INDICATIONS FOR BOWEL LENGTHENING/TAPERING PROCEDURE

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DEFINITION OF GUT FAILURE

Loss of nutritional autonomy due to absorptive, obstructive and motility disorders involving one or more of the abdominal visceral organs.

With the introduction of total parenteral nutrition (TPN) in the late 1960s the concept of gut rehabilitation was born, opening the way for visceral transplantation in the 1990s.
GUT FAILURE: THE CAUSES

• As fluid, nutrient and electrolyte absorption are directly related to the absorptive length of the small intestine, any reduction in the enterocyte cell mass will result in suboptimal absorption

Short bowel syndrome (SBS)

• approximately 100 cm or 60 cm (with functional colon) of intestinal tissue are required for PN independence
# GUT FAILURE: THE CAUSES

<table>
<thead>
<tr>
<th>Prenatal and neonatal</th>
<th>Childhood</th>
<th>Adult</th>
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</thead>
<tbody>
<tr>
<td>Short bowel syndrome</td>
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<tr>
<td>Gastrochisis</td>
<td>Volvulus</td>
<td>Ischemia</td>
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<tr>
<td>Atresia/s</td>
<td>Intussusception</td>
<td>Crohn’s disease</td>
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<tr>
<td>Apple peel syndrome</td>
<td>Trauma</td>
<td>Volvulus</td>
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<tr>
<td>Volvulus</td>
<td>Vascular abnormalities/thrombosis</td>
<td>Trauma</td>
</tr>
<tr>
<td>Long-segment Hirschsprung’s disease</td>
<td>Inflammatory bowel disease</td>
<td>Tumor</td>
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<tr>
<td>Necrotizing enterocolitis</td>
<td>Tumor</td>
<td>Tumor including desmoid, angioma</td>
</tr>
<tr>
<td>Vascular abnormalities/thrombosis</td>
<td>Neuromuscular disorders</td>
<td>Gardner’s/Familial polyposis</td>
</tr>
<tr>
<td>Congenital</td>
<td>Chronic intestinal pseudo-obstruction</td>
<td>Neuromuscular disorders</td>
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<tr>
<td>Congenital enterocyte abnormalities</td>
<td>Motility disorders</td>
<td>Chronic intestinal pseudo-obstruction</td>
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<tr>
<td>Neuromuscular disorders</td>
<td></td>
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GUT FAILURE: MANAGEMENT

Management of gut failure

Acute
- Intestinal stroke initiatives
  - Nutritional autonomy
    - Yes
    - No
      - Medical and surgical rehabilitation

Chronic
- Short bowel syndrome
- Functional, neoplastic and vascular disorders
  - Nutritional autonomy
    - Yes
    - No
      - Visceral transplant
EARLY STAGE INTERVENTIONS

- Resolution of Infectious Sources
- Relieve of Obstructions and Blind Loops
- Closure of fistulas
- Restoration of the Intestinal Continuity

In many cases these interventions could achieve definitive alimentary independence!!!
SECOND LOOK OPERATION
STRICTUROPLASTY

- Crohn's disease
- Previous small bowel resections
- Likelihood for subsequent surgery
Fig. 2. Surgical rehabilitation of intestinal failure. (A) Multiple enterocutaneous fistulae causing intestinal failure. (B) Multiple surgical resections. (C) Reestablishment of intestinal continuity. Full nutritional autonomy was achieved after 4 weeks.
INTERVENTIONS IN THE LATE STAGE

- Prevention of TPN related complications
- Enteral Autonomy
- Individualized approach
  - available bowel length
  - intestinal transit
  - extend of dilation
  - overall patient condition
  - presence of comorbidities (Portal hypertension)
- Specialized Intestinal Failure Center
- Autologous Gastrointestinal Reconstruction (AGIR)
- Referral for Transplantation
AUTOLOGOUS GASTROINTESTINAL RECONSTRUCTION (AGIR)

- Bowel adaptation (enterocyte and crypt cell proliferation, smooth muscle hyperplasia and hypertrophy, and an increase in microvilli along the epithelial surface) rapidly progresses during the initial 4 – 24 months following intestinal loss and allows for increased absorption of nutrients and weaning from parenteral nutrition in most patients.
Worldwide trends in visceral transplant case volumes. After the steady increase of overall case volumes over time, pediatric case volume has decreased since 2008.

SLOWING THE INTESTINAL TRANSIT

- Reversed Intestinal Segment
  Nicoldani 1887
- Antiperistaltic segments insertion
- As distal as possible
- 10 cm for adults, 3 cm for children
- Pigot et al. 1990, Panis et al. 1997

45% complete parenteral nutrition weaning
SLOWING THE INTESTINAL TRANSIT

- Isoperistaltic Colon Segment Interposition
- Intact colon and not dilated small bowel remnant
- Length: 8 – 24 cm
- Mid-portion of the remnant small bowel or more proximal
- Histological changes allowing improved motility and better fluid and electrolyte absorption
- Glick and De Lorimier 1984

65% wean off TPN and long term survival
SLOWING THE INTESTINAL TRANSIT

- Intussusception valve
- Previous ileo-colic anastomosis
- A partial obstruction (valve) mechanism is created to delay transit
SLOWING THE INTESTINAL TRANSIT
SOME CONSIDERATIONS

- Large volume diarrhea despite medical treatment and relatively long segments of intestine
- In the presence of end ileostomy w/o colon the reversed segment is the only option
- The nipple valve has been utilized as temporary measure to promote bowel dilation and sequent lengthening procedures

**RISKS**

- Obstruction
- Ischemia secondary to mesenteric rotation
- Enterocolitis
- Progressive intussusceptions, small bowel obstruction and bacterial overgrowth (valve)
LENGTHENING AND IMPROVING INTESTINAL MOTILITY

- Longitudinal Intestinal Lengthening and Taipering (LILT)
- Bianchi 1980
- Small bowel diameter at least 4 cm
- Length - 20 cm
  28-100% off PN
LENGTHENING AND IMPROVING INTESTINAL MOTILITY

- Iowa procedure
- Kimura and Sober 1993
- Two stages
  - enteropexy (abdominal wall or liver)
  - intestinal elongation (6 – 8 w)
- Preserved absorption
- Risk for devascularization

Limited experience
LENGTHENING AND IMPROVING INTESTINAL MOTILITY

- Serial Transverse Enteroplasty (STEP)
- Kim et al. 2003
- Small bowel diameter >5cm
- Any location
- Any small bowel length
- Could be repeated

STEP registry
Feasibility

<table>
<thead>
<tr>
<th></th>
<th>LILT</th>
<th>STEP</th>
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</thead>
<tbody>
<tr>
<td>Dissection of mesentery</td>
<td>Necessary</td>
<td>Not necessary</td>
</tr>
<tr>
<td>Risk of vascular compromises</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Total number of intestinal</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>anastomoses necessary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applicability on short and</td>
<td>Not feasible</td>
<td>Feasible</td>
</tr>
<tr>
<td>asymmetrical dilated intestinal</td>
<td></td>
<td></td>
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<tr>
<td>segments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applicability on duodenum</td>
<td>Not feasible</td>
<td>Feasible</td>
</tr>
<tr>
<td>Repetition of procedure on</td>
<td>Not feasible</td>
<td>Feasible</td>
</tr>
<tr>
<td>same redilated segment</td>
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AUTOLOGOUS GASTROINTESTINAL RECONSTRUCTION: LILT V/S STEP

- Surgical complication rates in %

<table>
<thead>
<tr>
<th></th>
<th>LILT</th>
<th>STEP</th>
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<tbody>
<tr>
<td>Bleeding</td>
<td>16.1 (0–71.4)</td>
<td>22.2 (7.1–33.3)</td>
</tr>
<tr>
<td>Obstruction/Stricture</td>
<td>17.7 (7.4–42.8)</td>
<td>17.5 (5.3–33.3)</td>
</tr>
<tr>
<td>Leakage</td>
<td>13.2 (4.1–22.2)</td>
<td>12.1 (5.3–16.7)</td>
</tr>
<tr>
<td>Abscess</td>
<td>6.6 (2.0–11.1)</td>
<td>2.6</td>
</tr>
<tr>
<td>Intestinal necrosis</td>
<td>10.6 (7.4–16.7)</td>
<td>n.r.</td>
</tr>
<tr>
<td>Intestinal perforation</td>
<td>10.1 (3.7–14.3)</td>
<td>n.r.</td>
</tr>
<tr>
<td>Fistula</td>
<td>7.4 (3.7–12.2)</td>
<td>n.r.</td>
</tr>
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</table>

*Comparison of LILT and STEP procedures in children with short bowel syndrome — A systematic review of the literature*


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**Department of General, Visceral and Transplantation Surgery, University of Heidelberg, Im Neuenheimer Feld 110, 69120 Heidelberg, Germany
### Outcome

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<th>STEP</th>
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<tbody>
<tr>
<td>Lengthening (fold)</td>
<td>1.48 (1.25–2.0)</td>
<td>1.63 (1.4–2.2)</td>
</tr>
<tr>
<td>Weaning from PN (% cases)</td>
<td>71.5 (4–100)</td>
<td>58.1 (20–100)</td>
</tr>
<tr>
<td>Time to weaning from PN (months)</td>
<td>10.3 (5–21)</td>
<td>9.4 (6–16)</td>
</tr>
<tr>
<td>Postoperative intestinal redilatation (% of cases)</td>
<td>39.0 (8–100)</td>
<td>49.0 (30–67)</td>
</tr>
<tr>
<td>Subsequent SBTX (% cases)</td>
<td>26.0 (5–52)</td>
<td>16.1 (7.9–25)</td>
</tr>
<tr>
<td>Time to subsequent SBTX (months)</td>
<td>42.8 (33.7–60)</td>
<td>7.1 (4.5–12)</td>
</tr>
<tr>
<td>Mortality (% cases)</td>
<td>30.2 (14.3–66.7)</td>
<td>14.3 (0–21.4)</td>
</tr>
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LENGTHENING AND IMPROVING INTESTINAL MOTILITY

- Spiral Intestinal Lengthening and Tailoring (SILT)
- Csermi et al. 2011, 2013
- Preserves the blood supply (no need for mesenteric split)
- Minimal interference with motility (incisions parallel to the fibers)
- Safe and viable technique

Limited experience
GLP-2 ANALOGUE IN SBS

- approved in the USA (2012) and Europe as the first targeted treatment for adults SBS
- mucosa growth, gastric emptying inhibition, intestinal transit time, gastric acid secretion suppression, bone mineral density improvement, intestinal barrier function and intestinal blood flow increased
- As expected, length of remaining intestine, presence of colon and less volume of TPN are predictors of favorable outcome with teduglutide treatment, including reduction or discontinuation of TPN
ROLE OF AGIR SURGERY

- **Whom?**
  
  Failure to progress to alimentary independence on optimal medical therapy

- **When?**
  
  After maximal adaptation has occurred and prior to development of advanced liver damage

- **What?**
  
  - Without bowel dilation and sufficient length – Antiperistaltic segment interposition
  - Significant dilation and insufficient length – LILT or STEP

  Early referral for Transplantation!
IN CONCLUSION

• Improved understanding of the pathophysiology and surgical anatomy of visceral organ failure is essential for the proper management of these complex patients.
• No single AGIR technique offers a rapid or guaranteed cure for all cases of short bowel syndrome.
• Even if complete parenteral nutrition weaning is not achieved, AGIR can serve as a bridge to intestinal transplantation.

AGIR should be considered an integral part of the structured plan toward enteral autonomy rather than restricting its use as a rescue procedure.
REFERENCES


