



Critical surgical errors by junior fellows and trainees in low rectal cancer surgery: How to overcome?(A cross-sectional study)

Yasser Elghamrini^{*}, Mohamed Ibrahim hassan, Karim Sabry abdel samee, Ahmed aly khalil

Department of General Surgery, Colorectal Unit, Faculty of Medicine, Ain Shams University, Cairo, Egypt

ARTICLE INFO

Keywords:

Low rectal cancer
Surgical mistakes
Colorectal fellows training
Salvage techniques

ABSTRACT

Aim: Technical difficulties are usually reported in low rectal cancer (LRC) surgery. Moreover inadvertent surgical errors could happen mostly due to lack of experience of the assisting surgeons. Unfortunately, these errors may end up with raising a permanent stoma. In this study we are reporting seven inadvertent surgical mishaps during surgeries for LRC which resulted in failure of the planned circular end to end anastomosis and how we approached them by different salvage techniques.

Patients and methods: All surgical mistakes were salvaged by two of our senior consultants with intraoperative decision to shift to another approach to attain intestinal continuity. Two patients had direct handswen coloanal anastomosis, three received colon pull through and two with redo stapled circular end to end anastomosis after shifting to the anterior perineal plane. Postoperative assessment of the functional state using wexner score was done for all cases.

Results: All surgical mistakes had been overcome after shifting to the transanal and/or perineal approach and we were able to regain intestinal continuity in all cases Circumferential and distal margins were free in all specimens. Two patients showed optimal continence with wexner score 3,5 respectively, Two had suboptimal continence Wexner 6,7. Female patient with iatrogenic rectovaginal fistula suffered from poor quality of life and asked for permanent stoma.

Conclusion: All trainees and junior fellows in should receive a clearly defined training program and focused education with different staplers; additionally they should work under supervision of the senior consultants who should be sufficiently experienced with different salvage approaches.

1. Introduction

Despite the technical feasibility of surgery in most cases of rectal cancer, surgery for low rectal cancer (LRC) is still demanding even in the hands of experienced colorectal surgeons [1] It has two major objectives, first the deep pelvic dissection to ensure curative resection, and second, restoration of colorectal/anal continuity [2]. Although low anterior resection (LAR) with circular end to end anastomosis is now the standard sphincter saving surgery in LRC, however technical difficulties are usually reported especially with males narrow pelvis, morbidly obese patients, previous pelvic sepsis and neoadjuvant radiotherapy [3, 4]. Moreover inadvertent surgical errors could happen either due to lack of experience of the assisting surgeons, or at the final steps of a lengthy procedure where most of the surgical team becomes exhausted. Unfortunately, these errors may end up with failure of completing the stapling procedure and the unhappy decision of raising a permanent stoma.

Many salvage procedures which could help in such critical circumstances to restore intestinal continuity and avoid raising a permanent stoma have been described. Most of these techniques did not gain popularity, which may be attributed to the rapid progression in stapling devices technology.

In this study we are reporting seven inadvertent surgical mishaps during surgeries for LRC which resulted in failure of the planned circular end to end anastomosis and how we approached them to avoid raising a permanent stoma.

2. Patient and method

2.1. Patient selection

This is a cross-sectional analysis focusing on 7 cases (4 laparoscopic and 3 open) who underwent successful curative resections for low rectal

^{*} Corresponding author. 17 Abdel Hamid Lotfy Street, Nasr City, Cairo, Egypt.
E-mail address: yasser_elghamrini@med.asu.edu.eg (Y. Elghamrini).

<https://doi.org/10.1016/j.amsu.2021.01.078>

Received 27 November 2020; Received in revised form 20 January 2021; Accepted 21 January 2021

Available online 28 January 2021

2049-0801/© 2021 Published by Elsevier Ltd on behalf of IJS Publishing Group Ltd. This is an open access article under the CC BY license

(<http://creativecommons.org/licenses/by/4.0/>).

cancer that ended up with unintended intraoperative surgical mistakes with failure to complete the circular end to end anastomosis. We defined surgical mistakes as technical error by one of the surgical team, That resulted in failure of regaining colorectal/coloanal continuity by the planned original procedure and resorting to another salvage technique to regain intestinal continuity. We excluded patients with stapler related failures. Our work has been reported in line with the STROCSS criteria [5].

All surgeries were done in the Colorectal Surgery Unit between January 2014 to January 2020 after multidisciplinary team (MDT) evaluation. In the same study period, 372 elective surgeries (228 male, 144 females) for rectal cancer (0–14 cm from the anal verge) were done. Successful resection was achieved in 348 patients (curative in 338, palliative in 10), 260 patients had low anterior resection with double stapled technique, 24 with intersphincteric resection (ISR), 46 had abdominoperineal resection and 18 with Hartmann's procedure. Laparoscopic procedure was completed successfully in 188 cases with 28 cases converted to open while 160 had open surgery from the start. The data were collected and published upon approval of the ethical committee of our university. We registered through Researched Registry with registration unique identifying number (UIN): 5914.

Surgeries were planned 6–8 weeks after finishing the neoadjuvant chemoradiation with the routine metastatic work up according to our protocols in the unit (chest and pelvi-abdominal CT, pelvic MRI with rectal protocol).

2.2. Patients details and surgical procedure

The demographic data, planned procedure and pathology of all patients are shown in Table 1. Seven patients were enrolled in the study (5 males and 2 females, age range 41–65y). One male patient had history of severe pelvic trauma after motor car accident which resulted in abnormally narrow pelvis, One male patient with chron's disease gave history for open small intestinal resection and surgical drainage of pelvic abscess ten years ago which impacted the outcome of surgery for rectal cancer. All surgical mistakes were salvaged by two of our senior consultants with intraoperative decision to shift to another approach to attain intestinal continuity. Covering loop ileostomy was constructed in all cases. We followed up our patients in the colorectal clinic every three months after closure of the covering loop ileostomy for assessment of the functional state using wexner score and any reported recurrence

Table 1
Patient's demographic data, planned procedure, pathology and TNM stage.

No.	Age	Sex	Planned procedure	Pathology	TNM stage
1	46	Male	Laroscopic (LAR)	Invasive mucinous carcinoma Ulcerating mass 6 × 6cm	ypT3, ypN0, M0
2	51	Male	Open (LAR)	Infiltrating mucinous adenocarcinoma ulcerating mass 2.5 × 1.3 × 1cm	ypT3, ypN0, M0
3	55	Male	Laprosopic (LAR)	infiltrating adenocarcinoma with extracellular mucin production ulcer 2 cm	ypT2, ypN0, M0
4	41	Male	Open (LAR)	Moderately differentiated adenocarcinoma ulcerating mass (3.5 cm)	ypT3, ypN0, M0
5	47	Male	Laprosopic (LAR)	Moderately differentiated adenocarcinoma Ulcerating mass (3 cm)	ypT3, ypN1, M0
6	65	Female	Open (LAR)	Moderately differentiated adenocarcinoma	ypT3, ypN1c, M0
7	58	Female	Laprosopic (LAR)	Moderately differentiated adenocarcinoma Ulcerating mass (3 × 3cm)	ypT2, ypN0, M0

LAR: Low anterior resection.

(locoregional or systemic). The detailed of outcome for all patients, Follow up and salvage technique are shown in Table 2.

Two male patients after having successful laproscopic low anterior resection with total mesorectal excision and rectal transection using endo-GIA stapler, the circular stapler was introduced forcefully by the assistant with complete disruption of the stapled anal stump. The anal stump was short and attempts to redo the stapled anastomosis failed due to stump retraction. The procedure was completed transanally in the two patients, one patient had direct handsewn straight coloanal anastomosis (CAA), and one had colon pullthrough (PT), the protruded colon was auto-amputated on the 8th day postoperative.

One male patient had successful open resection for low rectal cancer. While the patient was put in the lithotomy position to complete the stapled coloanal anastomosis, a forceful digital rectal examination was mistakenly done by one of the junior residents disrupting the stapled anal stump, The patient had a severely contracted narrow pelvis and short anal canal, and the patient was salvaged by pull through coloanal anastomosis.

One female patient, after completing her open anterior resection successfully, had iatrogenic rectovaginal fistula by false introduction of the circular stapler transvaginally by a trainee. This was not discovered till doing routine air leak test we observed air bubbles from the vagina, Digital rectal and vaginal examination confirmed the presence of a defect between the anterior rectal wall and posterior wall of the vagina. Two stay sutures were taken at the angle of the stapled rectal stump and transabdominal dissection in rectovaginal plane was done till the fistula was reached. However extra rectal stump length was needed to redo the stapling safely. We decided to use the transperineal approach. The patient was put in the lithotomy position and a curvilinear incision was made midway between the anal verge and the vagina after injecting saline/adrenaline (1/200000), we carefully dissected the external anal sphincter and transverse preni muscle then we continued cephalic in the rectovaginal plane with left index finger applied transvaginally to avoid further injury to the wall of the vagina till we reached our dissection plane created transabdominal. Repair of the posterior wall of the vagina was done with continuous absorbable sutures (vicryl 2/0) then TA stapler was applied transperineal distal to fistula then stapled circular end to end anastomosis was done. Closure of the perineal wound with interrupted absorbable sutures.

A male patient had laproscopic low anterior resection and the rectum was transected using a contour stapler. Unfortunately during drapping of the perianal region the senior surgeon unintentionally introduced the long sterilizing sponge clamp *trans*-anally with complete opening of the stapled anal canal which was short to grasp and redo the stapled anastomosis, So we go for direct handsewn coloanal anastomosis (see Fig. 1).

A female patient underwent curative laproscopic resection for rectal cancer, pursestring sutures were taken by one of our new fellows in our team, circular end to end anastomosis was constructed, yet the proximal doughnut was incomplete, air-leak test was positive, the pfennistiel incision was extended with double check of the leaking point transabdominally combined with digital rectal and proctoscopic examination, unfortunately more than 50% of the staple line was incomplete, we dismantle the disrupted anastomosis for redo, Yet extralength with further dissection was needed distally which was difficult transabdominal, So we shift to the anterior perineal plane. Dissection continue in recto-vaginal plane as described before till we reach our plane created transabdominally then TA stapler was applied transperineal just distal to disrupted anastomosis followed by successful stapled circular end to end anastomosis.

A male patient underwent successful open rectal resection for LRC, however during firing of the circular stapler the assistant inadvertently missed the safety plate with consequent fracture of the stapler which was hardly extracted with full thickness avulsion in posterior wall of anal stump which was repaired by transanal interrupted absorbable sutures, redo of the circular anastomosis was extremely difficult as male

Table 2

Distance of the tumor from anal verge, surgical error, salvage procedure and wexner score.

No.	Distance from anal verge	Surgical error	Salvage procedure	Follow up after closure of stoma (month)	Wexner score	Others
1	6 cm	Inadvertent <i>trans</i> -anal introduction of long sponge clamp during drapping of the perineum	Handsewn coloanal anastomosis	5	–	Stoma not closed.
2	7 cm	False PR examination of stapled anal stump	Colon pullthrough	12	5	Under adjuvant chemo.
3	5 cm	Forcefull introduction of the circular stapler	Colon pullthrough	–	–	Optimal function Died 5 th day post-operative due to massive PE
4	6 cm	Missing of safety plate	Colon pullthrough	18	6	History of pelvic trauma
5	7 cm	Forcefull introduction of the circular stapler	Handsewn coloanal anastomosis	13	3	Developed liver, lung Nodules after 18 months
6	9 cm	Transvaginal introduction of the circular stapler with iatrogenic rectovaginal fistula	Combined abdomino-perineal approach	10	15	Requested permanent Stoma
7	8 cm	Inadequate pursestring sutures	Combined abdomino-perineal approach	26	7	Suboptimal function

PE:Pulmonary embolism.

**A****B**

Fig. 1. a). Delivery of the proximal colon for handsewn coloanal anastomosis after disruption of the rectal stump by long sterilizing clamp with failure to redo stapled coloanal anastomosis.

b). Six months after handsewn coloanal anastomosis.

patient with history of pelvic trauma 20 years ago so we considered colon pull through as saving procedure with second stage resection of the exteriorized colon 8 weeks postoperative.

3. Results

All surgical mistakes had been overcome with successful salvage procedure after shifting to the transanal and/or perineal approach and we were able to regain intestinal continuity in all cases. Circumferential and distal margins were free in all specimens. All patients received adjuvant chemotherapy, No local or systemic recurrences were reported except for one patient developed liver and lung nodules after 18 months in the follow up.

Two patients had direct handsewn coloanal anastomosis, three received colon pull through and two with redo stapled circular end to end anastomosis after shifting to the anterior perineal plane.

All anastomoses were covered by proximal loop ileostomy. Stoma was closed in five patients with follow up from 5 to 26 months (mean duration 14 months) Two patients (one with handsewn CAA and other had colon pullthrough) showed optimal continence with wexner score 3,5 respectively, Two had suboptimal continence Wexner 6,7 (one with pull through and other with anterior perineal plane respectively). Female patient with iatrogenic rectovaginal fistula) suffered from poor quality of life after stoma closure and asked for permanent stoma.

All patients are still alive except for one male (55 years, diabetic, BMI = 52) who developed massive pulmonary embolism (PE) on 5th day post-operative in spite of full anticoagulation. One patient is still under adjuvant chemotherapy.

4. Discussion

In the present study, seven patients were reported for unacceptable intraoperative surgical mistakes during low rectal cancer surgery. We believe that three golden prerequisites are essential for any colorectologist to operate on such challenging cases, First to know how to do safe and curative resection, Second to be aware of the different updated surgical devices, staplers and how to use them correctly, Third to have enough experience with the different restorative and salvage sphincter saving techniques. Resection margins were negative in all patients in the present study denoting that the first prerequisite was successfully achieved. Thus we would like to highlight in the present study on the second and third prerequisites.

Surgeries for low rectal pathologies were greatly enriched by the introduction of circular staplers by Steichen and Ravitch to the operating theatre which facilitates the surgeons to go deeper in the pelvis creating an easy and safe anastomoses which were not possible by the traditional techniques and accordingly saving many patients from permanent stomas with abdominoperineal resection [6].

The double stapled technique (DST) was invented by *Knight and*

Griffen in 1980 which become now the standard for restoration of bowel continuity after rectal resection, they reported two important tricks. First stapling should be done under visual control, second protection of interposition of the surrounding tissue into the staple line. Therefore lack of knowledge, experience for the described technique with missing tips and tricks may result into surgical mistakes that may end up with permanent stoma [7].

In 2007 Analysis published by **Mardestein et al.** [8] with 266 staple misfire during rectal resection with permanent stoma in 23 patients in one year duration, **Davis** [9] stated that it is difficult to accurately estimate the percentage of personal errors in such problems, additionally he said that in many surgeries the assistant is the one who mostly apply the stapler which could be the first time to do without previous experience so trainees and fellows should receive intensified courses to use these devices in proper manner.

We attributed the errors in our analysis due to lack of experience of our residents, trainees and junior fellows. In 2010 **Offodile et al.** [10] reported 67 cases with technical mistakes accompanying the circular stapler, Similarly he ascribed most of these errors to the limited experience of surgical trainee with little knowledge and sense about the use of these advanced technological devices, all patients were managed with handsewn suturing or stapling redo.

Transanal introduction and extraction of the circular stapler is a crucial step in the construction of the end to end coloanal anastomosis, we experienced two cases with disruption of stapled anal stump accompanying this steps, also **Kyzer et al.** [11] declared three patients with surgical problems during application of the suture and other three with difficult extraction of the stapler, **Offodile et al.** [10] reported 18 patients with similar technical troubles.

Recto-vaginal fistula (RVF) is one of the reported complications with the double stapled technique which mostly associate surgical error, we presented 65 year old female patient with iatrogenic recto-vaginal fistula, We can imagine that circular stapler was introduced *trans*-vaginal by one of our trainee without visual control then passing the pin through posterior vaginal wall, anterior rectal wall and staple line of distal rectal stump then meeting the anvil secured in the proximal colon with colo-vaginal and recto-vaginal fistula (see Fig. 2) (Fig. 1), this was detected intraoperative with immediate repair as described. Similarly in 2015 **Milcho et al.** [12] reported 39-year old woman with RVF after DST for LAR for rectal cancer however diagnosed three months postoperative due to surgical mistake from international educator engaged by the government. An interesting case published by **Zhongshu in (2005).** [13] with unintended colo-vaginal anastomosis during reversal of hartmann

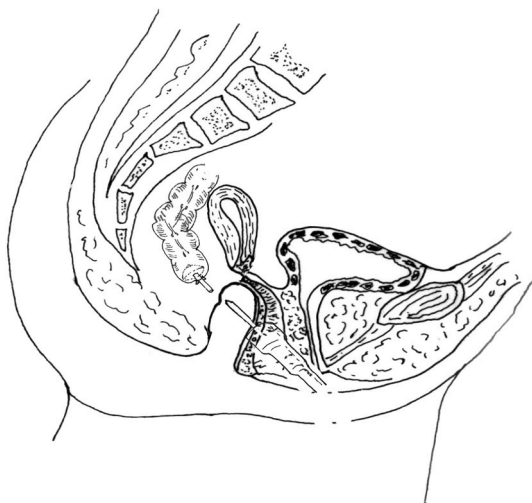


Fig. 2. Iatrogenic rectovaginal fistula by inadvertent transvaginal introduction of the circular stapler with the pin passed through anterior vaginal wall then posterior rectal wall with meeting the anvil at the stapled rectal stump.

with two stage repair. **Rex and Khubchandani** [14] reviewed 57 patients with RVF and stated that 53 had circular stapled anastomosis .

Although pursestring sutures seems to be simple for the junior surgeons, However if placed inadequately with missing its principles (A full thickness sliding monofilament sutures including the whole bowel circumference) an incomplete donuts will be inevitable result, we showed one case with positive air leak test with incomplete donuts due to inadequate pursestring by one of our residents, **Offodile et al.** [10] reported 13 cases with incomplete donuts, **Kyzer et al.** [11] experienced 5 patients with failure of pursestring clamp and one with incomplete tying.

Surgical errors are not limited to co-surgeons or assistants only, but senior consultants may be the one responsible for the mistake, we showed one error done by the consultant himself during perianal draping with accidental transanal application of the long sterilizing clamp with disruption of the stapled anal canal. We explain this as our consultant had lack of confidence in the surgical team doing every step by himself and thus unintended mistakes could happen especially with lengthy operations, no similar cases were found in the literature, however it could happen especially at the final steps when the surgeon becomes exhausted.

The third requisite we believe that colorectal surgeons should be aware with the different salvage procedures in surgeries for different rectal pathologies.

Many novel techniques were described for restoration of coloanal continuity with sphincter preservation, In our analysis three different approaches were utilized to overcome the accompanying technical mistakes (Direct handsewn coloanal anastomosis, colon pull through and combined abdomino-perineal approach), all of them succeeded in restoration of coloanal continuity with acceptable degree of continence.

The direct handsewn coloanal anastomosis was first introduced by **Parks [15] in 1972** which become one of the ideal salvage procedures especially with short anal stump and/or failure of stapled techniques, this was utilized in two of our patients with optimal functional outcome in one of them, the continence degree with handsewn CAA was accepted in the literatures [16,17] which may be attributed to better inhibitory anal reflex due to better nerve growth [18]. Additionally **Warner et al.** [19] stated that although tumors were nearer to the anal verge in the handsewn group, There was no difference between stapled and handsewn coloanal anastomosis as regards low anterior resection syndrome, Conversely **Ptekkis** reported higher Wexner score in patients with handsewn coloanal anastomosis [20].

The technical mistakes in our analysis were saved in 3 patients by the pull through technique with adequate continence and oncologically safe results. Although pullthrough gained popularity due to acceptable functional outcome, lower rate of leakage and avoidance of stoma, However some limitations were reported in rectal cancer with suspicions of positive circumferential margins or risk of anal sphincter avulsion with large tumors [21], additionally evolution of stapled colo-anal anastomosis and the necessity to have exteriorized colon decreased the popularity of this technique, However the technique reappears again in the literatures as one of the sphincter salvage technique, in retrospective analysis for 100 cases with pull through and delayed coloanal anastomosis Jarry and coll. Reported 36% morbidity and a mean Wexner score of 7.8 was reported in the second year postoperative [22], also **Remzi et al.** [23] reported comparable functional outcome between immediate coloanal anastomosis and pullthrough. In retrospective analysis. **Abou-zeid** [24] published 28 cases with two stage pullthrough with marked improvement in the continence after 6 months follow up and concluded that pullthrough is saving option in challenging situations with staple failure, anastomotic stricture, leak with pelvic sepsis and pelvic anatomical difficulties.

Resection of the distal rectum using the anterior perineal plane was first described by **Cuneo** [25] in 1908 then reports of sixty patients were published in 1988 [26], however the technique was not taken into consideration by colorectal surgeons. It comes back again in the

literature in 2007 by **Abouzeid** [27] for a case with difficult reversal of Hartman, then Williams [28] published 14 cases received the technique with acceptable oncological and functional outcomes with mean Wexner score of 5. We used the perineal plane to approach the distal stump in two patients after iatrogenic RVF and redo of coloanal anastomosis, however the former had poor functional outcome. **Abouzeid et al.** [29] reported that optimal continence was achieved in minority of patients.

Minor complications were reported in our cases, One patient developed pelvic sepsis after pull through that was managed conservatively and another showed perineal wound infection and wound dehiscence with conservative management.

There are two major limitations in the current study: First, the small number of the patients enrolled in the study but we explain that such surgical mistakes are rare to occur, and second, the difficulty in collecting data for highly selected patients among hundreds of reports in our colorectal unit however we carefully excluded all patients reports not matching our inclusion criteria.

Although trainees and fellows are responsible for most of the surgical errors in our study, However consultants are not excused from liability as they should inspect their residents step by step intraoperative with clarified explanation for the procedure details, Technical tips and tricks in order to avoid such errors.

In our analysis we went over a critical issue in rectal cancer surgery which is not reviewed enough in the literatures except for some case reports published for surgical mistakes and therefore we would like to highlight some golden rules for colorectal surgeons in order to reduce the possibility of such errors [10,12]:

- 1 Junior surgeons must be joined to the consultants without barriers.
- 2 Consultants should master different salvage and sphincter saving procedures.
- 3 Workshops should be offered to the residents with a focus on updated devices and technology in surgery.
- 4 Staplers are double-edged sword with the possibility of irreversible errors with inexperienced surgeon.
- 5 Teamwork is important in such exhausting lengthy operations.
- 6 Complications should be discussed clearly with the patient before surgery with an emphasis on the possibility of raising permanent stoma especially with low rectal cancer patients.
- 7 Many of historical approaches in rectal surgery proven efficiency as saving procedures in critical situations.

5. Conclusion

All trainees and junior fellows in colorectal units should receive a clearly defined training program and focused education with different staplers, additionally they should work under supervision of the senior consultants who should be sufficiently experienced with different salvage approaches and how to correct unexpected surgical errors, moreover it should be noted that staplers are an aid only to skilled and well trained surgeons.

Funding/support

None reported.

Financial disclosure

None reported.

Authors contributions

Data acquisition: Yasser elghamrini. Data analysis and interpretation: Elghamrini, Hassan, Abdelsamee, Khalil. Drafting the article: Elghamrini, Hassan, Abdelsamee, Khalil. Critical revision: Yasser elghamrini.

Declaration of competing interest

The authors declare that there are no conflicts of interests throughout all listed work and data in this study.

Acknowledgements

We acknowledge the great effort done by prof. Abou-zeid, M.D., FRCS; who participated significantly in operating and supervising the salvage techniques with great revision for the current manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amsu.2021.01.078>.

References

- [1] C. Gokhan, M. Mahmut, Y. Erkan, M. Naim, A. Erhan, Inter-sphincteric resection and coloanal anastomosis in treatment of distal rectal cancer, *Int. J. Surg. Oncol.* 2012 (2012) 10, 581258.
- [2] F.P. Prete G. Chir, The pull-through: back to the future 34, 2013, pp. 293–301, 11/12.
- [3] Y. Xuefei, Z. Guixi, J. Li, Z. Hao, L. Zhihai, L. Jingsi, D. Yang, P. Kai, K.M. Joe, Laparoscopic sphincter-saving surgery for low rectal cancer through marker meeting approach, *Ann. Transl. Med.* 6 (16) (2018) 3241.
- [4] A. Abbas, J. Yosra, S. Fereydoun, M.J. Sayed, S.N. Mohammad, A. Arezou, A. Mohsen, A novel approach to lower rectal anastomosis: technique innovation and the preliminary report of twenty cases, *J. Coloproctol (Rio J)* 36 (2) (2016) 80–85.
- [5] R. Agha, A. Abdall-Razak, E. Crossley, N. Dowlut, C. Iosifidis, G. Mathew, for the STROCSS Group, The STROCSS 2019 guideline: strengthening the reporting of cohort studies in surgery, *Int. J. Surg.* 72 (2019) 156–165.
- [6] F.M. Steichen, M.M. Ravitch, *Stapling in Surgery*, Year Book Medical Publishers, Chicago, 1984, p. 271.
- [7] C.D. Knight, F.D. Griffen, An improved technique for low anterior resection of the rectum using the EEA stapler, *Surgery* 86 (1980) 710–714.
- [8] E. Marderstein, J. Trunzo, J. Stulberg, B. Champagne, H. Reynolds, C.P. Delaney, Analysis of stapler misfire during colorectal surgical procedures using a National Event Report Database, Available from, <http://www.casesurgery.com/research/Abstract08WEB.pdf>, 2007.
- [9] Davis B and Rafferty JF: Complexities in Colorectal Surgery Decision-Making and Management. Technical aspects 501-515.
- [10] A.C. Offodile, D.L. Feingold, A. Nasar, R.L. Whelan, T.D. Arnell, High incidence of technical errors involving the EEA circular stapler: a single institution experience, *J. Am. Coll. Surg.* (3) (2010) 331–335.
- [11] S. Kyzer, P.H. Gordon, Experience with the use of the circular stapler in rectal surgery, *Dis. Colon Rectum* 35 (7) (1992) 696–706.
- [12] P. Milcho, R.S. Ivana, F. Igor, D. Darko, S. Vasilcho, Colovaginal anastomosis: a totally unacceptable surgical error, *Int. J. Surg. Case Rep.* 7 (2015) 66–696.
- [13] Zhongshu Yan, Guoqing Liao, Colovaginal anastomosis: an unusual complication of stapler use in restorative procedure after Hartmann operation, *World J. Surg. Oncol.* 3 (2005), 74.
- [14] J.C. Rex, I.T. Khubchandani, Rectovaginal fistula complication of low anterior resection, *Dis. Colon Rectum* 35 (1992) 350–356.
- [15] A. Parks, Transanal technique in low rectal anastomosis, *ProcR Soc Med* 65 (1972), 975.17.
- [16] E. Rullier, C.A. Sa, P. Couderc, A. Rullier, R. Gontier, J. Saric, Laparoscopic intersphincteric resection with coloplasty and coloanal anastomosis for mid and low rectal cancer, *Br. J. Surg.* 90 (2003) 445–451.
- [17] S.H. Baik, N.K. Kim, K.Y. Lee, S.K. Sohn, C.H. Cho, Handsewn coloanal anastomosis for distal rectal cancer: long-term clinical outcomes, *J. Gastrointest. Surg.* 9 (2005) 775–780.
- [18] P.G. Horgan, P.R. O'Connell, C.A. Shinkwin, W.O. Kirwan, Effect of anterior resection on anal sphincter function, *Br. J. Surg.* 76 (1989) 783–786.
- [19] V.W. Christina, D. Francois, S. Jeremy, N. Sandra, J.M. Slawomir, F.M. Anders, R. C. Jose, J.P. John, N. Johan, Low anterior resection syndrome scores in hand-sewn vs stapled coloanal anastomosis after low-rectal, *Cancer Resection* 227 (4) (2018) S68.
- [20] R. Lisa, M. Paul, S. Constantinos, Q. Shengyang, K. Christos, T. Emile, T. Paris, Complexity in coloproctology Functional outcomes with handsewn versus stapled anastomoses in the treatment of ultralow rectal cancer. *Updates in Surgery, J. Am. Colleague Surg.* 70 (2018) 15–21.
- [21] F. Prete, F.P. Prete, The pull-through: back to the future, *Geka Chiryu* 34 (11/12) (2013) 293–301.
- [22] J. Jarry, J.L. Faucheron, W. Moreno, C.A. Bellera, S. Evrard, Delayed colo-anal anastomosis is an alternative to prophylactic diverting stoma after total mesorectal excision for middle and low rectal carcinomas, *Eur. J. Surg. Oncol.* 37 (2011) 127–133.

- [23] F.H. Remzi, G. El Gazzaz, R.P. Kiran, V.W. Fazio, Outcomes following Turnbull-Cutait abdominoperineal pull-through compared with coloanal anastomosis, *Br. J. Surg.* 96 (2009) 424–429.
- [24] A.A. Abou-Zeid, A.H. Sherif, Modification of Turnbull-Cutait transanal colon pull-through as a salvage procedure in cases of failed low colorectal anastomosis, *Egypt. J. Surg.* 39 (2) (2020) 409–414.
- [25] M. Guibe, J. Quenu, *Chirurgie de l'abdomen*, Masson, Paris, 1926, pp. 306–311.
- [26] Y.P. Le Treut, J.R. Delpero, C.A. Kadji, C. Marinetti, C. Echinard, R. Bricot, Anterior perineal approach for low colorectal anastomosis - operative technique and results in 60 cases, *Dig. Surg.* 5 (1988) 36–42.
- [27] A.A. Abou-Zeid, M.T. Makki, Combined abdominal and perineal approach for delayed restoration of bowel continuity after low anterior resection in females, *Dis. Colon Rectum* 50 (2007) 544–547.
- [28] N.S. Williams, J. Murphy, C.H. Knowles, Anterior perineal plan E for ultra-low anterior resection of the rectum (the APPEAR technique): a prospective clinical trial of a new procedure, *Ann. Surg.* 247 (2008) 750–758.
- [29] A.A. Abou-Zeid, E.G. Yasser, Y. Tarek, The combined abdominal and perineal approach for dissection of the lower rectum. The development of new indications, *Int. J. Surg.* 13 (2015 Jan) 217–220.