

An Exploratory Analysis of the Epidemiology and Surgical Management of Perforated Diverticular Disease over a Two-Year Period at a Referral Centre in the Caribbean

PS Griffith¹, CL Powlett¹, AD Griffith², Markogiannakis H³, P Priego⁴, R Jonnalagadda¹, ER Walrond¹

ABSTRACT

Objective: We present an exploratory analysis of data collected on perforated diverticular disease (PDD) in Barbados and suggest possible areas for further study.

Subjects and Methods: All cases of perforated diverticular disease treated at the Queen Elizabeth Hospital (QEH) Barbados, between January 1, 2005 and December 31, 2006 were reviewed. The patient's age, gender, location of disease, Hinchey stage, operative procedure, rate of colostomy reversal, length of hospitalization, incidence of peri-operative morbidity and postoperative mortality were analysed using principal components analysis (PCA).

Results: Fourteen cases of PDD were treated at the QEH during this period. Six (43%) of the patients had perforated right-sided diverticulitis (PRSD).

In the PCA, Dimensions 1 and 2 were the two dimensions examined, as they both had Eigenvalues over 1. Dimension 1 can be taken as an indicator of the intensity of the disease. On dimension 2, length of hospitalization had the highest component loading (0.875). The mean hospital stay was 10.6 days in PRSD, 9.5 in left-sided perforations with primary anastomosis, and 16.2 days for those with a Hartmann's procedure. The overall peri-operative morbidity was 28% and there was no mortality in the series.

Conclusion: This preliminary study seems to show a relatively high incidence of PRSD in a predominantly Afro-Caribbean population. More research is needed to determine the exact aetiology of this disease. In our experience, primary anastomosis in carefully selected patients with either PRSD or perforated left-sided diverticulitis (PLSD) may result in shorter hospitalization.

Análisis Exploratorio de la Epidemiología y el Tratamiento Quirúrgico de la Enfermedad Diverticular Perforada Durante un Período de dos Años en un Centro de Remisión en el Caribe

PS Griffith¹, CL Powlett¹, AD Griffith², Markogiannakis H³, P Priego⁴, R Jonnalagadda¹, ER Walrond¹

RESUMEN

Objetivo: Presentamos un análisis exploratorio de la enfermedad diverticular perforada (EDP) en Barbados, y sugerimos posibles áreas de análisis ulterior.

Sujetos y Métodos: Se revisaron todos los casos de enfermedad diverticular perforada tratados en el Hospital Queen Elizabeth (QEH) de Barbados, entre enero 1 de 2005 y diciembre 31 de 2006. Mediante el análisis de componentes principales (ACP), se analizaron los siguientes: edad del paciente, género, localización de la enfermedad, estadio de Hinchey, procedimiento operatorio, tasa de colostomía inversa, tiempo de hospitalización, incidencia de morbilidad perioperatoria, y mortalidad postoperatoria.

From: ¹Department of Surgery, Queen Elizabeth Hospital, Bridgetown, ²Department of Sociology, the University of the West Indies, Cave Hill Campus, Barbados, ³Department of Endocrine Surgery, Hammersmith Hospital, Imperial College Healthcare NHS Trust, London, United Kingdom, and ⁴Department of Surgery, Hospital Ramón y Cajal (Madrid), Crta, Colmenar Viejo, Km 9,100, Madrid 28034, Spain.

Correspondence: Dr PS Griffith, Queen Elizabeth Hospital, Martindales Road, St Michael, Barbados. Fax: 1-246-436-6450, e-mail: atunakken@yahoo.com.

Resultados: Catorce casos de EDP fueron tratados en el HQE durante este periodo. Seis (43%) de los pacientes presentaban diverticulitis del lado derecho perforada (DLDP).

En el ACP, las dimensiones 1 y 2 fueron las dos dimensiones examinadas, ya que ambas tenían valores propios por encima de 1. La dimensión 1 puede tomarse como indicador de la intensidad de la enfermedad. En la dimensión 2, el tiempo de hospitalización tuvo la carga de componente más alta (0.875). La estadía promedio en el hospital fue de 10.6 días en los casos de DLDP, 9.5 en las perforaciones del lado izquierdo con anastomosis primaria, y 16.2 días para aquellos con procedimiento de Hartmann. La morbilidad perioperatoria fue 28% y no hubo mortalidad en la serie.

Conclusión: Este estudio preliminar parece mostrar una incidencia relativamente alta de DLDP en una población predominantemente afro-caribeña. Se necesita más investigación a fin de determinar la etiología exacta de esta enfermedad. En nuestra experiencia, la anastomosis primaria en pacientes cuidadosamente seleccionados, que sufren de DLDP o padecen diverticulitis del lado izquierdo perforada (DLIP), puede tener por resultado una hospitalización más corta.

West Indian Med J 2009; 58 (6): 562

INTRODUCTION

The advent of the Industrial Revolution brought with it the mechanization of food processing and preparation. From that point onwards, inhabitants of the “Western World” have had increased daily exposure to low fibre foods in their diets (1). This has led to a sustained increase in the incidence of diverticular disease in these countries (2, 3). As many of the Caribbean countries continue on a path of increasing affluence, a greater number of their inhabitants are consuming a Western-styled diet. It can therefore be expected that the changes in the incidence of diverticulosis seen in “developed” countries could be mirrored in this region. It is well recognized that the pattern of diverticular disease in the West is predominantly left-sided (4). However, 62% of the cases of diverticulosis among Africans was found to be right-sided (5), and among the Japanese populations, right-sided diverticular disease (RSD) was found in 70% of cases (6). The Caribbean represents an interesting and under-investigated locale, as the region has a genetic mix of African, Asian and European people. As such, we decided to review perforated diverticular disease (PDD) in a Caribbean context. We present here an exploratory analysis on data collected for PDD in Barbados and suggest possible areas for further study.

SUBJECTS AND METHODS

Using the coding system in place at the QEH, the notes of all patients who had emergency surgery for PDD between January 1, 2005 and December 31, 2006 were reviewed. The details concerning the patient age, gender, location of disease, [lesion to the right of the splenic flexure were labelled as right-sided disease, whilst those to the left of the splenic flexure were noted as left-sided disease] (7) Intra-operative findings [Hinchey stage] (8), operative procedure, rate of colostomy reversal, length of hospitalization, incidence of peri-operative morbidity (defined as complications that would lead to prolonged hospitalization or additional pro-cedures) and postoperative mortality (defined as in-hospital death) were analysed.

The multivariate analysis technique of Principal Components Analysis (PCA) was performed on the data utilizing

the variable principal as the normalization method. This was chosen since it optimized the association between variables. The PCA analysis allows standardization of variables that are at different levels of measurement by forming indicators of significance, called dimensions. These dimensions are deemed to be of statistical interest if the eigenvalue is greater than one. Even though this was an exploratory study with a small data set, the PCA allowed us to construct indicators for the treatment of per-forated diverticular disease at the QEH and to explain the interaction of the variables in the management of PDD even though they were at different levels of measurement.

RESULTS

Over the two-year period of observation, 14 cases of PDD were treated at the QEH. Roughly 43% of the patients were found to have had PRSD. In the PCA, dimensions 1 and 2 were the only two dimensions examined in the model; as the eigenvalues were greater than 1 and these dimensions accounted for a cumulative 71.1% of the variance in the model (Table 1).

Table 1: Model summary

Dimension	Cronbach's Alpha	Variance Total (Eigenvalue)	Accounted For % of Variance
1	0.7961435	2.9710922	49.5182036
2	0.2746374	1.2967593	21.6126542
3	-0.2810644	0.8105273	13.5087875
4	-0.3755967	0.7616124	12.6935396
Total	0.9945202	5.8399911	97.3331849

Total Cronbach's Alpha is based on the total Eigenvalue

In dimension 1, the variables of location of disease, Hinchey stage and surgical procedure performed were high but dissimilar (0.941, 0.864, and -0.972 respectively) (Table 2). From this, dimension 1 can be taken as an indicator of the

Table 2: Component Loadings

	Dimension			
	1	2	3	4
Sex	-0.451	0.404	0.603	-0.520
Age at time of surgery	-0.415	-0.473	0.585	0.511
Location of disease	0.941	-0.092	0.184	-0.100
Hinchev Score	-0.864	-0.351	-0.178	-0.155
Surgical procedure performed	-0.972	0.116	-0.196	0.001
Length of stay in hospital (days)	-0.135	0.875	0.012	0.443

intensity of the disease, with RSD patients tending to have less severe Hinchev stage disease than their left-sided counterparts and these factors were both found to have had impact on the surgical procedure performed. While all of the patients with PRSD had right hemicolectomy with a primary anastomosis, in the PLSD group, 62.5% had Hartmann's procedure and 25% had left hemicolectomy and primary anastomosis without a covering ileostomy or colostomy. The choice of surgical intervention was based on the preference of the operating surgeon, the preoperative American Society of Anaesthesiology (ASA) score (9), the level of haemodynamic stability and the extent of intra-peritoneal sepsis. When primary anastomosis was performed, the solid faeces was "milked" away from the anastomotic site, with no attempt to perform on-table lavage prior to anastomosis. One patient with Hinchev stage 1 disease had drainage of the abscess and placement of a sump drain as an emergency procedure. Elective left hemicolectomy was performed seven months later. The Hartmann's reversal rate was 20% in the series.

On dimension 2, length of stay in hospital had the highest component loading (0.875) suggesting that in this model, length of hospitalization is an important factor in the management of PDD. In this series, the mean hospital stay for right-sided perforations was 10.6 days. In the patients with left-sided perforations, those who had primary anastomosis had a mean hospitalization of 9.5 days while the Hartmann's group stayed in hospital an average of 16.2 days.

Given the possible multicollinearity between the surgical procedure performed and the location of the disease, the variable surgical procedure was removed from the equation. The new PCA performed still saw dimensions 1 and 2 accounting for a cumulative 72.7% of the variation in the data (Table 3). The table of component loadings for the

Table 3: Model summary

Dimension	Cronbach's Alpha	Variance accounted for total (Eigenvalue)	% of Variance
1	0.734	2.422	48.449
2	0.221	1.216	24.311
3	-0.314	0.799	15.981
4	-1.197	0.511	10.212
Total	0.997	4.948	98.952

Total Cronbach's Alpha is based on the total Eigenvalue

new equation was constructed (Table 4). In dimension 1, the high component loadings were from Hinchev stage (0.953)

Table 4: Component loadings

	Dimension			
	1	2	3	4
Sex	0.536	-0.479	-0.599	0.353
Age at time of surgery	0.581	-0.356	0.655	0.324
Location of disease	0.170	0.896	-0.047	0.407
Hinchev Score	0.953	0.151	0.031	-0.201
Length of stay in hospital (days)	0.927	0.181	-0.087	-0.274

and length of stay in the hospital (0.927). Thus patients with a higher Hinchev stage tended to have a longer hospital stay.

The overall peri-operative morbidity was 28%, with four patients having complications that prolonged their hospitalization. There was one case of a pelvic collection in the group whose left-sided perforations were managed with a Hartmann's procedure, and among those with right-sided disease, there was a case each of pneumonia, superficial wound infection and a burst abdomen. There was no mortality in the series.

DISCUSSION

As the English-speaking Caribbean continues to develop and access to primary healthcare is essentially guaranteed for all, the spotlight has become focussed on lifestyle diseases and their impact on the cost of healthcare provision. Diverticulosis and by extension, complications of diverticular disease are predominantly a post-industrialization, lifestyle phenomenon (1-3). Figures from series in more industrialized countries give incidences of this condition as present in roughly 10% of individuals below the age of 40 years, ballooning to an incidence of 66% in people over 85-years old (10). A large radiological study in Trinidad and Tobago, involving 971 consecutive barium enemas, revealed an incidence of diverticulosis of 24.6%, with 10% of the patients investigated having solely right-sided disease (11).

In European populations, it has been shown that while the incidence of diverticulosis is very high, the incidence of symptomatic patients is a relatively low 10-20% (12). Additionally, only 15% of these patients will develop significant complications (13). These patients, however, impact heavily on the cost of managing the disease (14, 15) with PDD currently rated as one of the five most costly gastrointestinal conditions affecting the United States of America [USA] (14). To this end, if the Caribbean is to deal properly with this entity, a protocol for the optimal surgical management of these patients within the framework of cost effectiveness must be devised.

Another issue facing the Caribbean stems from the fact that while the total population of the English-speaking countries of the region lies at approximately seven million, this population is broken up into individual small states, with varying hospital and specialist facilities. This means that

unless efficient multi-centre trials can be coordinated, researchers in the region are faced with having to analyse small data sets collected at individual institutions in these islands. This makes it difficult to perform accurate multivariate analysis to find statistically significant trends. Thus, most local surgeons use larger European and North American studies to tailor their management protocols. While this may be acceptable with some diseases, diverticulitis has proven to be an exception, as most of the populations studied in the Western world have had predominantly left-sided diverticular disease (LSD), quoting incidences of RSD as low as 2.2% (16).

The series from Trinidad and Tobago recorded a more significant proportion of right-sided disease in the Caribbean population (11). This present series also supports that finding. It is likely that protocols based on a population with predominantly left-sided disease would not accurately address the needs of the Caribbean patient. The use of the PCA for the statistical analysis, with its capacity to construct indicators even with a small data set, has been key in establishing the significance of some of the parameters investigated in this study.

From the PCA, it was shown that patients with PRSD tended to have less severe disease than their left-sided counterparts, a finding also noted by other researchers (7). The analysis suggested that this could be related to the surgical procedure performed, as indicated by the component "surgical procedures" in the dimension. This is an important finding in the Caribbean setting, as a larger proportion of our patients will present with PRSD, and most series have reported excellent results with primary resection and ileo-colic anastomosis (8, 16–18) or more minimal procedures such as diverticulectomy, invagination and over-sewing of the diverticulum (6, 19, 20) in managing this condition. In this series, all of the PRSD patients had right hemicolectomy with primary ileo-colic anastomosis. This procedure, in addition to addressing the septic focus, is quite safe (18, 21–23), had a mean hospital stay of 10.6 days and ultimately ensured that there is no possibility for disease recurrence.

The surgical management of PLSD has been more hotly debated. Initial studies in the pre-antibiotic era advocated the staged approach to the surgical management of PDD (24, 25) resulting in the Hartmann's procedure becoming the intervention of choice for PDD (26–28). This was reflected in the present series with 62.5% of the left-sided perforations receiving a Hartmann's. Admittedly, the patients in our cohort who had Hartmann's procedures were generally of a higher ASA grade than the primary anastomosis group. However, recent series have shown that a single stage procedure is possible in many carefully selected patients, even those with Hinchey stage 3 and 4 disease (29–31). It should be mentioned, though, that the use of a single stage procedure, although becoming more accepted, is still controversial and is associated with significant morbidity and some mortality (29).

In the present study, the choice of a Hartmann's procedure directly impacted on the hospital stay, as patients after a Hartmann's procedure were noted to have a mean stay at 16.2 days, compared to 9.5 in the primary anastomosis group. This trend towards shorter hospitalization with primary anastomosis has been supported by other larger series (33, 34). Further, a study at a large district hospital in the United Kingdom revealed that 70% of the cost of managing diverticular disease at that institution came from hospitalization costs (15). This suggests that if the length of hospitalization is reduced, then the cost of managing diverticular disease could be dramatically lowered. Therefore, a policy of primary anastomosis in all cases of PDD, once the general condition of the patient permits, could go a long way in the reduction of hospital spending on this disease.

The proportion of patients in this series with PRSD also merits closer attention. This entity is rare in Western countries (7) and as such has been less extensively studied than left-sided diverticulitis. It has been shown that increased consumption of red meat and decreased consumption of soluble fibre are associated with a symptomatic course in both right and left-sided diverticular disease (34, 35). However, the underlying aetiology of RSD has not been clearly identified. In earlier studies on non-European patient groups it was originally theorized that the right-sided pattern of disease was possibly due to diets that trend toward the western-styled diet yet still contain a greater amount of dietary fibre than the European diet. As such, RSD was thought to represent the form of diverticulosis seen with a transitional diet (5).

More recent studies have proven that this is not entirely true. In Japan it has been highlighted that aside from the role of the transitional diet, there may be a role played by the morphology of the colon (36). The researchers noted that in Mongoloid populations, the sigmoid colon tended to be long (37) and to have an "O" shape. They subsequently postulated that when this type of individual is exposed to low bulk stools, the areas of highest intra-luminal pressures are possibly sited in the more proximal colon, thus leading to RSD. More recent work by Hildebrand on a purely European population has shown right-sided diverticulosis to be associated with hypoganglionosis or aganglionosis of Auerbach plexus, as well as morphological changes of the plexus consistent with intestinal neuronal dysplasia (16). These findings make the elucidation of the exact aetiology among a predominantly Afro-Caribbean population quite an interesting prospect, as it may allow inferences to be made on the aetiology of RSD among all people with similar genetic make-up who have been exposed to the transitional diet.

Ultimately, this exploratory series has revealed that more research is needed to determine the exact aetiology of RSD in the Caribbean population, as this entity represented a large proportion of the case burden of the QEJH over the study period. Additionally, the role of diet and the possible effects

of a lifestyle modification campaign on the reduction of complications of diverticulosis should be explored. The type of surgical intervention performed impacted heavily on the length of hospitalization, with longer stays required for patients undergoing staged procedures. This suggests that further research into the feasibility of a more widespread policy of primary anastomosis is needed, if PDD is to be managed in an economically feasible manner. The findings of this study, however, are preliminary due to the small number of patients; they should thus be very cautiously interpreted and act as a basis for further study and evaluation.

In summary, this preliminary exploratory study seems to reveal a relatively high incidence of PRSD in a predominantly Afro-Caribbean population. More research is needed to accurately assess the epidemiology and aetiology of the disease in a predominantly Afro-centric population. Even within this small data set, primary anastomosis in a carefully selected cohort of patients with either PRSD or PLSD may result in a shorter hospital stay. The findings warrant further study and evaluation.

REFERENCES

1. Painter NS, Burkitt DP. Diverticular disease of the colon: a deficiency disease of western civilization. *BMJ* 1971; **2**: 450–4.
2. Janes SE, Meagher A, Frizelle FA. Management of diverticulitis. *BMJ* 2006; **332**: 271–5.
3. M. Santaniello and R. Bergamaschi. Perforated diverticulitis: should the method of surgical access to the abdomen determine treatment? *Colorectal Disease* 2007; **9**: 494–5.
4. T G Parks. Post-mortem studies on the colon with special reference to diverticular Disease. *Proc R Soc Med* 1968; **61**: 932–4.
5. Madiba TE, Mokoena T. Pattern of diverticular disease among Africans. *East Afr Med J* 1994; **71**: 644–6.
6. Sugihara K, Muto T, Morioka Y, Asano A, Yamamoto T. Diverticular disease of the colon in Japan: a review of 615 patients. *Dis Colon Rectum*. 1984; **27**: 531–7.
7. Law WL, Lo CY, Chu KW. Emergency surgery for colonic diverticulitis: differences between right-sided and left-sided lesions. *Int J Colorectal Dis* 2001; **16**: 280–4.
8. Hinchey EJ, Schaal PG, Richards GK. Treatment of perforated diverticular disease of the colon. *Adv Surgery* 1978; **12**: 85–109.
9. New Classification of Physical Status. American Society of Anesthesiologists Inc. *Anesthesiology* 1963; **24**: 111.
10. Painter NS, Burkitt DP. Diverticular disease of the colon, a 20th century problem. *Clin Gastroenterol* 1975; **4**: 3–21.
11. Naraynsingh V, Sieunarine K, Rao K, Raju GC. Diverticular disease in the West Indies: a Trinidad study. *J R Coll Surg Edinb* 1987; **32**: 137–8.
12. Stollman N, Raskin JB. Diverticular disease of the colon. *Lancet* 2004; **363**: 631–9.
13. Parks TG. Natural history of diverticular disease of the colon. *Clin Gastroenterology* 1975; **4**: 53–69.
14. American Gastroenterological Association. The burden of gastrointestinal diseases. Bethesda, MD: Am Gastroenterol Assoc 2001.
15. Papagrigoriadis S, Debrah S, Koreli A, Husain A. Impact of diverticular disease on hospital costs and activity. *Colorectal Dis* 2004; **6**: 81–4.
16. P Hildebrand, M Kropp, F Stellmacher UJ, Roblick HP, Bruch O, Schwandner. Surgery for right-sided colonic diverticulitis: results of a 10-year-observation period. *Langenbecks Arch Surg* 2007; **392**: 143–7.
17. Flückiger R, Styger S, Huber A. Diverticulitis of the caecum and ascending colon. *Chirurg* 1998; **69**: 174–9.
18. Violi V, Roncoroni L, Boselli AS, Trivelli M, Peracchia A. Diverticulitis of the caecum and ascending colon: an unavoidable diagnostic pitfall? *Int Surg* 2000; **85**: 39–47.
19. Sardi A, Gokli A, Singer JA. Diverticular disease of the caecum and ascending colon: a review of 881 cases. *Am Surg* 1987; **53**: 41–5.
20. Harada RN, Whelan TJ Jr. Surgical management of cecal diverticulitis. *Am J Surg* 1993; **166**: 666–71.
21. Nirula R, Greaney G. Right-sided diverticulitis: a difficult diagnosis. *Am Surg* 1997; **63**: 871–3.
22. Lane JS, Sarkar R, Schmit PJ, Chandler CF, Thompson JE Jr. Surgical approach to cecal diverticulitis. *J Am Coll Surg* 1999; **188**: 629–34.
23. Moberg AC, Ahlberg G, Leijonmarck CE, Montgomery A, Reiertsen O, Rosseland AR et al. Diagnostic laparoscopy in 1043 patients with suspected acute appendicitis. *Eur J Surg* 1998; **164**: 833–40.
24. Mayo WJ, Wilson LB, Giffin HZ. Acquired diverticulitis of the large intestine. *Surg Gynecol and Obstet* 1907; **5**: 8–15.
25. Judd ES, Pollack LW. Diverticulitis of the colon. *Ann Surg* 1924; **80**: 425–38.
26. Eng K, Ranson JH, Localio SA. Resection of the perforated segment. A significant advance in treatment of diverticulitis with free perforation or abscess. *Am J Surg* 1977; **133**: 67–72.
27. Röhlin M, Rietschi G, Largiadè F. Value of Hartmann's operation as an emergency intervention in sigmoid diverticulitis. *Swiss Surg*. 1997; **3**: 107–11.
28. Krukowski ZH, Matheson NA. Emergency surgery for diverticular disease complicated by generalized and faecal peritonitis: a review. *Br J Surg* 1984; **71**: 921.
29. Richter S, Lindemann W, Kollmar O, Pistorius GA, Maurer CA, Schilling MK. One-stage Sigmoid Colon Resection for Perforated Sigmoid Diverticulitis (Hinchey Stages III and IV). *World J Sur* 2006; **30**: 1027–32.
30. Nespoli A, Ravizzini C, Trivella M, Segala M. The choice of surgical procedure for peritonitis due to colonic perforation. *Arch Surg* 1993; **128**: 814–18.
31. Schilling MK, Maurer CA, Kollmar O, Büchler MW. Primary vs. secondary anastomosis after sigmoid colon resection for perforated diverticulitis (Hinchey Stage III and IV): a prospective outcome and cost analysis. *Dis Colon Rectum* 2001; **44**: 699–705.
32. Schwesinger WH, Page CP, Gaskill III HV, Steward RM, Chopra S, Strodel WE et al. Operative Management of Diverticular Emergencies Strategies and Outcomes. *Arch Surg* 2000; **135**: 558–63.
33. Regenet N, Pessaux P, Hennekinne S, Lermite E, Tuech JJ, Brehant O et al. Primary anastomosis after intraoperative colonic lavage vs. Hartmann's procedure in generalized peritonitis complicating diverticular disease of the colon. *Int J Colorectal Dis* 2003; **18**: 503–7.
34. Morris CR, Harvey IM, Stebbings WSL, Speakman CTM, Kennedy HJ, Hart AR. Epidemiology of perforated colonic diverticular disease. *Postgrad Med J* 2002; **78**: 654–8.
35. Lin OS, Soon MS, Wu SS, Chen YY, Hwang KL, Triadafilopoulos G. Dietary habits and right-sided colonic diverticulosis. *Dis Colon Rectum* 2000; **43**: 1412–8.
36. Nakaji S, Danjo K, Munakata A, Sugawara K, MacAuley D, Kernohan G et al. Comparison of etiology of right-sided diverticula in Japan with that of left-sided diverticula in the West. *Int J Colorectal Dis* 2002. **17**: 365–73.
37. Yamazaki S, Yamazaki K, Miyazaki T. An analysis on the length of the large intestine and its internal diameter amongst the Japanese. *J Japanese Soc Coloproctology* 1994; **47**: 31–9.