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Use of 'T-tube' enterostomy in the management of emergency neonatal intestinal problems: a case series

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Emergency neonatal intestinal problems, such as necrotizing enterocolitis (NEC), spontaneous intestinal perforation (SIP), intestinal atresia, meconium cyst and meconium ileus, pose serious challenges for pediatric surgeons and neonatologists. Stoma creation and primary anastomosis have been used for decades with various advantages and disadvantages of each approach.[1–4]

Stoma creation is usually required in cases with generalized peritonitis and when perfusion and viability of distal parts of the intestine are questionable during laparotomy. In these life-threatening situations stoma formation results in improvement of survival.[5] The main disadvantage of intestinal exteriorization is the need of another procedure for closure with prolonged hospitalization and repeated admissions. Other disadvantages include stoma-associated complications, such as high-output losses, electrolyte derangements, stenosis, skin excoriation, prolapse or retraction of the stoma, and parastomal protrusion or internal herniation through a mesenteric defect.[1–4]

Primary anastomosis should be performed in a neonate who is stable and has localized bowel disease.[6 7] Potential problems with primary anastomosis are anastomotic leak, peritonitis, anastomotic stricture, stasis, and bacterial overgrowth. These are the main reasons why primary anastomosis is not often attempted in extremely low birthweight (ELBW) newborns.[8]

'T-tube' enterostomy is an alternative technique for a variety of such emergent intestinal problems.[9–11] 'T-tube' combines the advantages of enterostomy (intestinal decompression, functioning low-output stoma) with those of primary anastomosis (restoration of intestinal continuity, preventing the need for a second operation, and avoiding stoma complications). We aim to assess the safety and effectiveness of 'T-tube' enterostomy in the management of emergency neonatal intestinal problems.

We treated neonates with emergency intestinal problems using 'T-tube' enterostomy between July 2016 and March 2020 in the Departments of Pediatric Surgery and Neonatology, King Saud Medical City, Riyadh, Saudi Arabia.

We included all premature and term neonates who underwent laparotomy for intestinal problems and had 'T-tube' placement during surgery. Demographic data collected included gestational age, weight, age at operation and final diagnosis. Postoperative surgical complications, outcome and follow-up information were retrieved.

Informed consent was obtained from parents. All the patients were operated by the same surgeon. The decision to use a 'T-tube' was made intraoperatively. This typically occurred in neonates that would otherwise require a proximal ostomy close to the duodenojejunal junction or in patients who underwent multiple bowel anastomoses. Prior to placement, the horizontal part of the 'T-tube' was trimmed to an appropriate length (figure 1) and was cut across the

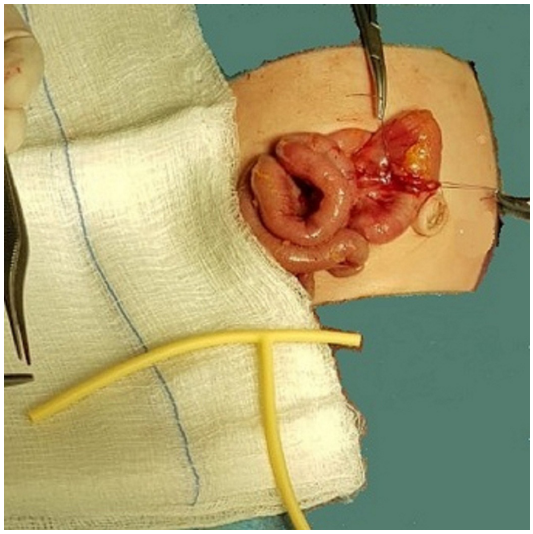

Figure 1 Horizontal part of 'T-tube' trimmed as needed.

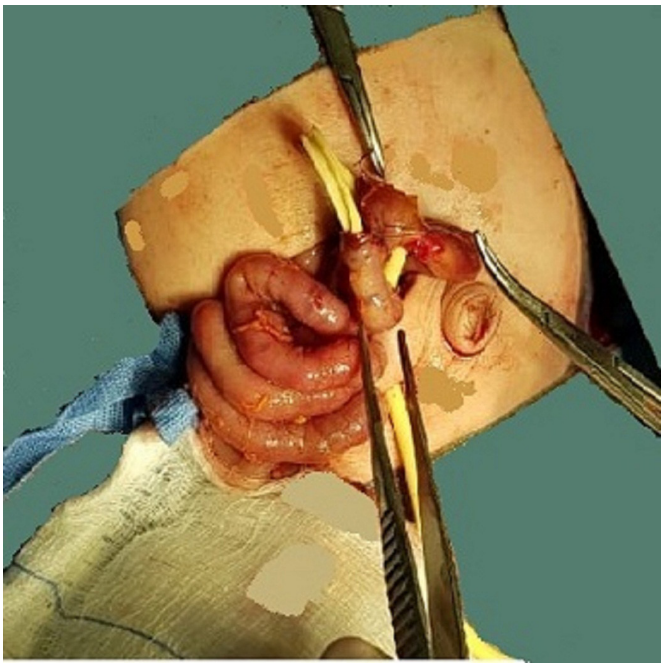

Figure 2 'T-tube' inserted into small bowel lumen prior to closing the anterior wall of the anastomosis.

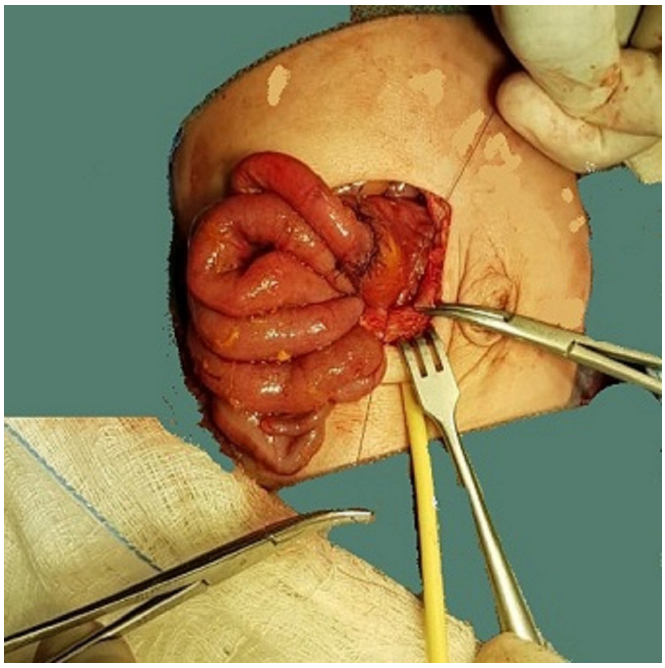

Figure 4 'T-tube' enterotomy site being sutured to abdominal wall from inside.

lumen lengthwise to form a semicircle shape. 'T-tube' sizes 12–16 Fr were used. Prior to closing the anterior layer of anastomosis, the short limb and vertical part were inserted proximally where the vertical limb was retrieved through an enterotomy made 5 cm proximal to the anastomosis and brought out through a separate stab incision in the abdominal wall. This left the short arm of the horizontal part of the tube sliding in the proximal bowel lumen and the longer limb of the horizontal part placed as a transanastomotic stent in the distal bowel (figures 2 and 3). A purse-string suture was made around the enterotomy site, and the bowel was attached to the abdominal wall internally (figure 4) with the same suture to facilitate external drainage in case of leakage. A peritoneal drain may or may not have been inserted, depending on the degree of soiling. The external limb of the 'T-tube' was shortened and was left open for intestinal decompression; then the tube was gently flushed once daily with 2 ml normal saline to prevent obstruction. A 'T-tube' contrast study may or may not have been done before removal of the 'T-tube'. A peritoneal drain was removed usually within 3–5 days depending on drain output.

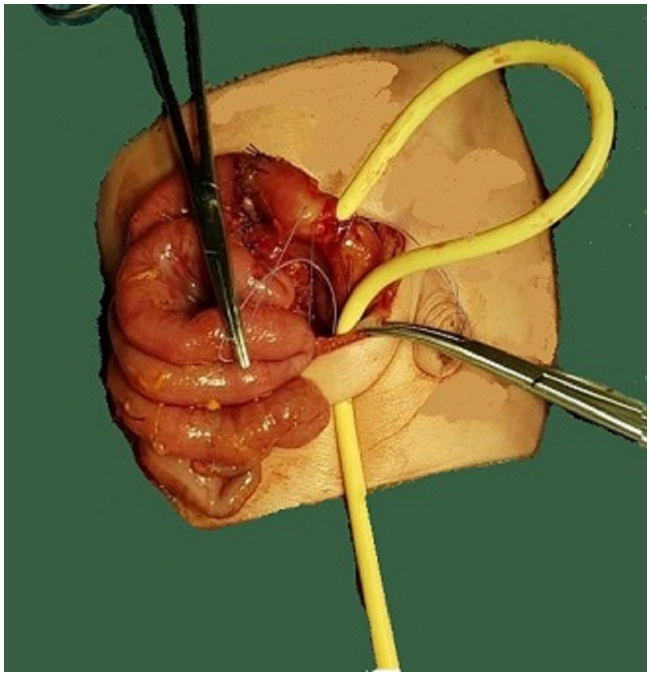

Figure 3 Vertical part of 'T-tube' retrieved through enterotomy and brought out through abdominal wall.

Fourteen neonates underwent laparotomy for different reasons and had 'T-tube' placement during surgery. The different etiologies were NEC with bowel perforation (n=8), SIP (n=1), jejunal atresia (n=3), ileal stenosis with perforation (n=1), and meconium cyst (secondary to antenatal bowel perforation) (n=1).

In all cases the 'T-tube' was placed in the small intestine. The output from the 'T-tube' was minimal and mostly contained gases. The tube was gently flushed daily with 2 ml of normal saline to keep it patent. Median gestational age of patients was 32 weeks [interquartile range (IQR)=25.75–34.75]. Median weight of neonates was 1.43 kg (IQR=0.95–2.05). Median age at operation was 10 days (IQR=4–24.5). Nine (64.28%) were males and five (35.72%) were females. Median duration of 'T-tube' was 12 days (IQR=12–15).

Eight (57%) of the 14 patients underwent contrast study through the 'T-tube' (figure 5) before its removal to confirm patency and integrity of the distal intestine. The peritoneal drain, if left during surgery, was removed

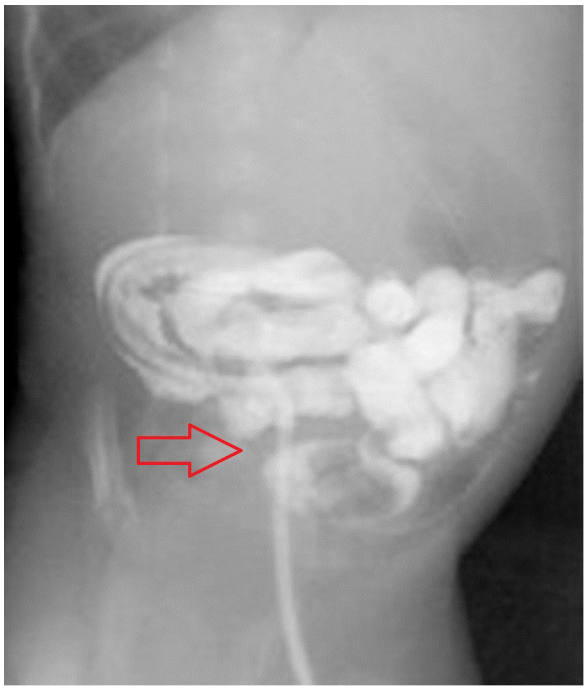

Figure 5 Postoperative contrast study via 'T-tube' indicated by arrow. Contrast study shows integrity and patency of intestine.

after 3–5 days. The 'T-tube' site usually closed spontaneously in 1–2 days. Feeding was started for almost all the patients within 1–2 days after removal of the 'T-tube'.

Three patients developed complications after the 'T-tube' placement. One patient developed pneumoperitoneum based on X-ray after 10 days postsurgery and had peritoneal drain placement. Bowel patency and integrity was confirmed with 'T-tube' contrast study (figure 5) after which the drain and 'T-tube' were removed. A second patient developed recurrent NEC and finally underwent laparotomy. The patient was found to have pneumatosis involving the whole colon with no ischemic changes, which suggested different pathology such as colitis. A diverting ileostomy was created, and the patient later underwent closure and was discharged home. A third patient developed enterocutaneous fistula after removal of the 'T-tube'. This baby was extremely premature with a weight of 720 g, and the tube was left in place for 16 days, which might have contributed to the development of the enterocutaneous fistula. Later the patient had surgical closure of the fistula, which was uneventful.

Three deaths occurred in the series. These deaths were not related to the 'T-tube' but were caused by other problems, such as sepsis, respiratory failure, and pneumothorax. The first patient died 2 months after surgery because of respiratory failure. This patient had been tolerating feeding until that time. The second patient also died after 1 month from surgery because of central line-related sepsis and had a 'T-tube' contrast study, which was unremarkable. The third patient died after developing a pneumothorax from percutaneous central line placement. This patient also had a 'T-tube' study done earlier and it was otherwise unremarkable. Table 1 shows the summary of characteristics of all neonates and their outcomes.

The 'T-tube' enterostomy was first used in Texas Children's Hospital in 1959 but reported later. Since the first report of 'T-tube' enterostomy by Harberg *et al* in 1981,[11] many reports described the use of 'T-tube' enterostomy in a variety of bowel problems.[12–14] Most of the initial reports were focusing on use of 'T-tube' in the management of

Table 1 Summary of characteristics of all neonates

No	GA (wk)	Sex	Weight (kg)	Diagnosis	'T-tube' days	Complication	Outcome
1	32	F	1.9	NEC	12	None	Discharged
2	30	M	1.5	NEC	12	None	Discharged
3	32	M	1.35	NEC	20	Pneumoperitoneum after 10 days postsurgery	Discharged
4	25	M	0.72	NEC	16	Enterocutaneous fistula	Discharged
5	32	M	1.9	NEC	11	Recurrent NEC	Discharged
6	24	F	0.68	NEC	12	None	Discharged
7	32	M	1.35	NEC	12	None	Discharged
8	25	M	1.17	NEC	15	None	Died
9	37	M	2.5	Jejunal atresia	12	None	Discharged
10	37	F	3	Jejunal atresia	13	None	Discharged
11	34	M	1.8	Jejunal atresia	15	None	Discharged
12	37	F	2.7	Meconium cyst	11	None	Discharged
13	26	M	0.78	Ileal stenosis with perforation	12	None	Died
14	28	F	1	SIP	12	None	Died

F, female; M, male;GA, gestational age; NEC, necrotizing enterocolitis; SIP, spontaneous intestinal perforation.

meconium ileus[11–13]; subsequent works described the use of this technique in various intestinal problems.[9 10 14]

In 2007, Rygl *et al*[10] showed the use of 'T-tube' enterostomy for intestinal perforations in five ELBW neonates with good survival and with no serious surgery-related complications.[10]

Survival following the use of this technique was reported to be 71% in NEC, 83% in SIP, and 100% in meconium ileus.[9] However, survival following resection and primary anastomosis in NEC has been reported to be 48%.[15] We did not have any patients with meconium ileus, probably owing to the rarity of this abnormality in our pediatric population. The survival rate for NEC in our small series of patients was 87.5%. The better survival rate was probably due to our selection of patients when using 'T-tube' in patients with NEC. Though all the patients were diagnosed with stage III B as per modified Bell's staging, it was segmental NEC with bowel perforation that might have contributed to a better survival in our cohort.

In 2015, Mohsen *et al*[16] reported the use of 'T-tube' in jejunal atresia with good results, comparable to our series. Our cohort also had three patients with jejunal atresia who had 'T-tube' and one of these patients even had multiple atresia with good outcome.

Almost all patients were started on feeds 1 day after the removal of the 'T-tube'. In some patients feeding was interrupted or held due to unrelated medical reasons. All infants that survived reached full feeds prior to being discharged home.

In conclusion, 'T-tube' enterostomy is an effective, safe and beneficial technique that provides an alternative to primary bowel anastomosis and stoma formation for treatment of selected cases of neonatal intestinal surgery.

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Contributors FNW contributed to conceptualisation, data curation, investigation, project administration and manuscript writing. AEA participated in conceptualisation, investigation, manuscript writing and editing. All authors read and approved the final manuscript.

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