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Stenting for Obstructing Colon Cancer: Fewer Complications and Colostomies

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ABSTRACT

Background and Objectives: Colonic stenting has been used in the setting of malignant obstruction to avoid an emergent colectomy. We sought to determine whether preoperative placement of a colonic stent decreases morbidity and the rate of colostomy formation.

Methods: Cases of obstructing sigmoid, rectosigmoid, and rectal cancer from January 1, 2010, to December 31, 2011, were identified in the Nationwide Inpatient Sample (NIS) database. All patients were treated at hospitals in the United States, and the database generated national estimates. Postoperative complications, mortality, and the rate of colostomy formation were analyzed.

Results: Of the estimated 7891 patients who presented with obstructing sigmoid, rectosigmoid, or rectal cancer necessitating intervention, 12.1% (n = 956) underwent placement of a colonic stent, and the remainder underwent surgery without stent placement. Of the patients who underwent stenting, 19.9% went on to have colon resection or stoma creation during the same admission. Patients who underwent preoperative colonic stent placement had a lower rate of total postoperative complications (10.5% vs 21.7%; $P < .01$). There was no significant difference in mortality (4.7% vs 4.2%; $P = .69$). The rate of colostomy formation was more than 2-fold higher in patients who did not undergo preoperative stenting (42.5% vs 19.5%; $P < .01$). Preoperative stenting was associated with increased use of laparoscopy (32.6% vs 9.7%; $P < .01$).

Conclusions: Our study characterizes the national incidence of preoperative placement of a colonic stent in the setting of malignant obstruction. Preoperative stent placement is associated with lower postoperative complications and a lower rate of colostomy formation. The results support the hypothesis that stenting as a bridge to surgery may benefit patients by converting an emergent surgery into an elective one.

Key Words: Colonic obstruction, Malignant bowel obstruction, Obstructing colon cancer.

INTRODUCTION

Left-sided colon cancer presents with obstruction in 8% to 26% of cases.[1,2] This clinical presentation often results in emergency operations that are associated with high rates of morbidity and mortality.[3–5] Many centers use an alternative to this approach that involves placement of a preoperative colonic stent. The stent serves as a temporizing measure for colonic decompression and provides a bridge to elective surgical resection.

Colonic stent placement for obstructing cancer has a multitude of potential benefits. Some data suggest a significantly lower incidence of postoperative complications in patients who undergo elective resection after stenting. In a randomized controlled trial, Cheung et al[6] demonstrated a significant decrease in rates of blood loss, pain, and infection in patients with stents. In a meta-analysis of randomized and retrospective studies, Zhang et al[7] report a decreased risk of postoperative complication in patients with stents, including intensive care unit stay (RR = 0.42) and anastomotic leak (RR = 0.31).[7]

Stoma formation is more strongly associated with emergent procedures.[7] One study reported that 83% fewer patients underwent stoma formation if they had preoperative stenting, and 2 meta-analyses similarly demonstrated lower stoma rates in these patients.[6–9] The evidence translates into fewer procedures in patients with stents, and fewer procedures are associated with lower costs and shorter hospital stays.[5,8] A 1-stage procedure may be associated with a significantly lower mortality rate versus a 2- or 3-stage procedure.[10] Preoperative decompression results in a less dilated bowel that is more amenable to a 1-stage procedure, as there may be an association between colonic diameter and risk to the anastomosis.[11,12] In addition, conversion to an elective procedure allows for

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Table 1.
ICD-9 Procedure Codes

	ICD-9 Code
Diagnosis	
Obstruction	560.89, 560.9
Sigmoid cancer	153.3
Rectosigmoid cancer	154.0
Rectal cancer	154.1
Iatrogenic injury	998.2
Generalized peritonitis	567.21, 567.9
Anastomotic complications, hepatic failure due to procedure, hepatorenal syndrome due to procedure, intestinal obstruction due to a procedure	997.4
Perforation	569.83
Total parenteral nutrition	991.5
Postoperative complication	
Shock	998.0
Hemorrhage	998.11
Hematoma	998.12
Seroma	998.13
Hypotension	458.29
Disruption of wound	998.3
Disruption of wound NOS	998.30
Disruption of internal wound	998.31
Disruption of skin	998.32
Disruption of traumatic injury	998.33
Non-healing wound	998.83
Infected seroma	998.51
Infection: sepsis or abscess (intra-abdominal or superficial)	998.59
Respiratory complications	997.3
Pneumonia, including aspiration	997.39
Pulmonary insufficiency	518.5
Cardiac complications (arrest, insufficiency, CHF)	997.1 DXCCS100
Urinary complications (oliguria, anuria, acute renal failure or insufficiency)	997.5

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Table 1.
continued

	ICD-9 Code
Comorbidity	
Cardiac disease	DXCCS 101, 103, 104
Arrhythmia	DXCCS 106
Pneumonia	DXCCS 122
COPD	DXCCS 127
Chronic kidney disease	DXCCS 158
Dementia	DXCCS 653
Malnutrition	DXCCS 52
Diabetes mellitus	DXCCS 49, 50
Procedure	
Colonic stent	46.86, 46.87
Left colectomy	45.75, 17.35
Sigmoidectomy	45.76, 17.36
LAR	48.62, 48.63
APR	48.50, 48.51, 48.52
Total colectomy	458, 45.81, 45.82, 45.83
Ileostomy formation	46.20, 46.21, 46.23
Colostomy formation	46.10, 46.11, 46.13
Conversion to open	V64.41
Blood transfusion	99.04

LAR = lower abdominal resection; APR = abdominal perineal resection; NOS = not otherwise specified; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease.

bowel preparation, which is standard for elective procedures at many institutions.[7,10]

The process of stent placement is not without complication. Colonic stenting is a technology that is not available in all centers, and the procedure has a learning curve for those who perform it.[13,14] The process of stent placement involves passing a self-expanding stent across a lesion under fluoroscopic guidance. The success of placement may be limited by tight strictures, complicated anatomy, and incomplete preparation, especially in critically ill patients.[15] In a prospective, multicenter, clinical cohort study, Meisner et al[12,16] cited complication rates comparable to those at other large multicenter studies, including perforations (3.9%), migration (1.8%), pain (1.8%), and bleeding (0.5%), with a procedural success rate of 94.8% and a clinical success rate of 90.5%.

For colonic stenting in malignant obstruction, the standard practice patterns of surgeons in the United States are unknown. Our goals were to define the rate of colonic stenting for malignant obstruction in the United States and to compare the morbidity, mortality, and colostomy rates associated with this approach. We also sought to investigate which demographic variables might influence whether a patient is a candidate for a colonic stent.

METHODS

Data Source

The Nationwide Inpatient Sample (NIS) database, a Healthcare and Utilization Project (HCUP) initiative, is the largest all-payer database in the United States. It collects demographic and diagnostic information for roughly 8 million hospital admissions annually. The collected data represent approximately 20% of all hospital admissions, and each data point is weighted to produce national estimates.[17]

Patient Selection

For the study dates January 1, 2010, through December 31, 2011, patients with a diagnosis of sigmoid, rectosigmoid, or rectal cancer and obstruction were identified according to International Classification of Diseases, Ninth Revision (ICD-9) codes (**Table 1**). Patients who underwent colonic stenting were identified by the associated procedure code. Partial resection was defined as left colectomy, sigmoidectomy, lower anterior resection, or abdominal perineal resection.

Outcomes

Patients who underwent primary resection or stoma creation were compared to those who underwent preoperative colonic stenting. Our primary outcome measures included the rate of stoma creation, total postoperative complications, and deaths. We also compared these groups for use of laparoscopy, rate of conversion to an open procedure, blood transfusion requirement, total parenteral nutrition, and variables related to cost.

Statistical Analysis

We performed our analysis with the Statistical Package for the Social Sciences (SPSS), version 22.0 (SPSS, Chicago, Illinois). Weighting according to hospital characteristics was applied to all analyses, to produce national estimates. Categorical variables were compared by χ^2 analysis. Medians were compared for continuous variables by nonparametric tests. Multivariate regression analysis was performed on factors that were significant according to univariate analysis.

RESULTS

Demographics and Comorbidities

During the study years 2010 to 2011, an estimated 7891 patients presented with sigmoid, rectosigmoid, or rectal obstruction, and underwent either colonic stent placement (12.1%; n = 956) or colon resection or stoma creation without stent placement (87.9%; n = 6935). The patients who underwent placement of a stent were younger, less likely to be white, less likely to be in the lowest income quartile, and slightly less likely to have arrhythmia, malnutrition, or diabetes (**Table 2A**). There were no significant differences between the stented and nonstented groups in the other demographic and comorbidity variables.

Of those patients who had placement of a colonic stent, 19.9% went on to have resection or stoma creation. Compared with patients with stents who did not have surgery during the same admission, those who underwent preop-

Table 2.
Demographic and Comorbidity Comparisons
A. Stent Versus No Stent

	Stent (n = 956)	Surgery Without Stent (n = 6935)	P[a]
Age (over 65)	47.7	53.0	<.01
White	62.7	74.5	<.01
Medicare/Medicaid	6.0	61.4	.41
Lowest income quartile[b]	18.1	27.0	<.01
Cardiac disease	14.5	14.5	.94
Arrhythmia	16.6	19.4	.04
Pneumonia	7.2	7.4	.86
COPD	7.5	9.2	.08
Chronic kidney disease	5.5	6.0	.55
Dementia	5.2	4.8	.58
Malnutrition	19.7	22.9	.03
Diabetes mellitus	17.2	20.4	.02

Data are the percentage of patients in the total study group. COPD = chronic obstructive pulmonary disease.

[a]By univariate analysis. Significant at $\alpha \leq .05$.

[b]Based on median household income by ZIP code (2010: <$41 000; 2011: <$39 000).

Table 2.
B. Stent and Surgery Versus Stent Without Surgery

	Stent and Surgery[a] (n = 190)	Stent Without Surgery (n = 766)	P[b]
Age (over 65)	62.1	44.1	<.01
White	64.9	62.2	.50
Medicare/Medicaid	67.7	58.1	.02
Lowest income quartile[c]	12.6	19.6	.03
Cardiac disease	7.9	16.2	<.01
Arrhythmia	22.6	15.3	.02
Pneumonia	2.6	8.4	.01
COPD	5.3	8.2	.17
Chronic kidney disease	5.3	5.6	.85
Dementia	4.7	5.4	.73
Malnutrition	17.4	20.2	.37
Diabetes mellitus	11.6	18.5	.02

Data are the percentage of patients in the total study group. COPD = chronic obstructive pulmonary disease.

[a]Patients with stents who eventually underwent resection or colostomy.

[b]By univariate analysis. Significant at $\alpha \leq 0.05$.

[c]Based on median household income by ZIP code (2010: <$41 000; 2011: <$39 000).

Table 2.
C. Stent and Surgery versus No Stent and Surgery

	Stent and Surgery[a] (n = 190)	No Stent and Surgery (n = 6935)	P[b]
Age (over 65)	62.1	53.0	.01
White	64.9	74.5	<.01
Medicare/Medicaid	67.7	61.4	.08
Lowest income quartile[c]	12.6	27.0	<.01
Cardiac disease	7.9	14.5	.01
Arrhythmia	22.6	19.4	.27
Pneumonia	2.6	7.4	.01
COPD	5.3	9.2	.06
Chronic kidney disease	5.3	6.0	.66
Dementia	4.7	4.8	.96
Malnutrition	17.4	22.9	.08
Diabetes mellitus	11.6	20.4	<.01

Data are the percentage of patients in the total study group. COPD = chronic obstructive pulmonary disease.

[a]Includes patients with stents who eventually underwent resection or colostomy.

[b]By univariate analysis. Significant at $\alpha \leq .05$.

[c]Based on median household income by ZIP code (2010: <$41 000; 2011: <$39 000).41 00039 000.

erative stenting represented an older population with a higher incidence of cardiac arrhythmia (**Table 2B**). They had a significantly lower incidence of cardiac disease, pneumonia, and diabetes mellitus. Patients in the lowest income quartile were underrepresented in the group that underwent preoperative stenting followed by surgery during the same admission.

When all surgical patients were compared, those who underwent preoperative stenting represented an older population (**Table 2C**). Those in the lowest income quartile were again underrepresented in the preoperative group with stenting compared with those in the operative group without stenting. Surgical patients who underwent preoperative stenting had a lower incidence of cardiac disease, pneumonia, and diabetes when compared with those who received no stent.

Operative Management and Outcomes

As shown in **Table 3**, patients with preoperative colonic stenting were less likely to undergo colostomy formation (19.5% vs 42.5%; $P < .01$). These patients were also more likely to undergo primary partial resection, rather than total colectomy or stoma formation without colectomy (86.8% vs 80.0%; $P = .02$). Use of laparoscopy was significantly higher in the stent group (32.6% vs 9.7%; $P < .01$); and, in the patients who underwent laparoscopy, the rate of conversion to an open procedure was significantly lower (13.9% vs 33.9%; $P < .01$). There was no significant difference in the rate of total colectomy or of ileostomy creation. Placement of a preoperative colonic stent was associated with a delayed median operative day (day 6 vs day 1, $P < .01$).

Patients who had preoperative placement of a colonic stent had a significantly lower rate of total postoperative complications (10.5% vs 21.7%; $P < .01$) (**Table 4**). This finding remained true when comorbidities were taken into account on multivariate regression analysis (**Table 5**). Preoperative colonic stenting was associated with a lower requirement for blood transfusion (8.9% vs 25.0%; $P < .01$). There was no difference in mortality, iatrogenic injury, or requirement for total parenteral nutrition. Perforation or peritonitis was associated with stent placement

Table 3.
Operative Management for the Stent Versus No Stent Groups

	Stent and Surgery[a] (n = 190)	No Stent and Surgery (n = 6935)	*P*
Colostomy formation	19.5	42.5	<.01
APR	9.5	4.0	<.01
Ileostomy formation	7.9	8.1	.91
Laparoscopic approach	32.6	9.7	<.01
Conversion to open procedure[b]	13.9	33.9	<.01
Partial resection[c]	86.8	80.0	.02
Total colectomy	5.8	3.9	.18

Data are the percentage of patients in the total study group. LAR = lower abdominal resection; APR = abdominal perineal resection.
[a]Includes patients with stents who eventually underwent resection or colostomy.
[b]Only patients with initially attempted laparoscopy.
[c]Left colectomy, sigmoidectomy, LAR, or APR.

Table 4.
Morbidity and Mortality for Stent and Surgery versus Surgery Without Stent

	Stent and Surgery[a] (n = 190)	No Stent and Surgery (n = 6935)	*P*
Total postoperative complications[b]	10.5	21.7	<.01
Mortality	4.7	4.2	.69
Anastomosis complications[c]	9.9	13.7	.18
Total parenteral nutrition	14.7	19.0	.14
Blood transfusion	8.9	25.0	<.01
Iatrogenic injury	4.7	3.3	.27

Data are the percentage of patients in the total study group.
[a]Includes patients with stents who eventually underwent resection or colostomy.
[b]Includes shock, hemorrhage, wound infection, hematoma, seroma, internal infections (e.g., abscess), and respiratory, cardiac, renal problems (**Table 1**).
[c]Includes patients who underwent resection, excluding APR. This ICD-9 code is nonspecific (**Table 1**) and was not included in the total postoperative complications.

in 2.6% of cases and may reflect stent-related complications (**Table 4**).

The median total hospital charge for patients who underwent preoperative stenting was higher ($108 530 vs $72 423; $P < .01$), and the median hospital length of stay was longer (12 days vs 10 days; $P < .01$). The median postoperative length of stay, however, was shorter in the stent group (6 days vs 8 days, $P = .02$). In addition, when all patients with stents were considered, including those who did not undergo an operation, their median total hospital charge and median hospital length of stay were both lower (**Table 6**).

Some patients received a stent but did not undergo surgery. There is no information available through the NIS database after hospital discharge, and we therefore could not analyze rates of neoadjuvant therapy, delayed resection, morbidity and mortality after discharge, and long-term oncologic outcomes.

DISCUSSION

Colonic stenting is a generally accepted method for palliation of obstructing colon cancer, although its use as a preoperative bridge to surgery is controversial, and data in

Table 5.
Multivariate Analysis: Association of Stenting, Age, and Comorbidities With Postoperative Complications

	OR for Postoperative Complications	95 CI
Stent	0.44	0.27–0.70
Age (over 65)	1.45	1.28–1.64
Cardiac disease	1.37	1.18–1.60
Pneumonia	2.72	2.26–3.29
Diabetes Mellitus	1.45	1.28–1.64

Variables compared to stenting were significant on univariate analysis (**Table 2C**). OR = odds ratio; CI = confidence interval.

the literature have been conflicting. In this study, we used a national database to define nationwide trends in management of malignant sigmoid, rectosigmoid, or rectal obstruction and analyzed the short-term outcomes.

The results demonstrated no difference in mortality in patients who received a stent, which is consistent with the findings in 3 meta-analyses.[7,9,18] Our data do suggest, however, a clinical advantage to preoperative placement of a stent. There was a decrease in postoperative complications in those patients who had preoperative stenting. In addition, the postoperative length of stay was shorter for them, perhaps because of the conversion of an emergent procedure into an elective one. This period of decompression is represented in our data by the significant difference in the median operative day; patients with stents were in the hospital 6 days before resection or stoma, whereas patients without stents underwent surgery on hospital day 1.

The comorbidities of patients with stents differed from those in the patients without stents. Those with stents had a lower rate of diabetes mellitus, pneumonia, and cardiac disease. Patients with these comorbidities, as well as elderly patients, were more likely to have postoperative complications. Preoperative stenting, however, still had a lower risk of postoperative complication when these factors were taken into account in multivariate logistic regression (**Table 5**).

There are theoretical benefits to having several days of bowel decompression before resection, and these benefits are reflected in our data. First, the patient can be optimized for surgery. It is likely that patients without stents who undergo emergent surgery are experiencing systemic disturbances that may later manifest as postoperative complications. In addition, the decision to create a stoma rather than restore continuity is also related to the patient's overall stability, and, in our study, the colostomy formation rate was significantly higher in patients without preoperative stenting.

Second, the bowel itself can be optimized for surgery. The lower rate of colostomy formation in patients undergoing preoperative stenting is most likely related to the physical state of the bowel. Many surgeons perform a mechanical or antibiotic bowel preparation before surgery, and this process is facilitated by stenting. Preoperative decompression will result in a bowel that is less inflamed and of more normal caliber. A grossly dilated colon proximally and the presence of fecal bulk can preclude anastomosis or require more extensive resection.[19] In this study, we were unable to determine whether preoperative stenting protects the anastomosis; rates of anastomotic leak could not be accurately determined, as the code for this diagnosis is nonspecific (**Table 4**).

Third, decompressing the large bowel before surgery has the potential benefit of facilitating the use of minimally invasive modalities. The data demonstrated a significantly greater use of laparoscopy in patients with stents. Although this increase may be due in part to physician preference at institutions where colonic stenting is available, the higher conversion rate for patients without stents suggests that preoperative stenting enables a minimally invasive approach.

Finally, we expect that the patient whose bowel is decompressed and optimized before surgery would have a shorter recovery. The postoperative hospital length of stay was indeed shorter for patients with stents. The hospital charge associated with stenting was lower when considering all patients with stents, although the cost includes many patients who may return at a later date for resection. Similarly, the cost associated with colostomy takedown during a subsequent admission is not included for any patients undergoing colostomy formation, and the cost is higher in the nonstented group. Nonetheless, patients who undergo preoperative stenting as a bridge to surgery have a longer stay on average and higher associated hospital charges.

The patient group that received a colonic stent differed from the nonstented group (**Table 2C**). Notably, patients in the lowest income bracket were underrepresented in the stented group. The difference may be related to the availability of colonic stenting at centers that provide care to low-income patients. Of interest, patients in the lowest income bracket who received a stent were more likely to be discharged without sur-

Table 6.
Cost Variables for Stent Versus Surgery Without Stent

	Stent[a]	No Stent	P^b	Stent and Surgery[c]	P^d
Total hospital charges	$48 216	$72 423	<.001	$108 530	<.01
Length of stay (days)	7	10	<.001	12	<.01
Postoperative length of stay (days)	—	8	—	6	.02

[a]Includes all patients with stents.
[b]Stent vs no stent.
[c]Includes patients with stents who eventually underwent resection or colostomy.
[d]Stent with surgery vs no stent.

gery; however, it is unknown how many of these patients returned for surgery after the initial discharge (**Table 2B**). Elderly patients who received a stent were more likely to have surgery during the same admission than to be discharged without surgery (**Table 2B**). A possible explanation for this difference is the decreased likelihood that an elderly patient would undergo neoadjuvant therapy with a stent in place. It is also possible, however, that the clinical success rate of stenting is lower in elderly patients; thus, surgery is necessary during the same admission. Further study is needed to explain these differences.

Limitations

Our study is limited by its retrospective design. Patients were not randomly assigned, and selection bias may have confounded our data. We addressed this possibility by comparing the demographic and comorbidity variables of our 2 groups. There may, however, be important covariates not considered, and more important, there may be inaccurate or incomplete coding of some of these variables in the NIS database.

We analyzed operative outcomes, including the likelihood of stoma creation, but we were unable to access records and operative notes to determine the actual decision-making that accounted for the operative variations between our groups. Notably, we were unable to determine the exact location of the malignant obstruction. These data would be helpful in reconciling the higher rate of abdominal perineal resection in patients who underwent preoperative stenting. The higher rate of stoma creation may be due to the emergent nature of the operation, which is mitigated by stent placement, but there could be other operative or patient variables that warranted stoma creation, independent of the factors related to emergent surgery. In addition, we were unable to ascertain the rate of stoma reversal in this sample of patients.

In this study, we were not able to directly measure the rate of perforation from stent placement. We indirectly assessed this complication by measuring the percentage of patients with stents who also had a diagnosis of peritonitis or bowel perforation during the same hospital stay. It is safe to assume that these conditions were not present before stent placement or on admission. Our estimated rate of 2.6%, however, is lower than the rate of 5.9% that is reported by Sagar[18] in a Cochrane Database meta-analysis of 5 randomized controlled trials. Despite this limitation, the negative sequelae of a clinically significant perforation would be reflected in the rate of postoperative complications, which still favors patients with stents.

The NIS database collects only information during a patient's hospital stay; any events after discharge are lost. The lack of follow-up history limits our data in several ways. First, our patients who received a preoperative stent had a shorter postoperative length of stay. Complications that occurred after discharge were missed, and this falsely depressed the rate of postoperative complication in patients with stents. The observed lower complication rate in patients with stents may nevertheless be real, as it most likely accounts for the shorter postoperative length of stay. We also cannot draw conclusions regarding the proportion of stomas that were permanent, nor can we determine the clinical success rate of stents for palliation or as a bridge to surgery. Finally, concern has been raised in the literature that patients who undergo preoperative placement of a colonic stent for obstructing cancer may have a higher cancer-related mortality.[20] We were not able to address the oncologic outcomes related to stent placement. The blood transfusion requirement was lower in the stented group—a notable finding, in that blood transfusion has been associated with poorer oncologic outcome in patients who undergo colectomy.[21]

CONCLUSIONS

Preoperative placement of a colonic stent is associated with lower postoperative complications, a lower rate of colostomy formation, and increased successful use of laparoscopy. As more data emerge regarding the long-term outcomes of patients who undergo stenting, the NIS database can be used to follow national trends in management of patients with malignant obstruction.

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