Minimally Invasive Surgery for Pelvic Exenteration in Primary Colorectal Cancer

Naveena AN Kumar, MS, MCh, Sajith P. Sasi, MS, MCh, Rajesh S. Shinde, MS, MCh,
Kamlesh Verma, MS, MCh, Pavan Sugoor, MS, MCh, Ashwin Desouza, MS, MCh,
Reena Engineer, MD, Avanish Saklani, MS, FRCS

ABSTRACT

Background: Minimally invasive surgery (MIS) for pelvic exenteration is not a well-established technique. The aim was to assess the safety and feasibility of MIS for pelvic exenteration in locally advanced primary colorectal cancer and to compare the perioperative outcomes with open surgery.

Methods: This is a retrospective analysis of patients, who had undergone pelvic exenteration for primary colorectal adenocarcinoma from May 2013 to July 2018. The short-term outcomes like perioperative details and histopathological characteristics were compared between the two groups.

Results: MIS was performed in 23 patients and open pelvic exenteration was carried out in 72 patients. The mean operative time was significantly more in the MIS group (640 vs. 432 min, $p = 0.00$). The intraoperative blood loss (900 vs. 1550 ml, $p = 0.00$) and the requirement for blood transfusion (170 vs. 250 ml, $p = 0.03$) was significantly less in the MIS group. The overall morbidity (60% vs. 49%, $p = 0.306$) was comparable between the two groups. The median length of hospital stay in the MIS group was 11 d, compared to 12 d in the open surgery group, ($p = 0.634$). The rate of R0 resection (87% vs. 89%, $p = 0.668$) was comparable between the two groups.

Conclusion: MIS is feasible and safe for total pelvic exenteration and posterior exenteration in carefully selected locally advanced primary colorectal cancer, when performed by an experienced surgical team in high volume centers. An R0 resection with adequate margin can be achieved with good perioperative outcomes in MIS. Long-term oncological outcomes would require further follow up to confirm.

Key Words: Minimally invasive surgery, Pelvic exenteration, Rectal cancer, Laparoscopic surgery, Robotic surgery.

Department of Surgical Oncology, Manipal Comprehensive Cancer Care Center, Kasturba Medical College, Manipal Academy of Higher Education (Dr Kumar).

Department of Colorectal Surgical Oncology, Tata Memorial Centre, Homi Bhabha National Institute (HBNI), Mumbai, India (Drs Sasi, Shinde, Verma, Sugoor, Desouza, and Saklani).

Department Radiation Oncology, Tata Memorial Centre, Homi Bhabha National Institute (HBNI), Mumbai, India (Dr Engineer).

Department of Colorectal Surgical Oncology, Tata Memorial Centre, Homi Bhabha National Institute (HBNI), Mumbai, India (Dr Saklani).

INTRODUCTION

Pelvic exenteration (PE) is indicated to achieve R0 resection in colorectal cancer (CRC) cases that are locally advanced as well as those that are locally recurrent.[1–3] Open exenterative surgery, even though associated with more blood loss and major morbidity, offers long-term survival in appropriately selected patients.[1–2,4] Minimally invasive surgery (MIS) with its perioperative advantages and improved visualization especially in male pelvises that are narrow and deep, may have significant benefits associated with it in PE.[5] With advanced surgical instrumentation, refined surgical techniques, and ever increasing experience of the surgeon, many centers have explored the feasibility of MIS in PE;[6,9] however, it has not become a well-established technique until recently.

Our hospital is one of the foremost referral centers for CRC in India.[10] We regularly perform exenterative surgeries, extended resections and multivisceral resections for CRC cases.[11–13] Our initial experience with regard to laparoscopic exenteration[14–15] and the techniques of robotic exenteration[16–18] were published previously.[9] There were only a few studies, which had compared MIS with open PE (OPE).[19] These studies had only a few patients in the MIS group with heterogeneous disease sub-types.[20–22]

We noticed a steady increase in the volume of patients undergoing exenterative surgeries at our institute every year (**Figure 1**). Hence, the aim of this study was to assess the feasibility and safety of MIS (laparoscopic and robotic) for PE in locally advanced primary CRC and also to compare the perioperative outcomes with conventional open surgery.

MATERIALS AND METHODS

Patients

Data was obtained from the prospectively maintained electronic database of the Gastrointestinal and Colorectal Services under the Department of Surgical Oncology. All consecutive patients who underwent PE for primary colorectal adenocarcinoma from May 2013 to July 2018 were evaluated. The patients with histological types other than adenocarcinoma and recurrent tumors, were excluded. Patients were denied surgery in accordance with the Beyond TME Collaborative Consensus guidelines suggesting certain contraindications.[3] The absolute contraindications were medically unfit patients or patients with poor performance status, circumferential bone involvement and bilateral sciatic nerve involvement by tumor.[3] The included patients were categorized into the MIS study group and the conventional OPE control group. The MIS group included laparoscopic and robotic surgery. Locally advanced primary rectal cancers with disease involving anterior and central pelvic compartments were carefully selected for MIS.[23] The inclusion criteria for MIS was primary rectosigmoid/rectal cancers confined to anterior and central pelvic compartments without any extension into posterior or lateral pelvic wall on preoperative magnetic resonance imaging (MRI). Patients with previous multiple abdominal surgeries, patients who were suspected to have extensive small bowel adhesions and tumors with doubtful involvement of the lateral pelvic wall and pre-

sacral fascia/sacrum in the preoperative MRI pelvis were excluded from undergoing MIS.[21]
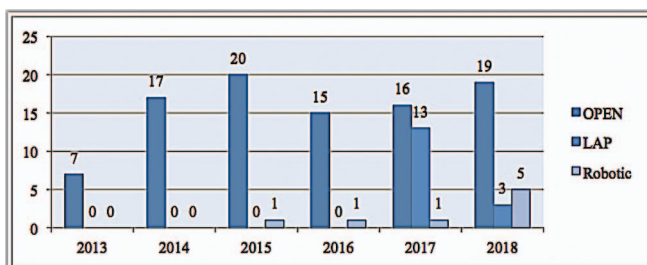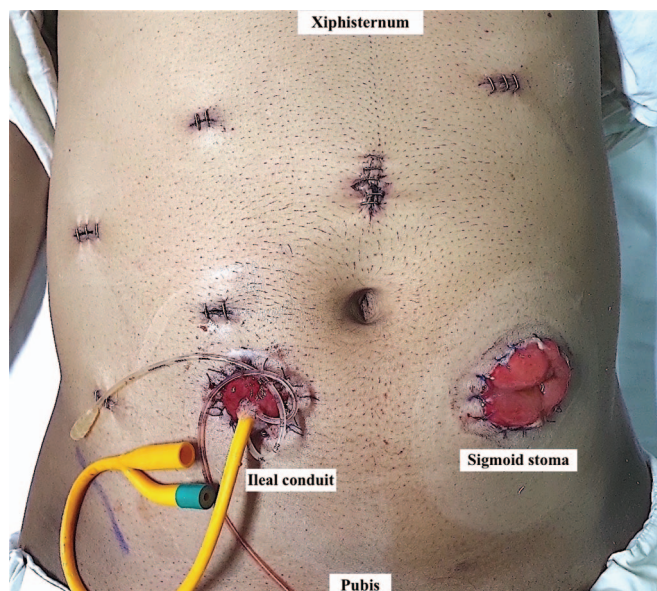
Treatment

As per protocol, all patients attending the colorectal clinic had to undergo standard evaluation with routine investigations, serum carcino-embryonic antigen (CEA) levels, colonoscopy, pelvic magnetic resonance imaging (MRI) and contrast enhanced computed tomography (CECT) of the thorax and abdomen. A multidisciplinary team was involved in the treatment plan. Locally advanced rectal cancer (LARC) patients (clinical stage T3-T4 or any N+) received neo-adjuvant concurrent chemo radiation therapy (NACRT). Following NACRT, patients were reassessed with MRI of the pelvis. If the mesorectal fascia (MRF) remained positive for tumor/node involvement, additional chemotherapy (4 cycles of Capecitabine/5FU and Oxaliplatin based chemotherapy) was administered. Patients with LARC, who were detected to have synchronous oligo-metastases, were subjected to treatment with short course radiotherapy (SCRT) and 3–4 cycles of neo-adjuvant chemotherapy. Patients with persistent involvement of adjacent organs on restaging MRI scan were planned for extended resections/PE in order to attain a margin clear R0 resection. Only patients with residual lateral pelvic lymph nodes following NACRT underwent lateral pelvic lymph node dissection (LPLND).

The type of pelvic exenteration performed was determined by the location, extent, and involvement of pelvic compartments.[24] Total pelvic exenteration (TPE) referred to the resection of the rectum, sigmoid colon, internal reproductive organs, urinary bladder, and lower ureters.[25] Posterior pelvic exenteration was defined as the resection of the rectum and the reproductive organs, sparing the bladder. Supralevator exenteration was defined as the removal of the rectum and bladder/reproductive organs and preserving the sphincter function with colorectal/colo-anal anastomosis.

Complications occurring within 30 days of surgery were defined as postoperative complications. Surgical complications were graded using the Clavien-Dindo (C-D) classification.[26]

Surgical Technique

Laparoscopic TPE was performed as described previously.[14–15] We have also standardized the technique of robotic TPE (**Figure 2**).[16] The steps of the abdominal part of surgery included retroperitoneal dissection (medial to lateral), inferior mesenteric artery and vein division, retro-

Figure 1. The rate of pelvic exenteration per year for colorectal cancer at Tata Memorial Hospital from 2013 to 2018 ($n = 118$).

Figure 2. Robotic total pelvic exenteration showing port position, ileal conduit and sigmoid end stoma.

rectal space dissection all the way down to the origin of the levator ani muscle, medialization of the ureters, dissection of the pararectal and paravesical spaces up to the endopelvic fascia, retzius space dissection, division of the dorsal venous complex, transection of the urethra, division of the ureters, and transection of the sigmoid colon.[9] The LPLND technique was also described previously,[17] which included ureteric medialization, dissection around the iliac vessels, obliterated umbilical artery dissection, obturator nerve identification, and a radical dissection up to the pelvic floor to complete the standard template.[9] The perineal part of the surgery was completed with or without plastic reconstruction comprising unilateral or bilateral VY advancement or pedicled flap depending on the size of the defect. The specimen was extracted through the perineal wound or through a small infra-umbilical incision in case of supralevator exenteration. The Bricker's ileal conduit was performed by making a small midline infraumbilical incision. In patients who had previously undergone a transverse stoma, the stoma was retained as such and a uretero-sigmoid anastomosis was done after ensuring that the colon was stapled distal to the transverse stoma (**Figure 3**).[9]

Posterior exenteration by minimally invasive approach has its own advantages; however, it is technically demanding. We used standard port placement as used for TPE.[14–16] Our technique of robotic posterior exenteration was published recently.[18] The initial steps of surgery until


Figure 3. Laparoscopic total pelvic exenteration showing distal end of ureters and sigmoid conduit.

dissection of the retro-rectal space were similar to MIS TPE. Further steps were as follows: division of the gonadal vessels, dissection of ureters until the uretero-vesical junction, dissection of perirectal space, dissection of parametrial tissue, division of uterine vessels (**Figure 4**), dissection of vesico-uterine space, vaginal transection, dissection in the rectovaginal space, rectal transection/intersphincteric dissection in supralevator exenteration or perineal dissection if sphincters were sacrificed, and suture closure of the vaginal cut end.
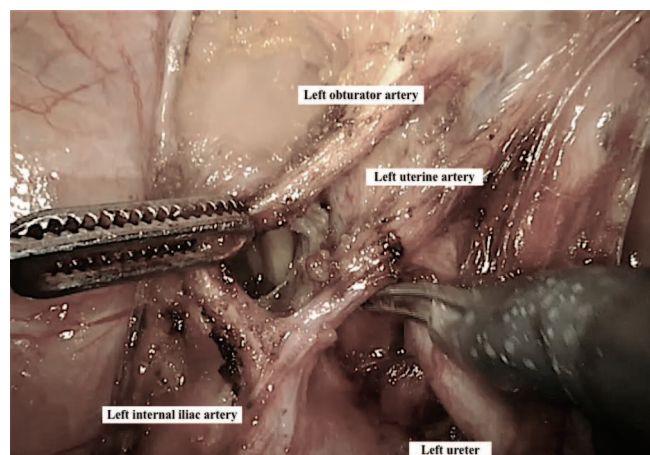
Figure 4. Robotic posterior exenteration showing dissection of left uterine artery.

Statistical Analysis

The short-term outcomes like perioperative details and histopathological characteristics were compared between the two groups. The comparison of qualitative variables was done by X-square or Fisher's exact test and the comparison of continuous variables was done by the Mann–Whitney test. All p values reported were two-sided and 0.05 was considered as significant. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS), version 20.0, for Windows (SPSS Inc., Chicago, Illinois).

Ethics

The ethical standards of the institutional research committee and the 1964 Helsinki Declaration and its later amendments were taken into account to make the study protocol. No formal consent was required for this study as this was a retrospective study and the institutional research committee approval was also not needed.

RESULTS

Twenty-three patients underwent minimally invasive PE and 72 patients underwent OPE. Thirteen patients underwent laparoscopic TPE and laparoscopic posterior exenteration was performed in 2 patients. Robotic TPE and robotic posterior exenteration was performed for 4 patients each. Three patients underwent supralevator exenteration and 12 patients underwent LPLND in the MIS group. The preoperative characteristics are shown in **Table 1**. The MIS group had predominantly lower rectal tumors and more LPLNs metastases (**Table 1**). Characteristics related to patient demographics and tumor and treatment variables were similar in both the groups (**Table 1**).

The perioperative characteristics are shown in **Table 2**. The MIS group had a mean body mass index (BMI) of 23 kg/m^2. The details of surgery are shown in **Table 2**. No patient required sacrectomy in either of the groups. More than half of the patients (61%) required plastic reconstruction for perineal defect in the MIS group. The mean operative time was found to be significantly more in the MIS group (640 vs. 432 min, $p = 0.00$). The intraoperative blood loss (900 vs. 1550 ml, $p = 0.00$) and the requirement for blood transfusion (170 vs. 250 ml, $p = 0.03$) was significantly less in the MIS group. One patient, who had a doubtful lateral resection margin on MIS was converted to open surgery to achieve R0 resection. We also performed robotic intracorporeal ileal resection and anastomosis and uretero-ileal conduit anastomosis in 2 patients.

The minor complication rates (Clavien-Dindo II) (35% vs. 29%, $p = 0.902$) and major complication rates [Clavien-Dindo IIIa (13% vs. 8.30%), IIIb and IV (13% vs. 10%, $p = 0.902$)] were comparable between the MIS and OPE groups respectively. Out of the 14 patients with complications in MIS group, only 3 patients (21%) required exploratory laparotomy, while the other patients were managed conservatively with radiological/local surgical interventions (21%) or with regular wound dressings and antibiotics (58%). The rate of paralytic ileus was low in MIS compared to OPE group (4% vs.14%, $p = 0.384$), which was statistically not significant due to the low number of patients in the MIS group. The MIS group had a median duration of hospital stay of 11 days vs. 12 days in the OPE group; however, this was not statistically significant.

The histopathological characteristics are described in **Table 3**. The rates of R0 resection (87% vs. 89%, $p = 0.668$), circumferential resection margin (CRM) positivity (13% vs. 11%, $p = 0.668$), mean pelvic lymph node yield (13 vs. 15, $p = 0.417$), lymph node positivity (39% vs. 38.8%, $p = 0.983$) and other histopathological characteristics were comparable between the MIS and OPE groups respectively. The circumferential resection margin was involved in 13% (3 of 23) and 9% (6 of 66) patients with MRI positive mesorectal fascia in the MIS and OPE groups respectively.

At a median follow up of 13.6 months (1–75 months), no local recurrence and 3 distant recurrences were noted in the MIS group, as compared to 8 local recurrences and 27 distant recurrences in the OPE group ($p = 0.031$). The estimated two-year disease-free survival was 73.50% in the MIS group and 60.90% in the OPE group, which was statistically not significant.

DISCUSSION

MIS has become an acceptable treatment modality for locally advanced CRC as confirmed by many randomized controlled trials.[27–30] The utilization of MIS for PE has been explored by many centers.[6–8] However, current literature on comparison of MIS and OPE includes only small case series and retrospective reports.[9,31] A recent systematic review of four retrospective studies by the PelvEx Collaborative group, reported the feasibility of MIS with good perioperative outcomes in selected cases.[19] However, all of the current reports have a small sample size and there was heterogeneity in the study.[20–22,32] In this comparative analysis, we studied 23 minimally invasive approaches and 72 conventional OPE, which to our knowledge is the

Table 1.
Preoperative Characteristics

Characteristics	Total (*n* = 95) (%)	MIS (*n* = 23) (%)	OPE (*n* = 72) (%)	*P* value
Age (year), mean (range)	45 (19–71)	45 (21–64)	45 (19–71)	0.924
>40	56 (59)	16 (70)	40 (56)	0.234
<40	39 (41)	7 (30)	32 (44)	
Sex				
Male	50 (53)	14 (71)	36 (50)	0.363
Female	45 (47)	9 (39)	36 (50)	
Site				
Rectum	84 (88)	22 (96)	62 (86)	0.384
Rectosigmoid/sigmoid	11 (12)	1 (4)	10 (14)	
Distance from anal verge (cm), mean (range)	4.69 (0–20)	3 (0–11)	5.24 (0–20)	**0.011***
<5 cm	62 (65)	20 (87)	42 (58)	**0.024***
>5 cm	33 (35)	3 (13)	30 (42)	
Histology				
WD/MD	67 (70)	18 (78)	49 (68)	0.502
PD	28 (30)	5 (22)	23 (32)	
cT4a	37 (39)	8 (35)	29 (40)	0.674
cT4b	51 (54)	13 (57)	38 (53)	
cN1 and above	93 (98)	22 (96)	71 (99)	0.979
cN0	2 (2)	1 (4)	1 (1)	
MRF involved	92 (97)	22 (96)	70 (97)	1.00
MRF free	3 (3)	1 (4)	2 (3)	
LPLN involved	37 (39)	13 (57)	24 (33)	**0.047***
cM1	11 (12)	2 (9)	9 (12)	0.903
CEA (ng/mL), median (range)	6 (1–1774)	5.5 (2–115)	6.1 (1–1774)	0.896
>5	55 (58)	13 (56)	42 (58)	0.878
Neo-adjuvant Rx	92 (97)	23 (100)	69 (96)	0.757
NACRT	72 (76)	19 (83)	53 (74)	0.550
SCRT	15 (16)	4 (17)	11 (15)	0.809
NACT	61 (64)	15 (65)	46 (64)	0.908
Post neo-adjuvant status				
Response status,				
Stable and Partial	70 (76)	16 (76)	54 (76)	0.535
Progression	22 (24)	5 (24)	17 (24)	
CEA (ng/mL), median (range)	2.95 (1–68)	2.5 (1.37–9.66)	3.4 (1–68)	0.391
MRF involved	89 (94)	23 (100)	66 (92)	0.178
cM1	14 (15)	2 (9)	12 (17)	0.548
Post RT delay (week), mean (range)	25 (5–119)	23 (5–63)	25 (6–119)	0.643
>12 weeks	66 (76)	17 (74)	49 (76)	0.799

MIS, minimally invasive surgery; OPE, open pelvic exenteration; WD, well differentiated; MD, moderately differentiated; PD, poorly differentiated; MRF, mesorectal fascia; LPLN, lateral pelvic lymph node; cM1, distant metastasis; CEA, carcino-embryonic antigen; Rx, treatment; NACRT, neo-adjuvant chemoradiotherapy; SCRT, short course radiotherapy; NACT, neo-adjuvant chemotherapy; RT, radiotherapy.

* = Statistically significant.

Table 2.
Peri-Operative Characteristics

Characteristics	Total ($n = 95$) (%)	MIS ($n = 23$) (%)	OPE ($n = 72$) (%)	P value
Physical status (ASA),				
I	63 (66)	14 (61)	49 (68)	0.526
II and above	32 (34)	9 (39)	23 (32)	
BMI (kg/m^2), mean (range)	22.7 (15–36)	23 (16–36)	22.6 (15–31)	0.569
> 25	29 (31)	7 (30)	22 (31)	0.929
Hemoglobin (g/dL), mean	11.15 (7–14)	11 (9–14)	11 (7–14)	0.925
< 12	64 (67)	17 (74)	47 (65)	0.442
Albumin (g/dL), mean	3.7 (2.1–4.7)	4 (2.9–4.7)	3.7 (2.1–4.7)	0.008
< 3.5	26 (27)	4 (17)	22 (31)	0.335
Preoperative diversion stoma	48 (51)	6 (26)	42 (58)	0.007
Surgery				
TPE	58 (61)	17 (74)	41 (57)	0.282
Posterior exenteration	38 (39)	6 (26)	31 (43)	
Sphincter preservation surgery (Supralevator)	29 (31)	3 (13)	26 (36)	0.067
LPLND	35 (37)	12 (52)	23 (32)	0.080
Posterior vaginal wall resection	16 (17)	4 (17)	12 (17)	1.00
Plastic reconstruction	26 (27)	14 (61)	12 (17)	**0.00***
Urinary conduit	58	15	41	
Ileum	56	2	0	
Sigmoid colon	2			
Duration Surgery (min), mean (range)	490 (180–800)	640 (420–800)	432 (180–660)	**0.00***
>420 min	41 (62)	18 (95)	23 (49)	**0.001***
Blood loss, (mL), median	1400 (150–4000)	900 (300–2600)	1550 (150–4000)	**0.00***
> 1000mL	62 (65)	6 (26)	56 (78)	**0.00***
Blood transfused (mL), median (range)	250 (0–1500)	170 (0–1200)	250 (0–1500)	**0.03***
Complications (%)				
Clavien–Dindo grade	49 (52)	14 (60)	35 (49)	0.306
CD II	29 (31)	8 (35)	21 (29)	0.902
CD IIIa	9 (9)	3 (13)	6 (8.3)	
CD IIIb and IV	10 (11)	3 (13)	7 (10)	
CD V	1 (1)	0	1 (1.4)	
Type of complications				
Anastomotic leak	9 (9.5)	2 (9)	7 (10)	1.00
Bowel	5	2	3	0.579
Urinary	4	0	4	0.384
Pelvic collection	9 (9.5)	1 (4)	8 (11)	0.289
Paralytic ileus	11 (12)	1 (4)	10 (14)	1.00
Stoma complications	3 (3.2)	2 (9)	1 (1)	0.227
Conduit complications	5 (5.3)	1 (4)	4 (6)	
Perineal wound infection	24 (25)	8 (35)	16 (22)	
Mortality	1	0	1	
Hospital stay (days), median (range)	12 (5–94)	11 (7–42)	12 (5–94)	0.634
>14 days	33 (35)	7 (30)	26 (36)	0.619
Re-admission in 30 days	9 (9)	3 (13)	6 (8)	0.793

MIS, minimally invasive surgery; OPE, open pelvic exenteration; ASA, American Society of Anesthesiologists; BMI, body mass index; TPE, total pelvic exenteration; LPLND, lateral pelvic lymph node dissection; CD, Clavien–Dindo.

* = Statistically significant.

Table 3.
Histopathology Characteristics

Characteristics	Total (*n* = 95) (%)	MIS (*n* = 23) (%)	OPE (*n* = 72) (%)	*P* value
Resection type,				
R0	84 (88)	20 (87)	64 (89)	0.668
R1 (CRM involved)	11 (12)	3 (13)	8 (11)	
pT0	18 (19)	4 (17)	14 (19)	0.761
pT1, pT2	13 (14)	3 (13)	10 (14)	
pT3	25 (26)	8 (35)	17 (24)	
pT4	39 (41)	8 (35)	31 (43)	
pT4a	5 (5)	2 (9)	3 (4)	0.574
pT4b	34 (36)	6 (26)	28 (39)	
pN0	58 (61)	14 (61)	44 (61)	0.983
pN1 and above	37 (39)	9 (39)	28 (38.8)	
LPLN involved	3 (3.2)	0	3 (4)	0.757
PNE	22 (23)	3 (13)	19 (26)	0.3
pCR	14 (15)	2 (9)	12 (17)	0.548
TRG < 2	29 (31)	8 (35)	21 (29)	0.799
Signet ring cell Histology	13 (14)	2 (9)	11 (15)	0.652
LVI+	20 (21)	2 (9)	18 (25)	0.169
PNI+	18 (19)	6 (26)	12 (17)	0.485
EMVI+	9 (10)	2 (9)	7 (10)	1.00
pM1	14 (15)	2 (9)	12 (17)	0.548
Total mesorectal LNs, mean (range)	13 (0–5)	12 (4–28)	13 (0–5)	0.513
Positive mesorectal nodes, mean (range)	1.6 (0–28)	2 (0–28)	1.5 (0–17)	0.466
U/L LPLN, mean (range)	3 (1–5)	3 (1–5)	3 (1–5)	0.749
Total Pelvic LNs, mean (range)	15 (0–78)	13 (4–28)	15 (0–78)	0.417

MIS, minimally invasive surgery; OPE, open pelvic exenteration; CRM, circumferential resection margin; LPLN, lateral pelvic lymph node; PNE, peri nodal extension; pCR, pathological complete response; TRG, tumor regression grade; LVI, lympho vascular invasion; PNI, perineural invasion; EMVI, extramural venous invasion; LN, lymph node; U/L, unilateral.

largest single center series of MIS for locally advanced primary colorectal adenocarcinoma.

We routinely perform laparoscopic and robotic TME for locally advanced CRC.[33] The refinement of the surgical technique along with its standardization, better perioperative care, advances in interventional radiology, implementation of multidisciplinary team approach and careful patient selection have helped us to adopt MIS for PE in our center.[9] The magnified view in the pelvis that is narrow and deep, the privilege of executing a meticulous dissection and careful transection of the small branches of internal iliac vessels, the controlled dissection of the distal part of ureters and uretero-vesical junction, and intersphincteric space in case of supralevator exenteration have encouraged us to perform more MIS procedures.

We emphasize on the careful selection of patients with a favorable anatomy and tumors with disease limited to the anterior pelvic organs for MIS. The presence of low-lying rectal tumors or lateral pelvic lymph node metastasis, whether neo-adjuvant chemo-radiotherapy/additional chemotherapy was given or not, response status to the neo-adjuvant treatment and preoperative diversion stoma did not influence our decision in considering MIS. We suggest performing the posterior and lateral dissection in the pelvis prior to the anterior dissection to avoid suspension of the bladder.[21] The idea of performing ureteric transection towards the end of the abdominal part of the surgery is to facilitate the urine output monitoring and to prevent urine leak.[9] The dorsal venous complex is divided at the last stage of the pelvic dissection and in case there is any

inadvertent bleeding, the intra-abdominal pneumo-peritoneum pressure is increased, the area packed with tape gauze and the bleeding vessel sutured during the perineal portion of the surgery.[9,15]

The mean operative time was significantly longer in the MIS group when compared to the OPE group, but this was still lesser time when compared to other reports (**Table 4**).[5,21] The longer duration of MIS could be due to multiple factors such as the learning curve as our reports included all initial cases of MIS, the fact that surgical trainees as residents and fellows would perform the initial part of surgery and because of the extra time taken for intracorporeal urinary conduit, more number of LPLNDs and plastic reconstruction. The intraoperative blood loss and the requirement for blood transfusion was significantly less in MIS. The magnified view and meticulous dissection and transection of small branches of internal iliac vessels facilitated lesser blood loss.

The overall rate of complications in the MIS group is comparable to OPE and is similar to other reports (**Table 4**).[19] These groups of patients are at risk for complications related to prolonged surgery and anesthesia like venous thromboembolism, extremity compression, peripheral neuropathies and hypothermia. However, we did not observe any increased incidence of these events in the MIS group. MIS reduces the hospital stay duration.[19,34] The recent systematic review on MIS PE reported the median hospital stay as 22 d in the MIS group and 28 d in the OPE group.[19] Our study reported a much shorter length of stay in the hospital in both the groups when compared to existing literature (**Table 4**),[19] which might be because of the high-volume rate at our hospital (**Figure 1**). If the perineal complications rate in the MIS group were lesser, this would have further reduced the hospital stay duration. The length of hospital stay in the MIS exenteration group is more compared to any laparoscopic/robotic colorectal surgery mainly due to the complexity of the procedure itself.[35] The high-volume rate in the MIS group would probably improve the perioperative outcomes and length of hospital stay in the future.

The rates of R0 resection, CRM positivity, mean pelvic lymph node yield and other histopathological characteristics were comparable between the MIS and OPE groups respectively; this was comparable to the existing literature as well (**Table 4**).[19] We advise, not to hesitate to convert to open surgery if an oncologically safe resection is uncertain with MIS.

The highlights of our study were larger sample size compared to previous reports in the MIS group and no heterogeneous disease sub-types. The histopathological characteristics were also compared in this study. The limitations were the retrospective nature of the study, selection bias, unmatched groups and short term follow up. The postoperative recovery, quality of life and cost of surgery were also not assessed.

CONCLUSION

MIS is feasible and safe for total PE and posterior exenteration in carefully selected, locally advanced primary

Table 4.
Retrospective Reports of Minimally Invasive Surgery and Open Pelvic Exenteration in Locally Advanced Colorectal Cancer and Outcomes

Study	Year	MIS/OPE (n)	Type of Pelvic Malignancy	Median Operative Time (min)	Median Blood Loss (mL)	Conversion Rate, n, (%)	Overall Morbidity (%)	Hospital Stay (days)	R0 Resection Rate
Present Study	2019	23/72	CRC	640.00	900.00	1 (4)	60.00	11.00	87.00
Uehara K et al [20]	2016	9/58	CRC and others	935.00	830.00	1 (11.1)	66.7	27.00	77.8
Ogura A et al [5]	2016	13/18	CRC and others	829.00	930.00	00.00	61.5	29.00	100.00
Yang K et al [19]	2015	11/37	CRC and others	565.2	547.3	00.00	9.09	15.3	100.00
Winters BR et al [31]	2015	3/9	CRC and others	610.00	550.00	00.00	33.34	7.34	66.7

CRC, colorectal cancer.

CRC cases, in patients with favorable anatomy, when performed by a surgical team with considerable experience and in high volume tertiary care centers. An R0 resection with adequate margin can be achieved with good perioperative outcomes in MIS. There is lesser intra-operative blood loss and decreased requirement for blood transfusion in MIS compared to open surgery. Long-term oncological outcomes would require further follow up to confirm.

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