. Furthermore, of the 4 patients who presented and were operated within 36 hours of life only one patient was assessed to have SSI and this corresponded to 25% of this population, while 6 patients out of a total of 99 patients who had their repairs at 36 hours of life or more were noted to develop SSI. Table 2 and Figure 5 showed the incidences of occurrence of postoperative CSF leaks. Table 3 addressed the titular subject matter by the weak negative relationship exhibited between surgical site infection and time to presentation.

Table 1. Age group of patients.

Age range (Days)		Frequency (N = 103)	Percent
≤28	Neonate	66	64.1
29 - 90	1 - 3 Months	17	16.5
91 - 180	>3 - 6 Months	10	9.7
181 - 365	>6 - 1 year	7	6.8
731 - 1095	>1 - 2 years	2	1.9
>1095	>2 years	1	1.0
Mean ± SD, median, CI, range		107.7 ± 38.3, 15, 31.7 - 183.8, 1 - 3650	

The patients ranged in age from 1 day to 3650 days old with a median age of 15 days.

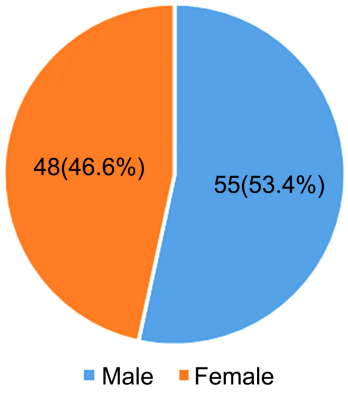


Figure 1. Sex distribution of patients.

Table 2. Patients clinical characteristics.

Variables	Frequency (N = 103)	Percent
Sex		
Male	55	53.4
Female	48	46.6
Time to presentation		
<36 hours	4	3.9
≥36 hours	99	96.1
Complications		
Hydrocephalus at birth		
Yes	6	5.8
No	97	94.2
Hydrocephalus post repair		
Yes	7	7.2
No	90	92.8
Hydrocephalus status (Total)		
With Hydrocephalus	13	12.6
Without Hydrocephalus	90	87.4
Hydrocephalus based on location of MM	n = 13	
Sacral	1	7.7
Lumbar	3	23.1
Lumbosacral	9	69.2
UV Prolapse		
Yes	1	1.0
No	102	99.0
Surgical Site Infection		
Yes	7	6.8
No	96	93.2
CSF Leak		
Yes	9	8.7
No	94	91.3
Treatment Modality Received		
Excision and repair + Fixation of prolapse	1	1.0
Excision and repair + Ventriculo peritoneal shunt	7	6.8
Ventriculoperitoneal shunt	7	6.8
Excision and repair	88	85.4

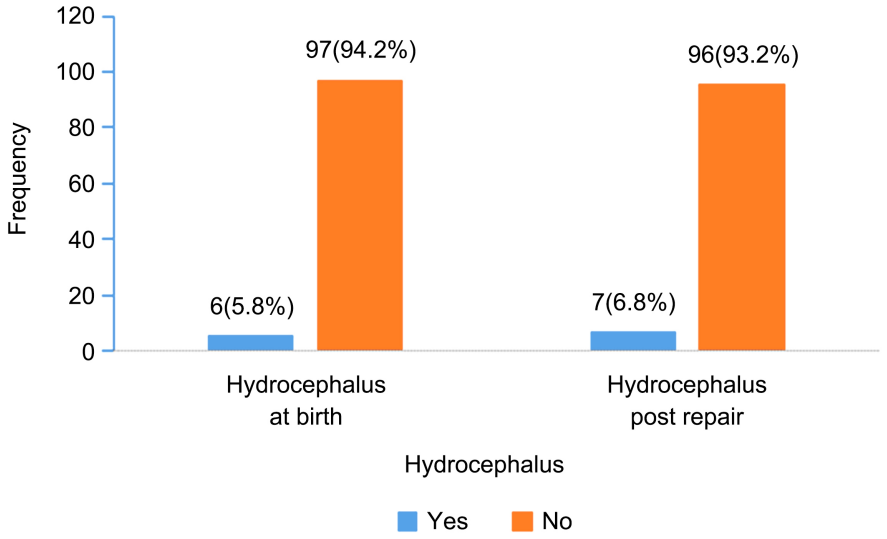


Figure 2. Incidence of hydrocephalus in patients with MM.

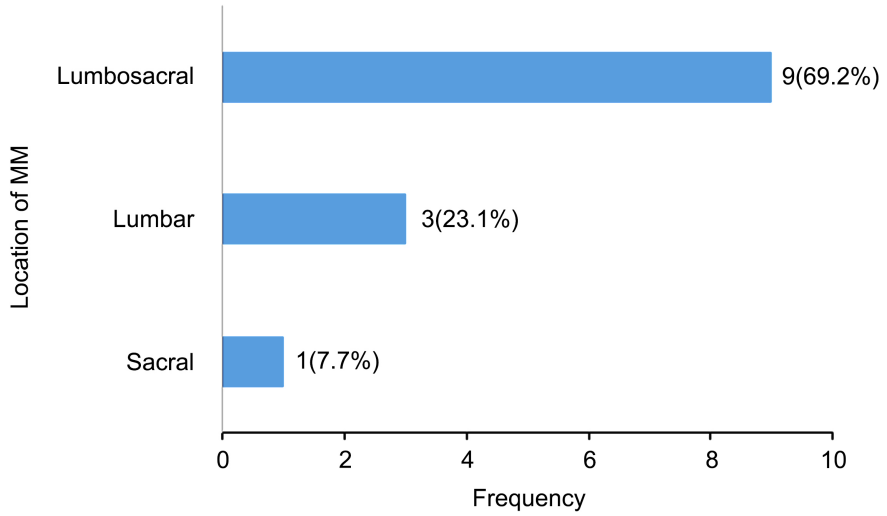


Figure 3. Incidence of hydrocephalus based on site of MM.

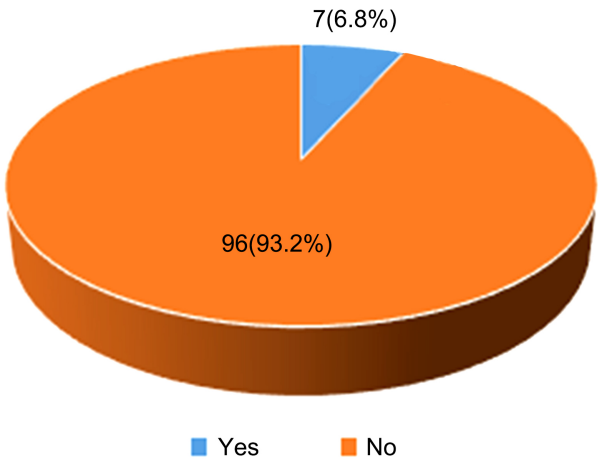


Figure 4. Surgical site infection.

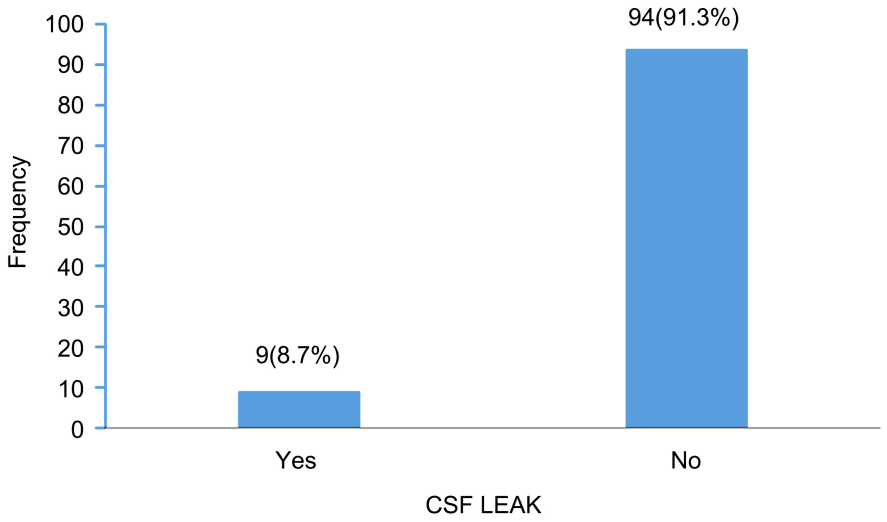


Figure 5. Post-operative CSF Leak after MM repair.

Table 3. Relationship between surgical site infection and time to presentation.

	Time to presentation		r	P-value
	<72 hours n = 4 n (%)	≥72 hours n = 99 n (%)		
Surgical Site Infection			−0.145	0.143
Yes	1 (25.0)	6 (6.1)		
No	3 (75.0)	93 (93.9)		

Note: the r = −0.145 (correlation coefficient) indicates weak negative relationship between Surgical Site Infection and Time to presentation which influences our time to intervene.

4. Discussion

Neural tube defects are a relatively uncommon development anomaly affecting approximately 1 in 850 live births. The burden for Africa is 17.00 per 10,000 infants, higher than that for California at 9 per 10,000 births [9]. The African high burden is varied per region as: Central Africa with the highest: 176.42; Eastern Africa: 55.53; Western Africa: 24.57; Northern Africa 7.22 and Southern Africa with the lowest: 6.53 [9]. Thus the enormous MM disease burden is borne by the developing world, including Asia. The more common variant of them is open spina bifida in which the posterior fusion failure results in the exposure of neural tissue with or without a covering meningeal sac, and the worst of these is the myelomeningocele, MM. As shown in **Table 1**, our patients displayed late presentation similar to the study by Onyia *et al.* [10]. While there are patients presenting after 2 years in our study, most studies show a presentation of less than 2 years [11]. Such presentations during teenage-hood may be due to a consideration of marriage particularly in respect of urinary incontinence management, as

was the case in the 10-year old in our study.

The finding, from **Table 2** and **Figure 1**, of a male to female preponderance of 53.4% - 46.6% is not consistent with worldwide literature reports from western countries which show a female preponderance [2]. There are several studies however, with results of a male preponderance of 52.0% - 56.7% from other regions of the world [3] [4] [6]. Also, our study is consistent with the finding from a Malian study as well as the study by Onyia et al that showed predominance of male affectation [10] [12]. Perhaps, studies restricted to myelomeningoceles only and further demographic characterization across Africa may be needed to elucidate this finding.

The incidence of surgical site infection, SSI, in patients operated within 48 hours of 25%, as shown in **Table 2** and **Figure 4**, is higher than that seen in literatures, being 7% - 11.7% [1]. However the incidence of SSI in patients operated within 72 hours of 6.1% is less than the 7% - 11.7% found in literatures for patients operated within 72 hours. A Zambian study had shown that at first preoperative evaluation, 28% of the neural tube defects were deemed infected (n = 21), allowing for a median age at surgery to be 21 days, from an interquartile range, IQR, of 15 - 36, despite an initial median age at first neurosurgical evaluation being 9 days with IQR, of 6 - 21 days [13]. In our study, there were no prior infected MM. Inference from **Table 3** showed a weak negative relationship between surgical site infection and time to presentation, revealing that despite the ethically sound rationale to close and repair a MM early, the reason of predominant infection prevention consideration may need further scientific interrogation. No doubt, neurological preservation with early surgical intervention will remain a prime consideration.

In **Table 2** of our study, the overall reported rate of postoperative complications is 29.1%. This is similar to the study by Gohar *et al.*, who found a complication rate of 28.7% [14]. Among these, CSF leaks were managed non-operatively and ventriculo-peritoneal shunts, VP shunts performed in patients who developed hydrocephalus after myelomeningocele. VP shunt was performed in 7 (6.8%) patients. No meningitis developed in any patient of our study. According to Reynolds *et al.*, after surgery for myelomeningocele, wound infection is the most common postoperative complication [13], this is due to a host of reasons like surgical techniques, poor neonatal immune factors, prior MM contamination etc.

The CSF leak rate from **Table 2** and **Figure 5** was 8.7%. Our rate when compared to controlled study such as the one by Daibu et al was lower. Daibu *et al.* attempted to improve the CSF leak rate by performing a single-continuous repair versus a double-breasted one. Their findings were very interesting: Postoperative CSF leak occurred in 2 (7.4%) patients in the single-continuous group compared to 3 (11.1%) patients in the double-breasted group. This difference may not be unrelated to surgical techniques [15]. Another study aimed at improving the rates of CSF leaks through the surgical procedure of V-Y Plasty by

Lobo and Nayak, from India, did not yield any significant difference when compared to our regular surgical technique. They studied 22 patients, 9 underwent primary repair, but had 100% CSF leak and the remaining 13 underwent V-Y Plasty and had 23.07% CSF leak rate [16]. Our finding show similarity to that of Shehu *et al.* in Zaria, North Western Nigeria, who reported a CSF leak rate of 6% [17]. Incidentally, studies from Pakistan on CSF leak rates appear to have higher rates. While Khan *et al.* found a CSF leak rate of 15%, Gohar *et al.* found a rate of 16.5% [14] [18]. These rates are comparatively higher than that from our study. They found that nearly 40% of patients who developed CSF leak had postoperative hydrocephalus and the leak resolved as soon as the VP shunt was placed in these patients. This finding suggests that there may be a need of early radiological screening investigations to survey for the development of postoperative hydrocephalus. For MM repair, we perform simple continuous dura stitch closure with polyglactin 910 (Coated Vicryl) 4 - 0 sutures in a water-tight fashion, using round-body needle tip.

A study from Florida, USA, was not so different from the Pakistani studies in terms of CSF leak rates. The study by James HE *et al.* and Khan *et al.* showed a higher incidence of post-operative wound infection of 20% (James HE *et al.*) and CSF leaks of 14% and 17.8% respectively. 10% of patients also underwent VP Shunt in the study by James HE *et al.* which is similar to our study [19]. Their study also showed an increased rate of CSF leaks in patients with myelomeningocele repair as compared to other conditions.

We found that the most common location of myelomeningocele is at the lumbosacral area (69.2%) in our study, followed by lumbar (23.1%) as shown in **Table 2**. This is in keeping with the body of literature, however, surprisingly, no thoracic nor cervical region presentation was seen during the study interval. Gohar et al had noted that lumbosacral presentation was the highest, 71.05%, followed by 15.7% and 13.1% respectively for thoracic and cervical presentations [14]. In a Hungarian study which included 352 cases of myelomeningocele and meningocele, the most common location was cervical (1.8%) followed by thoracic (4.2%), lumbar (16.8%), sacral (34.5%), and at junctions; Cervico-thoracic (0.9%) and Lumbosacral (22.3%) [20]. In a Western Nigerian study which included 106 cases, the most common location was lumbar (55.7%) [21]. The highest correlation rate of 90.4% was found by Onyia *et al.* of the most common location of the lesion being in the lumbo-sacral area [14].

Literatures have noted that 5% - 10% of myelomeningocele patients have clinically overt hydrocephalus at birth [14]. We noted a remarkable finding that the prevalence of hydrocephalus in our study was 5.8% at birth and 7.2% post MM repair (**Table 2** and **Figure 3**), this is in keeping with that clinically seen at birth from other studies. Higher incidence of hydrocephalus was recorded for MM of the lower spinal region when compared segmentally, particularly lumbosacral areas in our study as shown in **Figure 3**. It has been reported that the rate of treated hydrocephalus in patients with myelomeningocele varies with the ana-

tomic level of the lesion, 60.7% for sacral, 82.4% for lumbar, and 92.2% for thoracic [22]. We performed 7 (6.8%) ventriculo-peritoneal shunt procedures after myelomeningocele repair compared to 6 who had hydrocephalus at presentation. This correlates with the findings by Cherian *et al.*, who performed CSF shunts in 8% of the cases after surgery for myelomeningocele [23].

Study Limitation

The study was confined to a single centre where only 3.9% of the sample size presented within 72 hours of life, which could limit the generalizability of the findings. The small number of those presenting within 72 hours of life allows for an inherent bias already, as inadequate test subjects were available for the test analysis.

5. Conclusion

From our study, the timing of primary neurosurgical repair of myelomeningoceles suggests that its impact on surgical site infection may not be too significant. Therefore, closure of the spinal lesion within the first 72 hours of life may favor neural damage prevention more. These results indicate that early myelomeningocele repair may not impart significantly on the rate of wound-site infection. More studies, including a multicentre one, are required for further interrogation and elucidation of the fundamentals of MM.

Ethics Committee Approval

Due to the retrospective nature of this study, ethics committee approval was waived.

Informed Consent

Written informed consent was obtained from the parents of the patients who participated in this study.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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