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ORIGINAL ARTICLE

# Intracranial infection in patients with myelomeningocele: profile and risk factors

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**Abstract**

**Purpose** To describe the profile and determine the risk factors for the development of intracranial infections (ICI) in paediatric patients with myelomeningocele (MMC).

**Methods** Retrospective analysis of data from the records of patients with MMC admitted into our hospital between January 2006 and December 2015.

**Results** We managed a total of 688 paediatric non-trauma neurosurgical patients in our facility during the study period. 29.4% of these patients had MMC. We found the records for 49% of the patients. The male: female ratio was 1.3:1. Most of the MMCs were located in the lumbosacral region (71.7%). The lesion was ruptured in 42.4%, unruptured in 53.5%, and indeterminate in 4.0% of the patients. 48.5% of the MMCs were infected at presentation. Surgical repair of the spinal dysraphism was performed in 74.7% of the patients. Postoperative complications observed in our series include wound dehiscence, cerebrospinal fluid leak, and pseudomeningocele which occurred in 13.5%, 12.2%, and 2.7% of the operated cases of MMC respectively. 28.3% of the patients with MMC developed ICI during the course of hospitalization. 71.4% of patients with MMC-associated ICI had septic neural placode at the initial clinical evaluation. 70% of the patients who had wound dehiscence post-operatively developed ICI. Loculations and abscesses occurred only in patients who had surgical repair. A multivariate logistic regression analysis revealed that septic neural placode, hydrocephalus, a supra-lumbar location of the MMCs and surgical intervention were predictive of ICI ($p < 0.05$).

**Conclusion** Infection of the neural placode, hydrocephalus, locations of the lesions above the lumbar region, and surgical repair were the statistically significant risk factors for ICI in our study population. The trending but statistically insignificant risk factors for ICI in our series may require further assessment with a larger sample size.

**Keywords** Spina bifida cystica · Meningitis · Ventriculitis · Spinal dysraphism

## Introduction

MMC is a frequently encountered entity in paediatric neurosurgical practice. It remains a disease of public health importance in the developing countries where preventive measures are poorly implemented [1, 2]. It is often associated with significant disabilities which include paraplegia, sphincteric and sexual dysfunctions [1]. The patients with MMC have a high risk of developing ICI, which has the potential of further worsening the outcome of treatment and quality of life of the affected individuals [3]. Intracranial infection is of additional significance in MMC because of the often associated hydrocephalus which may require shunt treatment. The risk of infection increases following the first 3 days of life [3–6]. This time-dependent risk is particularly relevant in our low resource geographic region. In our practice, a significant proportion of patients with spinal dysraphism are delivered outside health care facilities, in rural health-centers or in hospitals where neurosurgical specialists are unavailable. Low socioeconomic status, religious beliefs, poor referral system and difficult access to urban regions with neurosurgical facilities

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also contribute to the delayed presentation. There is a paucity of data on the burden of infectious complications in this patient population. This study, therefore, aims to determine the profile of and risk factors for the development of intracranial infections in children with MMC presenting for care in our facility.

## Methods

### Study setting

Our hospital is the premier teaching hospital and neurosurgical training centre in the most populous black nation in the world. There was no public policy to fortify food items (with a view to preventing MMC) in our country during the study period. While the number of neurosurgeons and neurosurgical services have increased in the country (especially during the second half of the study), our hospital remains a major referral center for neurosurgical pathologies in the country.

### Data collection and analysis

We retrospectively analysed data from the records of patients admitted to our hospital for the treatment of MMC between January 2006 and December 2015. We obtained the biodata, location of the spinal dysraphism, state of the lesion at presentation, CNS defects and other associated anomalies as well as presence and type of CNS infection.

The data was analysed using SPSS version15 (SPSS Inc., Chicago IL). The level of significance was set at $P < 0.05$.

## Results

A total of 688 paediatric non-trauma neurosurgical patients were admitted into our facility during the study period. 29.4% of these patients had MMC. We were able to retrieve the case-files of only 49% of the patients. The age at presentation ranged from 1 to 1460 days with a mean of 39.9 ± 154.9 days. More than half of our patients (59.6%) presented after 72 h (Fig. 1). The male to female ratio was 1.3:1 [(56 males, 43 females) Table 1]. The MMC sac was located in the lumbosacral region in 71.7% and in the sacral region in additional 14.1% of the cases respectively (Fig. 2). The lesion was ruptured in 42.4%, unruptured in 53.5%, and indeterminate in 4.0% of the patients. The neural placode was infected in 48.5% of the cases at presentation (Table 1). There were associated CNS anomalies in 73.7% of the patients while 40.4% of the patients had anomalies outside the CNS. 74.7% of the patients had surgical intervention, 14.1% were discharged against medical advice, 2% died preoperatively while 9.1% of patients were lost to follow-up before the definitive care was instituted. A cerebrospinal fluid diversion was performed in 24.2% of the patients, out of which, 13.1% had an endoscopic third ventriculostomy (ETV), 8.1% had a ventriculoperitoneal shunt (VPS) and 3% patients had a VPS after a failed ETV. The complications of surgery encountered in our series include wound breakdown in 13.5%, CSF leak in 12.2% and pseudomeningocele in 2.7% of the patients. Meningitis occurred in 13.1%, ventriculitis in 9.1%, loculations/abscesses in 6.1% of the cases, with a total of 28.2% of patients having developed an ICI (Table 2). 67.9% of the ICIs occurred before surgical repair of the sacs. All cases of loculations and abscesses were postoperative (Fig. 3). The neural placode was infected at the time of presentation in 71.4% of the patients with ICI (Fig. 4). ICI occurred in 22.2% of the patients with CSF leak and 70% of the patients with wound dehiscence. The neural placode was infected at the initial presentation in 70% of patients with postoperative wound dehiscence. Following bivariate analysis, age > 24 h ($p = 0.042$), ruptured MMC sac ($p = 0.038$), presence of hydrocephalus ($p = 0.018$), infected neural placode ($p = 0.001$), surgical repair ($p = 0.028$), location above lumbar

**Fig. 1** Age of the patients at presentation

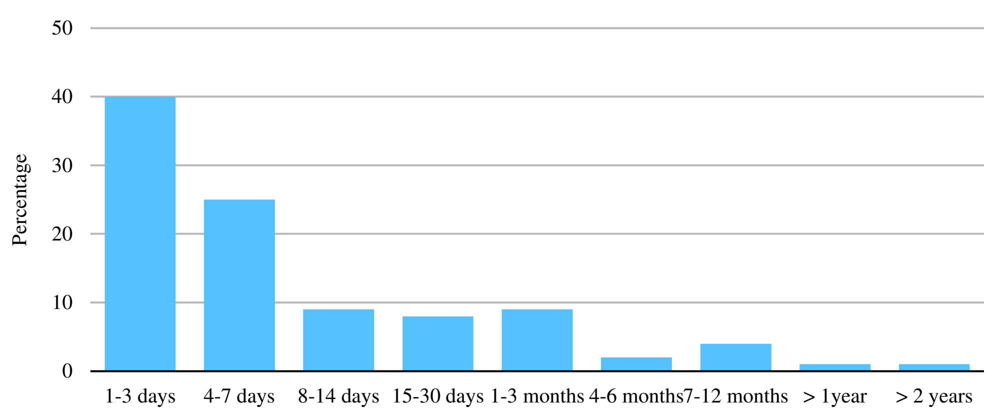

**Table 1** Demographic and clinical characteristics

| | Frequency ($n = 99$) | Percentage |
|---|---|---|
| Gender | | |
| Male | 56 | 56.6 |
| Female | 43 | 43.4 |
| Status of the sac | | |
| Ruptured | 42 | 42.4 |
| Unruptured | 53 | 53.5 |
| Indeterminate | 4 | 4.0 |
| Status of the neural placode | | |
| Infected | 48 | 48.5 |
| Not infected | 51 | 51.5 |
| Hydrocephalus | | |
| Present | 73 | 73.7 |
| Not present | 26 | 26.3 |
| Anomalies outside the CNS | | |
| Yes | 40 | 40.4 |
| No | 59 | 59.6 |
| Surgical repair | | |
| Yes | 74 | 74.7 |
| No | 25 | 25.3 |

region ($p = 0.033$) and wound dehiscence ($p = 0.008$) attained statistical significance as predictors of intracranial infection (Table 3). The significant variables were selected for multivariate regression analysis. Based on this final model, the significant risk factors for intracranial infection in this study were infection at the MMC site ($p = 0.011$), hydrocephalus ($p = 0.028$), lesions extending above the lumbar region ($p = 0.042$) and surgical repair of the lesion (0.040) (Table 4).

## Discussion

Myelomeningoceles are the most common neural tube defects in the paediatric population. The prevalence of this condition varies widely all over the world but has been on the decline in the developed countries, largely due to implementation of preventive measures [7–10]. There is a dearth on literature on its true prevalence in Nigeria (due to under-recognition and lack of documentation), where public health policies specifically targeting the reduction of its occurrence are non-existent [11]. However, an institutional-based study from our country reported a prevalence rate of neural tube defects (NTDS) of 0.52/1000 live-births [12]. Several studies from Africa have reported prevalence rate of NTDS between 0.52 and 12.6/1000 live-births and a study on the global estimate of NTDS estimated the prevalence rate in Sub-Saharan Africa at 1.5/1000 live-births and 1/1000 live-births without and with folic acid fortification [12, 13]. Figures from the same study reported the prevalence rate of NTDS in Southern-Asia to be 3.2/1000 live-births and in the Latin America and the Caribbean to have reduced from 2.3/1000 live-births to 0.77/1000 live-births with the institution of dietary supplementation of folic acid.

MMCs carry a high risk of infection which can potentially worsen the severe lifelong disabilities that are often associated with this condition and increase the economic burden on the families of the affected individuals [3]. We retrospectively evaluated 99 cases of spina bifida managed in our centre during the study period. There was male predominance in this study (M:F = 1.3:1) (Table 1). Although MMC is more commonly reported in females, male predominance has also been widely reported in the literature, especially in population series from our subregion [1, 14–18]. There was a wide variation in the ages of our patients at presentation (range = 1–

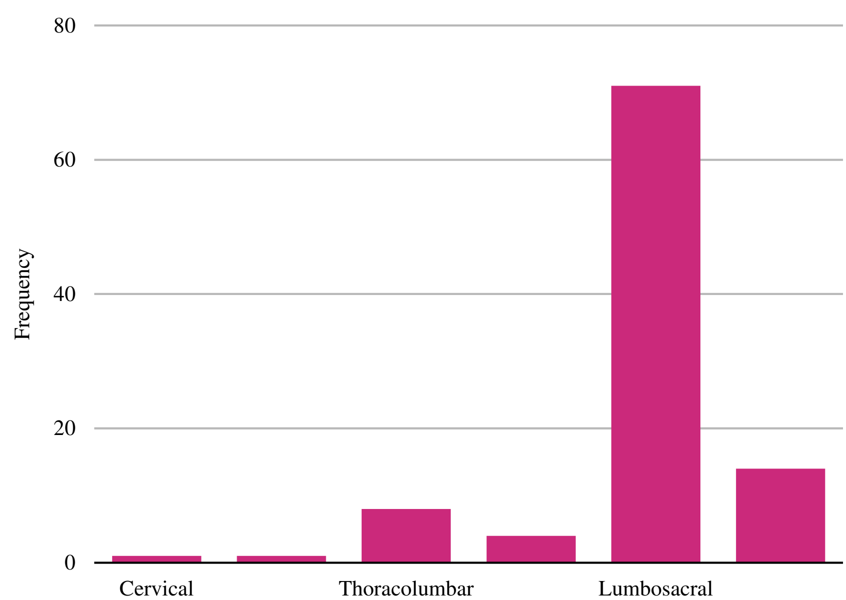


**Fig. 2** Location of the myelomeningocele sacs

**Table 2** Summary of intracranial infections

| | Frequency ($n = 99$) | Percentage |
|---|---|---|
| Intracranial infection | | |
| Yes | 28 | 28.3 |
| No | 71 | 71.7 |
| Intracranial infection type | | |
| Meningitis | 13 | 13.1 |
| Ventriculitis | 9 | 9.1 |
| Loculations/abscesses | 6 | 6.1 |

1460 days). More than half of our patients (59.6%) presented after 72 h, with only 15.2% presenting within the first 24 h and 17.2% presenting after the first month of life (Fig. 1). This late presentation may be explained by the fact that most of our patients are delivered outside the teaching hospitals and present for specialist evaluation after initial care at peripheral facilities. Poverty, religious/superstitious beliefs, lack of knowledge about the condition, social stigmatization, poor health-seeking attitude of caregivers also contribute to the delay in presentation for care. The MMCs in our series were mostly located in the lumbar region (Fig. 2). This finding has been widely reported in previous reports [1, 18–20]. The incidence of hydrocephalus and other congenital defects is high in MMC [1, 7, 21–23]. Hydrocephalus occurred in 73.7% of cases in our series while anomalies outside the CNS were observed in 40.4% of our patients (Table 1). The incidence of hydrocephalus in this study was higher than that reported by Abubakr et al. (65.7%) and by Uba et al. (68.35%), but lower than what was reported by Hashim et al. (88%) [1, 18, 22]. Rupture of the MMC sac occurred in 42.4% of our patients. Uba et al. in their study in a neurosurgical facility similar to ours reported a rupture rate of 42% [18]. This high rate may be due to the delayed presentation as well as mishandling by the caregivers and non-specialist medical professionals. The figures in these studies are significantly higher than those reported by Hashim et al. (3.8%) and Oktem (14.9%) [17, 22]. The neural placode was infected in 48.5% of our patients at presentation (Table 1), a figure higher than the 27.4% reported by Uba et al., from the northern part of our country [18]. Surgical repair of the lesion was performed in 74.7% of the patients. Postoperative complications in our study population include CSF leak (12.2%), wound dehiscence (13.5%) and pseudomeningocele (2.7%). The postoperative CSF fistula rate in our study was higher than those reported in the published work of Shehu et al. (6%) and Guthkelch et al. (7%) but lower than the 17% reported by McLone [6, 24, 25]. The reported incidence of

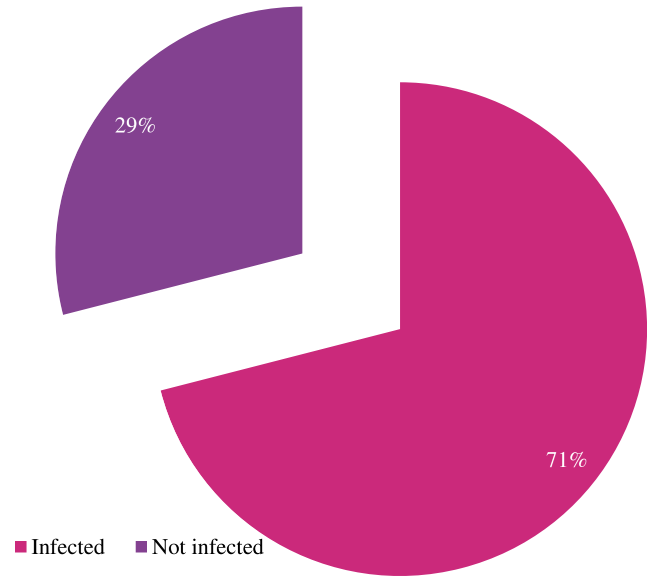


**Fig. 4** Status of the neural placode at presentation in patients who developed IC

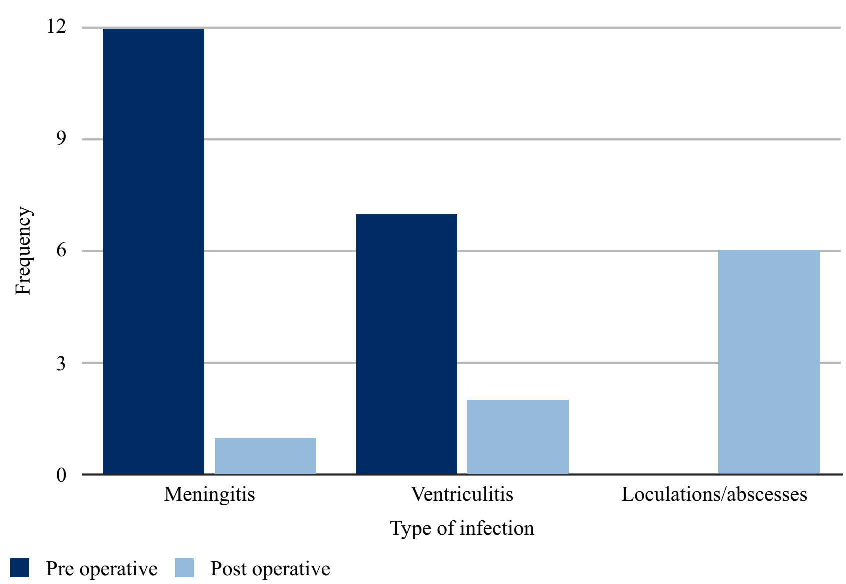


**Fig. 3** Timing of intracranial infections

**Table 3** Analysis of risk factors for intracranial infections

| | | *P* value |
|---|---|---|
| Gender | Male | 0.993 |
| | Female | |
| Age | > 24 h | 0.042 |
| | < 24 h | |
| Status of the sac | Ruptured | 0.038 |
| | Unruptured | |
| | Indeterminate | |
| Status of the neural placode | Infected | 0.001 |
| | Not infected | |
| Hydrocephalus | Yes | 0.018 |
| | No | |
| Repair | Yes | 0.028 |
| | No | |
| Location | Above the lumbar region | 0.033 |
| | Lumbar region and below | |
| Wound dehiscence | Yes | 0.008 |
| | No | |
| CSF leak | Yes | 0.511 |
| | No | |
| Non-CNS anomalies | Yes | 0.980 |
| | No | |

wound infection also varies widely in the literature. Shehu et al. reported a 9% rate while McLone and Brau et al. reported 12% and 22.4% respectively [6, 24, 26]. ICI was seen in 28.3% of our patients (Table 2). Meningitis occurred in 13.1%, ventriculitis in 9.1% and loculations and abscesses in 6.1% of the patients in our study. The incidence of meningitis in the series by Uba et al. was 6.6% [18]. Hashim et al. reported a 6% incidence of ventriculitis in their study while Brau et al. reported a 12.5% incidence [22, 26]. The rate of meningitis and ventriculitis were reported as 4% by Shehu, 7% by Charney et al., 7.7% by Seidel et al., 8% by Ammirati and Raimondi and 12.5% by Brau et al. [24, 26–29]. The risk of ICI in MMC increases with delayed repair, wound infection and poor wound healing [5, 20, 22]. These may explain the relatively high incidence of ICI in our patient population, the majority of whom were delivered in peripheral hospitals and presented to us late with infected neural placodes. Most of the cases of MMC-associated ventriculitis (77.8%) and meningitis (92.3%) occurred prior to surgical intervention while all cases of loculations and abscesses were postoperative (Fig. 3)**.** The preoperative predominance of ventriculitis and meningitis in this series rather than the widely reported postoperative predominance may in part also be explained by the late presentation and high rate of neural placode infection in this study. The neural placode was infected at presentation in 71.4% of patients with ICI, suggesting infection of the neural placode as a strong risk factor for ICI in patients with MMC (Fig. 4). 22.2% of the patients with postoperative CSF fistula developed ICI. 70% of patients with wound dehiscence developed ICI. Loculations/ abscesses, ventriculitis and meningitis accounted for 57.1%, 28.6% and 14.3% of the cases of ICI respectively. The neural placode was infected at presentation in most of the patients who developed wound dehiscence following surgical intervention (Fig. 3).

**Table 4** Independent risk factors intracranial infection

| | *p* value | 95% CI |
|---|---|---|
| Infected neural placode | 0.011 | 2.344–374.926 |
| Hydrocephalus | 0.028 | 0.002–0.676 |
| Location above lumbar region | 0.042 | 1.132–239.029 |
| Surgical repair | 0.040 | 1.134–238.026 |
| Wound dehiscence | 0.964 | 0.130–7.264 |
| Age more than 24 h | 0.325 | 0.361–21.644 |
| Ruptured MMC sac | 0.747 | 0.128–7.278 |

The trending risk factors for ICI in our study include age > 24 hours, rupture of the MMC sac, infection of the neural placode, presence of hydrocephalus, supralumbar location of the MMC sac, surgical intervention and wound dehiscence (Table 3). However, the statistically significant occurrence of the MMC sac above the lumbar region and surgical repair of the lesion (Table 4). While some of these factors are not modifiable, infection of the neural placode can be prevented or minimized. Although the number of neurosurgeons and neurosurgical centres in our country is on a steady rise (currently 81 neurosurgeons to a population of 200,000,000), they are still grossly inadequate and often concentrated in the urban areas [24]. The public health implications of MMC and its preventable complications (in this vulnerable patient demography) cannot be overemphasized, especially in our low resource setting where most of the population dwell in rural areas. We therefore suggest extensive advocacy by our national neurosurgical society with a view to educating the people involved in delivery and initial care of these patients especially in mission homes, primary health facilities, secondary health centres and even tertiary hospitals without neurosurgical service. There is a need for development of a protocol for the initial management of these patients with emphasis on handling, dressing, positioning, prompt referral and other aspects of initial care of these patients. A national policy on fortification of some food items in the country is also desirable.

## Limitations

This is a retrospective study in which completeness of record retrieval was limited. Because payment for health care is largely out of pocket, access to neuroimaging was restricted by cost. Finally, discharge against medical advice was frequent in the group of patients.

## Conclusion

Infection of the neural placode, hydrocephalus, locations of the lesions above the lumbar region, and surgical repair were the statistically significant risk factors for ICI in our study population. The trending but statistically insignificant risk factors for ICI in our series may require further assessment with a larger sample size.

### Compliance with ethical standards

**Conflict of interest** The author declares that they have no conflict of interest.

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