Droplet Exposure Risk to Providers From In-Office Flexible Laryngoscopy: A COVID-19 Simulation

Authors:
Michael J. Ye, MD[1], Dhruv Sharma, MD[1], Kolin E. Rubel, MD[1], Nicole L. Lebo, MD[1], Sarah J. Burgin, MD[1], Elisa A. Illing, MD[1], Jonathan Y. Ting, MD, MS, MBA[1], Michael G. Moore, MD[1], Jessica A. Yesensky, MD[1], Avinash V. Mantravadi, MD[1], Michael W. Sim, MD[1]

Author Affiliations:
[1]Indiana University Department of Otolaryngology – Head & Neck Surgery

Corresponding Author:
Michael J. Ye
Department of Otolaryngology – Head and Neck Surgery
Indiana University School of Medicine
1130 W. Michigan Street, Suite 400, Indianapolis, IN 46202
Telephone: 317.278.1258 | Fax: 317.274.8285| E-mail: mjye@iu.edu

Keywords: COVID-19, Coronavirus, Otolaryngology, Laryngoscopy, Flexible, Endoscopy, In-Office, Droplet, Splatter

Disclosure: The authors have no conflict of interests to disclose. This work has not been submitted for publication elsewhere.

Authorship:
Michael J. Ye, MD: Experimental design, IRB application, materials acquisition, subject recruitment, data collection, analysis, manuscript, final approval, corresponding author
Dhruv Sharma, MD: Experimental design, IRB application, materials acquisition, subject recruitment, data collection, analysis, manuscript, final approval
Kolin E. Rubel, MD: Experimental design, data collection, analysis, manuscript, final approval
Nicole L. Lebo, MD: Experimental design, data collection, analysis, manuscript, final approval
Sarah J. Burgin, MD: Experimental design, data collection, analysis, manuscript, final approval
Elisa A. Illing, MD: Experimental design, data collection, analysis, manuscript, final approval
Jonathan Y. Ting, MD, MS, MBA: Experimental design, data collection, analysis, manuscript, final approval
Michael G. Moore, MD: Experimental design, data collection, data analysis, manuscript, final approval
Jessica A. Yesensky, MD: Experimental design, data collection, analysis, manuscript, final approval
Avinash V. Mantravadi, MD: Experimental design, data collection, analysis, manuscript, final approval
Michael W. Sim, MD: Experimental design, IRB application, materials acquisition, subject recruitment, data collection, data analysis, manuscript, final approval, senior author

Funding Source: Self-funded

IRB: Approved by the Indiana University Institutional Review Board (IRB protocol #2005707046)

Words: 882/900

This is the author's manuscript of the article published in final edited form as:

Ye, M. J., Sharma, D., Rubel, K. E., Lebo, N. L., Burgin, S. J., Illing, E. A., Ting, J. Y., Moore, M. G., Yesensky, J. A., Mantravadi, A. V., & Sim, M. W. (2021). Droplet Exposure Risk to Providers From In-Office Flexible Laryngoscopy: A COVID-19 Simulation. Otolaryngology–Head and Neck Surgery, 164(1), 93–96. https://doi.org/10.1177/0194599820952800

Abstract

To provide data on risk of respiratory droplets from common otolaryngologic procedures during the COVID-19 pandemic, a novel simulation of droplet exposure from flexible laryngoscopy was performed. After completion of a nasal symptom questionnaire, topical fluorescein spray was administered into the nasal and oropharynx of 10 healthy volunteers who then underwent flexible laryngoscopy under two conditions: 1) routine without provoked response and 2) with prompted sneeze/cough. After each, droplets on the proceduralist and subject were counted under ultraviolet-A light. Droplets were observed on 1 of 10 subjects after routine laryngoscopy and 4 of 10 during laryngoscopy with sneeze/cough. A nasal symptom score based on congestion and rhinorrhea was significantly elevated among droplet producers after sneeze/cough ($p=0.0164$). No droplets were observed on the provider. Overall, with adequate personal protective equipment, flexible laryngoscopy poses minimal droplet risk to providers. Nasal symptoms can identify patients more likely to produce droplets after sneeze/cough.

Introduction

The highly contagious Coronavirus 2019 (COVID-19) has resulted in a global pandemic and heightened concern for viral transmission from healthcare procedures. This is particularly pertinent in otolaryngology, as contact with the upper respiratory mucosa procedures may be high risk due to high viral load in COVID-19 patients.[1-3] As respiratory droplets are a major mode of transmission,[4] this novel simulation of droplet exposure from flexible laryngoscopy was performed.

Materials and Methods

The study was approved by the Indiana University Institutional Review Board (IRB protocol #2005707046).

Using an atomizer-tipped syringe, 1.5 mL of 0.1% fluorescein solution was administered into each nostril and the oropharynx of ten healthy volunteers (0.5 mL per site). As fluorescein fluoresces yellow under ultraviolet A (UV-A) light, and blue materials do not, blue surgical gowns were used as background. The proceduralist wore a blue surgical gown and transparent face shield. Subjects wore a surgical gown without face shield. The safety and efficacy of similar designs in quantifying droplet splatter for endonasal and other otolaryngologic procedures are established in the literature.[5-10]

Laryngoscopy was performed using a standard flexible fiberoptic laryngoscope without suction or insufflation within two minutes of fluorescein administration. With the subject seated, the practitioner performed the flexible laryngoscopy in the standard fashion

through the less obstructed nasal cavity, visualizing via the eyepiece without a monitor view. During each instance of laryngoscopy, the larynx was visualized, and the subject was asked to protrude the tongue, phonate /e/, and puff out the cheeks.

The following experimental conditions were conducted: 1) routine flexible laryngoscopy and 2) flexible laryngoscopy with prompted sneeze/cough. Prior to each condition, garments worn by the subject and proceduralist were assessed for droplets and replaced if fluorescence was observed. After laryngoscopy, the practitioner and subject were examined for droplets. The provider's facemask was removed and laid flat against a blue background for examination. If droplets were seen, the distance from the nasal tip was measured, and gowns were laid flat under a grid of transparent 1x1 cm squares. Squares containing droplets were counted as positive using the chest, arms, and legs as predefined zones. All measurements were done by two independent observers under UV-A flashlight in a dark room.

Each subject completed a nasal symptom questionnaire on symptoms of congestion and rhinorrhea. These symptoms were rated 1-5 (1 = not at all; 2 = less than half the time; 3 = 50-75% of the time; 4 = 75%-99% of the time; 5 = 100% of the time). These ratings were summated into a combined nasal symptom score (range 2-10). Subjects were separated into droplet producing and non-producing groups based on the sneeze and cough condition. Symptom scores were compared between these groups using a Student's *t test*.

Results

Fluorescence under UV-A flashlight was confirmed on the laryngoscopy following endoscopy on all subjects **[Figure 1a]**. Droplets were identified on one of ten subjects after routine laryngoscopy, with one droplet observed on the leg ipsilateral to the endoscope. Four of ten subjects produced droplets after the sneeze/cough condition, distributed contralateral to the side of the endoscope downward from the nare onto the chest and legs **[Figure 1b/c]**. Distance ranged from 20.3-71.1 cm from the nasal tip. Droplet size ranged from <0.5-12.5 mm. No droplets were observed on the provider's arms, chest, legs, or facemask in any condition **[Table 1]**. Droplet producers had a higher combined nasal score (mean = 7) compared to non-droplet producers (mean = 3.17; p = 0.0164) **[Table 2]**.

Discussion

During routine laryngoscopy, the generation of one isolated droplet out of ten trials indicates that laryngoscopy without sneeze/cough response poses minimal droplet risk. The four of ten subjects who produced droplets after the sneeze/cough condition deposited droplets downward from the nares and contralateral to the laryngoscope, possibly due to a barrier effect from the endoscope. No droplets were seen on the provider in any condition. Based on these findings, we recommend that during laryngoscopy, practitioners should stand ipsilateral to endoscope when possible. Providers may consider gowning and draping patients in order to prevent transportation of droplets outside the clinic room after the procedure.

A nasal symptom score was higher in droplet producers compared to non-producers ($p = 0.0164$). Due to this, providers may consider deferring endoscopy for patients reporting nasal symptoms. For patients whose laryngoscopy cannot be deferred due to concern for urgent conditions or with chronic nasal complaints that are unlikely to improve over time, endoscopy should be performed with special care and droplet precautions.

There are several limitations to this study. Only fluorescent droplets visible to the human eye were measured. Quantification smaller aerosolized particles would require the use of an optical particle sizer. The risk of viral transmission posed by each droplet remains unclear. We also recommend interpreting the results of the simulated sneeze and cough with caution, as the droplet spread may be different with a true sneeze and/or cough. No differentiation between cough and sneeze was made in our experimental design and may be the subject of further investigation. Although we report the largest cohort in the literature, the sample size remains small with ten subjects.

Conclusion

With adequate precautions and personal protective equipment, in-office flexible laryngoscopy poses minimal droplet risk to providers. A nasal symptom score based on congestion and rhinorrhea was significantly elevated among patients who produced droplets after sneeze/cough.

References

1. Lu D, Wang H, Yu R, Yang H, Zhao Y. Integrated infection control strategy to minimize nosocomial infection of coronavirus disease 2019 among ENT healthcare workers. *J Hosp Infect*. 2020;104(4):454-5. Epub 2020/03/03. doi: 10.1016/j.jhin.2020.02.018. PubMed PMID: 32114056; PubMed Central PMCID: PMCPMC7124261.

2. Zou L, Ruan F, Huang M, Liang L, Huang H, Hong Z, et al. SARS-CoV-2 Viral Load in Upper Respiratory Specimens of Infected Patients. *N Engl J* Med. 2020;382(12):1177-9. Epub 2020/02/20. doi: 10.1056/NEJMc2001737. PubMed PMID: 32074444; PubMed Central PMCID: PMCPMC7121626.

3. Vukkadala N, Qian ZJ, Holsinger FC, Patel ZM, Rosenthal E. COVID-19 and the Otolaryngologist: Preliminary Evidence-Based Review. *Laryngoscope*. 2020. Epub 2020/03/29. doi: 10.1002/lary.28672. PubMed PMID: 32219846.

4. Fehr AR, Perlman S. Coronaviruses: an overview of their replication and pathogenesis. *Methods Mol Biol*. 2015;1282:1-23. Epub 2015/02/28. doi: 10.1007/978-1-4939-2438-7_1. PubMed PMID: 25720466; PubMed Central PMCID: PMCPMC4369385.

5. Saafan ME, Ragab SM, Albirmawy OA. Topical intranasal fluorescein: the missing partner in algorithms of cerebrospinal fluid fistula detection. *Laryngoscope*. 2006;116(7):1158-61. Epub 2006/07/11. doi: 10.1097/01.mlg.0000217532.77298.a8. PubMed PMID: 16826052.

6. O'Goshi K, Serup J. Safety of sodium fluorescein for in vivo study of skin. *Skin Res Technol*. 2006;12(3):155-61. Epub 2006/07/11. doi: 10.1111/j.0909-752X.2006.00147.x. PubMed PMID: 16827689.

7. Workman AD, Welling DB, Carter BS, Curry WT, Holbrook EH, Gray ST, et al. Endonasal instrumentation and aerosolization risk in the era of COVID-19: simulation, literature review, and proposed mitigation strategies. *Int Forum Allergy Rhinol*. 2020. Epub 2020/04/04. doi: 10.1002/alr.22577. PubMed PMID: 32243678.

8. Sharma D, Rubel KE, Ye MJ, Campiti VJ, Carroll AE, Ting JY, et al. Cadaveric Simulation of Otologic Procedures: An Analysis of Droplet Splatter Patterns During the COVID-19 Pandemic. *Otolaryngol Head Neck Surg*. 2020:194599820930245. Epub 2020/05/20. doi: 10.1177/0194599820930245. PubMed PMID: 32423287; PubMed Central PMCID: PMCPMC7240315.

9. Sharma D, Rubel KE, Ye MJ, Shipchandler TZ, Wu AW, Higgins TS, et al. Cadaveric Simulation of Endoscopic Endonasal Procedures: Analysis of Droplet Splatter Patterns During the COVID-19 Pandemic. *Otolaryngol Head Neck Surg*. 2020:194599820929274. Epub 2020/05/20. doi: 10.1177/0194599820929274. PubMed PMID: 32423283; PubMed Central PMCID: PMCPMC7240308.

10. Li Y, Guo YP, Wong KC, Chung WY, Gohel MD, Leung HM. Transmission of communicable respiratory infections and facemasks. *J Multidiscip Healthc*. 2008;1:17-27. Epub 2008/01/01. doi: 10.2147/jmdh.s3019. PubMed PMID: 21197329; PubMed Central PMCID: PMCPMC3004550.

Table 1: Droplet Splatter Results

Subject	S Chest	S Legs	P Chest	P Legs	P Arms	P Shield
1	0 (R); 4 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)
2	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)
3	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)
4	0 (R); 22 (SC)	0 (R); 147 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)
5	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)
6	0 (R); 0 (SC)	1 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)
7	0 (R); 11 (SC)	0 (R); 28 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)
8	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)
9	0 (R); 1 (SC)	0 (R); 2 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)
10	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)	0 (R); 0 (SC)

Droplet density measured by number of squares containing droplets on 1x1 cm grid covering each measured subsite. S = Subject; P = Provider; R = Routine Laryngoscopy; SC = Laryngoscopy with Sneeze and Cough

Table 2: Nasal Symptoms are Predictive of Droplet Productivity on Sneeze or Cough

Subject	Congestion Score	Rhinorrhea Score	Combined Nasal Score	Productive Sneeze or Cough Y/N (Laterality)
1	5	5	10	Y (Contralateral)
2	1	1	2	N
3	1	1	2	N
4	4	4	8	Y (Contralateral)
5	2	1	3	N
6	3	1	4	Y (Contralateral)
7	2	1	3	N
8	1	2	3	N
9	3	3	6	Y (Contralateral)
10	3	3	6	N

Congestion and rhinorrhea scored by participants from 1-5 depending on frequency of symptoms (1 = not at all; 5 = all the time). Combined nasal score is the sum of these numbers. Final column denotes those with droplet productivity in the sneeze and cough condition with laterality if applicable.

Figure Legends

Figure 1: a) Fluorescence seen on endoscope after retraction. b and c) Droplets on subject's chest and leg after the sneeze and cough condition (marked with arrows). These were distributed contralateral to the nasal cavity under examination (right side).

Figure

Click here to access/download;Figure;Figure 1.tif