

Background

Appendectomy is a common surgical procedure and minimally invasive approach is considered a standard treatment. However, the use of robotic-assisted (RAS) appendectomy is currently limited, and there is a lack of studies comparing it to existing techniques.

Objectives

- To characterize and analyze the trends in appendectomy cases in the US
- To compare the conversion rates of open, laparoscopic (LAP), and robotic-assisted (RAS) appendectomy.

Methods

- A retrospective database study was conducted using the PINC AI™ (Premier) healthcare database from 2018 to 2021.
- Patients who underwent Appendectomy were identified using ICD-10 and CPT codes.
- RAS were identified from LAP and Open using ICD-10-CM code 8E0**CZ, CPT code S2900 and robotic keywords in billing descriptions.
- The conversions from LAP and RAS to Open were identified using ICD-10 conversion codes.
- A 1:1 propensity score nearest neighbor matching was conducted to compare conversion rates using the following characteristics:
 - Patient characteristics: Gender, age, Race/Ethnicity, Charlson Comorbidity Index (CCI), Body Mass Index (BMI), admission type, inpatient/outpatient type, payor, concomitant procedures
 - Hospital characteristics: bed size, urban/rural, region, teaching status, hospital volume tertiles, admission year
 - Surgeon characteristics: Surgeon specialty, surgeon volume tertiles

Results

- 324,993 appendectomy patients were identified
- LAP was the most utilized modality for all years (Fig. 1)
- RAS utilization increased 1.2 times from 1.8% to 3.3%

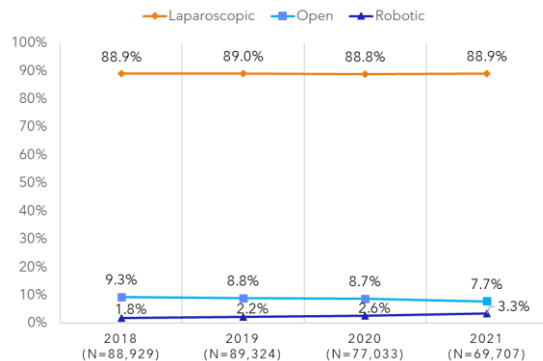


Figure 1: Appendectomy Surgical Approach by year

Abbreviations: LAP: Laparoscopic, RAS: Robotic Assisted, ICD: International Classification of Diseases, CPT: Current Procedural Terminology, BMI: Body Mass Index

Results

Table 1: Patient Characteristics at Baseline

Characteristics	LAP, N = 288,965	RAS, N = 7,870	p-value
Gender, n (%)			<0.001
Female	149,299 (51.7%)	5,444 (69.2%)	
Male	139,602 (48.3%)	2,425 (30.8%)	
Age groups, n (%)			<0.001
<18 years	825 (0.3%)	17 (0.2%)	
18-44 years	168,861 (58.4%)	3,068 (39.0%)	
45-65 years	84,025 (29.1%)	2,981 (37.9%)	
65+ years	35,254 (12.2%)	1,804 (22.9%)	
Race/Ethnicity, n (%)			<0.001
White	191,832 (66.4%)	5,441 (69.1%)	
Black	21,477 (7.4%)	745 (9.5%)	
Hispanic	44,331 (15.3%)	876 (11.1%)	
Other	15,885 (5.5%)	401 (5.1%)	
Unknown	15,440 (5.5%)	407 (5.2%)	
Charlson index category, n (%)			<0.001
CCI = 0	223,062 (77.2%)	4,506 (57.3%)	
CCI = 1	43,193 (14.9%)	1,210 (15.4%)	
CCI ≥ 2	22,710 (7.9%)	2,154 (27.4%)	
BMI category, n (%)			<0.001
BMI < 30	2,288 (0.8%)	179 (2.3%)	
BMI ≥ 40	16,501 (5.7%)	775 (9.8%)	
BMI between 30 and 39	24,576 (8.5%)	841 (10.7%)	
Unknown	245,600 (85.0%)	6,075 (77.2%)	
Admission type, n (%)			<0.001
Elective	27,022 (9.4%)	4,996 (63.5%)	
Emergency	244,633 (84.7%)	2,306 (29.3%)	
Other/Unknown	17,310 (6.0%)	568 (7.2%)	
Patient type, n (%)			<0.001
Inpatient	103,887 (36.0%)	3,992 (50.7%)	
Outpatient	185,078 (64.0%)	3,878 (49.3%)	
Payor, n (%)			<0.001
Commercial	162,363 (56.2%)	4,419 (56.1%)	
Medicaid	45,559 (15.8%)	823 (10.5%)	
Medicare	39,506 (13.7%)	1,899 (24.1%)	
Other	41,537 (14.4%)	729 (9.3%)	
Concomitant procedures			<0.001
Yes	5,189 (1.8%)	2,188 (27.8%)	

Figure 2: Emergency vs Elective Appendectomies in LAP and RAS

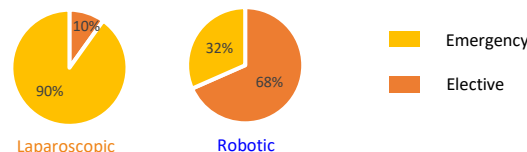
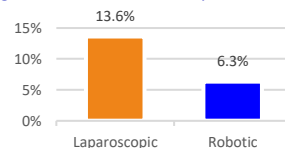


Figure 3: Conversion rates by in LAP and RAS



Results

Table 2: Hospital and Surgeon characteristics at baseline

Characteristics	LAP, N = 288,965	RAS, N = 7,870	p-value
Hospital number of beds, n (%)			<0.001
0 to 99 Beds	26,836 (9.3%)	462 (5.9%)	
100 to 199 Beds	56,818 (19.7%)	1,366 (17.4%)	
200 to 299 Beds	54,771 (19.0%)	1,282 (16.3%)	
300 to 399 Beds	45,485 (15.7%)	1,304 (16.6%)	
400 to 499 Beds	32,280 (11.2%)	854 (10.9%)	
500+ Beds	72,775 (25.2%)	2,602 (33.1%)	
Hospital urban, n (%)			<0.001
Rural	39,262 (13.6%)	416 (5.3%)	
Urban	249,703 (86.4%)	7,454 (94.7%)	
Teaching hospitals, n (%)			<0.001
Yes	116,268 (40.2%)	3,669 (46.6%)	
Provider Region, n (%)			<0.001
Midwest	65,628 (22.7%)	2,218 (28.2%)	
Northeast	42,667 (14.8%)	674 (8.6%)	
South	131,916 (45.7%)	3,588 (45.6%)	
West	48,754 (16.9%)	1,390 (17.7%)	
Hospital volume tertiles, n (%)			<0.001
Low Volume (0 - 144)	104,667 (36.2%)	2,490 (31.6%)	
Medium Volume (145 - 278)	102,627 (35.5%)	3,082 (39.2%)	
High Volume (279 - 1165)	81,671 (28.3%)	2,298 (29.2%)	
Year of admission, n (%)			<0.001
2018	79,071 (27.4%)	1,632 (20.7%)	
2019	79,496 (27.5%)	1,962 (24.9%)	
2020	68,394 (23.7%)	1,965 (25.0%)	
2021	62,004 (21.5%)	2,311 (29.4%)	
Surgeon specialty, n (%)			<0.001
Critical Care or Trauma Surgery	12,191 (4.2%)	85 (1.1%)	
Colorectal surgery	6,702 (2.3%)	645 (8.2%)	
General Surgery	221,018 (76.5%)	3,612 (45.9%)	
Others	49,054 (17.0%)	3,528 (44.8%)	
Surgeon volume tertiles, n (%)			<0.001
Low Volume (0 - 8)	96,745 (33.5%)	6,221 (79.0%)	
Medium Volume (9 - 25)	140,384 (36.1%)	947 (12.0%)	
High Volume (26 - 255)	87,836 (30.4%)	702 (8.9%)	

- More elderly patients (≥65 years) underwent RAS compared to LAP (22.9% vs 12.2%) and had a higher comorbidity index (CCI ≥2) (27.4% vs 7.9%). (Table 1 and 2)
- RAS appendectomies were less common in emergent cases (31.6% vs 90.1%) and were more common in urban hospitals (94.7% vs 86.4%)
- More inpatient surgeries were conducted by RAS (50.7% vs 36.0%) than outpatient cases and were concomitantly conducted by other surgeries (27.8% vs 1.8%)
- After propensity matching, the conversion rates to open surgery were lower for RAS compared to LAP (6.3% vs 13.6%, p<0.001). (Fig. 3)

Conclusion

- LAP appendectomy continues to be the most commonly used modality from 2018 to 2021.
- Patients undergoing RAS appendectomy were of higher age and had a higher comorbidity index.
- While RAS appendectomy rates remain low, especially for emergency appendectomies, RAS appendectomy shows promise as an alternative approach due to its lower conversion rates to open surgery.
- Further research to study clinical outcomes of RAS in appendectomy surgeries is warranted.