


Preoperative SARS-CoV-2 Screening Fails to Detect Viral Particles Prior to Airway Surgery

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Objectives/Hypothesis: Children have higher rates of asymptomatic SARS-CoV-2 infections or milder courses of infection, and their carrier status may potentially impact viral transmission to those providing them care. The aim of this study is to compare the existing COVID-19 preoperative screening protocols to the detection of SARS-CoV-2 viral particles in surgical samples.

Study Design: Cross-sectional study.

Methods: We conducted a prospective study with consecutive convenience sampling of children undergoing adenoidectomy between January and April 2021. Total nucleic acid was extracted from adenoid tissue and real-time reverse transcription-polymerase chain reaction was conducted to test for the presence of SARS-CoV-2 viral particles. Univariate logistic regression was used to summarize the effect size of variables of interest on the odds of having SARS-CoV-2 positive adenoid tissue.

Results: Forty adenoid samples were collected and 11 (27.5%) had a positive SARS-CoV-2 reverse transcriptase-polymerase chain reaction. Patients with positive adenoids were older (11.8 vs. 7.9 years, odds ratio: 1.3, $P = .01$) and more likely to have had a positive nasopharyngeal swab in the previous 90 days (4/11 or 36% vs. 0).

Conclusion: These data are the first report on the presence of SARS-CoV-2 particles in pediatric adenoidectomy specimens, with a high percentage of patients showing evidence of viral particles within the adenoid. This finding calls in to question the utility of preoperative COVID screening protocols which have yet to be rigorously validated in asymptomatic patients and have the potential to delay patients' surgical care.

Key Words: Child, COVID-19, SARS-CoV-2, adenoidectomy.

Level of Evidence: 3

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INTRODUCTION

SARS-CoV-2 appears to be more infectious and is associated with increased disease severity as well as higher mortality rate in comparison to other novel respiratory illness outbreaks such as SARS in 2003, H1N1 in 2009, or MERS in 2012.¹ Children have higher rates of asymptomatic SARS-CoV-2 infections or milder courses of infection,^{2–4} and their carrier status may potentially impact viral transmission to those providing them care. Early in the pandemic, concerns over disease transmission led to postponement of

surgical care especially in cases involving manipulation of the airway. With widespread availability of nasopharyngeal swab (NPS) reverse transcriptase-polymerase chain reaction (RT-PCR), hospitals resumed nonemergent surgical cases for children with a documented negative SARS-CoV-2 test within 72 hours of surgery. Research has demonstrated that asymptomatic children have significantly lower upper respiratory viral load than symptomatic children, which may further impact the reliability of nasal swab testing in such patients.^{5,6}

Prior to the COVID-19 pandemic, surgical adenoid samples obtained by otolaryngologists have been reported to have the highest sensitivity in the detection of respiratory viruses including coronavirus strains.⁷ This is hypothesized to be due to higher precision sampling afforded by surgical guidance. The aim of this study is to better understand the reliability of COVID-19 preoperative screening protocols by comparing detection of viral particles from preoperative NPS RT-PCR to surgical adenoidectomy specimens.

METHODS

We conducted a prospective study with consecutive convenience sampling of children undergoing adenoidectomy between January and April 2021. All but one included surgery was conducted prior to vaccine eligibility and availability for their respective age groups in Los Angeles, California (April 14, 2021

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for 16 years of age or older and May 10, 2021 for 12 years of age or older). One patient was over 16 years of age with a surgery date after April 14, 2021, and there was no indication of COVID vaccination in the preoperative anesthesia evaluation. This study was approved by the Children's Hospital Institutional Review Board, with written permission obtained from all parents/guardians and written assent from children over the age of 7.

Asymptomatic children were permitted to undergo elective surgery if they met the following criteria: Negative SARS-CoV-2 NPS (via CHLA Clinical Virology laboratory PCR tests as described below) within 72 hours of surgery, or if SARS-CoV-2 positive greater than 11 days but less than 90 days and asymptomatic, as per CDC guidelines⁸ (presumed resolved infection). All preoperative NPS samples were obtained by hospital nurses with specific training in proper NPS sampling technique. All patients underwent adenoidectomy for treatment of sleep-disordered breathing. After adenoid excision, study staff sectioned a portion of adenoid tissue into sterile saline for SARS-CoV-2 RT-PCR testing by the CHLA Clinical Virology laboratory, a CLIA certified laboratory responsible for all clinical SARS-CoV-2 testing at the hospital. Testing on adenoid tissue was performed as a research use only test with a turn-around time of 24 to 48 hours; however, the same extraction and PCR methodologies utilized in this study have been previously validated for clinical use. Strict measures were in place to minimize the risk of contamination. Total nucleic acid was extracted using the NucliSENS easyMag (bioMérieux, Durham, North Carolina). Real-time RT-PCR was conducted using either the CDC 2019-Novel Coronavirus Real-Time RT-PCR assay or the TaqPath COVID-19 Combo Kit (Thermo Fisher Scientific). Internal validation of both assays in the clinical laboratory from NPS demonstrated comparable sensitivity and specificity. The remainder of the adenoid sample was sent to clinical pathology for routine examination. Operating room staff were not tested for COVID-19 as part of this research and hospital protocol did not require testing after positive adenoid specimen results in this study.

Data collected from medical records included age, sex, race, and insurance status, as well as any documented SARS-CoV-2 testing from the previous 12 months. Follow-up data were not collected as part of this study; however, all patients were managed via our standard protocol of a 6-week postoperative visit, and no patients had any reported severe peri-operative respiratory adverse events. Body mass index (BMI) was calculated from height, weight, sex, and age at the time of surgery following the CDC growth chart percentiles for patients ≥ 24 months.⁹ We then converted the BMI values to *z*-scores and categorized as follows: Less than -2.0 wasted, -2.0 to 1.0 normal, greater than 1.0 to 2.0 risk of overweight, and greater than 2.0 overweight or obese. We created a categorical variable comparing overweight or obese

children to normal or risk of overweight. There were no children in the wasted category in our cohort. Univariate logistic regression was used to summarize the effect size for variables of interest on the odds of having positive adenoid tissue, and a *P*-value of $\leq .05$ was considered statistically significant. Due to the small sample size, multivariate regression analyses were not conducted. Study data were collected and managed using REDCap electronic data capture tools hosted at University of Southern California, Keck School of Medicine, and analyzed with STATA v13.1 (StataCorp, College Station, Texas).^{10,11}

RESULTS

Forty adenoid samples were collected from patients ranging in age from 2 to 16.5 years (mean 8.9 years). Eleven (27.5%) had a positive SARS-CoV-2 RT-PCR from adenoid tissue obtained during surgery. There were no differences between those with and without positive adenoids and sex, BMI, race, nor insurance type (Table I). Of the 36 patients with a negative preoperative NPS, 7 (19.4%) had positive adenoids (Fig. 1). The remaining 4 (15%) patients with SARS-CoV-2 positive adenoid tissue had documented positive SARS-CoV-2 NPS within 90 days of surgery and did not undergo preoperative COVID screening (Fig. 1). Patients with positive adenoids were older (11.8 vs. 7.9 years, odds ratio [OR]: 1.3 *P* = .01) and more likely to have had a positive NPS in the previous 90 days (4/11 or 36% vs. 0, Table I).

DISCUSSION

Preoperative COVID testing protocols are intended to ensure safe environments for healthcare workers. Our findings constitute the first report of adenoid tissue testing as a means of validating NPS sampling. As there is a large presence of SARS-CoV-2 virus in the nasopharynx,^{5,12,13} this pilot study highlights the potential persistence of this virus in airway tissue, despite a negative NPS. Even with the use of a screening protocol, 27.5% of patients admitted to the operating room in this study had a positive SARS-CoV-2 PCR from adenoid tissue, and 64% of those had a negative NPS test within 72 hours of surgery. This result resonates with other published literature indicating poor clinical sensitivity of NPS testing.^{12,14,15}

TABLE I.

Comparison of Subject Characteristics Between Those With Positive SARS-CoV2 Adenoid Tissue Test (+adenoid), and Those With Negative SARS-CoV2 Adenoid Tissue (–Adenoid).

	(+)Adenoidn = 11	(–)Adenoidn = 29	OR	<i>P</i> -Value	95% CI
Female sex	3 (27)	10 (34)	1.4	0.67	0.3, 6.5
Age in years, mean (standard deviation)	11.8 (3.3)	7.9 (3.7)	1.3	0.01	1.1, 1.7
Overweight or obese	9 (82)	14 (48)	4.8	0.07	0.9, 26.3
Public insurance	10 (91)	23 (79)	2.6	0.4	0.3, 24.6
Hispanic	6 (55)	11 (38)	1.96	0.3	0.5, 8.0
Positive test in previous 3 months	4 (36)	0	1.0	N/A	N/A

All values listed a n(%) unless otherwise specified. Unadjusted odds ratios (OR) and 95% confidence intervals (CI) reported from univariate tests.

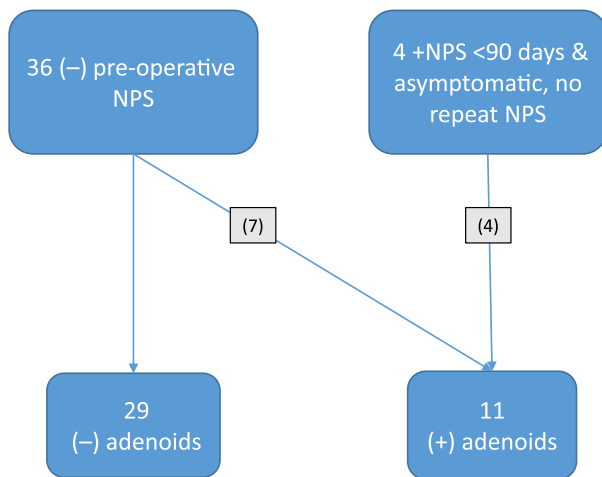


Fig. 1. Flow chart of pre-operative nasopharyngeal swab (NPS) reverse transcriptase-polymerase chain reaction (RT-PCR), and postoperative SARS-CoV-2 RT-PCR positive adenoid tissue (“+adenoids”). [Color figure can be viewed in the online issue, which is available at www.laryngoscope.com.]

We found older children and those with higher BMI percentiles potentially more likely to have SARS-CoV-2 positive adenoid tissue. There have been mixed reports of differing rates of infections among different age groups. Shane et al.² describe higher rates of positivity in older age groups, while some studies out of China have indicated more similarity in rates between young children and adolescents.¹⁶ The increased adenoid positivity rate in our study may simply be indicative of increased social interactions of adolescents, as opposed to any increased vulnerability to disease of older children. Obesity has been reported to be more common in children hospitalized with severe disease,^{17,18} however, the connection between obesity and susceptibility to infection is unclear. Additionally, previous literature supports respiratory viruses contributing to lymphoid tissue enlargement¹⁹ but the unique role of SARS-CoV-2 in inducing enlargement of adenoid tissue is yet not known.

The precise clinical significance of a positive test obtained from tissue sampling is unknown. Additionally, viral cultures were not performed so it is unknown if the presence of RNA correlated with the presence of actively replicating virus. However, NPS testing similarly does not test for truly viable and infectious particles. As a pilot study, this report is limited by its small sample size, and we are unable to report the true incidence of SARS-CoV-2 in pediatric adenoid tissue as any child with a positive NPS did not have surgery. There is also a small window of opportunity where patients may have become newly infected before surgery, but after their screening NPS.

Even with an aerosolizing procedure such as adenoidectomy and imperfect COVID screening protocols, no outbreaks within operating room staff at our institution were reported during weekly pandemic updates, potentially indicating a low risk of SARS-CoV-2 transmission from asymptomatic patients. The SARS-CoV-2 detected in both preoperative screening NP swabs and surgical samples may represent viral RNA fragments from past COVID-19 infections, further pointing toward a low risk for transmission.

CONCLUSION

These data are the first report on the presence of SARS-CoV-2 particles in pediatric adenoidectomy specimens, with a high percentage of patients showing evidence of viral particles within the adenoid. This finding calls in to question the utility of preoperative COVID screening protocols which have yet to be rigorously validated in asymptomatic patients and have the potential to delay patients’ surgical care. Future studies addressing the gap in knowledge of the population incidence of SARS-CoV-2 positive tissues and the transmission risk and clinical implications are warranted.

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