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FEASIBILITY OF REDUCED-PORT LAPAROSCOPIC COLORECTOMY WITH NATURAL ORIFICE SPECIMEN EXTRACTION SURGERY FOR COLORECTAL CANCER

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Abstract:

Over the past years rectal cancer surgery has been advanced with the addition of different techniques to reduce the invasiveness with better outcome. Minimal invasive surgery is the finest addition in the treatment with reduced post-operative pain, less wound complication, earlier return of bowel function, less adhesions, better cosmetic and possibly shorter hospital stay. In conventional technique of Specimen extraction, we need "mini-laparotomy" which needs a long cut on the abdomen for the extraction of specimen which mask the benefits of laparoscopic surgery. Natural orifice specimen extraction (NOSE) is a better technique to overcome this shortcoming in which we extract the specimen through the hollow viscus that already communicates with the outside world such as anus or vagina. The notion of this procedure is to remove the specimen with decrease trauma required for the removal of specimen with better outcome such as reduced post-operative pain, less use of analgesics, early healing with less wound complications and most important the excellent cosmesis effect compared to conventional specimen extraction. While the feasibility of NOSE has been demonstrated but there are also some limitation of NOSE which effect the application of this technique in colorectal surgery. Certain factor like BMI, ASA Score, Specimen size, and gender are main factors for effectiveness of this technique. The aim of this study is to review the feasibility and benefits of reduced port laparoscopic surgery with NOSES.

***Keywords**: natural orifice specimen extraction, colorectal cancer surgery, minimally invasive surgery, rectum, feasibility of NOSE, colorectal.*

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INTRODUCTION:

History and Feasibility

Colorectal Cancer is one of the major causes of death worldwide and the number of colorectal patients has significantly increased in the last few years. The treatment strategy for colorectal cancer, especially low rectal cancer has been changed and improved dramatically in the last century. Abdominoperineal resection subsequently became the standard surgical treatment for rectal cancer which was described around 1900, however the attendant risk of operative mortality was very high[1]. Preservation of the anal sphincter is a major aspect of colorectal cancer surgery which still exist today and achieved successfully in mostly cases. Anterior resection and the pull-through technique were developed and progress has been made in these procedures. In 1980s, Laparoscopic surgery was introduced and total mesorectal excision (TME) advocated for the thorough removal of cancer [2,3]. Laparoscopic colectomy and protectomy has become the standard technique for rectal cancer treatment now a days. Laparoscopic surgery is more beneficial and advantageous in term of enhanced visuals with high resolution, less postoperative pain, better quality of life with equivalent oncologic outcome. Clinical trials demonstrated the benefit of laparoscopic surgery over open surgery for rectal cancer [4,5,6].

The conventional multi-port laparoscopic colorectal surgeries (CMLS) are performed through multi-ports allowing variation of scope and other instruments placement for easy and safe dissection. The evolution of laparoscopic surgery has recently led to the introduction of Single Incision Laparoscopic Surgery (SILS) and Reduced Port Laparoscopic Surgery (RPLS), despite the limited laparoscopic handling space. Certain studies previously compared single-incision laparoscopic colectomy to conventional multi-port laparoscopic colectomy for CRC in terms of operative procedure and outcome. There were no differences in operative time, open conversion, number of harvested lymph nodes, length of hospital stay, postoperative complications and mortality but with certain technical difficulties and surgeon fatigue [7-9]. So a better technique is developed which combined the advantages of conventional laparoscopic surgery and SILS. This technique is known as Reduce Port Laparoscopic Surgery (RPLS) in which 3 or 4 ports are introduced in the body according to surgical technique (right hemicolectomy, left hemicolectomy or anterior resection). Additional ports may be added according to surgeon decision and operative difficulties. Results for RPLS are comparable to large clinical trials and results is not inferior to conventional laparoscopic surgery. Several studies of RPLS reported that operation time of RPLS was comparable to CMLS [10,11]. This technique must therefore prove to be equal to conventional techniques with regard to benefits and oncologic safety. Laparoscopic surgery can meet social needs towards quality of life (QOL) in cancer treatment by enhancing patient satisfaction with reduced abdominal wall trauma and post-surgical scarring. So RPLS is better technique which alleviate the glitches of SILS and open surgery and become a bridge between conventional laparoscopic surgery and SILS which provide a mid-way to for performing surgery with ease.

Specimen extraction is one of the basic and challenging process in colorectal surgery. A mini-laparotomy is needed in which extra incision is given on the abdomen for the removal of specimen extraction which compromise the benefits of laparoscopic surgery. The length of incision depend on the size of specimen and associated with increased wound infection, hernia, and postoperative pain. [12-16] Natural orifice specimen extraction (NOSE) eliminates this extra incision which is otherwise indispensable for specimen removal. NOSE is defined as the removal of specimen from the body via natural route which is already communicated with outside word i.e. vagina and gastrointestinal tract. NOSE remove the extra incision from the abdomen thus relieve the patient from comorbidities caused by mini-laparotomy. Feasibility of NOSE for colorectal surgery is acknowledged in literature. Stewert et al [17] and Nezhat [18] extract the colectomy specimen through the vagina reported in 1991 and 1992. In Nezhat's series, 9 patient were treated for endometriosis with transvaginal specimen extraction, however this technique is successfully used now for treatment of malignancy, diverticulitis and inflammatory bowel disease [19]. Successful colon and rectum cancer removal are described in various case reports and studies. Franklin et al [20] first describe the partial colectomy with NOSE via anus.

NOSE technique is difficult due to steep learning curve so need more technical skills. Intracorporeal anastomosis after the removal of distal site such as distal descending colon and sigmoid colon cancers is pre-requisite skill for the adoption of NOSES. Removal of more proximal specimen as in right hemicolectomy need an expert surgeon because of the length by which specimen passed and tortuous sigmoid colon made it difficult. Posterior colpotomy is needed in those patient in which specimen is removed by the vagina and this technique is normally not performed by colorectal surgeons. There is no standardization of NOSE technique which also intensified the technical diffuclties.

Practically left sided colon pathology is more easy and feasible to perform than right side colon pathologies. Long length of ascending colon,

transverse colon, descending colon and narrow tortuous sigmoid colon made it more difficult to pass the large size specimen of right colon cancer. So there is strict criteria of specimen size for the right side colon pathologies than left side colon lesions which limit its use for right sided colon cancer.

The vagina has been established as a specimen extraction route in NOSE for gynecological and colorectal pathologies. First vaginal specimen extraction is noted in 1990s. This technique has been used mostly for right side colon pathologies or bulky size specimen [21]. Vagina is better option because of its improved healing and elasticity but only possible in females [22-24]. A greater volume of literature focus on the extraction of sigmoid and rectal cancer via NOSE. Wound protection is needed to avoid from implantation of cancer cell and bacterial infection. To date, many studies are published for successful extraction of specimen via colon, rectum, anus and vagina to cure both benign and malignant tumor [19]. Many studies reports NOSE benefits over conventional specimen extraction in term of Post-operative analgesic use, time of first bowel function, cosmesis and length of hospital stay [25-27].

No.	Study Group	Successful NOSES/ Total Attempts	Success Rate (%)	Sex (M/F)	Age (Years) Mean (Range)	BMI Mean (Range)
1	Wolthuis et al, [41] 2015	19/20	95	5/15	54 (median) (31–72)	23.5 (18–29)
2	Saurabh et al,[25] 2017	77/82	93.9	47/35	63.3±13.9	24.4±4.2
3	Karagul et al [16],2017	49/67	73.1	40/27	57.9±13.4	Unk
4	Wolthius et al,[42] 2015	17/17	100	3/15	Unk	Unk
5	Pai et al, [43],2015	19/19	100	13/6	48 (median) (range:23–78)	Unk
6	Wang et al,[44], 2013	21/21	100	4/17	62 (median) (range:50–80)	23.6 (mean) (range:18–30)
7	Zhang et al,[45], 2014	18/18	100	10/8	56.6 (mean) (range:48–69)	22.6 (mean) (range:19.7–26.4)
8	Hisada et al,[46] 2014	20/20	100	12/8	63.7±9	25.47±3.02
9	Cotantino et al, [47] ,2012	16/17	94.1	6/11	60.1±9.42	25.47±3.02
10	Zhang et al, [48] ,2014	24/27	88.9	16/11	54.8 (mean) (range:37–77)	22.11 (mean) (range:18.4–30.2)
11	Han et al, [49] ,2013	21/21	100	12/9	45.4±3.6	23.1±2.8
12	Wolithus et al,[50] , 2015	110/110	100	13/97	38 (median) (range:32–56)	23 (median) (range:21–25)
13	Xingmao et al, [27] 2014	65/65	100	32/33	56.1±9.3	23.7±2.9
14	Franklin et al, [51] ,2013	303/303	100	Unk	Transvaginal: 69.9±14.8 Transanal: 65.3±11.6	Unk
15	Akamatsu et al,[52] , 2009	16/16	100	Unk	Unk	Unk
16	Nishimura et al,[53] ,2011	17/18	94.4	14/4	65.5 (mean) (range:52–89)	21.3 (mean) (range:16.1–24.9)
17	Wolthuis et al,[54] , 2011	21/21	100	2/19	41 (median) (range:34–66)	23 (median) (range:22–26)
18	Huang et al,[55] , 2016	32/32	100	17/15	68±13 (range: 43–90)	23.3±2.2 (range: 18–27)
19	Leung et al, [56] , 2013	35/35	100	13/22	62 (median) (range:51–86)	Unk
20	Kim et al, [57] , 2013	57/58	95	0/58	62.8±9	23.5±2.9
21	Denost et al, [58] , 2015	122/122	94.1	70/52	63 (median) (range:20–90)	24.3 (median) (17.3–33.6)
22	Awad et al, [59] , 2014	19/20	95	0/20	66.9±8.9	25.1±6.65
23	Park et al, [60] , 2011	32/34	94.1	0/34	61.0±11.2	23.9±3.1
24	Wolthius et al, [61] , 2011	21/21	100	Unk	35 (median) (range:30–38)	23 (median) (22–25)
25	Marks et al, [62] , 2017	193/193	100	135/58	59 (mean)	27 (mean)

No.	Comorbidity	Viserectomy Site	Location	Specimen Size
1.	ASA I=5 ASA II=15	Transanal=20	Left/sigmoid colon	Unk
2	ASA I=59 ASA II/III=23	Transanal=82	Rectosigmoid=69 Prox. Rectum=13	Largest diameter 2.9±1.6
3	Unk	Transanal=37 Transvaginal=12	Colon:Right=17 Transverse=1 Total=4 Rectosigmoid=30	4.6±3.4 (mean)
4	ASA I=4 ASA II=11 ASA III=2	Transanal=17	Left colon=17	Length: Camera sleeve: 23 (median)(range:20–26) Bag: 21 (median)(range: 15–25)
5	Unk	Transanal=19	Rectum=19	Unk
6	Unk	Transanal=16 Transvaginal=5	Rectum=21	2.8 (mean) (range:1.8–6.0)
7	Unk	Transanal=18	Midrectum=12 Low rectum=6	4.2 (mean) (range:3.5–6.5)
8	Unk	Transanal=20	Upper rectum/ sigmoid=20	2.7±0.9
9	1.47±0.51	Transanal=17	Sigmoid=17	Unk
10	Unk	Transanal=27	Sigmoid=13 Rectum=14	Unk
11	Unk	Transanal=21	Rectum=21	4.6±1.7
12	ASA I=45 ASA II=56 ASA III=9	unk	Left colon/sigmoid/ rectum=110	Unk
13	ASA I=10 ASA II=50 ASA III=5	Transanal=65	Sigmoid=27 Rectum=38	2.9±1.5
14	Unk	Transanal=277 Transvaginal=26	Unk	Unk
15	Unk	Transanal=16	Sigmoid/ Rectosigmoid=16	Unk
16	Unk	Transanal=18	Sigmoid=18	1.84 (mean) (range:0–4.0)
17	Unk	Transanal=21	Sigmoid=21	Length of specimen: 20 (median) (range:13–25)
18	ASA I=4 ASA II=20 ASA III=8	Transanal=32	Sigmoid=15 Rectosigmoid=9 Upper rectum=6 Mid rectum=2	3.3±1.8 (range:1.3–6.2)
19	Unk	Transanal=35	Left colon=35	2 (median) (range:2–4)
20	ASA I=20 ASA II=32 ASA III =6	Transvaginal=58	Sigmoid=21 Rectosigmoid=8 Rectum=29	3.4±1.8
21	Unk	Transanal=122	Low rectum=122	3.9 (median) (range:1–10)

22	ASA II=4 ASA III=15 ASA IV=1	Transvaginal=20	Right colon=20	4.735±3.61
23	ASA I=12 ASA II=18 ASA III=4	Transvaginal=34	Cecum=10 Ascending Colon=16 Proximal transverse colon=8	3.8±1.3
24	ASA I=13 ASA II=8	Transvaginal=21	Sigmoid=21	Length of specimen: 21 (median) (range:17–24)
25	ASA I=4 ASA II=92 ASA III=92 ASA IV=5	Transanal=193	Low rectum=193	Unk

(ASA American Society of Anesthesiologist Score; Unk Unknown)
Table 1: NOSE surgeries related to Criteria of patient selection

Potential benefits
There are certain benefits of laparoscopic surgery over conventional open surgery like less blood loss, less need of blood transfusion, Reduced Surgical Trauma, less use of epidural anesthesia, lower rate of postoperative complications after laparoscopic surgery, WBC and CRP are lower after laparoscopic surgery, less hospital stay, more lymph-node are harvested with CRT in low rectal cancer, lower rate of positive circumferential resection margin (CRM) due to better and magnified visuals by laparoscope [4,28].

Within laparoscopic surgery Reduced Port Laparoscopic surgery (RPLS) is the better in term of accessible movement of hands and less vulnerable port site infection. More trocar sites means more vulnerable sites for infection and more scars on body. So by decreasing the ports we have possibly less infection sites with less scars on the abdomen. While Single Incision Laparoscopic Surgery (SILS) is also comparable with RPLS but there is no additional ports exist and maneuvering is greatly restricted by nearby instruments. Therefore SILS requires an experienced surgeon to overcome the technical difficulties of triangulation, instruments crowding and pneumoperitoneum leakage [29-31]. SILS technique is good in term of cosmetic score but increase the technical difficulty and fatigue of surgeon [32-33]. Additional ports have been recommended for the safe completion of SILS.
Specimen extraction is a key factor with masks the benefits of laparoscopic surgery when specimen is extracted from abdominal site by giving an incision on the body. To avoid any incision we have the better option of Natural Orifice Specimen Extraction (NOSE) by which specimen extracted without giving any extra incision. The common focus of this technique is to reduce the incisional complication of pain, infection and hernia [34-36]. In male patients anus is main site for specimen extraction which can limit its application but in female vagina is better option especially in old female patients because of its elasticity and early healing properties. So NOSE is more feasible in female than male patients. Many clinical studies shows successful NOSE without any difficulty and complication.

Pitfalls
Downsides are present in surgical procedures as same in the case of NOSES. There are some limitation which bounds the patient selection for using this technique. In which the most important is size and stage of the tumor. The transanal specimen extraction (TASE) procedure may not be possible in patients with bulky tumors, a thick mesentery, a narrow rectum, or anal stenosis [37]. Other shortcoming of NOSES is Contamination caused by trans-anal specimen extraction (TASE) which can be classified into two categories. **Bacterial contamination** by bacterial colonies present in colon and **Tumor cell contamination** such as peritoneal dissemination, port-site recurrence, and delivery-site metastasis. Intra-corporeal contamination by tumor cells, which may arise during NOSE, must be avoided. McKenzie et al. reported that the risk of tumor seeding during transvaginal delivery is no higher than that associated with transabdominal extraction providing proper oncologic principles are followed and specimen handling is performed using a specimen retrieval bag [38-40]. Although rectal washout is performed, there is a risk of remnant tumor cells remaining. NOSE technique limitation is T4 stage cancer, large size specimen may injure the rectal wall or extra stretching of anal sphincter. Transvaginal specimen extraction (TVSE) procedure may not be possible for patients with bulky tumors, previous pelvic surgery or radiation, or a narrow vagina [38]. But overall this technique is feasible and beneficial for the specimen extraction.

DISCUSSION:
NOSES is comparable to conventional specimen extraction surgery in selected patient population.

Short term retrospective studies and randomized control trials shows benefits of NOSE over conventional specimen extraction surgery with mini-laparotomy. But we still need more randomized trials to compare the potential benefits of two techniques including early return of bowel function, less post-operative analgesic use, possible shorter hospital stay and wound complication significantly. The favorable outcomes motivate the use of this technique with caution for strictly selected criteria for patients. Several factors such as sex, BMI, pathology, anatomic location, size of tumor (width and length), distance from anal verge and specimen extraction site determines the feasibility of NOSE.

A few studies shows the role of NOSE in patient with BMI>30 is feasible especially related to wound complication but feasibility of NOSE is not well proven in such patients. Fat patients mean more visceral fat which may related to bulk of mesentery which impede the specimen removal from natural orifice. Usually laparoscopic surgery is not common practice in fat patients. One more population can take benefits from NOSE are elderly and ill patient due to advantages of less blood loss, less susceptible to infection, increased inflammatory markers and wound complication which result in early healing and fast recovery. In literature most of studies include patient with fewer comorbidities mostly ASA classes I and II. Further investigations are needed to explore the benefits in sick patients with more comorbidities. NOSE provide other means of specimen removal in case of complication such as first priority is by anal route if specimen is large or any other complication we can use vaginal route even if this is not possible we can extract specimen by conventional surgery. Standardizing NOSE is the main issue due to variation in technique and procedure followed by surgeons. Many studies have different techniques for anastomosis (single-stapled versus double- or triple-stapled anastomosis) and removal of specimen (with plastic bag or wound protector). Standardization of this technique help to improve the research on feasibility outcome for colorectal cancer surgeries.

Limitations:

This is a literature review. Publications from last ten years are randomly selected on the basis of proper method and results.

CONCLUSION:

Feasibility and safety of NOSE technique is shown by many clinical studies in the literature. Full effectiveness of this technique depends upon the patient selection. Criteria for patient selection should be BMI<30, ASA ≤3, T2 tumor stage and less bulky specimen. This technique is more effective in female because of vaginal specimen extraction. Sigmoid Colon Cancer and Low rectal cancer patient are most benefited from this technique. Reduced port surgery with NOSE is better technique than conventional open surgery results better outcome without compromising oncological safety of the patient.

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