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A retrospective study of infections after primary VP shunt placement in the newborn with myelomeningocele without prophylactic antibiotics

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Abstract
Purpose We aim to correlate the frequency of infections after ventriculoperitoneal (VP) shunt placement in neonates with myelomeningocele (MMC) who did not receive prophylactic antibiotics to the timing of VP shunt placement and the frequency of cerebrospinal fluid (CSF) leakage at the MMC wound.
Methods Fifty-nine newborns with MMC underwent VP shunt insertion in the period 1983–2007. We reviewed retrospectively all records.
Results After MMC closure, 24 out of 59 newborns had an infection. The relative risk (RR; 95%) of having an infection is significantly higher [RR=4,69 (1.145397–19.23568; *P*=.03761817)], and neuroinfection showed a tendency towards RR=3.5 (.7067445–17.03112; *P*=.15414095) in newborns without symptomatic hydrocephalus at birth when we had a wait-and-watch policy (late shunt placement) compared with newborns with prompt shunt placement. The RR (95%) of having an infection [RR=6,8 (3.314154–13.95228; *P*=1.235e-07)] and also neuroinfections [RR=4,76 (2.043019–11.09025; *P*=.00044478)] was highly significant if the child presented with MMC wound with CSF leakage before VP shunt insertion (Table 3).
Conclusions Centers with a conservative antibiotic policy should be even more careful to avoid CSF leakage before shunt placement as this gives a highly significant increased risk of both infections in total and neuroinfections, and they should reconsider this conservative policy in newborns with MMC due to the significantly high infection rate.

Keywords Ventriculoperitoneal shunt · Infection · Newborn · Antibiotics

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Introduction

Myelomeningocele (MMC) is the most complex, non-life-threatening central nervous system malformation known. Most of these children have hydrocephalus, cognitive problems, leg paresis, and bladder and bowel dysfunction [1, 2]. The incidence of MMC in Denmark is ten to 20 newborns.

Approximately 80% develop hydrocephalus requiring a shunt, and this shunt dependency relates to the MMC level (97% in thoracic, 87% in lumbar, and 68% in the sacral spine) [3]. Some are born with hydrocephalus and require an immediate shunt, but usually, they develop hydrocephalus due to insufficient cerebrospinal fluid (CSF) resorption in the days after MMC closure [4–8].

Most children with MMC has reduced learning ability (often with major problems in mathematics than in language) and impaired attention [9–11]. The underlying pathology could be co-cerebral malformations but could also be a result of severe shunt infections [8, 12–14].

Most shunt complications of both infection and dysfunction have been reported within the first 6 months [15]. Risk of having a shunt infection is estimated up to 15% for each shunt revision [16].

In this retrospective study, we aimed to correlate the frequency of infections after ventriculoperitoneal (VP) shunt placement in newborns with MMC who did not receive prophylactic antibiotics to timing of VP shunt

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Table 1 The relative risk (RR) of having an infection is significantly higher [RR=4,69 (0,7; 30,9); *P*=.03761817] if ventriculoperitoneal shunt insertion is done in a later procedure than the myelomeningocele surgery

	Late shunt placement	Early shunt placement	Total	Point estimate	95% confidence interval
Infections	23	1	24		
No infections	26	9	35		
Total	49	10	59		
Risk	.4693878	.1	.4067797		
Risk difference				.3693878	.0324298, .7063457 (tb)
Risk ratio				4.693878	1.145397, 19.23568 (tb)
Attr. frac. ex.				.7869565	.1269403, .9480133 (tb)
Attr. frac. pop				.7541667	

Chi2(1)=4.70, Pr>chi2=0.0302

Fisher's exact test, *P*=.03761817

Fisher's exact test 1, *P*=.02989348

Likelihood ratio test, *P*=.01921134

placement and frequency of CSF leakage at the MMC wound.

Materials and methods

The study group consists of 66 newborns, between 1983 and 2007, with MMC, who had required a VP shunt within the first 2 weeks after birth. All newborns had MMC closure and VP shunt placement at the Department of Neurosurgery, Aarhus University hospital, Denmark.

Among these, seven were excluded. Five MMC was closed after 72 h and thereby had a known increased risk of infection, one had an infection before MMC closure, and one died within the first week because of severe cardiac malformation.

Among the remaining 59 newborns, ten patients had symptomatic hydrocephalus and immediately got a VP shunt (early shunt placement), while we had a wait-and-watch policy on the 49 patients without symptomatic hydrocephalus at birth (late shunt placement).

Infection was defined as local MMC wound infection with fever and elevated white blood cell count and/or neuroinfection. Minor wound infections without systemic effects are not included.

CSF leakage was defined as late onset of continuous fluid leakage from the MMC wound after an initial dry MMC closure.

More than 10 years ago, newborns with MMC did not receive prophylactic antibiotics in our department. In the last decade, the treatment of choice has been a preoperative bolus of intravenous cefuroxime 50 mg/kg. There was not a

Table 2 The relative risk (RR) of having a neuroinfection showed a tendency but no significance [RR=3.5 (0.5–23.2); *P*=.15414095] if ventriculoperitoneal shunt insertion is done in a later procedure than the myelomeningocele surgery

	Late shunt placement	Early shunt placement	Total	Point estimate	95% confidence interval
Neuroinfections	17	1	18		
No neuroinfections	32	9	41		
Total	49	10	59		
Risk	.3469388	.1	.3469388		
Risk difference				.2469388	−.0688991, .5627767 (tb)
Risk ratio				3.469388	.7067445, 17.03112 (tb)
Attr. frac. ex.				.7117647	−.4149384, .941284 (tb)
Attr. frac. pop				.6722222	

chi2(1)=2.39, Pr>chi2=0.1222

Fisher's exact test, *P*=.15414095

Fisher's exact test 1, *P*=.11821547

Likelihood ratio test, *P*=.09312956

Table 3 The relative risk (RR) of having an infection if cerebrospinal fluid (CSF) leakage was present prior to ventriculoperitoneal shunt placement vs. placement before CSF leakage was highly significant [RR=6,8 (2,7–17,4); *P*=1.235e-07]

	CSF leakage present	CSF leakage not present	Total	Point estimate	95% confidence interval
Infections	20	4	24		
No infections	5	30	35		
Total	25	34	59		
Risk	.8	.1176471	.4067797		
Risk difference				.6823529	.4265154, .9381905 (tb)
Risk ratio				6.8	3.314154, 13.95228 (tb)
Attr. frac. ex.				.8529412	.6982639, .9283271 (tb)
Attr. frac. pop				.7107843	

chi2(1)=27.80, Pr>chi2=0.0000

Fishers exact test, *P*=1.235e-07

Fishers exact test 1, *P*=1.175e-07

Likelihood ratio test, *P*=4.150e-08

general prophylactic antibiotic guideline. We have reviewed all the files.

Results

Ten newborns had an early shunt placement, and 49 had late shunt placement. After MMC closure, 24 out of 59 newborns (41%) had an infection. Correlating this number with the timing of VP shunt placement, there was one out of ten infected in the early shunt placement group. In the late shunt placement group, 23 out of 49 had an infection. Six had a local MMC wound infection (four needing plastic surgery), and 17 had a neuroinfection.

The relative risk (RR; 95%) to get an infection is statistically significantly higher [RR=4,69 (1.145397–19.23568); Fisher's exact test, *P*=.03761817] in newborns with late shunt placement compared with newborns with early shunt placement (Table 1).

Looking solely at the neuroinfections, 18 out of 59 newborns (31%) had a neuroinfection, one in the early shunt placement and 17 in the late shunt placement group.

The RR (95%) to get a neuroinfection shows a tendency towards but not significantly higher risk [RR=3.5 (.7067445, 17.03112); Fisher's exact test, *P*=.15414095 (Table 2)].

After MMC closure, 25 out of 59 newborns (43%) had late onset of continuous fluid leakage from the MMC wound after an initial dry MMC closure. Out of these, only one had spontaneous closure after shunt placement, four needed plastic surgery but did not have signs of infection, six had a wound infection, and 14 had a neuroinfection.

When we correlate infections with CSF leakage, 20 had an infection out of 25 newborns with CSF leakage, and four had an infection out of 34 newborns with no CSF leakage.

Table 4 The relative risk (RR) of having a neuroinfection if cerebrospinal fluid (CSF) leakage was present prior to ventriculoperitoneal shunt placement vs. placement before CSF leakage was highly significant [RR=4,76 (2,65–17,43); *P*=.00044478]

	CSF leakage present	CSF leakage not present	Total	Point estimate	95% confidence interval
Neuroinfections	14	4	24		
No neuroinfections	11	30	35		
Total	25	34	59		
Risk	.56	.1176471	.3050847		
Risk difference				.4423529	.2025509, .6821549 (tb)
Risk ratio				4.76	2.043019, 11.09025 (tb)
Attr. frac. ex.				.789916	.5105283, .9098307 (tb)
Attr. frac. pop				.6143791	

chi2(1)=13.30, Pr>chi2=0.0003

Fisher's exact test, *P*=.00044478

Fisher's exact test 1, *P*=.00035128

Likelihood ratio test, *P*=.0002195

The RR (95%) of having an infection was highly significant [RR=6,8 (3.314154–13.95228); Fisher's exact test, P=1.235e-07] if the child presented with MMC wound with CSF leakage before VP shunt insertion (Table 3).

Looking solely at the neuroinfections, still 18 out of 59 newborns (31%) had a neuroinfection: 14 out of 25 in the CSF leakage group and four out of 34 in the nonleakage group (the leakage was avoided by fontanel puncture before shunt placement).

The RR (95%) to get a neuroinfection is also highly significant [RR=4,76 (2.043019, 11.09025); Fisher's exact test, P=.00044478 (Table 4)].

Discussion

The complications related to shunt placement, most commonly shunt infection, are always a major issue in pediatric patients and especially within the first 6–12 months postoperatively with a shunt infection rate of up to 15% [13, 15]. The algorithm for shunt insertion in the hydrocephalus related to MMC is variable in centers involved in care of these patients all over the world.

The treatment of choice varies between a prompt shunt insertion in patients having symptomatic hydrocephalus to a wait-and-watch policy in patients who do not have symptomatic hydrocephalus at birth. Patients presenting with nonsymptomatic hydrocephalus may require shunt placement at variable times following MMC closure. Up to 20% are reported to be shunt independent; these patients require some kind of wait-and-watch policy [3, 16, 17].

Use of systemic prophylactic antibiotics in preventing shunt infection, regardless of the patient's age and the type of internal shunt used, seems to reduce the risk of infection after shunt insertion; however, the benefit of its use after the first 24 h postoperatively remains uncertain [18]. In Scandinavian countries, we have a conservative attitude to the use of antibiotics. In the past, prophylactic antibiotic were not used in our clinic. A decade ago, we changed these guidelines to preoperatively antibiotics. Today, it gives us a unique chance to evaluate the natural risk factors of infections after MMC closure and shunt placements.

In this study, we found a surprisingly high frequency of infections despite skilled surgeons in all cases and a bolus of prophylactic antibiotics preoperatively in all newborns for the last 10 years. One reason for this high frequency could be that this series only includes newborns with MMC who had shunt inserted within 2 weeks after MMC closure. It is described that age below 4 months at shunt insertion, antenatal hydrocephalus, and MMC are significantly correlated to shunt infection [15, 19].

Secondly, the high number of infections could be related to a surprisingly high number of CSF leakages at 43%. The pathogenesis is probably raising intracranial pressure and progressive hydrocephalus resulting in MMC wound bulging and subsequently CSF leakage. In our clinic, we use plastic surgeons in MMC closure for MMC skin correction when the MMC is large.

The high number of CSF leakage is probably not a result of insufficient MMC closure but the result of a too long period of watchful waiting in the hope to avoid shunt dependency. This policy has resulted in a rather low shunt dependency of 80% in our children with MMC.

A third explanation can be that the risk of infection in these children is so high that they need a prophylactic antibiotic treatment also after MMC closure. Even if CSF leakage was avoided by fontanel puncture before shunt placement, four out of 30 newborns (13%) had an infection.

In conclusion, we looked at the natural risk factors of infections after MMC closure and shunt placements in newborns who did not receive prophylactic antibiotics or only had one preoperative bolus.

Centers with a conservative antibiotic policy should be even more careful to avoid CSF leakage before shunt placement as this gives a highly significant increased risk of both infections in total and neuroinfections, and they should reconsider this conservative policy in newborns with MMC due to the significant high infection rate.

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