Impact of Surgery for Neonatal Gastrointestinal Diseases on Weight and Fat Mass

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Objective To compare growth, fat mass (FM), and fat-free mass in surgical infants vs matched controls at similar postconceptional age (PCA).

Study design Anthropometric and body composition measurements by air-displacement plethysmography (PeaPod-Infant Body Composition System; LMI, Concord, California) were performed at the same PCA in 21 infants who received gastrointestinal surgery and in 21 controls matched for gestational age, birth weight, and sex.

Results Despite similar anthropometry at birth, postsurgical infants were shorter (50.4 [4.7] cm vs 53.2 [4.1] cm, $P = .001$), lighter (3516 [743] g vs 3946 [874] g, $P < .001$), and had lower FM content (%FM 14.8 [4.7]% vs 20.2 [5.8]%, $P < .0001$) than their peers at similar PCA (43 [4] weeks). All surgical infants but 1 (20/21) received parenteral nutrition (PN). Mean PN duration was 40 (30) days. Five infants in the control group received PN because of prematurity for 15 (9-30) days. Nine infants in the surgical group and 1 in the control group had PN-associated cholestasis.

Conclusions Neonates having surgery for gastrointestinal diseases were shorter, had lower weight, and lower FM content than their peers, despite receiving more PN. Body composition evaluation and monitoring may help optimize growth in these newborns. *(J Pediatr 2015;167:568-71)*.

Surgical newborns are at risk of impaired growth in the first year of life[1-3]: up to 15%-30% of infants who had surgery for gastroschisis or esophageal atresia were significantly underweight at 1 year of age.[1,3] Surgical necrotizing enterocolitis (NEC) increases the risk of poor growth at 18-22 months of age with respect to medical NEC.[2] Nutritional problems in neonates requiring gastrointestinal surgery are not unusual and nutritional support in these infants is often challenging. The gastrointestinal disease itself may be associated with critical illness and/or predisposed to intestinal failure. In addition, surgical neonates may have additional losses (such as stoma output or nasogastric aspirates) that worsen malnutrition. Moreover, after gastrointestinal surgery, adequate enteral feeding often has to be postponed for more than 1 week and parenteral nutrition (PN) support becomes necessary, sometimes for a long time, worsening cholestasis and malabsorption.[4] As a consequence, newborns having surgery for gastrointestinal diseases may have a different growth and body composition (BC) compared with their peers.

Assessment of growth is one of the major keys to the evaluation of nutritional requirements.[5] In addition to more traditional anthropometric measures such as weight and length, evaluation of BC allows assessment of the quality of growth in terms of fat mass (FM) and fat-free mass. Air-displacement plethysmography is a validated, simple, noninvasive method to measure BC in newborns and may potentially lead to a better nutritional management in infants with impaired growth.[6,7] The effects of intestinal surgery on BC are unknown. The aim of this study was to compare growth, FM, and fat-free mass in surgical infants vs matched controls at similar postconceptional age (PCA).

Methods

This study was carried out at the Institute for Maternal and Child Health – IRCCS Burlo Garofolo, Trieste, a level 3 hospital. The ethics committee of the institution approved the study, and parents provided written consent.

We enrolled all consecutive newborns treated with gastrointestinal surgery at our institution between September 2012 and September 2014. The healthy comparison group was matched for gestational age at birth (±3 gestational days), birth weight (BW) (±50 g), and sex. Gestational age calculation was based on first trimester sonogram. Cholestasis was defined as direct bilirubin >1.5-2 mg/dL. Data on postnatal nutrition and complications were retrieved from medical charts. When needed, PN was started soon after birth. According to our protocol, all infants started intravenous glucose at 5-6 mg/kg/min and

BC	Body composition
BW	Birth weight
FM	Fat mass
NEC	Necrotizing enterocolitis
PCA	Postconceptional age
PN	Parenteral nutrition

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increased up to a maximum of 10 mg/kg/min within 8-10 days. Intravenous aminoacids (6.5% amino acid solutions, TrophAmine B; Braun Medical Inc, Cherry Hill, New Jersey) were started at 2.5 g/kg within 24 hours from birth, and increased by 0.5-1 g/kg/d up to a maximum dose of 4-4.5 g/kg/d depending on BW. Lipids (SMOFlipid 20%; Fresenius Kabi, Bad Homburg, Germany) were started at 0.5 g/kg/d within 48 hours, and increased up to a maximum dose of 3 g/kg/d. With cholestasis, the PN composition was modified such that the infant received 1 g/kg of SMOFLipid and 1 g/kg of Omegaven (Fresenius Kabi). Energy intakes (glucose plus lipids) increased from 40 kcal/kg/d on day 1 up to a maximum of 80 kcal/kg/d by day 5 or subsequently. Enteral feeding was either breast milk (fortified breast milk was used for preterm infants weighting less than 1500 g at birth) or formula, when breast milk was unavailable or insufficient. Enteral feeding was progressively increased to a full enteral amount of 160-180 ml/Kg/d in all infants except those with jejunal enterostomy, in which case it was maintained at 10-20 mL/kg/d until closure of enterostomy.

Anthropometric and BC Measurements

Anthropometry (weight, length) was assessed at birth by two trained nurses. At birth, all infants were weighed within the first 30 minutes of life on the same scale (Seca GmbH and Co. Kg, Hamburg, Germany) with an accuracy of 10 g. Recumbent length was measured to the nearest 0.2 mm (Seca GmbH and Co. Kg). BC was assessed before discharge in surgical infants, possibly after discontinuation of PN, and at the same PCA in controls. Body weight, FM (both in gram and as percentage body mass [%FM]) and fat-free mass were measured by an air-displacement plethysmography system (PeaPod Infant Body Composition System). A detailed description of PeaPod's operating principles, validation, and measurement procedures is provided elsewhere.[7]

Statistical Analyses

Variables were reported as mean (SD) or median (IQR) if normally or non-normally distributed, respectively. Normally distributed continuous variables were compared with *t* test for paired samples. Regression analysis was used to assess the correlation between two continuous variables. A sample size of 20 infants per group was needed to detect a 3% difference in %FM between groups, with power of 90% and a significance level of 5%. Normality was assessed with D'Agostino–Pearson test. Statistical significance was assumed at $P < .05$. Statistical analyses were performed using MedCalc rel.9.3.9.0 (MedCalc Software, Mariakerke, Belgium).

Results

Twenty-one infants (10 female) who had surgery for gastrointestinal diseases and 21 matched controls were included in the analysis. The gastrointestinal conditions that required surgery are reported in Table I. Fifteen out of 21 (71%) infants had surgery during the first 72 hours of life and 17/21 (81%) during the first week of life. Two infants had surgery after the first month of life (Table I). In 9/21 infants, an enterostomy was formed after the first surgery. Of these, 1 was a jejunal enterostomy, the others were at the level of the terminal ileum. Enterostomies were closed after 35 (10) days. Eleven of 21 (52%) infants required

Table I. Baseline characteristics and nutritional data of 21 infants who had gastrointestinal surgery

Infant	Sex	GA (wk)	BW (g)	Diagnoses	Day of life at first surgery	Lengths of bowel resection (cm)	Enterostomy	PN (d)	Nihil per os (d)	Cholestasis
1	m	35	2360	Gastroschisis short bowel	1	120	No	Home PN	8	Yes
2	m	31	1870	Gastroschisis	1	0	No	30	18	Yes
3	m	28	1240	Ileal stenosis	62	8	Yes	104	6	Yes
4	f	39	2610	Duodenal atresia	2	0	No	11	6	No
5	m	33	2070	Ileal atresia, volvulus	1	2	Yes	70	6	Yes
6	f	39	3130	Meconium ileus (CF)	2	15	Yes	14	6	No
7	m	35	2250	Duodenal atresia, volvulus	1	0	Yes	78	21	Yes
8	f	35	2600	Jejunal atresia	1	20	No	26	5	No
9	f	37	3000	Ileal atresia, volvulus	3	0	Yes	28	7	No
10	m	38	3100	Malrotation	4	0	No	50	15	Yes
11	m	36	2240	TOF	1	16.5	No	13	6	No
12	f	24	790	NEC	11	3	Yes	74	22	Yes
13	f	34	1780	Multiple SIP	1	6	Yes*	81	22	Yes
14	m	32	1460	SIP	3	2	Yes	21	11	No
15	m	39	3680	Meconium ileus (CF), postoperative stricture	1	0	Yes	30	13	No
16	f	36	2740	Microgastria, mal rotation, heterotaxy	82	0	No	52	5	No
17	m	39	2896	TOF	1	0	No	12	8	No
18	f	41	4520	Malrotation	22	0	No	0	3	No
19	f	40	3470	Duodenal stenosis	4	0	No	7	5	No
20	m	30	910	TOF	2	0	No	66	6	No
21	f	34	2330	Duodenal atresia	1	0	No	26	8	Yes

CF, cystic fibrosis; *f*, female; *GA*, gestational age; *m*, male; *SIP*, spontaneous intestinal perforation; *TOF*, trachea-esophageal fistula.
*Jejunal enterostomy.