J Gastrointest Surg (2010) 14:743–752
DOI 10.1007/s11605-009-1084-3

REVIEW ARTICLE

Conventional and Laparoscopic Reversal of the Hartmann Procedure: a Review of Literature

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Received: 1 August 2009 / Accepted: 26 October 2009 / Published online: 21 November 2009

Abstract
Purpose The aim of this study was to provide a systematic overview on both laparoscopic and conventional Hartmann reversal. Furthermore, the Hartmann procedure is reevaluated in the light of new emerging alternatives.
Methods Medline, Ovid, EMBASE, and Cochrane database were searched for studies reporting on outcomes after Hartmann reversal.
Results Thirty-five studies were included in this review of which 30 were retrospective. A total of 6,249 patients with a mean age of 60 years underwent Hartmann reversal. Two thirds of patients were classified as American Society of Anesthesiologists (ASA) I–II. The mean reversal rate after a Hartmann procedure was 44%, and mean time interval between Hartmann procedure and Hartmann reversal was 7.5 months. The most frequent reported reasons for renouncing Hartmann reversal were high ASA classification and patients' refusal. The overall morbidity rate ranged from 3% to 50% (mean 16.3%) and mortality rate from 0% to 7.1% (mean 1%). Patients treated laparoscopically had a shorter hospital stay (6.9 vs. 10.7 days) and appeared to have lower mean morbidity rates compared to conventional surgery (12.2% vs. 20.3%).
Conclusion Hartmann reversal carries a high risk on perioperative morbidity and mortality. The mean reversal rate is considerably low (44%). Laparoscopic reversal compares favorably to conventional; however, high level evidence is needed to determine whether it is superior.

Keywords Hartmann · Reversal · Morbidity · Mortality

BJM and ESS performed the systematic review and drafted the manuscript. WAD coauthored the writing of the manuscript. ECJC and IAMJB also coauthored the writing and have given final approval of the version to be published.

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Introduction

The Hartmann procedure (HP) consists of a sigmoidectomy with rectal stump closure and a terminal colostomy. It is a common operation for left-sided colonic disease, especially in emergency cases. Initially, this procedure was solely performed in cases of neoplastic obstructions. Currently, indications include complicated diverticulitis, traumatic lesions, and perforated tumors of the rectosigmoid and volvulus.[1]

The Hartmann procedure was initially designed to reduce mortality caused by anastomotic dehiscence. However, reestablishing continuity after a Hartmann procedure (Hartmann reversal, HR) is still considered a major surgical procedure and carries serious risk of surgical morbidity and mortality of up to 50% and 5%, respectively, in the published literature.[2,3] Several attempts have been under-taken to perform HR by minimally invasive techniques with the objective to reduce high morbidity and mortality rates. Nevertheless, it has been estimated that approximately half of patients who undergo a Hartmann procedure will not have continuity restored by either a minimally invasive or open technique.[4,5]

Many studies on HR have been published. However, due to the large amount of studies on this subject, it is difficult to determine the characteristics and percentage of patients who undergo reversal and morbidity and mortality rates after both laparoscopic and conventional HR. Furthermore, the HR must be reevaluated in the light of new emerging alternatives. This study provides a systematic overview of the available current evidence to evaluate the aforementioned topics and put the HR in perspective of innovative alternatives.

Material and Methods

Literature Search

A systematic search of the literature was conducted to identify all studies on the reversal of the Hartmann procedure. We performed a duplicate search of the electronic databases PubMed, EMBASE, and the Cochrane library (from October 1987 until May 2009) using the following keywords and text word terms: “Hartmann”, “Hartman”, “Hartman’s”, “Hartmann’s”, “anastomosis”, “reconstruction”, “reversal”, “continuity”, and “restoration”. The “related articles” function in PubMed was also used to identify additional studies. References of the articles identified were also searched for by title and then subsequent abstract review.

Study Selection

Studies were selected according to the following selection criteria: (1) study is about reversal of Hartmann procedure, (2) publication is not an expert opinion or case report, (3) English language publication, and (4) more than ten patients included. The methodological quality of the included studies was judged in terms of the grades of evidence according to the Oxford Centre for Evidence-based Medicine Levels of Evidence. The methodological quality of the studies was judged independently by two reviewers (BJM and/or ES). Discrepancies between reviewers were resolved by discussion by a senior coauthor (WA).

Data Extraction

Patient-related data (indication of initial Hartmann procedure, age, gender, American Society of Anesthesiologists (ASA) classification), operative and hospital-related data such as the number of Hartmann procedures and reversals, reversal rate, reasons not to perform reversal, time interval between Hartmann procedure and reversal, hospital stay, morbidity (bleeding, wound infection, anastomosis leakage or stricture, and cardiac or pulmonary complications), mortality, operative time of both conventional and/or laparoscopic reversal, conversion rates, and reasons for conversion were gathered and analyzed. The ASA scores were divided in three groups: groups I–II, group III, and groups IV–V. ASA scores I–II represent healthy patients or with mild systemic disease. ASA III represents patients with moderate to severe systemic disease, and ASA IV–V represent patients with severe to life-threatening systemic disease.

Data Analysis and Presentation

Data analysis was limited to basic manipulation because of a lack of statistically relevant data, resulting from large trials. Descriptive statistics including means, counts, and percentages were used to describe the study population for all variables.

Results

Baseline and Patient Characteristics

The search initially yielded 813 articles (Fig. 1). After screening of title and abstract, 747 articles were excluded because they were not about HR. Sixty-six manuscripts were screened using the inclusion criteria. A total of 31 publications were excluded because they were not about HR (19 articles), included less than ten patients (ten articles), and were not about humans or in English (two articles) leaving 36 studies to be included in this review.[1–35]

In Table 1, the authors, year of publication, level of evidence, number of patients who underwent reversal, operative indication, ASA classification, age, and gender are presented. The year of publication ranged from 1987 to 2009. Five studies were prospective and 30 were retrospective.[6] The size of the individual study population ranged from 12 to 3,051 (mean 179) patients. The overall female–male ratio was 1:1.14 and the mean age was 60 years (38–71).

The indication for Hartmann procedure varied among studies. Diverticular disease and its associated complications (mostly fecal and purulent peritonitis followed by abscess, obstruction, and fistula) were the most common indication for Hartmann procedure in 67% of patients. Five studies included patients with diverticular disease only, with fecal and purulent peritonitis also being the most frequent indication for the initial procedure.[3] Colorectal malignancies causing obstruction or perforation were found

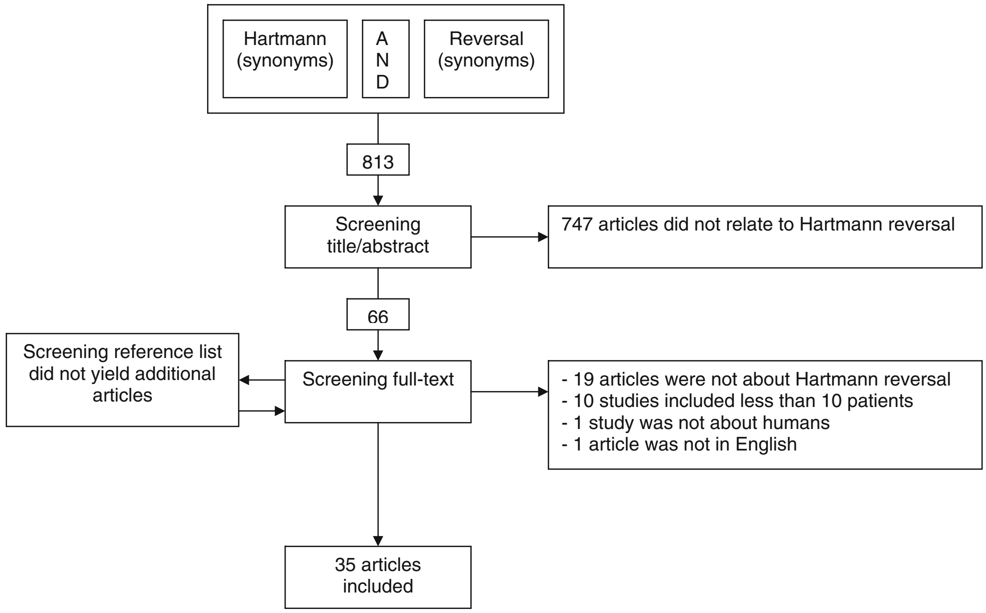

Figure 1 Flowchart describing the selection of studies included in this review.

to be the indication in 17% of patients. Other indications including inflammatory bowel disease, ischemia, volvulus, (iatrogenic) trauma, perforation, and anastomosis leakage following resection with primary anastomosis comprised 16% of cases.

Of the 646 patients who underwent reversal in these studies, 433 patients (67%) were considered relatively healthy (ASA I and II). For moderately healthy patients (ASA III), this amount was 200 patients (31%). A fraction of patients that underwent reversal was considered ASA IV (2%).[3,9,12,21,24] Reasons for performing reversal in this high risk group were not reported. Only two studies reported both the ASA classification of patients who underwent reversal and those that did not. Roque-Castellano et al. studied a population consisting of 162 patients that had an initial Hartmann procedure.[1] Of this group, 63 patients were considered ASA I or II, 72 patients ASA III, and 27 were considered ASA IV. Only 32 out of the 63 ASA I/II patients (51%) underwent reversal as shown in Fig. 2. For the ASA III patients, this amount was nine out of 72 (13%), and for ASA IV, one out of 27 patients (4%). Banerjee et al. reported that three out of 25 ASA IV patients (12%) underwent reversal.[18] The percentages of other ASA classifications were not reported.

Morbidity and Mortality of Hartmann Reversal

In Table 2 and Table 3, the hospital stay and morbidity and mortality rates after conventional and laparoscopic HR are presented. The overall morbidity rate of the HR (conventional plus laparoscopic approach) is considerably high ranging from 3.6% to 50% (mean 16.3%). The most frequent postoperative complication was wound infection which ranged from 5% to 30% (mean 12.5%).[18] Other common postoperative complications include cardiopulmonary complications ranging from 1% to 14.6% (mean 5.3%) followed by anastomosis leakage with a range of 0% to 16% (mean 5.2%) and postoperative bleeding from wound or anastomosis site ranging from 0% to 7% (mean 3.2%). Late complications including anastomosis stricture ranged from 2% to 10% (mean 5.8%).

Mainly because of anastomosis-related complications (leakage and stricture), between 0% and 20% (mean 5.3%) of evaluated patients required secondary surgery after reversal of HP. Of the patients that required a reoperation, 24% to 50% were left with a permanent stoma.[11,14,15,19,22,28–32] This proportion comprises 3% to 12.5% (mean 6.1%) of all patients that underwent HR.

Mortality was largely caused by septic complications due to anastomotic dehiscence or postoperative abscesses.[2,5,7,8,10,12,13,15,18–22,24–26,28,29,31–33] Some studies also reported renal failure and myocardial infarction after reoperation for wound dehiscence and dissipated malignancies as cause of death.[5,8–10,13]

Laparoscopic vs. Conventional Reversal of HP

Five studies compared laparoscopic surgery with the open approach of HR.[10,13] Seven studies were solely about laparoscopic HR.[4,11,21,25,29,31,32] A total of 396 patients had a laparoscopic HR vs. 5,853 patients with conventional HR.

Hospital stay appeared to be notably shorter after laparoscopic HR (mean 6.9, range 3–11 days) compared to conventional HR (mean 10.7, range 3–

Table 1 Baseline and Patient Characteristics of Included Studies

Reference	Year	Level	Reversal (*n* patients)	Age (years)	Gender		Initial indication			ASA classification		
					Female (*n*)	Male (*n*)	Div (%)	CA (%)	Other (%)	ASA I–II (%)	ASA III (%)	ASA IV–V (%)
Sweeney and Hoffmann	1987	IV	19	71	10	9	100	0	0	–	–	–
Basse	1991	IIb	27	50	14	13	50	22	28	–	–	–
Roe	1991	IV	69	67	38	31	70	30	0	–	–	–
Geoghegan and Rosenberg	1991	IV	55	65	–	–	58	31	11	90	10	0
Pearce	1992	IV	80	65	44	36	71	24	5	–	–	–
Keck	1993	IV	50	–	–	–	80	14	6	–	–	–
Sosa[b]	1994	IV	18	38	4	14	50	0	50	–	–	–
Khan	1994	IV	28	58	13	15	100	0	0	–	–	–
Wigmore	1995	IV	178	65	93	85	63	33	4	–	–	–
Macpherson[b]	1996	IV	12	62	7	5	75	17	8	–	–	–
Regadas[b]	1996	IV	20	52.8	10	10	10	20	70	–	–	–
Carcoforo[a]	1996	IV	19	–	9	10	–	–	–	–	–	–
Seetharam	2003	IV	23	–	–	–	84	8	8	–	–	–
Maggard	2004	IIb	765	–	–	–	–	–	–	–	–	–
Banerjee	2004	IV	66	59	30	36	–	–	–	71	25	4
Rosen[b]	2005	IV	22	54	12	10	68	9	23	–	–	–
Albarran	2004	IV	40	60	19	21	55	28	17	63	32	5
Bell	2005	IV	20	56	1	19	55	20	25	–	–	–
Aydin[a]	2005	IV	121	57	54	67	100	0	0	41	56	3
Khaikin[b]	2007	IV	27	–	10	17	70	19	11	56	44	0
Salem and Flum	2004	IV	3,051	–	–	–	–	–	–	–	–	–
Oomen	2005	IIb	65	63	32	33	100	0	0	–	–	–
Roque-Castellano	2007	IV	42	56	7	35	–	–	–	77	21	2
Faure[a]	2007	IIb	34	62	18	16	67	26	7	76	24	0
Boland	2007	IV	39	53.4	17	22	56	15	29	–	–	–
Schmelzer	2007	IV	113	49.5	41	72	38	15	48	61	39	0
Carus[b]	2008	IV	28	–	–	–	–	–	–	–	–	–
Haughn[a]	2008	IV	122	59	68	54	70.5	18	11.5	–	–	–
Leong	2008	IV	28	–	–	–	29	46	25	–	–	–
Mazeh	2009	IV	82	60.5	41	41	58	6.1	35.9	–	–	–
Petersen[b]	2009	IIb	71	–	32	39	–	–	–	–	–	–
Slawik and Dixon[b]	2008	IV	28	66	17	11	67.9	25	8.1	68	32	0
Vermeulen[a]	2008	IV	63	61	26	35	100	0	0	63	23	–
Chouillard	2008	IV	88	57	50	38	75	18	7	–	–	–
David	2009	IV	736	60	335	401	82.6	17.4	0	–	–	–
Total			6,249		1,052	1,195	–	–	–	–	–	–
Mean	–	–	179	60	38	43	67	17	16	67	31	2

Div diverticulitis, *CA* carcinoma

[a] Results of laparoscopic and conventional Hartmann reversal grouped together (conventional > laparoscopic)

[b] Results of laparoscopic Hartmann reversal only

18 days).[14,15,19,22,28,30,34] Furthermore, patients treated laparoscopically appeared to have a reduced mean overall morbidity rate (12.2% vs. 20.3%). This was mainly found for wound infection (mean 10.8% vs. 14.2%), anastomotic leakage (mean 1.2% vs. 5.1%), and cardiopulmonary complications (mean 3.6% vs. 6.9%). Reoperations occurred more often in conventional HR (mean 3.6% vs. 6.9%). The need for a permanent stoma was not reported for laparoscopic HR.

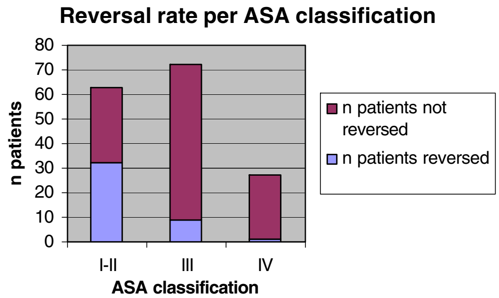

Figure 2 Reversal rate per ASA classification.

However, this percentage was on average 6.1% in the conventional group.

Mortality appeared to be comparable for both techniques (mean 0.9% vs. 1.1%). One study reported a mortality rate of 7% in a study population of 28 patients that were treated laparoscopically.[1,6–13,20,23,25,26,27,31,32,35] In this study, one patient died from a mesenteric embolus secondary to atrial fibrillation, and one patient died from anticoagulation induced hemorrhage.

The operating time was appeared to be comparable for laparoscopic (mean 153 min, range 30–356) and conventional HR (mean 170 min, range 57–500). Conversion from laparoscopy to conventional surgery ranged from 7% to 22% (mean 12.6%). Reasons for conversion were lack of visualization due to dense adhesions (80%), rectal stump perforation (7%), persisting infection of the rectal stump (5%), extensive neoplasm invasion (3%), and lesions to the bladder or spleen (5%).[30] Other intraoperative complications not requiring conversion included splenic lesions (4.5%), accidental enterotomy during adhesiolysis (2.8%), incomplete anastomosis (2.5%), and bladder or ureteral injury.

When comparing the group of patients treated laparoscopically to the group treated conventionally, patients treated laparoscopically appeared to be slightly younger (55 vs. 61 years) and were more often initially treated for other indications (32% vs. 13%), such as inflammatory bowel disease, ischemia, volvulus, and trauma rather than diverticulitis (55% vs. 67%) or malignancies (15% vs. 19%). Furthermore, the mean interval between Hartmann procedure and reversal was considerably shorter for patients treated laparoscopically (5.5 vs. 8.8 months). There were no apparent differences in ASA classification.

Reversal Rate and Factors

Nineteen studies mentioned the amount of patients who initially received a Hartmann procedure and therefore offered the opportunity to calculate the reversal rate (Table 4). A total of 12,302 patients had a Hartmann procedure of which 5,405 subsequently underwent reversal leading to a mean reversal rate of 44% (range 19% to 71%). Fourteen studies mentioned reasons or factors that possibly influenced the choice not to perform a HR. The most frequent reported reason or factor was a high ASA classification mentioned in 12 studies, followed by patient refusal in nine, metastatic disease in seven, and high age in five studies. Three studies reported other reasons which mostly concerned the inability to perform an anastomosis due to persisting rectal stump difficulties. Roque-Castellano et al. published a study focusing specifically on factors related to the decision of restoring intestinal continuity after Hartmann procedure.[1] They found that reestablishment of intestinal continuity was related in a statistically significant matter to male sex, nonneoplastic disorder, younger age, and lower ASA classification. Other studies also supported the fact that high age and ASA classification are associated with a low reversal rate.[1]

The interval between the original Hartmann procedure and its reversal varied widely between studies as demonstrated in Table 5. Two studies included patients who underwent their reversal after an interval shorter than 3 months.[13,28] These studies had comparable outcomes with studies that had a longer time interval. The longest interval reported was 13.5 months and was attributed to a long waiting list in the concerning hospital.[1] The mean interval of all included studies was 6.7 months. Approximately 7% to 16% of patients waiting for reversal died due to disease-related complications (mostly metastatic disease).[30]

Discussion

With this systematic review, we have attempted to summarize all evidence currently available in the literature concerning the indications of HP and the number and characteristics of patients who undergo reversal of this procedure with its morbidity and mortality. Although at this point in time high level studies are lacking, this study indicates that the initial HP is mainly reserved for patients with complicated (Hinchey III–IV) diverticulitis and patients with fecal or purulent peritonitis due to tumor perforation. Approximately 44% of patients undergo bowel continuity restoration after HP with a mean interval of 7.5 months. The majority of patients (mean age 60 years) undergoing reversal are considered ASA I–II. Reversal of HP is accompanied by a considerable risk of complications (mean 16.3%, range 3–50%) and has an overall mortality rate of 1%. When comparing the few studies on laparoscopic HR with conventional surgery, a lower overall morbidity rate is found (12.2% vs. 20.3%). Furthermore, patients treated laparoscopically have a shorter hospital time compared to conventional reversal (6.9 vs. 10.7 days). Mortality, however, is comparable for both operative techniques.

Table 2 Hospital Stay, Morbidity, and Mortality of Conventional Hartmann Reversal

First author (year)	Patients (*N*)	Hospital stay (days)	Morbidity								Mortality (%)
			Permanent stoma (%)	Bleeding (%)	Leakage (%)	Stricture (%)	Reoperation (%)	Wound infection (%)	Cardio/pulmonary (%)	Overall morbidity (%)	
Sweeney (1987)	19	18.1	–	–	16	–	–	5	–	21	0
Roe (1991)	69	14	–	–	4	–	6	10	1	15	3
Basse (1991)	27	3	–	4	4	–	0	–	–	8	0
Geoghegan (1991)	55	–	–	–	–	–	2	8	2	10	2
Pearce (1992)	80	13	8		16	–	–	–	–	16	4
Keck (1993)	50	12		–	4	8	0	20	–	32	2
Khan (1994)	28	12.5	–	–	7	–	4	7	11	25	0
Sosa (1994)	65	9.5	–	–	–	–	–	–	–		–
Wigmore (1995)	161	12	–	–	4	7	4	10	6	27	1
Carcoforo (1996)	12	–	–	–	–	10	–	–	–	10	0
Seetharam (2003)	23	–	–	–	–	–	–	–	–		0
Albarran (2004)	40	15.5	–	–	3	9	3	21	6	39	0
Banerjee (2004)	66	–	3	–	6	2	6	8	–	16	0
Bell (2005)	20	–	–	–	5	–	20	30	15	50	0
Oomen (2005)	65	–	4	2	5	–	17	–	8	15	3
Roque (2005)	42	13.5	–	7	–	–	–	24	–	31	0
Salem (2004)	3,051	7	12.5	–	–	–	–	–	–	–	0.4
Aydin (2005)	111	–	–	–	3	–	19	7	6	16	2
Boland (2007)	39	8	10	–	3	–	3	–	–	3	3
Schmelzer (2007)	113	6.8	–	6	1	–	–	16	2	25	0
Faure (2007)	20	11	–	–	5	–	–	–	–	5	–
Chouillard (2008)	44	6.8	–	–	7.1	–	4.5	20.5	–	27.6	0
Haughn (2008)	61	–	1.6	–	–	1.6	13.1	13.1	9.8	24.5	0
Leong (2008)	28	–	3.6	–	3.6	–	3.6	–	–	3.6	0
Vermeulen (2008)	63	–	–	(1.6)	(3.2)	–	–	(11)	–	15.8	(5)
David (2009)	736	11	–	–	2.3	–	–	11.7	–	14	1.4
Mazeh (2009)	41	8.1	–	2.4	0	–	4.9	19.5	14.6	36.5	0
Mean		10.7	6.1	3.8	5.1	6.3	6.9	14.2	6.9	20.3	0.9

In parentheses were results of laparoscopic and conventional Hartmann reversal grouped together (conventional > laparoscopic)

Table 3 Hospital Stay, Conversion Rate, Morbidity, and Mortality of Laparoscopic Hartmann Reversal

First author (year)	Patients (*N*)	Hospital stay (days)	Conversion (%)	Morbidity								Mortality (%)
				Permanent stoma (%)	Bleeding (%)	Leakage (%)	Stricture (%)	Reoperation (%)	Wound infection (%)	Cardio/ pulmonary (%)	Overall morbidity (%)	
Sosa (1994)	14	6.3	22	–	–	–	7	–	7	–	14	0
Regadas (1996)	20	4	15	–	5	–	–	5	10	–	15	0
Macpherson (1996)	12	8	0	–	–	–	–	–	8	8	16	0
Rosen (2005)	20	4.2	9	–	–	–	–	0	18	–	18	0
Khaikin (2007)	23	6	14.8	–	–	0	–	4	20	–	18	0
Faure (2007)	14	9.5	14.8	–	–	–	7.1	7	–	–	7.1	–
Slawik (2008)	28	3	3.6	–	–	–	–	–	7.1	–	7.1	7.1
Carus (2008)	28	8.6	17.9	–	–	3.6	–	7.1	10.7	–	14.3	–
Chouillard (2008)	44	4.8	9.1					2.2	9		11.2	2.2
Haughn (2008)	61	–	–	–	–	–	1.6	3.3	3.8	4.9	10.3	0
Mazeh (2009)	41	6.5	19.5	–	3	0	–	0	14.6	0	17.6	0
Petersen (2009)	71	–	12.7	–	1.4	–	–	–	–	1.4	2.8	1.4
Mean		6.9	12.6	–	3.1	1.2	5.2	3.6	10.8	3.6	12.2	1.1

ASA classification and high age are frequently reported as a reason to abstain from reversal. Although this review was not constructed to address this issue, it is generally thought that these factors are associated with higher morbidity and mortality rates.[16,18,33] Unfortunately, the majority of patients with a colostomy after HP are old and considered ASA III or higher. Therefore, a large group of patients are left with a permanent stoma mainly because reversal is considered risk full due to their fragile state of health. Such a group of patients may benefit from less invasive procedures.

Laparoscopic HR seems to be a promising alternative to open surgery. By reducing the invasiveness of the operation, this review has found decreased postoperative recovery time. Furthermore, the mean overall morbidity rate appears to be reduced for laparoscopic HR. However, there is considerable overlap in range between laparoscopic and conventional HR (2.8–17.6% vs. 3–50%). Conversion rates, ranging from 0% to 22%, reflect the fact that the operation is technically demanding and might also result in elevated morbidity rates. Laparoscopic reversal is a relatively new technique with only small numbers of retrospective case series each containing no more than seven to 71 patients. It is therefore uncertain what the effects of selection bias are on the outcomes after laparoscopic HR. Randomized trials are necessary to determine whether laparoscopic reversal is indeed superior to the conventional technique.

HP has been the operation of choice for complicated diverticulitis and tumor perforation with peritonitis. HP was recommended because it could potentially avoid intra-abdominal sepsis related to anastomotic leakage. However, several studies have demonstrated that primary anastomosis with or without defunctioning ileo- or colostomy after resection could safely be performed in patients with peritonitis and eliminate the need for an invasive second stage reversal. In a recent review, the leak rate of the primary anastomosis was described at 5.5% which compared favorably with the leak rate found in our review after HR (mean 3.2%, range 0–16%).[18,20] However, certain considerations must be taken into account. Firstly, most studies comparing the Hartmann procedure with primary anastomosis with or without defunctioning colo- or ileostomy are retrospective with inherent selection bias. Patients that undergo HP often suffer from more extensive disease when compared to patients who have primary anastomosis. Therefore, solid conclusions cannot sufficiently be drawn regarding this topic, and it therefore may be justified that the choice of operative technique should be considered on an individual basis. In The Netherlands, a trial has been developed to address this issue in the near future. Secondly, reversal of the ileo- and colostomies carry considerable morbidity themselves ranging from 4.6% to 34% with anastomotic leakage occurring in 0–2.2% of patients.[36]

Table 4 Reversal Rate and Reasons for Not Performing Reversal

First author (year)	Patients HP (*n*)	Patients HR (*n*)	Reversal rate (%)	Reasons for not performing reversal				
				High ASA	Patient refusal	Metastatic disease	High age	Other
Sweeney 1987)	30	19	63	X	X			
Roe (1991)	107	69	64	X	X	X		
Geoghegan (1991)	108	55	51	X	X	X		X
Pearce (1992)	145	80	55					
Keck (1993)	111	50	45	X	X	X		X
Khan (1994)	61	28	46	X	X	X		
Wigmore (1995)	345	178	47					
Carcoforo[a] (1996)	43	19	44					
Seetharam (2003)	124	23	19					
Banerjee (2004)	110	66	61	X			X	
Albarran (2004)	74	40	54		X			
Maggard (2004)	1,176	765	65	X			X	
Salem (2004)	5,420	3,051	56				X	
Oomen (2005)	91	65	71	X				
Roque (2007)	164	42	30	X		X	X	
Leong (2008)	70	28	40	X	X	X		
Vermeulen (2008)	139	63	45	X	X	X	X	X
Carus[b] (2008)	34	28	82	X	X			
David (2009)	3,950	736	23.3					
Mean	647	284	44	–	–	–	–	–

[a] Results of laparoscopic and conventional Hartmann reversal grouped together

[b] Studies reporting results of laparoscopic Hartmann reversal only

Moreover, 0–16.7% of colo- and ileostoma are never reversed (reasons are patient refusal, general inoperability, tumor progression, and anal sphincter insufficiency).[37–40] Noteworthy, however, this compares favorably to the reversal rate of 44% after the Hartmann procedure.

This review has several limitations. The analysis of data mainly serves as descriptive purposes identifying characteristics of patients undergoing HR, reversal rates, reasons not to reverse, and morbidity and mortality of laparoscopic and conventional HR. It does not intend to provide direct comparison between laparoscopic HR and conventional HR. Therefore, certain considerations must be taken into account when attempting to compare laparoscopic to conventional HR using results of this review. Firstly, the decision on surgical approach in the studies was based on surgeon's preferences leading to certain amounts of selection bias. Predominantly, the interval between Hartmann procedure and reversal was significantly lower in patients treated laparoscopically. It is difficult to evaluate to what extent this may have biased the results as it remains a controversial topic in the literature. Secondly, a serious confounder could be the moment of publication; studies on laparoscopic surgery were published since 1996, while studies on open reversal were published since 1987. As recent developments have led to shorter hospitalization times in general, more recent publications, such as studies on laparoscopic HR, might report shorter hospital stay compared to older publications such as studies on conventional HR. To date, clear comparison is nearly impossible as studies that attempted to compare laparoscopic HR to conventional HR are retrospective and not randomized.

Recently, an innovative promising technique has been developed which might be a solution for the aforementioned risk-full patients. In 2004, Gagner et al. described an endoscopic procedure to restore bowel continuity after HP in a canine model.[41] This procedure requires a modified HP during which the rectal stump is sutured to the sidewall of the colostomy limb in an end-to-side fashion to enable the opportunity to perform endoscopic reversal. During reversal, a rendezvous procedure is constructed during which a dedicated device is inserted through the colostomy that meets a standard circular stapler introduced through the anus. This procedure has several theoretical advantages. For one, it may eliminate the requirement for general anesthesia and associated morbidity (cardiopulmonary stress, gastrointestinal ileus). Secondly, by avoiding laparotomy or laparoscopy, the risk of postoperative associated complications may be reduced and patients may have shorter recovery time. Thirdly, this technique may be able to reduce the long time interval between HP and reversal found in this review consisting of approximately 7.5 months. There are certain considerations which must be taken into account. The modified HP may be more difficult in patients who are left with a short rectal stump. In addition, mobilization of the splenic flexure may be necessary which, however, creates an additional risk for complications (3.1%). Furthermore, until now, during endoscopic reversal, the final anastomosis is made without direct visualization of the circular anastomosis.

A comparable endoscopic technique has been performed in 13 patients by Vermeulen et al. Essentially, HR was performed through the stomal opening. Through an incision at the formal stoma side, lysis of intra-abdominal adhesions could be performed manually. The rectal stump was identified intra-abdominally using a transanal club, and an end-to-end colorectal anastomosis was created under manual control. There were two conversions due to strong adhesions in the lower pelvic cavity, and no complications occurred. Unfortunately, as in the technique described by Jacob et al., the anastomosis was made without direct visualization. In the future, an adjusted stapler with a fiber optic viewing channel might overcome this problem.

In conclusion, based on the published literature, reversal of the Hartmann procedure carries a high operative morbidity and mortality and is performed in only 44% of patients. Principally, relatively younger and healthy patients are eligible for reversal. This leaves a considerable group of patients, mainly older with poor health condition, with a permanent stoma. Laparoscopic reversal compares favorably to conventional; however, high level evidence is needed to determine whether it is superior. Endoscopic techniques might be upcoming and may introduce the possibility for the older and fragile patients to undergo reversal.

Table 5 Time Interval Between HP–HR and Mortality During This Interval

First author (year)	Interval between HP and conventional HR (*n* months)	Interval between HP and laparoscopic HR (*n* months)	Mortality in time interval (%)
Sweeney (1987)	5.6	–	–
Geoghegan (1991)	6.5	–	–
Roe (1991)	4.5	–	–
Pearce (1992)	6	–	–
Keck (1993)	8.5	–	–
Khan (1994)	3–6	–	–
Wigmore (1995)	0–3	–	–
Carcoforo (1996)	7.7	–	–
Macpherson (1996)	–	7.5	–
Seetharam (2003)	7.6	–	19
Banerjee (2004)	8.3	–	16
Maggard (2004)	5	–	–
Salem (2004)	5	–	–
Bell (2005)	10.6		–
Boland (2007)	11.5	–	–
Schmelzer (2007)	10.2	–	–
Roque (2007)	13.3	–	–
Faure (2007)	4	6	–
Leong (2008)	9	–	7
Haughn (2008)	14	5.7	–
Vermeulen (2008)	9.1	–	–
Chouillard (2008)	5.1	6.2	–
Carus (2008)	–	2.5	–
Mazeh (2009)	7.7	4.9	–
David (2009)	9.5	–	–
Mean	8.0	5.5	14

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