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# Anastomotic Leakage in Rectal Surgery: Role of the Ghost Ileostomy

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**Abstract.** *Background/Aim: A protective ileostomy performed during anterior resection in rectal surgery is considered a good practice to prevent anastomotic leakage. A derivative ostomy seems to be able to minimize the clinical consequences of an anastomotic leakage, but not to prevent it. The present study examined the role of the ghost ileostomy in anastomotic leakage following rectal surgery. Patients and Methods: This study included 82 patients that had undergone anterior rectal resection. A total of 32 patients underwent ghost ileostomy (GH) and 50 patients underwent ileostomy (IL). Results: The incidence of anastomotic leakage was equal to 7.32%, occurring in 3 patients of the IL group (6%) and in 3 patients of the GH group (9.38%), in which the ghost was converted into derivative ileostomy. Therefore, 47 patients with IL (94%) underwent useless ileostomy implementation, and 29 patients (90.62%) with GH avoided ileostomy. Conclusion: In this study no increase in morbidity and mortality rate was observed. Therefore, ghost ileostomy proved to be as safe as ileostomy in terms of outcome, morbidity and mortality.*

Anastomotic leakage (AL) is the main complication following anterior rectal resection; its incidence substantially differs among different trials, due to the lack of an unambiguous and standardized definition inherent to this complication. Anastomotic leakage has been defined by the International Study Group of Rectal Cancer as "an intestinal wall defect at the level of the anastomotic site, such as to establish a connection between intraluminal and extraluminal compartments". Moreover, the International Study Group of Rectal Cancer identified three degrees of severity of an anastomotic leakage (A, B, C), classified in relation to their impact on the clinical and surgical management of the patient. Grade A anastomotic leakage is defined as a complication that can be solved without further clinical management; grade B, instead, requires an active treatment despite being fixable without additional surgical or laparoscopic procedures. Lastly, grade C requires additional surgical intervention (1). Identification of the degree of severity of anastomotic leakage is linked to the morbidity and mortality rates following surgical resection for rectal cancer, the duration of hospital stay and the hospital costs, specifically when additional surgical procedures are required. Currently, despite technological improvements in colorectal surgery, clinical anastomotic leakage can be considered the most feared complication, occurring with a prevalence between 3 and 21% both in laparoscopy and in open surgery (2).

Furthermore, the simple anastomosis leakage is a common complication, and, when carefully sought, it can occur in up to 50% of the cases, often in the absence of clinical symptoms. In contrast, a full-blown leakage significantly enhances morbidity and mortality, being responsible for about 35% of demises after colorectal surgery (3). The incidence of this occurrence reported in literature has not significantly changed over recent decades; the variability depends especially on the analysis of very heterogeneous case-studies with regard to pathology, surgical timing and technique.

In this respect, implementation of ever lower intestinal anastomosis increases the risk of anastomotic leakage; moreover, radiological monitoring of anastomosis has not always been performed, so that subclinical leakages remain underestimated. Regardless of the advances in surgery and postoperative care, anastomotic leakage classification and treatment remain controversial issues. Several risk factors are involved, distinguished between generic and specific (4). Leaving aside the generic risk factors, there is no doubt that surgical procedures performed on inflamed tissues, as in case of inflammatory bowel diseases, or on tissues injured by previous radiation therapy, could result in increased risk of leakage since they have reduced ability to repair (5, 6).



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Equally, emergency surgical procedures are burdened by increased risk of leakage (7). The distance between anastomosis and anal verge seems to have an inverse relationship with leakage rate: the higher the distance the more frequent the leakage. Several factors explain this finding, including the total absence of the peritoneum in the distal rectum and its vascular precariousness. Technical imperfections and manipulating injuries arising from the greater difficulty of surgical procedures performed in the pelvis, which are sometimes associated with limited specific surgical experience, surely contribute to increase in the leakage rate.

Moreover, with the purpose to avoid opioid-related adverse effects, the use of NSAIDs (Non-Steroidal Anti-Inflammatory Drugs) has been recommended, but recent clinical studies suggest a harmful effect on anastomosis, increasing the occurrence of postoperative leakage; this could be related to the COX-2 inhibition, which might interfere with anastomotic healing (8, 9). Lastly, mechanical suture techniques, especially Knight-Griffen, seems to lead to an increased risk of anastomotic leakage, maybe because they are mainly used in order to make low or ultra-low anastomosis (10).

In order to protect anastomosis and prevent leakage, the usefulness of temporary ileostomy appliances is still discussed (4). Several studies (11, 12) have reported that derivative ostomy is able to minimize the clinical consequences of anastomotic leakage, but is not able to prevent it. However, the necessity of additional surgery to close the ostomy, the increased length of hospital stay, the ostomy side-effects and all the risks related to its complications are not negligible.

Miccini *et al*. have described a simple technique called "ghost ileostomy" with the purpose to combine all the advantages of an ileostomy without its complications, in patients subjected to low rectal anterior resection (13). An ileostomy realization is a simple technique, unencumbered by complications; moreover, in case of anastomotic leakage it could be turned into a defunctioning ileostomy easily and safely, under local anesthesia.

The purpose of this study was to retrospectively assess the data resulting from the surgical treatment of patients that had undergone anterior resection for rectal cancer, with the realization of an ileostomy or with "ghost ileostomy" (14). The main target was the evaluation of the anastomotic leakage incidence and its correlation with some risk factors. Secondarily, an analysis of the differences between ileostomy and ghost ileostomy in patients affected by anastomotic leakage in terms of therapeutic management, morbidity, mortality and postoperative complications related to the ileostomy was performed.

## Patients and Methods

This multicentric retrospective study, included 82 patients that had undergone surgical procedure for cancer from 2015 to 2017 at the Department of Surgical Sciences, "Sapienza" University of Rome, and at the Department of General Surgery, Humanitas Research Hospital, Rozzano, Milano.

All patients included in the study underwent anterior rectal resection and Knight-Griffen anastomosis (KG) with total mesorectal excision (TME).

All patients signed a detailed informed consent both for surgical treatment and the use of personal data.

The choice to perform a derivative ileostomy or a ghost ileostomy was based on the preference of the surgeon, without the use of established selection criteria. Intraoperative test of anastomosis leakage had always been performed.

All patients were divided into two groups: 32 patients (39.02%) underwent ghost ileostomy (GH) and 50 patients (60.98%) underwent ileostomy (IL). A total of 48 patients were male (58.5%) and 34 were female (41.5%); the mean age in the two groups was 65.68±10.01 and 68.77±11.01 years old, respectively.

With regard to the American Society of Anesthesiologist (ASA) score, 28 patients had an ASA I score (34.15%), 45 patients had an ASA II (54.88%) and 9 patients ASA III (10.97%). In 62 patients, rectal cancer was localized at a distance >6 cm (75.6%) from the anal verge, while in 20 patients it was localized at a distance <6 cm (24.4%). 30 patients underwent laparoscopic surgery, 52 underwent open surgery. Moreover, 37 patients (13 in the GH group and 24 in the IL group) had already received advance neoadjuvant therapy, including radiotherapy (45.12%).

The following characteristics of patients were compared: sex, mean age, Body Mass Index (BMI), the presence of eventual comorbidity (such as COPD, IBD, diabetes), ASA score, cancer localization and distance from the anal verge, neoadjuvant therapy, staging, intraoperative blood loss.

In order to meet the objectives of the study, the incidence of anastomotic leakage (clinical and radiological evidence), mean duration of hospitalization, therapeutic management of the anastomotic leakage (conservative or operative treatment), morbidity and mortality at 30 days were recorded and analyzed.

In patients affected by anastomotic leakage, ghost ileostomy was rapidly converted into derivative ileostomy, pulling out the intestinal loop previously isolated by a surgical incision in the abdominal wall. On the contrary, in the absence of anastomotic leakage, the intestinal loop was abandoned in the peritoneum for a mean period of 8 days.

In patients who underwent ileostomy, its reversal was performed with a new surgical procedure, through general anesthesia. Before recanalization surgery, barium enema X-ray was performed only in patients with clinical signs of anastomotic leakage.

Statistical analysis was performed using Chi-square test and Student's *t*-test.

## Results

There were some differences between the patients belonging to IL and GH groups: in patients belonging to the IL group (n=50), male sex prevalence was observed (34, equal to 68.4%) compared to female sex (16, equal to 31,6%); on the contrary, in the GH group female sex prevalence was higher compared to male sex (18 *versus* 14), representing 56% and 44% respectively; the mean age of patients belonging to each group was not statistically significantly different, since it was

Table I. *Risk factors*.

| | Group IL | Group GH |
|---|---|---|
| Mean Age | 68.77±11.01 kg | 65.68±10.01 kg |
| Gender | | |
| | F 16 (31.6%) | F 18 (56%) |
| | M 34 (68.4%) | M 14 (44%) |
| BMI | 25.22±4.41 kg/m$^2$ | 23.97±3.44 kg/m$^2$ |
| Smoking | 17 (34%) | 17 (53.13%) |
| Abuse of alcoholics | 0 | 1 (3.13%) |
| Diabetes | 2 (4%) | 0 |
| IBD | 0 | 0 |
| Neoadjuvant therapy | 24 (48%) | 13 (40.63%) |
| Preoperative haemoglobin value | 12.95±1.45 g/dl | 12.64±2.05 g/dl |
| Distance from Anal Verge | 6.68±2.75 cm | 10.36±3.38 cm |

Table II. *Staging of the patients*.

| Stage | Group IL (n=50 patients) | Group GH (n=32 patients) |
|---|---|---|
| I | 22 (44%) | 14 (43.75%) |
| II | 14 (28%) | 2 (6.5%) |
| IIA | 13 (26%) | 1 (3.25%) |
| IIB | 0 | 1 (3.25%) |
| IIC | 1 (2%) | 0 |
| III | 10 (20%) | 13 (40.35%) |
| IIIA | 4 (8%) | 3 (9.4%) |
| IIIB | 4 (8%) | 6 (18.75%) |
| IIIC | 2 (4%) | 4 (12.2%) |
| IV | 4 (8%) | 3 (9.4%) |

68.77±11.01 years old in the IL group and 65.68±10.01 years old in the GH group; the distance of cancer from anal verge was 6.68±2.75 cm in the IL group and 10.36±3.38 cm in the GH group; 48% of patients in the IL group *versus* 40.63% in the GH group underwent neoadjuvant therapy.

These data reflect overall the indications in literature, which suggest the performance of a protection ileostomy in patients with high risk of anastomotic leakage (male sex, distance from anal verge <6 cm, previous neoadjuvant radiotherapy). Furthermore, the main characteristics of the population appears to be homogeneous in both groups (mean age *p*-value=0.2633, BMI *p*-value=0.2360, preoperative Hb level *p*-value=0.8993, distance from anal verge *p*-value=0.4020) (Table I).

*Anastomotic leakage: incidence and correlation of risk factors*. The total incidence of anastomotic leakage (clinical and/or radiologic evidence) was equal to 7.32%, (6 patients on a total of 82). Particularly, it occurred in 3 patients of the GH group (9.38%) and in 3 patients of the IL group (6%). In all patients affected by this surgical complication, the risk factors affecting incidence were:

a) prevalence of male sex (4 out of 6 anastomotic leakages), representing 67% (*p*-value<0.0001, statistically significant);

b) Similar BMI mean values, close to the high range limit (>24.9 kg/m$^2$), were found in patients affected by AD and in patients without this complication (25.22±4.41 kg *versus* 23.97±3.44 kg, *p*-value=0.4033);

c) Diabetes was observed in only 1 patient affected by AL (16.7%), and 2 patients affected by diabetes in the total population (2.44%) (*p*-value=0.5322);

d) no patients receiving chronic corticosteroids therapy for inflammatory bowel diseases

e) patients affected by AL showed higher prevalence (83%) of ASA II and ASA III scores (ASA I 17%, ASA II 33% and ASA III 50%), while in patients without AL it was equal to 73.7% (in the IL group ASA I 15.8%, ASA II 34.2%, ASA III 13.2%; in the GH group ASA I 10.5%, ASA II 19.7%, ASA III 6.6%, *p*-value=0.0614);

f) the mean distance from anal verge in patients affected by AL was equal to 8.67±3.61cm (*p*-value=0.8740);

g) with regard to staging, in the GH group 14 patients were at stage I, 2 patients at stage II (1 IIA, 1 IIB and 0 IIC), 13 patients at stage III (3 IIIA, 6 IIIB and 4 IIIC) and 3 patients at stage IV; in the IL group, 22 patients were at stage I, 14 at stage II (13 IIA, 0 IIB and 1 IIC), 10 patients at stage III (4 IIIA, 4 IIIB and 2 IIIC) and 4 at stage IV. In the GH group, the patients who experienced AL were at stage I, IIIB and IIIC; while in the IL group, the patients affected by AL were at stage I, IIC and IIIC (Table II);

h) no patient presented relevant blood loss;

i) no patient was positive to the intraoperative anastomotic leakage test (air test);

j) bowel preparation was performed in 38 patients: AL occurred in 4 cases (10.53%, *p*-value=0.1033).

In view of these results, no statistically significant difference was found between anastomotic leakage and the following risk factors: high BMI, diabetes, IBD (inflammatory bowel diseases), COPD (chronic obstructive pulmonary diseases), chronic corticosteroids administration, ASA score, distance of cancer from anal verge, bowel preparation, staging and perioperative blood loss.

Therefore, in contrast to other studies, in this study statistically significant relations between the occurrence of anastomotic leakage and the presence of risk factors classically involved in the development of this complication were not found (15, 16).

*Anastomotic leakage: management, morbidity and mortality.* All patients belonging to the IL group and affected by anastomotic leakage (6%) underwent conservative treatment, with total parenteral nutrition (TPN), antibiotic therapy and

Table III. *Anastomotic leakage and risk factors in each case.*

| | Gender | Surgical procedure | Open *vs.* laparoscopy | Smoking or alcohol | Neoadjuvant therapy | Stage | Distance from anal verge |
|---|---|---|---|---|---|---|---|
| Group GH leakage | Male | ULAR | Open | No | No | I | 5 cm |
| | Female | LAR | Open | No | Yes | IIIB | 10 cm |
| | Male | RAR | Open | No | No | IIIC | 15 cm |
| Group IL leakage | Male | RAR | Laparoscopy | Smoking | No | IIIC | 9 cm |
| | Male | RAR | Laparoscopy | No | Yes | IIC | 8 cm |
| | Female | RAR | Open | No | Yes | I | 7 cm |

drainage placement. The mean duration of hospital stay was 9.96±4.12 days.

The incidence of anastomotic leakage in the GH group was 9.38%, since it occurred in 3 patients; ghost ileostomy was converted into derivative ileostomy and drainages were placed. The surgical procedure for the management of anastomotic leakage took place without technical difficulties under local anesthesia and the mean duration of hospital stay was 10.45±2.31 days ($p$-value=0.7751).

In order to analyze the distribution in the two groups, it's important to highlight that:

-in the IL group: only in 3 patients (6%) experienced anastomotic leakage, therefore 47 patients (94%) underwent useless ileostomy, because they had no complications.

-in the GH group: anastomotic leakage occurred only in 3 patients (9.38%), consequently in 29 patients (90.62%) ileostomy was avoided. Indeed, in patients with ghost ileostomy not affected by anastomotic leakage, the loop was removed after a mean period of 8 days (Table III).

The mortality at 30 days was equal to 0 in both groups.

*Complications related to the ostomy.* In the IL group, the following complications occurred: infection of parastomal region in 3 patients (6%), stomal hematoma in one patient (2%) and a case of intestinal subocclusion (2%) after surgical ileostomy reversal, which determined readmission and conservative treatment.

## Discussion

Anastomotic leakage is the most important complication after colorectal surgery, and it could also be considered as an important quality indicator of colorectal surgery. Its occurrence is influenced by several risk factors, which are not always present together. The performance of derivative ileostomy is a technique carried out by many surgeons in order to reduce, as much as possible, further complications arising from anastomotic leakage. A derivative stoma is required particularly when an anterior rectal resection with low anastomosis is performed.

Despite the potential benefits, of this approach is followed by a significant number of complications, requiring a further surgical procedure of ileostomy reversal. Moreover, ileostomy persistence is itself associated to an increased morbidity and to general conditions deterioration. Many studies have shown that in many cases, patients who had undergone ileostomy did not need fecal diversion.

On the other hand, the choice of not to perform an ileostomy still remains contentious, since it is not supported by enough scientific evidence. Furthermore, it is related to the necessity of a new surgical procedure (even if easy and fast) whenever an anastomotic leakage occurs. Consequently, the debate on the necessity of a derivative ileostomy to protect the anastomosis is still open, in the absence of a universal consensus about the causes and the risk factors for anastomotic leakage (17, 18).

In view of these results, many efforts have been carried out in order to identify the main preoperative risk factors for anastomotic leakage. For this purpose, Pommergaard *et al.* reviewed 23 studies which included 110.272 patients who had undergone colorectal resection. This metanalysis highlighted that low or ultra-low anastomosis, male sex and preoperative radiotherapy were risk factors for anastomotic leakage. The awareness of these factors could be useful to address treatment and overall management related to the surgical procedures, other than the real possibility to reduce the incidence of this complication (19).

Additionally, Krarup *et al.* have analysed anastomotic leakage incidence and risk factors in a study that included 9.333 patients who had undergone respective surgical treatment for colorectal cancer and primary anastomosis. This analysis showed that left hemicolectomy or sigmoid resection, intraoperative bleeding, blood transfusions, male sex and, surprisingly, laparoscopic surgery were associated with an increased risk of anastomotic leakage (20).

A further analysis of the data of 1,576 patients who had undergone surgical resection and anastomosis for colorectal cancer from 1984 to 2004 revealed that the mean age of patients was 67 years and 834 (52.9%) were males. This prospective analysis showed that anastomotic leakage was

more likely in the cases of complex gynecological (ovariectomy, hysterectomy) or urologic (radical cystectomy) procedures performed in the same operative session. Other important factors were anterior resection, anastomosis performed through mechanical stapler, postoperative blood transfusions, localization of the rectal cancer, and TNM stage equal to T2 or higher. Under these circumstances, anastomotic leakage showed a significant impact on overall survival (21).

Garcia-Granero *et al*. have performed a retrospective analysis, with the purpose to evaluate whether the surgeon could be an independent risk factor for the incidence of anastomotic leakage of colorectal anastomosis after left hemicolectomy and anterior rectal resection. The data of 800 patients who had undergone surgical procedure from 1993 to 2009 were analyzed; the surgical procedures were performed by 7 different surgeons. The main variable result was AL, radiographically, clinically, endoscopically and intraoperatively diagnosed.

AD occurred in 49 patients (6.1%); among these, 33 (67%) were surgically treated, 6 (12%) underwent drainage placement and 10 (21%) underwent conservative treatment. The mortality rate in the postoperative period was about 2.9%. In patients affected by AL, the mortality rate increased to 16% compared to 2% of the patients not affected by this complication. Amongst the independent AL risk factors, the surgeon who performed the procedure was the most important one (22). An interesting study with the purpose to identify a prognostic index which could be predict the individual risk of AL was carried out. This index was called PROCOLE (PROgnostic COlorectal LEakage). Rojas-Machado *et al*. (23) identified the potential AL risk factors and the developed prognostic index that included statistically relevant factors such as male gender, smoking, diabetes, obesity, cardiovascular and respiratory diseases, preoperative levels of haemoglobin and others. The PROCOLE index determines a value threshold for recommending the implementation of a protective ileostomy, and could be considered an interesting prognostic index, since it is able to predict the individual risk of AL occurrence.

AL is, in summary, a severe complication after colorectal surgery, resulting in an increased morbidity and mortality and predisposing to relapse of the malignancy (24); in this view, an early diagnosis and treatment is essential. This aim is often hindered by actual diagnostic methods, which are not specific and do not ensure essential information (25). Hirst *et al*. have systematically reviewed all the resources to predict and identify AL in colorectal surgery. TC scan and other diagnostic methods with contrast are the most performed techniques, but they are burdened with variable sensitivity and specificity, and could delay rapid intervention. Intraoperative endoscopy and imaging could offer some advantages, but their ability in predicting AL hasn't been proven yet (26).

More recent techniques, based on AL biomarker measurement, have the potential advantages to provide real time follow up of postoperative complications. Several recent studies have investigated the role of C-reactive protein (CRP) as an early AL marker after colorectal surgery. The cut off CRP values were determined at each postoperative day (POD) in a systematic review of the data from 2.483 patients carried out by Singh *et al*. (27). The total prevalence of AL was 6-9% and the mean day when AL was diagnosed was within POD 6 to 9. The levels of CRP in the serum in PODs 3, 4 and 5 showed a diagnostic accuracy in predicting AL.

Besides CRP, procalcitonin has been assessed to determine if it could serve as a reliable predictor of AL occurrence in these patients. Through a prospective study considering 205 patients who had undergone colorectal surgery, procalcitonin, CRP, leukocytes, platelets and vital parameters during the first 5 PODs. were assessed. AL was diagnosed in 17 patients (8.3%); among them, 11 (5.4%) were affected by AL grade B or C (needing drainage placement or surgical intervention) and neither of the above variables showed reliability in early leakages identification, both minor (grade A) and major (grade B and C). Furthermore, if only major grade AL were considered, procalcitonin and CRP proved to be reliable predictors in POD 3 and 5. Particularly, the best predictor was procalcitonin dosage in POD 5; the cut off value was equal to 0.31 ng/ml, corresponding to a sensitivity equal to 100%, specificity 72%, negative predictive value 100% and positive 17%. Consequently, both procalcitonin and CRP are reliable predictor in case of major AD occurrence after colorectal surgery, although the first proved to be more accurate.

The increase of serum concentrations of these markers in POD 3 and 5 should suggest a careful patient assessment before their discharge (28-30). Further studies were carried out in order to establish if, in addition to CRP values, Complete Blood Count (CBC) and leukocytes could be early predictors of postoperative septic complications, including AL in patients who had undergone laparoscopic surgery. However, the diagnostic accuracy of CRP and WBC levels was inadequate as they were weak diagnostic markers of postoperative septic complications, including AL (30).

Cong *et al*. (31) have carried out a systematic review using MEDLINE database, to define the incidence rate of AL after anterior rectal resection for rectal cancer. The selected studies were divided into 3 groups on the basis of tumor localization and, consequently, on the type of surgical procedure: anterior resection (AR), low anterior resection (LAR) and ultralow anterior resection (ULAR). A total of 40 studies were analysed and, among these, AD was described in 32 studies (80%). Grade A AL incidence, defined as "asymptomatic or radiologic leakage", was not considered, since it does not require any variations in patient management. They have

shown that the incidence rate of grade A AD was 2.57% of patients, while the incidence rate of grade B and C leakage was 2.37% and 5.40%, respectively (among the latter, 89.55% needed a temporary or permanent derivative ostomy). Moreover, the total AL incidence rate in AR and LAR was similar (8.58% vs. 8.88%) and both were a little higher compared to ULAR (7.41%). The total grade C leakage incidence rate in AR was higher (AR>LAR>ULAR). In addition, the total grade B leakage incidence rate was the least in AR (AR<LAR<ULAR) (32).

Despite the total incidence rate of AL among AR, LAR and ULAR is not particularly high, it's interesting to note the opposite trend in the overall grade B and C leakage incidence rate observed in these 3 groups. This result states that AL after an AR requiring a new surgical procedure are more frequent than AL occurring after LAR and ULAR. The authors suggested that such difference could be explained considering the largest number of derivative stomy (DS) performed d'emblée in low and ultralow resections (33, 34).

Dissenting data have been reported about the advantages *versus* morbidity related to derivative ostomy. Ileostomy implementation has a significant impact on morbidity and mortality in colorectal surgery. With the purpose to clarify pros and cons of this procedure, Thoker *et al*. have carried out a prospective study for a period lasting 30 months (from June 2008 to December 2010) including 78 patients affected by rectal cancer with a distance from anal verge ranging between 4 and 12 cm. These patients were randomly placed in 2 groups: group A composed of patients who underwent low anterior rectal resection (LAR) with ileostomy and group B composed of patients who underwent LAR without ileostomy. Following the surgical resection and barium enema X-ray between 4th and 8th week, ostomy reversal was performed after 12 weeks. The reversal ostomy follow-up was scheduled and morbidity and mortality rate were recorded. Moreover, each patient was subjected to a survey through a self-defined score in order to assess the quality of life after a LAR with or without ileostomy. Based on the results of these studies, it was concluded that LAR associated to ileostomy shall present small advantage compared to LAR without ileostomy in terms of anastomotic leakage, but not in terms of alimentation and recovery of the intestinal function, while the wound infection was higher in group A. Hypokalaemia was the most frequent electrolyte imbalance in the group A with ileostomy. The complications related to the ileostomy were instead the main disadvantages in LAR with ileostomy (11).

The derivative ostomy is a low risk surgical procedure from a technical point of view, but it could lead to a significant postoperative morbidity, which may adversely affect quality of life and length of hospital stay. The high-risk patients, such as those with low colorectal anastomosis (<10 from anal verge), coloanal anastomosis, technically difficult anastomosis, malnutrition and male patients seem to obtain the best advantages from a fecal diversion. Consequently, this latter procedure shall be recommended as a selective tool in order to reduce AD incidence after a colorectal anastomosis and improve its course, and it has been proven to be more advantageous when performed in high risk patients or in those with low pelvic anastomosis, which represent an increased risk of leakage.

In summary, there is no absolute consensus that all patients who undergo anterior rectal resection with TME should also undergo a derivative ileostomy, or alternatively only those considered as AL high risk (12).

Even if ileostomy is performed with the purpose to protect colorectal anastomosis, the decision to perform an ileostomy is still related to the surgeon's experience, who will analyze anastomosis safety during the surgical intervention, assessing local blood circulation and eventual suture under tension.

Derivative ileostomy has more advantages in the group of patients with a high risk of AL, with low rectal anastomosis or those that have been previously undergone to neoadjuvant radio-chemotherapy. Nevertheless, the advantages of protective ileostomy are reduced by stoma-related complications or by subsequent surgery for ileostomy reversal, with consequent increase of the costs and duration of hospital stay. The overall incidence of clinical AL is about 8%, so that the covering ileostomy is unnecessarily performed in 92% of the cases (10, 34-36).

In the present study, no statistically significant differences among the risk factors classically associated to an increased risk of anastomotic leakage and patients with AD after colorectal surgery were found. Moreover, protective ileostomy was not related to a reduced risk of anastomotic leakage; in fact, no statistically significant difference between patients with derivative ileostomy and patients with ghost ileostomy were observed. In our case study, all patients (2 of 2, 100%) with ileostomy d'emblée who experienced anastomotic leakage were treated conservatively and in no case new surgery was necessary. In a patient that underwent ghost ileostomy followed by anastomotic leakage, ghost ileostomy was opened and derivative ileostomy was performed. These results agree with the data of several studies, according to which derivative ileostomy reduces septic complications associated with leakage.

The strength of this study is the fact that among the 50 patients who underwent ileostomy, only 3 (6%) patients experienced anastomotic leakage, and 47 patients (94%) received a covering ileostomy without further complication. Therefore, in this group of patients, ileostomy was not necessary and led to the onset of stoma-related complications in 5 patients (26.31%). On the other hand, it is important to highlight that in the group of patients treated with ghost ileostomy, anastomotic leakage was observed in only 3 cases (9.38%); in 29 patients (90.62%) ileostomy was avoided,

preventing both the stoma-related complications and the deterioration of patient's quality of life (35).

Therefore, derivative ileostomy proved to be effectively necessary only in 5 cases among 82 patients (6.10%). In consideration of the low incidence of anastomotic leakage and the number of ileostomies performed without necessity (47, equal to 94%), the indication for the realization of an ileostomy d'emblée should be carefully considered. In patients belonging to the GH group who experienced leakage, the ghost was rapidly converted into an ileostomy through surgery under local anesthesia and without complications. Therefore, ghost ileostomy is expected to be a valid option compared to the derivative ileostomy performed at the time of resection: as a matter of fact, on one hand it avoids the realization of an ostomy when the latter may be not strictly necessary and without all the stoma-related complications; on the other hand it allows to rapidly pull out the intestinal loop previously isolated and to convert it into an ileostomy if anastomotic leakage occurs. Through this approach, neither an increase in morbidity nor in mortality rate was observed thus, ghost ileostomy proved to be similar to the realization of an ileostomy d'emblée in terms of morbidity and mortality. It represents an approach technically easy to perform and does not need a new surgical procedure, reducing hospital stay, keeping the costs low, and providing satisfactory quality of life.

The limitations of this study are its small sample size and the lack of objective criteria to identify which patients undergoing rectal surgery with anastomosis may develop a leak. In this view, there is no unequivocal consensus about the pre- or intraoperative criteria that will be used to decide whether to perform a ghost ileostomy or a derivative ileostomy.

In the matter in question, patients classified as having a low risk of anastomotic leakage should not undergo derivative ileostomy, since in these cases stoma-related complications are more common than the ones related to anastomotic leakage. However, in patients with high risk of anastomotic leakage, derivative temporary stoma could be recommended, because these patients are often not able to overcome the leakage-related complications, such as peritonitis or sepsis.

It is not easy to decide whether a patient with a medium risk of anastomotic leakage needs a protective stoma, and in these cases the surgeon's choice is based on his own personal experience. This could be considered as a bias, since there are no standardized procedures.

Despite the lack of direct correlations between risk factors and anastomotic leakage, it is really hard to predict whether this complication will occur. Ghost ileostomy has been proven to be a reliable solution, avoiding useless derivative stoma in patients who do not develop leakage and allowing an easy conversion to derivative stoma in all cases in which anastomotic leakage occurs.

## Conflicts of Interest

The Authors declare that they have no competing interests.

## Authors' Contributions

Palumbo P, Usai S and Lucchese S gave substantial contributions to conception and design of this study; Palumbo P, Caronna R, Bona S and Pansa A gave substantial contribution to acquisition, analysis and interpretation of data pertaining surgery; Palumbo P and Usai S wrote the paper; Palumbo P, Usai S and Bona S revised the paper critically and gave final approval of the version to be published.

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The study did not use experimental drugs or procedures, and obtained the Department's Scientific Committee approval. Consent to publish was obtained from the participant (or legal parent or guardian of children). The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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