New Rectal Construction After Abdominoperineal Resection for Carcinoma Rectum

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Abstract The results of the new reconstruction of the rectum after Abdominoperineal Resection (APR) with ‘S’-trap arrangement of the colon and continent perineal colostomy controlled by adynamic bilateral graciloplasty are evaluated. The fully stretched gracilis muscles were utilized for occlusion of the lumen of the colon. **METHODS and MATERIALS:** Between April 1993 and December 2006, selected 42 patients (30 males and 12 females) with median age of 43.5 years (25–64 years) were treated by a one-stage procedure without colonic diversion. All patients were suffering from adenocarcinoma of the lower third of the rectum. The abdominoperineal resection was carried out in all cases. A 25-cm-long vascular segment of the colon was installed in the sacral curve and ‘S’-shaped trap was developed with fixed colonic curves at the coccyx and to the left ischial rami of the pubic bone. The left gracilis was wrapped around just distal to the fixed curve of the colon to the left ischial rami and right one around the perineal colostomy with different grades of tightness. Continence was satisfactory in 34 patients; they could hold more than 1,000 ml of saline. Occasional soiling was reported in the night in 8 patients. All patients have achieved near-natural continence. The new rectal reconstruction with ‘S’ arrangement of colon and continent perineal colostomy achieved near-natural continence in 66% of cases.

Keywords Rectal reconstruction · APR · Continent perineal colostomy · ‘S’ arrangement of the colon · Modified transposition of the gracilis · Bilateral adynamic graciloplasty

Introduction

In 1908, Miles described abdominoperineal resection for carcinoma of the lower third of the rectum and diversion by permanent colostomy. Many techniques are tried to avoid permanent colostomy. The sphincter-preserving procedures are derived to save the anal sphincter, and they are justified by elaborating lesser tumor-free margins [1, 2]. With the advent of stapling instruments [3] and the techniques such as transanal coloanal anastomosis, the incidence of (APR) is reduced by 50% [4]. In spite of the tendency toward sphincter-saving procedures, a small proportion of 50% of the lower one-third rectal cancers still requires abdominoperineal resection and permanent iliac colostomy [5]. There are significant numbers of patients who do not agree to the treatment with permanent iliac colostomy [6]. The patients have immense interest in preserving lower-end continuity. The physical, psychological, and social consequences of a permanent iliac colostomy are a real challenge [7].

The gracilis muscle has all the qualities of an ideal muscle for transposition. It is a long muscle with single predominant neurovascular pedicle, situated superficially and easily accessible. Most of the experience about the gracilis muscle configurations (e.g., pinch cock, ‘U’ sling, and alpha sling) originates from the Pickrell’s operation for the treatment of fecal incontinence [8–10]. However, functional results of gracilis muscle transposition are unpredictable. The gracilis is a fast-twitch and fast-fatigue type-II striated muscle, which can contract continuously for a short period only. The basic problem has been that the patient cannot achieve sustained contraction of the transposed striated muscle. Therefore, the gracilis muscle was adequately electromyostimulated. During 1985–1996, Cavina and his coworkers [11, 12] from Paris reported the important dynamic graciloplasty procedures for incontinent

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perineal colostomy. They obtained good functional results by electromyostimulated.

The authors have successfully implemented gracilis muscle as an elastic and contractile band, which effectively closes the lumen of the colon during its resting phase. The muscle contractions are not required to occlude the lumen of the colon. Here we are presenting our clinical experience of the one-stage construction of the neorectum after abdominoperineal resection for cancer of the lower third of the rectum.

Patients

Between January 1993 and December 2006, 42 patients with carcinoma of the lower third of the rectum were treated in the Employee State Insurance Scheme (ESIS) Hospital at Mulund, Mumbai and Jeevan Jyot Hospital at Thane. The procedure was discussed in the ethical committee of ESIS Hospital Mulund, Mumbai, and permission was granted. The patients were explained about the quality of life and continence after procedure, and consent was taken for colostomy if it failed. All these patients were evaluated by clinical examination, proctoscopy, sigmoidoscopy, biopsy, contrast CT scan, ultrasonography, and serum carcinoembryonic antigen level. They were also investigated for their fitness for surgery and anesthesia. Well-differentiated adenocarcinoma of rectum grades I, II, and III and stages I and II involved rectum close to the sphincter were included in the study. The patients in stages III and IV, with poorly differentiated histology, in poor morbid health and extreme age group were excluded from the study.

Procedure

Under epidural/General Anaesthesia (GA), the patient was positioned in modified Lloyd-Davies lithotomy position and laparotomy was performed. The colon was transected at the midsigmoid colon at least 15–20 cm from the upper margin of growth. The inferior mesenteric vessels were ligated distal to the sigmoid first artery, and remaining vascular arches of the colon were preserved. About 20–25 cm extra-long segment of the colon was available after reaching the perineal wound. The distal segment of the colon was installed in the sacral cavity in natural lie without any twist or tension either on colon or its vessels. The available peritoneum was sutured around the colon. In the same position, 5–8 cm long segment of the colon was fixed by interrupted sutures between tenia coli and periosteal tissue covering the coccyx and the lower part of the sacrum. The remaining free distal segment of the colon was turned

upward to the left ischial rami of the pubic bone. The 5–7 cm tenia coli of the colonic segment was fixed to the rami of the pubic bone by interrupted sutures. Left gracilis muscle was threaded through a window created in a vascular arch and wrapped around the colon (Fig. 1). The distal part of the muscle was fixed at a measured length to reach its entry at pelvis. A ‘U’ sling was created by suturing the ascending and descending limbs of the gracilis muscle. The limbs of the ‘U’ sling were sutured up to the wall of the colon and the ‘U’ sling was converted into a circular sphincter. The circular sphincter was tight enough to occlude the lumen of the colon. It was allowing thumb and index fingers to enter in the occluded lumen of the colon without much force (as tested in an intestinal anastomosis). The portion of the gracilis muscle in contact with the seromuscular layer of the colon was blended together by 000 polyglactin interrupted sutures.

The seromuscular layer at the open end of the colon was fixed first on the lateral sides to the subcutaneous tissue of the perineal wound at the proposed colostomy site. Through the anterior and posterior open portions of the perineal wound, gracilis muscle was wrapped around the colon in alpha configuration and its distal end was fixed to the coccyx/left ischial tuberosity. A complete circular sphincter was constructed in the subcutaneous plane, which was tightly occluding lumen of the colon (Figs. 2 and 3). The tightness of the circular sphincter was evaluated by digital examination, which should grip the index finger. The tightness can be adjusted by limited exploration of the coccyx/left ischial tuberosity in future, if required. The margin of gracilis muscle in contact with seromuscular layer of the colon was blended with interrupted 000 polyglactin sutures. A drainage tube was installed into the sacral cavity and brought through the lower part of the perineal wound. Remaining portion of the anterior and posterior wound was closed. A full-thickness perineal colostomy was completed (Fig. 4). Both the gracilis muscles were supporting as new pelvic diaphragm as they were occupied almost the whole pelvic cavity.

Fig. 1 Lt gracilis wrapped around colon

Fig. 2 Diagrammatic operation

Modified Isolation and Transposition of the Gracilis Muscle

The incision was made 10 cm long and 10 cm below the pubic tubercle on gracilis muscle at the posteromedial aspect of the thigh. Gracilis was retracted delicately, medially to explore its neurovascular hilus. The neurovascular pedicle of gracilis was identified carefully, which enters the lateral border of gracilis muscle at the junction of the upper one-fourth and the lower three-fourths quite regularly. A plane catheter was passed around gracilis muscle about 5 cm distal to its hilus. A special new instrument, gracilis mobilizer, was used. It has a head-like rib respiratory and 50-cm-long rod (Fig. 5). The ring was passed around the muscle, guided by the index finger, to the free end of the head mobilizer. By repeated lifting and advancing forward movements of the mobilizer, the muscle was isolated up to the knee. The tendon of gracilis was lifted on the mobilizer and it was isolated and detached from the medial condyle of the tibia through 1-cm-long skin incision on medial condyle. The sural nerve was

Fig. 3 Anatomy of the procedure

Fig. 4 Continent perineal colostomy and drainage tube

identified and separated. The detached gracilis was pulled back into the thigh wound.

In the conventional transposition, gracilis is turned exactly in reversed direction to the pelvis. The reversed direction of the muscle transposition can potentially lead to stretch or avulsion injury to the neurovascular pedicle during or after operation due to uncontrolled contraction. The lateral border of gracilis was sutured to adductor longus, 3–4 cm in length at the level of the pedicle.

Results

In the series of 42 patients, 10 patients were females and 32 males. The average age was 48.5 years ranging from 35 years to 64 years. In 42 patients, tumor was localized 3–8 cm from the anal opening. Only invasive carcinomas of the lower rectum of stages I and II, assessed by clinical, CT scanning, and ultrasonography were included for the study. The CT scanning reported localized tumor spread to the anal sphincters in 18 patients, and in 10 patients the tumor was extended to the middle third part of the rectum, but there was no spread beyond the rectal wall. On histology examination, 39 patients had well-differentiated adenocarcinoma of the rectum grade II and 4 had carcinoma grade III. No significant increase in serum carcinoembryonic

Fig. 5 Gracilis mobilizer

antigen level was noted except in one patient. Preoperative chemoradiation was not used.

The selected 42 patients were treated by abdominoperineal resection and reconstruction of the new rectum was done. The average operative time was 4 h and 15 min; blood loss was approximately 540 cc. The hospital stay was on average 14.3 days, extending from 10 days to 21 days.

The perineal and abdominal wound infection was noticed in six and four cases, respectively. In two patients, ischemia of the partial thickness of the colostomy was detected, which required no treatment. No fecal impaction was present in any patient. Histology of the operative specimens indicated clearance of disease with good disease-free margins. It was classified as Duke's B in 34 patients and Duke's C in eight patients. The patients with Duke's C disease received adjuvant chemotherapy.

The lower neosphincter was evaluated clinically in resting state by digital examination. Its strength was equal to a forceful voluntary contraction of the external anal sphincter assessed by digital rectal examination. Adduction of the thighs resulted effective enhanced tightness of the lower neosphincter. All patients could hold more than 1,000 ml of normal saline enema even in standing position. All of them could void and hold saline on command. All the patients retained barium enema up to the cecum. In early phase, patients could recognize perception of voiding by lower abdominal discomfort and by colicky pain. After 6–8 months, sensation of the lower pelvic fullness developed in all patients, while perineal heaviness perception in only 21 patients. Of the 42 cases, six required retightening of the gracilis, performed by exploration of the lower wound at the coccyx. All patients had satisfactory continence during daytime. The soiling of liquid stool was reported in 14 of the 42 cases. These 14 patients were advised simple enema before going to bed. They had developed conditioned reflex in the 2–3 months period. In these 14 cases, occasional incontinence for liquid stool persisted, and they were advised to use pads. All 42 patients were followed up after every 3 months for a period of 2 years and later on at every 6 months. Six patients expired in a period of 2 years after surgery due to metastasis in the liver. Four patients expired after 3–5 years; the cause was not related to cancer. All patients expressed their satisfaction over the voluntary fecal control and continence.

Discussion

Patients disliked permanent colostomy after abdominoperineal resection of the rectum, majority of surgeons tried to develop procedures to save the lower end. The colon was used as a mere conduit without having any control. For perineal colostomy, no bag can be fixed and even if

something is fixed, it will cause great inconvenience. A sphincter constructed at the perineal end to the straight conduit of the colon bears gravitational force and intraluminal pressure directly on the sphincter. Even in the straight segment of the colon joined to the anus after the rectosigmoidectomy causes varying degree of incontinence, tenesmus, and soiling [13]. The sigmoid colon itself is a natural 'S' trap. The 'S'-shaped configuration of the colon avoids direct gravitational force on neosphincters. The 'S' trap also serves as a flap valve in sudden increase abdominal pressure during sneezing or coughing. Two new sphincters, one at the lower end and other at the level of pubic rami; divide intraluminal colonic pressure. In a few series, full-thickness necrosis of colonic stump of the perineal colostomy is reported, requiring revision of the stump [11, 14]. In our series, well-preserved vascular segment of the colon was used and it had prevented necrosis of the stump. In fact, ligation of inferior mesenteric artery below the sigmoid first artery increases blood supply by diverting blood to the remaining part of the colon. Only early two patients had ischemia of partial thickness of the colon, which required no surgical treatment.

The gracilis muscle has a significant role in the construction of neosphincters. Anatomical, physiological, and histochemical preservation and alteration of the function of the gracilis muscle require special elaboration. A simple method of calculation, based on distance between the pubic tubercle and the medial femoral condyle, allows quite precise determination of the point of entry of the main neurovascular pedicle into the gracilis [15]. The main neurovascular pedicle arises from medial boarder of adductors and enters at the junction of upper one-fourth and lower three-fourths gracilis at its lateral boarder. After clamping minor vascular pedicles, enough blood supply remained to the distal part of gracilis as detected using laser flowmetry [16, 17] in our series of 42 patients; no delay procedure of the gracilis was implemented.

The results of graciloplasty have been improved with the advent of electromyostimulated [18, 19]. In electrostimulated graciloplasty, sustained tetany of contraction of muscle is mandatory and there is little time for relaxation, which may pose certain problems. The constant accumulation of lactic and pyruvic acids may change acid–base balance of myoglobin, which would cause differed conduction of electrical stimulation. There are certain complications reported after electrostimulation such as electrode infection, explanations of pulse generator, excoriation of skin above the stimulators, premature battery discharge, fatigue during programming, rupture of gracilis tendon, fibrosis of the nerve, and others [11, 12]. In our series, changing from the adynamic bilateral graciloplasty to dynamic (electro-stimulated) was reserved only for unsatisfactory outcome. So far, no such conversion was

necessary. Gracilis is type-II striated muscle, which cannot have strong and sustained contraction for long duration. In our procedure, both gracilis muscles were used as elastic contractile bands in resting state, as they were wrapped in abduction position of the thighs in lithotomy position. They were used for occluding lumen of the colon at two levels with different grades of tightness, which is enhanced by adduction of the thighs in standing position. The left gracilis forms a circular sphincter and continues as a sling, which occludes the lumen of the colon in resting phase. The circular sphincter occludes the lumen of the colon tightly and the sling elevates it and compresses the colon against the pelvic wall during contraction of the muscle. The sphincter acts like a puborectalis sling. The right gracilis forms second circular sphincter at the perineal opening, which occludes lumen of the colon more tightly in resting phase than the left gracilis. The right gracilis creates greater gripping during its contraction, as its distal end is fixed to the coccyx ischial tuberosity exactly, on the opposite side of its entry in to the pelvis. The action of right gracilis sphincter resembles internal sphincter, which occludes lumen because of the tight wrapping and takes over the function of external sphincter when it contracts strongly during emergency voiding.

Usually, three significant steps are taken to accomplish security against any injury to the neurovascular pedicle of gracilis: (1) avoid dissection of the upper third part of the muscle, (2) avoid disturbance of the fascia over it, and (3) avoid stretching of the muscle. In routine transposition of the gracilis in the perineum, it is deflected in reverse direction to its normal course and slightest stretching can cause injury to its neurovascular pedicle. The gracilis is kept lax during transposition in fear of potential stretch and avulsion injury to the neurovascular pedicle. It loses power due to laxity of the muscle. It is possible to keep the muscle loose during surgery, but postoperatively during active contraction of the muscle, it cannot be predicted about such security so as its functional result. Both the sphincters demand full stretching of the gracilis muscle to occlude the lumen of the colon in resting state.

We have stepped up additional security to the neurovascular pedicle by fixation of gracilis to the adductor longus muscle. It has also created a new active fulcrum to the gracilis muscle during contraction. The adductor longus, being one of the powerful adductors of the thigh, enhances synergic strong action transferred along with the gracilis, during adduction of the thigh. Longitudinal margins of the wrapped gracilis in contact with the colon are blended, which increases their blood supply. The amalgamated colomuscular segment acts as a proprioceptor. When the colon is distended, the colomuscular segment is stretched, which sends perception to contract the colonic segment due to proprioceptor reflex. The gracilis is having segmental and

longitudinal neurovascular functional distribution, which is interconnected, and it can act as a small segment of the muscle as the colomuscular segment.

The sensory input is the significant requirement to initiate voiding reflex. The sensation of rectal fullness is probably depending on receptor in the pelvic wall muscles rather than in the rectum [20]. In the neorectum, a sensory input provided by distention of the colon causes hypogastric pain, pelvic fullness, and perineal heaviness; it also gives perception for voiding. As the colon has enormous capacity to distend, it requires no special reservoir. The sigmoid colon, which has transit time between 8 h and 16 h, helps as reservoir. The procedure is performed in one stage. No diversion colostomy was required. The one-stage procedure saves time, hospitalization, and the interest of the patients in treatment. Most of the similar procedures are multistaged; in such procedures, the patient may require 6 months in and around the hospital to become continent [21, 22].

The wrapped gracilis muscles occlude the lumen of the colon with a certain amount of tightness in its resting state. In standing position, as both thighs are adducted, the gracilis muscles are in sustained contraction, which enhances further tightening of the muscles. The squeezing force to occlude the lumen of the colon can be increased by bringing both the thighs firmly together in adduction in a dire emergency-voiding reflex. The force of the action of the gracilis in adduction is enforced by powerful synergic action of the adductor longus muscle. During the use of commode or squatting position, both the thighs are abducted and externally rotated resulting in maximum relaxation of the gracilis muscles. The intra-abdominal pressure is raised in squatting position because of the splinting action of the thighs against the lower abdomen. The physical force of the perineal sphincter is overcome by intraluminal pressure due to colonic peristalsis and intra-abdominal pressure together, which helps accomplish smooth defecation.

Pseudocontinent perineal colostomy is constructed by using 2–3 bands of involuntary muscle tenia coli encircled around the colon, which acts as a band without any voluntary contraction. It works as stenosis colostomy and requires regular enema. There is very little voluntary action for controlling urgent voiding reflex. In few cases, overflow incontinence has been reported [23].

The gluteoplasty has less traction on the neurovascular pedicle and is thought to be anatomically a safer procedure than graciloplasty [24–26]. The modified transposition of gracilis muscle has reduced potential danger of stretch injury to neurovascular pedicle. The sphincter constructed by gluteoplasty can hold only 200–250 cc of normal saline, which is thought to be much lesser volume than required for testing a continent sphincter. A good continent sphincter should hold more than 500 cc of saline [27]. In our series,

all patients could retain and hold more than 1,000 cc of saline, and voided and held at will. These patients could retain barium up to the cecum.

The closed mobilization of the gracilis was performed through a 10-cm-long longitudinal incision in the upper thigh and another 1-cm-long incision at the medial tibial condyle. Only 15 min were required for harvesting of gracilis with the help of gracilis mobilizer. It reduces morbidity of the donor site and has a better esthetic appearance [28].

Conclusion

Over all procedure is new and the series of 42 cases with 15 years experience. It is satisfactory and has near natural continence in 65 to 70% of cases. The mobilization of gracilis has become faster, easier and aesthetically much better with the use of the gracilis mobilizer. The modified transposition of the gracilis muscle has opened a new dimension for the use of gracilis muscle which has reduced uncertainty about the results due to secured neurovascular pedicle of the muscle. The gracilis was used as a contractile elastic band in resting state and requires no electrical stimulations for occlusion of the colon. The force of the tightness to occlude the lumen of the colon could be further enhanced due to contraction of gracilis and synergic action of powerful adductor longus muscle. The 'S'-trap arrangement of the colon divided intraluminal pressure and avoided active force of voiding pressure directly on the end sphincter than in straight conduit. The construction of new continent perineal colostomy and 'S'-trap arrangement of the colon has served well to develop the new rectum. As it is a one-stage procedure, it will be well accepted by the patients and surgeons.

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