



Report on lung cancer surgery during COVID-19 pandemic at a high volume US institution

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Background: The impact of COVID-19 has been felt in every field of medicine. We sought to understand how lung cancer surgery was affected at a high volume institution. We hypothesized that patients would wait longer for surgery, have more advanced tumors, and experience more complications during the COVID-19 crisis.

Methods: A retrospective review was conducted, comparing pathologically confirmed non-small cell lung cancer (NSCLC) surgical cases performed in 2019 to cases performed from March to May 2020, during the height of the COVID-19 crisis. Clinical and pathologic stage, tumor size, time to surgery, follow up time, and complications were evaluated.

Results: A total of 375 cases were performed in 2019 *vs.* 58 cases in March to May 2020. Overall, there were no differences in the distribution of clinical stages or in the distribution of median wait times to surgery between groups (COVID-19 16.5 days *vs.* pre-COVID-19 17 days, $P=0.54$), nor were there differences when subdivided into Stage I-II and Stage III-IV. Case volume was lowest in April 2020 with 6 cases *vs.* 37 in April 2019, $P<0.01$. Tumor size was clinically larger in the COVID-19 group (median 2.1 *vs.* 1.9 cm, $P=0.05$) but not at final pathology. No differences in complications were observed between groups (COVID-19 31.0% *vs.* pre-COVID-19 30.9%, $P=1.00$). No patients from the COVID-19 group tested positive for the disease during their hospital stay or by the median 15 days to first follow-up.

Conclusions: Surgical wait time, pathologic tumor size, and complications were not different among patients undergoing surgery before *vs.* during the pandemic. Importantly, no patients became infected as a result of their hospital stay. The significant decrease in surgical cases is concerning for untreated cancers that may progress without proper treatment.

Keywords: COVID-19; thoracic surgery; delays of surgery

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Introduction

COVID-19 has disrupted every aspect of medical care. Thoracic oncology has been particularly affected given the virus's effects on lung tissue and the pulmonary-disease-prone patient population that lung cancer typically affects

(1,2). Importantly, delays in the treatment of non-small cell lung cancer (NSCLC) have been associated with upstaging on pathology with worsened long-term outcomes (3-5).

Our aim was to discover how COVID-19 affected lung cancer care at our institution by evaluation of key oncology

care metrics. We hypothesized specifically that patients would wait longer for surgery, have more advanced tumors, and experience more complications during the COVID-19 crisis. We present the following article in accordance with the STROBE reporting checklist (available at <https://jtd.amegroups.com/article/view/10.21037/jtd-22-5/rc>).

Methods

This study was approved by the Mass General Brigham Human Research Protection Committee (Protocol number: 2006P002482) and informed consent for this retrospective analysis was waived. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

A cohort study included all patients with pathologically confirmed NSCLC after surgery at our institution from January 1, 2019, to December 31, 2019 (pre-COVID-19 group) and March 1, 2020 to June 2, 2020 (COVID-19 group). Surgeries performed included wedge resections, segmentectomies, lobectomies, bilobectomies, and pneumonectomies for curative intent. Morbidity was graded on the Clavien-Dindo system of surgical complications; Grade II and higher were considered significant. Time to first follow-up was collected for the COVID-19 group.

Statistical analysis

Values were compared between groups using Chi-square test, Wilcoxon rank-sum test, and Fisher's exact test where appropriate. Clinical stage was compared to pathologic stage to determine up- or down-staging. All statistical tests were performed with STATA version 14 (StataCorp. 2015. *Stata Statistical Software: Release 14*. College Station, TX: StataCorp LP).

All pandemic patients had negative COVID tests preoperatively and were directed to self-quarantine from the time of their COVID test until day of surgery.

The Massachusetts Governor issued some guidance on surgery and prohibited elective surgery during portions of the pandemic. At this institution, the surgical division was asked to triage case selection due to actual and predicted bed space secondary to limited availability from staffing and inpatient beds used for COVID-19 patients. For thoracic surgery cases, presumed diagnosis was listed and then triage was done by rating multiple variables on a 0–100 scale based on urgency, with 0 being not urgent and 100 being extremely urgent. Scores were based on documentation and discussion with the treating physician; a list of these

variables is available in [Table S1](#). An overall score was tabulated and then an overall Urgency Assessment value was created. Case selection was then done on an institutional level by a multidisciplinary group, including members of the thoracic surgery faculty, and cases proceeded based on fluctuating available bed space.

Hospital protocols in place in the early phase of the pandemic were evolving but primarily consisted of limiting visitor and non-essential personnel access to the hospital, daily symptom attestation, preoperative COVID-19 testing, individual rooms for patients, and dedicated intensive care units and hospital wards for COVID-19 positive patients.

Results

In 2019, 375 operations for NSCLC were completed *vs.* 58 during the height of the COVID-19 crisis (*Table 1*). Median clinical tumor size was minimally larger during the COVID-19 era *vs.* pre-COVID-19 and though not significant, a higher proportion of clinical Stage II–IV cases were encountered during COVID-19. Median time from final clinic visit to surgery was no different between groups or divided by early stage (I and II) *vs.* late stage (III and IV); and our group found no difference in the pathologic stage distribution. Overall rate of complications and grade of complications were no different between the pre-COVID-19 group and the COVID-19 group. There were no mortalities within 90 days among the COVID-19 group (*Table 2*). COVID-19 group median first follow-up was 15 days from surgery, and no patients reported symptoms or were diagnosed with COVID-19 disease by follow-up visit.

Upon direct comparison of the peak of the COVID-19 outbreak at our institution, March through May 2020, 53 cases were done *vs.* 107 in the same time period of 2019 (*Figure 1*). A significant deceleration was only seen in April 2020. By May 2020, case volume began to return to pre-pandemic levels, but was still half that of the same time period in 2019. No significant differences were seen in staging change for March through May 2020 *vs.* the same period the year prior (*Table 3*).

Discussion

This analysis covering COVID-19 and its effects on thoracic surgery found neither longer wait times nor an increase in upstaging on final pathology. However, the volume of surgery was much lower during the worst month of the crisis than in previous years. There is a clinically

Table 1 Lung cancer case details, 2019 vs. COVID-19 surge era

Characteristic	Pre-COVID-19, n=375	COVID-19, n=58	P value
Clinical tumor size (cm)	1.9 [1.2, 2.8]	2.2 [1.5, 3.2]	0.048
Clinical stage*			0.148
Stage 1	307 (81.9)	41 (70.7)	
Stage 2	31 (8.3)	8 (13.8)	
Stage 3	32 (8.5)	7 (12.1)	
Stage 4	5 (1.3)	2 (3.4)	
Time to surgery, all (days)	17 [9, 27]	16.5 [9, 34]	0.542
Time to surgery			
Early stage I+II (days)	18 [10, 27]	17 [9, 34]	0.562
Late stage III+IV (days)	11 [6, 20]	12 [10, 27]	0.345
Pathological stage			0.058
Stage 0	17 (4.5)	4 (6.9)	
Stage 1	272 (72.5)	40 (69.0)	
Stage 2	46 (12.3)	6 (10.3)	
Stage 3	35 (9.3)	6 (10.3)	
Stage 4	5 (1.3)	2 (3.4)	
Change in stage			
Early stage I+II			0.040
Decrease	14 (4.1)	6 (12.2)	
No change	272 (80.5)	39 (79.6)	
Increase	52 (15.4)	4 (8.2)	
Late stage III+IV			0.718
Decrease	20 (54.1)	4 (44.4)	
No change	17 (45.9)	5 (55.6)	
Increase	0 (0.0)	0 (0.0)	

Data were presented in mean [IQR] or n (%). *, staging under the American Joint Committee on Cancer (AJCC) TNM Staging System for Lung Cancer, 8th Edition. IQR, interquartile range.

important difference in the numbers of patients who received operations of each stage of lung cancer despite lack of statistical significance. This study was not able to capture patients whose initial diagnosis of NSCLC was delayed, who delayed treatment due to the pandemic, or who chose against surgery as initial treatment for their NSCLC. As the pandemic continues, the decrease in operations for surgically resectable NSCLC is concerning for untreated cancers that may progress without treatment, the consequences of which we may not see for 3–5 years. The early impact of these

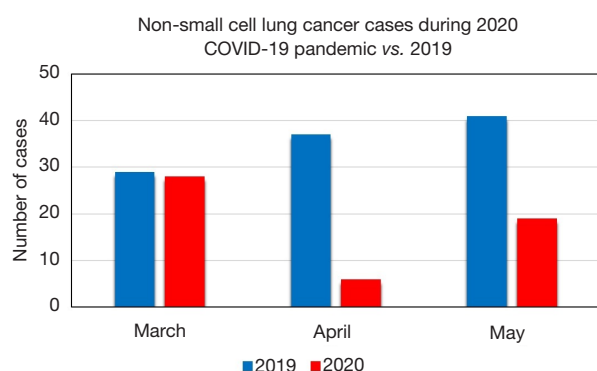
issues is already being seen with decreased screening for multiple cancers and especially for lung cancer (6,7).

Our institution benefitted from a novel triaging system that may limit the generalizability of this work, similar to other strategies reported (8,9). The system was developed to ensure timely delivery of care to our patients based on clinical stage, neoadjuvant treatment status, and need for surgery. This ensured low wait times between last clinic visit and surgery so that patients proceeded appropriately to resection. This avoidance of surgical delay is likely why

Table 2 Postoperative events & 30-60-90 day mortality, 2019 *vs.* COVID-19 surge era

Characteristic	Pre-COVID-19, n=375	COVID-19, n=58	P value
Any postop complication	116 (30.9)	18 (31.0)	1.000
Grade II*	101 (26.9)	15 (25.9)	1.000
Grade III	31 (8.3)	8 (13.8)	0.213
Grade IV	9 (2.4)	1 (1.7)	1.000
Grade V	1 (0.3)	0 (0.0)	1.000
30-day mortality	1 (0.3)	0 (0.0)	0.213
60-day mortality	3 (0.8)	0 (0.0)	1.000
90-day mortality	4 (1.1)	0 (0.0)	1.000

Data were presented in n (%). *, grade under the Clavien-Dindo classification of surgical complications.

**Figure 1** Graphical depiction of non-small cell lung cancer cases during the 2020 COVID-19 pandemic *vs.* 2019.

our downstaging, tumor size, complications, and overall distribution of cases was no different from the year before. Most importantly, none of the resected patients experienced symptoms or received a diagnosis of COVID-19 during their hospitalization or by their first follow-up.

There was a clinical—but not statistical—difference toward more advanced stages in the COVID era. This may be due to the triage system favoring advanced cases;

perhaps the result of symptomatic patients being more likely to visit the physician than asymptomatic patients, who were avoiding hospitals during this precarious time. However, this connection was not able to be ascertained due to the low case numbers, and specific outpatient details were not available in the database and were a limitation of the study.

Additional limitations to this work involve the lower number of patients, that while anticipated, obfuscate a high degree of precision in statistical comparisons of demographics and outcomes. This work was done at one institution; therefore, applicability may be limited outside similar environments.

In summary, a novel triage/scoring system for lung cancer patients may help to eliminate delays in lung cancer surgery when hospitals are forced to make system-wide adjustments to operating room availability. There was a clinical—but not statistical—difference toward more advanced stages in the COVID era. With proper precautions, definitive lung cancer treatment can be safely accomplished without incurring additional risk. However, the lower rate of surgery and the potential progression of patients who have not been assessed on time is concerning for the future.

Table 3 Lung cancer case details, March to May 2019 vs. March to May 2020

Characteristic	March–May 2019, n=107.	March–May 2020, n=53.	P value
Clinical tumor size (cm)	2.1 [1.2, 3.0]	2.2 [1.5, 3.4]	0.185
Clinical stage*			0.051
Stage 1	87 (81.3)	36 (67.9)	
Stage 2	7 (6.5)	8 (15.1)	
Stage 3	13 (12.1)	7 (13.2)	
Stage 4	0 (0.0)	2 (3.8)	
Time to surgery, all (days)	19 [9, 29]	14 [9, 30]	0.595
Time to surgery			
Early stage I+II (days)	19 [12, 30]	16.5 [8.5, 30]	0.463
Late stage III+IV (days)	9 [6, 26]	12 [10, 27]	0.228
Pathological stage			0.377
Stage 0	8 (7.5)	3 (5.7)	
Stage 1	75 (70.1)	36 (67.9)	
Stage 2	15 (14.0)	6 (11.3)	
Stage 3	9 (8.4)	6 (11.3)	
Stage 4	0 (0.0)	2 (3.8)	
Change in stage			
Early stage I+II			0.320
Decrease	7 (7.4)	5 (11.4)	
No change	70 (74.5)	35 (79.5)	
Increase	17 (18.1)	4 (9.1)	
Late stage III+IV			0.666
Decrease	8 (61.5)	4 (44.4)	
No change	5 (38.5)	5 (55.6)	
Increase	0 (0.0)	0 (0.0)	

Data were presented in mean [IQR] or n (%).*, staging under the American Joint Committee on Cancer (AJCC) TNM Staging System for Lung Cancer, 8th Edition. IQR, interquartile range.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at <https://jtd.amegroups.com/article/view/10.21037/jtd-22-5/rc>

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Data Sharing Statement: Available at <https://jtd.amegroups.com/article/view/10.21037/jtd-22-5/dss>

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <https://jtd.amegroups.com/article/view/10.21037/jtd-22-5/coif>). SJS is

a consultant for Ethicon and Covidien. The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Mass General Brigham Human Research Protection Committee (Protocol number: 2006P002482) and informed consent for this retrospective analysis was waived.

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Table S1 List of variables used to triage case priority and selection for limited operating room availability

Presumed diagnosis (Each variable below scored on a 0–100 scale based on degree of severity with 0 being not urgent and 100 being extremely urgent)

Likelihood of cancer

Aggressiveness of cancer

Neoadjuvant window impact

Impact of information on management and plan

Sepsis severity

Perforation/leak

Dyspnea

Pneumothorax

Dyspnea

Dysphagia

Hemoptysis

Hematemesis/ gastrointestinal bleed

Tamponade

Hemothorax

Effusion

Pain

Aspiration

Anxiety

Cough

Gastrointestinal reflux

Cough

Other symptom severity

Score

Urgency assessment