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Cynthia White
Wright State University - Main Campus, white.612@wright.edu

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Akpofure Peter Ekeh, M.D., Wright State University, Boonshoft School of Medicine,

Department of Surgery

Clinical Science and Research

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I indicate that my mentor has read and reviewed my report prior to submission

Abstract

Background

In a laparoscopic appendectomy, closure of the appendeceal stump can be done using an endostapler or endoloop. We compared outcome data of the two techniques in patients who underwent laparoscopic appendectomy.

Method

We included all patient > 18 years who underwent laparoscopic appendectomy for acute appendicitis at a single institution over a 4-year period. Demographic and outcome data were compared between both groups.

Results

501 patients, with no significant differences in age, gender or BMI, were identified for the study. No differences were noted in procedure length, readmission rates, complication rates (including intra-abdominal abscess) or hospital charges. There was a slightly shorter length of stay in the endoloop closure group (1.22 days) vs endostapler (1.38 days), p= 0.002.

Conclusion

Neither technique of appendiceal stump closure demonstrated a unique advantage. These findings may have more relevance in lower resource environments that may not have access to surgical staplers.

Keywords: Endoloop, endostapler, appendiceal stump closure, appendectomy

Introduction/Literature Review

In the United States there is about a 7% lifetime risk of experiencing acute appendicitis, making it the second most common abdominal pathology.[1] A laparoscopic appendectomy is the current recommended surgical approach for treatment of uncomplicated appendicitis, as this has been found to reduce hospital stays, postoperative pain, and risk of infection.[2] During this procedure, closure of the appendiceal stump is believed to be the most crucial step. Complications from incomplete closure include postoperative fistula, peritonitis, and sepsis.[3]

There are four main surgical approaches for closure of the appendiceal stump; however, the greatest debate is between use of an Endoloop or an Endostapler.[4-6] Endostaplers have been traditionally used to transect the appendices base and mesoappendix. Using an endoloop is an alternate method that can be utilized for the closure of the appendiceal stump— typically in conjunction with an energy source. There have been multiple studies evaluating the effectiveness of the two approaches, but these studies are limited and often contradictory in their conclusions. Multiple studies have found that the two methods similar outcomes and complication rates.[7-10] However, multiple studies have also concluded that use of the Endostapler lowered risk of intra-abdominal infection and hospital readmission.[11,12] In general, Endoloop ligature was found to reduce cost[7,10] and operative time.[8-10] However, one study was contradictory and found the Endostapler reduced operative time.[12] Despite studies evaluating the effectiveness of appendiceal stump closure, there is still no agreement on the best recommended technique.[13]

While there are some data, overall there is still no consensus on the optimal technique for closure of the appendiceal stump. The goal of our study is to identify significant determining factors for the use of the Endostapler versus Endoloop resulted in a difference in the length of procedure, length of hospitalization, clinical outcome, or hospital charges.

Hypothesis/Specific Aims/Research Questions

The aim of our research is to compare the two main appendiceal stump closure methodologies (Endoloop versus Endostapler) and determine any significant difference between them. Specific measures being evaluated will be detailed in the Methods section of the proposal.

Methods

The patient population studied included all patients 18 years or older who had their appendix removed at a single tertiary institution from January 1, 2015- December 31, 2018. Time period was chosen with a goal of including approximately 500 patients in our study. Sample size was chosen based on previous studies that included anywhere between 177-870 patients.[7,8,10,12] All patients under the age of 18 years old, prisoners, pregnant women, and all patients who had laparoscopic appendectomy and another procedure performed at the same time (i.e. ventral hernia repair) will be excluded from the study.

The study was a retrospective chart review. IRB exemption was received for the study. A list of patients who meet the inclusion criteria was compiled and patients were de-identified at the earliest opportunity. Data collection was kept on a password-protected spreadsheet. Standardized data was collected for each patient including the following measures: MRN number, age, BMI, existing comorbidities, overall length of stay (number of nights in the hospital), CT Scan Measurement of Appendix (in centimeters), technique used (Endoloop, Endostapler, or other), length of procedure (in minutes), complications, use of antibiotics (both pre- and post-operative) antibiotics, and post-operative complications.

Statistical analysis was done using a univariate and multivariate analysis. Continuous variables will be compared using the Mann Whitney U test. The Chi-squared test will be used to compare categorical variables. Statistical significance was set at a $p<0.05$.

Results

Over the studied period, 563 patients underwent laparoscopic appendectomy for acute appendicitis. Sixty-two patients who had additional procedures (e.g. ventral hernia repairs) or stump closure methods were excluded leaving a total of 501 patients that were included in the analysis. Our final sample consisted of 271 males (54.1%) and 230 (45.9%) females. The mean age was 38.4±14.8 years for females and 37.1±15.5 years for males. The average BMI was 29.8±5.6. The overall average length of the procedure was 48.8±21.8 minutes and the length of stay was 1.3 days. Overall re- admission rate was 57/501 (11.4%) and the complication rate was 43/501 (8.6%). Mean hospital charges were $38,600±13,936. Demographic data for all patients in the study is demonstrated in Table 1A and 1B.

The endostapler was utilized in the majority of cases (278 patients, 55.5%) and the endoloop in 223 (44.5%). Both groups showed a slightly higher proportion of males with the endoloop group having 54.3% and the endostapler group having 54.0% (p=0.946). Complication rates were similar between the two groups with the endoloop group having 8.5% and the endostapler group having 8.6% (p=0.954). Readmission rates were not statistically significant between the two groups with the endoloop group having 13.5% and the endostapler group having 9.7% (p=0.195). Data on gender, complication rates, and readmission rates were analyzed using a Chi-Square Test and are summarized in Table 2.

There were no statistically significant differences in age with the endoloop group having a median 36.00 (IQR 24.00) and the endostapler group having 33.00 (IQR 24.75) with a (p=0.436). There were no statistically significant differences in Body Mass Index with the endoloop group having a median 27.85 (IQR 9.48) and the endostapler group having 28.70 (IQR 8.52) with a (p=0.284). The median procedure length was 45.00 minutes (IQR 25.00) for the endostapler group and 45.00 minutes (IQR 25.00) for the endoloop group (p=0.326). Comparison of outcome data showed a statistically significant difference in the length of stay. The median length of stay for the endostapler group was 1.00 days (IQR 1.00) compared to the endoloop group at 1.00 days (IQR 0.00) (p=0.002). The median hospital charges were similar in both groups at $35,823.07 (IQR 7,824.29) and $34,357.78 (IQR 9,033.97) for the endostapler and endoloop respectively (p=0.083) Data was compared using the Mann-Whitney U Test and is summarized in Table 3.

Discussion

Our study showed that the technique used for closure of the appendiceal stump during a laparoscopic appendectomy did not lead to any difference in procedure length, readmission rates, complications, or hospital charges. The use of the endoloop resulted in a statistically significant shorter length of hospital stay. However, this was not of clinical significance or relevance (difference of 0.16 days).

The question of the optimal technique for appendiceal stump closure is not new. The data, however, has been conflicting especially when assessing the effect of the method on complications. Multiple studies evaluating the effectiveness of the endostapler vs. endoloop have been carried out but have resulted in differing conclusions with regard to superiority of either

technique. Some prior studies have had conclusions similar to our findings, that is the two methods have similar outcomes and complication rates.[7,8,10] Alternatively, some studies have concluded that use of the endostapler lowered risk of intra-abdominal infection and hospital readmission.[11,12]. Our study did not show significant difference in complication or readmission rates when comparing the endoloop and endostapler.

In general, endoloop ligature has been touted to reduce operative cost.[7,10] We were unable to demonstrate a cost advantage to using either the endostapler or the endoloop. An energy source is typically used to transect the mesoappendix with the endoloop (typically either ligasure, sonocision or harmonic scalpel), which may have equalized the costs in our study. Other studies have noted a reduced procedure length with using the endoloop.[8,10] We did not replicate that finding.

This study was retrospective and thus subject to all the typical limitations of such (i.e. using previously collected data). For example, hospital charges were used as opposed to operation costs or hospital stay costs due to the latter values not being known or available to the researchers. Hospital charges can be more difficult to interpret and correlate as they differ in variable ways from actual costs incurred by the hospital. Charges were also collated for the entire hospital stay as opposed to just the operation – therefore, they may not have reflected the true differences in costs between the two methods of appendiceal stump closure. More data regarding operation cost and hospitalization costs is needed. This could be gathered in a future prospective study. Additionally, another limitation was assignment of patients to the endostapler or endoloop group. Since this study was retrospective, assignments were based on the surgeon's preferred methodology. A future prospective study could randomly assign patients to a group and eliminate the decision being made on the individual surgeon's preferences.

Conclusions

In all, despite studies evaluating the effectiveness of appendiceal stump closure, there is still no general consensus or agreement on the best-recommended technique. Our study adds to the body of literature that does not prefer superiority to either method. Either may be utilized depending on the individual surgeon or hospital's preference. These findings may have more relevance in lower resource environments that may not have readily accessible surgical staplers.

Table 1A and 1B: Overall Sample Demographics

Table 1A

	N	**Percent**
Male	271	54.1%
Female	230	45.9%
Re-admission Rate	57	11.4%
Complication Rate	43	8.6%

Table 1B

	Mean	**Standard Deviation**
Age Male	37.1	14.8
Age Female	38.4	15.5
BMI	29.8	2.4
Mean Length of Procedure (min)	48.8	21.8
Mean LOS (days)	1.3	1.7
Mean Hospital Charges	$38,600	$13,936

Table: 2 Results of Chi-Square Tests

Category	Endo-loop Closure (n)	Endo-stapler Closure (n)	p-value
Gender			
Male	121 (54.3%)	150 (54.0%)	0.946
Female	102 (45.7%)	128 (46.0%)	
Complications			
Yes	19 (8.5%)	24 (8.6%)	0.954
No	204 (97.5%)	254 (97.4%)	
Readmission			
Yes	30 (13.5%)	27 (9.7%)	0.195
No	193 (86.5%)	250 (90.3%)	

Table 3: Group Comparison by Mann-Whitney U Tests

Category	**Endo-loop Closure**			**Endo-stapler Closure**			**p-value**
	Mean	Median	IQR	Mean	Median	IQR	
Age (years)	38.38	36.00	24.00	37.64	33.00	24.75	0.436
BMI	29.38	27.85	9.48	30.06	28.70	8.52	0.284
LOS (days)	1.22	1.00	1.00	1.38	1.00	0.00	0.002
Procedure Length	50.11	45.00	25.00	48.60	45.00	25.00	0.326
Charges ($)	38,645.35	34,357.78	7,824.29	38,568.27	35,823.07	9,033.97	0.083

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