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Technical note

How to perform a nasopharyngeal swab in adults and children in the COVID-19 era

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ABSTRACT

The nasopharyngeal swab is currently the main testing method used to diagnose COVID-19. The principle is to collect respiratory cells infected by the virus and to use the RT-PCR (Reverse Transcription - Polymerase Chain Reaction) technique to detect the RNA of the virus. The false negative rate is high, about 30%, which can mainly be explained by an incorrect execution of the technique may increase the false negative rate and decrease the test's sensitivity. The aim of this note is to help healthcare providers to perform this test correctly in adults and children.

1. Introduction

Previously, the nasopharyngeal swab was routinely used to diagnose viral upper respiratory tract infections in adults and children, but generally, the test was performed in hospitalized symptomatic patients by experienced caregivers. Currently, all over the world, the public health strategy during this COVID-19 pandemic is based on an early detection of suspicious cases, an early diagnosis of symptomatic patients, and isolation of patients with COVID-19 in order to contain the outbreak.

In this context the nucleic acid testing on nasopharyngeal swab has been performed on a massive scale and the training of the testing teams has often been hasty in response to the sheer scale of the needs. Training has sometimes been limited to watching educational videos (on YouTube® https://www.youtube.com/watch?v=mzs9c37N9RY, https://www.youtube.com/watch?v=syXd7kgLSN8, and also published in the NEJM) [1]. However, proper sample collection is the most important step in the laboratory diagnosis of infectious diseases. A sample that is not collected correctly may lead to false negative test results and have dire consequences. In other word, it's crucial to know how to collect the sample properly to decrease the false negative rate of nasopharyngeal SARS-CoV-2 RT-PCR regarding its important implication [2].

2. Technique

Before talking about the technique itself it is important to specify that the testing has to be performed in special room with strict sterilization of the entire environment to avoid the spread of the virus due to aerosolization. The testing personnel are required to wear personnel protective equipment (PPE) including FFP2 (N95) mask (or higher level), disposable cap, goggles, gown, apron, latex gloves and shoe covers. Before proceeding to the sampling, a brief explanation of the process is necessary to reassure the patient and to improve collaboration during the test. Brief past medical history should be obtained to identify any contra-indications to the test (any pathology or medication with high risk of epistaxis) or information to facilitate the sample (better air flow on one side for example indicating a wider nasal cavity). Patients should also be informed that the procedure is uncomfortable and can induce watering eyes. Two techniques can be used, the nasopharyngeal swab or nasopharyngeal wash/aspiration for young children.

3. The nasopharyngeal swab

Installation: the patient should be sitting with the head straight and not tilted to one side. In this position it's easier to follow the nasal floor, which is perpendicular to the axis of the face. It may be useful to ask the patient to rest their head on the chair's head support, to limit a reflex backwards movement of the head during the swab. Children are sat on their parents' knees who should have one palm on the forehead the other hand around both arms.

Adult patients should be wearing a surgical mask but also children old enough to do so (usually from 5–6 years old). Patients

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should position the mask just under the nose to cover the mouth, to protect from droplets in case of coughing or sneezing caused by the swab. In case of important rhinorrhoea, the patient should be asked to blow their nose prior to the test. The caregiver should be positioned on the side of the patient to limit exposure to droplet projections.

Then, the tip of the nose should be lifted to identify the area where the swab should be gently inserted. The swab should be held like a pen. The key point is to have two fulcrums (the nasal floor and the nasal septum) that guide the progression of the swab through the nasal cavity until a resistance is encountered indicating contact with the posterior wall of the nasopharynx. As such, the inclination of the swab should be in the same plane as that of the nose and the ear. The distance between the nostril and posterior wall of the nasopharynx is between 8 and 10 cm in adults. In the child, the nasal cavity is slightly shorter (6–7 cm). Usually there is a mark on the tip of the swab that indicates the right length to be inserted (although it is not always present). Gently rub and roll the swab. Leave the swab in place for several seconds to absorb secretions. Slowly remove the swab while continuing to rotate it. If the tip of the swab is inserted without following these two anatomical marks, the inferior or middle turbinate may be scraped which is painful limits the progression to the nasopharynx.

It's not necessary to collect samples from both sides if the tip is saturated with fluid from the first collection. If a deviated septum or blockage renders testing difficult or impossible on one side, the same swab may be used to obtain a sample from the nasal fossa. After the sample is made, the swab should be inserted in the sample tube, and the shaft snapped off to close the tube.

4. Nasopharyngeal wash/aspiration

The installation is identical. For babies the sample may be performed in supine position. The caregiver should also be positioned on the baby's side to limit exposure to droplet projections. A few drop of non-bacteriostatic saline (PH 7.0) maybe instilled into each nostril before testing. Nasopharyngeal secretions are aspirated through a catheter or probe, connected to a mucus trap and fitted to a vacuum source. The catheter is inserted into the nostril parallel to the nasal floor and should reach the nasopharynx. The vacuum is applied and the catheter is slowly withdrawn with a rotating motion. If the aspirated sample is in fact limited to the probe or catheter, a small quantity of sterile saline may be aspirated to bring the fluid into the tube. The sample is placed in a sterile viral transport media tube, as described in the following article "Centers for Disease Control and Prevention. Interim Guidelines for Collecting, Handling, and Testing Clinical Specimens from Persons for Coronavirus Disease 2019 (COVID-19)" (https://www.cdc.gov/coronavirus/2019-ncov/lab/guidelines-clinical-specimens.html).

5. Discussion

The nasal epithelium is an entry point for the initial infection and an important transmission point of SARS-CoV-2 as in other viral upper tract respiratory infections. Cellular entry of coronavirus depends on the binding of spike (S) protein by cellular proteases. SARS-CoV-2 uses ACE2 as a receptor for cellular entry. The binding affinity of the S protein and ACE2 was found to be major determinant of SARS-CoV-2 replication rate and disease severity [3]. The sample is obtained deep in the nose and in the nasopharyngeal area because the expression of ACE 2 receptors there is higher than in the proximal part of the nose. However, it is not easy for untrained caregivers to reach the nasopharynx. Qian et al. from Wuhan published their strategy of nasopharyngeal specimen collection [2]. According to their experience, one of the key points is the training of professional testers (nurses), the standardization of the method and process for swab collection.

Despite the important number of publications concerning COVID-19 in the past months, there are still a lot of questions without answers. One of them is the possible replication of the SARS-CoV-2 in the adenoid tissue. The study published in Nature medicine by Sungnak and al. [3] showed that SARS-CoV-2 entry factors are highly expressed in nasal epithelial cells especially in nasal secretory cells and ciliated cells. The adenoid tissue has not been tested but lymphocytes do not express these SARS-CoV-2 entry factors. It is important to clear this point concerning children because a correctly done test is in effect an adenoid swab.

Regarding to the drawbacks of the nasopharyngeal swab sample collection method (its sensitivity, unpleasant experience for the patient, personal protective equipment (PPE) required for collectors) others sample techniques are being studied. Yale University researchers have performed RT-PCR on self-collected throat washing samples (which should be differentiated from the oropharyngeal swab that concerns only the posterior wall of pharynx and tonsillar areas and that is less effective [4]). Their findings suggest that saliva samples could be used for at-home coronavirus tests on a large scale nationally. This hypothesis is supported by the study of Xu et al. that demonstrates high ACE2 receptor expression in the epithelial cells of the oral mucosa and the base of the tongue [5]. The results are very encouraging, this sample method gives results that are at least as accurate as nasopharyngeal swabs, which are still much more commonly used for COVID-19 screening in the United States [6]. If confirmed, saliva could be a promising option for mass-testing of the SARS-CoV-2: a minimally invasive, reliable and reproducible test. On the 8th May 2020 the salivary test has been approved by the Food and drug Administration.

Management of the child in the COVID-19 era follows specific guidelines [7], and the preferred testing technique depends on who performs the test. Nurses are comfortable with nasal aspiration because this technique is used routinely in paediatric departments to diagnose viral upper respiratory tract infection, such as the VRS infection. However, we still do not know if this technique is as reliable as a nasopharyngeal swab. If a trained caregiver is performing the test, a nasal pharyngeal swab may be done even in young children. The age limit may be determined by the comprehension and the collaboration of the child. Fixed 50% nitrous oxide oxygen mixture may help and a local anaesthetic spray may also be used if the child is 6 years old or over. It is interesting to notice that in Chinese publications the nasopharyngeal swab has been the gold standard method for diagnosis even for children [2]. In the younger children, an anal swab is also being studied. It is can be easily done and its effectiveness has already been shown as SARS-CoV-2 remains for a long period in faecal samples [8,9]. Also, epidemiological data suggests that children are poor vectors of SARS-CoV-2 and are rarely infected, thus indications for virologic testing are far more limited than in adults [10,11], also described in this Australian study "National Center for Immunisation Research and Surveillance. COVID-19 in schools – the experience in NSW" (http://ncirs.org.au/sites/default/files/2020-04/NCIRS%20NSW%20Schools%20COVID_Summary_FINAL%20public_26%20April%202020.pdf).

6. Conclusion

COVID-19 diagnosis is key to prevent the spread of the SARS-CoV-2 and to date the nasopharyngeal swab remains the most widely used and validated technique. Its two main drawbacks are its technicality and painfulness. Well-trained testing teams should help increase the sensitivity of the test and make it less unpleasant.

Disclosure of interest

The authors declare that they have no competing interest.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.anorl.2020.06.001.

References

[1] Marty FM, Chen K, Verrill KA. How to obtain a nasopharyngeal swab specimen. N Engl J Med 2020;382:e76, http://dx.doi.org/10.1056/NEJMvcm2010260.
[2] Qian Y, Zeng T, Wang H, et al. Safety management of nasopharyngeal specimen collection from suspected cases of coronavirus disease 2019. Int J Nurs Sci 2020;7:153–6, http://dx.doi.org/10.1016/j.ijnss.2020.03.012.
[3] Sungnak W, Huang N, Bécavin C, et al. SARS-CoV-2 entry factors are highly expressed in nasal epithelial cells together with innate immune genes. Nat Med 2020;26:681–7, http://dx.doi.org/10.1038/s41591-020-0868-6.
[4] Wang X, Tan L, Wang X, et al. Comparison of nasopharyngeal and oropharyngeal swabs for SARS-CoV-2 detection in 353 patients received tests with both specimens simultaneously. Int J Infect Dis 2020;94:107–9, http://dx.doi.org/10.1016/j.ijid.2020.04.023.
[5] Xu H, Zhong L, Deng J, et al. High expression of ACE2 receptor of 2019-nCoV on the epithelial cells of oral mucosa. Int J Oral Sci 2020;12:8, http://dx.doi.org/10.1038/s41368-020-0074-x.
[6] Wyllie AL, Fournier J, Casanovas-Massana A, et al. Saliva is more sensitive for SARS-CoV-2 detection in COVID-19 patients than nasopharyngeal swabs. medRxiv 2020, http://dx.doi.org/10.1101/2020.04.16.20067835.
[7] Leboulanger N, Sagardoy T, Akkari M, et al. COVID-19 and ENT Pediatric otolaryngology during the COVID-19 pandemic. Guidelines of the French Association of Pediatric Otorhinolaryngology (AFOP) and French Society of Otorhinolaryngology (SFORL). Eur Ann Otorhinolaryngol Head Neck Dis 2020, http://dx.doi.org/10.1016/j.anorl.2020.04.010.
[8] Kipkorir V, Cheruiyot I, Ngure B, et al. Prolonged SARS-CoV-2 RNA Detection in Anal/Rectal Swabs and Stool Specimens in COVID-19 Patients After Negative Conversion in Nasopharyngeal RT-PCR Test. J Med Virol 2020, http://dx.doi.org/10.1002/jmv.26007.
[9] Li J, Feng J, Liu T-H, et al. An infant with a mild SARS-CoV-2 infection detected only by anal swabs: a case report. Braz J Infect Dis 2020, http://dx.doi.org/10.1016/j.bjid.2020.04.009.
[10] Danis K, Epaulard O, Bénet T, et al. Cluster of coronavirus disease 2019 (Covid-19) in the French Alps, 2020. Clin Infect Dis 2020, http://dx.doi.org/10.1093/cid/ciaa424.
[11] Gudbjartsson DF, Helgason A, Jonsson H, et al. Spread of SARS-CoV-2 in the Icelandic Population. N Engl J Med 2020;382:2302–15, http://dx.doi.org/10.1056/NEJMoa2006100.