Use of right colon vaginoplasty in gender affirming surgery: proposed advantages, review of technique, and outcomes

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Abstract

Introduction Various methods have been described to create a functional neovagina with feminizing (male-to-female) gender affirming surgery. Intestinal vaginoplasty using ileal or colon segments confers natural mucus production and greater canal depth with primary vaginoplasty. In this work we describe an alternative approach to primary and salvage vaginoplasty using right colon. We focus on relative advantages compared to use of other bowel segments, and we review patient outcomes.

Methods Transgender women who had previously undergone primary vaginoplasty underwent laparoscopic right colon vaginoplasty at our center between 12/2017 and 7/2019. Demographic, medical, outcome, and satisfaction data was collected and retrospectively reviewed.

Results Twenty-two consecutive transgender women patients underwent laparoscopic right colon vaginoplasty. Mean age was 39.3 years. There were two intraoperative complications:1 injury of the ileocolic pedicle, and 1 minor bladder injury. *Four of 22* patients (18.2%) had short-term complications (< 30 days): 3 had postoperative ileus/small bowel obstruction and 1 had intra-abdominal hemorrhage. All were managed conservatively. *Six of 22* patients (27.3%) experienced a total of 14 long-term complications (> 30 days): 1 developed Crohn's (not involving the neovagina); 1 developed late small bowel obstruction (SBO) (managed conservatively); 5 developed neovagina prolapse; 4 developed stenosis (2 at the vaginal introitus, and 2 had extrinsic obstruction at the recto-vaginal junction (all underwent successful laparoscopic surgical correction); and 3 were diagnosed with diversion neovaginitis (all treated conservatively). All complications were successfully treated with conservative and/or surgical intervention**.** All (100%) patients reported satisfaction with neovagina function and appearance.

Conclusion This is the only outcomes series of transgender women patients who have undergone right colon vaginoplasty, to date. Our study finding suggests that laparoscopic right colon for primary or salvage vaginoplasty has several important advantages over use of Sigmoid colon or Ileum, and is a reliable technique whose complications can be managed successfully, with favorable, satisfactory long-term outcomes.

Keywords Right colon · Vaginoplasty · Transgender · Prolapse · Stenosis · Diversion neovaginitis

Today approximately 0.6–0.7% of the U.S. population (1.4–1.65 million) identifies as transgender. The majority of transgender adults seeking gender affirming surgery report their first experience of gender dysphoria before age 7 [1].

While it is not known what proportion of these elect genital gender affirming surgery, estimates suggest that this number is significant [2]. Vaginoplasty as a feminizing (male-to-female) gender affirming surgery was first introduced

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in the early 1900s [3]. In the years since, variations of the surgery have been developed to better serve the needs of transgender patients [4–6]. According to literature, an ideal vaginoplasty should meet several criteria: natural feminine aesthetics, moist and hairless inner lining, sufficient depth and width for satisfactory intercourse, erogenous sensation, and minimal maintenance [4, 6–8]. Short recovery times and minimal postoperative morbidities and complications are also preferred. Currently, the most popular and described vaginoplasty technique is penile inversion with skin graft [6, 9]. Despite being the current gold standard, common drawbacks of this method include malodor, lack of natural lubrication, development of granulation tissue within the canal, and need for lifetime maintenance [6, 7, 9].

Recently, there has been appreciable interest in the efficacy of intestinal vaginoplasty, in which an ileal segment or portion of the sigmoid colon is used as the neovagina graft [6, 10–12]. Defining advantages of this approach include natural sensation and mucus production, typically sufficient canal depth and lumen width, and good overall functionality and cosmesis, which contribute to greater psychological and sexual satisfaction [13–16]. However, the procedure is associated with important risks: anatomic variation of the vascular pedicle that precludes surgical feasibility, and, postoperative prolapse, stenosis, and diversion neovaginitis [13, 14, 17]. Thus, colovaginoplasty is typically reserved for secondary operations following failed primary procedures, or when the patient expresses dissatisfaction with the aesthetic or utility of the neovagina [18].

To date, there are no published reports describing the surgical technique or outcomes related to the use of *right colon* as the graft source for vaginoplasty. We propose rationale for *why* the right colon should be the preferred segment for vaginoplasty: 1. The primary vascular pedicle of the right colon (ileocolic artery) is robust, long, and more anatomically reliable (i.e. seldom varies) as compared to the sigmoid colon, allowing for a more facile and reliable reach of the colon segment to the vaginal introitus [19–22]; 2. The resulting ileocolic anastomosis has significantly lower anastomotic leak rate and is located in the right upper quadrant (RUQ), where it is easily accessible (in the event of an anastomotic leak) and far from the neovagina, as compared to the colorectal anastomosis with sigmoid vaginoplasty, which is located in the lowe left quadrant (LLQ) and abuts the neovagina [23, 24]. Under these premises, right colon vaginoplasty may prove to be the favored type of intestinal vaginoplasty in terms of technical feasibility and postoperative outcomes.

Here, we present the outcomes of a population of transgender (male-to-female) women patients who underwent secondary laparoscopic right colon vaginoplasty. All had previously undergone primary vaginoplasty (mostly with, but including some without creation of a vaginal canal). Our study is the first to assess the short and long-term outcomes of right colon vaginoplasty for genital gender affirming surgery.

Patients & methods

Selection of study cohort

We conducted a retrospective review of a database of consecutive transgender (male-to-female) women patients who underwent elective laparoscopic right colon vaginoplasty at Cedars-Sinai Medical Center (Los Angeles) from 12/2017 to 7/2019. The database includes over 80 variables encompassing preoperative demographics and comorbidities, intraoperative events, and 30-day postoperative outcomes. Long-term outcomes exceeding 30 days were derived from chart review and phone encounters. The operation was performed simultaneously by surgeons Dr. Yosef Nasseri (colorectal surgery) and Dr. Maurice Garcia (urologic and transgender surgery). Approval for this retrospective study was obtained from our Institutional Review Board (IRB) Committee.

Statistical analysis

Demographics of interest included age, body mass index (BMI), relevant medical comorbidities (human immunodeficiency virus [HIV], hypertension, cardiopulmonary, diabetes, obesity), and prior operations (vaginoplasty and other abdominal operations). Thirty-day postoperative outcomes included length of stay, readmissions, infectious and gastrointestinal (GI)-related complications, and overall complications. Long-term postoperative outcomes (> 30 days) included overall complications and those specific to the neovagina such as prolapse, stenosis, and diversion neovaginitis. Related reinterventions and reoperations were also recorded. Patient characteristics were reported as means and standard deviations (SD), as well as medians and upper and lower bounds (Q1–Q3) for continuous variables.

Preparation and technique

All patients were referred to our transgender surgery program for care. Prior to surgery, *all* patients underwent computed tomography (CT) scan (±intravenous (IV) contrast) of the abdomen and pelvis and underwent colonoscopy (to rule out colitis, masses or any anatomic anomalies or pathology that would preclude using any part of the colon as a neovagina). Prior to operation, mechanical and antibiotic bowel prep was administered. In the operating room, the patient is placed in a lithotomy position to allow simultaneous laparoscopic abdominal and trans-perineal surgery.

Mobilization of the right colon (representative video was presented at the 2019 SAGES meeting)

We use four laparoscopic trocars (Fig. 1). First, the right colon is mobilized fully laterally along the white line of Toldt up to and including the hepatic flexure. Then, the transverse colon proximal to the middle colic artery is fully mobilized from the adjacent stomach, duodenum, gallbladder, and liver. This is executed with a combination of blunt and sharp dissection and an energy device (Ligasure). The omentum is dissected away from the proximal half of the transverse colon to minimize bulk.

Creation of the vaginal canal space

After we have confirmed availability of an adequate graft segment, we proceed with the transvaginal portion of the surgery to establish a canal space between the vaginal introitus and the pelvis. We begin by excising a circular segment of skin (12.5 cm) centered over the planned location of the new vaginal introitus. If the patient has previously undergone creation of a vaginal canal, it is important to consider that remnant vaginal canal epithelial lining can produce infection and hair, and because it is often scarred, bulky obstruction. It is essential to either sharply excise or ablate any viable remnant epithelium (Fig. 2).

When there is no remnant vaginal canal space, we establish a new canal by the same technique we use for all of our primary vaginoplasties which include canal creation:
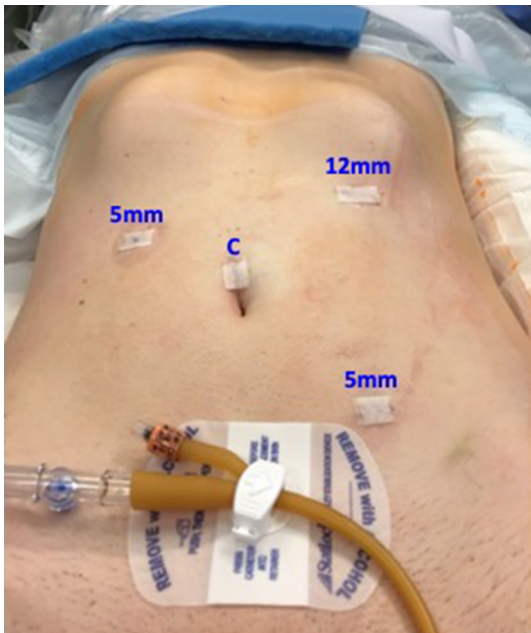

Fig. 2 It is feasible to resect the entire vaginal canal lining (*shown*) by meticulous sharp scissor dissection adhering closely to the epithelium to separate it from surrounding tissues and aided by intermittent guidance from a gloved finger in the rectum to help prevent rectal injury

we insert an 18 Fr male urethral sound to reach the bladder neck, and, while using the tip of the sound to push the bladder-neck/prostate posteriorly we push the handle of the sound *cephalad*. This displaces the entire prostate gland *posteriorly* from behind the pubic symphysis (where it can be easily be palpated via the perineal wound), and it rotates the prostate apex *anteriorly*, such the posterior aspect of the prostate apex can be palpated easily by the tips of the surgeon's index and middle fingers.

Next, at midline 0.5–1 cm from the posterior aspect of the prostate-apex (urethra), we use fine-tip bi-polar electro-cautery and scissors to dissect directly *onto* the prostate capsule; we extend this dissection laterally to the prostate's lateral margins. We then lay the flat blade-tip of a Simon retractor onto the exposed prostate capsule, and, while gently pushing the retractor blade onto the prostate, we *simultaneously* relax and withdraw the urethral sound from the urethra. As we do this, the prostate retreats anteriorly, and the retractor slides cephalad along the natural avascular plane *anterior* to Denonvillier's Facia and *posterior* to the prostate/bladder. Using a Foerster Sponge Forceps, we dissect cephalad to the origin of Denonvillier's Fascia: the vesico-rectal peritoneal reflection (Pouch of Douglas).

Completion of passage between the vaginal canal space and the pelvis

Before we incise the peritoneal reflection, we fill the bladder with 180 mL of saline to delineate its inferior border.

Fig. 1 Laparoscopic trocar sites, covered post-operatively by Steri-Strips™, and their diameter. (*C* Camera)

A dilator introduced into the canal-space "tents-up" the peritoneum of the recto-vesical fold (Fig. 3a). Next, we measure the distance ("D") between the vaginal introitus and the rectovesical fold. We insert a Penrose drain (marked with 1-cm. marker-lines) into the abdomen and use the "D" measurement and ruler to confirm that the end of the segment of colon we plan to harvest will reach the vaginal introitus.

Upon confirmation, we then use hook-electrocautery (mode: cut) to incise the peritoneal reflection horizontally *directly upon* the dilator-tip (to minimize risk of collateral injury). Progressively larger-diameter dilators are inserted and turned in different directions to better expose and incise the peritoneum-edges surrounding the entry site, and thereby widen the passage (Fig. 3B).
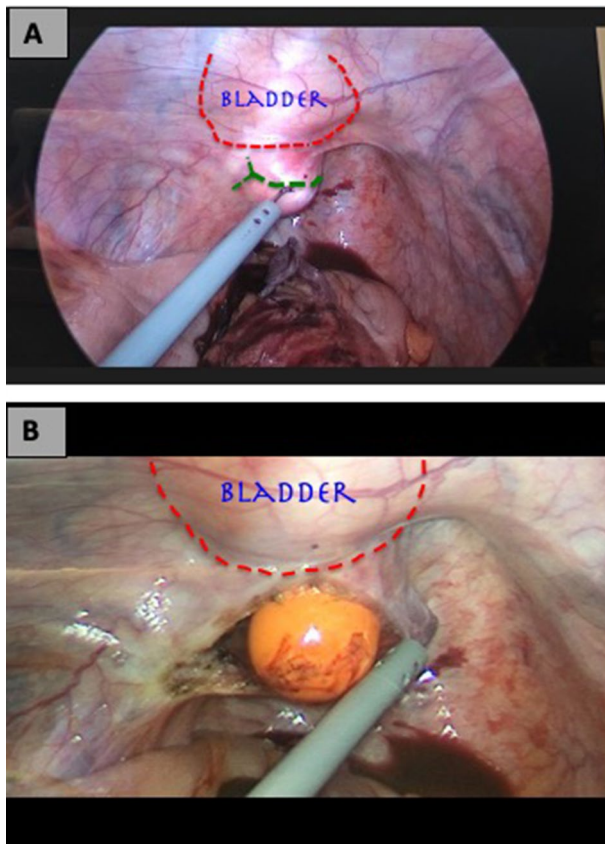

Fig. 3 **A** The tip of a dilator inserted via the vaginal canal space elevates the center of the recto-vesical peritoneal reflection (Pouch of Douglas). Before cutting through the peritoneal reflection here, the bladder margins are identified by filling the bladder with saline. A laparoscopic hook-cautery instrument (mode: cut) incises the peritoneal reflection horizontally (*green hatched line*). **B** Successively larger-diameter dilator instruments (*orange*) can be passed into the pelvis. The dilator can be angled to better expose the peritoneum surrounding its entry site, so that the peritoneum can be incised at multiple sites in a radial fashion, to ensure easy and unobstructed passage of the largest dilator into the pelvis (Color figure online)

Harvest of the right colon segment

Next, we complete preparation of the mobilized colon segment (Fig. 4). We perform appendectomy. Next, the mesentery to the terminal ileum is divided inferior to the ileocolic vessels, taking great caution not to compromise the ileocolic vascular pedicle to the ultimate neovagina. The mesentery of the transverse colon together with the left branch of the middle colic artery is ligated proximal to the middle colic arterial trunk. At this point, the terminal ileum and the proximal transverse colon are divided.

The right colon is then turned 180 clockwise and the cut end of the transverse colon is pulled into the pelvis and grasped gently by a Babcock clamp introduced through the peritoneal opening in the recto-vesical fold (Fig. 5). Clockwise rotation of the right colon is preferred to counterclockwise rotation, as this leads to less kinking and relieves tension of the accompanying vascular pedicle. Proper orientation of the colon-segment is ensured by orienting the tinea to the 12 O'clock position. It is very important to observe the vascular pedicle as this is done, to ensure that excessive traction (which could avulse the pedicle) is not applied.

Anastomosis of the distal colon segment at the vaginal introitus

The stapled end of the distal colon segment is trimmed away flush to the introitus, and the colon is sutured to the circular skin edge surrounding the introitus using interrupted full-thickness 2-0 Vicryl sutures.

Ileocolic anastomosis and pexy of neovagina colon segment

An intra-corporeal side-to-side ileo-transverse colon anastomosis is then undertaken. After making a colotomy and an enterotomy, an endo-GIA stapler is used to create the common opening between the ileum and the colon. Then, the anastomosis is completed by suturing closed the opening in the bowel in a 2-layered fashion using 3-0 braided, absorbable sutures. Finally, the back end of the neovagina is pexy'd to the right lateral abdominal wall using two interrupted 2-0 permanent braided sutures to prevent prolapse of the neovagina. Lastly, endoscopy of the colon neovagina is performed through the vaginal introitus, to wash out fecal material, assess overall viability/rule-out ischemia, and to rule out staple line leak or dehiscence. A vaginal packing (moistened with Silvadene crème) was left inside the distal-half of the colon neovagina (to tamponade potential bleeding from the colon-cutaneous anastomosis).

Fig. 4 Ascending and proximal transverse colon (*green*) are mobilized. Appendectomy is performed (*solid double red lines*). While the Ileocolic artery is preserved, the right colic artery, and the right branch of the middle colic artery are divided. Only after confirming reach of proximal transverse colon to the vaginal introitus are the terminal ileum (*hatched red line*) and the proximal transverse colon divided (**B**-**b′**). The stapled end of the transverse colon is brought to the vaginal introitus. The terminal ileum (**a′**) is anastomosed to the distal transverse colon (**b′**) (Color figure online)
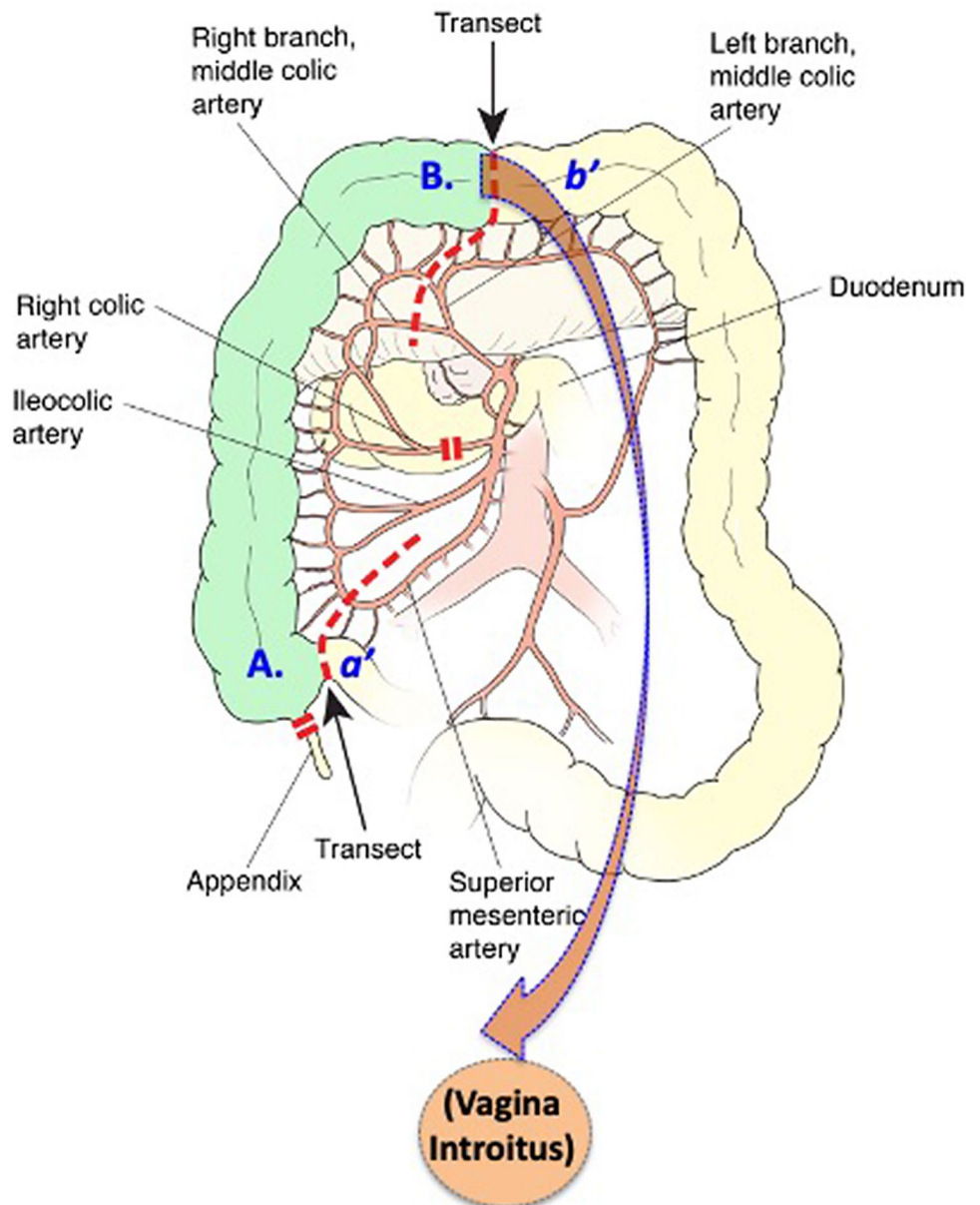
Routine post-operative management

Postoperatively, patients were enrolled in the enhanced recovery after surgery (ERAS) pathway. They were placed on a clear liquid diet on postoperative days (POD) 0 and 1 and advanced to a solid diet on postoperative day 2. No nasogastric or intraoperative drains were placed. Patients were maintained on bedrest per discretion of the Urology team for 48 h and then mobilized three times a day (TID) thereafter. Pain control was multimodal with around the clock Gabapentin, Tylenol, and as needed Tramadol moderate to severe pain and IV Dilaudid for breakthrough.

If the patient had already had a bowel movement, the vaginal packing and urethral catheter were removed on POD #5. Patients were taught how to perform (and underwent) vaginal dilation on POD #5.

Patient satisfaction with outcomes

Patients completed two 5-point Likert scale inventories > 3 months after their surgery (or last revision surgery) which queried their satisfaction with the *function* of their vaginal canal and the *appearance* of their vaginal opening. (Very satisfied = 5, Satisfied = 4, Neutral (neither satisfied or dissatisfied) = 3, Dissatisfied = 2, and Very Dissatisfied = 1).
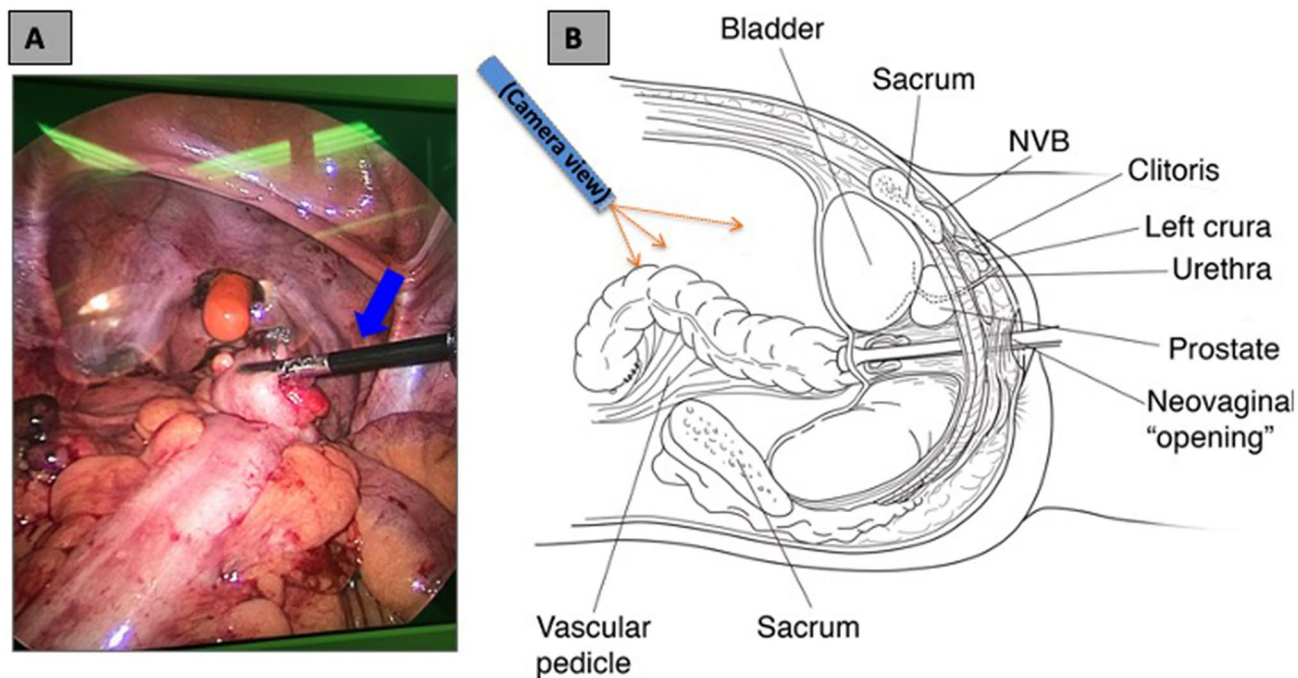
Fig. 5 A A laparoscopic grasper (*blue arrow*) is used to pass the distal end of the Right colon segment to an instrument that will be inserted into the pelvis via the vaginal canal space (*occupied here by an orange dilator*). **B** A Babcock clamp is inserted into the pelvis to, under direct vision, grasp the stapled transverse colon end and gen- tly pull it through the vaginal canal to the vaginal introitus. Both the degree of tension on the vascular pedicle and the orientation of the segment (Tenia at 12:00) are monitored under direct vision (Color figure online)

Results

Patient demographics and surgical history

Twenty-two transgender women underwent elective lapa- roscopic right colon vaginoplasty between July 2017 and October 2019. Median age and BMI of patients were 36.5 years and 23.7, respectively. Most patients were fairly healthy with mean ASA of 2 and few comorbidities (Table 1).

Previous operations: vaginoplasty and prior abdominal surgery

All patients had previously undergone vaginoplasty sur- gery: Twenty patients underwent colon-vaginoplasty as a secondary/salvage procedure following loss of the pri- mary vaginal canal (perioperative dehiscence or delayed stenosis) constructed using penile and often scrotal skin, and two underwent this following shallow-depth vagi- noplasty (do not include creation of a vaginal canal) as the second-stage of a planned two-stage procedure. Six patients underwent prior abdominal operations (Table 2).

Table 1 Preoperative variables

Characteristics	No. (% of all patients)
Demographics	
No. of patients	22 (100)
Salvage/secondary vaginoplasties	20 (90.9)
Two-staged primary colon vaginoplasty	2 (9.1)
Median age [Q1–Q3], range	36.5 [31–49], 20–59
Median BMI [Q1–Q3]	22.5 [20.5–24.8]
Mean ASA [SD]	2.0 [0.7]
Comorbidities	
HIV	3 (13.6)
Hypertension	2 (9.1)
Cardiopulmonary	4 (18.2)
Diabetes	2 (9.1)
Obesity (*BMI range 27.9–35.94)	4 (18.2)
Smoking (*Tobacco held for 60 days pre-op)	1 (4.5)

Intraoperative details

In all cases, the vaginal canal space was created via a trans- perineal retrograde approach, using an 18 Fr urethral sound inserted to the bladder-neck to rotate the prostate anteri- orly, incise the terminus of Denonvillier's fascia safely

Table 2 Previous operations

Characteristic	No. (% of all patients)
Prior vaginoplasty	
Failed primary penile inversion	19 (86.4)
Failed primary sigmoid vaginoplasty (performed 2 years prior at outside hosp.)	1 (4.5)
Shallow-depth vaginoplasty (first stage of a two-stage colon vaginoplasty)	2 (9.1)
Other prior abdominal operations	
Laparoscopic cholecystectomy	3 (13.6)
Laparoscopic appendectomy	1 (4.5)
Open ileal conduit	1 (4.5)
Laparoscopic gastric bypass	1 (4.5)

upon the surface of the prostate, and thereby gain access to the surgical plan anterior to Denonvillier′s fascia during cephalad blunt dissection towards the recto-vesical fold. All abdominal portions of our surgery were completed using only standard laparoscopy. Median total operative time was 288.6 min, with median blood loss of 30 mL. In all cases, this figure included additional urologic revision-surgery related procedures (e.g. urethroplasty; clitoroplasty revision, vulvaplasty). We estimate that the colon vaginoplasty portion alone averaged ~ 210 min. (3.5 h) (Table 3).

Postoperative details

Mean time to bowel function return was 2.7 days. The median postoperative length of stay was 5 days (Table 3).

Table 3 Intraoperative & postoperative events

Characteristic	No. (% of all patients)
Intraoperative details & complications	
Median operative time [Q1–Q3]; min	300 [210–330]
Median blood loss [Q1–Q3], range; mL	30 [20–50], 10–500
Mean distance "D" between introitus and recto-vesical fold [SD]; cm	10.8 [0.91]
Complications: overall number of patients	2 (9.1)
Bowel ischemia	1 (4.5)
Bladder injury	1 (4.5)
Post-operative details and short-term complications (< 30 days)	
Mean return of bowel function [SD]; days	2.7 [0.7]
Median length of stay [Q1–Q3], range; days	5 [5, 6], 5–14
Readmissions within 30 days	2 (9.1)
Complications: Overall number of patients	4 (18.2)
Ileus/SBO	3 (13.6)
Infection (deep + superficial)	0
Anastomotic leak	0
Urinary tract infection	0
Urinary retention	0
Bleeding requiring transfusion	1 (4.5)
Long-term post-operative complications (> 30 days)	
Overall number of patients	6 (27.3)
Small bowel obstruction	1 (4.5)
Crohn's flare-up (*neovagina not involved)	1 (4.5)
Prolapse (median time until intervention [Q1–Q3])	5 (5 [2–10] months)
Mucosal	1
Full-thickness	4
Stenosis (median time until intervention [Q1–Q3])	4 (9.5 [7.1–10.1] months)
Superficial	2
Deep	2
Diversion neovaginitis (median time until diagnosis [Q1–Q3])	3 (9.5 [6–11.5] months)
Median follow-up [Q1–Q3], range	4 [2–13], 1–24 months

Intraoperative complications

There were two intraoperative complications (9.1%), one bowel ischemia and one punctate (2 mm) posterior bladder-wall perforation. The bowel ischemia was the result of an inadvertent injury of the ileocolic pedicle that rendered the right colon ischemic and led to the use of the sigmoid colon as the colonic neovagina. The operation was successful, and the patient ultimately received a functional neovagina with the substitute sigmoid colon graft. The bladder injury occurred during incision of the pelvic peritoneum to widen the colon neovagina opening. It was immediately recognized and managed with 2-layer suture-repair and delayed removal of the indwelling urinary catheter (14 days). There were no conversions to open surgery and no mortalities (Table 3).

Short-term complications (< 30 days)

There were four 30-day postoperative complications among 4/22 patients (18.2%), which consisted of three cases of ileus/small bowel obstruction (SBO) and one case of intraperitoneal bleeding (Table 3). All cases of ileus and SBO were managed conservatively by withholding oral intake and placing a nasogastric tube. The intraperitoneal bleeding was self-limiting but required transfusion of 2 units of packed red blood cells. These complications led to two 30-day readmissions ($n = 2$, 9.1%): one for recurrent small bowel obstruction and one for intraperitoneal hemorrhage. Both were resolved with conservative, nonoperative management.

Long-term complications (> 30 days)

Six of 22 patients (27.3%) experienced a total of 14 postoperative complications that occurred beyond 30 days (Table 3). One patient had flare-up of dormant Crohn's disease despite a normal preoperative colonoscopy, which was successfully managed with Infliximab infusion. Another 1 patient had an SBO that was resolved with conservative management.

Five patients developed prolapse of the colonic neovagina at a median of 5 months following operation ($n = 5$, 22.7%): one was prolapse of the mucosa only, and in four prolapse was full-thickness. Mucosa prolapse was repaired through a perineal approach (perineoplasty), by excision of redundant colon mucosa and re-anastomosis of the fresh colon mucosa edge to surrounding vaginal introitus skin. Full-thickness prolapse was managed by laparoscopic pexy of the proximal colon segment-end to the sacral promontory using braided permanent sutures. This technique mirrors that which is used for a posterior non-mesh rectopexy.

Four patients developed stenosis at a median of 9.5 months following surgery ($n = 4$, 18.2%): in two patients the stenosis was superficial (at the vaginal introitus), and in

two it was located deep (where the colon segment passed through the opening in the peritoneal reflection at the recto-vesical junction). Stenosis at the vaginal introitus was addressed with perineoplasty and dilation. Stenosis located at the recto-vesical junction was managed with hood electrocautery incision of scar tissue at the peritoneal window found to be extrinsically compressing the colon segment.

Three patients developed diversion neovaginitis at a median of 9.5 months following surgery ($n = 3$, 13.6%). Patients that presented with an increase in drainage and bleeding through the neovagina underwent diagnostic endoscopy with confirmatory biopsy, and positive cases were treated with Rowasa (Mesalamine) enemas.

One patient experienced both prolapse and stenosis, and two patients experienced prolapse, stenosis, and diversion colitis concurrently. Median follow-up time was 4 months, with all patients ultimately acquiring aesthetic and functional neovaginas (Table 3).

Reoperations and other post-operative interventions

A total of 6 of 22 individual patients (27.3%) required post-operative surgery. Surgery was performed for *either* prolapse (5/6) or stenosis (4/6). A majority of these 6 patients required surgery of both types. A total of three patients' cases were suspected diversion neovaginitis based on symptoms (vaginal pain, scant bleeding). All 3 underwent endoscopy and biopsy, and for 2/3 biopsy results were consistent with diversion neovaginitis, while 1 patient had completely normal endoscopy and biopsy results (Table 4). All patients with diversion neovaginitis were treated with one or more treatments with Rowasa (Mesalamine) enemas.

Table 4 Reoperations and repeat interventions

Complication (treatment)	No. of patients (# reoperations each patient required)
Prolapse	5 individual patients
Mucosal prolapse (perineoplasty)	2 (1, 2)
Full-thickness (laparoscopic pexy)	4 (1, 1, 2, 2)
Stenosis	4 individual patients
Superficial [at introitus] (perineoplasty)	3 (1, 1, 1)
Deep [at recto-vesical junction] (laparoscopic lysis of scar/adhesions)	2 (1, 1)
Diversion neovaginitis	3 individual patients
(Endoscopy with biopsy)	3 (1, 1, 2)

Table 5 Self-reported patient satisfaction (5-point Likert Scale)

Satisfaction with colon vaginal canal function [SD]	4.4/5 [0.58]
Satisfaction with vaginal introitus appearance [SD]	4.1/5 [0.87]

Patient satisfaction with outcomes

Mean satisfaction with colon neovagina *function* was 4.4/5 (SD 0.5), and 4.1/5 (SD 0.87) for *appearance* of the introitus. All but one response ranged from "Neutral" (3) to "Very satisfied" (5). One patient who underwent salvage vaginoplasty after surgery elsewhere endorsed being "Satisfied" with function but "Very dissatisfied" with appearance of the introitus and overall appearance of the vagina, and subsequently sought to de-transition many months later (Table 5).

Discussion

There are many proposed techniques for the creation of a neovagina for transgender women, with split/full-thickness skin grafts and penile/penoscrotal skin flaps being the most common due to their simplicity and vastly studied outcomes [4, 7, 8]. Intestinal vaginoplasty largely involving the sigmoid colon remains a popular option for both primary and secondary (salvage) vaginoplasty for several of its benefits, which include natural mucus production, increased canal depth, and, what many patients report to be a more "natural-feeling" (soft, moist) lumen [11–13]. Those with negative perceptions about colovaginoplasty, however, cite the more invasive nature of the procedure (i.e. pelvic *and* abdominal surgery), need for bowel anastomosis, and potential for prolapse and "diversion colitis" of the vaginal segment as unnecessary risks unique to intestinal procedures [17, 18, 25, 26]. Our approach is to offer right colon vaginoplasty as either a *salvage procedure* whenin the *entire* vaginal canal/space must be replaced, or, as a primary surgery option for occasional cases where a patient has insufficient penile and scrotal skin for penile inversion vaginoplasty.

We have also found that while peritoneal vaginoplasty is an excellent choice for select salvage cases when a relatively small loss of vaginal depth (only) has occurred, in our hands it is not an option when either the remnant vaginal canal is less than ~8 cm in length, or, the remnant canal is significantly *narrowed* (<<12 cm, which ~equals erect penis girth [27–30]. Our present work found that the distance between the introitus and the peritoneal fold at the recto-vesical junction is 10–11 cm. While peritoneum can be tubularized and *added* to a vaginal canal of at least 8 cm., we have *not* found that it is possible to replace the first ~8 cm length of vaginal canal. For example, for a patient

has lost ~all canal depth, to achieve a final vaginal canal length of ~5.5 inches (14 cm) and circumference C of 12 cm circumference, the required surface area of peritoneum is: Surface Area $= 2\pi rh + 2\pi r^2 = 189$ cm^2, where $h = 14$ cm, $C = 12$ cm, and $r = C/2\pi = 1.91$ cm. This is a substantial area of peritoneum that must be mobilized to reach the introitus. In addition, there is risk that the distal-most end of a peritoneal pedicle may not survive. Peritoneal free-grafts require additional suture lines and have an increased risk of not surviving.

For these reasons, we perform intestinal vaginoplasty almost exclusively for select salvage cases where we feel peritoneal vaginoplasty is not feasible: 1. Remnant vaginal canal diameter is significantly narrowed, and/or 2. The remnant canal has adequate diameter but depth is less than ~8 cm). Our rationale for this is based on not only the greater surgical complexity with use of intestine, but also, that patients should preserve colon vaginoplasty as an option should they need salvage vaginoplasty in the *future*.

Right colon vaginoplasty shares many of the same risks associated with sigmoid vaginoplasty. However, it has several key advantages: *First*: the ileocolic vascular pedicle of the right colon is more anatomically consistent, identifiable, and reliable compared to the sigmoidal and/or inferior mesenteric vascular pedicles. This consistency allows for a more facile reach to the deep pelvis without risking unnecessary tension or damage to the blood supply of the colonic pouch as it is being maneuvered towards the vaginal introitus. The benefits of these significant distinctions are reflected in the low number of adverse intraoperative events and postoperative complications amongst our cohort. Prolapse, stenosis, and diversion colitis did occur, but the rates of affected patients were low and aligned with those reported in sigmoid vaginoplasty studies. *Second:* Right colon vaginoplasty allows for a safer ileo-transverse colon anastomosis rather than a colorectal anastomosis: the leak rate of ileocolic anastomosis is typically 1–2%, as compared to 5–7% with colorectal anastomosis (when sigmoid colon is used) [31–33]. *Third:* The location of the ileocolic anastomosis in the RUQ keeps it far from neovagina, and not adjacent to it in the LLQ, as it is with sigmoid vaginoplasty [23, 24]. This separation between the neovagina and the anastomosis protects *each* in the event that surgical intervention is needed (e.g. to manage either an anastomotic leak or vaginal prolapse).

There were two intraoperative complications amongst our 22-member cohort. Both intraoperative events (bowel ischemia, bladder injury) were resolved and did not compromise completion of the surgery. Mean operative time of 289 min for right colon vaginoplasty was longer than that of previously reported sigmoid vaginoplasties. Bouman et al. reported a mean operative time of 210 min for *primary* total laparoscopic sigmoid vaginoplasty [34]. The discrepancy may be attributed to our study including mostly salvage

cases, and, due to the fact that salvage cases often required additional reconstructive procedures. However, the longer operative time did not translate to a greater incidence of adverse postoperative events. Patients tolerated a regular diet and mean time to return of bowel function was 2.7 days.

Ileus/SBO was the most common short-term complication, occurring in three patients. These were resolved with conservative management. One patient experienced intraperitoneal hemorrhage requiring transfusion of 2 units of blood, which resolved without any further intervention. The two 30-day readmissions were due to recurrent small bowel obstruction and intraperitoneal hemorrhage. There were no instances of wound infection, anastomotic leak, urinary tract infection, or urinary tract retention, at least one of which have been cited in other reports [26].

Other complications associated with sigmoid vaginoplasty, such as abscess and necrosis were not observed in our cohort [34]. Similarly, there were relatively low rates of long-term postoperative complications (> 30 days). One patient had a flare-up of dormant Crohn's disease, but we suspect that this was an aggravated pre-existing condition rather than a direct complication of right colon vaginoplasty. One patient was readmitted after 30 days with an SBO which was managed conservatively. Based on our findings, the use of the right colon does not appear to introduce any novel or unprecedented complications when compared to traditional colovaginoplasty.

According to current literature, prolapse, stenosis, and diversion neovaginitis are the most consistent complications of sigmoid vaginoplasty. These complications were seen in our cohort with the following rates: prolapse-22.7%; stenosis-18.2%; diversion neovaginitis-13.6%. All cases of prolapse and stenosis were successfully managed surgically, and all cases of diversion neovaginitis were successfully treated with Mesalamine enemas.

Prolapse in the context of vaginoplasty refers to bulging or frank passage, of some or all of the neovagina through the introitus. Morrison et al. published their rectosigmoid experience with 83 patients, finding of protrusion at 21.7% and prolapse at 2.4% [26]. In Djordjevic et al.'s report on 86 cases of rectosigmoid vaginoplasties, the incidence of prolapse was 8.13% [35]. The lowest frequency of sigmoid prolapse was described by Bouman to be 2.4% [34]. In our study, prolapse was categorized as being one of two degrees of severity: mucosal or full-thickness. There was one mucosal (4.3%) and four full-thickness (17.4%) prolapses, which were revised with perineoplasty and laparoscopic pexy, respectively. We noticed that patients with wide pelvises and those who had a previous cystoprostatectomy were more prone to prolapse. Also, we found that, to help prevent full-thickness prolapse, use of permanent sutures to pexy the proximal colon segment was more effective and permanent than use of absorbable sutures.

Stenosis is characterized by progressive narrowing or closing of the neovaginal canal, which often leads to discomfort and dyspareunia. The reported incidence of stenosis is anywhere between 0 to 55.6% [36]. In our series it was 18.2%. We found that stenosis occurred in one of two locations and with variable severity: at the vaginal introitus (typically mild), versus deep from the introitus (8–10 cm) within the colon segmernt (more severe). We attribute deep stenosis to scar-tissue that forms around the passage through the peritoneal reflection and "chokes" the colon segment. Stenosis at the introitus was addressed with perineoplasty, whereas we treated deep stenosis with laparoscopic lysis of adhesions and further widening of the peritoneal opening. While stenosis seems commonplace in colovaginoplasty, there is evidence to suggest that regular dialtion and/or sexual activity could prevent the need for revision surgery [36]. In our series patients experiencing stenosis were sexually inactive or tended to cease dilation in the following months of the operation, mostly due to pain or discomfort. We require patients to commence dilation for 8 min TID early after surgery (POD 5 or 6).

Diversion neovaginitis is another potential complication after colovaginoplasty, though its incidence is low or underreported. The inflammation of the colonic mucosa is thought to be a result of the insufficient supply of luminal nutrients after the altered fecal stream, most notably short-chain fatty acids [36]. Four of our patients developed burning with mild bleeding/discharge symptoms, consistent with diversion neovaginitis. Three underwent endoscopy that showed mucosa edema and telangiectasia. In all patients with visible signs of inflammation within the colon segment, these changes were located in the *proximal-most* segment, which leads us to consider whether chronic stasis of mucus (which is likely colonized with bacteria) in the proximal-most segment may contribute to these intermittent inflammatory flares. To help patients better empty mucus, we ask them to douche in a recumbent position, to facilitate irrigation of the proximal-most segment, and, to stand and insert the *narrowest* dilator for 30–45 s after douching so that it acts as a stent, to help drain the colon segment.

All three patients with proven/suspected neovaginitis improved after a 2-week course of twice-daily Rowasa enemas. Notably, one of the diagnosed patients had dormant Crohn's; thus, it was difficult to distinguish whether the inflammation was from the Crohn's flare-up or a new case of diversion neovaginitis. The rate of diversion neovaginitis in our cohort (13.6%) is higher than that of other reports. Studies by Morrison et al. (primary sigmoid vaginoplasty) did not report any instances of diversion neovaginitis [26, 35, 37]. Bouman reported an incidence of 4.8% [34]. We believe that the rates of other series are underreported and possibly insufficiently investigated, as in some studies endoscopy was not performed. We recommend administering mesalamine

enemas to patients reporting increased and persistent drainage and/or bleeding, and resorting to a diagnostic endoscopy if the issues persist. If neovaginitis persists or recurs after mesalamine enemas, we recommend douche with whole milk/cream, or short-chain fatty acid solution.

Overall, patients in our series, where a majority were salvage cases, had very good outcomes with high reported satisfaction. This is the first outcomes series of right-colon vaginoplasty. All but two of our 22 patients underwent right-colon vaginoplasty as *salvage* surgery hence, outcomes using this as a primary procedure remain unstudied, as does whether or not performing it in one stage versus two improves outcomes. Limitations of our study include the inherent limitations of a retrospective study design and that the sample size ($n = 22$) was relatively small. While the focus of this paper is primarily on the technical outcomes of right colon vaginoplasty, outcomes related to psychological/sexual satisfaction are also very important. Future directions should include long-term patient follow up with standardized questionnaires evaluating parameters such as cosmetic appearance, sexual function/satisfaction, and improvements in quality of life [35, 38].

Conclusion

This is the first report of *right colon* vaginoplasty surgical technique and outcomes. Laparoscopic right colon vaginoplasty is a safe and reliable option for salvage and primary gender affirming vaginoplasty surgery. The anatomy of the right colon and other anatomic-surgical factors compare favorably to use of alternatives such as sigmoid colon. Although not without surgical risks, right colon vaginoplasty is associated with largely favorable complication rates and outcomes.

Compliance with ethical standards

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