Dietary management of intestinal failure

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Overview

- Effect of resection on absorption
- Evidence for dietary management of short bowel
- Oral nutritional supplements & enteral nutrition
- Practicalities of integrating diet with the intestinal failure treatment plan
- Patient education
Bowel resection

Nutritional consequences depend upon

- Site & extent of resection
- Integrity, function & adaptation of remaining bowel
Oesophagus

Stomach

Bile

Pancreatic enzymes

Jejunum

Ileum

Duodenum

Colon

Minerals

Fat

Vitamins

Protein

CHO

Fatty acids

Water & fat soluble vitamins

Amino acids and peptides

Mono & disaccharides

Bile salts

Vitamin B12

Water & sodium
Macronutrient absorption

<table>
<thead>
<tr>
<th>Study</th>
<th>Woolf (n=8)</th>
<th>Messing (n=10)</th>
<th>Crenn (n=39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jejunum (cm)</td>
<td>100-200</td>
<td>0-200</td>
<td>22-190</td>
</tr>
<tr>
<td>Colon (n)</td>
<td>3/8</td>
<td>9/10</td>
<td>34/39</td>
</tr>
<tr>
<td>% Absorption</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td>81 ± 5</td>
<td>61 ± 19</td>
<td>70 ± 17</td>
</tr>
<tr>
<td>Energy</td>
<td>62 ± 3</td>
<td>67 ± 12</td>
<td>68 ± 15</td>
</tr>
</tbody>
</table>

High energy 30-60kcal/kg/d = 2000 - 3000kcal/d
High protein 0.2-0.25gN₂/kg/d = 80 - 100g protein/d

Energy balance

Messing et al, Gastroenterology 1991:100:1502
Jejunostomy (& EC fistula)

Loss of Ileum & colon causes

- Fluid & electrolyte depletion
- Fast transit
- Malabsorption of macronutrients, vitamin B12 & bile acids, fat & fat soluble vitamins

Resulting in weight loss and malnutrition

>100cm jejunum = diet + supplements +/- fluid & electrolytes
<100cm jejunum = Parenteral nutrition + diet
Jejunostomy: oral fat absorption

High fat diet beneficial

Jejunostomy: fibre intake

- Limited evidence
- Studies with mixed patient populations
- Theoretical benefit
  - ↑ intestinal transit time
  - ↑ contact time with gut lumen
- Low fibre diet useful if strictures & adhesions

Low fibre diet recommended
## Jejunostomy: oral nutritional supplements

Polymeric, peptide or elemental?

<table>
<thead>
<tr>
<th></th>
<th>McIntyre (n=7)</th>
<th>Cosnes (n=6)</th>
<th>Pironi (n=8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jejunum (cm)</td>
<td>80-150</td>
<td>90-150</td>
<td>20-150</td>
</tr>
<tr>
<td>Route</td>
<td>Oral &amp; NG</td>
<td>NG</td>
<td>Oral</td>
</tr>
<tr>
<td>Intervention</td>
<td>Elemental vs polymeric</td>
<td>Peptide vs polymeric</td>
<td>Peptide vs polymeric</td>
</tr>
<tr>
<td>%Absorption</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fat</td>
<td>→</td>
<td>→</td>
<td>-</td>
</tr>
<tr>
<td>Protein</td>
<td>→</td>
<td>↑ Peptide</td>
<td>-</td>
</tr>
<tr>
<td>Energy</td>
<td>→</td>
<td>→</td>
<td>↑ Polymeric</td>
</tr>
</tbody>
</table>

Ideal ONS: jejunostomy

Minimise jejunal losses of water & Na
↑energy, ↓volume & ↓osmolality

1st line nutritionally complete
• Polymeric 1.5kcal/ml, fibre free (Rodrigues et al 1989 APT 3:159)

1st line modular (low volume)
• Calogen Extra (LCT)
• Procal Shot (LCT & MCT)
• Fresubin 5kcal Shot (LCT & MCT)
• Prosource liquid (10g protein, 100kcal in 30ml)
## Recommended diet

**Jejunostomy/EC fistula**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Per kg/day</th>
<th>% from diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>30-60 kcal/kg/d</td>
<td></td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.2-0.25g/kg/d</td>
<td>20-30%</td>
</tr>
<tr>
<td>Fat</td>
<td></td>
<td>30-40%</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td></td>
<td>40-50%</td>
</tr>
<tr>
<td>Fibre</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Salt</td>
<td></td>
<td>Added</td>
</tr>
<tr>
<td>ONS</td>
<td>Polymeric 1.5 kcal/ml fibre free</td>
<td></td>
</tr>
</tbody>
</table>
Jejuno-colic anastomosis (JCA)

Loss of terminal Ileum causes malabsorption of
- Vitamin $B_{12}$ & bile acids
- Fat soluble vitamins
- Calcium & magnesium

Presence of colon allows
- Water & sodium absorption
- Slower intestinal transit
- Nutrient absorption
- Salvage of energy from short chain fatty acids by microflora

$>100$ cm jejunum + colon = diet +/- supplements
$50-100$ cm jejunum + colon = diet + supplements
$<50$ cm jejunum + colon = PN
SCFA absorption by the colon

Digestive and absorptive processes in the colon

Indigestible, nondigested/nonabsorbed carbohydrates (fiber)

- Enzymes in colonic bacteria

  Short-chain fatty acids (acetate, propionate, butyrate)

- Efficiently absorbed in the colon
Jejunocolic anastomosis
Carbohydrate

14 patients (8 JCA; 6 Jejunostomy)
● Constant diet of 2500kcal, 20% protein
● Compared low fat (20%), high CHO (60%)
or high fat (60%), low CHO (20%)

JCA - Energy absorption ↑ from 49 to 69% with high CHO diet

● CHO colonic digestion can supply 1000 kcal/day

High CHO diet recommended
Jejunocolic anastomosis: carbohydrate

14 patients (8 JCA; 6 Jejunostomy)

- Constant diet of 2500kcal, 20% protein
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  or high fat (60%), low CHO (20%)

JCA: high CHO diet ↑energy absorption from 49 to 69%


- CHO colonic digestion can supply 1000 kcal/day

High CHO diet recommended
JCA: lactose intolerance?

- **Arrigioni et al Am J Clin Nutr 1994:60;926**
  - 17 patients
  - 11 JCA, 6 jejunostomy
  - Mean SB length 67cm

  Lactose absorption
  - 76% for yogurt
  - 50% for milk

- **Marteau et al Nutrition 1997:13;13**
  - 14 patients
  - 8 JCA, 6 jejunostomy
  - Mean SB length 67cm
  - Lactose free diet or 20g of lactose from milk/yogurt/cheese

  Lactose absorption
  - 61% JCA
  - 53% jejunostomy
  - No clinical signs of intolerance or difference in faecal weight

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No need to limit lactose
Jejuno-colic anastomosis: fat

Unabsorbed fats in the colon

- ↑ Diarrhoea
- ↑ Ca\(^{2+}\) & Mg\(^{2+}\) losses
- ↑ Oxalate absorption & risk of renal stones

Low fat diet (40g)

- ↓ Diarrhoea & ↓ oxalate absorption\(^1\)
- ↓ Losses of Ca & Mg\(^2\)

Medium chain triglycerides

- 10 JCA & 9 jejunostomy patients\(^3\)
- Isocaloric diet: 50% LCT or 25% LCT & 25% MCT
- MCT: ↑ Fat absorption from 23 to 58%
  - ↑ Energy absorption from 46 to 58%

Moderate fat with MCT based diet beneficial

Jejuno-colic anastomosis: fibre

<table>
<thead>
<tr>
<th><strong>Pectin</strong></th>
<th>Water soluble, non-cellulose fibre fermented by microflora to SCFA. Enhanced absorption in rodent studies</th>
</tr>
</thead>
</table>
| **Methods**     | 6 short bowel patients (SB length 50cm)  
                 | 4g of oral pectin tds for 2 weeks                                                                    |
| **Results**     | ↑ SCFA production & excretion (p=0.2)  
                 | No difference in absorption: fluid, energy, nitrogen, fat or CHO  
                 | No change in faecal volume  
                 | Non significant ↑ in gastric emptying & orocolonic transit |
| **Conclusion**  | Pectin ↑ SCFA production but no effect on intestinal absorption                                       |

Atia et al (2011) JPEN, 35:229
Renal stones

25% jejuno-colic patients develop symptomatic renal stones

Normal absorption

Bile acids → FFA → Ca → Oxalate
Jejunocolonic anastomosis

 Preferential binding of Ca\(^{2+}\) by unabsorbed fats releases oxalate for absorption resulting in increased colonic oxalate absorption

Prevention

☐ Avoid high oxalate
  - spinach, beetroot, rhubarb, peanuts, branflakes, nuts, chocolate, parsley & tea

☐ Fat in moderation

☐ Encourage calcium intake

☐ Avoid chronic dehydration

Ideal ONS: JCA

Minimise intestinal losses of water & Na
↑energy, ↓volume & ↓osmolality

1st line nutritionally complete
• MCT based i.e. Peptamen, Vital 1.5

1st line modular (low volume)
• Liquigen (MCT) & MCT oil
• MCT Duocal
• Procal Shot (LCT & MCT)
• Fresubin 5kcal Shot (LCT & MCT)
## Recommended diet: JCA

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</tr>
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<td>Nitrogen</td>
<td>0.2-0.25g/kg/d</td>
<td>20%</td>
</tr>
<tr>
<td>Fat</td>
<td></td>
<td>20% (MCT)</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td></td>
<td>60%</td>
</tr>
<tr>
<td>Fibre</td>
<td></td>
<td>Low - medium</td>
</tr>
<tr>
<td>Salt</td>
<td></td>
<td>Normal</td>
</tr>
<tr>
<td>Oxalate</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>ONS</td>
<td></td>
<td>MCT based</td>
</tr>
</tbody>
</table>
Micronutrients

- Vitamin & mineral deficiencies can develop
  - $B_{12}$ if >60cm terminal ileum resected
  - Mg & zinc if intestinal losses high

- Monitor for deficiencies & toxicities
  - Vitamin C, E & K were suboptimal when weaning off PN (Braga et al 2011 J.PEN, 35:493)

- If deficiency identified
  - Appropriate individual supplement
  - 1-2 x RDA from complete supplement
Vitamin D

All new patients transferred to IFU (n=84)
- Mean vitamin D: 41 ± 25 nmol/L (9-126 nmol/L)
- 11% deficient, 64% insufficient
- Not associated with age, gender or IF aetiology
- Lower in men (p=0.009)
- \( \uparrow \) vitamin D in patients receiving 300,000IU IM (p=0.001)

## Treatment Plan
### Maximise oral intake & hyperphagia

| Choose nutritious meals | • Include protein - meat, fish, cheese, eggs, milk, yogurt, pulses (if vegetarian)  
|                         | • Include carbohydrate - cereals, bread, rice, pasta, potato |
| Choose nutritious puddings | • Milk pudding, custard, trifle, yogurt, ice cream |
| Choose nutritious snacks | • Sandwiches, cereal, cakes, crisps, biscuits, chocolate, cheese & biscuits |
| Supplement meals with energy dense foods | • Butter, margarine, sugar, honey, cheese, milk powder, cream |
IF diet down under

Anzac biscuits

Lamingtons

Kangaroo Pie
Treatment plan: monitoring response

Outcome

- If adequate absorption achieved, withdraw PN & prepare patient for discharge

- If inadequate absorption achieved with diet & supplements, proceed to enteral nutrition
Enteral nutrition

- Supplementary enteral feeding
- Commence via NG tube to establish tolerance before inserting gastrostomy
- Slow process to establish efficacy
- Whole team (& patient) need to understand
Continuous enteral feeding

4 jejunostomy & 11 JCA (25 - 130cm SB)
Polymeric via NG v usual diet v polymeric + usual diet

- No difference in faecal volume
- ↑ energy, nitrogen & fat absorption in polymeric via NG + usual diet compared to usual diet (p<0.001)
- Total energy gain >1000kcal/day with polymeric via NG

Continuous administration is crucial for ↑ absorption

Ideal enteral formula: jejunostomy

↑ energy, ↓ volume & ↓ osmolality to increase absorption of macronutrients and minimise jejunal losses of water & sodium

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Products</th>
<th>Osmolality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard whole protein 1kcal/ml</td>
<td>Nutrison Standard, Osmolite, Fresubin Original</td>
<td>288 - 315</td>
</tr>
<tr>
<td>High energy whole protein 1.2-1.25kcal/ml</td>
<td>Nutrison Protein Plus, Osmolite Plus</td>
<td>355 – 360</td>
</tr>
<tr>
<td>High energy whole protein 1.5kcal/ml</td>
<td>Nutrison Energy, Osmolite 1.5, Fresubin Energy</td>
<td>430 – 614</td>
</tr>
</tbody>
</table>
Ideal enteral formula: JCA

↑energy, ↓volume, ↑ MCT & ↓osmolality to increase absorption of macronutrients, fluid & sodium

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Products</th>
<th>% MCT</th>
<th>Osmolality (mosmol/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polymeric 1kcal/ml</td>
<td>Nutrison MCT</td>
<td>61</td>
<td>315</td>
</tr>
<tr>
<td>Polymeric 1.5kcal/ml</td>
<td>Fresubin HP Energy</td>
<td>57</td>
<td>400</td>
</tr>
<tr>
<td>Semi elemental 1 kcal/ml</td>
<td>Peptamen</td>
<td>70</td>
<td>240</td>
</tr>
<tr>
<td>Semi elemental 1.3 kcal/ml</td>
<td>Survimed OPD</td>
<td>51</td>
<td>350</td>
</tr>
<tr>
<td></td>
<td>Nutrison Peptisorb</td>
<td>47</td>
<td>535</td>
</tr>
<tr>
<td>Semi elemental 1.5 kcal/ml</td>
<td>Peptamen HN</td>
<td>70</td>
<td>450</td>
</tr>
<tr>
<td></td>
<td>Perative</td>
<td>40</td>
<td>385</td>
</tr>
<tr>
<td>Semi elemental 1.5 kcal/ml</td>
<td>Peptamen AF</td>
<td>50</td>
<td>455</td>
</tr>
<tr>
<td></td>
<td>Vital 1.5</td>
<td>67</td>
<td>630</td>
</tr>
</tbody>
</table>
What about elemental?

- Not used as no benefit over polymeric
- May lead to ↑ intestinal losses
- High osmolality (502–725mosmol/kg)
- Low macronutrient & sodium content
- High volume needed to meet requirements

Levy (1988) BJS 75:549
Sodium

- Need additional sodium to reach optimum concentration of sodium in jejunal lumen
- Aim 100mmol sodium/1000ml of feed
- Add 30% sodium chloride solution (10ml = 50mmol)
- May allow patients to stop taking additional oral rehydration solution or can be used for flushing if unable to tolerate orally

Patients with IF were recruited in out patients

Baseline assessments:
- Knowledge
- Oral intake & intestinal output
- Nutritional status
- Quality of life

An information booklet was given and explained with guidance tailored to the individual depending on:
- Clinical & nutritional status
- Intestinal anatomy and current intake

Follow-up assessment was undertaken 3-6 months later

Results

- 48 patients completed the study
- Knowledge improved after receiving the booklet (p<0.001)
- Reductions in HPN achieved

<table>
<thead>
<tr>
<th>Variable</th>
<th>Before</th>
<th>After</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td>Oral energy (kcal)</td>
<td>43</td>
<td>2129 ± 895</td>
<td>2341 ± 983</td>
</tr>
<tr>
<td>HPN energy (kcal)</td>
<td>33</td>
<td>1045 ± 391</td>
<td>948 ± 460</td>
</tr>
<tr>
<td>HPN volume (ml)</td>
<td>33</td>
<td>2311 ± 880</td>
<td>2198 ± 950</td>
</tr>
<tr>
<td>HPN frequency (days)</td>
<td>33</td>
<td>6.3 ± 1.3</td>
<td>5.9 ± 1.5</td>
</tr>
<tr>
<td>HPN nitrogen (g)</td>
<td>33</td>
<td>9.4 (8, 11)</td>
<td>9 (7.9, 11)</td>
</tr>
</tbody>
</table>

Positive effect of education resulting in clinical benefits
Conclusion

- Aim of individualised dietary treatment is to optimise residual intestinal function
- Improvements in absorption due to hyperphagia should be encouraged to maintain nutritional status
- Composition of the diet is crucial and relates to intestinal anatomy
- Patient education is paramount to minimise dependence or achieve independence from parenteral fluid/nutrition