SCIENTIFIC PAPER JSLS

Vacation Appendicitis

Jay A. Redan, MD, Michael B. Tempel, MD,
Shannon Harrison, RN, MBA, CCRC, Xiang Zhu, MS

ABSTRACT

Objective: When someone plans a vacation, one of the last things taken into consideration is the possibility of contracting an illness while away. Unfortunately, if people develop abdominal pain while planning for a vacation, they usually proceed with the vacation and do not consider getting medical attention for their pain. The purpose of this study was to examine the effect of being on vacation and its association with ruptured appendicitis.

Methods: From January 1, 2007 to December 31, 2008, the incidence of ruptured appendicitis cases at Florida Hospital–Celebration Health, located 5 miles from Walt Disney World, was compared with that of Florida Hospital–Orlando, approximately 30 miles away from Walt Disney World. We evaluated whether patients "on vacation" versus residents of Orlando have an increased incidence of ruptured appendicitis.

Results: Of patients treated for presumed appendicitis, 60.59% at Florida Hospital–Celebration Health had ruptured appendicitis during this time versus 20.42% at Florida Hospital–Orlando. Of those 266 patients seen at Florida Hospital–Celebration Health, 155 were on vacation versus only 21 at Florida Hospital–Orlando.

Conclusion: Although there is not a direct cause and effect, it is clear that there is a higher incidence of ruptured appendicitis in patients on vacation versus in the regular community in the Orlando, Florida area.

Key Words: Appendicitis, Ruptured appendicitis.

Department of Surgery, Florida Hospital–Celebration Health, Celebration, Florida, USA (all authors).

Presented as a poster at the American College of Surgeons, October 2011, San Francisco, CA.

Address correspondence to: Jay A. Redan, MD, FACS, Director of Minimally Invasive General Surgery, Florida Hospital–Celebration Health, Associate Professor of Surgery, University of Central Florida Medical School, 400 Celebration Place, Suite A-140, Celebration, FL 34747. Telephone: 407-303-4602, Fax: 407-303-4602, E-mail: Jay.Redan.MD@flhosp.org

DOI: 10.4293/108680812X13517013318355

INTRODUCTION

Appendicitis is one of the most common causes of abdominal pain and requires surgical treatment. Lifetime risk of appendicitis ranges from 6% to 7%.[1] Delayed presentation can lead to prolonged inflammation and subsequent rupture of the appendix. Increasing duration between the onset of inflammation and surgical intervention increases the risk of perforation of the appendix. Retrospective chart reviews by Bicknell et al have shown that rupture risk was <2% when symptoms were present for <36 hours. Thereafter, rupture risk rises to 5%.[2] This leads to prolonged hospitalization in addition to increased risk of postoperative morbidity.

Over 2 years, we analyzed patients who presented to our facility and required emergency surgery for presumed appendicitis. We divided our patients between those who were visiting on vacation and those who lived as residents in the area. Because of our location near Walt Disney World, Universal Studios, and many other resorts and hotels, we see a large number of patients on vacation with their families; this includes both domestic and international visitors. Because of the factors associated with taking a vacation, such as time off of work, arranging flights and hotels, saving money, and arranging children's time away from school, people experiencing abdominal pain before their vacation may often delay treatment. Consequently, when they do present to the emergency department, pathology is often advanced, secondary to delay of treatment. As stated previously, this can add to both postoperative morbidity and cost of hospital stay. Our hypothesis is that, simply because of our location, we see a higher-than-average number of vacation emergencies versus emergencies in patients who live in the area. We compared this with the incidence of appendicitis (perforated and nonperforated) to a local teaching hospital in our health system, Florida Hospital–Orlando (FHO), a large tertiary care teaching hospital with 938 beds.

MATERIALS AND METHODS

This is a retrospective chart review using patient data from Florida Hospital–Celebration Health (FHCH), a small 112-bed community hospital in Celebration, Florida, approxi-

mately 5 miles from Walt Disney World. A request was made and granted from our institutional review board to conduct this chart review. The review uses data from January 1, 2007 to December 31, 2008. The study population consists of patients undergoing emergent or urgent surgery for presumed appendicitis. All patients in the study were >18 years (all patients <18 were sent to FHO). All appendectomies are performed laparoscopically at FHCH. Data regarding laparoscopic versus open procedures were not available at FHO. The conversion rate to open is <1% among the experienced surgeons at FHCH. Only "positive appendectomies" were included in this study; however, negative appendectomies are unusual because of the high-quality imaging studies now available in most hospitals. These patients were analyzed with respect to age, sex, race, actual pathology, and length of hospital stay. More importantly, we analyzed the patients with respect to home geographic location indicated by zip codes. FHCH has a service area of 30 zip codes. For the purpose of this study and to allow for overlap of the comparative hospital zip codes, we assumed that any patient who came to FHCH whose home residence was not in Florida was considered to be "on vacation." This obviously includes patients from other countries and those from out-of-state. Finally, we compared these data with those obtained over a similar period at FHO, the flagship hospital for the Florida Hospital Health System. It is a tertiary care and teaching hospital located in downtown Orlando with 938 beds.

Statistics

In this retrospective study, in addition to vacationers (ie, people visiting Orlando as nonresidents), there were also other factors examined, such as age, gender, medical insurance, and race, which might be associated with perforation development of appendicitis patients but not under control. This aggressive statistical analysis was performed to rule out the possibility that our high incidence of ruptured appendicitis was not a result of chance. In addition, hospital facility characteristics, such as location and size, as a whole might somehow affect the pattern of patients' use of the emergency department and, hence, result in different levels of perforation rate in different patient populations. We first used univariate analysis, which included frequency χ^2 test for percentage number comparison, Student t test for age comparison, and Wilcoxon rank-sum test for length of stay (LOS) comparison, to investigate the association of perforation with campuses, patient type (resident patient vs on-vacation patient), age, gender, medical insurance status, and race, separately. Then we used multiple regression analysis to further isolate and evaluate the effect of each factor on the perforation rate with the rest factors under control.

In the multiple regression analysis, we adopted multiple logistic regression models to analyze perforation rate. We designated perforation as a dependent variable and coded it as "1" for perforated and "0" for nonperforated. We designated all other factors as independent variables, including (1) patient type (binary variable, "1" for on-vacation patients who live outside the service area and "0" for resident patients who live in the service area); (2) campus (binary variable, "1" for FHCH and "0" for FHO); (3) age (continuous variable); (4) gender (binary variable, "1" for male and "0" for female); (5) race (binary, "1" for white and "0" for nonwhite; we grouped races into 2 categories because some races had too few observations); and (6) medical insurance status (binary variable, "1" for with insurance and "0" for without insurance). We estimated odds ratios of perforation versus nonperforation on the condition of patient type with other independent variables treated as adjustment factors.

To investigate the relationship of LOS with perforation, we used multiple Poisson regression analysis. Poisson regression was applied because LOS was a count variable following a Poisson distribution **(Figure 1)**. In the Poisson regression analysis, we designated LOS as a dependent variable and all other factors (perforation, age, gender, race, patient type) as independent variables.

Stata version 10.0 (StataCorp, College Station, TX) was used for all analyses. All data were presented as mean ±

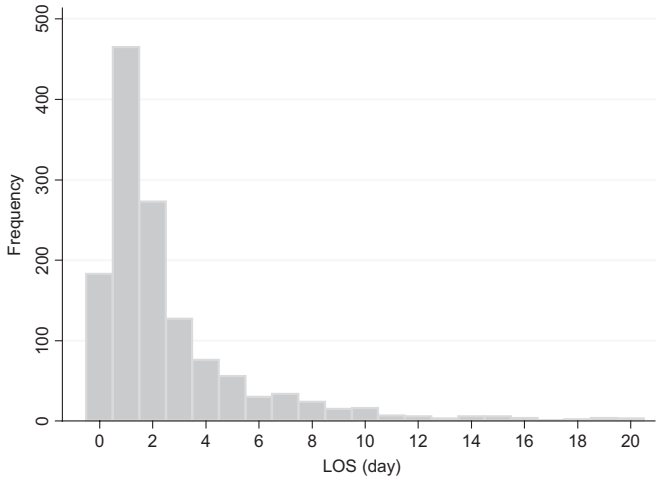

Figure 1. Frequency distribution of LOS ranging from 0 to 20 days.

standard error unless otherwise specified, and the significance level for all tests was set at $P < .05$.

RESULTS

Following are the new results based on the data where patients <18 years are removed from both the FHCH and FHO campuses. In addition, to unify the criteria that both campuses used to distinguish on-vacation patients from resident patients, we classified the patients who lived in Florida as resident patients, and those who did not as on-vacation patients.

If the patients <18 years were excluded from this study (ie, removed from both campuses), the total number of patients included was 943, 439 (46.55%) of which were from the FHCH campus and 504 (53.45%) from the FHO campus. If the patients who lived in Florida were identified as resident patients, and the patients who lived outside as on-vacation patients, the total number of resident patients versus the total number of on-vacation patients was 767 (81.34%) versus 176 (18.66%).

Table 1 shows the results of the association of perforation with age, race (as noted in the chart face sheet), and campus.

The multiple Poisson regression analysis showed that LOS was significantly positively associated with perforation, age, gender, medical insurance status, and campus **(Table 4)**. According to the model, we predict that if other conditions are held unchanged, patients with a perforated appendix have a 68% longer LOS than patients with a nonperforated appendix. With a patient age increase of 1 year, the LOS increases by 2%; male patients have a 7% longer LOS than female patients; patients with medical insurance have a 9% longer LOS than patients without medical insurance; and patients at FHCH have a 13% longer LOS than at Orlando campus. Race and patient type do not significantly affect LOS.

To avoid multicollinearity among independent variables, we conducted Kendall τ test. We did not detect any high collinearity (>0.8) among the independent variables that we incorporated into our models, suggesting that the structure of our models is valid.

From the period of January 2007 through December 2008, 439 patients were admitted to FHCH for presumed appendicitis. All patients were taken to the operating room. The appendix was removed and sent for pathological analysis. Final diagnoses were classified as acute appendicitis either with or without perforation.

In contrast, 504 patients were admitted to FHO with presumed appendicitis. **Table 5** summarizes these data.

Table 6 further divides the totals from FHCH into those patients within the service area (ie, 30 surrounding zip codes) and those "on vacation." As before, these patients were also grouped into acute versus perforated/peritonitis.

Finally, **Table 7** displays the admission data for each campus as a function of percentage of acute and perforated appendicitis.

Table 1.
Comparison of Patient Populations between the Celebration Campus and the Orlando Campus[a]

	Celebration	Orlando	Overall	χ^2	*P* Value
Number of patients	439	504	943		
On-vacation patients (%)	155 (35.31)	21 (4.17)	176 (18.66)	149.89	.000
Perforated (%)	266 (60.59)	113 (22.42)	483 (40.19)	142.22	.000
Male (%)	205 (46.70)	271 (53.77)	476 (50.48)	4.70	.030
Age (SD, min–max)	41.2 (15.4, 18–90)	38.7 (16.9, 18–97)	39.9 (16.2, 18–97)	–2.34[b]	.020
White (%)	436 (99.32)	404 (80.16)	840 (89.08)	88.51	.000
Medical insured (%)	384 (87.47)	381 (75.60)	765 (81.12)	21.61	.000
LOS (SD, min–max)	4.3 (6.5, 0–71)	2.9 (7.6, 0–147)	3.6 (7.1, 0–147)	–6.12[c]	.000

[a]Patients <18 years old were excluded, and patients who lived outside Florida State were identified as "on-vacation" patients.
[b]Two-tailed *t* test.
[c]Wilcoxon rank-sum test.

Table 2.
Comparison of Patient Characteristics Between Those with Perforated Versus Nonperforated Appendix[a]

	Perforated	Nonperforated	Overall	χ^2	*P* Value
Number of patients	379	564	943		
On-vacation patients (%)	100 (26.39)	76(13.48)	176 (18.66)	24.89	.000
Celebration (%)	266 (70.18)	173 (30.67)	439 (46.55)	142.22	.000
Orlando (%)	113 (29.82)	391 (69.33)	504 (53.45)		
Male (%)	179 (47.23)	297 (52.67)	476 (50.48)	2.67	.102
Age (SD, min–max)	43.2 (16.6, 18–91)	37.6 (15.6, 18–97)	39.9 (16.2, 18–97)	–5.26[b]	.000
White (%)	345 (91.03)	495 (87.77)	840 (89.08)	2.68	.115
Med. insured (%)	325 (85.75)	440 (78.01)	765 (81.12)	8.86	.003
LOS (SD, min–max)	5.1 (7.1, 0–71)	2.6 (6.9, 0–147)	3.6 (7.1, 0–147)	–9.60[c]	.000

[a]Patients <18 years old were excluded, and patients who lived outside Florida State were identified as "on-vacation" patients.
[b]Two-tailed *t* test.
[c]Wilcoxon rank-sum test.

Table 3.
Estimation of Odds Ratio of Perforated versus Nonperforated Appendix in Relation to Age, Gender, Race, Medical Insurance Status, Patient Type, and Campus Using a Multiple Logistic Regression Model[ab]

	Odds Ratio	SE	*Z*	*P* Value	95% CI	
					Lower	Upper
Age	1.02	0.00	4.61	.000	1.01	1.03
Gender	0.96	0.14	–0.28	.781	0.72	1.28
Medical insurance	1.15	0.23	0.69	.491	0.78	1.69
Race	0.49	0.12	–2.84	.005	0.30	0.80
Patient type	1.02	0.20	0.09	.931	0.69	1.49
Campus	6.03	1.04	10.45	.000	4.30	8.44

[a]Patients <18 years old were excluded, and patients who lived outside Florida were identified as "on-vacation" patients.
[b]Pseudo $R^2 = 0.138$, $\chi^2(6) = 175.9$, $P = .000$.

Table 4.
Estimation of Effects of Perforation, Age, Gender, Medical Insurance, Race, Patient Type and Campus on LOS Using the Multiple Poisson Regression Model[ab]

	Incidence Rate Ratio	SE	*z*	*P* Value	95% C.I.	
					Lower	Upper
Perforation	1.59	0.06	12.03	.000	1.47	1.71
Age	1.03	0.00	28.34	.000	1.03	1.03
Gender	1.06	0.04	1.62	.106	0.99	1.13
Medical insurance	1.05	0.05	0.94	.347	0.95	1.16
Race	1.00	0.07	0.07	.943	0.88	1.14
Patient type	0.99	0.05	–0.17	.868	0.91	1.08
Campus	1.17	0.05	3.75	.000	1.08	1.28

[a]Patients <18 years old were excluded, and patients who lived outside Florida were identified as "on-vacation" patients.
[b]Pseudo $R^2 = 0.162$, $\chi^2(7) = 1194.36$, $P = .000$.

DISCUSSION

Appendicitis is one of the most common conditions requiring surgical intervention. Lifetime risk of appendicitis is estimated to be 6% to 7% overall. Although simple acute appendicitis requires a relatively simple operation with a short hospital stay (possibly even same-day discharge), delays in treatment lead to perforation of the appendix with subsequent localized abscess and/or peritonitis.

It is our goal to study the effects of treatment delay—namely, vacation time away from home—on the course of appendicitis. Our small community hospital is located approximately 4 miles from the Walt Disney World and Resorts complex, with an estimated 50 million visitors annually. In addition to the 4 theme parks at Walt Disney World, Universal Studios, and Sea World, there are other theme parks, themed hotels, resorts, and local attractions.

Table 5.
Patients Admitted with Presumel Appendicitis

Orlando total	504
Acute appendicitis with perforation	113
Celebration total	439
Acute appendicitis with perforation	266

Table 6.
Florida Hospital Celebration Health From Service Area vs On Vaction and Acute Appendicitis vs Perforated Appendicitis (n=439)

	439
Appendicitis in service area	81
Appendicitis out of service area	92
Perforated appendicitis in service area	93
Perforated appendicitis out of service area	173

Table 7.

Hospital and Appendix Pathology	Total No. Admissions 2007–2008 (%)
Orlando	504
Perforated appendicitis	113 (22.42)
Celebration	439
Perforated appendicitis	266 (60.59)
Perforated appendicitis in service area	121 (21.18)
Perforated appendicitis out of service area	157 (65.04)

Given the time and finances needed to organize time away from home (as discussed previously), it is easy to see how someone may dismiss the initial vague abdominal pain of appendicitis as a hassle rather than a condition requiring surgical attention. Consequently, as time progresses and treatment is delayed, a simple procedure transforms into a more complicated one as patients arrive at their "vacation destination."

Our goal was to compare our data regarding perforated appendicitis with data from a large tertiary-care teaching hospital and to show that, based simply on location, our smaller hospital sees a proportionately larger number of perforated appendicitis cases than a larger hospital with more resources, a higher bed capacity, and a larger service area.

During the period from 2007 to 2008, FHO admitted 504 patients with presumed appendicitis. Of those, 113 patients (22.42%) had perforation. During the same period, FHCH admitted 439 patients with the same diagnosis of presumed appendicitis. Of our 439 patients with presumed appendicitis, 266 (60.5%) had perforations at the time of operation. Our patients with perforated appendicitis were further divided into those inside the service area and those "on vacation." It is interesting to note that 93 patients (21.18% of total) with perforated appendicitis were in our service area. In addition, 173 patients (65.04% of total) with perforated appendicitis were outside of our service area. In other words, based only on vacationing patients visiting our area, we had almost 3 times as many appendiceal perforations as did our flagship hospital.

Of note, appendicitis is traditionally thought of as a disease of children. Our hospital policy directs us to send any patients <18 years to FHO for treatment. Pediatric surgical patients at FHCH do not exist and may have skewed the data; however, the average age of patients at our hospital is 36.5 years.

CONCLUSIONS

Perforation is significantly associated with age, race, and campus (FHCH vs FHO), and on-vacation patients have a 30% higher odds ratio of perforation rate than resident patients.

FHCH accepted a higher percentage of patients with perforations than did FHO, but this could not be explained by the fact that FHCH had a larger percentage of on-vacation patients compared with FHO.

Although factors such as age, gender, medical insurance status, race, and patient type were taken into account, the difference in perforation rates between campuses (ie, "campus effect") was still significant. This part of effect at the campus level is still unclear, probably because of some unobserved reasons.

The criteria used to classify on-vacation patients and resident patients at FHCH and FHO might not be the same "ruler" to reflect all aspects of their patient populations. This may have been problematic when all data were pooled to evaluate the effect of patient type on perforation rate.

Of the patients with suspected appendicitis, 65.04% of the visitor patients at FHCH had perforated appendicitis versus 22.42% at FHO. All comparisons were statistically significant, $P < .001$ by χ^2 analysis. We concluded that

developing appendicitis while on vacation is associated with a statistically significantly higher incidence of perforated appendicitis in Orlando, Florida, $P < .001$. Although there is no way to definitively prove cause and effect, we believe that patients planning an expensive vacation tend to "ignore" warning signs of a more serious illness than when they are "at home" and not planning a vacation.

References:

1. Fischer JE, et al. Chapters 129–230. In: *Mastery of Surgery*. Fifth edition. Philadelphia: Lippincott Williams & Wilkins; 2007.

2. Bicknell NA, Aufses AH Jr, Rojas M, Bodian C. How time affects the risk of rupture in appendicitis. *J Am Coll Surg*. 2006; 202(3):401–406.

3. Bickell NA, Siu AL. Why do delays in treatment occur? Lessons learned from ruptured appendicitis. *Health Serv Res*. 2001;36(1):1–5.

4. Sicard N, Tousignant P, Pineault R, Dubé S. Non-patient factors related to rates of ruptured appendicitis. *Br J Surg*. 2007; 94:214–221.

5. Eldar S, Nash E, Sabo E, et al. Delay of surgery in acute appendicitis. *Am J Surg*. 1997;173:194–198.

6. Deck KB, Pettitt BJ, Harrison MR. The length-time correlate in appendicitis. *JAMA*. 1980;244:806–807.

7. Temple CL, Huchcroft SA, Temple WJ. The natural history of appendicitis in adults. A prospective study. *Ann Surg*. 1995;221: 278–281.

8. Penfold RB, Chisolm DJ, Nwomeh BC, Kelleher KJ. Geographic disparities in the risk of perforated appendicitis among children in Ohio: 2001–2003. *Int J Health Geogr*. 2008;7:56.

9. Davies GM, Dasbach EJ, Teutsch S. The burden of appendicitis-related hospitalizations in the United States in 1997. *Surg Infect (Larchmt)*. 2004;5:160–165.

10. Kraemer M, Franke C, Ohmann C, Yang Q; Acute Abdominal Pain Study Group. Acute appendicitis in late adulthood: incidence, presentation, and outcome. Results of a prospective multicenter acute abdominal pain study and a review of the literature. *Langenbecks Arch Surg*. 2000;385(7):470–481.

11. Hansson LE, Laurell H, Gunnarsson U. Impact of time in the development of acute appendicitis. *Dig Surg*. 2008;25(5):394–399.

12. Papaziogas B, Tsiaousis P, Koutelidakis I, Glakoustidis A, Atmatzidis S, Atmatzidis K. Effect of time risk of perforation in acute appendicitis. *Acta Chir Belg*. 2009;109(1):75–80.