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Current Elective Surgical Treatment of Inflammatory Bowel Disease

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Abstract

The incidence of inflammatory bowel disease (IBD) is increasing world-wide and most patient will require some surgical treatment once in life. IBD surgical patients are a challenge to surgeons. Main goals of surgical treatment are (1) to preserve the small bowel integrity because many resections may lead the patient to a small bowel short syndrome and (2) restore normal function as they have absorption disturbances. IBD patients may present mal-nutrition status and/or immunosuppression at the time of surgery. Types of surgery range from a simple plasty in Crohn disease to a total procto-colectomy in Ulcerative Colitis. For Crohn disease most procedures avoid resection and use diseased segments to prevent disabsorption. Herein we describe the most currently used techniques to treat IBD patients, when to indicate surgery and how to prepare them to less outcomes. Patients with Crohn disease with high risk for short bowel syndrome and intestinal failure should be submitted to Strictureplasty otherwise, Bowel Resection is the favored surgical technique for the management of fibrostenotic. Bowel Resection is associated with lower recurrence rate and longer recurrence-free survival.

Keywords: inflammatory bowel disease, strictureplasty, bowel resection, Crohn's disease, ulcerative colitis, surgical outcomes

1. Introduction

1.1 Epidemiology

Many epidemiologic studies report an increase in incidence and prevalence of Crohn's disease [CD] and Ulcerative Colitis (UC) in a global proportion. It is more evident in countries that going through an industrialization process, e.g., Asia, South America and Middle East [1–3]. The incidence follows the country industrialization and people living in urban areas has a greater incidence of IBD [4, 5]. The global prevalence of IBD has increased from 79.5 to 84.3 per 100,000 persons in recent years. IBD has been considered a disease of high-income regions. The USA had the highest age-standardized prevalence rate globally; approximately a quarter of total global patients with IBD living there in 2017. The UK had the highest age-standardized prevalence in Europe. The prevalence of IBD range from 252 to 439 cases per 100 000 population in the USA and 373 per 100 000 population in UK [6].

1.2 Pathogenesis

The complete mechanism of pathogenesis of IBD still unclear. IBD has a complex immune-mediated inflammatory disease that affects primarily the digestive tube. Those individuals with a genetic predisposition when exposed to different environmental factors may initiate an inflammatory response that is influenced by gut microbiome (**Figure 1**) [7]. The process is characterized by chronic relapsing and remitting inflammation for life.

Many diet components were reported to be protective factors to IBD as fiber, short-chain fatty acids, wheat, gluten, zinc, vitamin D. On the other hand some kind of food may worsen the disease: FODMAPs, red meat, emulsifiers and sugar [8].

The interaction of diet components with the microbiome is not so simple: more fiber, less flares. Some patients complain worsening of symptoms with fibers consumption. One hypothesis is that altered microbiome may produce incomplete fermentation and then, originating pro-inflammatory byproducts as succinate [9].

The microbiome is the group of all organisms found in the whole gut and includes bacteria, fungi, viruses and protozoa. Most of them are found in the colon. Many studies showed that IBD patients have altered microbiome and pro-inflammatory bacteria. When you treat a patient with Crohn disease and make an ostomy avoid intestinal transit in affected bowel segment it result in decreased inflammation [10–13].

Another evidence of environmental factor is the impairment in Peroxisome proliferator-activated receptors- γ (PPAR γ) activity. Environmental pollutants can block the PPAR γ signaling pathway while mesalazine enhances its expression [14].

The Hippo pathway is an evolutionarily conserved pathway that controls organ size and homoeostasis through modulating cell proliferation, survival, apoptosis, and stemness. Hippo pathway is involved in the IBD pathogenesis, including intestinal cell regeneration, gut microbiota, and angio- genesis of the intestines [15, 16].

Crohn disease (CD) and Ulcerative Colitis (UC) are grouped as inflammatory bowel diseases but each one has distinct clinical characteristics (**Table 1**). These differences have to be in mind when a bowel resection and anastomosis is done in a patient with Crohn disease.

Clinically CD may be classified into three phenotypes: inflammatory, penetrating (fistulizing) and stricturing [17]. During the diagnosis evaluation 10% may be

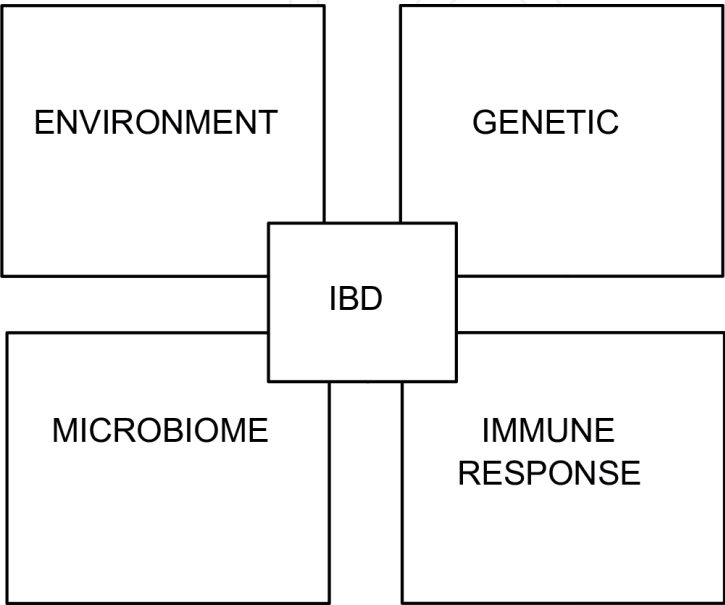


Figure 1.
Pathogenesis of IBD.

in the stricturing group and one decade later up to one third of patients may present stricturing **Figure 2** [18, 19].

The treatment of strictures may be done by endoscopy (endoscopic balloon dilatation, strictureplasty or surgical resection of bowel segment.

According to Cosnes et al. [18] the site of lesions is the most important factor to determine the disease behavior and progression to complication:

- Small bowel and anoperineal > stricture and penetrating complications;
- Esphagogastroduodenal and colon > inflammation.

In general, 75% of patients with strictures may require surgery once during life-time but it may range from 70–90%. Right timing in indication of surgery for CD

Differences	Crohn disease	Ulcerative colites
Histopathology	Full thickness inflammation of bowel wall	Compromise mucosa
Organs	All gastrointestinal segments; Generally ilium and colon; Non-continuous pattern.	Rectum and/or entire colon; Continuous pattern.
Complications	Abscesses, fistulas, strictures.	Bleeding, perforation, toxic megacolon.

Table 1.
Characteristics of n disease (CD) and Ulcerative Colites (UC).

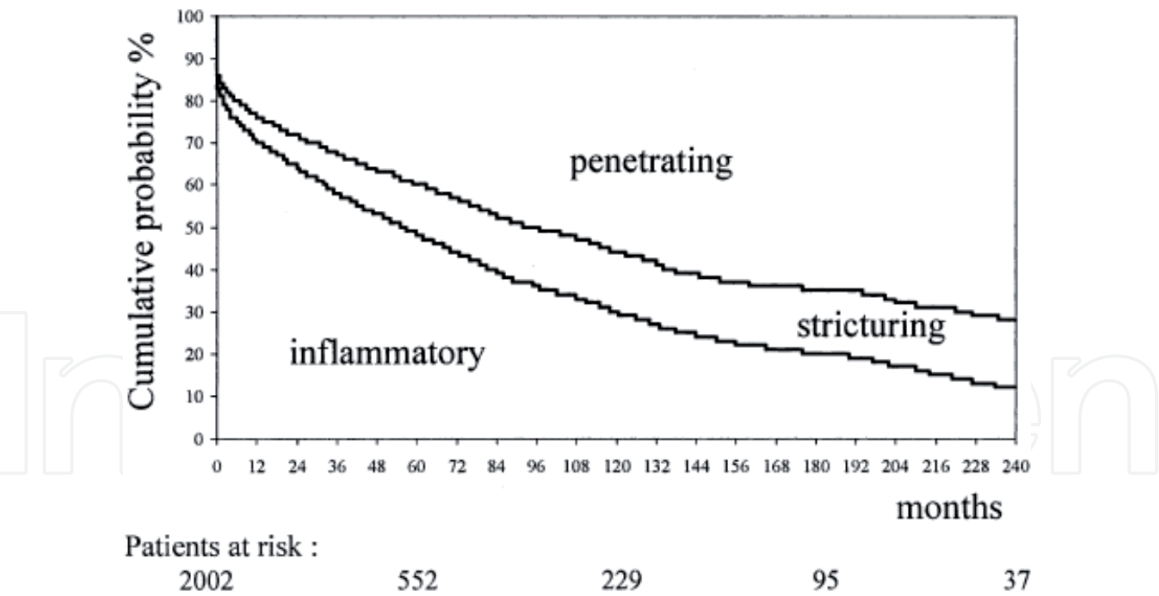


Figure 2.
Natural progression of Crohn disease. (From Jacques Cosnes et al. [18].)

- Refractory to medical therapy
- Fibrostenosing
- Growth retardation
- Fistulizing disease and related complications
- Neoplasia and dysplasia

Table 2.
Indications for surgery in CD.

may reduce complication rates, diminish operative technical difficulties and stoma indication, less emergency surgeries and also better mortality rates [18, 20, 21].

As CD does not have cure, surgery has a well-defined hole in therapeutic armamentarium. The aim of surgery is to treat complications, control symptoms, to try to preserve bowel length and keep to bowel function (**Table 2**).

2. Preoperative exams

2.1 Endoscopy and enteroscopy

Endoscopy may confirm the IBD diagnosis in most cases up to 90% of patients with Crohn disease or Ulcerative colitis. It allows a detailed examination of the mucosa of terminal ileum, colon and rectum. It is considered the gold standard exam for IBD diagnosis. Enteroscopy is indicated in patients with normal colonoscopy and gastroscopy but present suspicion of Crohn disease. Enteroscopy may be diagnostic or therapeutic with dilation of strictures areas (**Figure 3**) [22].

2.2 Enterography CT and MR

Both radiological methods CT or MR Enterography have been the best non-invasive exams to evaluate the small bowel in Crohn disease. Enterography may identify affected segments, disease activity and complications (abscess and fistula). Enterography may help to differentiate inflammatory or fibrotic areas of stenosis (**Figure 4–6**). Stricture is defined as a bowel segment with luminal narrowing and unequivocal upstream bowel dilation (**Table 3**) [23].

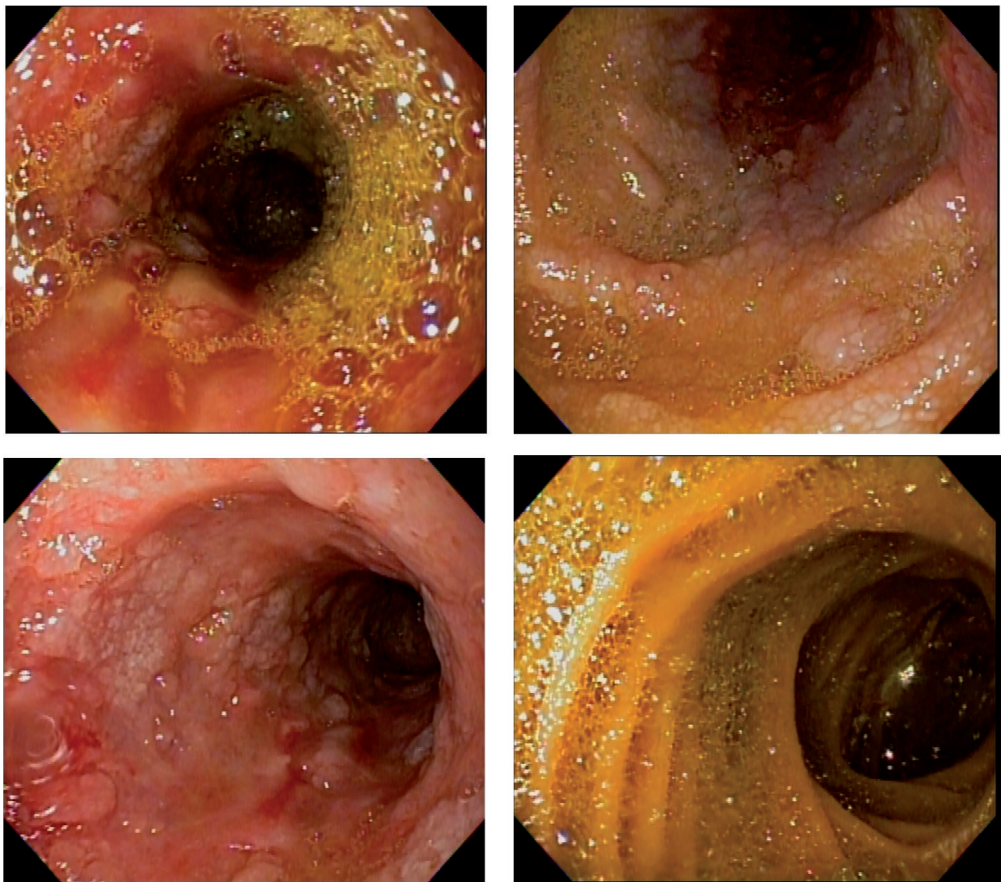


Figure 3.
Enteroscopy showing lesions in the jejunum and normal ileum.

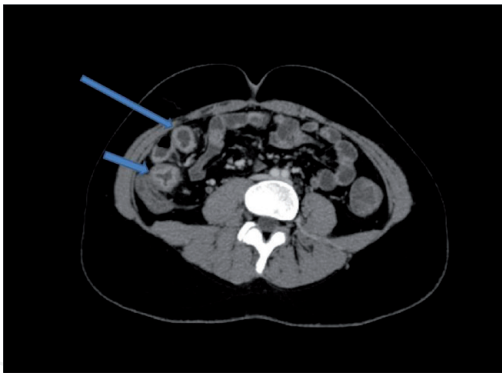


Figure 4.
Axial contrast- enhanced CT enterography: homogeneous mural hyperenhancement (long arrow) and stratified mural hyperenhancement (short arrow).

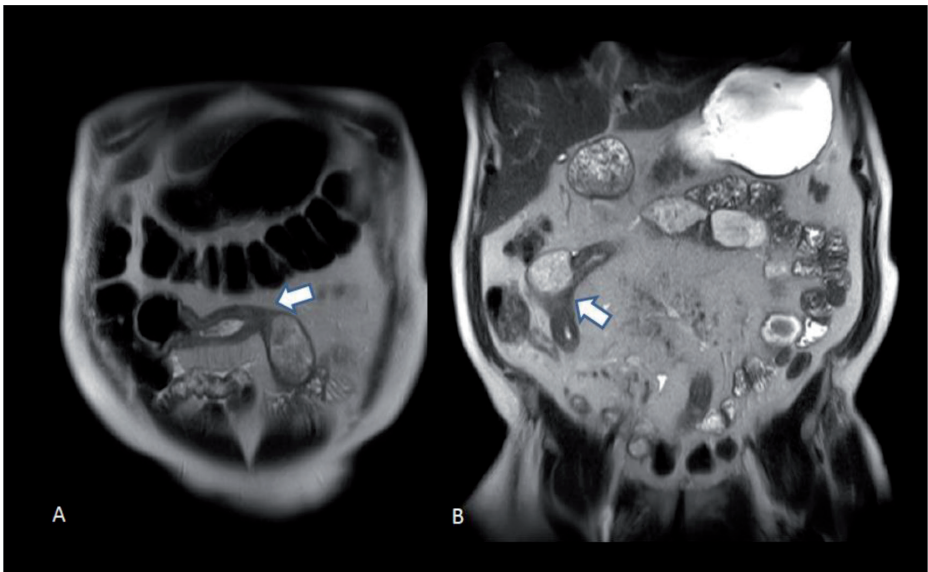


Figure 5.
A – Coronal T2 sequence MR enterography: homogeneous small bowel wall thickening and sacculations (arrow); B - Coronal T2 sequence MR enterography: small bowel wall thickening with stratified (bilaminar) mural hyperenhancement (arrow).

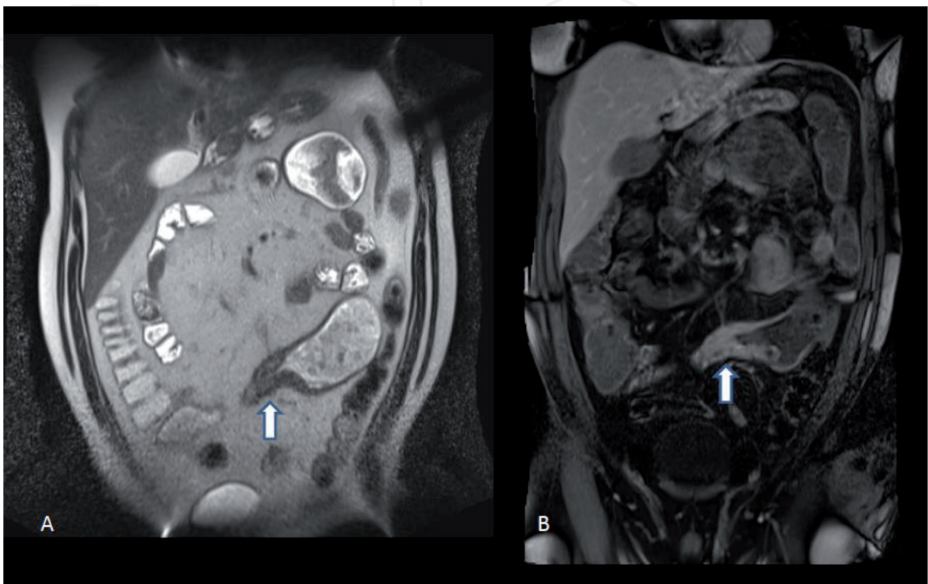


Figure 6.
A – Coronal T2 sequence MR enterography: homogeneous small bowel wall thickening (arrow); B - Coronal contrast-enhanced fat-suppressed T1-weighted MR enterography: small bowel wall thickening with stratified (bilaminar) mural hyperenhancement (arrow).

Segmental mural hyperenhancement
<ul style="list-style-type: none">• asymmemetric• stratified – bilaminar or trilaminar• homogeneous, symmetric
Wall thickening
<ul style="list-style-type: none">• mild – 3 -5 MM• moderate –>5–9 MM• severe - >10 mm
Stricture
<ul style="list-style-type: none">• probable stricture without upstream dilation (< 3 cm)• stricture with mild upstream dilation (3–4 cm)• stricture with moderate to severe upstream dilation (> 4 cm)

Table 3.
Radiological findings in CT or MR enterography in Crohn disease.

3. Crohn disease

3.1 Surgical options

3.1.1 Resection

The primary approach is to resect the small bowel stricture. Resection is associated to lower rates of recurrence. Patients submitted do strictureplasty alone may present a higher rate of disease recurrence [24]. The patient should have a small length stricture and no prior resection (**Table 4**).

Surgery may be done by laparotomy or laparoscopy with same good results and 2 cm margins of normal tissue is advised to make an anastomosis. Both anastomosis may be used: hand-sewn or stapled.

When a ileocolic resection is done the mesentery should be removed. When mesentery is left it is associated with higher recurrence rates and reoperations [25].

3.1.2 Bypass

Bypass surgery has been rarely employed due to the risk of neoplasia in the excluded segment [26, 27]. It may be an option to treat duodenal disease. There are two types of bypass: simples bypass and exclusion bypass [28]. Exclusion bypass

Crohn's disease is a panintestinal disease, with intermittent activity and the potential of focal exacerbations throughout the patient's life
It is impossible to cure Crohn's disease by excision. The surgeon is required only to treat the complications
The essence of surgical treatment is to make the operation as safeas possible. If the operation becomes safe and patients survive, they will inevitably have recurrences and so repeated operations may be required.
Therefore, it is important to conserve as much gut as possible All diseased bowels need not be excised, only that part with complications
If only stenotic complications are being treated, perhaps the stenosis can be simply widened by strictureplasty or dilatation

Table 4.
Five “Golden Rules” of surgical management of Crohn's disease.

is used when you cannot remove the affected segment because adhesences to the retroperitoneum (**Figure 7**).

3.1.3 Strictureplasty

Strictureplasty is indicated to prevent small bowel syndrome in those patients after repeated resections or extensive bowel resections. Strictures are identified by palpation of the small bowel or alternatively introducing a 20 mm ball into the

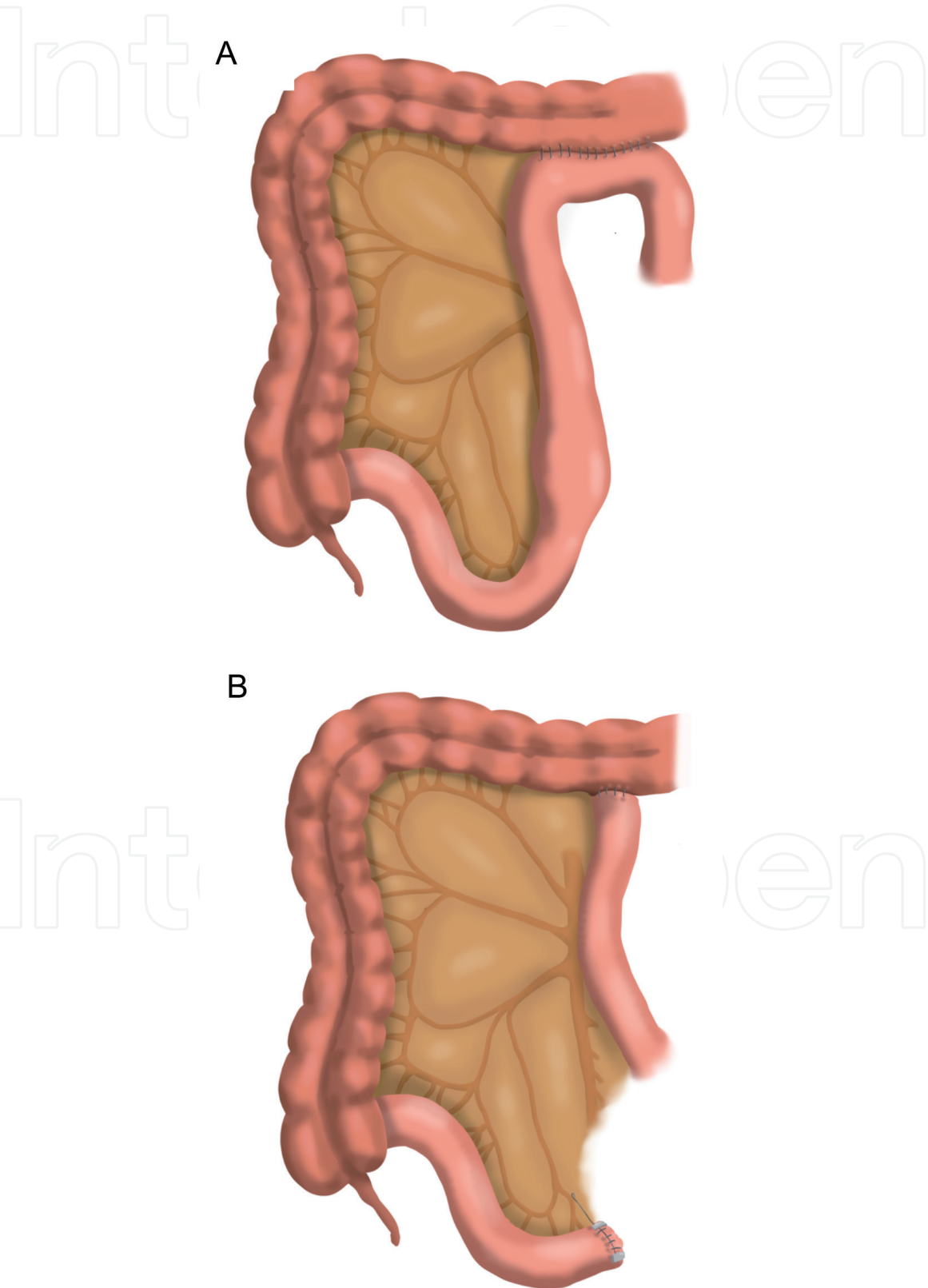


Figure 7.
Bypass surgery: simple bypass (A) and exclusion bypass (B).

Size of stricture	Techniques
Short-length (<10 cm)	Heineke-Mikulicz
	Moskel-Walske-Neumayer
	Judd
Medium-length (10–20 cm)	Finney
	Jaboulay
Long-length (>20 cm)	Michelassi
	Poggioli
	Sasaki
	Hotokezaka

Table 5.
Techniques of strictureplasty.

intestine and locating those points where the ball stops. The type of surgery is chosen according to the size of stricture (**Table 5**). The most used techniques are Heineke-Mikulicz 81%, Finney 10%, side-to-side isoperistaltic 5%, others 4%. The segments more affected are jejunum and/or ileum (94%), previous ileocolonic or ileorectal anastomosis (IRA) (4%), duodenum (1%), and colon (1%) [29, 30].

Strictureplasty should be used in those patients with concern for development of short bowel syndrome [31, 32].

- Diffuse involvement of the small bowel with multiple strictures.
- Non phlegmonous fibrotic stricture.
- Rapid recurrence of Crohn’s disease manifested as obstruction.
- Stricture(s) in a patient who had undergone previous major resection(s) of small bowel (>100 cm).
- Stricture in a patient with intestinal failure or short bowel syndrome.

Strictureplasty has some contraindications [29, 32]:

- Colonic strictures.
- Free or contained perforation of the small bowel.
- Hypoalbuminemia (<2.0 g/dL).
- Multiple strictures within a short segment.
- Phlegmonous inflammation involving the affected site.
- Stricture in close proximity to a site chosen for resection.

4. Short-lenght stricture

The technique of Heineke-Mikulicz (**Figure 8**) [33, 34] is the most used one and is similar to that used for pyloroplasty. A small incision over the stricture is extended

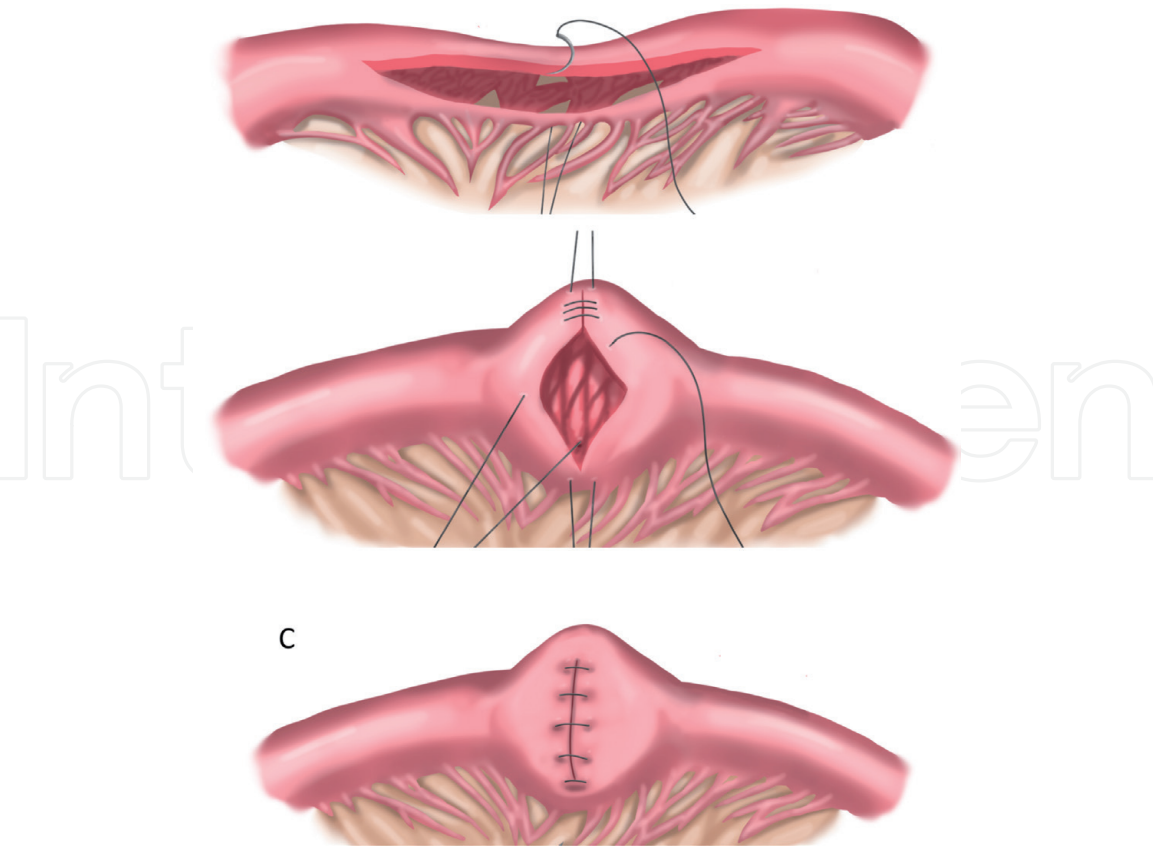


Figure 8.
The Heineke-Mikulicz technique. A - Longitudinal incision; B - transverse suture; C - final aspect.

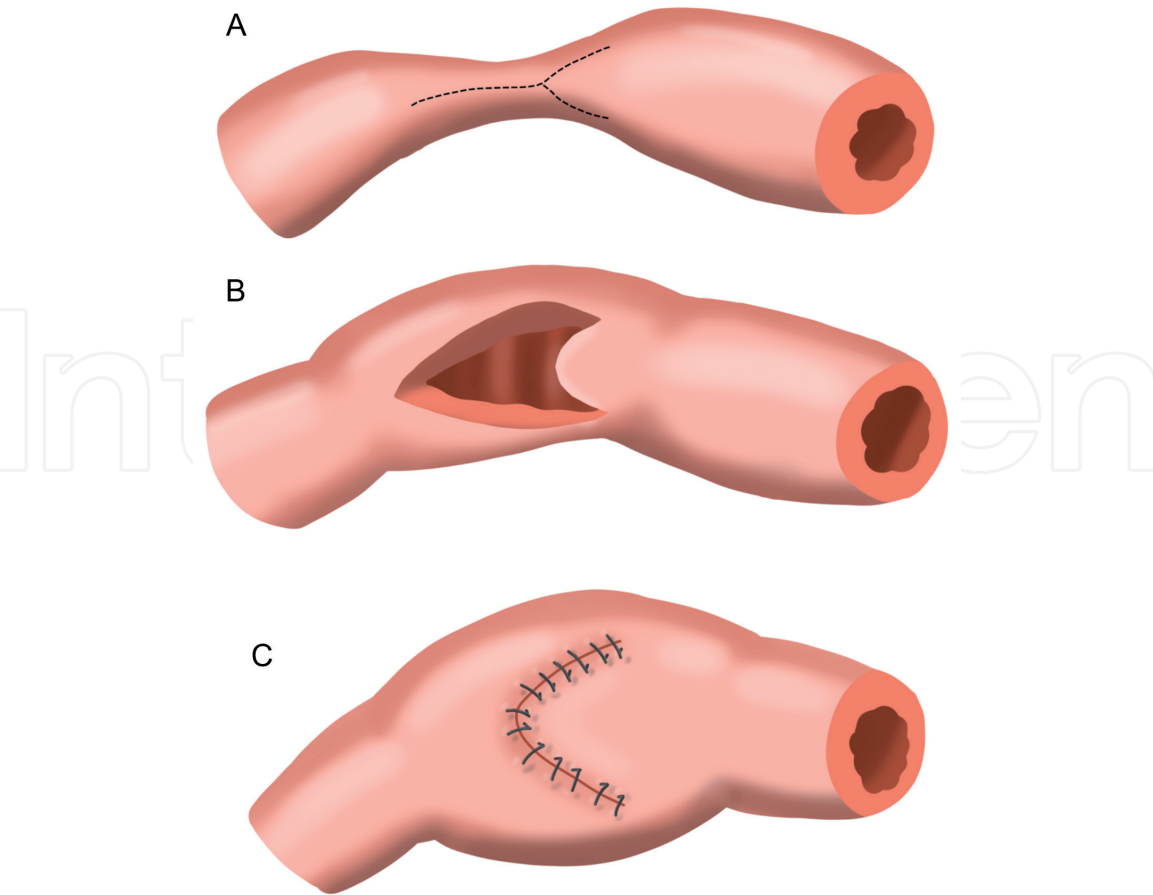


Figure 9.
The Moskel-Walske-Neumayer technique. A-Stenosis between segments with different diameters; B - It is made an Y shape incision; C - A free-tension suture is made.

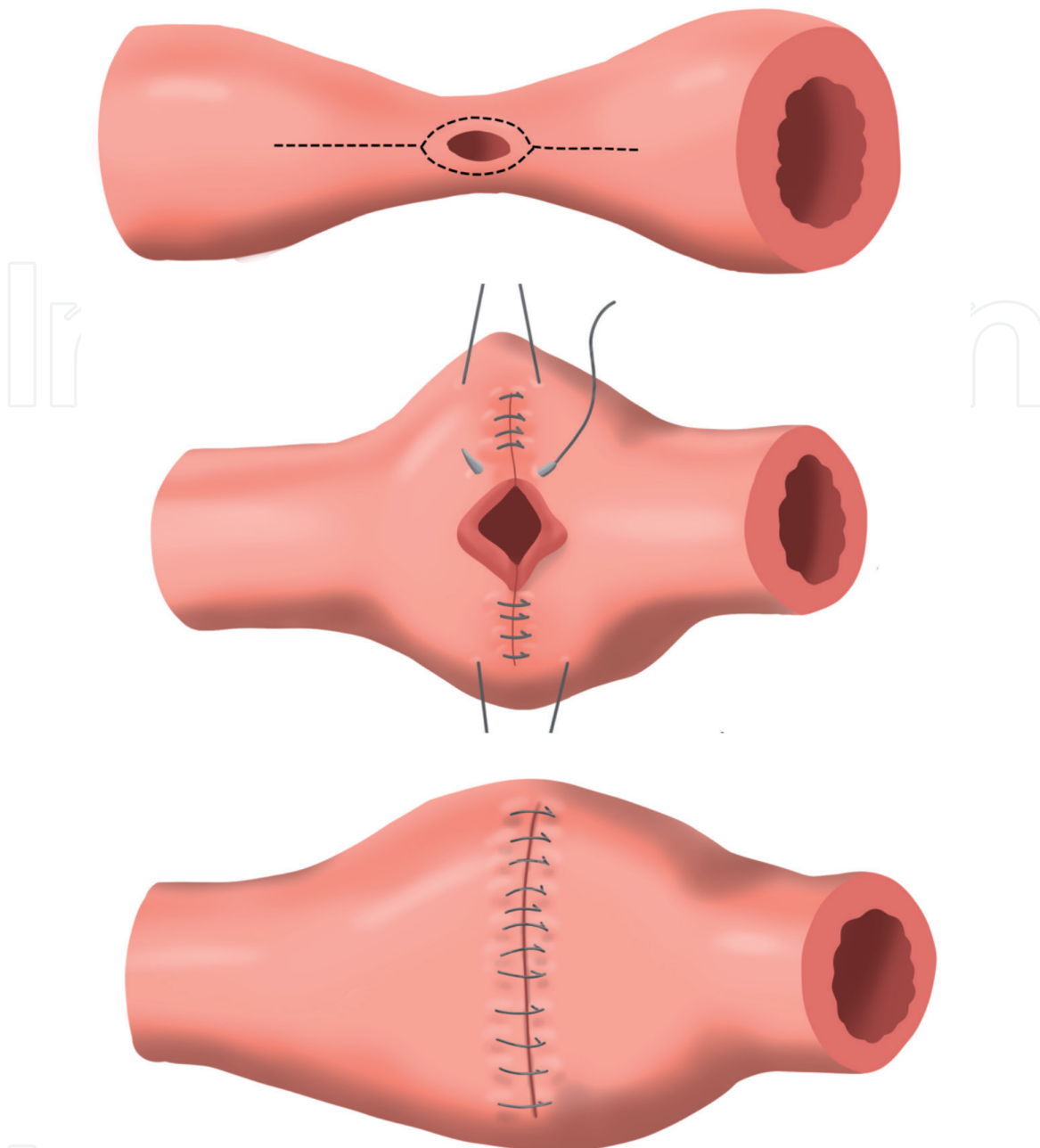


Figure 10.
The Judd technique. A- stenosis with fistula; B - the fistula is removed; C - end-to-end anastomosis.

to 2 cm in normal tissue. The incision is closed transversally: 1 or 2 layers with absorbable suture and continuous or separate stitch. The Moskel-Walske-Neumayer technique (**Figure 9**) is used when you have a great difference in the width of bowel to anastomosis. If you have a fistula in the stricture the Judd (**Figure 10**) technique is preferable to remove the fistula tract and repair the stenosis.

5. Medium-length stricture

The Jaboulay technique requires 2 incisions in normal segments avoiding the center of the stenosis (**Figure 11**).

The Finney technique (**Figure 11**) consist in one incision along the stenosis reaching up the normal tissue and then the bowel is folded in a U shape to be closed.

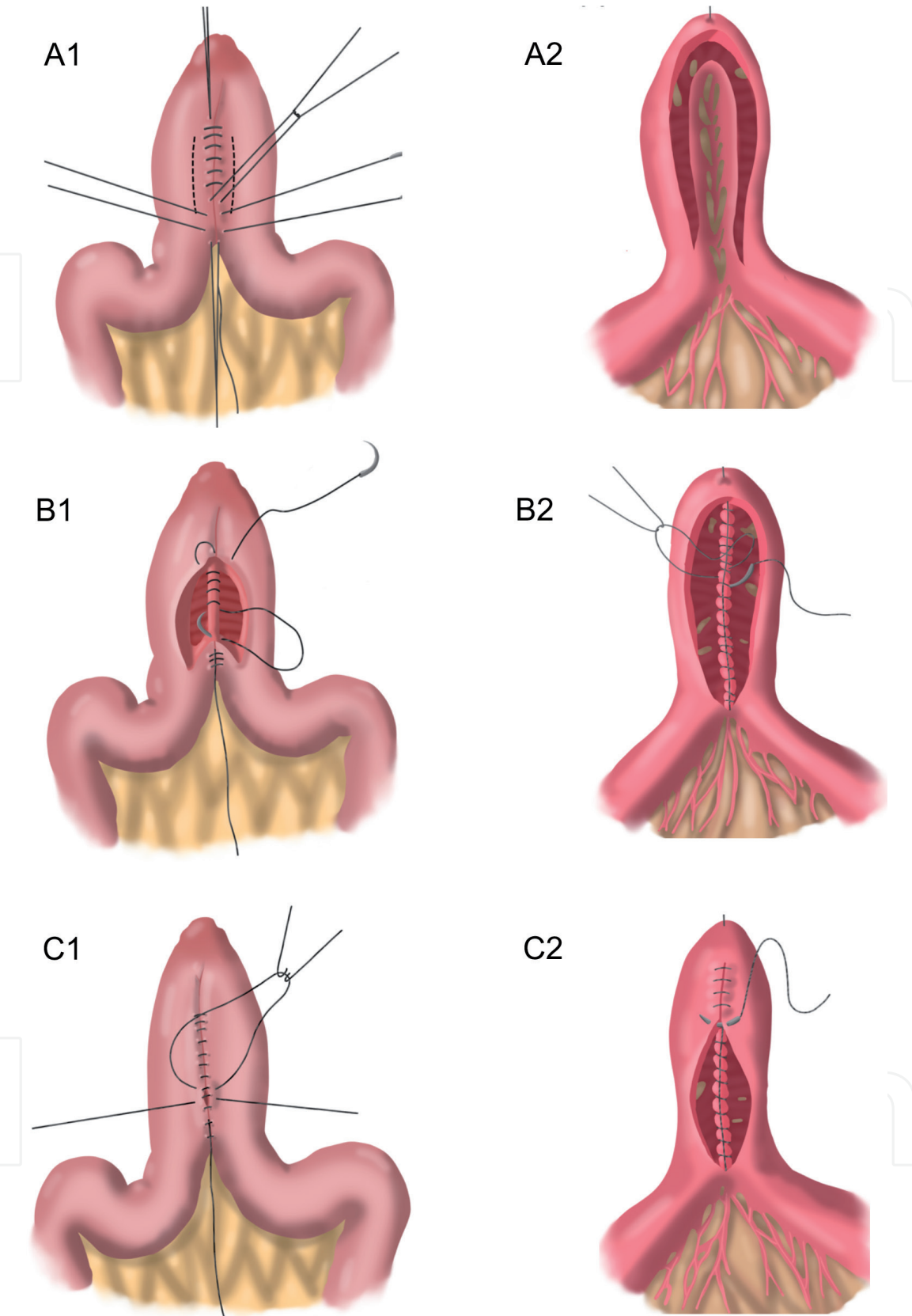


Figure 11.
The Jaboulay technique (1): two incisions in normal segments. A1 - the diseased segment is excluded from the incision; B1 - Posterior and C1 - anterior sutures are made. The Finney technique (2): A2- one incision including the diseased segment is made; B2 and C2 show the posterior and anterior sutures.

6. Long-length stricture

In the Michelassi technique [35] the stenotic segment is divided in the middle and a longitudinal incision is made in both segments. A restoring anastomosis is

made with the overlapping of both diseased segments (**Figure 12**). The Sasaki technique is a modification of Michelassi technique with the use of nonspatulated bowel ends to create an additional Heineke-Mikulicz strictureplasty on both ends (**Figure 12**) [36].

The Poggioli technique [37] is a modification of Michelassi technique and the difference is that we overlap a diseased segment with a non-diseased segment (**Figure 13**).

A combination of resection and enterostomy was described by Hotokezaka (**Figure 14**) [38]. The bowel segment with severe stenosis is removed. The remaining segment with stenosis is divide in the midpoint. A side-to-side antimesenteric

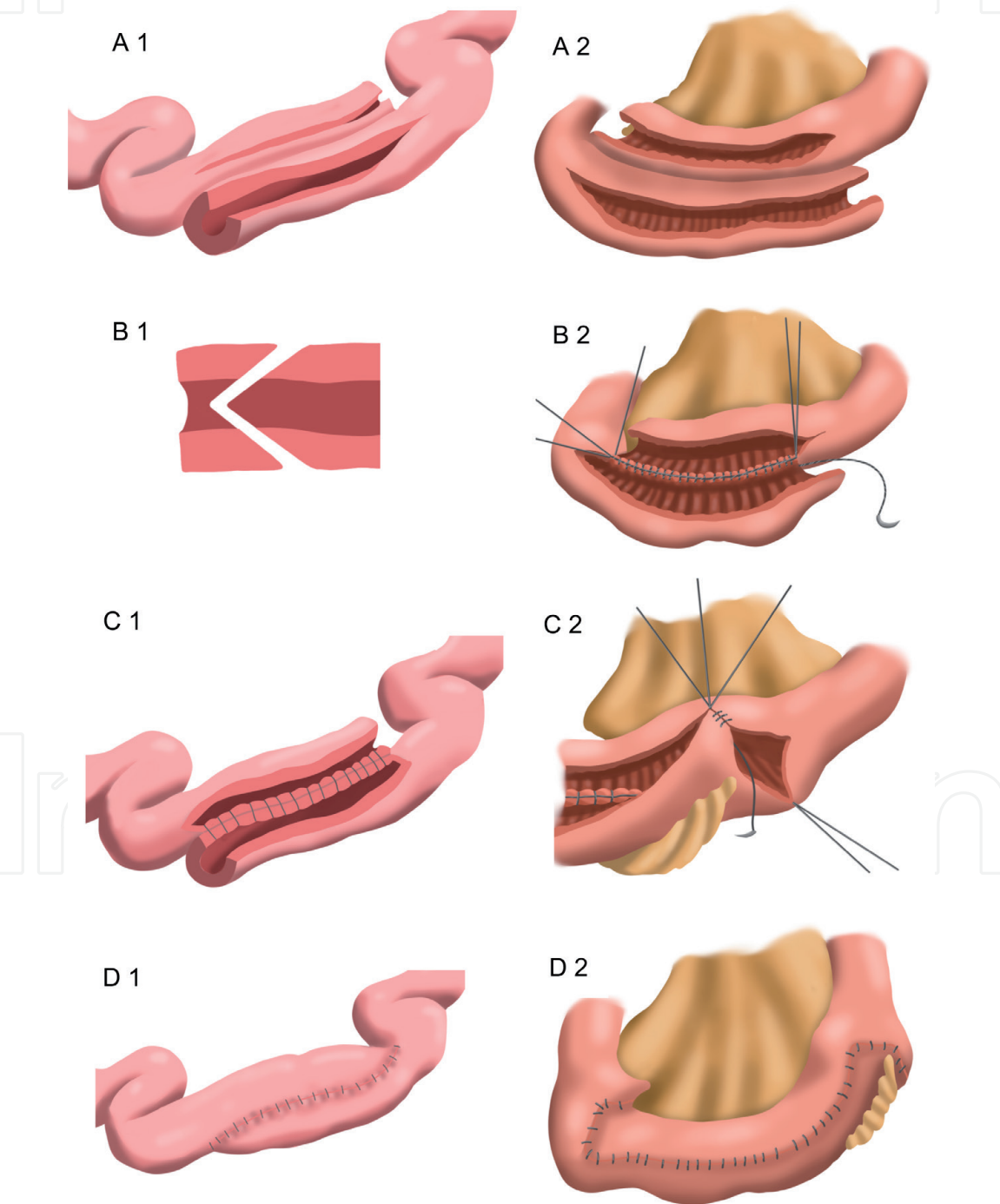


Figure 12.
The Michelassi technique (1): A1 - anastomosis of two stenotic segments B1 - the edges of bowel can be trimmed to allow better approximation; C1 - latero-lateral anastomosis; D1- final aspect. The variation is the Sasaki technique (2): A2 - anastomosis of two diseased segments; B2 - the edges of bowels are maintained; C2 - the end of the anastomosis is then transversely closed; D2 - final aspect.

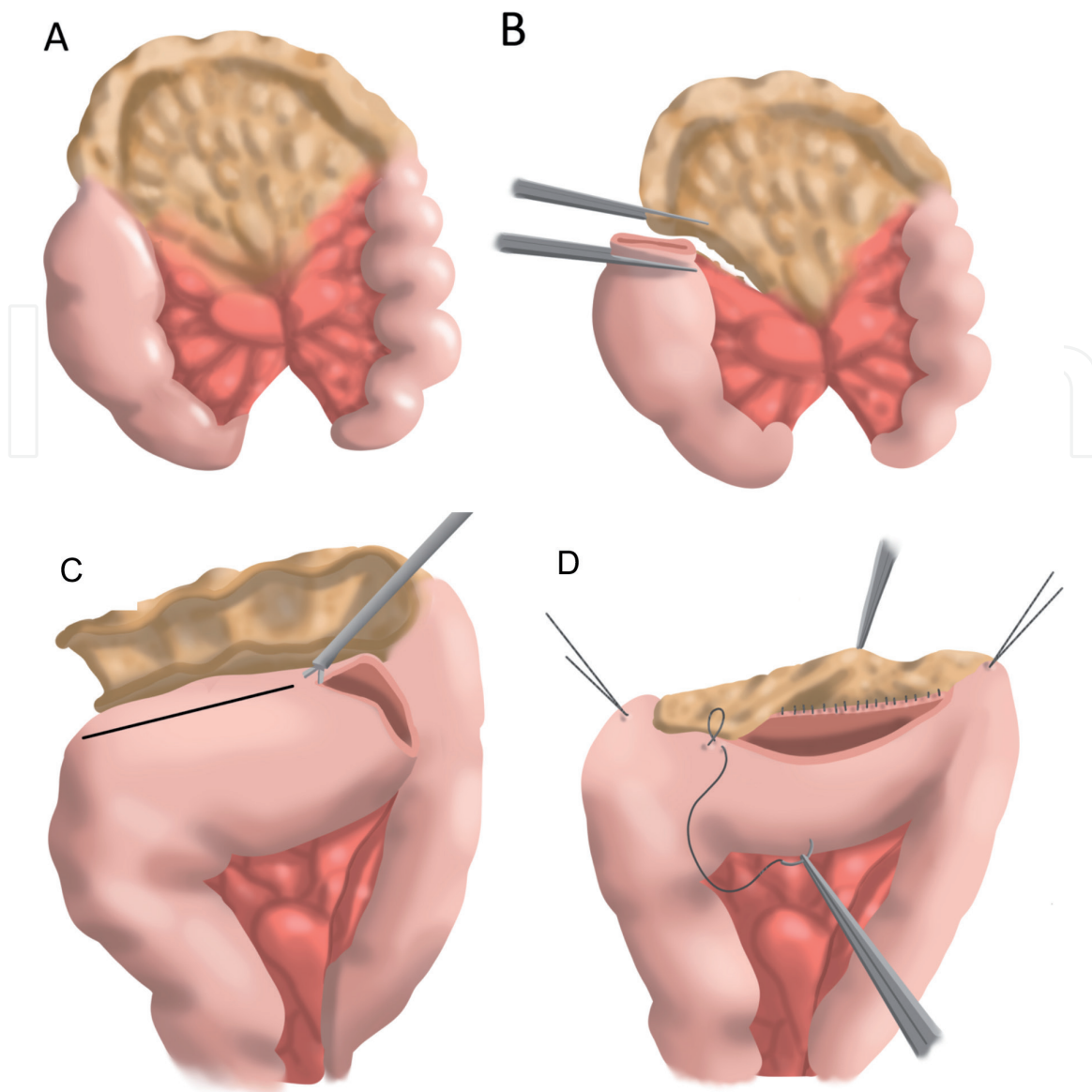


Figure 13.
The Poggioli technique. A - long diseased segment; B - the diseased segment is separated from normal segment; C - a longitudinal incision is made in both segments; D - lateral enterostomy with overlap of affected and normal segments.

enterostomy with the 2 bowel segments are made and them and end-to-end anastomosis are made between the strictureplasty and the resection site.

Results Strictureplasty vs. Resection.

The rate of complication for strictureplasty is about 4% to abscess, fistula and leakage [31]. Bowel resection is associated with lower recurrence rate (25.1%) compared to structureplasty (35.9%; $p = 0.04$). Recurrence-free survival was longer for bowel resection vs. strictureplasty ($p = 0.02$) [39, 40].

Surgical recurrence was higher for bowel resection (29.4%) vs. strictureplasty (39.7%; $p = 0.002$). No difference was observed for medical recurrence for bowel resection (12.4%) vs. strictureplasty (18.0%; $p = 0.82$) and also for overall morbidity between bowel resection (18.1%) vs. strictureplasty (10.7%; $p = 0.65$) [39, 40].

In fact, most cases a combination of techniques are used: resection for the severe lesion and plasty for the other. This approach seems to have the same rate of complications. This approach may decrease the risk of intestinal failure because patients may need future interventions and additional resection. Young age may be a risk for recurrent stricture. The 5-year reoperation rate for recurrent obstruction was 22%

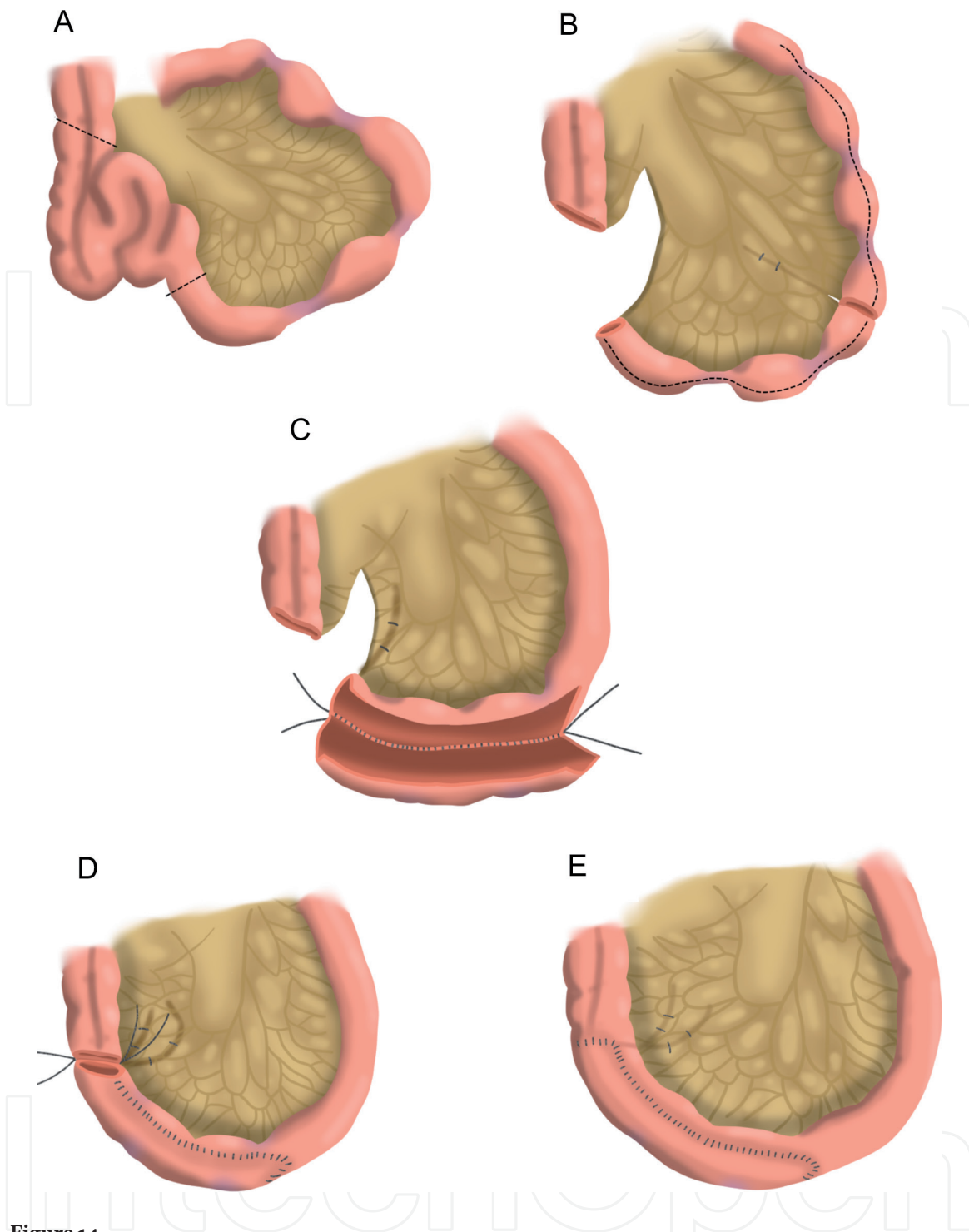


Figure 14. The Hotokezaka technique. A - cecum and terminal ileum are resected; B - a less affected segment is used to strictureplasty; C - Diseased segment is divided at the middle; D - side-to-side antimesenteric enterostomy with the 2 bowel segments is made; E - final aspect.

for resection alone, 30% for strictureplasty alone and 42% for strictureplasty and resection ($P = 0.038$) [39, 40].

7. Kono-S anastomosis

Kono et al. [41] reported a new technique of anchored anastomosis that could prevent recurrence. After resection of a severe stenosis with linear staple both ends are put together with suture and a Jaboulay like side-to-side anastomosis is performed (**Figure 15**) [42].

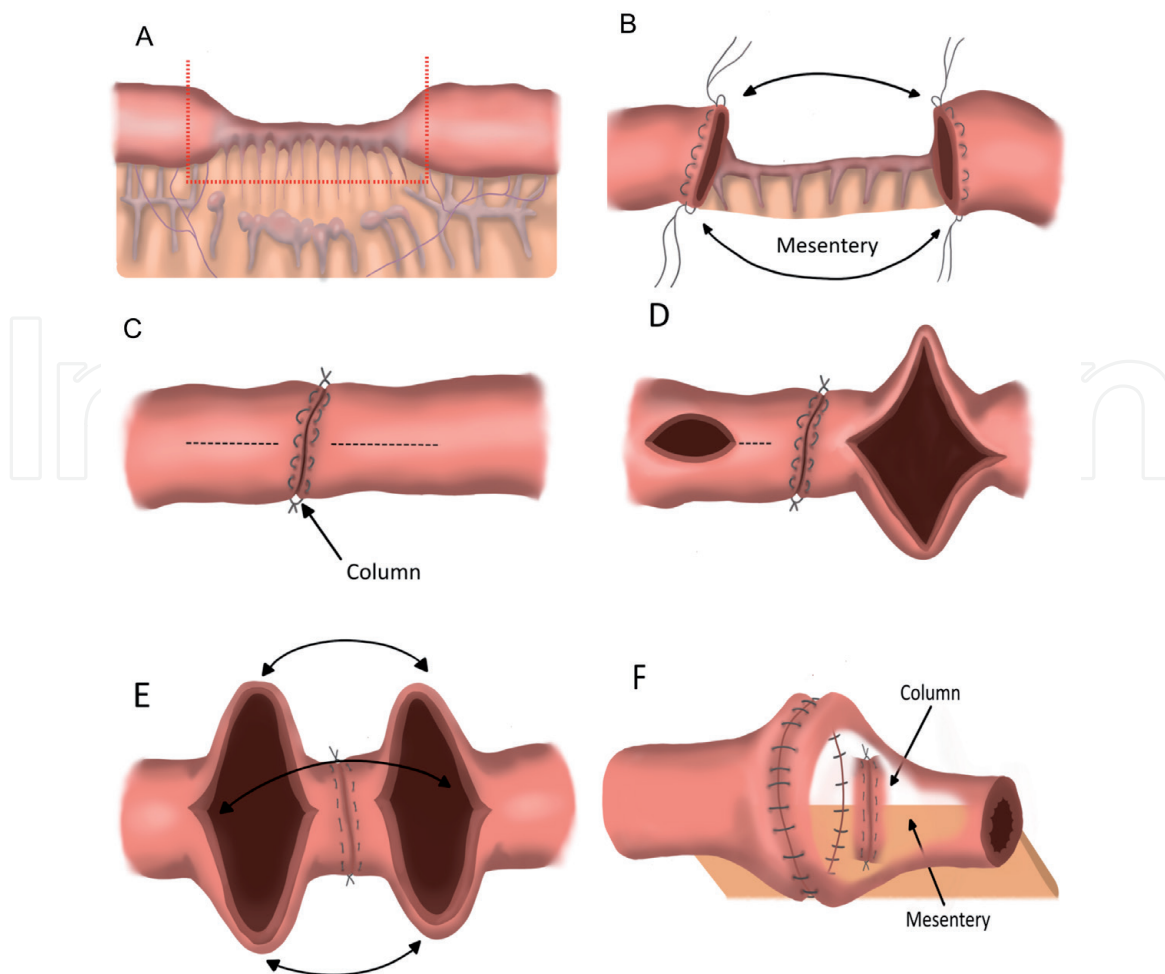


Figure 15.

Kono-S anastomosis: A - stenosis is removed; B - the ends of both segments are closed; C - both ends are put send-to-end; D - longitudinal incisions are made in both segments; E - the suture column beside the laterallateral anastomosis may sustain the lumen open and prevent stenosis; F - final aspect.

8. Fecal diversion

The use of fecal diversion is not common but in some clinical conditions may be indicated [31]:

- long-term and/or high-dose steroid use,
- recent use of biologics,
- malnutrition with hypoalbumenia (<2 g/dL).

9. Colonic disease

Colonic Crohn disease may be treated by segmental or total colectomy with ileo-rectal anastomosis. Total proctocolectomy with definitive ileostomy are indicated in those patients with severe perineal disease. Ileal pouch–anal anastomosis is less indicated due to pouch complications.

Strictureplasty should not be used in large bowel because the risk of malignization. Chronic inflammation is a risk factor for colon cancer and dysplasia is considered to be the precursor of most colorectal cancer in IBD patients [43].

10. Duodenal Crohn disease

Due to its anatomical characteristics duodenal stricture may require different therapeutic alternatives: endoscopic dilatation, bypass, resection or strictureplasty. The incidence of duodenal or upper gastrointestinal tract by Crohn disease varies according to age: adults 0.3 to 5%, adolescents 28% and 43% in pediatric patients with CD [44]. Patients with duodenal CD may present more aggressive evolution with high rates of recurrence and needs for surgical treatments [45].

Clinically patient complain: Epigastric pain, nausea, anorexia, early satiety, bloat and belching, weight, Less common symptoms are: anemia, diarrhea, feculent vominiting, hematemesis or melena [46].

Surgical treatment indication: outlet obstruction (83%), refractory pain (11%), and bleeding (5%) [47]. Surgical options are: resection, gastrojejunostomy, duodeno- jejunostomy, gastroduodenostomy and by-pass.

11. Ulcerative Colitis

Ulcerative colitis (UC) is a chronic inflammatory condition of the colon and rectum. Initial therapeutic approach is based in different classes of medicine: anti-inflammatory, immunosuppressant (aminosalicylates, corticosteroids, thiopurines) and biological treatment as anti-tumor necrosis factor (anti-TNF), anti-integrins, anti-jak and other. However, most patients have successful clinical control and good evolution approximately 20–30% of patients will require surgery during their life [48].

However, surgery is a curative treatment for UC, the decision about an elective surgery is preference-sensitive. Generally, the indications for surgery are: medically refractory disease, dysplasia and carcinoma.

The surgery basically is total proctocolectomy with anastomosis or end ileostomy. The proctocolectomy with anastomosis is the ileal pouch–anal anastomosis (IPAA).

Total abdominal colectomy with ileorectal anastomosis is not indicated to patients with UC. The reasons are: half of patients will have a worsen disease in the rectum that will need proctectomy and the risk of rectal cancer is 7–8% [49].

Proctocolectomy and ileal pouch–anal anastomosis (IPAA)

IPAA procedure may be done in stages:

- Three-stage operation: (1) total colectomy with end ileostomy and rectal stump, (2) proctectomy with IPAA and loop ileostomy, and (3) ileostomy closure;
- Two-stage operation: (1) total proctocolectomy with IPAA and loop ileostomy and (2) ileostomy closure;
- One-stage operation: total proctocolectomy with IPAA and no diversion.

There are different types of pouch and most surgeons favor the J pouch due to the simplicity to construct and good outcomes. The procedure may be done by laparotomy, laparoscopy, robotic or associated approaches.

12. Continent ileostomy or Kock pouch

It is indicated for those patients who does not meet the criteria for IPAA. It is contraindicated in obese patients. The patient has to be able to handle the ostomy and do self-intubation.

13. Conclusion

Surgery for bowel Crohn disease is not curative and procedures hat to be as less aggressive as possible. Surgery is indicated only in those cases with complication as obstruction and fistula. Resection approach is preferable to patients without risk to develop short bowel syndrome. Strictureplasty may be used to preserve bowel integrity. Different techniques are used depend upon the length of the stenosis. Bowel Resection is associated with lower recurrence rate and longer recurrence-free survival.

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Conflict of interest

The authors declare no conflict of interest.

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