RESEARCH ARTICLE

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Received: 17.11.2021
Acceptance: 10.02.2022
DOI: 10.18521/ktd.1024822

Etiology and Mortality Investigation in Neonates that Underwent Surgery

ABSTRACT

Objective: We aimed to examine the demographic characteristics, etiology and postoperative mortality rates of neonates operated on in our hospital.

Methods: The records of neonates who were operated in our tertiary care level university hospital between 2013 and 2019 were reviewed retrospectively. Patients with a diagnosis requiring surgical procedure, age (days), gender, anatomical region where the surgical procedure was performed, length of hospital stay, and mortality rates were investigated.

Results: 329 neonates were included in the study of which 213 (64.75%) were male and 116 (35.25%) were female. Gastrointestinal system surgery was performed in 214 patients (65.04%), respiratory system surgery in 95 (28.87%) patients and urogenital system surgery in 17 (5.16%) patients. The mortality rate of 156 patients that were followed up in our neonatal unit in the postoperative period was 16.6%. The mortality rate of female babies (21.3%) was higher than that of male babies (13%). Considering the mortality rates of the patients according to the surgical areas, the highest mortality rate was found in respiratory system surgery (38.46%) which was trailed by gastrointestinal system surgery (12.28%) and urogenital system surgery (7.69%), respectively.

Conclusions: Despite advances in neonatal care and surgical techniques, immaturity and congenital anomalies still have an important place among the most common causes of death in infants. In particular, the detection of organ dysfunctions due to congenital anomalies which are considered among the preventable causes of death in infants, efforts to correct them will be beneficial to a certain extent in reducing the mortality rates of neonates.

Keywords: Neonatal, Surgical Procedure, Mortality.

Ameliyat Olan Yenidoğanlarda Etiyoloji ve Mortalite Araştırması

ÖZET

Amaç: Hastanemizde ameliyat edilen yenidoğanların demografik özelliklerini, etiyolojilerini ve postoperatif mortalite oranlarını incelemeyi amaçladık.

Gereç ve Yöntem: Üçüncü basamak üniversite hastanemizde 2013-2019 yılları arasında ameliyat edilen yenidoğanların kayıtları geriye dönük olarak incelendi. Cerrahi işlem gerektiren tanısı olan hastaların yaş (gün), cinsiyet, cerrahi işlemin yapıldığı anatomik bölge, hastanede kalış süreleri ve mortalite oranları araştırıldı.

Bulgular: Çalışmaya 213'ü (%64,75) erkek, 116'sı (%35,25) kız olmak üzere 329 yenidoğan alındı. 214 hastada (%65.04) gastrointestinal sistem cerrahisi, 95 (%28,87) hastada solunum sistemi cerrahisi ve 17 (%5.16) hastada ürogenital sistem cerrahisi uygulandı. Yenidoğan ünitemizde postoperatif dönemde takip edilen 156 hastanın mortalite oranı %16,6 idi. Kız bebeklerin ölüm oranı (%21,3) erkek bebeklerden (%13) daha yüksekti. Hastaların cerrahi alanlara göre ölüm oranlarına bakıldığında, en yüksek ölüm oranı solunum sistemi cerrahisinde (%38,46) bulunurken, bunu sırasıyla gastrointestinal sistem cerrahisi (%12,28) ve ürogenital sistem cerrahisi (%7,69) izledi.

Sonuç: Yenidoğan bakımı ve cerrahi tekniklerdeki gelişmelere rağmen, immatürite ve konjenital anomaliler, bebeklerde en sık ölüm nedenleri arasında hala önemli bir yer tutmaktadır. Özellikle bebeklerde önlenebilir ölüm nedenleri arasında sayılan doğumsal anomalilere bağlı organ işlev bozukluklarının saptanması, düzeltilmesine yönelik çabalar yenidoğan bebek ölüm oranlarının azaltılmasında bir ölçüde faydalı olacaktır.

Anahtar Kelimeler: Yenidoğan, Cerrahi Prosedür, Mortalite.

Konuralp Medical Journal
e-ISSN1309–3878
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INTRODUCTION

Neonatal period refers to the first 28 postnatal days after birth. The most important cause of neonatal death in developed world regions is reported as prematurity (1). The rate of respiratory distress syndrome, necrotizing enterocolitis, congenital anomaly, and sepsis due to a prolonged hospital stay is encountered higher in low-birthweight and preterm neonates than in term neonates (2). The most important causes of infant deaths in developed countries are congenital anomalies, morbidities associated with prematurity and low birth weight, sudden infant death syndrome, morbidities associated with maternal diseases and accidents (3,4). The most common and the most important basic cause of infant deaths in our country is morbidity associated with prematurity, which is also the most important cause of neonatal deaths (5). Although congenital anomalies are responsible for approximately one third of infant deaths in developed countries, it has been observed that these mortality rates are decreasing. One of the reasons for this alleviation is the increased survival rate of many major congenital anomalies, -especially those in cardiovascular, gastrointestinal, or genitourinary nature, with corrective surgical treatments (6,7).

Surgical interventions performed by pediatric surgeons in the neonatal period, most if not all are aimed at congenital anomalies such as congenital diaphragmatic hernia, anal atresia, esophageal atresia, and the rest can be counted as complication management like necrotizing enterocolitis due to prematurity (8,9). These congenital anomalies and complications are surgical diseases that often stand in need of long-term care and an out-patient follow-up. Almost the entirety of the cases operated in the neonatal period should be followed up under neonatal intensive care conditions (9). Due to the technical developments in neonatal intensive care units in recent years, there is an increase in the number of surviving premature neonates and so does the frequency of subsequent surgical intervention (10).

The infant's prenatal follow-up and transfer, physical facilities of the neonatal intensive care unit and operating theatre, post-operative care quality and the experience of the personnel employed hereabouts affect mortality rates of neonatal operations either in the pre-operative or in the post-operative period (8). In this study, the records of 329 neonates who were hospitalized in the tertiary neonatal intensive care unit after being operated on by the pediatric surgery clinic between 2013 and 2019 were analyzed. To provide appropriate and safe anesthesia practices and effective respiratory support during the surgery for all patients' surgical procedures, the anesthesia team worked in coordination with surgeons and neonatal intensivists both before and after the surgery. The etiology of the surgical procedure and the mortality rates that developed in the post-operative period were investigated.

MATERIAL AND METHODS

This study was conducted on 329 neonates who were hospitalized and subsequently operated on in the tertiary neonatal intensive care unit of Harran University hospital between 2013 and 2019. The data of the cases were obtained retrospectively by scanning the inpatient files within the hospital's software data system. The patients' age (days), gender, anatomical region where the surgical procedure was performed, length of hospital stays, and mortality rates were investigated.

General anesthesia was performed in all cases. Sevoflurane was used for inhalation anesthesia. After the operation, the patients were managed in the neonatal intensive care unit. Institutional permission from the hospital management and ethical approval from the Harran University Clinical Research Ethics Committee (dated 22/02/2019 and decision number HRU/19.02.36) were obtained for the use of patients' data before the study.

Statistics: Data analysis and evaluation were performed using SPSS version 24.0 (SPSS Inc., Chicago, IL). Data were expressed as mean ± standard deviation, number of cases and (%). Results were evaluated using Chi-square test, t-test, and Kruskal-Wallis. P value < 0.05 was considered significant.

RESULTS

329 neonates were included in the study comprising of 213 (64.75%) boys and 116 (35.25%) girls. When the ages of the neonate cases were examined based on the day they were operated on, the mean age was 7.46±7.97 days; the mean age in girls was 6.56±7.58 days, and the mean age in boys was 7.95±8.15 days. 217 (65.95%) of our neonate cases were operated on the first 7 day of their lives. This was followed by 43 patients on 8-14th days (13.06%), 38 patients between 15-21st days (11.55%) and 31 patients between 22-28th days consecutively. The classification of the surgeries performed was sorted according to the surgical fields. Gastrointestinal system surgery was performed in 214 patients (65.04%), respiratory system surgery in 95 (28.87%) patients, and urogenital system surgery in 17 (5.16%) patients. (Table 1).

Table 1. Demographic data of patients and distribution of surgeries by anatomical regions

Gender		**Female (n,%)**	**Male(n,%)**	**Total**
		116 (%35.25)	213 (%64.75)	329
Age (Days)	1-7	82 (%24.92)	135(%41.03)	217 (%65.95)
	8-14	12(%3.64)	31(%9.42)	43 (%13.06)
	15-21	14(%4.25)	24(%7.29)	38 (%11.55)
	22-28	8(%2.43)	23(%6.99)	31 (%9.42)
	Mean	6.56±7.58	7.95±8.15	7.46±7.97
Surgical field	Respiratory System	44(%13.37)	51(%15.50)	95 (%28.87)
	Gastrointestinal system	71(%21.58)	143(%43.46)	214 (%65.04)
	Urogenital system	0(%0)	17(%5.16)	17 (%5.16)
	Musculoskeletal System	1(%0.30)	2(%0.60)	3 (%0.91)

Since 173 of the patients were referred to our hospital for surgical procedure from an external center, they were transferred back to the relevant hospital under appropriate conditions after the surgical procedure. Postoperative treatments of 156 patients, who were born in our hospital or referred to our hospital before the surgery, were continued in our neonatal intensive care unit. Therefore, mortality rates and length of hospital stay were calculated on 156 patients who were hospitalized in our hospital in the postoperative period. Although the mortality rate of female infants (21.3%) was higher than that of male infants (13.8%), this difference was not statistically significant (p=0.240). The mortality rate of all patients managed in the postoperative period was 16.6%. Considering the mortality rates of these patients as per to the surgical areas, the highest mortality rate was found in the respiratory system surgery (38.46%) which was followed by gastrointestinal system surgery (12.28%) and genitourinary system surgery (7.69%), respectively (p=0.007) (Table 2).

Table 2. Comparison of patients' mortality rates according to gender and surgical fields

		Mortality (n,%)		**Hospitalization duration (days)**	
			p value		p value
Gender	Female	10(%21.3)	0.240 [a]	18.53±22.27	**0,018** [b]
	Male	15(%13.8)		11.38±13.04	
Surgical field	Respiratory System	10 (%38.46)	**0.007** [a]	17.53±10.19	**0,00** [c]
	Gastrointestinal system	14 (%12.28)		13.78±18.31	
	Urogenital System	1 (%7.69)		6.00±8.38	
	Musculoskeletal System	0		2.33±2.30	

a: chi-square; b: t test; c: Kruskal-Wallis

The mean hospital stay of the patients was 13.53±16.63 days. It was determined that the mean hospitalization span of female babies (18.53±22.27 days) was longer than that of male babies (11.38±13.04 days) ($p<0.05$). Considering the hospitalization times of the patients according to their surgical fields, it was found that the longest hospitalization was in respiratory system surgeries (17.53±10.19 days), and the shortest was in musculoskeletal surgeries (2.33±2.30 days) ($p< 0.05$) (Table 2).

Glancing at the complications of the peri- and postoperative period; a patient who underwent tracheoesophageal fistula repair was lost due to an intraoperative cardiac arrest. It was also detected that recovery from anesthesia was delayed in 2 patients who were operated on for testicular torsion and inguinal hernia. While 13 patients died in the first 24 hours postoperatively, 11 patients died after 24 hours (Table 3).

Table 3. Distribution of patients according to their exitus period and gender

Mortality	**Female**	**Male**	**Total**
Postoperative first 24 hours	6	7	13
Intraoperative	0	1	1
Postoperative after 24 hours	4	7	11
Total	10	15	25

DISCUSSION

In recent years, the rate of survival for premature neonates has increased due to advances in medicine. Parallel to this situation, the number of neonates who underwent surgical intervention by pediatric surgeons has also risen. Neonatal surgery is one of the most specialized areas of pediatric surgery and requires a momentous cooperation of the pediatric surgeon with the neonatal specialist, anesthesiologist, and neonatology nurses (11,12) Çevik et al. reported that they performed surgical procedures mostly because of esophageal atresia (13). In another study, this surgical procedure was given as the most frequently performed procedure (11). In the current study, our frequency of the operated surgical systems was compatible with the literature as gastrointestinal system (65.04%), respiratory system (28.87%), and urogenital system surgery (5.16%), consecutively.

The causes of death in neonates who underwent surgical intervention are multifactorial (14). These reasons can be listed as suitable transfer conditions for the patient, appropriate operating room, safe anesthetic agents, physical conditions of the intensive care unit, training and experience of the employees, prenatal follow-up and risks arising from the severity of the cases themselves. Although it has been reported that the mortality rate in

neonates undergoing surgical procedures is not different between genders (14), Çevik et al. reported that mortality in female cases was statistically higher than in males (13). Similar results have been reported in this regard, depending on the region of residence and socioeconomic structure, and it has been determined that the incidence of mortality is high in female neonates in rural areas (15). In our study, although the mortality rate of female infants (21.3%) was higher than that of male infants (13.8%) which is consistent with the current literature, it was not statistically significant ($p>0.05$).

In a study examining the patients in the surgical neonatal intensive care unit, Siddharth et all found that the mortality rates in the surgical neonatal intensive care units may vary according to countries and regions, the mortality rates are between 20-60% in developing countries and this rate is below 5% in developed countries. They also added that their mortality rate was 14.5%. In the same study, the duration of hospitalization was reported as 16.41±11 (1-101 days) and mentioning similar results in terms of gender. The authors reported that 80.7% of the patients were admitted in the early neonatal period and all deaths occurred in this period. (16). In our study, we found that 65.95% of the patients who underwent surgery were operated within the first 7 days and 80% of all deaths occurred in this first week period. The mortality rate of the patients followed up in the postoperative period was 16.02%. We found the mean hospitalization period of the patients were 13.53±16.63 (1-115 days), and this period was significantly longer in female infants than in males ($p<0.05$). In addition, although the mortality rate was found to be higher in girls which was similar to the length of hospital stay in our study, it was not statistically significant ($p>0.05$).

In the neonatal period, patients requiring intervention by pediatric surgery are frequently of low-birth-weight patients with a possible late diagnosis (2,9,15). Early detection of congenital anomalies and taking precautions for a congenital anomaly in the early postnatal period greatly reduce the risk of neonatal mortality and morbidity (17). The incidence of mortality was reported to be high in patients with necrotizing enterocolitis (NEC), diaphragmatic hernia, and esophageal atresia (13). In the retrospective evaluation of 114 cases with jejunoileal atresia, the mortality rate was 11%, while the mortality rate in cases with NEC could reach 25% (18,19). NEC is one of the leading causes of gastrointestinal mortality in premature infants with an incidence of 1-5 per 1000 neonates (20). In multicenter studies, it is estimated that 7-13% of neonates born before 33 weeks of gestation and weighing less than 1000 g have NEC. Mortality is expected approximately as 50%, especially in those requiring surgical treatment. While most cases are premature infants, the incidence of NEC in term infants is quite low with the overall mortality rate ranging from 15% to 63% (21,22).

In the current study, the mortality rate in all patients that were managed in the postoperative period was 16.6%. The highest mortality was detected in respiratory system surgery (38.46%) which was followed by gastrointestinal system surgery (12.28%) and genitourinary system surgery (7.69%), respectively. Since the organ systems were considered as a whole, no distinction was made according to the diagnoses.

In a study by Puri A et al which comprised of 150 neonates, 30-day mortality rate was found 56.81% in 44 patients who had thoracic surgery and 24.17% who had abdominal surgery. This is roughly consistent with our results (23). Respiratory system surgeries carry a higher burden of risk from the anesthesiologic point of view. Alveolar maturation in the neonatal period is still a proceeding process at birth achieving its peak until 8-10 years of age. Surgery and anesthesia together decrease the durability of an already unstable physiology of the sick neonates (24,25). Therefore, we attribute the high mortality rate of respiratory system surgery to insufficient alveolar development of neonates, further curtailment in respiratory capacity during surgery, and negative effects of anesthetic agents on respiratory parameters such as functional residual capacity.

In our study, we examined patient records through the hospital automation system. Therefore, we completed our study with the data we could obtain. When examining the mortality data of the patients, we could not include those transferred to another center. Since the perioperative anesthesia records of the patients were not recorded on the hospital automation system at the time of the examination, we stated the anesthesia complications in the epicrisis reports. Due to limited data, we interpreted our study according to demographic data, mortality, and surgical field information.

CONCLUSION

To reduce the incidence of mortality of cases undergoing surgical procedure, we believe that it can be possible with appropriate prenatal and postnatal follow-up, easy access to health services countrywide, appropriate transport procedures, employment of physicians and nurses experienced in neonatal care and surgery, appropriate anesthesia settings and conditions along with the improvement of neonatal intensive care unit environment.

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