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Robotic-Assisted Abdomino-Perineal Resection: Efficacy and Safety In A Community Hospital Setting, A Case Series And Review Of The Literature

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Robotic-Assisted Abdomino-Perineal Resection: Efficacy and Safety In A Community Hospital Setting, A Case Series And Review Of The Literature

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Abstract

OBJECTIVE: Robotic assisted (da Vinci System, Intuitive Surgical, Inc) surgery for abdominoperineal resection (APR), can be a challenging procedure for approach to low rectal and anal cancers. This study presents a case series to highlight the safety and efficacy of robotic assisted APR even in a community setting. A review of the literature follows.

DESIGN: Retrospective non-randomized study

SETTING: A 95-bed community medical center.

PATIENTS: All patients who underwent abdominoperineal resection surgical procedure with use of a robotic surgical system or open surgery during the period of 2012.

METHODS: A retrospective analysis was done of 10 consecutive APR procedures performed by a single surgeon between January 2012 and December 2012. Six cases were open and four were done with robotic resection using the da Vinci robotic system. Patient demographics, perioperative, intraoperative and postoperative outcomes were reviewed retrospectively and prospectively as part of clinical follow up. Literature review was performed analyzing multicenter studies.

RESULTS: 10 patients; 6 males and 4 females underwent abdominoperineal resection. 6 patients were in the open group and 4 were in the robotic group. Mean age was 49.1 years and the mean Body Mass Index (kg/m2) was 28.9kg/m2. The median American Society of Anesthesiologist classification was 3. Average blood loss was lower in the robotic group at 265cc versus 596cc in the open group. Robotic docking time averaged 20.5 minutes and the console time was 80.0 minutes. Robotic operative time was 218 minutes +/- 35 minutes. Open APR operative time was 274 minutes. Surgical margins were adequate in all cases.

There was one postoperative complication consisting of delayed perineal wound healing in our open operative group and there was a single intraoperative complication of bleeding towards the end of the robotic case for which the procedure was converted to open.

CONCLUSION: Robotic assisted APR can be safe and effective in a community hospital setting. Operative exposure is enhanced deep in the pelvis. The tridimensional view and endowrist instruments with the robotic systems allowed adequate maneuverability and microdissection in the background of irradiated fields. Perioperative and oncologic outcomes were similar compared to open surgery.

KEYWORDS: Robotic abdomionperineal resection, safety, efficacy, microdissection

Introduction

The da Vinci system® (Intuitive Surgical, Inc., Sunnyvale, California) was introduced in 1997 and approved by the FDA in 2000. This system allows for direct manipulation and dissection capabilities and has become the most widely used operative "robotic" system. The first robotic procedure using the da Vinci system was a cholecystectomy performed in Brussels in 1997.[(1)] The role of robotic surgery is becoming commonplace for many gynecological and urological procedures, its acceptance in the general surgery realm has been slow. Designed to increase surgical precision and minimize complications, the Da Vinci robotic assisted APR procedures may afford better outcomes for patients than traditional laparoscopic surgery or open surgery.

Review of the literature has shown various studies outlining intraoperative and short term postoperative advantages of the robotic APR approach. We report our retrospective study of APR done by a single surgeon over a one year period which consists of four robotic and six open APR's. This was a retrospective, non-randomized study in which we analyzed our data with robotic minimally invasive APR and compared them to open APR.

Methods

A retrospective literature review of subsequently published results was performed. A retrospective comparison of 10 patients non-randomized to open and robotic APR was performed between January 2012 and December 2012. Patient demographics, intraoperative and postoperative outcomes and complications were evaluated. Four APRs were performed by a single surgeon using the da Vinci robot (Intuitive Surgical, Inc., Sunnyvale, CA) 6 APRs were performed open.

The perioperative patient workup was multidisciplinary, including anesthesia, computed tomography imaging, pathology and TNM staging. Intraoperative data included EBL (estimated blood loss), docking time, which is defined as the time required to position and secure robotic arms and ports. Surgical console time, defined as surgeon time spent at the console and total operative time. Patient demographic data included BMI (body mass index), EBL (estimated blood loss), gender, age and ASA (America Society of Anesthesiologist score).

Our decision to perform laparoscopic versus robotic or open surgery was based on a number of factors. Consideration was given to patient size and body habitus, previous surgical procedures and surgeon preference.

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Surgical Technique

The da Vinci system includes a surgeon's console, a surgical cart, and the vision tower. The surgeon's console includes binocular monitors, foot pedals, and hand-held master controls for manipulation of the surgical instruments and camera.

The patient was prepared in the appropriate fashion and positioned in the lithotomy position. The robot was draped and docked into the field and included up to four surgical arms, 12mm camera trocar, and 3 8mm trocars and an additional 12mm trocar for the surgical assistant. Optimal intraperitoneal standard carbon dioxide insufflation pressure was achieved. The surgical technique was standardized, access, mobilization of splenic flexure and left colon mobilization; identification of the ureters and ligation of the IMA and IMV. Identification and preservation of the hypogastric nerves and autonomic nerves was performed. Total mesorectal excision was done, and the rectum was dissected circumferentially as well. Retraction of the bladder or vagina was performed Division of the levator ani muscle was performed to posteriorly and anteriorly down to the ischiorectal fossa. Lastly, the perineal portion of the surgery was performed and the specimen is delivered via the perineum.

Results

Patient preoperative demographics are presented in (Table1). Six male and four female patients underwent abdominoperineal resection. Six cases were open and four were performed robotically. The mean body mass index was 28.9 kg/m2 and the mean age was 53.5 years. An omental flap was created to fill the pelvis when adequate omentum was available. Table 2 summarizes intraoperative and postoperative outcomes. Mean operating time for the open and robotic cases was 252.3 minutes, robotic docking time of 22 minutes, surgeon console time of 86.5 minutes. The estimated blood loss mean was 463cc for open and robotic procedures. The mean length of stay for both procedures was 5.2 days. There was one intraoperative complication of bleeding which was converted to open after the robotic dissection was completed. We report one postoperative complication of delayed perineal wound healing. We encountered no postoperative port site wound infections or rectal perforation. There were no morbidities associated with either robotic or open APR procedure.

Discussion:

We wanted to show that robotic APR approach is not only efficacious as related to length of hospital stay, lower blood loss, and lower infection rates, but importantly feasible and safe for surgeons to perform in smaller community hospital settings. This safety aspect parallels similar findings in the literature citing the technical aspects of the robotic technology. Our case study noted the technical superiority of the three-dimensional visualization, which allowed for more precision and control in anatomically narrow pelvises, large bulky tumors, obese patients, irradiated tissue and preservation of key structures such as nerves. Additionally, the surgeon console allows for dual control of not only instrumentation via the endowrist, but also the camera as well again affording the surgeon greater dexterity.

Feasibility and efficacy of robotic assisted APR can be related to surgeons' learning curves which assesses understanding, competence and operating familiarity with the robotic technology. The CUSUM, (Cumulative Sum Method) identifies three distinct learning phases and mastery of particular unique facets of robotic assisted technology.[(3)] Bokhari et al.[(4)] proposes that mastery of the learning phases particularly, surgeon console time, is a direct marker of operative competency.

Our decision to proceed with robotic versus open/laparoscopic approach was defined by surgeon operative, individual patient demographics, anatomical barriers and limiting postoperative complications. We encountered a patient base with increased BMI and enlarged abdominal girth and/or habitus. Additionally, the advantage of the robotic 3rd and 4th arm would facilitate intraoperative maneuvers such as bowel manipulation and retraction by the surgical assistant.

The decision to proceed robotically allowed our surgical team to overcome some of the limitations of laparoscopy when operating on the obese patient. Another advantage over conventional laparoscopy in the obese patient population included the immobile position of the trocars, which are maintained in a fixed position, allowing a reduction in intraperitoneal pressures and thereby facilitating ventilation of the patient.

There were no infection related problems encountered postoperatively in our patients. We concluded that accounting for modifiable factors and optimization of physiologic variables such as smaller incision site, pre and postoperative glucose control; which we maintained at or equal to 110 milligrams/deciliter. Postoperative glucose levels were maintained per insulin sliding scale protocol. Additionally, antibiotics were administered preoperatively, however no additional studies in our research was evaluated. Review of the literature shows that postoperative hyperglycemia to be the most important risk factor for surgical site infection in general and colorectal cancer surgery patients, and serum glucose levels higher than 110 milligrams per deciliter were associated with increasingly higher rates of post-surgical infection.

Additionally, careful inspection of the trocar sites during and prior to removal was also important. We carefully inspected for trocar site hematomas. Copious irrigation of the trocar sites was performed. Other factors possibly attributable to our postoperative infection rate are copious irrigation of the trocar sites and inspection and closure of fascia and anatomical layers to eliminate dead-space where infections can begin. Nyström *et al.*(18) demonstrated in a prospective study of 189 colorectal operations, the subcutaneous fat layer in the abdominal incisional wound was measured for correlation with wound infection. The infection rate was 20% when the fat layer was greater than or equal to 3.5 cm and 6.8% when the thickness was less than or equal to 3 cm (statistically significant difference). This threefold rise indicates that in obese patients special attention should be directed to antibiotic and other prophylaxis against incisional infection

There have been a few studies that showed trends toward an increase in complications for obese patients. Dostalik *et al.*(6) evaluated 435 patients that had undergone elective laparoscopic colorectal surgery. There were 80 patients (18%) in the obese group (BMI >30 kg/m^2) and 355 patients (82%) in the non-obese group (BMI <30 kg/m^2). post-operative complications were more frequent in the obese group (33% vs 24%). They also saw more frequent re-operations in this same group (13% vs 7%).

Khoury *et al*.(5) re-evaluated 36 patients which were grouped according to BMI. Patients were stratified to either obese (BMI >40 kg/m^2) or non-obese (BMI <30 kg/m^2). The obese patients were found to have a higher rate of wound infection, anastomotic leak, and abdominal abscess as well as higher readmission and reoperative rates.

Due to anatomical constraints, i.e., deep pelvis, irradiated tissue, conventional approach such at open and laparoscopic to abdominoperineal resection has demonstrated the standard minimally invasive approach desirable, however demanding with a conversion rate of 33%.(4) A study conducted by Marecik *et al.(7)* reported no conversions amongst 5 robotic-assisted E-APR's. Popescu *et al.(8)* noted a similar conversion rate in their study of 5.2% for the robotic group versus 10.5% for the laparoscopic group. Kang *et al.*(9) reported no conversions to open approach as well.

While the laparoscopic approach is feasible, studies have shown an increased conversion rate found with the obese patients who underwent laparoscopic resection. Pikarsky *et al.*(11) reported an overall conversion rate of 18 %. When broken down, the patients with a BMI >30 kg/m^2 were more likely to need conversion when compared with a non-obese patient. (39% vs 13.5%, $p = 0.01$) The conversion rate in the literature ranges from 11% to 39%.(12) The reason for conversion in the obese group was more likely to be from poor visualization secondary to intra-abdominal fat or bleeding, which we accounted for in one operative procedure; where as the most likely reason for conversion in the non-obese group was adhesions.

Chemo radiation usually serves as the initial treatment however in cases of residual or recurrent disease abdominoperineal resection as a salvage procedure is offered as the only remaining treatment. For years, the curative approach for recurrent or residual anal/rectal cancer salvage treatment of rectal cancer has involved a multitier approach. The annual age adjusted incidence of anal and anorectal cancer are 1.7 per 100,000 men and women per year, with most being diagnosed, 26.1% between the age of 55 and 64.(13)

Irradiated tissues can change the architecture and structure while performing microdissection. Improved visualization overcomes the limitations of standard open or laparoscopic approach and allows for a more precise pelvic dissection with nerve preservation as well as decreased blood loss. In our study, we did not encounter excessive hemorrhage or nerve violation.

Risk of rectal perforation increases in abdominoperineal resections secondary to mesorectal dissection and tapering.(2) Perforation has been directly related to local tumor recurrence secondary to tumor spillage and higher mortality.(13, 14) A similar study cited no perforations due to the robotic approach, thereby avoiding inadvertent rectal injury.(7)

Robotic APR approach to rectal cancer has significantly diminished the aforementioned constraints such as allowing for superior visualization in the pelvis allowing for a more precise pelvic dissection.(2, 10, 16) Our literature review has shown similar studies outlining the advantages of robotic APR. Pigazzi *et al.*(2) noted amongst 31 robotic APR cases, technical advantages such as reduced hand tremor, improved microdissection accuracy which accounted for reduced morbidity. Hance *et al.*(17) noted that the robotic panoramic view, fingertip controls, Endowrist articulated controls and enhanced dexterity deemed the robotic approach to rectal cancer a safe and feasible procedure. The transition from laparoscopic to robotic seems to less of a hurdle that one would assume. In the hands of a previously skilled laparoscopist, a study noted that the transfer to 12 robotic operations had similar outcomes as compared to 100 laparoscopic procedures.[24]

Table 3 outlines current study intraoperative and postoperative outcomes as well as previous case studies for open and robotic abdominoperineal resections. Our current study found the following: Mean operation time of 218 minutes which was less than previous studies.[17, 20] Open APR operative time was 274.6 minutes. The mean estimated blood loss (EBL) was 150 cc as compared to previous studies.[21.10, 17, 4, 11] The overall LOS was 4.5 days and we report one post-operative complication rate of delayed perineal wound healing. We report no hospital readmissions.

Marecik *et al.*[7] in there study of five robotic E-APR reported no conversions. Our outcome compared favorably with previous studies. A study following 294 patients undergoing robotic abdominoperineal resections found a mean operation time of 298.1 minutes, mean LOS of 10.4 days.[20] Post-operative complication rates were lower in previously reported cases for open approach.[17, 20, 10] Smaller incision size, postoperative pain was also shown to be reduced.[17]

The trend to incorporate robotic APR in smaller hospital settings is not only attributed to objective case comparison, but additionally particular analysis of surgeon characteristics to attain competency and mastery of robotic APR. The cumulative sum (CUSUM) (Figure 3) technique, devised in the 1970's was specifically designed to analyze learning curves for particular surgical procedures.[22, 16] Malak *et al*.[10] focused on surgeon console time as a surrogate marker for operative competency.

Mastery of overcoming the loss of tensile and tactile feedback, conceptualization of spatial relationships and mental visualization of the spatial relationships of the robotic arms and cart are factors that improve with various learning curve phases. Bokhari *et al.*[4] noted that operative time and complication rates decreased through each phase , however an increase in surgeon console time was noted in phase three, secondary to more technical challenging cases (Figure 3). In our study, we noted the surgeon console time of 86.5 minutes. Patel *et al.*[23] reported console time of 93.0 minutes. Bokhari *et al.* [4] reported a cumulative 115 minutes.

Conclusions

We conclude that robotic assisted abdominoperineal resection is a safe and efficient option for treatment of rectal cancer compared to conventional open or laparoscopic approach in our center. We cited particular advantages that robotic abdominoperineal resection which include, better visualization in narrow, irradiated pelvis, decreased intraoperative blood loss, decreased infection rate in the obese surgical patient and length of hospital stay. Additionally, operative microdissection is improved through the eradication of tremor and smaller incisions. Technological advancement as well as identification and analysis of surgeon CUSUM learning curve phases facilitate this approach in smaller single institutions. Data suggests that after a learning curve of 15 to 25 cases, operative competence increases. Our data compared with larger studies could warrant the wide-spread option of robotic abdominoperineal resections as a feasible operative option in smaller hospital centers.

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Figure 1. Robotic port placement. OT - Optical trocar, R1/R2/R3 - robotic arms, A - Assistant

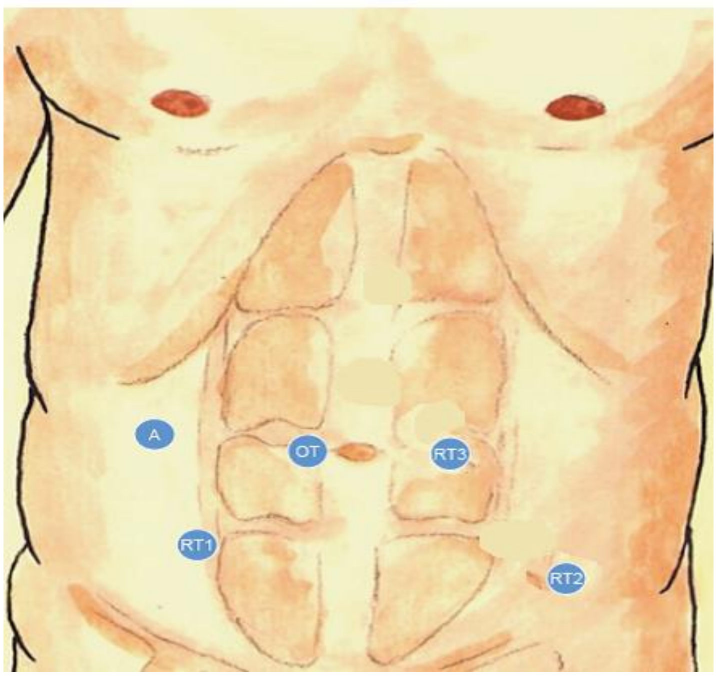

Figure 2. The Robotic cart is placed at an angle of 30 or 40 degrees, to the left side of the patient

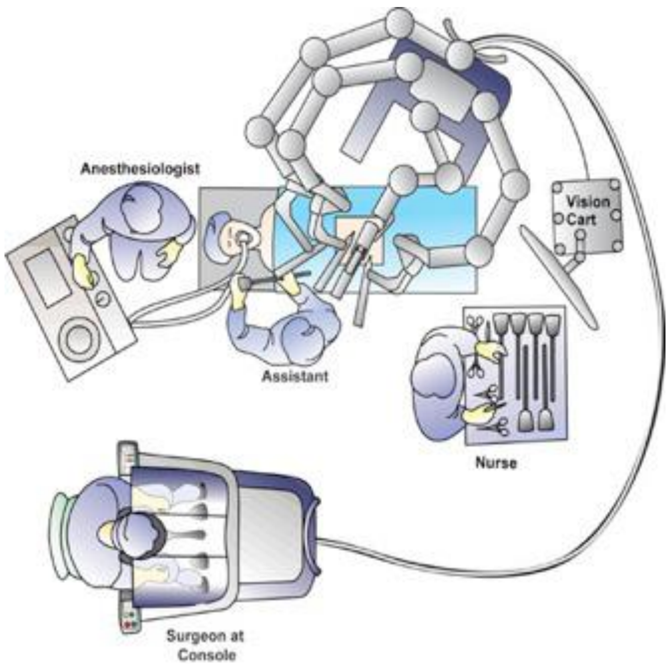

Figure 3. Surgeon console time (SCT). **A** SCT plotted against case number. **B** Cumulative sum (CUSUM) $_{SCT}$ plotted against case number (*solid line*). The *dashed line* represents the curve of best fit for the plot

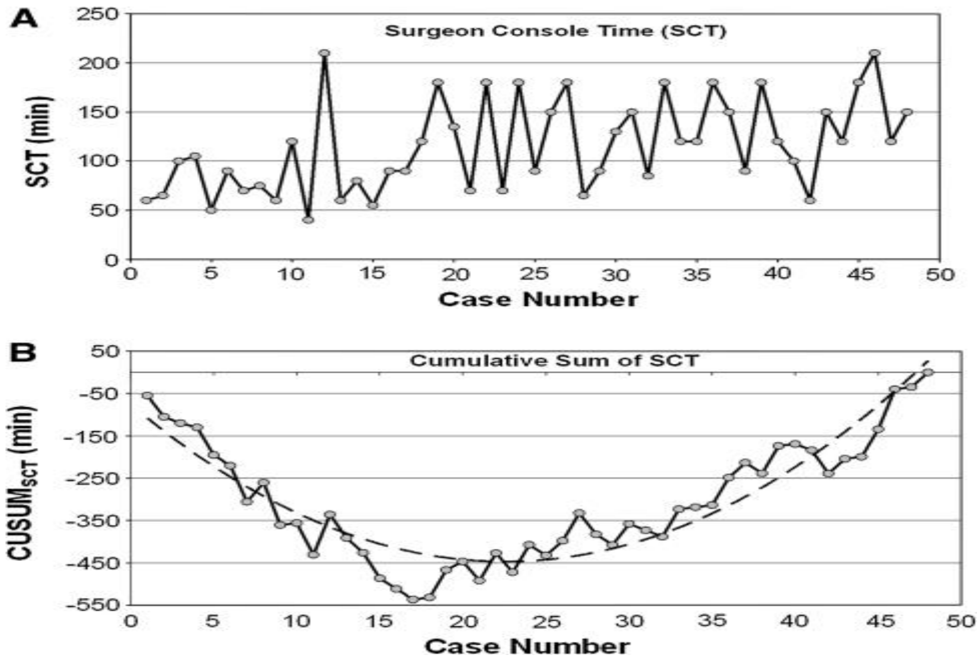

Table 1. Preoperative Demographics. ASA (American Society of Anesthesiologist), BMI (Body Mass Index)

Patient	**Procedure**	**Age Years**	**Gender**	**BMI Kg m-2**	**ASA score**
1	open	56	F	40	3
2	robotic	45	M	27.6	2
3	open	50	M	24	4
4	open	67	M	27.6	4
5	robotic	69	M	31.9	2
6	robotic	40	F	29.3	3
7	open	53	M	29.4	3
8	robotic	35	M	28.1	3
9	open	55	F	22	3
10	open	65	F	29	4
Mean		53.5	60%M	28.9	3.1

Table 2. Intraoperative and postoperative summary. ST-surgical technique, RDT-robotic docking time, SCT-surgeon console time, OT-operating time (minutes), EBL-estimated blood loss (cc), LOS- length of stay (days), VS-vital status (A=alive)

Patient	**ST**	**RDT**	**SCT**	**OT(min)**	**EBL(cc)**	**LOS**	**VS**
1	open	-	-	278	700	5	A
2	robotic	24	90	200	400	5	A
3	open	-	-	230	400	7	A
4	open	-	-	270	1100	4	A
5	robotic	20	80	215	300	4	A
6	robotic	20	76	240	150	5	A
7	open	-	-	300	250	4	A
8	robotic	24	100	220	230	4	A
9	open	-	-	280	300	6	A
10	open	-	-	290	800	8	A
mean		22	86.5	252.3	463	5.2	100

Table 3 Summary of robotic and open postoperative APR outcomes. RAPR-robotic abdomionperineal resection, OT-total operating time, EBL-estimated blood loss, LOS-length of stay, preop chemo-preoperative chemotherapy, preop xrt-preoperative chemoradiation, nr-no result

Study	procedure	# with APR salvage Rx	pre op chemo	preop xrt	OT	EBL (cc)	LOS(days)
Yarbrough et al 2013	RAPR	4	yes	yes	218	270	4.5
Yarbrough et al 2013	OPEN	6	yes	yes	274	591	5.6
Patel et al 2010	RALS	5	yes	yes	204	150	5.4
Ellenhorn et al 1994	OPEN	38	yes	yes	nr	nr	21
Schiller et al 2007	OPEN	39	yes	yes	360	1100	16
Stewart et al 2007	OPEN	22	yes	yes	nr	400	7.5
Lefevre et al 2009	OPEN	95	yes	yes	nr	nr	24.3
Ferenschild et al 2005	OPEN	18	yes	yes	210	1250cc	nr
Baik et al 2013	RAPR	34	nr	nr	298.1	60.3	5.5