MEDICAL REVIEW

The Specialty of Colon and Rectal Surgery: Its Impact on Patient Care and Role in Academic Medicine

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The specialty of colon and rectal surgery, a specialty of general surgery, has evolved from the field of proctology. Clinical care has demonstrated decreased number of patients requiring intestinal stomas, improved quality of life in patients with benign anorectal disorders, and more favorable results in patients afflicted with primary and recurrent colorectal cancer. Basic science investigations have spawned from clinical questions such as the molecular biology of colorectal cancer, use of cyclooxygenase inhibitors and polyp regression, and novel cytokine antagonists in inflammatory bowel disease. Medical students are exposed to surgeons with expertise in anorectal anatomy and physiology, mechanisms of carcinogenesis and the importance of screening for detection of colorectal cancer, and novel therapies for inflammatory bowel disease. Surgical residents benefit by having a colorectal surgeon on the faculty by repetitive exposure to anorectal surgery, low pelvic anastomoses, stoma creation and closure, and surgery involving the small intestine. Senior colorectal surgeons will develop critical pathways for the healthcare delivery of patients afflicted with colorectal disease. The specialty of colorectal surgery will continue to translate into improved patient care and positively impact in academic medicine by providing expertise into student and resident training and generate highly sophisticated clinical and basic science investigations.

INTRODUCTION

The controversy over specialization in medicine has existed for almost 100 years. Specialization has evolved to provide care for specific populations, for explicit services and as a result of new technology. Clearly, the healthcare market demands driven by the consumer have championed demands to no end. Specialization provides state-of-the-art knowledge and care of complex areas, high volumes of routine procedures, educational benefits to students and those in postgraduate training and intangibly provides the answers to questions that continue to appear in the clinical arena that need to be translated from bench research to evidenced based medicine. This is all so true

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Abbreviations: CT, computed tomography; FDG-PET, flurodeoxyglucose positron emission tomography; FAB, familial adenomatous polyposis; HNPCC, hereditary non-polyposis colorectal cancer; MRI, magnetic resonance imaging.
for the specialty of colon and rectal surgery. The surgical anatomy is challenging; physiology is better understood but unknown to those outside the specialty; pharmacology is playing a crucial role as in the mediators of the anal sphincters; and pathology is never-ending. Clinically, the issues are challenging: fears of stomas in cancer surgery, young adults undergoing major intestinal resections for inflammatory bowel disease, life-altering bowel dysfunction in patients with fecal incontinence and constipation, and anal disease that if mismanaged can be quite costly to the patient and surgeon. The opportunities for investigation are numerous and include colorectal cancer genetics, biological therapies for colorectal cancer, mediators of inflammation, implantable devices, tissue engineered intestine and robotics. This review will discuss the specialty of colon and rectal surgery as it relates to its evolution, training and board certification, spectrum of clinical activity, educational initiatives, and frontiers of research.

EVOLUTION OF THE SPECIALTY

It was Frederick Salmon founder of St. Mark’s Hospital, whose interests in anal fistulas and other diseases of the rectum attracted his successors, William and Herbert Allingham, to create the new specialty of proctology in the mid-1800s. In 1878, it was the American Dr. Joseph Matthews who upon noticing that in his practice in Kentucky a lack of interest and attention for patients with rectal problems, went to study with Dr William Allingham. Upon his return to Kentucky, he announced that he was going to limit his practice to diseases of the colon and rectum and became America’s first full-time proctologist. He later became Professor of Surgery in the Kentucky School of Medicine and in 1883, established the Department of Proctology in the Medical School [1]. Since the 1880s there have always been a few surgeons who devoted special attention to colon and rectal surgery. Until lately, the vast bulk of bowel surgery remained in the hands of general surgeons. In the United Kingdom, surgeons such as Percy Lockhart-Mummery and John Goligher, paved the way for specialization in colon and rectal surgery. In the United States, recognition of colon and rectal surgery as a distinct field has only become evident over the past twenty years [2].

AMERICAN BOARD OF COLON AND RECTAL SURGERY

Since its inception in 1899, the American Proctologic Society has been innovative and, above all, concerned with patients needs. Always moving forward, members of this society organized and incorporated into the American Board of Proctology in 1935. It was the sixth specialty board to be organized and tenth board to be incorporated. After becoming a subsidiary of the American Board of Surgery from 1935 to 1949, there were continued efforts for independence. After continuing efforts to gain independent status, in February 1949, The American Board of Proctology was granted independent status. Over the next ten years, the Board became active not only in examining and certifying physicians but also involved in medical education. On April 15, 1961, the Advisory Board for Medical Specialties granted the American Board of Proctology to adopt the name The American Board of Colon and Rectal Surgery. In 1980, the Board mandated completion of a general surgery residency and becoming board certified in general surgery prior to being able to acquire board certification in Colon and Rectal Surgery [3, 4].

FELLOWSHIP TRAINING AND BOARD CERTIFICATION

During the chief-resident year, a prospective board eligible general surgery resident makes application through the National Residency Matching Program for fellowship training in colon and rectal
surgery. There are currently 41 training programs in colon and rectal surgery throughout the United States and Canada. The number of fellows in each program ranges from one to four. The fellowship is of one-year duration of clinical colon and rectal surgery with certain programs having the option for an additional year of research or further clinical training as a fellow. Upon completion of training, candidates for board certification in colon and rectal surgery must be in good standing, submit a case log to the board, and demonstrate board certification in general surgery. To become board certified, a written examination including sections in pathology and radiology must be passed (qualifying examination) and an oral certifying examination will certify the applicant as board certified in colon and rectal surgery. Physicians with an interest and expertise are encouraged to become a member of the American Society of Colon and Rectal Surgeons. Recertification for those certified after 1990 is every ten years.

IMPACT ON PATIENT CARE

Benign anorectal disease

Hemorrhoids: Hemorrhoids are one of the most common gastrointestinal disorders affecting nearly 5 percent of the United States population. It is estimated that two and a half million persons per year visit physicians for treatment [5]. Therapy can be broadly categorized into oral therapy such as fiber, topical treatments, nonsurgical destructive techniques, and surgical intervention. The decision to treat is based on the nature, frequency, and severity of symptoms. It is also based upon patient preference and operator experience. The overwhelming majority of patients who seek treatment will receive conservative therapy where the goal is to relieve symptoms and maintain remission. Fiber supplements and increased water intake are often first-line therapy, however the results remain inconsistent. Regardless, fiber supplements given over six weeks are superior versus placebo for reduction of bleeding symptoms [6]. It will remain first-line therapy because it is safe and inexpensive. Topical therapies reduce symptoms by exerting a local anesthetic effect eliminating the symptoms of burning and itching. A number of topical therapies are available. Only one randomized trial utilizing 5-ASA suppositories demonstrated significant reduction in hemorrhoidal symptoms when compared to placebo [7]. Bleeding or other symptoms that persist despite conservative management require more aggressive therapy. This entails either non-surgical options or surgical hemorrhoidectomy. The goal of non-surgical therapy is tissue fixation of the hemorrhoid pedicle. These methods include rubber band ligation, injection sclerotherapy, and infrared coagulation. None of these techniques have been investigated individually against placebo-controlled trials [8]. However, randomized trials comparing these modalities with each other have been performed. These results failed to demonstrate a clear advantage and appear to be equally effective. Two meta-analyses [9, 10] comparing all three modalities have been performed. Both trials demonstrated IRC and RBL to be more efficacious than sclerotherapy. IRC required repeat treatment, while RBL was significantly more painful. The decision to proceed to surgical hemorrhoidectomy requires a mutual decision between the patient and physician and is reserved for patients who fail non-operative therapy [9]. It is also indicated for the rare instances of acutely thrombosed and gangrenous internal hemorrhoids. When contemplating surgery, the risk of complications, postoperative pain, and cost must be realized. A number of excisional techniques have been described and are performed in the operating room under local, regional, or general anesthesia. Despite its effectiveness, few patients should require excisional hemorrhoidectomy. Laser hemorrhoidectomy results in delayed
bleeding, increased pain and increased cost. The most significant change in hemorrhooid surgery is the use of the circular stapler. A randomized controlled trial examining pain, complications, cost, and recurrence using this modality is underway.

**Anal fissure:** Fissure-in-ano is a common condition seen by primary care physicians and surgeons. It presents with pain after defecation that persists for a variable period of time and may be associated with rectal bleeding. Although the pathogenesis often remains poorly understood, it is felt to be related to a combination of spasm of the internal anal sphincter and relative ischemia of the posterior midline of the anal canal. Other etiologies of an anal fissure, especially when located away from the midline, should be sought out. Manometric studies have demonstrated high resting anal canal pressures and ultraslow pressure wave activity in the internal anal sphincter. Classic treatment involves stool softeners, fiber supplements, and warm, tub baths. This will heal about 30 percent of fissures. If the fissure does not heal, then it becomes chronic. This is manifest by anatomic signs such as exposed anal sphincter fibers, sentinel piles, and hypertrophic anal papilla. The standard classic treatment following failure of conservative therapy involves a surgical anal internal sphincterotomy, which is effective in the overwhelming majority of patients. Various refinements in the procedure, open versus closed, partial versus total have occurred [10, 11]. Currently, full thickness, partial, lateral sphincterotomy is what is supported. Regardless, division of the internal anal sphincter may result in variable degrees of fecal incontinence especially in women who have undergone vaginal delivery with occult sphincter damage. This rare, but distressing complication, has resulted in surgeons seeking alternatives to conventional sphincterotomy. The neurotransmitter in the internal anal sphincter leading to relaxation is nitric oxide. Chemical sphincterotomy utilizing nitric oxide donors applied to the anal margin of patients with anal fissure have been utilized with variable success [12-14]. Alternative agents have also been investigated. Botulism toxin injection prevents the release of acetylcholine by presynaptic nerve terminals and injection into the internal anal sphincter lasts clinically for three to four months. The internal anal sphincter has a calcium dependent mechanism and an extrinsic cholinergic innervation which can be exploited to reduce resting anal pressure. Topical diltiazem and betanechol are currently being investigated and may be additive [16]. Surgery is referred for medical treatment failures or to meet immediate patient wishes.

Operative techniques commonly used for anal fissure include a anal stretch, open and closed lateral sphincterotomy, posterior midline sphincterotomy, and dermal flap coverage. Anal stretch has a higher risk of persistence of fissure symptoms when compared to sphincterotomy and carries a higher risk of incontinence. There is little difference between open and closed lateral internal sphincterotomy regarding persistence of fissure and risk of incontinence. It is unclear whether posterior midline sphincterotomy should be primary surgical treatment [11]. The management of anal fissures will continue to evolve similar to that of hemorrhoids in that there will be less anal sphincterotomies performed in the future.

**Fistula-in-ano and abscess:** A fistula is defined as an abnormal communication between any two epithelial lined surfaces. A fistula-in-ano is an abnormal tract or cavity communication with the rectum or anal canal by an identifiable internal opening. These result, in the majority of cases, from a previous anorectal abscess and become a fistula secondary to chronicity. The classification by Parks is the most helpful classification currently. There are four classifications of fistula-in-ano: intersphincteric, transspincteric, supraspincteric, and extraspincteric. These are often cryptoglandular in nature but may also arise as a consequence of Crohn's disease
and other infectious etiologies. For challenging cases, especially in the presence of recurrence, physical examination should be supplemented with fistulography, intrarectal ultrasound or magnetic resonance imaging (MRI)\(^6\) [17]. It is extremely rare for a fistula-in-ano to heal by conservative measures. The principles of fistula surgery are to eliminate the fistula, prevent recurrence, and preserve sphincter function. The type of fistula will often dictate which operative procedure should be performed. Fistulotomy using the lay-open technique is used for the treatment of simple intersphincteric and low trans-sphincteric fistulas. The problem of preserving anal continence and treating the fistula is more complicated when treating high intersphincteric fistulas. Insertion of a seton in combination with a lay open technique may be safer in this situation [18]. In patients with high trans-sphincteric fistulas and suprasphincteric fistulas, consideration to a anorectal advancement flap should be given [19]. Extrasphincteric fistulas, which are exceedingly rare, depend on the etiology (abscess, Crohn’s disease, or foreign body) and often require fecal diversion along with eliminating the fistula. Impaired continence is greatly feared following fistula surgery. This, along with varying recurrence rates have caused surgeons to seek sphincter muscle sparing techniques to treat anal fistulas. The use of tissue adhesives or sealants in surgery has increased because of improved autologous and commercially available products. A number of studies have now demonstrated fistula closure rates at approximately 85 percent [20, 21]. Functional results have remained excellent. Future investigations are necessary to determine the most effective fibrin glue type and operative technique to improve on these results.

**Ulcerative colitis**

Many of the surgical innovations in surgery have impacted favorably on the treatment of ulcerative colitis. This includes the Brooke ileostomy, the ability to successfully and safely complete an ileorectal anastomosis, the Kock continent ileostomy, and finally the ileal pouch anal anastomosis. The etiology of ulcerative colitis remains obscure, however environmental, dietary and genetic factors continue to be implicated [22]. It is a disease with a bimodal peak in age that affects men and women equally. Innovative medical therapies such as the development and ability to deliver adequate amounts of 5-ASA compounds to the colon, development of novel steroid compounds with minimal side effects and immunosuppressive therapies have all contributed to the well being of patients [23]. The primary indication for surgery remains intractability with acute surgical emergencies less so and surgery for invasive cancer exceedingly rare. Aggressive colonoscopic surveillance has resulted in detection of dysplasia and mass lesions, which has hopefully translated into fewer operations for cancer. Proctocolectomy with construction of an ileoanal reservoir anastomosis is the procedure of choice and may be either a staged or single procedure. There remains complications related to the procedure such as anastomotic dehiscence, which may result in chronic pelvic sepsis or anal stricture as well as pouch fistula to either the vagina or perineum. Remedial operations to correct pouch derangements such as advancement flaps or creating a neo-reservoir can be successfully performed in experienced hands [24]. In properly selected patients, the ileoanal pouch anastomosis provides patient satisfaction at over 90 percent [25]. Patients are plagued with pouchitis resulting in watery diarrhea that often responds to metronidazole. Probiotics are currently under investigation to balance pouch ecology. In patients felt not be candidates for a restorative operation, proctocolectomy and Brooke ileostomy improves quality of life and rids the patient of medication. In patients who have had a previous proctocolectomy and sacrifice of the anal sphinc-
ter mechanism, a continent ileostomy may be considered. Patients with “indeterminate colitis” have been shown to be candidates for a restorative proctocolectomy [26].

**Crohn’s disease**

Crohn’s disease is associated with transmural involvement of any portion of the gastrointestinal tract and, similar to ulcerative colitis, no specific etiology has been identified. Medical therapy has reduced the number of reoperations and is also utilized to prevent recurrence after all gross disease has been removed at surgery. Because of the nature of this disease, patients are plagued with obstructive symptoms secondary to strictures, sepsis as a result of perforations and fistulas, and the challenges of managing their perianal disease. Clearly, tremendous advances have been made regarding the potential etiologies, pathophysiology, diagnostic imaging, medical therapies, and role of nutritional supplementation of this disease since its initial descriptions in the early 1900s. Efforts to elaborate on each of these issues is beyond the scope of this article, and readers are encouraged to review the myriad of papers addressing each of these issues.

Surgery remains an integral part of treatment and should not be viewed as doom and gloom. Clearly the results of operative therapy have dramatically improved patients quality of life, even in the setting of temporary or permanent fecal diversion [27]. Surgery for small and large intestinal disease has evolved from bypass procedures and extensive intestinal resection to a more conservative approach involving conservative surgical therapies. This has been facilitated by the use of interventional radiology involving percutaneous drainage of abscesses, total parenteral nutrition including its use in the home setting, and the use of medical therapy in the postoperative setting following resection of all macroscopic disease. Wide intestinal anastomoses using linear stapling techniques, the use of limited (< 2 cm) resection margins, and the technique of strictureplasty has decreased short and long term morbidity and improved quality of life [27, 28]. Similarly, conservative resectional treatment involving the colon also continues to evolve [29].

Two areas deserve special interest, they being acute surgical emergencies and perianal Crohn’s disease. The morbidity and mortality for acute emergencies such as toxic colitis, hemorrhage and perforation has somewhat diminished due to improvements in surgical technique and intensive care medicine. It is also my perception that patient compliance to medical care and specialization in gastroenterology in the area of inflammatory bowel disease has potentially reduced the number of surgical emergencies.

Perianal Crohn’s disease has continued to plague surgeons because of the fear of fecal incontinence, uncontrolled pelvic sepsis, and the need for removing the patients rectum necessitating permanent colostomy. Currently, conservative approaches involving drainage of abscesses with mushroom catheters, use of non-cutting setons, antibiotics, and anti-TNF therapy has resulted in controlled sepsis and preservation of function.

**Colorectal cancer screening**

Current colorectal cancer screening options include fecal occult blood testing, flexible sigmoidoscopy, air-contrast barium enema, fiberoptic colonoscopy, virtual colonoscopy, and stool DNA tests. Guidelines for screening revolve around whether you are a high-risk or average-risk patient as well as the results of the initial screening procedure. Fecal occult blood testing is non-invasive, least expensive, and most widely available but has suboptimal sensitivity and prevents the fewest cancers. Barium enema is inexpensive and cost-effective but insensitive when compared to colonoscopy. Fiberoptic colonoscopy is very sensitive for colorectal lesions, but is most invasive and costly. Stool DNA testing is evolving. This is promising tech-
nology because colorectal cancers contain genetic mutations or inactivated genes. The test hopes to identify genetic abnormalities in colonocytes shed in the stool. Early clinical studies suggest that multi-target, DNA-based stool tests are capable of detecting both premalignant adenomas and cancers with high sensitivity and specificity. This form of testing is attractive because it is non-invasive, requires no bowel preparation or dietary restrictions and requires a single specimen [30].

Screening colonoscopy is cost-effective and provides high patient satisfaction because it provides effective diagnosis and treatment in a single session. Virtual colonoscopy (Computed tomography [CT] and MR) colonography performance relies on the use of state-of-the-art scanners, computer workstations and trained radiologists. Both CT and MR colonography currently report excellent sensitivity equal to colonoscopy and the advantage of MR is lack of ionizing radiation [31].

**Inherited colon cancer**

Approximately 80 percent of patients with colorectal cancer appear to have sporadic disease whereas approximately 20 percent have a potentially definable inheritable component. Several hereditary syndromes caused by specific germline mutations have been characterized and account for 5 to 6 percent of all colorectal cancer patients [32]. These include familial adenomatous polyposis (FAP), hereditary non-polyposis colorectal cancer (HNPCC), Peutz-Jeghers syndrome, and juvenile polyposis. When used appropriately, genetic testing is available for diagnosis of the major inherited syndromes of colon cancer. FAP is an autosomal dominantly inherited syndrome that arises from germline mutations of the APC (adenomatous polyposis coli) gene. Clinically it is characterized by the occurrence of hundreds to thousands of colorectal adenomatous polyps at an early age and inevitably colon cancer unless colectomy is performed. In addition to polyps, patients with FAP can develop a variety of extracolonic lesions. These include both benign and malignant tumors. The diagnosis is confirmed by the presence of 100 or more adenomas on colonoscopic examination. Also the diagnosis of FAP can be confirmed by genetic testing for the APC gene mutation. It will be present in 80 to 90 percent of affected individuals. If the mutation is found in pedigree, yearly sigmoidoscopy should begin at age 12, decreasing in frequency after each decade up to age 50, at which time screening should conform to American Cancer Society guidelines for average risk patients [33]. Surgery is recommended at the time of diagnosis to minimize the risk of malignancy. There are several options including total abdominal colectomy with ileorectal anastomosis or total proctocolectomy with either ileostomy or ileoanal pouch anastomosis. If the rectum can be cleared endoscopically, rectal preservation is preferred. Surveillance of the rectum is performed. Cyclooxygenase inhibitors have been shown to be effective in inducing regression of polyps in the retained rectum.

HNPCC is an autosomal dominant inherited disorder that accounts for 3 to 5 percent of all colorectal cases. It is caused by a mutation in any one of the five mismatch repair genes. Colorectal cancer arises from a single flat polypoid lesion in the absence of polyposis. It is characterized by a young age for developing colorectal cancer, multiple tumors, proximal lesions, and metachronous tumors within 10 years of resection. Similar to FAP, other cancers can occur in HNPCC especially gynecological. The phenomenon on microsatellite instability is found in 90 percent of HNPCC tumors and is the first step in genetic testing followed by MMR gene testing to confirm the diagnosis. In a patient with HNPCC who develops colorectal cancer, subtotal colectomy with ileorectal anastomosis is recommended. Postoperative endoscopic surveillance should be performed every six months.
[34]. It is uncertain whether prophylactic hysterectomy and oophorectomy is indicated.

Rectal and anal cancer

The management of rectal cancer has progressed tremendously over the past 100 years, in part because of an increased understanding of the pathology and natural history of the disease [35]. Currently, surgery remains the mainstay of therapy and includes a spectrum of operative procedures both radical and local with a trend towards increased number of sphincter sparing procedures. Preoperative diagnostic imaging has provided preoperative assessment of loco-regional and distant disease and aids in decisions of whether to employ preoperative neoadjuvant therapy involving radiation and chemotherapy [35]. Regardless, outcome appears to be related to tumor biology, stage of the lesion at presentation, and type of operation performed. Recently, the impact of the surgeon performing the operation may also influence outcome [36]. Preoperative imaging remains an essential part of the assessment of the patient with rectal cancer. CT is useful in assessing patients thought to harbor extensive local or metastatic disease. Endorectal ultrasound is the best method for evaluating loco-regional disease. It is highly accurate for detecting depth of invasion and less so for perirectal lymph nodes. Magnetic resonance imaging (MRI) can also detect local tumor extension. Nuclear medicine techniques utilizing either fluorodeoxyglucose positron emission tomography (FDG-PET) and immunoscintigraphy are utilized to detect occult or recurrent cancer [35]. Radiation therapy is an integral part of treatment for patients with rectal cancer. Its role is to decrease local recurrence and hopefully translate into improved survival rates. In the preoperative setting, radiation can increase respectability of bulky lesions and increase chance of sphincter preservation in distal lesions. Intraoperative radiation therapy is applied to locally advanced primary and recurrent rectal cancer. Postoperative adjuvant chemotherapy has shown survival benefit with the optimal regimen evolving.

Anal cancer is rare and accounts for 1 to 6 percent of all anorectal neoplasms. It is important to distinguish anal canal from anal margin neoplasms as the former are more aggressive. The goals of treatment are cure, local control, sphincter salvage, and avoiding permanent colostomy. There remains various histiotypes, with squamous cell being most common while adenocarcinoma arising from the anal glands and anal melanoma being uncommon. Throughout the 1970s, abdominoperineal resection was the standard treatment resulting in a permanent colostomy, high local recurrence rates, and low five-year survival rates. Nigro initiated the force of change and began the first successful use of combined fluorouracil and mitomycin with external beam radiation as potentially curable therapy [37]. Today modifications of Nigro's protocol remain the standard of care for treatment of squamous cell carcinoma of the anal canal. Abdominoperineal resection remains salvage therapy for treatment failures with variable survival rates. Anal adenocarcinoma is treated similarly to that of rectal adenocarcinoma employing surgery with or without adjuvant chemoradiation. Anal canal melanoma has a continued poor prognosis where surgery is the only meaningful method of treatment with the goal being local control [38].

Fecal incontinence

Fecal incontinence remains one of the most devastating conditions. Its exact incidence remains unknown but varies between 1 to 3 percent and up to 7 percent in healthy adults over 65 years of age [39]. There is a higher rate in women secondary to obstetric-related structural sphincter damage. The etiologies are numerous and are often related to obstetrical trauma, previous anal surgery, rectal prolapse, pelvic floor denervation, radiation, and following sphincter-saving
operations. Fecal incontinence may be either passive or urgent in nature. Passive incontinence relates to losses occurring without patient awareness usually associated with internal sphincter dysfunction and reduced maximum resting anal pressure. Patients with urgency incontinence are unable to defer defecation, which usually reflects either external sphincter dysfunction or excessively strong bowel contraction that cannot be opposed by the external sphincter pressure. A careful history and physical examination is imperative to differentiate isolated sphincter dysfunction from general metabolic and neurologic disorders. Special physiologic examinations have allowed the physician to permit assessment of the anal sphincters, pudendal nerves, and pelvic floor. These include anal manometry, cinedefecography, electromyography, anal ultrasonography, and magnetic resonance imaging [40].

Many patients can be managed by means of pharmaceutical products such as antidiarrheals or behavioral modification such as biofeedback. Daily colonic irrigation remains another alternative but has potential adverse sequela. A number of surgical procedures are available for the treatment of anal incontinence. Most operations attempt to restore the sphincter mechanism and anorectal angle. These include either anorectal muscle repairs such as direct apposition and overlapping sphincteroplasty or total pelvic floor repair [41]. Severe multifocal damage to the sphincter complex may not be suitable for direct sphincter repair and require either a static or dynamic neosphincter repair [42]. These include gluteus and gracilis muscle transpositions or free muscle transpositions involving sartorius muscle. Implantation of an artificial sphincter was initially popularized in 1992 and remains under investigation [43]. Finally, the creation of an intestinal stoma remains the last option for treatment of incontinence. This can be performed laparoscopically. Neurogenic incontinence remains a difficult condition and may benefit by biofeedback and other conservative measures [44].

**Functional and pelvic floor disorders**

The majority of functional pelvic floor disorders are the result of or result in abnormal defecatory habits. Often these disorders have constipation as the predominant symptom [45]. Sophisticated physiological testing and diagnostic imaging techniques have identified the etiology of many of these defecatory disorders and resulted in therapies to patients who would have previously been ignored. Paradoxical or non-relaxing puborectalis syndrome (anismus) occurs when the puborectalis inappropriately contracts or fails to relax during defecation resulting in pelvic outlet obstruction. The diagnosis is confirmed with a combination of anorectal manometry, electromyography and cinedefecography. Biofeedback therapy is the initial treatment of choice [46]. Treatment failures may respond to Botox injections. Surgery has no role. The Descending Perineum Syndrome has a similar presentation as anismus with obstructed defecation as the predominant symptom. It is felt to be secondary to many years of straining to defecate. It is diagnosed by perineometric measurements and cinedefecography. Treatment is limited to nonoperative methods including biofeedback. A rectocele may also produce obstructed defecation. The diagnosis is made by a history of straining and the need for digital rectal or vaginal evacuation. Physical examination provides the diagnosis in about two-thirds of cases where the rectum is seen bulging into the vagina. Defecography will reveal the rectocele and provide useful information about the anorectal angle. Treatment is initially conservative. Surgery is recommended for patients rectocele's greater than 4 cm partial emptying during defecography and the need to digitally evacuate. A wide range of transvaginal, transrectal, and transperineal procedures have been advocated with variable success. Rectal prolapse
is full thickness protrusion of the rectum through the anal sphincters. Internal or "hidden" prolapse occurs when the rectum intussuscepts, but does not pass beyond the anal canal. Symptoms include protrusion, bleeding, fecal incontinence, and a sense of incomplete rectal emptying. Full thickness rectal prolapse must be differentiated from rectal mucosal prolapse seen in association with advanced hemorrhoidal disease. Management of rectal prolapse is surgical [47]. Over 100 procedures have been described. They may either be abdominal or perineal. Normal anatomy is restored. A widely variable effect of prolapse surgery on disturbed evacuation occurs. Continence is often restored.

**Intestinal stomas and alternatives to conventional ileostomy**

During the first half of the twentieth century, an ileostomy was associated with significant morbidity secondary to serositis of the exposed bowel wall. This was rectified by the development of the technique of an evverting ileostomy in 1952 by Brooke [48]. This dramatically changed surgical treatment and life with an ileostomy. Nevertheless, patient dissatisfaction of a constantly draining stoma and the requirement of a full-time pouch caused physicians to develop alternatives. In 1969, Nils Kock [49] described the creation of an ileal reservoir drained by an access segment through the rectus muscle. He modified this with a nipple valve of intussuscepted ileum creating complete continence. A further modification was proposed by William Barnett who developed the Barnett reservoir utilizing a living collar of ileum wrapped around the neck of the pouch to improve continence [50]. The utility of these procedures has diminished as a direct consequence of the creation of the ileoanal pouch for the treatment of ulcerative colitis and familial adenomatous polyposis. Although pouch salvage following anal and perineal complications of restorative proctocolectomy continue to improve, there is a role for a continent ileal stoma in the even the pouch can not be salvaged [51, 52].

**Anorectal physiological testing**

Manometric, electrophysiologic and radiologic techniques used in combination provide important basic information necessary to understand anorectal and pelvic floor disorders. Anorectal physiological testing evaluates the function of the anorectum, pelvic floor, and anal sphincters [53]. Its utility centers mostly on the evaluation of fecal incontinence [54]. The tests used most frequently are anorectal manometry, pudendal nerve terminal motor latency, concentric needle EMG, single fiber EMG, cine defecography, and colonic transit studies. Anorectal manometry utilizes various catheters probes and recording devices to determine resting sphincter pressures, anal sphincter length, maximum squeeze pressures, rectoanal inhibitory reflex, and rectal sensory volumes. Indications for anorectal manometry include evaluating patients with chronic constipation determining whether the patient has Hirschprung's disease as evidenced by absence of the anorectal inhibitory reflex, to quantitate a sphincter defect and assess contribution of the neural and muscular components necessary for fecal continence. Electromyography is the recording of electrical activity generated by muscle fibers and can be measured either during voluntary contraction or at rest. It is used to evaluate muscles whose nerve supply may have been damaged and thus is valuable in patients with pelvic floor disorders and fecal incontinence. It can be recorded with surface electrodes, concentric needle electrodes, and single fiber electrodes. Pudendal nerve terminal motor latency is best evaluated for anal sphincter injury secondary to trauma or vaginal delivery prior to surgical repair and evaluation of idiopathic fecal incontinence. Concentric needle EMG allows for selective recording of muscles of interest such as the puborectalis in patients with anismus [55].
Imaging of the anal sphincters and pelvic floor

Recent advances in ultrasonography have improved significantly the accuracy and applicability of intrarectal and intranal ultrasonography to the management of benign and malignant diseases of the anus and rectum. Intrarectal ultrasonography has demonstrated a high degree of accuracy in the assessment of extent of local invasion of rectal carcinomas as well as the degree of regional lymphadenopathy. It is also capable of detecting occult anorectal abscesses. In patients with fecal incontinence, it allows for the identification of sphincter defects. Defecography is a radiologic study in which thickened barium is introduced into the rectum and the patient is seated on a radiolucent commode and instructed to evacuate contrast material. A video recording is taken in the lateral projection. It is useful in evaluating patients with obstructed defecation in an effort to determine if patients have anismus, rectocele, internal proctocele, or excessive perineal descent. Colonic transit studies require patients to ingest radiopaque markers while receiving a normal diet, without using laxatives. Serial radiographs are taken at specified intervals to determine the speed with which the markers traverse the colon. A normal study should pass 80 percent of the markers by five days. If not, this is suggestive of colonic inertia. MR defecography with an open configuration magnet allows accurate assessment of anorectal morphology and function in relation to surrounding structures without exposing the patient to harmful ionizing radiation [56].

Minimally invasive techniques

The field of laparoscopic colon and rectal surgery has evolved slowly over the past decade as compared to other laparoscopic procedures. This is mainly due to the complexities of the procedures. Minimally invasive techniques can involve either abdominal procedures utilizing standard laparoscopic instruments or approaches to the rectum utilizing transanal endoscopic microsurgery. It is appealing for those who have pulmonary disease, those who would benefit from small incisions, and those who desire cosmesis. Almost every disease encountered in colon and rectal surgery is approachable laparoscopically, however, colorectal cancer patients at this time are best entered into a prospective randomized trial. Nevertheless, there remains a steep learning curve due to the fact that colorectal surgeons do little laparoscopy. Improvements in technology such as hand-assisted laparoscopy have gained momentum. Regardless, it is estimated that the number of colectomies performed by a totally laparoscopic, laparoscopically assisted, or hand-assisted laparoscopic technique is nationally less than 10 percent. There is currently some evidence that a minimally invasive approach may decrease postoperative ileus, requirements for postoperative analgesia, length of hospital stay, and cost. This is highly institutional dependent. Regardless minimally invasive approaches are attractive to patients with polypoid lesions of the colon not amenable to endoscopic removal, functional disorders such as rectal prolapse surgery, and select patients with inflammatory bowel disease. It would be premature to define its oncologic benefit or risk in colorectal cancer prior to the maturity of currently undertaken prospective randomized trials [57, 58]. For any colorectal surgeon, its utility will depend upon referral patterns and acuity and complexity of patients seen in their daily practice. It is doubtful that colorectal surgery will be dominated by laparoscopy, but it will continue to have a role in properly selected patients.

ROLE IN ACADEMIC MEDICINE

Resident and medical student education

Expertise by the educator often brings tremendous credibility to the learning environment. Currently, department chair-
men are recruiting faculty with specialization within general surgery in an effort to strengthen not only surgical education but to grow practices and increase clinical revenues. Popular areas of specialization include minimally invasive surgery, surgical oncology, endocrine surgery, and colon and rectal surgery. Within each of these disciplines “super specialization” with exposure, training, and experience in areas such as laparoscopic morbid obesity surgery, inflammatory bowel disease, minimally invasive parathyroidectomy, soft tissue sarcomas, and pancreatic neuroendocrine tumors also lends further credibility. Few papers have been written regarding the benefits of colon and rectal surgery to surgical education, but the advantages are obvious [59, 60]. Increased exposure of uncommon and poorly understood procedures involving the anus, the small intestine as well as creation of low pelvic anastomoses with or without an intestinal reservoir has been elegantly reported [61, 62]. Medical student exposure to surgery is a limited experience often involving three to four months of a 48-month curriculum. When rotating on surgery, there is often heightened enthusiasm for “knife and gun club surgery,” the cerebral aspects of surgical critical care, and the removal of large tumors en-bloc with other contiguous organs. However, a medical student may be uncertain about the indications for surgical hemorrhoidectomy, believe that all patients with rectal cancer require an abdominoperineal resection, or perceive that women with fecal incontinence have nothing to be offered other than a colostomy. As the specialty of colon and rectal surgery truly offers the benefits of a complete specialty: a challenging office practice, sophisticated diagnostic skills such as ultrasound and endoscopy, and a plethora of surgical possibilities involving the abdomen, pelvis, and perineum, it serves as a good role model of what a physician is all about. Furthermore one learns communication skills, develops personality traits, and practices ethical behavior when confronted with the anxiety and at times the tragedy of colorectal cancer, the functional limitations of fecal incontinence or living with a stoma, how disease can affect intimacy and personal relationships, and finally the effect of disease as it occurs in the late stages of one’s adult life.

Frontiers of research

Three principal areas that will continue to receive attention and funding in colorectal disease include mechanisms of carcinogenesis and therapy, suppressing inflammation and modulating inflammatory mediators seen in intestinal inflammatory states such as Crohn’s disease and ulcerative colitis and finally exploring mechanisms of intestinal motility and dysmotility as seen in irritable bowel syndrome and poor functional results following operations restoring intestinal continuity. It is likely that the majority of the research efforts in colon and rectal disease will involve cancer. The continuing advances being made in molecular biology will involve genetic profiling [63] resulting in identification of high-risk groups (inherited colorectal cancer) This will lend one to stratify an individual’s risk, develop alternative methods of detection such as fecal DNA sampling in sporadic cases, and bring about novel medical treatments involving biological therapies such as vaccines [64]. Angiogenesis appears to have come to the forefront of colorectal cancer investigation with the realization that the growth of tumors is dependent on angiogenic factors [65]. Chemoprevention involving dietary supplements such as calcium and folic acid or the daily administration of compounds that block critical enzyme pathways implicated in carcinogenesis such as cyclooxygenase continue to receive attention [66]. Continued emerging surgical technology will involve reducing surgical stress and its potential immunologic consequences by utilizing surgical trauma.

Understanding the mechanisms of the inflammatory cascade and use of novel
cytokine antagonists, growth hormone and colon stimulating factors have and will continue to impact favorably in intestinal inflammatory states. Infliximab (Remicaid) is a anti-tumor necrosis factor compound which has had a major impact in refractory fistulizing Crohn’s disease involving the intestine and the anorectum. From this landmark study, it is reasonable to assume that other compounds will be developed to regulate the inflammatory cascade. This will clearly be aided by the further understanding of the molecular events that occur during inflammation.

Surgeons with expertise in colon and rectal surgery are often called upon by their medical counterparts to evaluate patients with a variety of functional bowel disorders often manifested by abdominal or pelvic pain, cramping, constipation, diarrhea and incontinence. The benefits of colectomy for chronic constipation in highly selected patients and a combination of bowel retraining, biofeedback, and, where applicable, anal sphincter repair for fecal incontinence have been well established. However, a tremendous amount of time and healthcare resources have been utilized in patients with other functional disorders often with variable or unfavorable results. Recent advances in the understanding of neurotransmitters and gut hormones that regulate intestinal physiology have come to the forefront. After many years of failure of compounds such as cholinergic agonists and dopamine antagonists, highly focused research has directed physicians to learn how to manipulate the serotoninergic (5-hydroxytryptamine-5HT) mechanisms within the gut. A number of significant advances including 5-HT3 antagonists for diarrhea predominant irritable bowel and 5-HT4 agonists for constipation irritable bowel have been met with favorable results [67].

CONCLUDING REMARKS

Colon and rectal surgery is a true specialty. Expertise can have a favorable impact on patients afflicted with afflictions of the colon, rectum, and anus. It will impact favorably on patients who develop rectal cancer by both increased number of sphincter preserving procedures and decreased local recurrence, increased the number and quality of restorative procedures for ulcerative colitis, offer alternatives for patients with disabling fecal incontinence, result in diminished complications following surgery for benign anorectal disease and overall diminish the number of patients who require an intestinal stoma. Within the academic setting, the path is clearly paved for novel and influential research initiatives in both the basic sciences and translational research. Its multifactorial role in education, character building and as a role model has yet to be fully realized but will continue to come of age.

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