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ORIGINAL ARTICLE

Robotic-assisted laparoscopic abdominoperineal resection for anal cancer: feasibility and technical considerations

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Abstract

Background Robotic-assisted laparoscopic surgery is an emerging technology that may prove advantageous for complex colorectal procedures involving the irradiated pelvis, such as abdominoperineal resection for recurrent anal cancer. The authors' initial experience is presented, with assessment of feasibility, safety, and oncologic principles.

Methods Over a 6 month period, five abdominoperineal resections were performed using the da Vinci® robot for recurrent anal cancer in patients initially treated with definitive chemoradiation therapy. Demographics, intraoperative parameters, pathology, and outcomes were assessed.

Results Five patients underwent surgery with a mean age of 58.8 years and body mass index of 24.9 kg m^{-2}. The interval between chemoradiation and salvage APR was 14.2 ± 10.0 months. Operative time was 204 ± 39.1 min with robotic docking time 12.2 ± 2.8 min and console time 93.0 ± 24.9 min. The mean estimated blood loss was 150 cc and there were no intraoperative complications. The mean hospital length of stay was 5.4 days. Pathology analysis revealed that all surgical margins were adequate. There was one postoperative complication consisting of a seroma.

Conclusion Robotic-assisted laparoscopic surgery for anal cancer was found to be a safe and feasible procedure. It facilitated enhanced visualization and dissection through deep irradiated pelvic structures. Copyright © 2010 John Wiley & Sons, Ltd.

Keywords anal cancer; robotic surgery; salvage procedure; abdominoperineal resection; feasibility

Introduction

The annual incidence of anal cancer has significantly increased over the past few decades, more than doubling from 0.8 per 100,000 in 1975 to 1.7 per 100,000 in 2005 (1). There are 5290 new cases of and 710 deaths due to anal cancer in the USA each year (2). Since Nigro and colleagues introduced their protocol in 1974, anal cancer has traditionally been treated with chemoradiation in the USA (3). In cases of residual or recurrent disease following chemoradiation therapy, abdominoperineal resection (APR) is the only remaining curative approach and may be offered as a salvage procedure. The procedure is usually difficult due to the recurrent nature of the disease in an irradiated field located in the deep and narrow constraints of the pelvis.

Robotic surgery offers many advantages when operating in a deep narrow space such as the pelvis (4,5). We introduced this technique into our practice for colorectal diseases, especially of the rectum and rectosigmoid, capitalizing on its technical advantages with regards to high-resolution 3D optics and meticulous dissection techniques. We chose a robotic-assisted laparoscopic surgery (RALS) approach for the treatment of recurrent anal cancer in the background of an irradiated field due to its advantage in the deep pelvis combined with improved maneuverability and visualization. We present our initial experience with this emerging technology for the treatment of recurrent anal cancer in five cases, with assessment of feasibility, safety, and oncologic principles.

Material and Methods

This study was conducted in accordance with NIH Office for Human Research Protections guidelines and was approved by the Institutional Review Board. Over a 6 month period commencing in November 2008, five abdominal perineal resections were performed using the da Vinci® robot (Intuitive Surgical, Inc., Sunnyvale, CA) for anal cancer. All patients were initially treated with definitive chemoradiation therapy and presented with residual or recurrent disease. Patient demographics, intraoperative parameters, pathology, and postoperative outcomes were assessed.

Technique

A total of five trocars were used for the procedure – three 8 mm trocars for robotic instruments, one 12 mm trocar for robotic camera, and one 12 mm trocar for the surgical assistant (see Figure 1). Initial exploration and lysis of adhesions was performed laparoscopically. The robotic-assisted approach was performed in a medial-to-lateral fashion with early identification and high ligation of the superior rectal artery with care to identify and preserve the left ureter. Presacral dissection in the avascular plane was performed with preservation of the fascia propria of the mesorectum and autonomic nerves. The dissection continued through the inferior fascia of the pelvic diaphragm (Waldeyer's fascia), lateral stalks, and Denonvillier's fascia, exposing the entire posterior wall of the vagina or the prostate. The robotic portion of the surgery was completed with division of the levator ani in a horseshoe-like fashion.

The perineal portion of the procedure was limited to dissection of the perianal skin and soft tissue to complete the resection. As indicated, the plastic surgery service performed flap reconstruction in two patients.

Data analysis

Data analysis was performed using Intercooled Stata version 9 software (Stata Corporation LP, College Station, TX).

Results

Table 1 summarizes preoperative parameters including demographics, time from chemoradiation therapy (CXRT) to recurrence and surgery, prior abdominal surgeries, and HIV status. Two female (40%) and three male (60%) patients underwent surgery with a mean age of 58.8 years and mean body mass index (BMI) of 24.9 kg m^{-2}. One patient (patient 3) presented with residual disease (<6 months post-CXRT). The mean interval from definitive chemoradiation therapy to recurrence and salvage APR was 14.8 months (n=4 patients) and 14.2 months (n=5 patients), respectively. One female patient had previous abdominal surgery consisting of hysterectomy and bladder surgery. Two male patients were HIV positive.

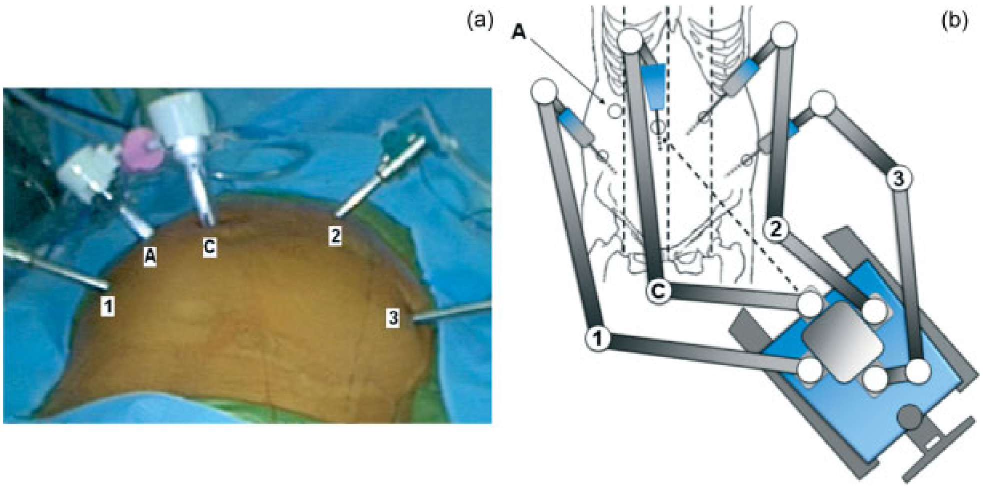

Figure 1. Port placement during abdominoperineal resection (APR) for recurrent anal cancer. Robotic arms 1, 2, and 3 connect to 8 mm trocars. Camera arm (C) and accessory port (A) connect to 12 mm trocars. (a) Intraoperative picture. (b) Schematic drawing

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Table 1. Preoperative parameters

Pt. No.	Age (years)	Gender	BMI (kg m^{-2})	ASA score	CXRT to recurrence (months)	CXRT to surgery (months)	Previous abdominal surgery	Preoperative HIV status
1	46	M	19.6	4	9	10	None	Positive
2	70	F	25.4	2	30	31	HYS, BS	Negative
3	67	M	29.8	3	4[§]	5	None	Negative
4	50	M	24.1	3	9	10	None	Positive
5	61	F	25.4	2	11	15	None	Negative
Mean±SD or percentage	58.8 ± 10.5	60% M	24.9 ± 3.6	2.8 ± 0.8	12.6 ± 10.0	14.2 ± 10.0	80% No	60% Negative

APR = abdominoperineal resection, ASA = American Society of Anesthesiologists, BMI = body mass index, BS = bladder surgery, CXRT = chemoradiation therapy, HYS = hysterectomy, SD = standard deviation. [§]Residual disease.

Table 2 summarizes intraoperative, short-term postoperative, and pathology outcomes. The total operative time was 204 ± 39.1 min with a robotic docking time of 12.2 ± 2.8 min and surgeon console time of 93.0 ± 24.9 min. The robotic portion of the procedure (docking time and surgeon console time) represented 52% of the total operative time. The mean estimated blood loss was 150 cc and there were no intraoperative complications. The mean hospital length of stay was 5.4 days (range: 4–8). There was a single postoperative complication that consisted of a seroma of the perineal incision, which was drained in the office setting. There were no surgical site infections, significant medical morbidities, or 30-day hospital readmissions.

Pathology analysis confirmed recurrent anal cancer in all patients and negative surgical margins in four patients. One patient had negative gross margins but positive microscopic margins with extension of disease into the posterior wall of the prostate. There were no positive mesenteric lymph nodes. This patient subsequently developed local failure and expired 6 months later.

Discussion

We have performed robotic-assisted laparoscopic surgery for benign and malignant disease involving the rectum and rectosigmoid since 2008. This surgical approach affords both optical and technical benefits, including magnified 3D visualization, motion scaling, tremor reduction, and wristed movements with six degrees of freedom (6,7). However, tradeoffs encountered with use of the robotic-assisted approach include lack of tactile feedback (8) and increased operative time (9). The advantages of the robotic technique are most helpful in the constraints of the narrow pelvis, which prompted our application of this technique for those presenting with recurrent anal cancer. This is an especially difficult procedure as it not only involves the presence of the tumor in the anal canal and deep pelvis, but is also performed in those who have received pelvic radiation many months prior to presentation.

Robotic surgery for rectal cancer has been reported in a large multicenter series of 143 patients by Pigazzi *et al.*, in which 93 patients (65.1%) received neoadjuvant CXRT and 31 cases (21.7%) were robotic APR (10). They also noted the technical advantages of robotic APR to be improved visualization, reduced tremor, and motion scaling, and concluded that it was a safe and feasible procedure. In addition, they reported on improved microdissection accuracy possibly accounting for reduced morbidity, e.g. anastomotic leak rate (10). The novelty of the current study is that the cohort underwent salvage APR for anal cancer in which there was a prolonged interval of several months between CXRT and surgical resection.

A previous randomized trial reported 6–8 weeks as the ideal time to operate in the pelvis after CXRT (11). Fragile vasculature with increased risk of bleeding may be present when surgery is performed too soon after completion of CXRT. However, a delay in surgery increases the chances of a fibrotic environment, making it technically difficult to achieve surgical dissection planes, resulting in greatest chance for injury, especially avulsion of the pelvic plexus with resulting hemorrhage. The mean time to APR after CXRT was 14.2 months in this series, thereby reflecting the latter situation. However, we did not encounter violation of the plexus even in the irradiated and fibrotic tissues, in part due to the optimized visualization and technical advantages of the robotic instrumentation with fine motion scaling and wristed movements. This may be an important oncological consideration for treatment of those with rectal cancer, because there is some data to suggest that a longer CXRT–surgery interval may predict improved pathological complete response rate, local control, and overall survival (12).

With regard to the intraoperative and postoperative parameters evaluated by the current study, Table 3 summarizes previous reports of open APR for the management of anal cancer recalcitrant to CXRT. The mean total operative time (OT) of 204 min in this series was less than the previously reported OT for open technique: 360 min (median, (13)), 276 min (mean, (14)), and 210 min (median, (15)). The mean estimated blood loss (EBL) of 150 cc reported in the present RALS APR study is less than the range of 400–1250 cc reported in open APR studies (13–16). Robotic approach enabled dissection through the deep boundaries of the pelvis up to and through the levator ani muscles. Thus, these deep layers of the pelvis, which are traditionally approached during the perineal portion of the procedure, were directly

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Table 2. Intraoperative, short-term postoperative, and pathology outcomes

Pt. No.	DT (min)	SCT (min)	OT (min)	EBL (cc)	Flap	LNE	Positive LNs	LOS (days)	Distal margins	Radial margins	Follow-up (months)	Vital status
1	15	90	180	250	Yes – VRAM flap	4	0	4	Negative	Negative	15.7	Alive
2	10	80	210	200	No	2	0	4	Negative	Negative	13.5	Alive
3	15	90	240	100	No	6	0	4	Negative	Negative	13.0	Alive
4	9	135	240	100	Yes - GMCF	12	0	8	Negative	Negative	6.0	Dead
5	12	70	150	100	No	11	0	7	Negative	Negative	7.5	Alive
Mean±SD or Percent	12.2 ± 2.8	93 ± 24.9	204 ± 39.1	150.0 ± 70.7	60% No	7.0 ± 4.4	0 ± 0	5.4 ± 1.9	100% Negative	100% Negative	11.1 ± 4.2	80% Alive

DT = robotic docking time, EBL = estimated blood loss, GMCF = bilateral gracilis myocutaneous flap, LN = lymph node, LNE = lymph node extraction, LOS = postoperative hospital length of stay, OT = total operative time, SCT = surgeon console time, SD = standard deviation, VRAM = vertical rectus abdominis musculocutaneous

Table 3. Summary of intraoperative and postoperative outcomes of abdominoperineal resection as salvage therapy for anal cancer refractory to chemoradiation therapy

Study	Surgical technique	No. of patients with APR salvage therapy	Preop chemo	Preop XRT	Time from CXRT to recurrence (months)	OT (min)	EBL (cc)	LOS (days)	Postoperative complication rate (%)/Operative reintervention rate	Follow-up (months)/Overall survival rate (%)
Ellenhorn *et al*., 1994 (21)	Open	38	Yes	Yes	11[a]	NR	NR	21[a]	≥32%[§]/5%	60/44%
van der Wal *et al*., 2001 (14)	Open	17 (n=13 curative intent, n=4 palliative intent)	Yes	Yes	<6 (n=12) >6 (n=5)	276[b]	430[b]	14[b]	59%/NR	60/47% (based on curative intent cases)
Ferenschild *et al*., 2005 (15)	Open	18	Yes	Yes	12[a]	210[a]	1250[a]	NR	67%/44%	36/50% 60/30%
Schiller *et al*., 2007 (13)	Open	39	Yes (n=38)	Yes	12.4[a] (based on n=21)	360[a]	1100[a]	16[a]	72%/≥3%[§]	36/53% 60/39%
Stewart *et al*., 2007 (16)	Open	22 (n=20 curative intent, n=2 palliative intent)	Yes	Yes	7[a], 9.7[b]	NR	400[a], 542[b] (based on n=13)	7.5[a], 8[b]	81%/NR	15[b] /46%
Lefevre *et al*., 2009 (19)	Open	95	Yes (n=66)	Yes (n=87)	<6 (n=41) >6 (n=46)	NR	NR	24.3[b]	30.5%/21%	60/6%
Current study	**RALS**	**5**	**Yes**	**Yes**	**12.6[b]**	**204[b]**	**150[b]**	**5.4[b]**	**20%/0%**	**11[b] /80%**

[a]median, [b]mean, [§]insufficient information, APR = abdominoperineal resection, chemo = chemotherapy, CXRT = chemoradiation therapy, EBL = estimated blood loss, LOS = length of hospital stay, OT = total operative time, Preop = preoperative, RALS = robotic-assisted laparoscopic surgery, XRT = radiation therapy

visualized and divided via robotic technique. Although RALS technique traditionally requires longer OT than open or CLS technique (17), this improvement led to reduction in the perineal portion of the procedure, in which 'blind spots' and cumbersome bleeding are often encountered.

Short-term outcomes in the current study compared favorably with previously reported open approaches; however, the differences in sample size among the series should be noted as a caveat. We did not encounter any major complications such as abscess, wound dehiscence, or delayed wound healing, which have been reported in the range 30–59% following APR in a irradiated field (13,14,18–21). The length of hospital stay (LOS) reported in this series (mean 5.4 days) was shorter than the range 7.5–24 days previously reported (13,14,16,19,21). This reduction in hospitalization has been noted following minimally invasive approaches such as RALS (22), thereby offering another advantage of this technique. Other advantages may include smaller incision, reduced postoperative pain, and less narcotic use (23,24). The postoperative complication rate of 20% is less than the range 30.5–81% previously reported for open approach (13–16,19,21).

Analysis of pathology outcomes revealed that negative margins were obtained in four patients, and the fifth patient had negative gross margins with disease infiltrating the posterior wall of the prostate. Under robotic technique, the recurrent cancer was resected en bloc with a superficial layer of the posterior wall of the prostate. Intraoperative frozen section revealed stage T4 disease. Postoperatively, the patient was offered pelvic exenteration but declined, and ultimately succumbed to local failure at 6 months postoperatively.

With regard to technical considerations, we performed a side-docking technique in order to facilitate simultaneous access to the perineal portion of the procedure by a second surgeon, while maintaining robotic dissection. This created some limitations in access to the left pelvic side wall, which was in part overcome by maintaining an acute angle between the patient cart and long axis of the patient. In male patients with a deep pelvis or those with higher BMI, the instrumentation may not reach through the levator ani and therefore it was important to place the ports in a more inferior position. Also, the positioning of colostomy was borne in mind in order to avoid a port that may have interfered with the colostomy appliance.

Flap reconstruction is an important consideration following APR in a irradiated field and is indicated when the defect cannot be closed primarily in a tension-free fashion or when revascularization of the region is required (19). In all cases, the plastic surgery service was present before the ports were placed, to ensure that their location would not compromise the creation of a potential flap. We found that we did not have to make significant adjustments of the proposed port sites. In this series, two patients required myocutaneous rotational flaps for reconstruction because of a large perineal defect. Patient 1 required a vertical rectus abdominis musculocutaneous (VRAM) flap, while patient 4 required bilateral gracilis myocutaneous flaps (GMCF). The robotic approach with the placement of ports as outlined in Figure 1 did not preclude use of VRAM flap. Although patient 1 required a lower midline incision for the VRAM flap, we believe that the robotic approach was warranted given the benefits that are realized in a previously irradiated field – in this case, 10 months prior to the salvage APR.

Although RALS APR for the management of recurrent anal cancer appears promising, a major limitation of this study is the small number of patients in the series. With regard to the technique, potential limitations include the use of steep Trendelenburg position and longer operative time. In addition, increased utilization of hospital resources may result in increased operating room related costs; however, such costs may be mitigated with reduced length of stay and complication rates.

Conclusion

Robotic-assisted laparoscopic abdominoperineal resection for recurrent anal cancer was found to be a safe and feasible procedure. This technique facilitates dissection through deep pelvic structures under direct vision, thus limiting the perineal portion of the procedure to the perianal skin and soft tissues. Although further studies are needed in order to determine if the observed benefits are sustained in larger samples, these results indicate reduced hospital length of stay and complication rates.

Disclosure statement

The authors have no potential conflicts of interest to declare.

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