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1 **Original Article**

2

3 **Natural Orifice Specimen Extraction (NOSE) During Laparoscopic Bowel**

4 **Resection For Colorectal Endometriosis: Technique And Outcome**

5

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15

16

17 *Attila Bokor and Peter Lukovich contributed equally to the preparation of this*

18 *manuscript.*

19

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40

41 **Precis**

42 NOSE-colectomy is feasible, safe, offers shorter recovery and can eventually lead to
43 quicker surgery compared to traditional laparoscopic bowel resection.

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44 **Abstract**

45

46 **STUDY OBJECTIVE**

47 We first present a detailed description of a modified NOSE-colectomy technique.
48 Secondly, we report the postoperative outcomes of our prospective case series when
49 compared to conventional laparoscopic bowel resection in a relatively large series of
50 patients.

51 **DESIGN**

52 Canadian Task Force Classification II-1.

53 **SETTING**

54 University tertiary referral center.

55 **PATIENTS**

56 **Patient selection**

57 The last 90 consecutive patients in our care with DIE of the bowel are presented in
58 this study. Patients were diagnosed at the 1st Department of OB/GYN Semmelweis
59 Universtiy Budapest, Hungary.

60 **INTERVENTIONS**

61 We performed laparoscopic bowel resection using the transrectal NOSE-technique
62 and compared the results of the new operative method (n=30) to traditional
63 laparoscopic bowel resection (n=60).

64 **MEASUREMENTS AND MAIN RESULTS**

65 **Duration of operations**

66 The median duration of surgery was 121 minutes in the control group and 96
67 minutes in the NOSE-group ($p=.005$).

68 **Postoperative complications**

69 According to Clavien-Dindo classification, we observed a severe, grade IIIb or
70 higher, overall complication rate of 3.3% among all 90 patients. In the control group

71 anastomosis insufficiency occurred in 3.3% of patients (2/60 cases) and in one
72 patient with anastomotic leakage a rectovaginal fistula was observed (1.7%). There
73 was no significant difference in rates of severe postoperative complications ($p=0.55$).

74 **Hospital stay**

75 The length of hospital stay in the control group was a median of 7 (5-13) days
76 whereas in the NOSE-group this was 6 (3-11) days ($p<.001$).

77 **CONCLUSION**

78 According to our findings, the use of NOSE-colectomy offers shorter recovery and
79 can eventually lead to shorter surgery duration compared to traditional laparoscopic
80 bowel resection.

81

82

83 **INTRODUCTION**

84

85 Deep infiltrating endometriosis (DIE) represents the most severe form of
86 endometriosis and is present in 20-35% of all women suffering from the disease [1].
87 Intestinal nodules are observed in 3% to 37% of endometriosis patients [2]. In cases
88 of colorectal DIE, adequate therapy depends on the depth of infiltration, and the size
89 of the lesion and the woman's quality of life [2-4]. According to recently published
90 data, the location of the lesion is the most important factor in determining optimal
91 surgical management. Some authors suggest that conservative surgical treatment is
92 preferred to segmental resection, particularly for low rectal lesions due to an
93 increased risk of potential complications [4].

94

95 Removal of the specimen after segmental bowel resection can be performed by
96 either a conventional method (mini-laparotomy) or by the natural orifice specimen
97 extraction (NOSE) technique [5-7]. The conventional method raises concerns
98 because this could disrupt the integrity of the abdominal wall. Moreover, extraction
99 site laparotomy is associated with higher postoperative pain scores and the
100 occurrence of particular complications such as incisional hernias [5-12].

101 In order to avoid these complications, the NOSE technique has been introduced.
102 During NOSE colectomy the specimen is extracted through a natural orifice and an
103 intracorporeal anastomosis is performed [5-7, 12-14].

104

105 Herein we first present a detailed description of a modified NOSE-colectomy
106 technique which differs in many aspects from the previously published procedures.
107 Secondly, we report the postoperative outcomes of our prospective case series when
108 compared to conventional laparoscopic bowel resection. Third, we give a short
109 overview of the relevant data from the literature.

110

111

112

113 **MATERIALS AND METHODS**

114

115 **Patients and preoperative workup**

116

117 Between January 2015 and January 2017, 90 consecutive patients underwent
118 segmental bowel resection due to colorectal DIE at the 1st Dept. of Obstetrics and
119 Gynecology Semmelweis University Budapest.

120

121 The surgical plan was made individually, tailored to the signs and symptoms of our
122 patients. Nodules larger than 3 cm causing obstructive problems and affecting more
123 than 50% of the bowel circumference or multifocal DIE nodules (less than 2 cm from
124 the principal lesion) or multicentric nodules more than 2 cm from the principal lesion
125 were treated by segmental resection and anastomosis.

126

127 For bowel endometriosis, medical management was the first line therapy, due to the
128 significant risk of postoperative complications and morbidity associated with surgical
129 treatment. If medical management failed or, in the setting of acute obstruction,
130 surgical management was considered as the treatment of choice [4]. Apart from
131 obstructive sequelae, medical therapy resistant endometriosis-related severe pain
132 (visual analog scale, VAS, ≥ 7) qualified for surgical management as well [3].

133

134 A conventional segmental laparoscopic bowel resection was done via a laparotomy
135 for specimen extraction up until October 2015 when we implemented the transrectal
136 NOSE technique. From October 2015 until January 2017 NOSE colectomies with

137 transrectal specimen extraction method were performed in all but three cases. Two
138 patients refused to undergo surgery using the new operative technique while the
139 third case had an ultralow nodule (lower than 5cm from the anal verge), therefore,
140 we performed a protective colostomy. The protective colostomy was reversed after
141 90 days. In this particular case the patient had multifocal lesions where the size of
142 the largest distal nodule was 4cm. There was no complication during this procedure.

143

144 Surgeries were all performed by a multidisciplinary team, with the participation of the
145 same gynecologist specialist (AB) and colorectal surgeon (PL). Preoperative workup
146 included a physical examination, transvaginal sonography, abdominal and pelvic MRI
147 and colonoscopy.

148

149 Patients received antibiotic prophylaxis 30 minutes pre-operatively (2x1.5g
150 Cefuroxime iv. and 2x500mg Metronidazol iv.) and a bowel preparation (2 packs of
151 laxatives containing sodium picosulphate and magnesium citrate) the day before
152 surgery.

153 Although mechanical bowel preparation is not generally recommended for
154 laparoscopic colorectal resection, we administered bowel preparation in order to
155 decrease the chance of contamination after viscerotomy [15].

156

157 Our study protocol was approved by the Institutional Ethical and Review Board of
158 Semmelweis University, Budapest, Hungary for the protection of human subjects
159 (No: 58723-4/2016/EKU).

160

161 **Operative technique**

162

163 The goal of the surgical treatment in our group of patients was to eliminate all
164 macroscopically visible endometriotic foci and to preserve fertility. All surgeries were
165 performed laparoscopically, in a multidisciplinary setup with the contribution of a
166 gynecologist, colorectal surgeon and with the assistance of a urologist if needed.

167

168 The OR setup was the same for all procedures. Patients were placed in a modified
169 dorsal lithotomy position. The pneumoperitoneum was created by inserting a Veres-
170 needle in the umbilicus. A 4-port approach was used: the first 10mm port was
171 inserted in the umbilicus. Three lower quadrant trocar sleeves were placed under
172 direct visualization. Two, 5mm and one 12mm trocars, were placed lateral to the

173 rectus abdominis muscles 2 cm above and 2 cm medial to the anterior superior iliac
174 spine. The third 5mm port was placed in the midline, suprapubically. The patient was
175 then placed in steep Trendelenburg. In the presence of pelvic adhesions,
176 adhesiolysis was performed in order to mobilize the rectum and sigmoid colon. The
177 ureters were dissected until the level of the uterine arteries. A nerve-sparing
178 approach was used at the level of the uterosacral ligaments in order to preserve the
179 autonomic innervation of the pelvis.

180

181 In cases of low rectum (5-8 cm from the anal verge) and vaginal nodules, special
182 care was taken in order to preserve the branches of the inferior hypogastric plexus.
183 In cases of a central DIE nodule, the preservation of the vegetative nerve fibres
184 was not very difficult. We used a nerve "avoiding" technique with gentle pulling of the
185 fibres laterally along with surgical instruments possessing minor lateral thermal
186 effects. In addition, we performed a limited tubular resection in a meso-sparing
187 manner, close to the bowel in order to preserve the branches of the inferior
188 hypogastric plexus.

189 When we encountered large nodules with extensive lateral fibrosis, we enabled
190 visualization of branches of the inferior hypogastric plexus and the parasympathetic
191 splanchnic nerves according to the technique reported by Kavallaris [16].

192

193 During our procedures, the bilateral development of "Heald's space" and of the
194 rectovaginal septum as well as of Latzko's pararectal space was needed for the
195 identification of uterosacral, lateral rectal and rectovaginal ligaments. By using these
196 anatomic landmarks it was possible to avoid injury to autonomic visceral nerves in
197 most cases.

198

199 Severe neurogenic complications seem to occur only in cases of bilateral
200 involvement [17, 18]. In cases when R0 resection was not possible without major
201 neural damage, we decided to leave a minimal amount of fibrotic tissue. The
202 residual fibrotic tissue was never in the proximity of the ureters.

203

204 The endometriotic lesions were excised and then extracted with the help of the
205 modified transrectal NOSE technique (Video and Fig 1). The proximal rectum was
206 freed from the mesorectum using a vessel-sealing device (Harmonic scalpel ACE,

207 Ethicon Endo-Surgery, Cincinnati, OH, USA), therefore, in case of sigmoid resection,
208 the ampulla recti's reservoir function could be preserved. In case of a low anterior
209 resection where the preservation of ampulla recti was not possible, a transanal
210 NOSE-colectomy was performed.

211

212 In cases when transrectal/transanal NOSE-colectomy was performed, the standard
213 procedure was modified as follows. The sigmoid/rectum was isolated and both the
214 proximal sigmoid colon and proximal rectum were tied off laparoscopically with a
215 non-absorbable suture (Dafilon 0, B. Braun AG, Melsungen, Germany). Cephalad to
216 the resection line a laparoscopic atraumatic temporary intestinal clamp (atraumatic
217 laparoscopic intestinal clamp, Aesculap, Tuttlingen, Germany) was placed in order to
218 decrease the chance of fecal spillage (Fig. 2.). A transverse colotomy was performed
219 in sano using a harmonic scalpel (Fig. 3.) to deliver the anvil from a circular stapler
220 (Proximatew ILS CDH 29, Ethicon Endo-Surgery, Cincinnati, OH, USA) introduced
221 through the anus using a sterile laparoscopic camera sleeve (Folded laparoscopic
222 camera sleeve, 3M, St. Paul, MN, USA). The use of the camera sleeve for anvil
223 introduction into the abdominal cavity reduces the possibility of contamination of the
224 peritoneal cavity (Fig. 4.).

225

226 Since the rectum/sigmoid colon is transected completely, the specimen can be
227 extracted transrectally through the camera sleeve in a specimen retrieval bag (Fig 5).
228 The proximal part of the anastomosis was completed by suturing the anvil in place
229 with a purse string of a mono-filament laparoscopic suture (PDS 2.0, Ethicon, Inc.,
230 Cincinnati, OH, USA) (Fig. 6.). The intestinal clamp was then removed.

231 The distal rectum was closed using a 45/ 60-mm endoscopic linear stapler
232 (EchelonFlex Endopath Ethicon Endo-Surgery, Cincinnati, OH, USA) (Fig. 7.).

233

234 Extensive saline irrigation was performed wherein the suture of the distal rectum was
235 checked by the Michelin-test. End-to-end anastomosis was made using the circular
236 stapler (Proximatew ILS CDH 29, Ethicon Endo-Surgery, Cincinnati, OH, USA)
237 (Fig. 8.). At the end of the operation a second irrigation was performed using a total
238 of 6L saline solution. A Michelin-test was repeated and a drain was placed in the
239 pouch of Douglas. When feasible, a tension-free omental flap was placed on the
240 anastomosis in order to prevent recto-vaginal fistula formation.

241

242 During the postoperative course, on the first postoperative day, only oral fluid intake
243 was allowed. The time to resume a normal diet was 3 to maximum 6 days.

244 Evidence shows that fast-track programs or enhanced recovery after surgery (ERAS)
245 protocols improve surgical stress response and postoperative outcomes [19-21].

246

247 However, there are no data regarding the use of fast-track programs in combination
248 with NOSE –procedures. Therefore, since we are routinely not creating a diverting
249 ileostomy, to increase the safety of our procedures we administered a combination of
250 fast-track and standard postoperative care. Similiarly to the ERAS protocols, we
251 advise oral carbohydrate fluid intake on the first day after surgery. On the second
252 and third day we started a low fibre diet.

253

254 The criteria for hospital discharge in all cases were tolerance of a solid diet and
255 passage of flatus and stool. Patients were asked to present for a postoperative
256 check-up four weeks and six months after surgery. In the postoperative period, all
257 of our patients who did not wish to conceive were advised to start ovarian
258 suppression therapy either with oral contraceptives (OC) or dienogest [22].

259 We administer OC or dienogest since they have an acceptable side effect profile [22,
260 23]. In addition dienogest exhibits antiproliferation activity by growth suppression of
261 endometrial cells and its uterotropic index is high, similarly to natural progesterone
262 [24, 25]. Furthermore, dienogest exerts direct effects on the endometrium which
263 serve the basis for the proven efficacy in endometriosis [26].

264 The first line therapy is the use of OC, in cases of OC intolerance, we switched to
265 dienogest treatment. In those women scheduled for surgery and not desiring fertility,
266 we administered the same medical therapy in both groups [23].

267 See Table 1.

268

269 All of our procedures were video recorded and analyzed after the operation by the
270 surgical team.

271

272 **Statistical analysis**

273

274 The study data were evaluated by descriptive statistical methods, such as median,
275 range frequency and distribution. Variables were tested for normality using the
276 Kolmogorov–Smirnov Lilliefors and the Shapiro–Wilk tests. Groups of values without

277 normal distribution were compared by the Mann-Whitney U test. Fisher's exact test
278 was used in case of small cell counts

279 All tests are two-sided and $P < .05$ was accepted as a significant difference.

280 Statistical analysis was undertaken using Graphpad Prism (version 5.0a, GraphPad
281 Software, San Diego, CA, USA,).

282

283

284 **Fertility**

285 At the time of admission patients filled a questionnaire (EHP 30 and a validated
286 questionnaire for pain catastrophization) regarding their symptoms and fertility [27].

287 57% of patients of the transrectal NOSE-group claimed infertility and 33% in the CG.

288 Intraoperative chromopertubation results are noted in Table 2.

289

290 **RESULTS**

291

292 We included in this study patients operated for colorectal endometriosis between
293 January 2015 and January 2017. During this period we had a total number of 1240
294 patients operated for endometriosis. Out of the 1240 patients there were 256
295 diagnosed with colorectal DIE and 90 required segmental anterior-resection. The
296 rest of the patients were treated either with rectal shaving or full thickness discoid
297 resection. From our series 90 consecutive patients who underwent laparoscopic
298 segmental bowel resection are presented in this study. Patients were consulted and
299 diagnosed at our Department's Endometriosis Clinic.

300

301 Since we wanted to introduce a new surgical technique to our daily practice we
302 designed this study with the aim to critically analyze the outcomes of the NOSE
303 technique compared to the conventional laparoscopic bowel resection. After 30
304 cases of NOSE colectomy, we found the procedure safe, offering shorter recovery
305 and operative times as compared to the conventional method.

306 At this point we decided to share our experience with the new technique.

307 Accordingly, to the best of our knowledge, we report the highest number of
308 consecutive NOSE colectomies performed for the treatment of colorectal
309 endometriosis.

310

311 The NOSE-group consisted of 30 transrectal specimen extraction cases (TRG) while
312 the control group (CG) had 60 patients who underwent conventional laparoscopic
313 colorectal resection.

314

315 At the time of surgery, the median age of the patients was 32 years in the CG and 33
316 years in the TRG. The median BMI of these patients showed no difference between
317 the two groups. All of our patients received hormonal treatment (either OC or
318 dienogest) prior to surgery. In the conventional group 10% of patients had
319 undergone previous laparotomies , whereas in the NOSE group this rate was 6%.
320 For detailed data see Table 1.

321

322

323

324 **Intraoperative findings**

325

326 **Stage of endometriosis, localization of the nodules**

327

328 The average median and range of rAFS (Revised American Fertility Society) scores
329 of the patients are presented in Table 1. The anatomical distribution and the number
330 of endometriotic nodules were similar in both groups. In more than 50% of cases we
331 performed a low rectum (5-8 cm from the anal verge) resection in both groups
332 ($p=0.65$).

333

334 In the NOSE group, a single nodule was detected during histological examination in
335 56% and in 58% of the CG ($p=0.88$). Multifocal (2 or more) lesions were diagnosed
336 in 44% of specimens from the NOSE-colectomy group and 42% among the CG
337 ($p=0.66$, see Table 2).

338

339 The length of the resected bowel section varied from 5 to 29 cm, the average length
340 was 10 cm in CG and 7cm in the transrectal NOSE group ($p=0.31$).

341

342 Endometriosis was present in areas other than the colorectal region in most cases.

343 The frequency of extra-colonic localization of endometriotic lesions was similar in the
344 NOSE and the CG. Most commonly these were found in the rectovaginal septum,
345 pelvic peritoneum and in the ovaries (Table 2).

346

347 From the CG 8 patients (13%) while in the TRG 2 women (7%) required vaginal
348 resection because of transmural vaginal involvement.

349

350 DIE of the bladder was found in 18% of CG and 20% of TRG ($p=0.85$). Ureteral
351 endometriosis was present in 18.7% of TRG and 10% of CG ($p=0.32$, Table 2).

352

353

354

355 **Duration of operations**

356

357 There was a statistically significant difference between the duration of surgeries in
358 the CG when compared to the TRG: median 121 minutes (85-205) and median 96
359 minutes (60-190) minutes respectively ($p=.005$).

360 **Postoperative complications**

361

362 According to Clavien-Dindo classification we observed a severe (grade IIIb or higher)
363 overall complication rate of 3.3% among our 90 patients [15]. Anastomosis
364 insufficiency occurred in 2 cases, 3.3% of patients from the CG and none in the TRG
365 ($p=0.55$). Among the two patients with anastomotic insufficiency rectovaginal fistula
366 appeared in one case (1.7% of all patients, 1/60 cases) after conventional
367 laparoscopic colectomy ($p=1$). The patient with rectovaginal fistula had a full
368 thickness vaginal resection because of transmural vaginal vault infiltration. When
369 comparing the CG and TRG with regards to rates of severe postoperative
370 complications we found no statistically significant difference ($p=0.55$).

371

372 When the rectovaginal fistula was diagnosed, an immediate second laparoscopy was
373 done and sigmoidostomy was performed. The fistula was closed and the
374 sigmoidostoma was repaired after three months.

375

376 It is well known that concomitant vaginal resection and anterior colorectal resection
377 notably increases the chance of rectovaginal fistula formation. However, performing
378 a limited segmental resection and using a surgical technique which maintains the
379 vascularization of a tension-free anastomosis lowers the chance of this complication
380 [1, 3, 4].

381

382 The other patient with anastomotic insufficiency underwent laparoscopic suture of
383 the leak and a subsequent sigmoidostomy was performed.

384

385 In one patient from the CG (1.7%) clinical recurrence was diagnosed. She
386 underwent a second laparoscopy and had a rectal nodule situated 5cm proximally to
387 the resection line, completely removed by full thickness discoid resection. The
388 resection margins were negative at the time of first surgery. The recurrence occurred
389 despite postoperative ovarian suppression therapy with combined continuous OC.

390 From the NOSE-group there was no clinical recurrence of the disease so far.

391

392 Postoperative bleeding from the umbilical portsite occurred in one patient from the
393 CG. A compression dressing was administered.

394

395 Transient bladder dysfunction (urinary retention) was present in 2 (3.3%) of our
396 patients from the CG and one (3%) from the TRG ($p=1$). The voiding problems were
397 medically treated with oral pyridostigmine (3x60mg/day) and lasted for maximum 7
398 days in all cases. In all other cases we successfully used the nerve-sparing
399 technique in order to avoid vegetative neural dysfunction. The complication rates are
400 summarized in Table 3.

401

402 **Histological examination**

403

404 Histological examination confirmed bowel endometriosis infiltrating the muscularis in
405 81/90 and in 9 cases the mucosal layer was also involved.

406

407 **Hospital stay**

408

409 The median length of hospital stay in the CG was 7 days (95% CI, 5-13) days
410 whereas in the TRG 6 days (95% CI, 3-11). Patients had shorter time of
411 hospitalization from the NOSE-group when compared to the CG ($p<.001$).

412

413 **Intraoperative blood loss**

414 We found no statistically significant difference with regards to the intraoperative
415 blood loss between the CG and TRG ($p=0.82$).

416

417

418 **DISCUSSION**

419

420 To our best knowledge there are few multidisciplinary teams [28, 29] active in the
421 surgical management of colorectal DIE by NOSE-colectomy using a laparoscopic
422 intracorporeal anastomosis. Our new technique differs in many ways from the one
423 used by the group in Leuven, Belgium and Strassbourg, France. Firstly, we perform
424 our procedure from the classic gynecologic port sites, thus avoiding additional
425 abdominal incisions after the end of the initial gynecologic part of the operation.
426 Second, during our method we fix the anvil using a hand sewn purse-string-suture,
427 hence fewer linear staplers are utilized, which makes our procedure faster and less
428 expensive. On the other hand, the complete transection of the colon presented in our
429 method potentially increases the chance of contamination. Therefore, to mitigate this,
430 we introduced the use of a laparoscopic intestinal clamp and a camera sleeve for the
431 anvil introduction as previously described. In addition, meticulous bowel preparation,
432 antibiotic prophylaxis and extensive lavage was performed. Third, our method allows
433 one to perform a more physiological end-to-end anastomosis avoiding negative
434 consequences such as fecolith formation.

435

436 The limitation of these statements is the relatively low number of patients in our
437 cohort who underwent bowel resection combined with the modified transrectal
438 technique. In addition, due to the recent introduction of the transrectal NOSE
439 technique at our institution, the median follow-up period is shorter than 1.5 years.
440 Therefore, an accurate postoperative assessment of the quality of life and
441 reproductive outcome was not possible.

442

443 Prior studies provided initial evidence that the use of NOSE during laparoscopic
444 colectomy offers several benefits to patients [12, 14, 28, 30]. We have provided
445 further evidence that our novel modified technique is feasible and offers shorter
446 recovery and operative duration when compared to the conventional laparoscopic
447 segmental resection.

448 The method has attracted attention as a technique to minimize the negative
449 consequences of conventional laparoscopic surgery by avoiding a mini-laparotomy
450 [6, 7, 12, 31-34]. Wolthuis and colleagues in their fundamental randomized clinical
451 trial used a standardized surgical technique and reported lower postoperative pain
452 scores and a decreased need of analgetics in favor of the NOSE procedure [28].
453 However, inflammatory responses (CRP levels and white blood cell counts) were

454 greater in the NOSE-colectomy group. Postoperative anorectal function,
455 complications and hospital stay were similar for the two groups [28].

456

457 Recently, Ma et al conducted a meta-analysis to investigate if laparoscopic resection
458 with NOSE has better postoperative outcomes. They revealed that the NOSE group
459 showed faster convalescence, less postoperative pain, and a lower prevalence of
460 postoperative complications but experienced a longer operation time [12].

461

462 In our series, the overall rate of severe surgical complications (Clavien-Dindo stage
463 IIIb or higher) was 3.3% (2 cases). This is comparable to the results of other groups
464 which ranged from 2.4-13.2 % [12]. In order to decrease the chance of rectovaginal
465 fistula formation we performed omentoplasty in all cases when full thickness vaginal
466 excision was done simultaneously.

467

468 The radicality of surgeries and the use of a nerve sparing technique can affect the
469 incidence of complications [3, 4, 17, 18]. In our practice all surgeries were performed
470 with a nerve-sparing intention. Neurogenic bladder disorder occurred in two of the
471 CG patients and in one patient from the TRG. Urinary dysfunction improved within 7
472 days. None of our patients experienced long term postoperative urinary dysfunction.

473

474 There are conflicting results in the literature concerning the operative times.
475 According to Zhang et al., the NOSE technique is associated with shorter times than
476 for conservative operative laparoscopy. Conversely, Ma and Wolthuis et al. reported
477 a significantly longer duration of NOSE surgeries which may be reduced with
478 experience [14]]. Comparing our 60 cases of conventional laparoscopy and 30 cases
479 of transrectal NOSE-colectomy procedures, we detected a statistically significant
480 difference between the duration of the operation (121 vs 96 minutes $p=0.005$). Our
481 data show that by applying the transrectal NOSE technique, operating time was
482 shorter when compared to traditional laparoscopy.

483

484 According to the previously published data, after NOSE procedures the length of
485 hospital stay is shortened, with faster recovery and better cosmetic results [14]. In
486 our study we did not assess the cosmetic outcomes. However, the statistically
487 significantly shorter hospital stay observed in our cohort of women favors the
488 transrectal NOSE technique ($p<0.001$).

489

490 **CONCLUSION**

491 According to our findings the use of NOSE-colectomy is safe, offers shorter recovery
492 and can eventually lead to quicker surgery compared to traditional laparoscopic
493 bowel resection.

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602 Figure 1/A: The rectum is tied off distally and proximally to the DIE nodule then a
603 laparoscopic atraumatic temporary intestinal clamp is placed proximally to the
604 resection line

605

606 Figure 1/B: A transverse colotomy is performed using a harmonic scalpel

607

608 Figure 1/C: A laparoscopic camera sleeve is used for anvil introduction into the
609 abdominal cavity

610

611 Figure 1/D: The oral part of the anastomosis was done by suturing the anvil in place
612 with a purse string laparoscopic suture

613

614 Figure 1/E: The distal rectum was closed using a 45/ 60-mm endoscopic linear
615 stapler and the anvil is sutured in place after the removal of the atraumatic clamp

616

617 Figure 1/F: End-to-end anastomosis was created with a circular stapler

618

619

620 Figure 2. Application of the atraumatic intestinal clamp

621

622 Figure 3. A transverse colotomy was performed in healthy tissue, orally and caudally
623 from the nodule, using a harmonic scalpel

624

625 Figure 4. Transrectal anvil introduction using a camera sleeve

626

627 Figure 5. Transrectal specimen extraction using a laparoscopic specimen retrieval
628 bag

629

630 Figure 6. Anvil fixation after a purse string suture in the proximal colonic end

631

632 Figure 7. Use of a linear stapler for closing the distal rectal stump

633

634 Figure 8. An end-to-end anastomosis was created with a circular stapler

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637 Table 1.
 638 Characteristics and demographic data of patients undergoing a conventional laparoscopic anterior resection or laparoscopic
 639 colectomy with transrectal specimen extraction

Total Number of Surgical Procedures n= 90		
	Conventional n=60	NOSE n=30
Age (median, range)	32 (24-48)	33(25-45)
BMI (kg/m ²) (median, range)	21(19-29)	21(18-27)
ASA score [n (%)]		
ASA I	50(83)	24(80)
ASA II	10(17)	6(20)
ASA III	0(0)	0(0)
rAFS stage [n (%)]		
I	0(0)	0(0)
II	1(1.7)	0(0)
III	9(15)	3(10)
IV	50(83.3)	27(90)
rAFS score (median, range)	75(12-112)	73(16-125)
Previous medical treatment [n (%)]		
Dienogest containing OAC	24(40)	17(57)
Other OAC	3(5)	0(0)
Dienogest only pills	30(50)	13(43)
Desogestrel containing OAC	3(5)	0(0)
Previous surgical treatment [n (%)]		
Laparotomy		
1	3(5)	0(0)
2	1(1.7)	1(3)
Laparoscopy		
1	25(42)	10(33)
2	3(5)	4(13)
3	1(1.7)	1(3)
4	1(1.7)	2(7)
5	0(0)	0(0)
6	1(1.7)	0(0)
TUR	1(1.7)	0(0)

640 NOSE= Natural Orifice Specimen Extraction

641 TUR= Transurethral Resection

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646 Table 2.

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648 Surgical data

Operative data n=90			
	Conventional n=60	NOSE n=30	p (Conventional vs. NOSE)
Duration of surgeries (min) (median, range)	121(85-250)	96 (60-190)	0.005
Intraoperative blood loss (ml) (median, range)	35(0-150)	15(0-30)	0.82
Conversion rate [n (%)]	0(0)	0(0)	1
Need for transfusion [n (%)]	1(1.7)	0(0)	1
Number of DIE lesions of the bowel [n (%)]			
1	35(58)	17(57)	0.88
2 – sigmoid & rectum	4(7)	1(3)	0.66
multilocular			
– sigmoid colon, rectum	17(28.3)	8(26)	0.87
– coecum & sigmoid/rectum	2(3.3)	2(7)	0.6
– appendix & sigmoid/rectum	2(3.3)	2(7)	0.6
Length of the resected bowel (cm) (median, range)	10(5-29)	7(5-17)	0.31
Low rectum resection [n (%)]	31(52)	17(57)	0.65
Other localisations of endometriosis [n (%)]			
endometrioma – unilateral	17(28)	13(43)	0.15
– bilateral	5(8)	2(7)	1
peritoneal	53(88)	26(86)	1
bladder	11(18)	6(20)	0.85
ureter – unilateral	10(17)	2(7)	0.32
– bilateral	1(1.7)	1(3)	1
rectovaginal septum	53(88)	25(83)	0.52
vagina (transmural involvement)	8(13)	2(7)	0.28
diaphragm	1(1.7)	2(7)	0.26
coecum/ileum	2(3.3)	0(0)	0.55
n. ischiadicus	1(1.7)	0(0)	1
liver	1(1.7)	0(0)	1
umbilicus	1(1.7)	0(0)	1
Chromopertubation [n (%)]			
bilateral patency	22(37)	6(20)	0.11
unilateral patency	22(37)	3(10)	0.011

bilateral occlusion	16(26)	21(70)	<0.0001
Infertility [n (%)]	20(33)	17(57)	0.034
Mean hospital stay (median, range)	7(5-13)	6(3-11)	<0.001

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652 Table 3. Short term outcome of conventional laparoscopic rectum/ sigmoid resections and NOSE-colectomies performed for
 653 colorectal DIE
 654

	Conventional n=60	NOSE n=30	p (conventional vs. NOSE)
Recurrence [n (%)]	1 (1.7)	0(0)	1
Anastomosis insufficiency [n (%)]	2(3.3)	0(0)	0.55
Rectovaginal fistula [n (%)]	1(1.7)	0(0)	1
Postoperative bleeding [n (%)]	1(1.7)	0(0)	1
Injury of the ureter [n (%)]	0(0)	0(0)	1
Rectal bleeding [n (%)]	1(1.7)	2(6)	0.26
Gastrointestinal infection [n (%)]	2(3.3)	0(0)	0.55
Incisional hernia [n (%)]	0(0)	0(0)	1
Haematoma in the wound [n (%)]	0(0)	0(0)	1
Subileus [n (%)]	0(0)	1(3)	1
Neurogenic bladder dysfunction(max 7 days) [n (%)]	2(3.3)	1(3)	1

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