Factors Affecting the Intensive Care Stay of Patients with Spinal Neural Tube Defects

Durmus Oguz KARAKOYUN¹, Yucel DUZENLI²

¹Ordu University School of Medicine, Department of Neurosurgery, Ordu, Turkey
²Dr. Ersin Arslan Training and Research Hospital, Department of Neurosurgery, Gaziantep, Turkey

Corresponding author: Durmuş Oğuz KARAKOYUN ☐ droguzk@gmail.com

ABSTRACT

AIM: To evaluate the duration of hospitalization and the factors that increase this duration in cases treated in the neonatal intensive care unit with the diagnosis of a spinal neural tube defect (NTD).

MATERIAL and METHODS: The demographic characteristics, NTD type and level, ventriculoperitoneal (V-P) shunt needs, accompanying spinal deformity, antibiotherapy applied during treatment, and intensive care stay periods of 73 patients treated in our clinic between July 2017 and 2020 were retrospectively evaluated.

RESULTS: The intensive care stay of NTD cases was 7–109 (mean=23) days. Fifty-one cases (69.9%) had myeloschisis, and 22 cases (30.1%) had myelomeningocele (MMC) sac. A V-P shunt was applied to 24 cases (32.9%) during hospitalization, and additional antibiotherapy was given to 32 (43.8%) cases.

CONCLUSION: In myeloschisis cases compared with MMC marsupial cases, incidences of ventricular dilatation, kyphotic/scoliotic spine pathology, V-P shunt requirement, and longer hospital stay were observed. No difference in the duration of hospitalization was found in patients who underwent defect repair between the first day and 48 h after birth. However, the length of stay in hospital increased in patients operated on after 48 h. The period was longer in cases operated after seven days postnatally. Therefore, by performing NTD surgical treatment within the first 48 hours, the need for additional antibiotherapy and hospital stay can be shortened.

KEYWORDS: Myelomeningocele, Intensive care unit stay, Ventriculoperitoneal shunt, Children

INTRODUCTION

Neural tube defect (NTD) is a congenital central nervous system anomaly that causes mortality and morbidity. NTD is a congenital malformation in which the spinal cord is divided (bifid) as a result of incomplete closure of the embryonic neural tube due to its success in primary or secondary neuralization at intrauterine 3–4 weeks (9). The most common clinical variants of NTDs are spina bifida occulta, spina bifida cystica (meningocele, myelomeningocele), myeloschisis, and anencephaly (3). In myelomeningocele (MMC), there is a defect in the junction of the lateral edges of the neural placode in the midline, and an opening is observed in the dorsal of the spinal cord due to this defect. It can occur anywhere in the spine, but is more common in the lumbosacral region (19).

Although the etiology of NTD is not fully understood, it has been shown to be associated with genetic reasons, geographical differences, low socio-economic status, and folic acid deficiency (5). Damage to the spinal cord and peripheral nerves is evident at birth. In the lower extremities, it causes a neurological dysfunction associated with the spinal cord level of the lesion (23).

In these cases, bowel and bladder dysfunctions are observed in addition to paralysis, loss of sensation, and muscle atrophy in the lower extremities. Orthopedic disorders (e.g., clubfoot, hip dislocation, contractures, kyphosis, and scoliosis) and other anomalies of the nervous system (e.g., Chiari type 2, hydrocephalus) also frequently occur (31). Although it has been reported that minimal neurological deficits and good
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Clinical results can be obtained by applying maternal-fetal surgical procedures for the treatment of MMC cases, this treatment can be applied in a limited number of centers due to the need for appropriate materials, resources, and personnel (8). Nevertheless, the method commonly used for the repair of the sac is the postnatal procedure (28). This surgical treatment aims to close the exposed spinal cord and nerve roots without cerebrospinal fluid (CSF) leakage. Therefore, central nervous system infections due to CSF leakage are prevented (19).

This study evaluates the types of spinal NTDs operated in our hospital, the follow-up and treatment times in the intensive care unit, and the factors affecting this duration.

**MATERIAL and METHODS**

Ethics committee approval for our study numbered 161 was obtained from Ordu University on August 20, 2020 (Approval No:161).

Seventy-three cases who were hospitalized in the neonatal intensive care clinic with diagnosis of NTD and operated by a single surgeon in the Neurosurgery Clinic between 2017 and 2020 at the Gaziantep Dr. Ersin Arslan Training and Research Hospital were retrospectively screened. The cases were evaluated in terms of gender, birth weight, NTD localization and type, time of operation, presence of ventricular dilatation, time of ventriculoperitoneal (V-P) shunt application, type of antibiotic therapy applied during treatment, and duration of hospitalization. Postnatal cranial and spinal magnetic resonance imaging (MRI) was performed on all cases. With MRI examination, the cases with hydrocephalus, localization of the MMC lesion, and congenital central nervous system anomalies were evaluated (Figure 1A-D). In addition, computed tomography (CT) examination was performed during the follow-up of the patients’ hydrocephalus.

The cases were grouped in terms of the time they underwent surgery. Accordingly, those who were operated within the first 24 hours after birth were classified as Group A, those who were operated within 24–48 hours as Group B, those who were operated within 3–7 days as Group C, and those who were operated after 7 days as Group D.

The cases were also grouped by NTD type. The V-P shunt requirements for patients with myeloschisis and myelomeningocele cysts were evaluated in terms of the rate of accompanying kyphotic/scoliotic deformity, additional antibiotic therapy needs, and length of stay.

**Surgical Technique**

All patients were operated under general anesthesia in the prone position with neuromonitoring. Subcutaneous tissue adjacent to the defect was detached. The dura defect on the neural plate was primarily repaired (Figure 2A, B). In cases deemed necessary, it was closed with a synthetic dural graft. After the dura repair, the Valsalva maneuver was performed, and no CSF leak was observed. Following hemostasis, the subcutaneous/skin defect was closed (Figure 3A, B).

**Clinical Observation**

Cefotaxime and amikacin treatment was started as prophylactic after the cases were admitted to the intensive care unit. Following the sending of blood, urine, wound, and tracheal aspiration cultures from the patients with high fever and high CRP in their follow-up, vancomycin and meronem treatments were started. According to the culture results, antibiotics were changed or continued. Daily head circumference follow-up, MRI, or CT examination was performed according to the hydrocephalus clinic of the cases. A V-P shunt was applied to the patients diagnosed with hydrocephalus in the same session or in a different session according to their clinical follow-up.

**Statistical Analysis**

SPSS statistical software (SPSS 11.5, SPSS Science, Chicago, IL, USA) program was used for statistical analysis. For data analysis, the Mann-Whitney U test, Kruskal-Wallis H test, and chi-square test were used.

**RESULTS**

Among the cases, 40 (54.8%) were female and 33 (45.2%) were male. Fifty-four patients (74%) were refugees of Syrian origin, and 19 (26%) were citizens of the Republic of Turkey. Birth weights were between 2,000 gm and 5,030 gm (mean = 3,177 gm). The admission period of the patients to the hospital ranged from just after delivery to the postnatal 27th day. Nineteen (26%) refugee cases, who were referred to our clinic from abroad, were admitted to the hospital on the

![Figure 1: A) MMC seen in thoracic region on T2 sequence sagittal MRI. B) The bone deformity seen in the spinal canal in the sagittal CT examination of the lesion, C) formation of two separate vertebral canals in the thoracic region in axial MRI examination of the case, and D) image of two separate spinal canals in thoracic axial CT examination.](image)
The patients were hospitalized in the intensive care unit for 7–109 days (mean=23). When the intensive care hospitalization periods were examined according to the groups, the longest hospitalization period was in the patients who were operated on after the seventh postnatal day. When the hospitalization periods of the groups were compared, no significant difference was found between Groups A and B, but the difference between Groups B and C and between Groups C and D was significant. The distribution of cases and the hospitalization periods in the groups are given in Table I, and the statistical comparison is presented in Table II.

V-P shunt operation was applied to 24 cases (32.9%) but not to 49 cases (67.1%). Forty-one (56.2%) cases were given prophylactic antibiotic therapy only during their hospitalization, and 32 (43.8%) patients required additional antibiotic therapy during their hospitalization. The rate of applying V-P shunt and additional antibiotic therapy was higher in patients who were operated on after the seventh day. However, this high rate was not statistically significant due to the small number of patients in group D (Table III).

In the distribution of the cases by NTD type, 51 (69.9%) had myeloschisis and 22 (30.1%) had MMC sac. The incidences of kyphotic or scoliotic spine deformation and ventricular dilatation at birth were higher in cases with myeloschisis than in those with MMC marsupials. In cases with myeloschisis, the V-P shunt application rate, additional antibiotic requirement, and long hospital stay were higher in the clinical follow-up. These values were statistically significant (Tables IV).

V-P shunt operation was performed between the postnatal 3rd–60th day (mean=21.6). It was performed in the same session, with defect repair in only one case. Shunt insertion was conducted in different sessions in 23 cases (95.8%). None of our patients required shunt revision during the hospitalization period.

The MMC sac was located in the lumbosacral region in 20 cases (90.9%) and in the thoracal region in two cases (9.1%). The myeloschisis cases were distributed according to their
The referral of 19 refugee cases (24.7%) from Syria to our hospital was within 3–27 days (mean=8.4). The length of stay in the intensive care unit of these patients was 8–109 days (mean=32.7). In 13 of these cases (68.4%), antibiotherapy was given in addition to prophylactic antibiotic treatment. In nine of these cases (47.4%), shunt application was required during the intensive care follow-up.

**DISCUSSION**

NTD incidence per 1,000 live births is 0.8–1.0 worldwide (39), 0.5–1.0 in the United States (34), 0.91 in European countries...
infection between patients who were operated immediately
3–7 days later (7). Pinto et al. reported no difference in wound
closed within the first 48 hours and those who were closed
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The timing of the postnatal surgical repair of NTDs is a
additional antibiotherapy was required.
contrary to the literature, cases with myeloschisis (69.9%) were
the thoracolumbar region (68.6%) in patients with myelochisia.
 MMC is most frequently localized in the lumbar region (69%)
(15). Eseoglu et al. reported that MMC distribution was
76.5% in the lumbar region, 10.9% in the thoracolumbar
region, 3.1% in the thoracic region, and 1.5% in the cervical
region (12). In our study, the lesion was mostly located in the
lumbosacral region (90.9%) in patients with MMC sac and in
the thoracolumbar region (68.6%) in patients with myelochisia.
Contrary to the literature, cases with myeloschisis (69.9%) were
more common than cases with MMC sac (30.1%). This may
be due to the regular follow-up during the gestational period
compared with the past, the easier detection of the MMC sac
in the intrauterine period compared with myeloschisis, and the
termination of such pregnancies in the early period. Cases with
lesions with a smaller MMC diameter have a shorter hospital
stay, less neurological complications are seen in the early
period, and an increase in the diameter of the sac increases
the duration of antibiotic therapy and adversely affects the
prognosis (12). In our study, patients with myeloschisis were
hospitalized longer than MMC cases, the need for V-P shunts
increased, kyphotic/scoliotic spine defects were frequent, and
additional antibiotic therapy was required.

The timing of the postnatal surgical repair of NTDs is a
controversial issue in the literature. Arslan et al. reported that
delay in the repair of NTD caused an increase in the general
infection rate (1). John et al. found that the rate of wound
infection and meningitis was lower in patients who underwent
surgical repair within 48 hours (2,16). Charney et al. found no
significant difference in ventriculitis between those who were
closed within the first 48 hours and those who were closed
3–7 days later (7). Pinto et al. reported no difference in wound
infection between patients who were operated immediately
after birth and those who were operated on 3.9 days later
(29). In our study, the use of additional antibiotics was higher
in patients who were operated after seven days, but the
difference was not statistically significant. The rate of additional
antibiotherapy use was higher in cases with myeloschisis than
in cases with MMM sac, and the difference was statistically
significant. No significant difference was found in terms of
hospital stay between patients who were operated in the
first 24 hours and those who were operated within 48 hours.
However, the hospitalization period of the cases operated in
3–7 days was longer than the cases operated in the first 48
hours. Those who were operated after seven days stayed in
the hospital for a longer period than the patients who were
operated within 3–7 days. Wound infection or ventriculitis
that may develop due to colonization on NTD due to delay
in surgical treatment may require additional antibiotics and
prolong the stay. In addition, since hydrocephalus may develop
in the patient after central nervous system infection, follow-up
may have extended the length of stay in terms of the need
for V-P shunt. In our study, it was observed that patients who
were operated after the 2nd day had longer treatment times
and if the expected time for defect repair was prolonged, the
duration of hospital stay was also prolonged. Therefore, if
the patients are operated within the first 48 hours, the need
for additional antibiotics can be reduced and the length of
hospital stay can be shortened.

Ersahin and Yurtseven reported that the defects seen in their
study were mostly small and could be closed by bringing the
neural plate close to the midline without tension, but that the
defects could be large in 25% of cases (11). According to
Ramasastry and Cohen, if the diameter of the defect is greater
than 5 cm, the defect can be repaired with reconstruction flaps
(30). Musculocutaneous flaps can be used to close excessively
enlarged MMC defects (25). Various reconstruction methods
have been described in the literature (7,10,17,22,24,33,38).
Regardless of the size of the lesion in our cases, sufficient
subcutaneous tissue was detached, duroplasty was performed, and the skin was closed by approximation to the
midline. None of our patients required wound site revision.

Large-sized MMCs are usually found in the thoracolumbar
and lumbar regions. Nejat et al. reported that these lesions
were mostly associated with symptomatic hydrocephalus
and severe neurological deficits, and that simultaneous V-P
shunting with defect repair would increase the duration and
cost of surgery while reducing the risk of CSF leak (26). As
only 2%–25% of MMC patients have obvious hydrocephalus
(1,20), simultaneous shunt operation for MMC repair is
doubtful, and it can increase the risk of shunt infection and
failure in simultaneous shunt application (35,36). No difference
was found in terms of the development of shunt infection
between V-P shunt application performed simultaneously with
MMC repair and its application in the first and second weeks
(13). Chakraborty et al. found that moderate ventriculomegaly
could occur after MMC repair, which is a slight progression,
and that unnecessary shunts should be avoided and close
follow-up should be performed in asymptomatic patients
instead of wearing shunts (6). Similarly, Oktem et al. confirmed
that shunting in the same session as MMC sac repair is not
acceptable and recommended shunting in a separate session

(18), 0.62–13.8 in Arabic countries (14), and 5.6 in Turkey (37).
The risk of anencephaly and spina bifida is known to increase
with the use of insufficient folate or its synthetic form, folic acid,
before and during pregnancy (23). According to case control
studies and randomized clinical studies, if pregnant women do
not take folic acid supplements or multivitamin supplements
containing folic acid, they are 2–8 times more likely to be at
risk (39). NTD affecting the lumbar spine is commonly seen in
societies with a low socio-economic status (19). As the city
where our hospital is located is found on the Syrian border,
most of our cases are refugees residing in our country due to
the Syrian civil war or those who were referred to our hospital
because they could not obtain adequate healthcare despite
living in their country. Owing to the current situation in this
region, the low socio-economic level increases the number of
cases and makes obtaining health services difficult. Thus, 74%
of our cases consisted of Syrian origin refugees. In addition,
19 of these cases were born in Syria, but were referred to our
hospital for surgical treatment due to the lack of equipment
there. It was observed that 68% of these cases received
additional antibiotic treatment and 47% needed a V-P shunt
and the length of hospital stay was observed due to these
reasons. In these regions, planning should be made for the
detection of NTD cases by increasing pregnancy follow-ups
and for the realization of labor in centers where postpartum
treatment can be performed.

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that shunting in the same session as MMC sac repair is not
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in appropriate cases if there are no signs of infection (27). Sankhla and Khan reported that mild-to-moderate ventricular dilatation could be seen after MMC repair, and that increases in ventricle size could be treated without a shunt. Shunt application was recommended for severe hydrocephalus cases in the high intracranial pressure clinic, and shunt was applied in 56% of the cases in their study (32). Mapstone et al. reported that cases not requiring shunt insertion reached higher IQ levels than cases that required shunt insertion (21). Our rate of applying V-P shunt to our cases was 32.9%, and all these cases had myeloschisis. A shunt decision was made in all our cases after clinical and radiological follow-up, except for one patient with the same session. This situation prolonged our intensive care follow-up periods. In addition, there was no complication due to shunt application or a need for shunt revision in our cases.

MMC cases require constant surveillance of neurological, urological, and musculoskeletal systems after the neonatal period. Routine measurements for head circumference should be taken, followed up for shunt dysfunction and infection, and monitored for neurological complications, such as tethered cord and seizure (23). Patients should be monitored for urological complications (urinary retention, ureteral reflux) that could occur due to abnormal neurogenic bladder dysfunction. Personalized continence programs should be established in terms of renal failure as a result of recurrent urinary tract infections (4).

Our study has several limitations. It was performed on a relatively limited number of cases, and its retrospective nature could diminish its scientific value. The lack of prenatal follow-ups and information about when and how the birth was taken for all cases from the Syrian region and the lack of regular post-discharge check-ups also limited our study. Therefore, prospective, large-scale, multi-center clinical trials are needed to further validate our results.

**CONCLUSION**

In myeloschisis cases compared with MMC marsupial cases, incidences of ventricular dilatation, kyphotic/scoliotic spine pathology, V-P shunt requirement, and longer hospital stay were observed. No difference in the duration of hospitalization was found in patients who underwent defect repair between the first day and 48 hours after birth. However, the length of stay in hospital increased in patients operated on after 48 hours. The period was longer in cases operated after seven days postnatally. Therefore, by performing NTD surgical treatment within the first 48 hours, the need for additional antibiotic therapy and hospital stay can be shortened.

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