Appendectomy in US Veterans
A Two-Decade Study

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Objective

Appendectomy remains the principal management for acute appendicitis with reported morbidity and mortality of 5.5-14.5% and 0.03-0.24%, respectively.

This study examins the profile and outcome of appendectomy in veterans over two decades.

We look to see the similarities and differences between laparoscopic versus open appendectomy.

Methods

- Retrospective Cohort Study
- Cases of appendectomy in the Veterans Affairs Surgical Quality Improvement between 1999-2019 were identified.
- Exclusion criteria: Appendectomies performed for cancer, interval appendectomy, or as part of another major operation.
- Demographics, clinical/operative details, and outcomes of open (OA) and laparoscopic (LA) appendectomies wer compared along with trend analysis over that period.
- Chi-square test for categorical variables, Studend's t-test for continuous variables with parametric distribution, and the Mann-Whitney test for continous variables with non-parametric distribuion were used for univariate analysis. Logistics regression was performed to detect independent predictors of morbidity. *P*<0.05 was considered significant.

Methods *(Continued)*

Table 1. Patient Characteristics and Comorbidities Comparing Open Vs Lap appendectomy.

N. (%)	All n= 12,006	Open n=3,595	Lap n=8,411	P value
Age (Mean ±SD)	52.3 ± 16.3	54.9 ± 15.9	51.2 ± 16.4	<0.001
Age ≥65	2,759 (22.9)	950 (26.4)	1,809 (21.5)	<0.001
Sex (Male)	10,927 (91.1)	7,560 (89.9)	3,367 (93.7)	<0.001
ASA Class				<0.001
1 or2	5,964 (49.7)	1,583 (44.0)	4,381 (52.1)	
≥3	6,042 (50.3)	2,012 (56.0)	4,030 (47.9)	
BMI (Mean ±SD)	29.5 ± 5.7	29.2 ± 5.8	29.6 ± 6.7	0.001
Obesity (BMI ≥30)	5,375 (44.8)	1,636 (45.5)	3,739 (44.5)	0.287
Current smoker	3,825 (31.9)	1,193 (33.2)	2,632 (31.3)	0.044
Current alcohol use	852 (7.1)	271 (7.6)	581 (6.9)	0.212
Independent Functional Status	11,501 (95.8)	3,383 (94.1)	8,118 (96.5)	<0.001
Steroid use	141 (1.2)	63 (1.8)	78 (0.9)	<0.001
Weight loss >10%	100 (0.8)	35 (1.0)	65 (0.8)	0.267
Five factor modified frailty index (+2)	2,553 (21.3)	977 (27.2)	1,576 (18.7)	<0.001
Emergency	7,882 (65.7)	2,668 (74.2)	5,214 (61.9)	<0.001
Comorbidity				
Renal Failure	59 (0.5)	25 (0.7)	34 (0.4)	0.037
CVA	207 (1.7)	72 (2.0)	135 (1.6)	0.125
Preoperative Sepsis	677 (4.5)	302 (8.4)	375 (4.5)	<0.001
Albumin <3.5 mg/dL	1,110 (9.3)	475 (13.2)	635 (7.6)	<0.001

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); WBC, white blood cell count. SI conversion factors: To convert creatinine to micromoles per liter, multiply by 88.4; hematocrit to proportion of 1.0, multiply by 0.01; platelet count to x109 per liter, multiply by 1.0; and WBC count to x109 per liter, multiply by 0.001.

Results

- A total of 12,006 cases were identified (91.1% male, mean age 52.3, mean BMI 29.5, 50.3% with ASA ≥3, 31.9% current smokers, and 95.8% functionally independent).
- Mean operative time was 1.2 hours, and 65.7% were performed within the first 24 hours. There were 40 (0.33%) mortalities and complications occurred in 1,051 (8.8%). Mean length of stay (LOS) was 3.5 days.
- OA was performed in 29.9% and LA in 70.1%.

Results *(Continued)*

- Compared to OA, LA group were younger (51.2 vs. 54.9 p<0.001), more males (93.7% vs. 89.9%, p<0.001), with lower ASA class ≥3 (47.9% vs. 56.0%, p<001), higher BMI (29.6 vs. 29.2, p=0.001), less smokers (31.3% vs 33.2%, p=0.044), more functional independent (96.5% vs. 94.1%, p<0.001), less frail (Frailty index +2) (18.7% vs. 27.2%, p<0.001), and less hypoalbuminemic (7.6% vs. 13.2%, p<0.001).
- LA was less likely to be performed within the first 24 hours (61.9% vs. 74.2%, p<0.001), less in patients with sepsis (4.5% vs. 8.4%, p<0.001), and had shorter OT (1.2hr vs. 1.3hr, p<0.001, shorter LOS (2.7 days vs. 5.1 days, p<0.001), lower morbidity (6.2% vs. 14.9%, p<0.001), and lower mortality (0.18% vs. 0.7%, p<0.001).
- Sepsis (OR 2.2, p<0.001), dependent functional status (OR 1.6, p=0.001), frailty index >1 (OR 1.3, p<0.001) and current smoking status (OR 1.2, p=0.015) were independent predictors of morbidity, while chronic steroid use (OR 14.8, p<0.001), preoperative sepsis (OR 4.6, p<0.001), and age ≥65 (OR 4.5, p<0.001) were independent factors of mortality.
- Laparoscopy had protective effect on both morbidity (OR 0.4, p<0.001), and mortality (OR 0.3, p<0.001).
- Trend analysis over the study period showed significant improvement in morbidity and LOS, (C-statistics 19.1, p<0.001 and C-statistics 11.1, p<0.001, respectively), increase in LA (C-statistics 69.3, p<0.001) by 56%, and drop of the total number of appendectomies by 70%.

Results *(Continued)*

Table 2. Unadjusted Analysis of Operative and Postoperative Mortality, LOS, and Morbidities Comparing open vs. lap appendectomy.

N. (%)	All n= 12,006	Open n=3,595	Lap n=8,411	P value
Operation Duration, mean ±SD, hour	1.2 ± 1.0	1.3 ± 1.3	1.2 ±0.85	<0.001
No. of patients received red blood cell unit Intraoperatively	39 (0.3)	18 (0.5)	21 (0.3)	0.027
Junior attending staff (<5 years)	11,747 (97.8)	3,543 (98.6)	8,204 (97.5)	<0.001
30-Day mortality	40.0 (0.33)	25 (0.7)	15 (0.18)	<0.001
Postoperative LOS, (mean ± SD)	3.5 ± 4.6	5.1 ± 5.7	2.7 ± 3.7	<s0.001
Morbidity	1,051 (8.8)	534 (14.9)	517 (6.2)	<0.001
Surgical complications				
Superficial SSI	276 (2.3)	185 (5.2)	91 (1.1)	<0.001
Deep SSI	104 (0.9)	60 (1.7)	44 (0.5)	<0.001
Organ space SSI	256 (2.2)	71 (2.1)	185 (2.2)	0.676
Wound dehiscence	67 (0.6)	49 (1.4)	18 (0.2)	<0.001
Reoperation	384 (3.2)	178 (4.9)	206 (2.5)	<0.001
Medical complications				
Pneumonia	88 (0.7)	47 (1.3)	41 (0.5)	<0.001
Need for reintubation	114 (1.0)	54 (1.5)	60 (0.7)	<0.001
Pulmonary embolism	26 (0.2)	13 (0.4)	13 (0.2)	0.025
Renal failure	281 (1.0)	177 (0.7)	104 (2.6)	<0.001
Cardiac arrest	31 (0.3)	18 (0.5)	13 (0.15)	0.001
Urinary tract infection	61 (0.5)	24 (0.7)	37 (0.4)	0.108
Deep venous thrombosis	20 (0.2)	10 (0.3)	10 (0.1)	0.05

Abbreviations: SD: Standard Deviation; LOS: length of stay; SSI: surgical site infection.

Table 3. Multivariable Logistic Regression Analysis for Independent Predictors of Morbidity in appendectomy.

	Odds Ratios	Confidence Interval 95%	P value
Morbidity			
Lap appendectomy	0.4	.37-0.49	<0.001
Emergency	1.2	1.1-1.4	0.01
Preop Sepsis	2.2	1.8-2.7	<0.001
Smoke	1.2	1.0-1.4	0.015
Dependent fun status	1.6	1.2-2.1	0.001
Frailty index >1	1.3	1.2-1.5	<0.001

Conclusion

When compared to national reports, Laparoscopic Appendectomy (LA) is performed at comparable rates with similar outcome in high-risk veterans and it is superior to OPen Appendectomy (OA).

Recent trends show declining number of appendectomies, improving outcome, and more application of laparoscopy.