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Surgical Intervention for Right-Side Diverticulitis: A Case-Matched Comparison with Left-Side Diverticulitis

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Right-side diverticulitis (RSD) is an uncommon disease in Western countries. We conducted a case-matched comparison of surgically managed right-side and left-side diverticulitis (LSD) from the Southern California Kaiser Permanente database (2007–2014). Of 995 patients undergoing emergent surgery for diverticulitis, 33 RSD (3.3%) met our inclusion criteria and were matched (1:1) to LSD based on age, gender, year of diagnosis, and Hinchey class. Mean age of the RSD group was 56 ± 13.9 years, and 24.2 per cent were Asian. RSD was classified as Hinchey class III or IV in 28.1 per cent and 9.4 per cent of cases, respectively. Right hemicolectomy was performed in 87.9 per cent and laparoscopy was used in 24.2 per cent of the cases. Surgically managed RSD patients were more likely to be Asian (25% *vs* 3.1%, $P = 0.03$) and have body mass index < 25 (31.3% *vs* 6.3%, $P = 0.02$) compared with LSD patients. Diverting stoma was less common in the RSD (6.3% *vs* 62.5%) ($P < 0.001$). Hospital stay was shorter in RSD (7.6 ± 4.2 *vs* 12.8 ± 9.4 days, $P = 0.006$) and more common in the RSD group ($P < 0.01$). Open surgery (90.6% *vs* 71.9%) and postoperative complications (37.5% *vs* 25%) were more common in the LSD group, but that was not statistically significant ($P > 0.05$). Surgery for complicated RSD was associated with shorter hospital stay and decreased likelihood of diverting ostomy.

COLONIC DIVERTICULAR DISEASE is one of the most common medical problems in Western populations.[1] The disease can affect any part of the colon, but it most commonly affects the left side, with only 10 per cent involving the right side.[1] By contrast, right-sided disease is more common in Asian countries and represent 80 per cent of the cases.[2] Right-side diverticulitis (RSD) is even less common, representing 1 to 2 per cent of patients presenting with diverticulitis in Western countries and very few of those patients fail medical treatment to undergo surgical management.[1, 2] As such, our understanding of this disease entity and its surgical management in the West is limited by the small number of cases that is mostly presented as small, single-center, case series[3, 4] and very few comparative studies.[5] Recently two large, U.S. population–based studies used the National Inpatient Sample database to report the outcomes of surgical approach (laparoscopic *vs* open)[6] and risk factors associated with surgical management of RSD.[7] The large sample size of these studies is helpful to provide meaningful information about the management of RSD; however, the quality of the data is limited with the lack of significant information that could affect the surgical outcomes.

Despite the higher incidence of RSD in Asian countries, there is still lack of consensus about its proper management, with both operative and nonoperative managements reported.[1, 2] Furthermore, studies comparing the outcomes of RSD and left-side diverticulitis (LSD) are inconsistent,[5–7] with a few reports suggesting less complications after the surgical management of RSD than LSD.[5]

As there is limited information about the management of RSD in general, and of those undergoing colectomy for RSD in particular, the aim of this study is to present the characteristics and outcomes of patients undergoing surgical management of pathologically confirmed RSD and to compare the outcomes with those undergoing surgical management for LSD from a large multicenter database.

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Methods

We retrospectively surveyed the Kaiser Permanente Southern California database (2007–2014) for patients admitted emergently who underwent surgical intervention for diverticulitis within the same admission. Those undergoing right hemicolectomy, cecectomy, or ileocecectomy were reviewed and included in the study if the pathology confirmed RSD. ICD Ninth revision codes were used to identify patients. Those with other diagnoses discovered intraoperatively or postoperatively (on pathology), missing key information to confirm RSD, or who had right hemicolectomy for cecal perforation secondary to obstructing sigmoid diverticular stricture were excluded. Those included in the study were matched (1:1) to patients undergoing emergent surgery for LSD using propensity score analysis. It was decided *a priori* that the matching criteria would be limited to age, gender, year of diagnosis, and Hinchey class. The demographics, admission diagnosis, intraoperative details, and postoperative outcomes of patients with RSD were presented and subsequently compared with the case-matched cohort of patients with LSD. Outcomes of interest were total hospital length of stay (LOS), preoperative and postoperative LOS, 30-day morbidity and mortality, hospital readmission, and ostomy creation. Specific and overall complication rates were reported. Comparisons were performed using chi-squared test for categorical variables and Student' *t* test for continuous variables.

Results

Using the initial selection criteria, we identified 125 patients undergoing cecectomy or right hemicolectomy for diverticulitis; however, after chart review only 33 cases were eligible for inclusion in the study. Those with other diagnoses discovered intraoperatively (N = 58) or postoperatively (on pathology, N = 6), missing key information to confirm RSD (N = 16), or who had right hemicolectomy for cecal perforation secondary to obstructing sigmoid diverticular stricture (N = 12) were excluded (Fig. 1). Mean age was 56 ± 13.9 years and mean Body mass index (BMI) was 27 ± 6.8. Approximately 24 per cent of the cohort were Asian. Acute appendicitis was the most common preoperative diagnosis (33.4%), whereas 21.2 per cent had an accurate preoperative diagnosis and 18.2 per cent had suspicion for diverticulitis preoperatively. Hinchey classes III and IV were present in 28.1 per cent and 9.4 per cent, respectively. Right hemicolectomy was performed in 87.9 per cent and laparoscopy was used in 24.2 per cent of the cases. Two patients (6.3%) underwent diverting stoma. There were no mortalities and 30.3 per cent had postoperative complications

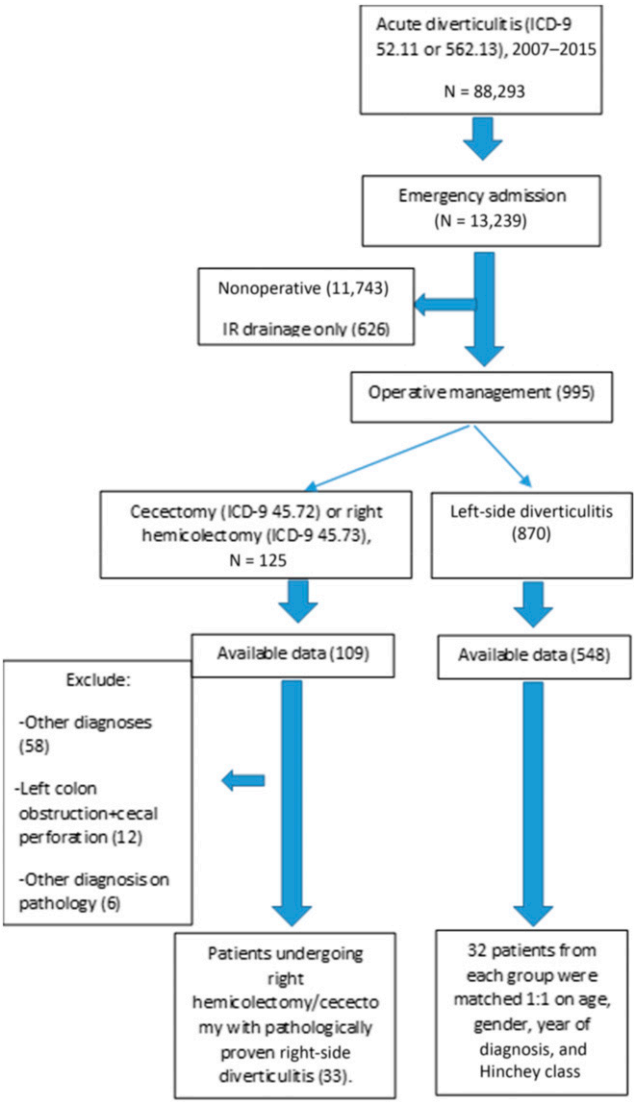

FIG. 1. Cohort selection.

(Table 1). In a case-matched cohort, surgically managed RSD patients were more likely to be Asian (25% *vs* 3.1%, $P = 0.03$) and have BMI < 25 (31.3% *vs* 6.3%, $P = 0.02$) compared with LSD patients. Diverting stoma (6.3% *vs* 62.5%), accurate preoperative diagnosis (28.1% *vs* 90.6%), and longer hospital stay (7.6 ± 4.2 *vs* 12.8 ± 9.4 days) were more common in the LSD group ($P < 0.01$). Open surgery (90.6% *vs* 71.9%), postoperative complications (37.5% *vs* 25%), and mortality (3.1% *vs* 0%) were also more common in the LSD group but that was not statistically significant ($P > 0.05$) (Table 2).

Discussion

Right-side diverticulitis is present in 1 to 2 per cent of patients with diverticulitis in Western populations.[1, 2]

TABLE 1. *Baseline Characteristics*

	Number = 33	(%)
Age (years), mean ± SD	56 ± 13.9	
Gender (Male)	13	39.4
Ethnicity		
White	17	51.6
Asian	8	24.2
Hispanic	8	24.2
American Society of Anesthesiologists class ≥ 3	5	18.5
BMI, mean ± SD	27 ± 6.8	
Preoperative diagnosis		
Diverticulitis	7	21.2
Possible diverticulitis	6	18.2
Appendicitis	11	33.4
Colonic mass	4	12.1
Other	5	15.1
Hinchey class		
1 or 2	20	62.5
3	9	28.1
4	3	9.4
Operation performed		
Right colectomy/ileocecectomy	29	87.9
Partial cecectomy	4	12.1
Stoma creation	2	6.3
Procedure type		
Open	23	69.7
Laparoscopic	8	24.2
Lap converted to open	2	6.1
LOS (days), mean ± SD	7.5 ± 4.1	
Complications within 30 days (yes)	10	30.3
Type of complications		
Clostridium difficile colitis	1	3.0
Abdominal abscess s/p interventional radiology drainage	1	3.0
Anastomotic leak with return to operating room	1	3.0
Superficial wound infection	3	9.1
Wound dehiscence	1	3.0
Ileus	2	6.1
Hematochezia	1	3.0
Readmission	3	9.1
Mortality	0	0.0

Our understanding of this disease and its surgical management is limited by the small number of cases reported in the Western literature.[1, 3, 4] The diagnosis of RSD is challenging and is often missed preoperatively.[1–4] Preoperative diagnostic accuracy in our study was 39.4 per cent, which is better than that reported in other studies; however, it is still low overall.[3, 4] Harada and Whelan, reported a preoperative diagnosis of diverticulitis in 12 (13%) of 90 patients in their series from Hawaii.[3] In addition, Lane et al. reported a large series from mainland United States, with only three (6%) patients reported to have accurate preoperative diagnosis.[4] In more recent series, with more common CT scan utilization, preoperative diagnostic accuracy ranged from 30 to 75 per cent.[5] Despite the utilization of CT scan in 90 per cent of cases in our series, the diagnosis was missed in more than half of the cases suggesting that surgeons should consider this diagnosis in patients with right lower quadrant abdominal pain and be prepared to perform more extended surgery under these circumstances. It is also important to note that low diagnostic accuracy in combination with the lack of specific ICD code for RSD could result in case misclassification in retrospective studies. In our study, ICD-9 codes were used to identify patients undergoing right hemicolectomy or cecectomy for acute diverticulitis. This method had been used before to identify patients undergoing surgery for RSD in retrospective population studies using the National Inpatient Sample database.[6, 7] After careful review of the charts, 74 per cent of the cases in our study were excluded because of wrong diagnosis (50%), sigmoid diverticulitis (18%), or lack of diverticulitis on pathology (6%). This finding highlights the need for proper case identification, beyond ICD coding, when contemplating retrospective studies. It is concerning that, even the newer ICD-10 code system does not distinguish between left- and right-sided diverticulitis, despite different outcomes. Given these problems with coding and our finding that 74 per cent of cases need to be excluded based on coding alone,

TABLE 2. *Comparison of Patients with Colectomy for RSD to LSD*

	Left Side (N = 32)	(%)	Right Side (N = 32)	(%)	*P*
Age (years)					
<40	4	12.5	3	9.4	0.699
40–49	6	18.8	5	15.6	
50–59	5	15.6	10	31.3	
60–69	10	31.3	8	25	
70+	7	21.9	6	18.8	
Gender (male)	10	31.3	13	40.6	0.434
Hinchey class					
1	18	56.2	20	62.5	0.884
2	1	3.1	0	0	
3	10	31.3	9	28.1	
4	3	9.4	3	9.4	
Ethnicity					
White	18	56.3	16	50	0.032
Asian	1	3.1	8	25	
Hispanic	10	31.3	8	25	
Other	3	9.4	0	0	
BMI					
<25	2	6.3	10	31.3	0.026
25–29	13	40.6	15	46.9	
30–39	6	18.8	4	12.5	
40+	4	12.5	2	6.3	
American Society of Anesthesiologists class					
1	15	46.9	6	23.1	0.252
2	12	37.5	15	57.7	
3	3	9.4	4	15.4	
4	2	6.3	1	3.8	
Preoperative diagnosis					<0.001
Diverticulitis	29	90.6	13	39.4	
Appendicitis	2	6.3	11	33.4	
Colonic mass	0	0	4	12.1	
Other	1	3.1	4	12.1	
White blood cells at presentation, mean ± SD	14.81 ± 6.4		13.33 ± 4.01		0.295
Diverting stoma (yes)	20	62.5	2	6.3	<0.001
Procedure type					0.117
Open	29	90.6	23	71.9	
Laparoscopic	3	9.4	7	21.9	
Lap converted to open	0	0	2	6.2	
Hospital LOS (days), mean ± SD	12.8 ± 9.4		7.6 ± 4.2		0.006
Postoperative hospital stay (days), mean ± SD	10.6 ± 9.3		6.5 ± 3.4		0.021
Preoperative hospital stay (days), mean ± SD	2.7 ± 3.1		1.1 ± 1.8		0.019
Postoperative complications (yes)	12	37.5	8	25	0.275
Mortality	1	3.1	0	0	0.313
Type of postoperative complications					
Superficial wound infection	3	9.4	2	6.3	0.641
Organ/space infection	4	12.5	1	3.1	0.162
Septic shock	4	12.5	1	3.1	0.162
Reoperation	3	9.4	1	3.1	0.302
Wound dehiscence	2	6.3	1	3.1	0.554
Ileus	3	9.4	2	6.2	0.641
Other	7	21.9	3	9.4	0.168

studying RSD really requires chart review and limits the utility of large database studies in which chart review is not performed.

Only three patients with RSD had Hinchey class IV and two of them had diverting ostomy at the index procedure because of hemodynamic instability. These findings suggest that the resection and primary anastomosis for patients with RSD is safe and could potentially avoid the morbidity of stoma creation when the patient is hemodynamically stable. In a case-matched cohort, with a comparable rate of disease severity between RSD and LSD, those undergoing surgery for LSD were 10 times more likely to have a stoma created. The rate of stoma creation for LSD and RSD in our study was 62.5 per cent and 6.3 per cent, respectively, which is comparable with that reported in the literature.[8] It is not clear whether this is considered an overuse of diverting stoma in the management of Hinchey I to III LSD or whether there were other factors that led the surgeons to perform diverting ostomies that could not be ascertained

because of the retrospective nature of the study. Hartman's procedure is the standard of care for patients with Hinchey class IV or hemodynamic instability; however, in patients with Hinchey classes I to III, resection and primary anastomosis or laparoscopic lavage and drainage are viable, yet controversial alternatives.[8] Overall, patients undergoing colectomy for RSD should expect a low chance of having a diverting ileostomy.

Overall, hospital stay was longer in patients with LSD compared with RSD even after matching for Hinchey class, which is the most significant predictor of hospital LOS for patients with RSD in our study. Many factors could be associated with this finding. First, shorter recovery from right-side colectomy than left-side colectomy is not unexpected and has been previously reported in the literature for diverticulitis[6] and colon cancer.[9] Second, patients in this study, as well as other studies, experienced higher rates of complications after surgery for LSD than RSD[2, 5]; which can contribute to longer postoperative stay. Finally, the preoperative stay was longer in the LSD group compared with the RSD group. This can be partially explained by the high rate of wrong preoperative diagnosis of appendicitis, which is most commonly managed by surgical intervention without delay. In comparison, LSD is often managed by nonoperative approach first, unless otherwise indicated.

The higher rate of using laparoscopy in the management of RSD might be related to the higher rate of preoperative diagnosis of appendicitis that is often managed laparoscopically. It is possible that when surgeons identify the correct intraoperative diagnosis, some might feel comfortable completing the procedure laparoscopically. Furthermore, prior population studies suggest that higher proportion of right colectomies are performed laparoscopically in comparison with left colectomies,[10] probably because the former is less challenging and more surgeons feel comfortable performing laparoscopic right colectomies. Our findings also suggest the safety of the laparoscopic approach for managing RSD; however, we did not find any benefit in terms of postoperative morbidity or length of hospital stay. The latter might be attributed to the small sample size, which precludes identifying significantly different outcomes. Before population-based studies found better outcomes with laparoscopy for RSD than open procedures.[7] On the other hand, recent, small, single-center comparative study did not demonstrate a difference in morbidity or length of hospital stay between both approaches.[11]

There are many limitations associated with this study. Selection bias is inherent to the retrospective design of the study. Although we did perform propensity score matching, there are certain factors that may not be accounted for and could affect postoperative outcomes. Although the small sample size may preclude making definitive conclusions for certain outcomes, our study is still one of the largest in the literature from Western populations. It is also important to remember that this study does not include patients with RSD who were treated conservatively, thus, we could not report the outcomes of conservative management of RSD. In conclusion, we found that RSD is often misdiagnosed preoperatively and proper ICD coding is lacking, thus, specific ICD codes for RSD are needed and retrospective studies should rely on pathological diagnosis for case definition. In addition, when patients with RSD need surgery, laparoscopic and open approaches have equal outcomes. Finally, patients with RSD have shorter hospital stay and lower rates of stoma creation in comparison with those undergoing surgery for LSD.

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