

FREQUENCY OF LESIONS AND OPERATIVE RESULTS IN SURGICAL NEONATES*

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Neonatal surgery carries its own hazards by virtue of the size and maturity of the infant as well as the lesions which require surgical intervention at this age. The majority of these lesions are admittedly of congenital origin. Their operative mortality continues to be significant particularly when the lesions are multiple and occurring in a premature subject.

This report outlines our personal experience with neonatal surgery at the American University of Beirut Medical Center (AUBMC) during the three-year period between January 1981 and December 1983. An analysis of the surgical results is presented. Reference is made to a previous recent review by us of 29 consecutive premature surgical neonates¹.

Material, Methods and Findings

This series comprises 107 infants operated on in the first month of life in the Division of Pediatric Surgery and excludes those operated for cardiovascular, neurosurgical and orthopedic malformations.

The infants were divided into two groups, the premature (neonates under 2500 grams, old definition) and full-term. There were twenty-eight neonates in the former category, and of these 17 were pre-term and 11 were term-small for gestational age (T-SGA). The remainder, i.e. 79 patients, were full-term. The hospital mortality rate was 41% in the pre-term, 18% in the T-SGA and 7.6% in the full-term babies. Of the 107 surgical neonates 92 survived, giving an overall hospital mortality rate of 14% (Table I).

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TABLE I
**Hospital Mortality Rate of Surgical
 Neonates in Relation to Gestational
 Age and Birth Weight**

	<u>No. of infants</u>	<u>Hospital mortality</u>	
		<u>No.</u>	<u>Rate</u>
Premature	28	9	(32%)
Pre-term	17	7	(41%)
Term-SGA*	11	2	(18%)
Full-term	79	6	(7.6%)
Total	107	15	(14%)

* SGA: Small for gestational age.

The relative frequency of the lesions requiring operation in the neonatal period, and their distribution between premature and full-term appears in Table II. In decreasing order of frequency, the lesions were: pyloric stenosis (19), inguinal hernia (17), esophageal atresia with or without tracheo-esophageal fistula (15), diaphragmatic hernia (10), imperforate anus (9), Hirschsprung's disease (9), gastrointestinal atresia or stenosis (7), omphalocele (4), necrotizing enterocolitis (3), miscellaneous (14). These miscellaneous lesions included meconium ileus, multicystic kidney, ectopic liver on the surface of the umbilicus, renal vein thrombosis, perianal abscess, adrenal hemorrhagic cyst, chest wall mesenchymal tumor, nesidioblastosis, lobar emphysema, midgut volvulus, hygroma of neck and mediastinum and intestinal obstruction due to Meckel's diverticulum.

Of the 17 infants with inguinal hernia, seven had to be operated on because of incarceration giving an incidence for this complication of 41%. The youngest patient requiring repair of an inguinal hernia was one day old.

Of the 15 infants with esophageal atresia, 12 had a distal tracheoesophageal fistula and three had atresia without fistula (Table III). Ten of the 15 infants (67%) were premature and two had imperforate anus. Four were considered to be too sick for complete repair and subsequently died. The mortality rate in the 11 infants that were totally repaired was 9%. Of interest, three infants undergoing total repair required a circular esophageal myotomy of the upper blind pouch to relieve tension on the anastomosis.

TABLE II
Relative Frequency of Surgical Lesions Among
Premature and Full-term Infants

Lesions	Premature	Full-term	Total
Pyloric stenosis	1 (0)	18 (0)	19 (0)
Inguinal hernia	1 (0)	16 (0)	17 (0)
Esophageal atresia + TEF	9 (3)	4 (0)	13 (3)
Esophageal atresia + TEF + imperforate anus	1 (1)	1 (1)	2 (2)
Diaphragmatic hernia	2 (1)	8 (1)	10 (2)
Imperforate anus	2 (0)	7 (0)	9 (0)
Hirschsprung's disease	—	9 (1)	9 (1)
GI atresia or stenosis	4 (1)	3 (0)	7 (1)
Omphalocele	1 (0)	3 (2)	4 (2)
NEC	3 (2)	—	3 (2)
Miscellaneous	4 (1)	10 (1)	14 (2)
	28 (9)	79 (6)	107 (15)

() = Number of hospital deaths; TEF = tracheo-esophageal fistula; NEC = necrotizing enterocolitis; GI = gastrointestinal.

TABLE III
Analysis of Findings in 15 Infants with
Esophageal Atresia

	Number	Frequency
1 Associated		
Distal TEF	12	(80 %)
Prematurity	10	(66.7 %)
Imperforate anus	2	(13.3 %)
2 Total surgical repair (TR)	11	(73 %)
Circular myotomy during TR	3	(27 %)
3 Incomplete surgical repair (IR)	4	(26.6 %)
4 Mortality: overall	5	(33.3 %)
After TR	1	(9 %)
After IR	4	(100 %)

TEF = tracheo-esophageal fistula.

Of the 10 infants with diaphragmatic hernia, nine had a left Bochdalek type of hernia and one had a hiatal hernia with gastroesophageal reflux. The preoperative arterial pH, as related to the age on admission of babies with the Bochdalek type of diaphragmatic hernia, appears in Table IV. The lowest pH was 6.8 and was followed by survival after an emergency repair of the defect. This baby required the use of a respirator for five days postoperatively. Five of the nine with diaphragmatic hernia underwent repair during the first 24 hours after birth, and of these one died. Two of the nine babies in this group died post-operatively (mortality rate of 22%). Of the four babies with a preoperative arterial pH of less than seven, two died; while all of the remaining five with a preoperative pH of more than seven survived.

TABLE IV
**Arterial pH on Admission in 9 Infants with
Left Bochdalek Type Diaphragmatic Hernia
Versus Operative Results**

Age on admission	Preoperative pH		Outcome
	<7.0	7.1 - 7.4	
< 12 hours	3	—	2 A, 1 D
	—	1	1 A
13 - 24 hours	—	1	1 A
25 - 48 hours	—	2	2 A
49 - 72 hours	1	—	1 D
20 days	—	1	1 A
	4	5	7 A, 2 D

A = alive; D = dead.

Of the 11 infants with imperforate anus, two died because of an association with esophageal atresia with or without tracheoesophageal fistula (Table V). Six of the 11 infants with imperforate anus had major associated malformations.

Of the nine patients with Hirschsprung's disease, seven required colostomy in the first week of life, one in the second week of life and one at the age of one month. Two of the nine infants had aganglionosis extending to the splenic flexure, whereas the disease was limited to the rectosigmoid area in the remaining seven. A loop colostomy above the transition zone was established in all. The diagnosis of the disease was confirmed by a transabdominal rectal muscle biopsy. All had the radiological barium enema findings pathognomonic of Hirschsprung's disease.

Of the seven infants with gastrointestinal atresia or stenosis, the pyloroduodenal area was involved in four cases and of these one had a duodenal stenosis and the remainder had atresia. One infant had multiple sites of atresia and died.

TABLE V
**Findings and Results in 11 Babies with
Imperforate Anus**

	Number
Sex (male : female)	11 : 0
Level of imperforation:	
Supralevator	9
Intermediate	2
Prematurity	2
Associated major anomalies:	6
Trisomy 21 + microcephaly	
+ other skeletal anomalies	1
Cyanotic CHD	2
Agenesis of one kidney	
+ skeletal anomalies	2
Esophageal atresia + TEF	2
Hospital mortality	2 (18 %)

CHD = congenital heart disease; TEF = tracheo-esophageal fistula.

Postoperative Complications

Six infants who had open surgery on the gastrointestinal tract developed wound infections which were mostly caused by gram-negative organisms (Table VI). In one infant there was a *Staphylococcus aureus* infection which was further complicated by a wound dehiscence. It is worth noting that four of these six infants weighed less than 2.5 kilograms; the lightest baby, a premature weighing 1.3 kilograms, had a perforated appendix presumably due to necrotizing enterocolitis and was discharged from the hospital in good condition.

The mortality rate was related, among other factors, to the age of the patient at the initial operation. Thirteen of the 61 infants operated on in the first week of life died (a mortality rate of 21%), whereas only one of the 40 infants operated on after the age of two weeks died (a mortality rate of 2.5%. See Table VII). This difference in mortality may also be accounted for by the gravity of the surgical lesion. Interestingly, the operative mortality rate in this series of 107 neonates, (i.e. death within one month after operation) was 12%, while the hospital mortality rate was 14%.

TABLE VI
Wound Infections in 6 of 107 Infants
Undergoing Neonatal Surgery

Lesions	Gestational age (weeks)	Birth weight (kg)	Infecting bacteria	Outcome
GI Atresia	34	2.0	E. coli	D
	33	2.1	E. coli	A
	FT	2.2	Proteus	A
	FT	3.1	E. coli	A
Perforated appendix (NEC)	29	1.3	E. coli	A
Strangulated inguinal hernia	FT	2.9	Staph. aureus	A

A = alive; D = dead; GI = gastrointestinal; NEC = necrotizing enterocolitis; FT = full-term.

TABLE VII
Mortality Versus Age at Initial Operation

Age at initial operation (days)	No. of infants	Hospital mortality	Operative mortality
<7	61	13 (21 %)	11 (18 %)
7 - 13	6	1 (17 %)	1 (17 %)
14 - 30	40	1 (2.5 %)	1 (2.5 %)
Total	107	15 (14 %)	13 (12 %)

TABLE VIII
Surgical Lesions in 15 Postoperative Hospital Deaths

Lesion	No.	Lesion	No.
Esophageal atresia	5	Diaphragmatic hernia	2
Meconium ileus	2	Hirschsprung's disease	1
Necrotizing enterocolitis	2	Multiple intestinal atresia	1
Omphalocele	2		

The lesions in the 15 infants who died post-operatively are listed in Table VIII. Five patients had esophageal atresia, and there were two cases each of meconium ileus, necrotizing enterocolitis, omphalocele and Bochdalek-type diaphragmatic hernia, one case of Hirschsprung's disease and one of multiple intestinal atresia. Preoperatively, three had hyaline membrane disease and one had cardiopulmonary arrest before a gastrostomy was carried out for esophageal atresia. Six infants were full-term and nine were premature with weights ranging between 1.5 and 2.4 kg. Eleven of the 15 babies had major associated congenital malformations. Postoperatively four patients developed necrotizing enterocolitis and died; of these two had meconium ileus, one had diaphragmatic hernia and one had esophageal atresia. Pneumonia and sepsis were the most frequent direct causes of death.

Discussion

In this series of 107 consecutive neonates requiring operation on systems other than the cardiovascular, neurological and skeletal, 28 were premature and 79 were full-term. The highest hospital mortality rate was noted in the 17 pre-term babies, and was 41%. For the 79 full-term babies the rate was 7.6%.

The mortality rate appeared to be related also to the nature of the malformation; four of the ten premature babies with esophageal atresia and two of the three premature ones with necrotizing enterocolitis died after operation, whereas only three of the remaining 15 premature babies with other malformations died postoperatively. Furthermore, our observations indicate that the presence of multiple major anomalies of the alimentary tract are associated with a high mortality rate.

In this survey, there were only three neonates who required operation for urinary tract malformations. Further, the number of patients with gastrointestinal perforations was small compared to the experience of Olcay et al², who reported 38 neonates with gastrointestinal perforations due to variable causes with an operative mortality rate of 74%.

Other factors that affected the outcome of surgery included pulmonary and septic complications. In some instances the former started preoperatively as, for example, hyaline membrane disease. Gram-negative infections accounted for the majority of fatalities and were complicated sometimes by disseminated intravascular coagulopathy and/or multi-system failure. In four patients, necrotizing enterocolitis developed postoperatively and the outcome was, in all cases, fatal. Despite advances in surgical technique and the advent of supportive measures including ventilatory support, total parenteral nutrition and the newer antibiotics, the risks of neonatal surgery remain proportionately related to the birth weight,

the gestational age and to the severity and multiplicity of the malformations. An early diagnosis and prompt surgical management of these lesions are strongly recommended.

Summary

One hundred and seven consecutive cases of neonates receiving surgical treatment at the American University of Beirut Medical Center during the first month of life, are presented. The period covered is from January 1981 to December 1983. Twenty-eight patients were premature and 79 were full-term. The hospital mortality rate in the former was 32% and in the latter 7.6%. The factors affecting survival in this category of neonates are discussed.

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