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The Challenges of the Hartmann's Rectal Stump Reversal: A Clinical Audit and Review of the Literature

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Background: Hartmann's procedure is performed in patients who are not candidates for immediate reestablishment of colonic continuity. A shrunken rectal stump poses a great challenge at the time of its reversal.

Objective: To determine the factors [level of inferior mesenteric artery (IMA) ligation and duration prior to Hartmann's reversal] contributing to a shrunken rectal stump. The value of imaging and success rate of the technique used in the Hartmann's reversal were also assessed.

Methods: A retrospective analysis of 36 patients who underwent Hartmann's procedure and reversal between 2012 and 2014 was performed. Patient demographic profile, initial pathology, operation setting, level of IMA ligation, complications, duration prior to reversal, imaging modality, state of rectal stump, outcome, and reversal technique were documented.

Results: Thirty-six patients were considered for reversal of Hartmann's procedure. In 95.5% of subjects who underwent a high IMA ligation, proximal rectum stricture and short, shrunken rectal stumps were noted. Patients who underwent reversal after 6 months had a significant incidence of a short shrunken rectal stump (n = 19; 82.6%). The percentage of successful outcomes in the reversal of the short rectal stump using the stapling technique was 93.8% (n = 27). Twenty-six patients who underwent barium enema correlated strongly with the operation findings.

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Conclusion: High ligation in Hartmann's procedure contributes to a short shrunken rectal stump. The duration prior to reversal of more than 6 months correlates with a shrunken rectal stump. Preoperative imaging evaluation serves as a good predictor for the length of the rectal stump. A staples anastomotic technique shows good outcome.

Key words: Hartmann's procedure – Reversal – Shrunken rectal stump

Hartmann's procedure was first described by the French Surgeon Henri Albert Hartmann in 1921 for the excision of left colon cancer.[1,2] In its classic description, the procedure is the division of the rectosigmoid colon at the level of its peritoneal reflection, closure of the distal rectal stump, and an end colostomy. In current practice, the Hartmann's procedure is frequently performed for complicated diverticulitis and complicated left colon cancer in Europe and North America[3,4] and for sigmoid volvulus and complicated left colonic cancer in sub-Saharan Africa.[5,6] The Hartmann's procedure was designed to reduce mortality from anastomotic dehiscence and is mainly reserved for patients who are not candidates for immediate reestablishment of colonic continuity because of local disease, general health, or the experience of the operating surgeon.

It is not clear whether Hartmann intended the colostomy to be reversible. The restoration of colonic continuity after this procedure is a challenge; reversal is associated with high morbidity rate (up to 55%)[7] and a significant mortality (up to 4%).[8] A substantial number of patients (up to 74%)[7] may be left with a permanent stoma that is associated with its own complications and suboptimal quality of life. Reversal of a Hartmann's procedure requires considerable planning. Factors related to successful reversal need to be established to facilitate treatment strategies and to counsel patients regarding the likely outcomes. Technical difficulties include the identification of the rectal stump, atrophy of the rectal stump, dense adhesions, and anastomosis to a short rectal stump, when identified.

Presently, the use of stapling devices has largely facilitated restorative procedures in patients with a retracted short rectal stump; however, reversal maybe performed by laparotomy with either hand sewn or stapled techniques. Regardless of technique used, attempts at reversal may fail occasionally, and anastomotic leakage is a major complication.[9]

The aim of the study is to assess the challenges and technical difficulties associated with reversal of the Hartmann's pouch and whether these challenges can be prevented by taking appropriate measures at the initial operation and whether the duration between the 2 stages constitutes an important factor. The role of preoperative imaging in predicting the status of the residual rectal stump merit review as this may foresee the challenge prompted by a shortened rectal stump.

Materials and Methods

Setting

This study was conducted at King Edward VIII Hospital, Durban, a regional teaching hospital affiliated to the University of KwaZulu-Natal and at the Umhlanga Hospital, a private hospital also in Durban, KwaZulu-Natal, South Africa.

Study design

In this retrospective clinical audit, the medical records of patients aged 13 years and older who underwent Hartmann's procedure with successful or unsuccessful reversal between January 2012 and May 2014 were evaluated. In addition to the demographic details, the pathology encountered at the index operation, whether the index surgery was elective or an emergency or prompted by trauma, the level of ligation of the inferior mesenteric artery [IMA; high tie (close to aorta) versus low tie (close to the bowel with preservation of the superior rectal artery (SRA)], and complications following both the index and restorative procedures were documented. At the initial operation, in all patients, the colon was transected at the level of the sacral promontory. The residual rectal stump was anchored to the sacral promontory using a nonabsorbable suture.

At the reversal of the Hartmann's procedure, the characteristics of the rectal stump were evaluated; a short and shrunken rectal stump was defined by a rectal stump that was at the midsacral level (6 cm superior to the anus) or lower or not visible and required rectal sound manipulation for identification of the rectal stump. A long rectal stump was defined by an easily identified rectal stump with a patent lumen up to the sacral promontory (between

Table 1 Initial operation

Setting of initial operation	Frequency	Percent
Elective	16	44.4
Trauma	4	11.1
Emergency	16	44.4
Total	36	100

10 and 12 cm superior to the anus), whereas a strictured rectal stump was that that was easily identifiable between 10 and 12 cm from the anus but had significant luminal narrowing proximal to the midsacral level.

Ethical issues

This study was approved by the Biomedical Research Ethics Committee (BREC). Approvals were also obtained from the hospital managers of both King Edward VIII and Umhlanga Hospitals to conduct the study.

Selection of cases

The cases evaluated from January 2012 to May 2014 were identified through a manual search of medical records from surgical wards, intensive care unit (ICU), high-dependency unit (HDU), and operating theaters.

Statistical analysis

Descriptive data analysis was conducted using SPSS 21 (University of Kwazulu Natal, Durban, South Africa). Baseline variables were summarized using percentages for categorical variables and mean or median for continuous variables.

Results

Age distribution

Thirty-six patients were considered for reversal of Hartmann's procedure during the evaluation period. The mean age of presentation was 58.97 years [median of 61.5 years (range: 23–74 years)]. Males (n = 22) accounted for 61.1% of the study group.

Table 2 Initial pathology

Initial pathology	Frequency	Percent
Cancer	12	33.3
Sigmoid volvulus	11	30.6
Trauma	4	11.1
Diverticular disease	9	25.0
Total	36	100

Table 3 Initial operation with level of arterial ligation

	Level of arterial ligation		
Initial pathology	High tie (%)	Low tie (%)	Total
Cancer	10 (83.3)	2 (16.7)	12
Sigmoid volvulus	9 (81.8)	2 (18.25)	11
Trauma	1 (25)	3 (75)	4
Diverticular disease	2 (22.2)	7 (77.8)	9

Distribution of study subjects in relation to the initial operation

At the initial operation, Hartmann's procedure was performed in 44.4% as an elective procedure, in 44.4% as the emergency intervention, and prompted by trauma in 11.1%. There was no significant correlation with the setting of the operation and the level of IMA ligation (Table 1).

Distribution and correlation of patients with initial pathology and level of arterial ligation

Of the 36 cases evaluated, 33.3% presented with colorectal cancer, 30.6% presented with sigmoid volvulus, 25% presented with diverticular disease, and 11.1% presented with trauma (Table 2). There was a correlation of the level of arterial ligation with the original pathology of the patient; a high tie was performed in 61.1% of cases, invariably in the setting of cancer (83.3%) and sigmoid volvulus (80%) (Table 3).

Correlation between duration prior to reversal with operation findings at reversal

Most patients (63.9%) had a reversal of Hartmann's procedure more the 6 months after the initial operation. This has been attributed due to the initial postoperative complications that occurred in 19 (52.7%) patients and was consistently associated with wound sepsis and recurrent intra-abdominal sepsis requiring relaparotomy. Largely due to logistic reasons, delays in obtaining imaging techniques in the State sector contributed to the prolonged duration prior to reversal. The patients who underwent reversal longer than 6 months had findings of strictured and short shrunken rectal stumps in 82.6% of cases (n = 19). The patients who underwent reversal in less than 3 months had a finding of a long rectal stump of 87.7%. However,

Table 4 Duration prior to reversal with operation findings at reversal

Duration prior to reversal (mo)	Operation findings at reversal			Total
	Strictured proximal rectum (%)	Short, shrunken rectal stump (%)	Long healthy rectal stump (%)	
<3	0	1 (14.3)	6 (85.7)	7
3–6	0	4 (66.7)	2 (33.3)	6
>6	3 (13)	16 (69.6)	4 (17.4)	23

the sample size was too small (n = 7) to show significant relevance (Table 4).

All the reversal procedures (77.8%) were performed using the stapled techniques (n = 28). In 8 cases, the procedure was abandoned intraoperatively due to technical challenges such as dense adhesions, inability to identify the rectal stump, and marked strictured, shrunken rectal stump. Because there were no hand-sewn anastomoses performed within this study group, a correlation of reversal technique (handsewn versus stapled) cannot be reliably established. However, the successful outcome in the reversal of short rectal stump using the stapling technique was 93.8% within this study group. Of 16 patients who underwent a stapled reversal technique for short shrunken rectal stumps, 1 patient developed an anastomotic failure resulting in persisting intra-abdominal sepsis; a permanent colostomy was fashioned for this patient (Table 5).

Correlation of the level of arterial ligation with the operation findings at reversal

The findings in respect to the status of the rectal stump at reversal showed a strong statistical significance with the level of arterial ligation at the initial operation. A total of 22 patients underwent high ligation at the initial operation, whereas 14 patients underwent low ligation. Ninety-six percent of the study subjects in whom a high arterial ligation was performed revealed proximal rectum stricture and short shrunken rectal stumps at the midsacral level (6 cm superior to the anus). In those who underwent low ligation, 78.6% demonstrated a long rectal stump patent up to the sacral promontory (between 10 and 12 cm superior to the anus) at the time of reversal. The results point out a high frequency of short shrunken rectal stump with an initial high ligation procedure that was statistically significant ($P < 0.01$; Table 6; Fig. 1).

Table 5 Reversal anastomotic technique

Reversal technique	Frequency	Percent
Stapled anastomosis	28	77.8
Reversal abandoned	8	22.2
Total	36	100

Correlation of the imaging findings with the operation findings at reversal

Among the 36 patients, 26 patients underwent barium enema as a preoperative assessment of the rectal stump. Overall, there was a strong correlation between the imaging and operation findings at the reversal procedure. In patients with barium enema reporting a short rectal stump (n = 16), there was a 100% positive finding at time of reversal. In those patients where the imaging showed a long rectal stump (n = 10), a positive finding of 90% was found intraoperatively (Table 7).

Discussion

Historically, the presence of a short shrunken rectal stump often precluded the attempt for a restorative procedure. The challenges often encountered include dense adhesions, the identification of the rectal stump, and the undertaking of a safe anastomosis. Thus, the Hartmann's reconstruction is associated with significant morbidity and mortality. Knowledge of the factors that predispose to poor outcome related to the Hartmann's reconstruction is required to develop treatment strategies and counsel patients realistically.

Tokode *et al* reviewed 184 patients from 2 District General Hospitals in the United Kingdom between January 1996 and December 2005 and concluded that, despite the challenging nature of Hartmann's reversal, colostomy closure can be achieved without mortality in a District General hospital. Furthermore, reversal of Hartmann's procedure was signif-

Table 6 Level of arterial ligation with the operation findings at reversal ($P < 0.01$)

Level of arterial ligation	Operation findings at reversal			Total
	Stricture proximal rectum (%)	Short shrunken rectal stump (%)	Long rectal stump (%)	
High tie	2 (9.1)	19 (86.4)	1 (4.5)	22
Low tie	1 (7.1)	2 (14.3)	11 (78.6)	14

icantly related to patient's age, mode of admission, American Society of Anesthesiologist (ASA) grading, Duke's staging, benign pathology, and extracolonic cancer.[10] Schmetzer *et al* demonstrated that reversal of the Hartmann's operation did not have increased postoperative morbidity and mortality based on advanced age, higher ASA score, or presence of multiple comorbidities. The only preoperative comorbidity prediction of complications was a preoperative serum albumin <3.5 g/dL.[11]

The rectosigmoid junction has been frequently regarded by surgeons as an indistinct zone, a region comprising the last 5–8 cm of sigmoid and the uppermost 5 cm of the rectum.[12] However, others have considered it a clearly defined segment because it is the narrowest portion of the large intestine characterized at endoscopy as a sharp and angulated segment. The IMA branches into the left colic artery and between 2 to 6 sigmoidal arteries. The sigmoidal arteries form arcades within the sigmoid mesocolon and anastomose with the branches of the left colic artery proximally and the SRA distally; the SRA is the continuation of the IMA.

The anatomy of the mesenteric circulation is still a matter of controversy. The central anastomotic artery connecting all colonic mesenteric branches is known as the marginal artery of Drummond. A potential area of discontinuity of the marginal artery is the Sudeck's critical point, situated between the lowest sigmoid and the SRA; however, surgical experience and radiologic studies have demonstrated adequate communication between these vessels.[13] The other area of interest is the presence of the middle rectal artery, which originates from the internal iliac artery and its subsequent anastomosis with the superior and inferior rectal arteries supplying the rectum. This artery is of critical

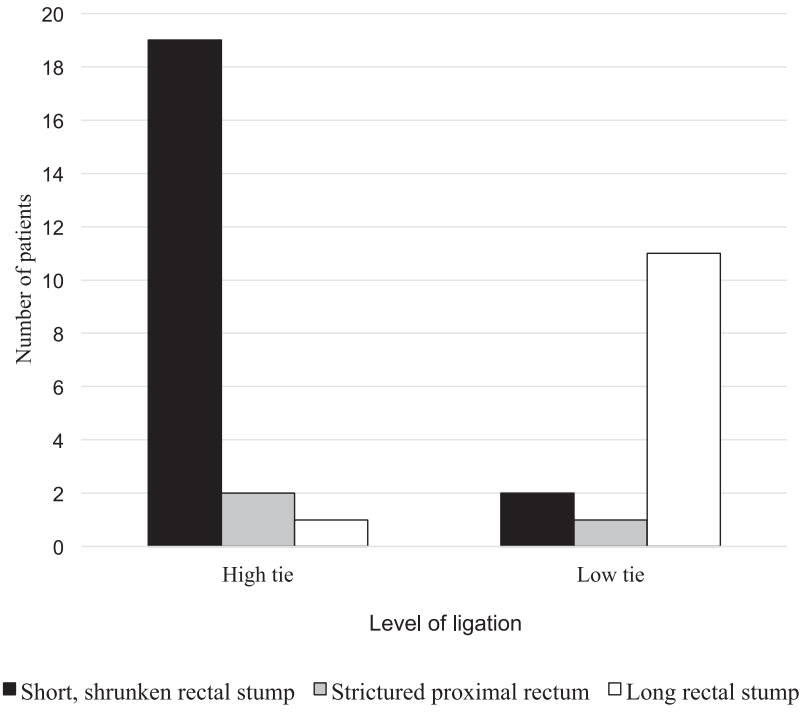

Fig. 1 Correlation of level of ligation to operation findings at reversal.

Table 7 Imaging findings prior to reversal with operation findings at reversal

Imaging findings prior to reversal	Operation findings at reversal			Total
	Stricture proximal rectum (%)	Short shrunken rectal stump (%)	Long rectal stump (%)	
Enema: short rectal stump	2 (12.5)	14 (87.5)	0 (0)	16
Enema: long rectal stump	0 (0)	1 (10)	9 (90)	10

importance because of its inconsistency and therefore impacts on the viability of the rectum stump following a Hartmann's procedure. DiDio *et al* studied the middle rectal arteries in 30 cadavers of adult and older individuals and reported its presence only in 56.7% of the cases. The most frequent point of penetration in the rectum wall is about 6 cm superior to the anus.[14] Shafik *et al* studied the arterial pattern of the rectum in 32 cadavers; the middle rectal arteries could be identified in only 50% of cases.[15]

The inconsistent presence of the middle rectal artery justifies, when possible, the preservation of the SRA when performing a Hartmann's procedure to avoid the ischemic stricturing of the residual rectal stump. The high ligation of the IMA in the absence of the middle rectal artery would result in the residual rectal stump reliant on blood supply exclusively from the inferior rectal artery, with the development of a short shrunken rectal stump.

The role of high ligation of the IMA (high tie) versus low ligation of the IMA (low tie) while performing the Hartmann's procedure is controversial. A high tie is classically considered to be the ligation of the inferior mesenteric artery proximal to the left colic branch or flush to the aorta and a low tie as its ligation distal to the left colic branch close to the bowel, thereby preserving the SRA. In this study, preserving the SRA correlates to a nonshrunken distal rectal stump, thereby avoiding dependency on the inconsistent middle rectal artery. As described in this study, 95.5% in high ligation led to a shrunken or strictured distal rectal stump, whereas 78.6% in low tie contributed to a long healthy rectal stump at the time of reversal. This justifies the preservation of the SRA at the initial operation and therefore merits recommendation when possible.

The level of IMA ligation in the setting of colorectal carcinoma remains controversial, but there is evidence suggesting no change in survival benefit when using either the high or low ligation techniques.[16] The nonpreservation of the SRA while performing a Hartmann's procedure may be considered as an independent risk factor for a shrunken rectal stump given that the middle rectal artery may be present in only approximately 50% of individuals. Subsequently, this may challenge the undertaking and viability of the anastomosis following Hartmann's reversal.

The timing of reversal of Hartmann's operation is controversial. Restoration of intestinal continuity at 6 months or more is associated with better results, as suggested by Pearce *et al*.[17] In the present study, 63.9% of patients underwent reversal of Hartmann's procedure after more than 6 months, and 69.6% of patients were found to have a shrunken rectal stump. Delayed reversal allows improvement of the clinical and nutritional state of the patient and may be technically easier as adhesions may be less dense. However, long intervals between primary surgery and reversal may lead to atrophy of the distal stump, particularly when a high ligation is performed.

In considering the changes in the anorectum following the Hartmann's procedure, Roe *et al* reported that the rectal stump undergoes shrinkage and demonstrates changes of diversion colitis over time. The closed rectum undergoes fibrosis with distortion of the apex of the stump.[18] The identification of the rectal stump is problematic when the rectal stump is short and has retracted deeply in the pelvis. The exact reason for this is unclear. A long-held view is that hypoplasia is known to occur in the defunctioned rectum.[19] The tagging of the rectal stump with nonabsorbable sutures to the sacrum has been found to be of variable help in identifying the rectal stump.[20]

The role of imaging has been an essential modality to detect abnormalities of the rectal stump prior to reversal of Hartmann's procedure. Barium enema helps in identifying strictures, diversion colitis, recurrent tumor, dense pelvic adhesions, fistulas, or even leaks.[21] In addition, barium enema can reveal the length, size, and position of the pouch in the pelvis, thereby predicting some of the

intraoperative challenges. This has a great impact in decision making and planning of subsequent surgery. In the present study due to resource challenges, barium enema was performed in 72.2% of patients and correlated 100% with the intraoperative findings of the short shrunken rectal stump and with findings of long rectal stump in 90% of cases.

In addition to the difficulties with its identification, the restoration of continuity in the setting of a short shrunken rectal stump is equally challenging. The handsewn technique is technically difficult and may result in the damage of vital pelvic structures, thereby increasing the rate of complications. Zachariah *et al* described the reverse transrectal stapling technique using the end-to-end anastomotic stapler. The method involves a reverse application of the anvil, namely into the distal loop and the gun through the proximal loop via a colostomy.[22] Singh *et al* demonstrated a the use of a circular stapler to create an end-to-side colorectal anastomosis with the proximal loop to the posterior rectal wall in patients where there is a short distal stump and whereby dissection anteriorly carries a substantial risk of injury and subsequent fistula formation.[23] In the present study, 77.8% of patients underwent stapled anastomosis for short shrunken rectal stump; 93.8% had a successful outcome. The stapled reversal technique used in this study was similar to that reported by Singh *et al*.

Conclusion

The level of arterial ligation when performing the Hartmann's procedure is a strong predictor for the condition of the rectal stump at time of its reversal. High ligation poses a challenge at reversal because of its association to a short shrunken rectal stump (86.4%). Preoperative imaging evaluation using a barium enema serves as a good indicator for the length of the rectal stump. A stapling technique is the preferred method of reversal. The duration prior to reversal of more than 6 months correlates with the findings of a short shrunken rectal stump (69.6%). In patients who underwent reversal within 3 months, the majority has a long rectal stump, although sample size is too small to show a statistical significance.

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