Surgery for Constipation

A Review

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PURPOSE: Constipation is related to intestinal motility disorders (colonic inertia (CI)), pelvic floor disturbances (pelvic outlet obstruction), or a combination of both problems. This review summarizes the physiologic and pathophysiologic changes in patients with intractable constipation and gives an overview of surgical treatment options. RESULTS: Although subtotal colectomy with ileorectal anastomosis is the best surgery for CI, there are still approximately 10 percent of patients who will complain of pain and constipation. A completion proctectomy and an ileoanal pouch procedure may be a viable option in a highly select group of patients. In patients with megabowel, reported results are mixed. Subtotal colectomy, partial colectomy for megacolon, and the Duhamel procedure for megarectum have all been reported with variable results. In patients with an isolated distended sigmoid colon, sigmoid colectomy has achieved good results. Anorectal myectomy has not been proven to be successful in the long term. However, in patients with adult short segment Hirschsprung's disease, myectomy can be successful. Patients with pelvic outlet obstruction can be successfully treated with biofeedback. In a small group of patients with a rectocele or a third degree sigmoidocele, surgical intervention yields a high success rate. Division or resection of the puborectalis muscle is not recommended. In patients with a mixed pattern of CI and pelvic outlet obstruction, surgical intervention alone is often not successful. These patients achieve better results by conservative treatment of pelvic outlet obstruction, followed by a colectomy. CONCLUSION: Surgical intervention for patients with intractable constipation is rarely necessary. However, thorough preoperative physiologic testing is mandatory for a successful outcome. [Key words: Constipation; Colonic inertia; Pelvic outlet obstruction; Anorectal physiology; Megabowel; Megarectum; Paradoxical puborectalis contraction; Colorectal surgery]

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HISTORY

Almost 90 years have elapsed since Sir Arbuthnot Lane[1] published the results of the first series of abdominal procedures for treatment of chronic intractable constipation. He surmised that "autointoxication" caused by chronic constipation was responsible for a large number of problems in the population of London. Dilation of the stomach, peptic ulcerations, mobility of the kidney, and degenerative changes of the breasts were all attributed to chronic constipation. Considering the 30-day mortality rate of 21 percent for a "benign disease," his advocacy of colectomy for constipation was an issue of controversy among surgeons; this controversy still exists today.

In 1911, Chapple[2] published a series of 50 patients, 44 women and 6 men, with intractable constipation. This series included some of Sir Arbuthnot Lane's patients. Operations performed included colectomy with ileosigmoid anastomosis in 3 patients, colectomy with ileorectal anastomosis in 10 patients, colonic bypass operations with ileorectal anastomosis in 10 patients, ileosigmoid anastomosis in 3 patients, colonic bypass operations without specified anastomosis in 17 patients, and colectomy without specified anastomosis in 7 patients. Seven patients who had a previous bypass operation underwent subsequent colectomy. Postoperatively, 14 percent required occasional enemas or cathartics. One patient experienced a fecal fistula, four patients had small bowel obstruction, and two patients had multiple episodes of obstruction, both of whom required adhesiolysis. However, despite the high complication and morbidity rate, no deaths were reported in this series.

In the last three decades, the pathophysiology of constipation has become more understood through the use of physiologic studies. Thus, it has become evident that there is indeed a small group of patients who can benefit from surgery. This review article evaluates indications and results of surgery in adult patients with severe intractable constipation.

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INTRODUCTION

Constipation is one of the most frequently experienced gastrointestinal complaints and one of the most frequent indications for medical consultation.[3] Constipation is basically related to intestinal motility disorders, pelvic floor disturbances, or a combination of both. Its exact origin, however, is still unknown.

DEFINITION

The definition of constipation includes both subjective and objective aspects. Furthermore, physicians and patients have different opinions regarding the definition of constipation. Although most physicians consider two or less bowel movements per week as constipation,[4] most patients include subjective findings such as incomplete or difficult evacuation, abdominal or rectal pain, firm stool consistency, straining for evacuation, nausea, bloating, and tenesmus. Thus, even a patient with daily defecation may be constipated and requires investigation.[5] This finding has been confirmed in a study by the National Health and Nutrition Examination Survey, in which 9 percent of patients with daily bowel movements reported that they were constipated.[6] Therefore, "in practice . . . constipation presents as a problem when the patient feels the situation to be unsatisfactory."[5]

In a recent international workshop on constipation, Whitehead *et al.*[7] suggested that the definition of constipation is as follows. Two or more of the following complaints present in a patient who has not used laxatives for at least 12 months: 1) straining during more than 25 percent of bowel movements; 2) feeling of incomplete evacuation after more than 25 percent of bowel movements; 3) hard or pellet-like stools on more than 25 percent of bowel movements; 4) stools less frequent than two per week with or without other symptoms of constipation.

Drossman *et al.*[8] proposed a simpler but equally acceptable definition, "Two or fewer stools per week and/or straining at stool more than 25 percent of the time." A scoring system for constipation has recently been proposed that may assist in a more accurate comparison of indications and results of candidates for surgery for constipation (Agachan F, Wexner SD, personal communication). The epidemiology including socioeconomic factors and normal bowel habits has been discussed in detail elsewhere.[9–23]

NORMAL MOTILITY

The most frequently used techniques in studying the passage of colonic content are radiopaque marker studies.[24, 25] Twenty or 24 radiopaque rings are ingested, and, on days 3, 5, and 7, plain abdominal x-rays are performed. For calculation, the colon is divided into three segments (right, left, and rectosigmoid) by an inverted "Y" drawn down from the posterior spinosous processes to the fifth lumbar vertebral body and then to each true pelvic brim. Normally, after eight hours the markers enter and remain in the right colon for up to 38 hours, in the left colon for up to 37 hours, and in the rectosigmoid colon for up to 34 hours.[26] Alternatively, using the single capsule method at least 80 percent of the markers should be spontaneously passed by the fifth day, and all 20 or 24 markers should be expelled from the average patient by day 7.[25, 26]

Colonic motility studies have revealed electric activity that is presented in three different ways: rhythmic or sporadic nonpropagating bursts and sporadic propagating bursts, which occur approximately six times every 24 hours.[27] They are better known as mass movements and are responsible for propagating stool within the colon and rectum.[28] Motor activity in the colon is normally increased after meals.[29]

Colonic motility is modulated by gastrointestinal hormones such as gastrin,[30] serotonin[31] vasoactive intestinal polypeptide,[32, 33] and substance P[33] and by a number of local colon reflex pathways.[34] Also, the emotional state of an individual has sharp influence on colonic motility.[35]

Dynamics of anorectal function and tests that function and malfunction have recently been reviewed[36] and described in detail elsewhere.[37–60] Table 1 shows a sample questionnaire used to assess patients with constipation; Table 2 lists the causes of constipation.

ASSESSMENT OF ABNORMAL MOTILITY

Colonic Motility Study

Passage of colonic contents has been studied using several methods including indigo carmine, charcoal, barium, radioisotopes, microtelemetry units, and radiopaque markers.[24, 25, 61–63] The latter technique is the least expensive, easiest to perform, and most informative. Intraluminal measurement of colonic myoelectric and motor function is still in its infancy.[64] Anorectal manometry and associated tests have been described in detail elsewhere.[65–73] Cinedefecography

Table 1.
Specific Questions for Constipated Patients

Topic	Questions
Frequency, bowel movements	1–2 times every 1–2 days
	2 times per week
	Less than once per week
	Less than once per month
Difficulty, painful evacuation effort	Always
	Usually
	Sometimes
	Rarely
	Never
Completeness, feeling incomplete evacuation	Always
	Usually
	Sometimes
	Rarely
	Never
Pain, abdominal pain during defecation	Always
	Usually
	Sometimes
	Rarely
	Never
Time, minutes in lavatory per attempt	Less than 5
	5–10
	10–20
	20–30
	More than 30
Assistance, use of help	Digital help or enema
	Stimulative laxatives
	Without assistance
Failure, unsuccessful attempts for evacuation per 24 hours	Never
	1–3 times
	3–6 times
	6–9 times
	More than 9 times
History, constipation duration (yr)	0 years
	1–5
	5–10
	10–20
	More than 20

and electromyography (EMG) have also been written about extensively.[74–79]

Small Bowel Motility

Recent studies suggest that there might be a group of constipated patients in whom orocecal transit time is delayed[80] and that small bowel motility shows discrete clustered contractions.[81] Delayed small bowel transit is believed to be responsible for increased risk of small bowel obstruction and recurrent constipation.[7] The simplest way to measure orocecal transit time is with the lactulose hydrogen breath test.[82] This test is simple, noninvasive and reproducible. Basically, after ingestion of lactulose, fermentation by colonic flora produces hydrogen and short chain fatty acid. Hydrogen, a very diffusible gas, is excreted orally. The advent of a significant increase of hydrogen in the breath determines the end of the small bowel transit, and the length of the small bowel transit can thus be estimated.

Other methods of evaluating small bowel transit can be done scintigraphically.[83] Esophageal manometry, gastric motility, and small bowel transit studies have shown that there may be two different kinds of idiopathic slow-transit constipation.[84] One type involves just the colon, and the other involves the whole gastrointestinal tract. Long-term results after colectomy are much worse in patients with total gastrointestinal dysmotility disorders compared with patients with isolated colonic slow-transit constipation.[84]

Psychologic Investigation

Before surgery for constipation, a psychologic investigation is strongly recommended. Several studies have shown the correlation of psychologic factors and constipation.[85–88] When the Minnesota Multiphasic Personality Inventory was used, elevations in hypochondriasis, depression, and hysteria (the "neurotic triad") were noted as statistically significantly elevated in constipated patients.[89] Furthermore, Kamm[90] stated that "those patients with the greatest psychologic problems may have the lowest tolerance for abdominal pain and seek surgical treatment."

Other Tests

Many other studies have been proposed such as ultrasonography,[91] perineometry,[92] scintigraphic assessment of rectal evacuation,[93] mechanical and electric stimulation of sensation,[94] and evoked potentials by rectal or cerebral stimulation.[95] No single study is pathognomonic; therefore, diagnosis of functional disorders must be based on collective interpretation of several studies. Complete physiologic investigation is mandatory to achieve a good postoperative outcome.[96]

INTERPRETATIONS OF RESULTS

The aim of diagnostic evaluation is to determine if the patient has objective abnormalities associated with constipation. Therefore, initially extracolonic and structural disorders are excluded. If no cause for constipation is identified, a transit study should be performed. If transit is normal, an assessment of the

Table 2.
Extracolonic Causes of Constipation

Endocrine and metabolic	Carcinomatosis
	Diabetes mellitus
	Glucagonoma
	Hypercalcemia
	Hyperparathyroidism
	Hypokalemia
	Hypopituitarism
	Hypothyroidism
	Milk-alkali syndrome
	Pheochromocytoma
	Porphyria
	Pregnancy
	Uremia
Neurologic	
Cerebral	Parkinson's disease
	Stroke
	Tumors
Spinal	*Cauda equina* tumor
	Ischemia
	Iatrogenic
	Meningocele
	Multiple sclerosis
	Paraplegia
	Shy-Drager syndrome
	Tabes dorsalis
	Trauma
Peripher	Autonomic neuropathy
	Chagas disease
	Multiple endocrine neoplasia, Type 2B
	Von Recklinghausen's disease
Drugs	
	Anesthetic
	Analgesic
	Antacids (calcium and aluminum compounds)
	Anticholingeric
	Anticonvulsant
	Antidepressant
	Anti-Parkinsonian
	Barium sulfate
	Calcium channel blockers
	Diuretics
	Ganglion blockers
	Hematinics (iron)
	Hypotensives
	Laxative abuse
	Monoamino oxidase (MAO) inhibitor
	Metals (arsenic, lead, mercury, phosphorus)
	Opiates
	Paralytic agents
	Psychotherapeutics
Myopathic	
	Amyloidosis
	Dermatomyositis
	Myotonic dystrophy
	Scleroderma

pelvic floor should be undertaken. The most valuable tests are cinedefecography and EMG.

If the patient presents with megabowel, neurologic, toxic, mechanical, and degenerative pathologies such as Hirschsprung's or Chagas' disease, recurrent volvulus, and systemic sclerosis must be excluded before labeling the megabowel as "idiopathic." After completing diagnostic evaluation, functional constipation can be categorized as follows: 1) colonic cause—colonic inertia (CI), idiopathic megabowel, adult Hirschsprung's disease; 2) pelvic outlet obstruction—pelvic floor dysfunction, paradoxical puborectalis contraction (PPC), combined pelvic floor dysfunction and PPC; 4) combined colonic inertia with outlet obstruction; 4) normal transit constipation (probably the result of irritable bowel syndrome).

SURGICAL TREATMENT

Colonic Causes

Colonic Inertia (Slow-Transit Constipation). Patients with an abnormal transit and normal pelvic floor physiology who do not respond to conservative treatment options are candidates for surgery. The most common technique is subtotal colectomy with ileorectal anastomosis (IRA), ileosigmoid anastomosis (ISA), or cecorectal anastomosis (CRA). Subtotal colectomy with CRA has the theoretic advantage of retaining the ileocecal valve to enhance absorption of water. However, conversely, preservation of the cecum is often complicated by cecal distention.[97] Thus, results have been variable. Fasth *et al.*[98] reported a success rate in just 25 percent of patients. Preston and colleagues[99] noted a higher postoperative constipation rate after CRA, whereas Yoshioka and Keighley[100] found no differences between CRA and IRA.

Subtotal colectomy with ISA also predisposes to persistent constipation. Pemberton *et al.*[101] converted 50 percent of patients from an ISA to an IRA. Overall, subtotal colectomy and IRA have success rates of over 90 percent (Table 3). However, complications, mainly small bowel obstruction, have been reported in up to 50 percent of patients with a relaparotomy rate ranging from 0 to 0.5 percent (Table 4).

Segmental resections of the colon have been associated with less impressive results (Table 5). Removal of only a part of the colon usually results in recurrent constipation and dilation of the remaining colon. Moreover, the overall reported success rate of 89 percent after total abdominal colectomy is only 68 percent after segmental colectomy.

Table 3.
Subtotal Colectomy and Ileorectal Anastomosis

Author	No.	Female (%)	Mean Age	FU (yr)	Physiology	BE	BX	No MC (*n*)	Success (%)	MC (*n*)	Success (%)
Watkins and Farmington, 1966[102]	3	100	43	0.7	—	Yes	Yes	—	—	3	100
Lane and Todd, 1977[103]	3	33	46	2.2	M, RC, RS	Yes	Yes*	—	—	3	33
Smith *et al.*, 1977[104]	1	100	18	3	—	Yes	Yes	—	—	1	100
McCready and Beart, 1979[105]	6†	65	32	2.4	—	Yes*	Yes*	—	—	6	100
Hughes *et al.*, 1981[106]	17	94	35	—	—	Yes	Yes	10	80	7	100
Belliveau *et al.*, 1982[107]	9	—	—	5.4	—	Yes*	—	—	—	7	78
Klatt, 1983[108]	9‡	100	39	2.1	—	Yes	—	3	100	6	100
Gilbert *et al.*, 1984[109]	6†	86	36	0.7	—	Yes	—	—	—	6	100
Keighley and Shouler, 1984[110]	10	100	27	—	D, E, SigM	Yes	—	10	90	—	—
Preston *et al.*, 1984[99]	8	100	26	5.7	T, RAIR, RS	Yes	Yes	8	63	—	—
Krishnamurthy *et al.*, 1985[47]	12	100	33	—	—	—	—	12	100	—	—
Todd, 1985[97]	16	—	—	—	—	—	—	16	88	—	—
Barnes *et al.*, 1986[111]	6	43	38	5	RAIR*	Yes	Yes	—	—	6	67
Roe *et al.*, 1986[112]	7	—	—	0.7	D, M, RS, RSigM, T	Yes	Yes	7	71	—	—
Beck *et al.*, 1989[113]	14	100	41	1.2	M*, T*	Yes	Yes*	14	100	—	—
Gasslander *et al.*, 1987[114]	6	86	37	2	D*	Yes	Yes*	6	100	—	—
Leon *et al.*, 1987[115]	13†	100	31	2.6	EM*, ET*, GE*, SBT*	Yes*	Yes	13	77	—	—
Walsh *et al.*, 1987[116]	19	86	—	3.2	M*, RAIR*, T*	Yes*	Yes*	17	65	2	50
Åkervall *et al.*, 1988[117]	12	100	39	3.4	M, RAIR, RC, RS, SigM, T*	Yes	—	12	66	—	—
Kamm *et al.*, 1988[118]	33	100	34	2	Bexp, E, T	Yes	Yes	33	50	—	—
Vasilevsky *et al.*, 1988[119]	51†	94	45	4	M*, T*	Yes	—	24	71	14	93
Yoshioka and Keighley, 1989[100]	40§	98	35	3	E, M, RS, SigM*, T*	Yes	Yes	32	58‖	8	58‖
Zenilman *et al.*, 1989[120]	12	100	35	2	M, T	Yes*	Yes*	12	100	—	—
Coremans, 1990[121]	11	100	46	3.8	D, E, M, T	Yes	Yes	10	60	1	100
Kuijpers, 1990[60]	12†	—	42	—	D, E, T	—	—	12	50	—	—
Stabile *et al.*, 1991[122]	11	64	43	7	D*, M*, RAIR*, T*	Yes	—	—	—	11	100
Tajana *et al.*, 1990[123]	7	—	—	—	E, M, T	Yes	—	5	100	2	100
Pemberton *et al.*, 1991[101]	38	84	40	—	Bexp, D*, E, M, RAIR, SBM*, ScE, T	Yes	—	38	100	—	—
Wexner *et al.*, 1991[96]	16	92	45	1.2	D, E, M, T	Yes	Yes	16	94	—	—
Mahendrarajah *et al.*, 1994[124]	9	100	38	1.3	D, T	—	—	9	88	—	—
Stewart *et al.*, 1994[125]	1	—	11	2	—	—	—	—	—	1	100
Takahashi *et al.*, 1994[126]	38†	—	—	3	Bexp, D, E, M, RC, RS, T	Yes	Yes	37	97	—	—
Piccirillo *et al.*, 1995[127]	54	78	49	2.2	D, E, M, SBT, T	Yes	Yes	54	94	—	—
Redmond *et al.*, 1995[84]	34	92	43	7.5	D, E, EG, EM, M, SBM, T	Yes	—	34	90¶#, 13	—	—
Total	369	89	37	3				444	83	84	88

Bexp = balloon expulsion test; CI = colonic inertia; CRA = cecorectal anastomosis; D = defecography; E = electromyogram; EG = electrogastrography; EM = esophagomanometry; ET = esophageal transit time; Fem = female; FU = followup; GE = gastric emptying; GID = gastrointestinal dysmotility; IRA = ileorectal anastomosis; ISA = ileosigmoid anastomosis; M = anorectal manometry; MC = megacolon; n = number of patients; NS = not stated; RAIR = rectoanal inhibitory reflex; RC = rectal capacity; RS = rectal sensation; RSigM = rectosigmoid motility; SBM = small bowel motility; SBT = small bowel transit; ScE = scintigraphic evacuation; SigM = sigmoid motility; BE = barium enema; BX = biopsy; T = transit time.

* Not all patients.

† IRA or ISA.

‡ ISA.

§ 34 IRA, 5 CRA, 1 ISA.

‖ Overall success.

¶ for CI.

for GID.

Table 4.
Small Bowel Obstruction After Colectomy

Author	Patients (n)	Small Bowel Obstruction (%)	No.	Overall % of Reoperation
McCready and Beart, 1979[105]	11	9	1	9
Hughes *et al.*, 1981[106]	10	50	5	50
Belliveau *et al.*, 1982[107]	37	8	3	NS
Gilbert *et al.*, 1984[109]	6	50	3	33
Preston *et al.*, 1984[99]	21	38	5	14
Roe *et al.*, 1986[112]	9	0	0	0
Barnes *et al.*, 1986[111]	22	23	5	NS
Beck *et al.*, 1989[113]	14	1	1	7
Gasslander *et al.*, 1987[114]	6	0	0	0
Leon *et al.*, 1987[115]	13	31	4	31
Åkervall *et al.*, 1988[117]	12	33	4	33
Kamm *et al.*, 1988[118]	44	8	8	2
Vasilevsky *et al.*, 1988[119]	52	18	12	15
Yoshioka and Keighley, 1989[100]	40	4	3	8
Zenilman *et al.*, 1989[120]	12	8	1	0
Pemberton *et al.*, 1991[101]	38	4	3	5
Wexner *et al.*, 1991[96]	16	3	0	0
Pena *et al.*, 1992[128]	105	25	12	6
Stabile *et al.*, 1991[122]	40	10	4	10
Mahendrarajah *et al.*, 1994[124]	12	17	2	8
Piccirillo *et al.*, 1995[127]	54	9	5	6
Redmond *et al.*, 1995[84]	37	18	—	NS
Total	611	17	81	12

NS = not stated.

Isolated left-sided colectomy has also achieved poor results. Gray and Marteinsson[134] reported zero success in all four patients, the same failure rate that Preston *et al.*[99] reported in five patients. Kamm and colleagues[131] reported two female patients, ages 19 and 30, respectively. Both patients were evaluated with transit study, expulsion test, anorectal manometry, and cinedefecography. A left colectomy with a distal rectal anastomosis was undertaken in one patient and a coloanal anastomosis in the other. Both patients remained well at two and three years after surgery, respectively. In a very small carefully selected subgroup of patients, this operation may provide better symptomatic results than colectomy with IRA.

Although a very radical surgical approach, an ileoanal pouch technique has been reported in the literature as having been used in patients with intractable constipation (Table 6). Nicholls and Kamm[135] applied this technique to two women who refused an ileostomy; both patients had had a subtotal colectomy with IRA with persistent constipation.

Postoperatively, the 29-year-old female reported spontaneous bowel movements two to three times per day. The second patient, 31 years of age, was improved, although she required self-catheterization for evacuation.

A 35-year-old man presented to us two years after a low anterior resection for rectal adenocarcinoma. Examination revealed an anastomosis 2 cm above the dentate line; physiologic studies showed a typical slow-transit constipation pattern. No outlet obstruction was demonstrated, and there was no evidence of recurrent carcinoma. The patient underwent a successful ileoanal pouch procedure. Almost two years after surgery, the patient recorded a bowel frequency of two to four per day, complete continence, and no pain.

Idiopathic Megabowel. Megabowel can also be seen as megarectum, megasigmoid, megacolon, or a combination of these findings. Between 25 and 50 percent of megabowel will not be the result of Hirschsprung's disease.[99, 103] This diagnosis is excluded by evidence of ganglia in a full-thickness biopsy or anorectal myectomy. Furthermore, the rectoanal inhibitory reflex is present.

Patients with idiopathic megarectum or megabowel can often be successfully managed conservatively. Unlike Hirschsprung's disease, the sex distribution is

Table 5.
Segmental Resection for Colonic Inertia and Megabowel

Authors	No.	Female (%)	Mean Age	Follow-Up (Yr)	Pathology	Procedure	Success (n)	Success
Jenning, 1967[129]	8	—	—	—	MS	SR	1	13
Lane and Todd, 1977[103]	2	—	—	8	MRS	LHC	1	50
	6	—	—	—	MRS	SR	1	16
Smith *et al.*, 1977[104]	1	0	16	2	MR	Duhamel	1	100
McCready and Beart, 1979[105]	13	—	—	—	MS	LHC, 8 AR	11	85
	4	—	—	9.2	MR	Swenson	3	75
Hughes *et al.*, 1981[106]	5	0	—	—	MS	SR	5	100
Belliveau *et al.*, 1982[107]	7	—	—	5.4	MS	SR	6	85
	1	—	—	5.4	CI*	RHC	1	100
Preston *et al.*, 1984[99]	5	100	35	5	MS	LHC, 3 SC	1	20
Järvinen and Rintala, 1985[130]	1	0	36	—	MRS	RSR	1	100
Barnes *et al.*, 1986[111]	4	43	38	5	MC	pC	2	50
Gasslander *et al.*, 1987[114]	2	100	36	2	1 MS, 1 CI	RSR	1	50
Coremans, 1990[121]	2	100	34	3.2	MS	SR	2	100
Kamm *et al.*, 1991[131]	2	100	20	2.5	CI	LHC	2	100
Keighley, 1993[132]	2	—	—	—	MR	LAR	1	50
Stabile *et al.*, 1992[133]	7	30	19	1	MRS	RSR	5	71
Total	72	53	29	4			45	69

AR = anterior resection; CI = colonic inertia; pC = partial colectomy; LAR = low anterior resection; LHC = left hemicolectomy; MC = megacolon; MR = megarectum; MRS = megarectosigmoid; MS = megasigmoid; n = number of patients; RHC = right hemicolectomy; RSR = rectosigmoid resection; SR = sigmoid resection; SC = sigmoid colectomy.

* Megacolon not stated.

approximately equal.[99] Surgery is indicated only if conservative treatment fails.

Compared with patients with CI, there is no difference in treatment options, although treating megabowel is surgically more challenging. Because of dilation, it is often not possible to staple the distal rectal stump. Thus, a hand-sutured anastomosis must often be performed.[136]

Reported results of surgery for megabowel are confusing. Most studies are retrospective, and very often physiologic investigations such as anorectal manometry, cinedefecography, EMG of the pelvic floor, pudendal nerve motor latency studies, and transit studies are lacking. In patients with a moderately or extensively dilated megacolon or with a dilation of the left colon, colectomy with an IRA seems to yield the best results.

A recent series from St. Mark's hospital[137] discussed 40 patients with idiopathic megarectum and megabowel, including 22 patients who underwent colectomy and CRA, 11 patients with colectomy and IRA, and 7 patients following a sigmoid resection; 83 percent had normal postoperative bowel function. The only group in which recurrence was avoided was IRA. As was seen in CI, subtotal colectomy with CRA resulted in a higher incidence of constipation.[138]

Stabile *et al.*[133] reported segmental resection in seven patients with a mean age of 19 years. One patient had a previous Duhamel operation. All patients had a megarectum and megasigmoid and underwent resection with a coloanal anastomosis. One patient died from a complicated pelvic abscess, another had a pelvic abscess, and another had a rectovaginal fistula. Only four patients reported success.

Idiopathic megasigmoid is probably the best indication for sigmoid resection. Hughes and colleagues[106] mentioned satisfactory results in all five patients (100 percent), Belliveau *et al.*[107] in six of seven patients (86 percent), McCready and Beart[105] in six of eight patients (75 percent), and Coremans[121] in both patients with a megasigmoid (100 percent). However, Lane and Todd[103] reported a success rate of only 17 percent in six patients with a megasigmoid and megarectum. Similarly, the success rate of sig-

Table 6.
Pouch Procedures

Authors	No.	Female (%)	Mean Age	Follow-Up (Yr)	Pathology	Procedure	Success (n)	Success (%)	Pouch	Compli-cation	Relapar-otomy
Nicholls and Kamm, 1988[135]	2	100	30	0.6	CI	Proct	2	100	2 W	1 P, 1 cath	
Yoshioka and Keighley, 1989[100]	6	—	—	—	6 MR	RPC	4	70	3 J, 3 W	3 P	
Hosie *et al.*, 1990[136]	13	62	—	1.8	4 MR, 5 MCR, 4 CI	RPC	11	85	11 J, 2 W	5* SBO	3* Adhe-siolysis
Keighley, 1993[132]	6	—	—	—	6 MCR	RPC	5	83	—	1 C	—
	10	—	—	—	10 MR	Proct; C J-pouch	7	70	—	3 C	2 Stoma, 1 RPC
Stewart *et al.*, 1994[125]	18	—	—	6	8 MR, 10 MRS	8 crA; 2 caA, 8 C J-pouch	14	78	8 C J-pouch	3 C	2 Ileost; 1 pouch ex, RPC
						14 RPC					1 Gracil, 4 pouch ex
	14	—	—	6	5 MCR, 9 MR		10	71	14 J	4 P, 1 FI	
Wexner, 1991	1	0	35	1.9	CI	RPC	1	100	1 J	None	None
	70			3			54	82			

C = constipation; cath = self-catheterization; CI = colonic inertia; col = colonic; caA = coloanal anastomosis; crA = colorectal anastomosis; ex = excision; FI = fecal incontinence; W = W-pouch; gracil = graciloplasty; ileost = ileostomy; J = J-pouch; MCR = megacolon and megarectum; MR = megarectum; MRS = megarectosigmoid colon; P = pain; Proct = proctectomy; RPC = restorative proctocolectomy; SBO = small bowel obstruction; C J = colonic J.
* 1 with MCR.

Table 7.
Procedures for Megabowel

Author	No.	Female (%)	Mean Age	Barium Enema	Physiology	Biopsy (%)	Follow-Up (yr)	Pathology	Procedure	Anastomosis	Success (n)	Success (%)	Complication	Reoperation
Watkins and Farmington, 1966[102]	3	100	44	Yes	—	33	1	MC	3 SC	3 IRA	3	100	2 Ileus, 2 diarrhea	—
Haddad, 1969[143]	50	34	—	—	—	—	2	50 MC	Du		30	60	6 PA, 5 F, 5 C, 11 FI, 3 death, 1 leak, 1 stricture, 1 sex dysfunction	—
Smith *et al.*, 1977[104]	4	75	29	Yes*	—	100	—	2 MCR, 2 MR	3 SC, 1 Du	2 CRA, 1 IRA	4	100	1 C	—
Lane and Todd, 1977[103]	14	57	38	Yes	RC*, RS*, M*	71	8.2	2 MC	2 SC	1 IRA, 1 ISA	1	50	1 P, 1 SBO	1 Adhesiolysis
								10 MCR	6 SC, 2 LHC, 2 SR	4 CRA, 2 IRA	7	70	2 P, 2 C, 1 SBO, 1 LBO	2 Adhesiolysis
								2 MRS	1 SC, 1 SR	1 CRA	1	50	1 C	—
McCready and Beart, 1979[105]	23	65	32	Yes*	—	22	2.4	6 MC, 6 MCR, 2 MRS	6 SC, 5 LHC	6 IRA or ISA	11	100	1 SBO	1 Adhesiolysis
							8		8 AR		6	75	2 SBO, 1 Wound Infection	2 Adhesiolysis
							9.3		4 Swenson		1	25	2 PA, 1 Death, 1 Stricture, 1 Urinary retention	1 Drainage, 1 Stricturoplasty
Hughes *et al.*, 1981[106]	12	58	—	Yes	—	100	—	7 MC, 5 MS	7 SC, 5 SR	7 IRA	6	100	2 SBO	2 Adhesiolysis
Barnes *et al.*, 1986[111]	22	43	38	Yes	RAIR*	71	5	MR or MRS	10 SC	10 CRA	7	70	3 P, 4 C	—
									6 SC	6 IRA	4	67	5 SBO	NS
									4 LHC		2	50	—	—
Coremans, 1990[121]	1	100	46	—		NS	3.8	MC	1 SC	IRA	1	100	—	—
	2	100	34	—	NS	NS	3.2	2 MS	2 SR		2	100	—	—
Tajana *et al.*, 1990[123]	4	—	—	Yes	D, E, M, T	—	—	2 MC, 2 MR	2 SC, 2 Int. Myect	2 IRA	4	100	—	—
Stabile *et al.*, 1991[142]	20	30	25	Yes	—	Yes	4.5	18 MRS, 2 MCR	Du	—	10	50	2 Diarrhea, 7 C, 3 PA, 1 F, 4 SBO	Colostomy, 1 fistula repair, 4 adhesiolysis
Stabile *et al.*, 1992[148]	7	29	19	Yes	—	Yes	1	7 MRS	RS, R	caA	5	71	1 C, 1 P, 2 FI, 1 PA, 1 F, 1 Death	1 EUA, 1 SC and Ileostomy, 2 Reanastomosis
Rex *et al.*, 1990[149]	1	100	20	—	D, E, M, RC, RS, T	Yes	2	1 MR	Colostomy		1	100	—	—
Stabile *et al.*, 1992[146]	12	42	35	Yes	—	Yes	—	6 MRS, 2 MC	8 Colostomy	—	4	50	2 F, 2 C, 2 P	1 Proctectomy, 3 SC
								4 MRS	4 Ileostomy	—	4	100	1 Stoma prolapse	—
Total	175	64	33				4							

CRA = cecorectal anastomosis; D = defecography; E = electromyogram; IRA = ileorectal anastomosis; ISA = ileosigmoid anastomosis; M = anorectal manometry; MC = megacolon; RAIR = rectoanal inhibitory reflex; RC = rectal capacity; RS = rectal sensation; MCR = megacolon and megarectum; MR = megarectum; MRS = megarectosigmoid colon; MS = megasigmoid; LHC = left hemicolectomy; SR = sigmoid resection; AR = anterior resection; C = constipation; FI = fecal incontinence; P = pain; SBO = small bowel obstruction; caA = coloanal anastomosis; F = fistulas; PA = pelvic abscess; SC = sigmoid colectomy; EUA = examination under anesthesia; Int myect = internal myectomy; Du = Duhamel; M* = megacolon not stated; LBO = large bowel obstruction; T = transit time; RSR = rectosigmoid resection.

moid colectomy for an isolated 3° sigmoidocele was also reported as 100 percent.[139]

In patients with a megarectum, anorectal myectomy did not offer good long-term results.[140] The role of rectal excision using the Soave or Duhamel technique or the pull-through technique according to Soave is still controversial. Results of the Duhamel technique are mixed because high complication rates have been reported.[141–143] Other procedures such as the Swenson operation and the Soave coloanal anastomosis are anecdotal. Lateral puborectalis division for megarectum[144] or sympathectomy for megacolon often fail.[145] Another option for a grossly dilated colon is a restorative proctocolectomy with an ileoanal pouch.[136, 125]

Stewart *et al.*[125] reported 34 patients with idiopathic megarectum and megacolon; 18 patients had megarectum and megasigmoid, 1 patient had an isolated megacolon, and 15 patients had combined megarectum and megacolon. Eight patients underwent a straight low colorectal, and two patients had a coloanal anastomosis. Eight patients had a colonic pouch-anal anastomosis, and 14 patients had a restorative proctocolectomy with creation of an ileal J-pouch; 1 patient underwent a subtotal colectomy with IRA, and 1 patient had only a loop ileostomy. One patient died two years after the procedure because of pneumonia that complicated a small bowel obstruction. Of patients with straight low colorectal or coloanal anastomosis, eight were continent and two had recurrent constipation. One patient was treated with an ileostomy, and another patient subsequently had an ileoanal J-pouch with a stool frequency of two to six. In the colonic J-pouch group, one pouch had to be excised, and one patient had an ileostomy because of recurrent soiling. Twelve of 14 ileoanal J-pouch patients were continent, 1 had recurrent soiling, and one was incontinent and required a stimulated graciloplasty. Four patients became dissatisfied because of persistent pain, and the pouch had to be excised.

The most simple alternative to colonic resection is formation of an ileostomy in patients with a megacolon or a proximal colostomy if only the distal colon or the rectum is grossly dilated. Morbidity is low, and results may be satisfactory.[146] However, the procedure is well suited to laparoscopy.[147] Table 7 outlines operations performed in patients with megabowel.

Adults Hirschsprung's Disease. Posterior anorectal myectomy is done by removing a 1 cm wide and at least 6 cm long strip of internal anal sphincter and circular muscle starting 2 cm cephaled to the dentate line. This technique is usually performed to confirm and possibly treat short or ultrashort segment Hirschsprung's disease. Hamdy and Scobie[46] reported good results in patients with a mean age of 21 years. In two patients in whom anorectal myectomy was not successful, low anterior resection was performed with 100 percent success. Fishbein *et al.*[150] reported good results in two patients with a long myectomy.

Abdominal procedures for treatment of adult Hirschsprung's disease include the Swenson abdominoperineal pull-through, the Duhamel retrorectal transanal anastomosis, and the Soave endorectal pull-through techniques. Elliot and Todd[151] reported the results of 39 patients (26 male, 13 female) with a mean age of 23.1 years who underwent the Duhamel procedure; 37 had a history of lifelong constipation since birth. Of note, one patient did not have a bowel movement for one year. Thirteen patients had undergone previous surgeries, five had undergone a colostomy, and three patients had a failed Swenson operation. Of 26 patients, a barium enema demonstrated a narrow segment in 11. Anorectal physiology was undertaken in 28 patients. The rectoanal inhibitory reflex was absent in 26 patients and, interestingly, present in 2. Full-thickness biopsy confirmed the diagnosis in all patients. The use of a linear cutter to divide the colorectal septum was done in the last 10 patients and has supplanted the previous method of clamp application to produce necrosis and sloughing of the colorectal spur. Excellent functional results were achieved in 92 percent. Postoperative anastomotic complications were seen in 13 percent; there was no mortality.

Excellent results were also reported by Natsikas and Sbarounis[152] using Martin's modification of the Duhamel procedure in six patients (5 males, 1 female). All patients were treated with preliminary colostomy for decompression, and, ultimately, all had normal bowel function, continence, and sexual function.

Luukkonen *et al.*[153] used the Duhamel procedure in seven patients and the Soave procedure in one. Although postoperatively their bowel frequency was normal, five patients had intermittent episodes of incontinence.

Wheatley *et al.*[154] performed four Soave procedures with good long-term success. However, one patient who underwent a Duhamel operation had to undergo further surgery because of constipation secondary to retained colorectal septum.

Pelvic Outlet Obstruction

Pelvic Floor Dysfunction. Sigmoidoceles may account for symptoms of obstructed defecation. Jorge and colleagues[139] classified sigmoidoceles as first (above the pubococcygeal line), second (between the pubococcygeal and ischiococcygeal line), and third (below the ischiococcygeal line) degree. Five of eight patients with a third degree and one of seven with a second degree sigmoidocele underwent colonic resection; five had sigmoidectomy, and one had subtotal colectomy. The latter procedure was undertaken because of the concomitant presence of colonic inertia. Although the other patients with second or third degree sigmoidocele were managed conservatively with an improvement in just two patients, all six patients who underwent surgery reported excellent results at a mean follow-up of 23 months.[139]

In the literature, rectoceles are seldomly mentioned as a cause of pelvic outlet obstruction. Usually the rectocele does not become symptomatic until the fourth or fifth decade of life, although the defect in the rectovaginal septum may have existed for several years. During straining, the apex of the rectocele moves inferiorly and anteriorly, and stool, which may be trapped, cannot be evacuated, as straining and pushing brings the stool further away from the anal canal opening. Clinically, patients present with incomplete evacuation, pain, soiling, and bleeding. Frequently, history reveals the necessity of digitation to achieve a bowel movement.

A significant rectocele is generally defined as one larger than 2 to 3 cm during cinedefecography, which does not empty during the investigation[155]; this causes fullness and thus reproduces the patients' symptoms. According to some authors, transvaginal repair does not provide sufficient relief.[156–159] Therefore, a combined rectovaginal or endorectal approach alone is recommended. However, Sehapayak[158] reported a lower infection rate with transrectal compared with combined transrectal and transvaginal repair.

Sullivan *et al.*[159] were the first to describe a transrectal rectocele repair. They reported a success rate of 97.5 percent in 151 patients. Only one patient developed a rectovaginal fistula, with a 4 percent wound infection rate.

Sehapayak[158] reported 355 women with a mean age of 50 years who underwent a transrectal repair technique; improvement was seen in 98 percent. Janssen and van Dijke[160] reported excellent or good results in 92 percent of 76 women at a follow-up of one year.

In 25 patients reported by Mellgren *et al.*,[161] a transvaginal repair was used. All patients were preoperatively evaluated with a standardized questionnaire, cinedefecography, colonic transit studies, anorectal manometry, and electrophysiology. The operative technique was a posterior perineorrhaphy and colporrhaphy. Although the symptoms improved in 21 patients, three of 16 sexually active females complained of postoperative dyspareunia. Care must be taken not to overtreat rectoceles, whether found during physical examination or on cinedefecography.

The exact etiology of perineal descent is unknown. At the present time, there is no surgical option. Biofeedback[162] or artificial devices[163] to support the pelvic floor during defecation may improve symptoms. A discussion of surgical management of entities such as rectoanal intussusception or rectal prolapse is beyond the scope of this review article.

Paradoxical Puborectalis Contraction. In 1964, Wasserman[164] reported 75 percent success in four patients who had a posterior partial V-shaped resection of the puborectalis muscle. Wallace and Madden[165] reported a similar success rate in 44 patients. However, Keighley[166] reported success in only one of seven patients when he partially divided the puborectalis muscle. Barnes and colleagues[167] reported a success rate of just 24 percent in nine patients. Besides the two patients with improvement, five became incontinent to gas and liquid stool. Kamm *et al.*[144] and Kawano *et al.*[168] reported success rates of 24 and 43 percent, respectively, in 18 and 7 patients. Although Yu[169] had a success rate of 83 percent in 18 patients, most authors recommend a conservative approach to paradoxical puborectalis function (Table 8).[166, 170, 171]

Combined Pelvic Floor Dysfunction and PPC. If physiologic studies show a combination of PPC and pelvic floor dysfunction, biofeedback is usually successful.[170, 171] After conservative resolution of PPC, a surgical approach may be considered, if a concomitant sigmoidocele or rectocele is present and remains symptomatic.

Combined Colonic Inertia with Outlet Obstruction

Several reports regarding failure of subtotal colectomy are probably attributable to concomitant pelvic outlet obstruction. Kamm *et al.*[118] reported a series of 44 patients with CI in which 13 of 20 patients tested

Table 8.
Puborectalis Operations

Author	No.	%	Age	Years	Operation	No.	%
Wasserman, 1964[164]	4	0	53	—	PPR	3	75
Wallace and Madden, 1969[165]	44	0	7	2.6	PPR	33	75
Keighley, 1988[166]	7	100	—	—	PD	1	14
Barnes *et al.*, 1985[167]	9	100	42	—	PD	2	24
Kamm *et al.*, 1988[144]	18*	100	34	1.1	PD	4	24
Kawano *et al.*, 1987[168]	7	—	—	—	PR	3	43
Yu, 1995[169]	18	NS	—	—	PR	15	83
	89		34			61	48

* Both sides.
PPR = posterior partial resection; PD = partial division; PR = partial resection; NS = not stated.

had a concomitant PPC and 21 of 29 failed the balloon expulsion test. Not surprisingly, the postoperative success rate at a mean of three years was just 50 percent. Yoshioka and Keighley[100] reported similar results. In 40 patients, 48 percent had a concomitant PPC, with a final success rate of only 58 percent. Therefore, if a combined pattern of colonic inertia with outlet obstruction is diagnosed, a conservative approach to treat outlet obstruction is recommended. After successful treatment of pelvic floor disturbance, the anticipated success rate of surgical treatment of CI should increase.

Normal Transit Constipation (Probably Caused by Irritable Bowel Syndrome)

At the present time, there is no successful surgical option.

CONCLUSION

Chronic intractable constipation is a symptom that can be responsible for a variety of diseases. Only a small group of patients may be suitable for surgical intervention, and thorough physiologic examination is mandatory to achieve a successful outcome in the vast majority of these patients.

REFERENCES

1. Lane WA. Results of the operative treatment of chronic constipation. BMJ 1908;1:1126–30.
2. Chapple H. chronic intestinal stasis treated by short-circuiting or colectomy. BMJ 1911;1:915–22.
3. Sonnenberg A, Koch TR. Physicians visits in the United States for constipation: 1958–1986. Dig Dis Sci 1989; 34:606–11.
4. Shouten WR, De Graaf JR. Severe, long standing constipation in adults: indications for surgical treatment. Neth J Surg 1991;43:222–9.
5. Kumar D, Bartolo DC, Devroede G, *et al.* Symposion on constipation. Int J Colorectal Dis 1992;7:47–67.
6. Sandler RS, Jordon MC, Skelton BJ. Demographic and dietary determinants of constipation in the U. S. population. Am J Public Health 1990;80:185–9.
7. Whitehead WE, Chaussade S, Corazziari E, Kumar D. Report of an international workshop on management of constipation. Int Gastroenterol 1991;4:99–113.
8. Drossman DA, Sandler RS, McKee DC, Lovitz AJ. Bowel patterns among subjects not seeking health care. Gastroenterology 1982;83:529–34.
9. Sonnenberg A, Koch TR. Epidemiology of constipation in the United States. Dis Colon Rectum 1989;32:1–8.
10. Jones R, Lydeard S. Irritable bowel syndrome in the general population. BMJ 1992;304:87–90.
11. Welch GW, Pomare EW. Functional gastrointestinal symptoms in a Wellington community sample. N Z Med J 1990;103:418–20.
12. Bommelaer G, Rouch M, Dapoigny M, *et al.* Epidemiology of intestinal functional disorders in an apparently healthy population. Gastroenterol Clin Biol 1986; 10:7–12.
13. Langman MS, Logan RF. The epidemiology of human colonic diseases. In: Kirsner JB, Shorter RG, eds. Diseases of the colon, rectum and anal canal. Baltimore: William & Wilkins, 1988:179–80.
14. Talley NJ, O'Keefe EA, Zinsmeister AR, Melton LJ. Prevalence of gastrointestinal symptoms in the elderly: a population-based study. Gastroenterology 1991;102: 895–901.
15. Everhart JE, Go VL, Johannes RS, Fitzsimmons SC, Roth HP, White LR. A longitudinal survey of self reported bowel habits in the United States. Dig Dis Sci 1989;34: 1153–62.
16. Johansen JF, Sonnenberg A. The prevalence of hemorrhoids and chronic constipation: an epidemiologic study. Gastroenterology 1990;98:380–6.
17. Wald A, Hinds JP, Caruana BJ. Psychological and physiological characteristics of patients with severe idiopathic constipation. Gastroenterology 1989;97:932–7.

18. Devroede G, Girard G, Bouchoucha M, *et al.* Idiopathic constipation by colonic dysfunction: relationship with personality and anxiety. Dig Dis Sci 1989;34: 1428–33.
19. Bingham SA, Cummings JH. The effect of exercise on large intestinal function. Gastroenterology 1989;97: 1389–99.
20. Cordain L, Latin RW, Behnke JJ. The effects of an aerobic running program on bowel transit time. J Sports Med 1986;26:101–4.
21. Anderson JW. Health implications of wheat fiber. Am J Clin Nutr 1985;41:1103–12.
22. Whitehead WE, Drinkwater D, Cheskin L, Heller BR, Shuster MM. Constipation in the elderly living at home: definition, prevalence and relationship to lifestyle and health status. J Am Geriatr Soc 1989;37:423–9.
23. Dent OF, Goulston KJ, Zubrzycki J, Chapius PH. Bowel symptoms in an apparently well population. Dis Colon Rectum 1986;29:243–7.
24. Martelli H, Devroede G, Ahran P, *et al.* Some parameters of large bowel motility in normal man. Gastroenterology 1978;75:612–8.
25. Hinton JM, Lennard-Jones JE, Young AC. A new method for studying gut transit times using radiopaque markers. Gut 1969;10:842–7.
26. Ahran P, Devroede G, Jehannin B, *et al.* Segmental colonic transit time. Dis Colon Rectum 1981;24:625–9.
27. Bassotti G, Gaburri M, Imbimbo BP, *et al.* Colonic mass movements in idiopathic chronic constipation. Gut 1988;29:1173–9.
28. Schang JC, Devroede G. Fasting and postprandial myoelectric spiking activity in the human sigmoid colon. Gastroenterology 1983;85:1048–53.
29. Bassotti G, Imbimbo BP, Betti C, Dozzini G, Morelli A. Impaired colonic motor response to eating in patients with slow-transit constipation. Am J Gastroenterol 1992;87:504–8.
30. Preston D, Adrian T, Christofides N, Lennard-Jones J, Bloom S. Positive correlation between symptoms and circulating motilin, pancreatic polypeptide and gastrin concentration in functional bowel disorders. Gut 1988; 26:1059–64.
31. Lincoln J, Crowe R, Kamm MA, Burnstock G, Lennard-Jones JE. Serotonin and 5-hydroxyindoleacetic acidare increased in the sigmoid colon in severe idiopathic constipation. Gastroenterology 1990;98:1219–25.
32. Koch TR, Carney JA, Go L, Go VL. Idiopathic chronic constipation is associated with decreased colonic vasoactive intestinal peptide. Gastroenterology 1988;94: 300–10.
33. Milner P, Crowe R, Kamm MA, Lennard-Jones JE, Burnstock G. Vasoactive intestinal polypeptide levels in sigmoid colon in idiopathic constipation and diverticular disease. Gastroenterology 1990;99:666–75.
34. Kerrigan DD, Lucas MG, Sun WM, Donnelly TC, Read NW. Idiopathic constipation associated with impaired urethrovesical and sacral reflex function. Br J Surg 1989;76:748–51.
35. Schang JC, Devroede G, Hebert M, Hemond M, Pilote M, Devroede L. Effects of rest, stress and food on myoelectric spiking activity of left and sigmoid colon in humans. Dig Dis Sci 1988;33:614–8.
36. Rasmussen O. Anorectal function. Dis Colon Rectum 1994;37:386–403.
37. Scharli AF, Kiesewetter WB. Defecation and continence: some new concepts. Dis Colon Rectum 1970; 13:81–107.
38. Varma KK, Stephens D. Neuromuscular reflexes of anal continence. Aust N Z J Surg 1972;41:263–72.
39. Duthie GS, Bartolo DC. Faecal continence and defaecation. In: Henry MM, Swash M, eds. Coloproctology and the pelvic floor. 2nd ed. Oxford: Butterworth-Heinemann, 1992:86–97.
40. Lennard-Jones JE. Constipation: pathophysiology, clinical features and treatment. In: Henry MM, Swash M, eds. Coloproctology and the pelvic floor. London: Butterworth-Heinemann, 1985:350–75.
41. Pemberton J. Anatomy and physiology of the anus and rectum. In: Beck DE, Wexner SD, eds. Fundamentals of anorectal surgery. New York: McGraw-Hill, 1992: 1–24.
42. Mahieu P, Pringot J, Bodart P. Defecography I: description of a new procedure and results in normal patients. Gastrointest Radiol 1984;9:247–51.
43. Neill ME, Parks AG, Swash M. Physiological studies of the anal sphincter musculature in faecal incontinence and rectal prolapse. Br J Surg 1981;68:531–6.
44. Todd IP. Adult Hirschsprung's disease. Br J Surg 1977; 64:311–2.
45. Meier-Ruge W, Lutterbeck PM, Herzig B, Morger R, Moser R, Schárli A. Acetylcholinesterase activity in suction biopsies of the rectum in a diagnosis of Hirschsprung's disease. J Pediatr Surg 1972;7:11–7.
46. Hamdy MH, Scobie WG. Anorectal myectomy in adult Hirschsprung's disease: a report of six cases. Br J Surg 1984;71:611–3.
47. Krishnamurthy S, Schuffler MD, Rohrmann A, Pope CE II. Severe idiopathic constipation is associated with a distinctive abnormality of the colonic myenteric plexus. Gastroenterology 1985;88:26–34.
48. Pinotti HW, Habr Gama A, Cecconell I, Felix VN, Zilberstein B. The surgical treatment of megaeophagus and megacolon. Dig Dis Sci 1993;11:206–15.
49. Habr Gama A, Raia A, Netto AC. Motility of the sigmoid colon and rectum: contribution to the physiopathology of megacolon in Chagas disease. Dis Colon Rectum 1971;14:291–304.
50. Turnbull GK, Thompson DG, Day S, Martin J, Walker E, Lennard-Jones JE. Relationship between symptoms,

menstrual cycle and orocaecal transit in normal and constipated women. Gut 1989;30:30–4.
51. Devroede G. Psychophysiological considerations in subjects with chronic idiopathic constipation. In: Wexner SD, Bartolo DC, eds. Constipation: etiology, evaluation, and management. Oxford: Butterworth-Heinemann, 1995:104–34.
52. Crowell MD, Whitehead WE, Cheskin LJ, Schuster MM. Twenty-four hour ambulatory monitoring of peristaltic activity from the colon in normal and constipation-predominant IBS patients [abstract]. Gastroenterology 1989;96:A103.
53. Frieri G, Parisi F, Corazziari E, Caprilli R. Colonic electromyography in chronic constipation. Gastroenterology 1983;84:737–40.
54. Connell AM, Hilton C, Irvine G, Lennard-Jones JE, Misiewicz JJ. Variation of bowel habit in two population samples. BMJ 1965;2:1095–9.
55. Lowery SP, Srour JW, Whitehead WE, Schuster MM. Habit training as treatment of encopresis secondary to chronic constipation. J Pediatr Gastroenterol Nutr 1985;4:397–401.
56. Levine MD. Children with encopresis: a descriptive analysis. Pediatrics 1975;56:412–6.
57. Von der Ohe MR, Camillieri M, Carryer PW. A patient with localized megacolon and intractable constipation: evidence for impairment of colonic muscle tone. Am J Gastroenterol 1994;89:1867–70.
58. Meunier P, Marechal JM, De Beaujeu MJ. Rectoanal pressures and rectal sensitivity studies in chronic childhood constipation. Gastroenterology 1979;77:330–6.
59. DeMedici A, Badiali D, Corazziari E, Bausano G, Anzini F. Rectal sensitivity in chronic constipation. Dig Dis Sci 1989;34:747–53.
60. Kuijpers HC. Application of the colorectal laboratory in diagnosis and treatment of functional constipation. Dis Colon Rectum 1990;33:35–9.
61. Kirwan WO, Smith AN. Colonic propulsion in diverticular disease, idiopathic constipation, and the irritable colon syndrome. Scand J Gastroenterol 1977;12: 331–5.
62. Waller SL. Differential measurement of small and large bowel transit times in constipation and diarrhea: a new approach. Gut 1975;16:372–8.
63. Metcalf AM, Phillips SF, Zinsmeister AR, McCarty RL, Beart RW, Wolff BG. Simplified assessment of segmental colonic transit. Gastroenterology 1987;92:40–7.
64. Camilleri M, Thompson WG, Fleshman JW, Pemberton JH. Clinical management of intractable constipation. Ann Intern Med 1994;121:520–8.
65. Jorge JM, Wexner SD. A practical guide to basic anorectal physiology investigations. Contemp Surg 1993; 43:214–24.
66. Jorge JM, Wexner SD. Anorectal manometry: techniques and clinical applications. South Med J 1993;86: 924–31.
67. Karulf RE, Coller JA, Bartolo DC, *et al.* Anorectal physiology testing: a survey of availability and use. Dis Colon Rectum 1991;34:464–8.
68. Coller JA. Clinical application of anorectal manometry. Gastroenterol Clin North Am 1987;16:17–33.
69. Schouten WR, van Vroonhoven TJ. A simple method of anorectal manometry. Dis Colon Rectum 1983;26: 721–4.
70. Varma JS, Smith AN. Anorectal profilimetry with the microtransducer. Br J Surg 1984;71:867–9.
71. Taylor BM, Beart RW Jr, Phillips SF. Longitudinal and radial variations of pressure in the human anal sphincter. Gastroenterology 1984;86:693–7.
72. Reissman P, Piccirillo M, Nogueras JJ, Wexner SD. Manometry may not be necessary in the evaluation of constipation in adults [abstract]. South Med J 1994;87: S18–9.
73. Keighley MR, Henry MM, Bartolo DC, Mortensen NJ. Anorectal physiology measurement: report of a working party. Br J Surg 1989;76:356–7.
74. Goei R, van Engelshoven J, Schouten H, Baeten C, Stassen C. Anorectal function: defecographic measurement in asymptomatic subjects. Radiology 1989;173: 137–41.
75. Goei R. Anorectal function in patients with defecation disorders and asymptomatic subjects: evaluation with defecography. Radiology 1990;174:121- 3.
76. Jorge JM, Wexner SD, Marchetti F, Rosato GO, Sullivan ML, Jagelman DG. How reliable are currently available methods of measuring the anorectal angle? Dis Colon Rectum 1992;35:332–8.
77. Pfeifer J, Oliveira L, Park UC, Gonzalez A, Nogueras JJ, Wexner SD. Are interpretations of cinedefograms reliable and reproducible? [abstract]. South Med J 1995;88: S23.
78. Teoh TA, Cheong D, Salanga V, Nogueras JJ, Wexner SD. A prospective comparative study of the intra-anal sponge *versus* the needle electrode for electromyographic (EMG) puborectalis activity in constipated patients [meeting abstract]. Dis Colon Rectum 1995;38: P17.
79. Henry MM, Snooks SJ, Barnes PR, Swash M. Investigation of disorders of the anorectum and colon. Ann R Coll Surg Engl 1985;67:355–60.
80. Cann PA, Read NW, Brown C, Hobson N, Holdsworth CD. The irritable bowel syndrome (IBS): relationship of disorders in the transit of a single meal to symptom patterns. Gut 1983;24:405–11.
81. Kellow JE, Phillips SF, Miller LJ, Zinsmeister AR. Dysmotility of the small intestine in irritable bowel syndrome. Gut 1988;29:1236–43.
82. Jorge JM, Wexner Sd, Ehrenpreis ED. The lactulose

hydrogen breath test as a measure of orocaecal transit time. Eur J Surg 1994;160:409–16.
83. Argenyi EE, Soffer EE, Madsen MT, Berbaum KS, Walkner WO. Scintigraphic evaluation of small bowel transit in healthy subjects: inter-and intravariability. Am J Gastroenterol 1995;90:938–42.
84. Redmond JM, Smith GW, Barofsky I, Ratych RE, Goldsborough DC, Schuster M. Physiological tests to predict long-term outcome of total abdominal colectomy for intractable constipation. Am J Gastroenterol 1995; 90:748–53.
85. Merkel IS, Locher J, Burgio K, Towers A, Wald A. Physiologic and psychologic characteristics of an elderly population with chronic constipation. Am J Gastroenterol 1993;88:1854–9.
86. Bergeron C, Monto G. Personality patterns seen in irritable bowel syndrome patients. Am J Gastroenterol 1985;80:448–51.
87. Whitehead WE, Crowell MD. Psychologic considerations in the irritable bowel syndrome. Gastroenterol Clin North Am 1991;20:249–67.
88. Devroede G, Girard G, Bouchoucha M, *et al.* Idiopathic constipation by colonic dysfunction: relationship with personality and anxiety. Dig Dis Sci 1989;34: 1428–33.
89. Heymen S, Wexner SD, Gulledge AD. MMPI assessment of patients with functional bowel disorders. Dis Colon Rectum 1993;36:593–6.
90. Kamm MA. Role of surgical treatment in patients with severe constipation. Ann Med 1990;22:435–44.
91. Bartram CI. Anal endosonography. Ann Gastroenterol Hepatol (Paris) 1992;28:185–9.
92. Henry MM, Parks AG, Swash M. The pelvic floor musculature in the descending perineum syndrome. Br J Surg 1982;69:470–2.
93. O'Connell PR, Kelly KA, Brown M. Scintigraphic assessment of neorectal motor function. J Nucl Med 1986;27:460–4.
94. Roe AM, Bartolo DC, Mortensen NJ. New method for assessment of anal sensation in various anorectal disorders. Br J Surg 1986;73:310–2.
95. Herdmann J, Bielefeldt K, Enck P. Quantification of motor pathways to the pelvic floor in humans. Am J Physiol 1991;260:20–3.
96. Wexner SD, Daniel N, Jagelman DG. Colectomy for constipation: physiologic investigation is the key to success. Dis Colon Rectum 1991;34:851–6.
97. Todd IP. Constipation: results of surgical treatment. Br J Surg 1985;72:S12–3.
98. Fasth S, Hedlund H, Svaninger G, Öresland T, Hulten L. Functional results after subtotal colectomy and caecorectal anastomosis. Acta Chir Scand 1983;149:623–7.
99. Preston DM, Hawley PR, Lennard-Jones JE, Todd IP. Results of colectomy for severe idiopathic constipation in women. Br J Surg 1984;71:547–52.
100. Yoshioka K, Keighley MR. Clinical results of colectomy for severe constipation. Br J Surg 1989;76:600–4.
101. Pemberton JH, Rath DM, Ilstrup DM. Evaluation and surgical treatment of severe chronic constipation. Ann Surg 1991;214:403–13.
102. Watkins GL, Farmington MO. Operative treatment of acquired megacolon in adults. Arch Surg 1966;93: 620–4.
103. Lane RH, Todd IP. Idiopathic megacolon: a review of 42 cases. Br J Surg 1977;64:305–10.
104. Smith B, Grace RH, Todd IP. Organic constipation in adults. Br J Surg 1977;64:313–4.
105. McCready RA, Beart RW Jr. The surgical treatment of incapacitating constipation associated with idiopathic megacolon. Mayo Clin Proc 1979;54:779–83.
106. Hughes ES, Mc Dermott FT, Johnson WR, Polglase AC. Surgery for constipation. Aust N Z J Surg 1981;51: 144–8.
107. Belliveau P, Goldberg SM, Rothenberger DA, Nivatvongs S. Idiopathic acquired megacolon: the value of subtotal colectomy. Dis Colon Rectum 1982;25: 118–21.
108. Klatt GR. Role of subtotal colectomy in the treatment of incapacitating constipation. Am J Surg 1983;145: 623–5.
109. Gilbert KP, Lewis FG, Billingham RP, Sanderson E. Surgical treatment of constipation. West J Med 1984; 140:569–72.
110. Keighley MR, Shouler P. Outlet syndrome: is there a surgical option? J R Soc Med 1984;77:559–63.
111. Barnes PR, Lennard-Jones JE, Hawley PR, Todd IP. Hirschsprung's disease and idiopathic megacolon in adults and adolescents. Gut 1986;27:534–41.
112. Roe AM, Bartolo DC, Mortensen NJ. Diagnosis and surgical management of intractable constipation. Br J Surg 1986;73:854–61.
113. Beck DE, Fazio VW, Jagelman DG, Lavery IC. Surgical management of colonic inertia. South Med J 1989;82: 305–9.
114. Gasslander T, Larsson J, Wetterfors J. Experience of surgical treatment for chronic idiopathic constipation. Acta Chir Scand 1987;153:553–5.
115. Leon SH, Krishnamurthy S, Shuffler MD. Subtotal colectomy for severe idiopathic constipation. Dig Dis Sci 1987;32:1249–54.
116. Walsh PV, Peebles-Brown DA, Watkinson G. Colectomy for slow transit constipation. Ann R Coll Surg Engl 1987;69:71–5.
117. Åkervall S, Fasth S, Nordgren S, Öresland T, Hulten L. The functional results after colectomy and ileorectal anastomosis for severe constipation (Arbuthnot Lane's disease) as related to rectal sensory function. Int J Colorectal Dis 1988;3:96–101.
118. Kamm MA, Hawley PR, Lennard-Jones JE. Outcome of

colectomy for severe idiopathic constipation. Gut 1988;29:969–73.
119. Vasilevsky CA, Nemer FD, Balcos EG, Christenson CE, Goldberg SM. Is subtotal colectomy a viable option in the management of chronic constipation? Dis Colon Rectum 1988;31:679–81.
120. Zenilman ME, Dunnegan DL, Super NJ, Becker JM. Successful surgical treatment of idiopathic colonic dismotility. Arch Surg 1989;124:947–51.
121. Coremans GE. Surgical aspects of severe chronic non-Hirschsprung constipation. Hepatogastroenterology 1990;37:588–95.
122. Stabile G, Kamm MA, Hawley PR, Lennard-Jones JE. Colectomy for idiopathic megarectum and megacolon. Gut 1991;32:1538–40.
123. Tajana A, Mori G, Micheletto G, *et al.* Current status of surgery for severe idiopathic constipation. Coloproctology 1990;6:340–2.
124. Mahendrarajah K, Van der Schaaf A, Lovegrove FT, Mendelson R, Levitt MD. Surgery for severe constipation: the use of radioisotope transit scan and barium evacuation proctography in patient selection. Aust N Z J Surg 1994;64:183–6.
125. Stewart J, Kumar D, Keighley MR. Results of anal low rectal anastomosis and pouch construction for megarectum and megacolon. Br J Surg 1994;81:1051–3.
126. Takahashi T, Fitzgerald SD, Pemberton JH. Evaluation and treatment of constipation. Rev Gastroenterol Mex 1994;59:133–8.
127. Piccirillo MF, Reissman P, Carnavos R, Wexner SD. Colectomy as treatment for constipation in selected patients. Br J Surg 1995;82:898–901.
128. Pena JP, Heine JA, Wong WD, Christenson CE, Balcos EG. Subtotal colectomy for constipation—a long term follow up study [meeting abstract]. Dis Colon Rectum 1992;35:P19.
129. Jenning PJ. Megarectum and megacolon in adolescents and young adults: results of treatment at St. Mark's hospital. J R Soc Med 1967;60:805–6.
130. Järvinen HJ, Rintala R. Funnel anus and megacolon in an adult. Dis Colon Rectum 1985;28:957–9.
131. Kamm MA, Van der Sijp JR, Hawley PR, Phillips RK, Lennard-Jones JE. Left hemicolectomy with rectal excision for severe idiopathic constipation. Int J Colorectal Dis 1991;6:49–51.
132. Keighley MR. Megacolon and megarectum. In: Keighley MR, Williams NS, eds. Surgery of the anus, rectum and colon. Vol. 1. London: WB Saunders, 1993:658–73.
133. Stabile G, Kamm MA, Phillips RK, Hawley PR, Lennard-Jones JE. Partial colectomy and coloanal anastomosis for idiopathic magarectum and megacolon. Dis Colon Rectum 1992;35:158–62.
134. Gray EJ, Marteinsson TH. Dolichocolon: indications for operations. Am Surg 1971;37:509–11.
135. Nicholls RJ, Kamm MA. Proctocolectomy with restorative ileoanal reservoir for severe idiopathic constipation: report of two cases. Dis Colon Rectum 1988;31:968–9.
136. Hosie KB, Kmiot WA, Keighley MR. Constipation: another indication for restorative proctocolectomy. Br J Surg 1990;77:801–2.
137. Stabile G, Kamm MA, Hawley PR, Lennard-Jones JE. Colectomy for idiopathic megarectum and megacolon. Gut 1991;32:1538–40.
138. Kamm MA, Stabile G. Management of idiopathic megarectum and megacolon. Br J Surg 1991;78:899–900.
139. Jorge JM, Yang Y-K, Wexner SD. Incidence and clinical significance of sigmoidoceles as determined by a new classification system. Dis Colon Rectum 1994;37:1112–7.
140. Pinho M, Yoshioka K, Keighley MR. Long-term results of anorectal myectomy for chronic constipation. Dis Colon Rectum 1990;33:795–7.
141. Parc R, Berrod JL, Tussiot J, Loygue J. Le megacolon de l'adulte: a propos de 76 cas. Ann Gastroenterol Hepatol (Paris) 1984;20:133–41.
142. Stabile G, Kamm MA, Hawley PR, Lennard-Jones JE. Results of the Duhamel operation in the treatment of idiopathic megarectum and megacolon. Br J Surg 1991;78:661–3.
143. Haddad J. Treatment of acquired megacolon by retrorectal lowering of the colon with a perineal colostomy: modified Duhamel operation. Dis Colon Rectum 1969;12:421–9.
144. Kamm MA, Hawley PR, Lennard-Jones JE. Lateral division of the puborectalis muscle in the management of severe constipation. Br J Surg 1988;75:661–3.
145. Dixon CF, Judd DB. The surgical treatment of congenital megacolon. Surg Clin North Am 1983;63:886–903.
146. Stabile G, Kamm MA, Hawley PR, Lennard-Jones JE. Results of stoma formation for idiopathic megarectum and megacolon. Int J Colorectal Dis 1992;7:82–4.
147. Jager R. Laparoscopic enterotomy. In: Jager R, Wexner SD, eds. Laparoscopic colorectal surgery. New York: Churchill-Livingston, 1996:153–60.
148. Stabile G, Kamm MA, Phillips RK, Hawley PR, Lennard-Jones JE. Partial colectomy and coloanal anastomosis for idiopathic megarectum and megacolon. Dis Colon Rectum 1992;35:158–62.
149. Rex DK, Lappas JC, Popp B. Association of anterior ectopic anus and partial absence of levator musculature in a woman with impaired defecation: report of a case. Dis Colon Rectum 1990;33:974–6.
150. Fishbein RH, Handelsman JC, Schuster MM. Surgical treatment of Hirschsprung's disease in adults. Surg Gynecol Obstet 1986;163:458–64.
151. Elliot MS, Todd IP. Adult Hirschsprung's disease: results of the Duhamel procedure. Br J Surg 1985;72:884–5.
152. Natsikas NB, Sbarounis CN. Adult Hirschsprung' dis-

ease: an experience with the Duhamel-Martin procedure with special reference to obstructed patients. Dis Colon Rectum 1987;30:204–6.

153. Luukkonen P, Heikkinen M, Huikuri K, Jarvinen H. Adult Hirschsprung's disease: clinical features and functional outcome after surgery. Dis Colon Rectum 1990;33:65–9.
154. Wheatley MJ, Wesley JR, Coran AG, Polley TZ Jr. Hirschsprung's disease in adolescents and adults. Dis Colon Rectum 1990;33:622–9.
155. Bartram CI, Turnbull GK, Lennard-Jones JE. Evacuation proctography: an investigation of rectal expulsion in 20 subjects without defecatory disturbance. Gastrointest Radiol 1988;13:72–80.
156. Capps WF Jr. Rectoplasty and perineoplasty for the symptomatic rectocele: a report of fifty cases. Dis Colon Rectum 1975;18:237–43.
157. Marks MM. The rectal side of the rectocele. Dis Colon Rectum 1967;10:387–8.
158. Sehapayak S. Transrectal repair of rectocele: an extended armantarium of colorectal surgeons: a report of 355 cases. Dis Colon Rectum 1985;28:422–33.
159. Sullivan ES, Leaverton GH, Hardwick CE. Transrectal perineal repair: an adjunct to improved function after anorectal surgery. Dis Colon Rectum 1968;11:106–14.
160. Janssen LW, van Dijke CF. Selection criteria for anterior rectal wall repair in symptomatic rectocele and anterior rectal wall prolapse. Dis Colon Rectum 1994; 37:1100–7.
161. Mellgren A, Anzen B, Nilsson B-Y, *et al.* Results of rectocele repair: a prospective study. Dis Colon Rectum 1995;38:7–13.
162. Farouk R, Duthie GS, Bartolo DC. Functional anorectal disorders and physiological evaluation. In: Beck D, Wexner SD, eds. Fundamentals of anorectal surgery. New York: McGraw-Hill, 1992:68–88.
163. Lesaffer LPA. Defecography—update 1994. Gent Story-Scientia 1994;75–80.
164. Wasserman IF. Puborectalis syndrome rectal stenosis due to anorectal spasm. Dis Colon Rectum 1964;7: 87–98.
165. Wallace WC, Madden WM. Experience with partial resection of the puborectalis muscle. Dis Colon Rectum 1969;12:196–200.
166. Keighley MR. Surgery for constipation. Br J Surg 1988; 75:625–6.
167. Barnes PR, Hawley PR, Presto DM, Lennard-Jones JE. Experience of posterior division of the puborectalis muscle in the management of chronic constipation. Br J Surg 1985;72:475–7.
168. Kawano M, Fujiyoshi T, Takagi K, *et al.* Puborectalis syndrome. J Japanese Society Coloproct 1987;40:612.
169. Yu D-H. Surgical treatment of puborectalis hypertrophy. In: Wexner SD, Bartolo DC, eds. Constipation: etiology, evaluation, and management. Oxford: Butterworth-Heinemann, 1995:232–9.
170. Wexner SD, Cheape JD, Jorge JM, Heymen S, Jagelman DG. Prospective assessment of biofeedback for the treatment of paradoxical puborectalis contraction. Dis Colon Rectum 1992;35:145–50.
171. Nogueras JJ, Wexner SD. Biofeedback for nonrelaxing puborectalis syndrome. Semin Colon Rectal Surg 1992; 3:120–4.