Iyer, A. , Tikka, T., Calder, N., Qamar, S. N. and Chin, A. (2020) Effect of personal protection equipment (PPE) and the distance from the eye piece of surgical microscope on the field of vision; an experimental study. *Otology and Neurotology*, (doi: 10.1097/mao.0000000000002989)

Abstract

Background

During the Covid-19 pandemic, otolaryngologists are at risk due to aerosol-generating procedures such as mastoidectomy and need enhanced personal protective equipment (PPE). Eye protection can interfere with the use of a microscope due to a reduction in the field of vision. We aimed to study the effect of PPE on the microsurgical field.

Methods

Five surgeons measured the visual field using digital calipers at different power settings. They were done with no PPE, a surgical mask, FFP3 mask (N99) and with the addition of small goggles, large vistamax goggles, vistamax plus a face shield, and only a face shield. The measurements were repeated with rings of 5 mm increments. We also measured the "eye relief" of the microscope which is the ideal distance for maximum field of view.

Results

There was no major reduction of the field with the surgical or FFP3 mask. But even simple goggles reduced the field up to 31.6% and there were progressive reductions of up to 75.7% with large goggles, 76.8% when a face shield was added and 61.9% when only face shield was used. The distance rings more than 5 mm also affected the field of view.

The eye relief of our eyepiece was found to be 15 mm.

Conclusion

The current PPE eye protection is not compatible with the use of a microscope. There is scope for research into better eye protection. Mitigation strategies including barrier drapes and alternative techniques such as endoscopic surgery or use of exoscopes should also be considered.

Iyer, A. , Tikka, T., Calder, N., Qamar, S. N. and Chin, A. (2020) Effect of personal protection equipment (PPE) and the distance from the eye piece of surgical microscope on the field of vision; an experimental study. *Otology and Neurotology*, (doi: 10.1097/mao.0000000000002989)

Introduction

The novel coronavirus epidemic was declared a public health emergency of international concern on 30th January by the World Health Organization (WHO) and many parts of the world have been affected causing more than 18 million cases and 689,219 deaths. (1,2). Otolaryngologists might be susceptible due to the concentration of the SARS-CoV-19 virus in the nasopharynx and many otolaryngologic procedures can be aerosol-generating procedures (AGP) (3-5). A review of procedures in otolaryngology found strong evidence that high-speed drilling and cautery to be AGP along with nasal endoscopy, tracheostomy, and airway suction (6). Mastoidectomy causes significant particle dispersion and it can be reduced by using a specially designed "ototent" but personal protective equipment (PPE) is still advised (7,8). Another cadaveric study demonstrated that drilling the mastoid was AGP but not ventilation tube insertion (9).

A review on the enhanced PPE noted that respirator masks and eye protection need to be used in AGP but the standards vary (5). The Center for Disease Control and Prevention (CDC) has recommended an N95 or higher-level respirator, eye protection, gloves, and a gown. The exact type of eye protection is not mentioned but either goggles or a face shield that covers the front and sides is recommended. (10). But the guidance on this is not uniform, for example, Public health England has recommended the use of FFP3 (filtering facepiece, FFP3 is similar to N99) mask and full visor or face shield (11), and the WHO has suggested N95 mask and either goggles with side protection for eyes or full face shields (12). The use of the eye protection is important as the presence of SARS-CoV-19 has been noted in the conjunctival swabs of patients with Covid-19 (13) and ACE2 and TMPRSS2 are expressed on the human ocular surface, suggesting susceptibility to SARS-CoV-2 infection via the conjunctival route (14)

Iyer, A. , Tikka, T., Calder, N., Qamar, S. N. and Chin, A. (2020) Effect of personal protection equipment (PPE) and the distance from the eye piece of surgical microscope on the field of vision; an experimental study. *Otology and Neurotology*, (doi: 10.1097/mao.0000000000002989)

Surgeons have encountered difficulties in using the microscope with enhanced PPE but there are no studies so far which measured the effect of PPE, especially the eye protection on the field of vision when using the microscope. While routine ear surgery with drilling can be postponed, in emergencies we still have to proceed with caution (15).

Materials & Methods

Our study aimed to measure the effect of PPE on the micro-surgical field. Since the eye protection strategies are not standard, we have decided to include various combinations of PPE. To standardize the results, we did the second group of observations using graduated rings of increasing sizes to quantify the effect of distance from the eyepiece of the microscope on the surgical field.

Five surgeons were recruited from our Otolaryngology department in a university hospital. Three of them are fully qualified consultants (attending surgeons, 2 dedicated otologists & one with general otology practice). We also included two senior residents. Three of them had normal visual acuity and the other two had fully corrected visual acuity with spectacles.

The microscope used is the OPMI Vario, Carl Zeiss AG, and is fitted with an f170 mm, 180 degrees tiltable widefield eyepiece with 12.5x magnification. The microscope has variable working distance ranging from 200 to 415 mm and has a motorized zoom ratio of 1:6 with a magnification factor y= 0.4 x to 2.4 x. To measure the field of view we used the background of a graph paper with a single solid vertical and horizontal line. This was fixed to the operation table using tapes. The working distance was fixed to 300 mm and the angle of the objective

lens and eyepiece were all fixed allowing only change of interpupillary distance. The field of vision in a vertical plane and horizontal plane was measured using an electronic digital caliper with a resolution of 0.01 mm and an accuracy of 0.02 mm (ORIA IP54 digital calipers). Each measurement was repeated 3 times alternating between vertical and horizontal axis. The surgeon was asked to look for the tips of the measuring jaws to be just visible inside the field of view. The cross-section of the solid lines was always kept in the middle of the field. Each set of measurements was taken at magnifications of 0.4, 0.6, and 1.0 (Fig1).

The first set of measurements were made with 1) no PPE, 2) surgical mask, 3) FFP3 respirator mask (3M 8833), 4) FFP3 and a non-splash safety goggles with no side protection (UVEX, Germany, skylite, W-166F), 5) FFP3 and goggles with all-around protection of eye for airborne particles & biohazard (Honeywell Vistamax VNC21, Honeywell safety products, Cedex, France), 6) FFP3, Vistamax goggles and a full face shield (Medline NONFS300, Medline, USA), and lastly 7) FFP3 and the face shield (Fig 1 B). In addition to the field of view, we also measured the distance from the eyepiece to the lateral canthus of the observer on both sides using digital calipers and an average was used. Lateral canthus was used as it was better visible through the layers of PPE than the transparent anterior surface of the cornea which was impossible to see with some PPE. Measurement of the distance from lateral canthus to the anterior surface of the cornea was then made when the surgeon was looking straight without any PPE as we could get as close to the cornea reducing the chance of parallax error. This is a well-validated method used in ophthalmology to measure exophthalmos (16). This value was then deducted from the previous measurement to arrive at the distance between the cornea and the eyepiece.

To further standardize the measurements, the second set of measurements were made after attaching graduated carbon fiber spacer rings with an inner diameter of 286 mm (Shenzhen Gongsi, China) to the eyepiece of the microscope (Fig 1 D). The widths of 5, 10, 15, 20, 25, 30, 35, and 40 mm were used after making sure that sizers start from the edge of the eyepiece. The same measurements of fields were made at a magnification of 0.4, 0.6, and 1.0.

We also measured the ideal distance or "eye relief" at which an observer will get the best field of vision using any optical device such as the microscope. This is the distance at which the “exit pupil" which is the smallest cross-section of the beam of light from the eyepiece of a microscope through which all the light from the instrument passes. At this distance, the light coming from the eyepiece will form a sharp "pupil" and if the cornea is placed at this distance the observer will get the maximum image without loss of light (17). The eye relief was measured by moving eyepieces closer to a solid surface while the microscope is focussed on a bright reflective surface. The distance at which the sharpest image of a light circle called "exit pupil" is visible is measured using the calipers from the edge of the eyepiece to give the available eye relief (18) and was repeated 3 times (Fig 2).

Statistical Analysis

Following the assessment of normality, the paired t-test was used to compare the mean differences from baseline (no PPE) in the vertical and horizontal field of view measurements for each of the applied conditions. The same was done for the second set comparing with the baseline of no spacers. The Pearson's r statistic was used to assess for correlations between the measurements and the distance from the eyepiece for each of the tested conditions. The SPSS

Iyer, A. , Tikka, T., Calder, N., Qamar, S. N. and Chin, A. (2020) Effect of personal protection equipment (PPE) and the distance from the eye piece of surgical microscope on the field of vision; an experimental study. *Otology and Neurotology*, (doi: 10.1097/mao.0000000000002989)

20 statistical software was used for the analysis and a p-value of 0.05 was considered as statistically significant.

Iyer, A. , Tikka, T., Calder, N., Qamar, S. N. and Chin, A. (2020) Effect of personal protection equipment (PPE) and the distance from the eye piece of surgical microscope on the field of vision; an experimental study. *Otology and Neurotology*, (doi: 10.1097/mao.0000000000002989)

Results

The first part of the study analyzed the effect of PPE on the visual field of the microscope in 3 different power settings. All the results are shown in table1. Using a surgical mask or an FFP3 respirator slightly reduced the field of view when compared to no PPE. In case of the surgical mask the maximum reduction was 6.1% at 0.6 vertically (p=0.003) and 3.5% at 0.4 horizontally (p=0.041). For the FFP3, the vertical field of view reductions varied from 4.96% in magnification 1 (p= 0.014) to 6.8% at 0.6 (p= 0.024) and 7.9% at 0.4 (p= 0.013). The horizontal field of view was much less affected with 3 % reduction at magnification 1 (p= 0.076) to 4.6% at 0.6 power (p=0.064) and 5% at 0.4 (p=0.025). Even though the percentage of reduction was in single digits, it was still statistically significant in all three power settings in the vertical plane and at 0.4 power in the horizontal field. But as soon as a simple goggle was worn in addition to FFP3, there was even more of a reduction in the field of view ranging from 23.8% at 0.4 to 31.6 % at a magnification of 1 vertically and 22.1% at 0.4 to 31.1% at 1 horizontally. All of these reductions were statistically significant (p= 0.001).

Since the recommendation for PPE in AGP includes a better goggle with side splash protection and possibly a face shield in addition to N95 or FFP3, we analyzed the results for these as well. When vistamax goggles were used with FFP3 the reduction of field of vision was major and ranged from 74.5% at 0.6 to 75.7% at 1 magnification vertically and 75.6% at 0.4 to 76.8 % at 0.6 horizontally and this was highly significant (p=0.001). When we added a face shield to the big goggles and repeated the test, the reductions were worse ranging from 76.8% at 0.4

vertically and 77.4 % at 0.6 horizontally and this was also highly significant (p= 0.001). The last group was with only a face shield in addition to an FFP3 mask. This produced a maximum reduction of 61.9 % in vertical measurement at 1 to 60.2 % horizontally at 0.4. All of these reductions were also statistically significant (p= 0.001).

The distance from the cornea to eyepiece amongst the surgeons was highly variable when wearing a smaller goggle (17-31 mm) and when using only a face shield (21-43mm) partly because of the use of spectacles and also how hard they pressed on the face shield. But not surprisingly the distances were fairly stable when using the large vistamax goggles (36-42 mm) and also when vistamax was used with face shield (40-44mm) (table2). Pearson 2 tailed correlation test showed that the distance between the cornea and eyepiece among the surgeons was statistically significant in the horizontal field of view when using only the goggles (p= 0.033) and both vertical (p= 0.001) and horizontal (P =0.001) when using only the face shield. The mean difference also showed a larger variation as shown by the larger confidence intervals in these two groups (Fig3)

The second part of the study analyzed the effect of graduated distances from the eyepiece starting at 5 mm and then increasing at 5 mm intervals reaching 40 mm in the end. This showed that at 5mm there was only a small reduction of field of vision ranging from 3.6 % at 0.4 magnification to 6.8 % at a magnification of 1. Horizontal field reduction ranged from 3.3% at 0.4 magnification to 6.9 % at a magnification of 1. With each 5 mm additional distance there were worsening of the visual field in both vertical and horizontal directions until there was a maximum loss of 81.2 % at 40 mm and 1.0 magnification. In all the distances beyond 5 mm,

there was a reduction of more than 20% in the field of view and the reduction was more than 50% at 20 mm distance from the eyepiece and all of these were statistically significant (p=0.001) (Table 1 & Fig 4).

The eye relief distance was measured 3 times and the average value of the available eye relief for our eyepiece was 15 mm.

Discussion

Many otological procedures use microscopes and drills which are aerosol-generating and there is a risk of infection for the healthcare professionals during the Covid-19 pandemic (19). A recent study confirmed the presence of SARS-CoV-2 in the middle ear and mastoid in post-mortem specimens (20) and some studies show the presence of other coronaviruses and respiratory syncytial viruses (RSV; types A and B) in the middle ear fluid (21,22). Therefore, it is safer to presume that the SARS-CoV-2 virus may be present in the middle ear and mastoid even in asymptomatic patients and we need to find ways of performing ear surgery safely.

Recently minimally invasive trans-canal endoscopic ear surgery without drilling has been adopted by many surgeons around the world, but there are limitations especially when the disease such as cholesteatoma is extending deeper into the mastoid (23-26). Moreover, complications of chronic otitis media often present as emergencies and the surgeons cannot avoid drilling (27,28). With the Covid-19 pandemic and its potential to spread via aerosols, there is a need to find ways of reducing the aerosol generation and also consider adequate PPE to protect the staff in operating rooms. The various organizations such as the WHO, CDC, and Public Health England have come up with slightly different guidelines about the appropriate

PPE (10-12). The size and shape of eyewear and the distance from the eye varies depending on the manufacturer.

The ideal working distance from the eyepiece in any binocular ophthalmic instrument such as microscopes is decided by "eye relief". The eye relief of a "wide-field" eyepiece which has better eye relief has been noted to vary according to magnification from 15.5 to 18.9 mm (17,18). The "available" eye relief (distance from the edge of rubber protector or eyepiece to cornea) for our microscope, was found to be 15 mm. At this distance any microscope user will have the best view of the entire field. Any deviation from this in both directions will cause vignetting and reduction in the field of view. Another problem when getting closer to the eyepiece or any other part of the equipment will be the eyelashes touching the equipment and the user is unlikely to go closer due to natural response.

Our study shows that while a surgical mask or FFP3 mask causes a very minimal reduction in the field of view, but adding eye protection in the form of simple goggles leads to significant difficulties due to reduced vision. It was noted that surgeons with corrective spectacles may find it harder due to increasing distance from the eyepiece which will further reduce the field of vision. This was confirmed using Pearson’s 2 tailed correlation test which showed significant correlation between distance from the eye and reduction of field of vision when using simple goggles. If the refractory error is myopia or hyperopia, it can be easily solved by using the correction that is built in the eyepiece of the microscope instead of spectacles. But the most common cause of refractive error in adults all around the world is astigmatism (29) and this can't be corrected with eyepiece adjustments. Since the simple goggles are not going

to prevent aerosols coming in contact with eyes, we may need to use goggles with all-around protection (Vistamax). This has rigid sidewalls and the distance from eyes was much more with no huge variation among users and the reduction of the field of vision was very severe ranging from 75.6 % to 76.9 %. When we also added a face shield, the reduction ranged from 76.8% to 77.4 %. This drastic reduction of the visual field would be incompatible with any microsurgical procedures. Even when using only a face shield along with an FFP3 mask, reduction of field of vision showed a range of 57.4 % to 61.9%. Thus, we found that almost all options of PPE with eye protection can affect the field of vision to varying degrees.

When the carbon fiber rings were attached to the eyepiece, the 5mm ring didn't produce any major reduction of field of vision since the eye relief was 15 mm. But with a 10 mm distance ring added there was reduction of field of view of more than 20%. This was unexpected as the eye relief was 15 mm. We believe that due to the eyelashes touching the carbon ring, the surgeon is unlikely to go very close to the edge of the eyepiece. There was a progressive reduction of the field of vision when further distance rings were added and beyond 15 mm the image size shrunk by 50% or more (Table1). The percentage reduction was more when in higher magnification as the field of view was narrower, to begin with. We can, therefore, assume that any eye protection which causes the working distance to increase beyond 15 mm from the cornea will cause considerable difficulties in microsurgery.

Research on mitigation strategies on reducing aerosols in mastoid surgery using a barrier drape "Ototent" has shown very promising results. The initial study on cadavers showed that a large number of particles are dispersed all around the surgical area and a simple Ototent will reduce it significantly (7). Further studies were done using two types of tents, ototent 1 where

surgeons arm goes under the drape and ototent 2 with a floor and openings for arms and another port for instruments. The Ototent 2 was found to be much better in terms of reducing the aerosols. The use of a second aerosol scavenging suction and delayed removal of the tent after drilling is effective in reducing the aerosols to near baseline levels. Another advantage of using such mitigation strategies is that it will reduce exposure to all healthcare workers in the operating room. However, the use of PPE is still advocated to further reduce risks (8).

There are emerging technologies such as 3D "exoscopes" which can be used instead of a microscope in skull base and cholesteatoma surgery (30,31). When using these, the operator is looking at a screen rather than the eyepiece. But these systems can be very expensive, and many hospitals don't have them. Endoscopic middle ear surgery can also play a bigger role in the management of middle ear disease but has its limitations in extensive disease.

Further research in the field of PPE is needed to develop better eye protection which may not limit the field of vision significantly. The distance from the eye to the eyepiece will be a key factor affecting the use of microscope. The options might include custom made "slimline" eyewear with prescription glasses for surgeons who use spectacles and plain glasses for others. Custom made face shields with less distance from the eye to a microscope can also be very useful. Any of these should also be compatible with respirator masks such as FFP3 or N95. Many otolaryngological organizations have therefore advised to screen the patients for the SARS-CoV-2 virus and also to postpone non-urgent ear surgery that involves drilling (32,33).

Limitations of the study

Iyer, A. , Tikka, T., Calder, N., Qamar, S. N. and Chin, A. (2020) Effect of personal protection equipment (PPE) and the distance from the eye piece of surgical microscope on the field of vision; an experimental study. *Otology and Neurotology*, (doi: 10.1097/mao.0000000000002989)

There are some limitations to this study. We could only enroll a small number of surgeons due to constraints of lockdown and ethical consideration of using the valuable resource of PPE. We studied only one operating microscope with a 12.5 x eyepiece. The size and shape of PPE can also vary between departments. We also couldn't study the effects on any real operations as most of the surgical cases were postponed.

Conclusion

During the Covid-19 pandemic, it is very important to use PPE to protect the surgeons and other healthcare professionals while doing AGP such as high-speed drilling. We studied the available eye protection and almost all of them had a negative effect on the field of vision. The available eye relief distance with our microscope was 15 mm and any further distance will reduce the field of vision significantly as demonstrated by the results when using the distance rings. Mitigation strategies should include the use of barrier drapes such as “ototent” with second suction and delayed drape removal. There is scope for further research in improving PPE for microsurgery. The alternative technology to microsurgeries such as endoscopic ear surgery and exoscopes might play a useful role in the future.

Iyer, A. , Tikka, T., Calder, N., Qamar, S. N. and Chin, A. (2020) Effect of personal protection equipment (PPE) and the distance from the eye piece of surgical microscope on the field of vision; an experimental study. *Otology and Neurotology*, (doi: 10.1097/mao.0000000000002989)

Reference:

1) Statement on the second meeting of the International Health Regulations (2005) Emergency Committee regarding the outbreak of novel coronavirus (2019-nCoV); 30 January 2020 Statement, Geneva, Switzerland
2) COVID-19 situation update worldwide, as of 3 August 2020, accessed via https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases on 08/03/2020
3) Vukkadala N, Qian ZJ, Holsinger FC, Patel ZM, Rosenthal E. COVID-19,and the otolaryngologist – preliminary evidence-based review. The Laryngoscope. n/a(n/a). doi:10.1002/lary.28672
4) Zhao C, Viana A Jr, Wang Y, Wei HQ, Yan AH, Capasso R. Otolaryngology during COVID-19: Preventive care and precautionary measures [published online ahead of print, 2020 Apr 22]. Am J Otolaryngol. 2020;102508. doi:10.1016/j.amjoto.2020.102508
5) Mick P, Murphy R. Aerosol-generating otolaryngology procedures and the need for enhanced PPE during the COVID-19 pandemic: a literature review. J Otolaryngol Head Neck Surg. 2020;49(1):29. Published 2020 May 11. doi:10.1186/s40463-020-00424-7
6) Thamboo A, Lea J, Sommer DD, et al. Clinical evidence based review and recommendations of aerosol generating medical procedures in otolaryngology - head and neck surgery during the COVID-19 pandemic. J Otolaryngol Head Neck Surg. 2020;49(1):28. Published 2020 May 6. doi:10.1186/s40463-020-00425-6

7) Chen JX, Workman AD, Chari DA, et al. Demonstration and mitigation of aerosol and particle dispersion during mastoidectomy relevant to the COVID-19 era [published online ahead of print, 2020 May 8]. Otol Neurotol. 2020;10.1097/MAO.0000000000002765.doi:10.1097/MAO.0000000000002765

8) Chari DA, Workman AD, Chen JX, et al. Aerosol Dispersion During Mastoidectomy and Custom Mitigation Strategies for Otologic Surgery in the COVID-19 Era [published online ahead of print, 2020 Jul 14]. Otolaryngol Head Neck Surg. 2020;194599820941835. doi:10.1177/0194599820941835

9) Sharma D, Rubel KE, Ye MJ, et al. Cadaveric Simulation of Otologic Procedures: An Analysis of Droplet Splatter Patterns During the COVID-19 Pandemic [published online ahead of print, 2020 May 19]. Otolaryngol Head Neck Surg. 2020;194599820930245. doi:10.1177/0194599820930245

10) Interim Infection Prevention and Control Recommendations for Patients with Suspected or Confirmed Coronavirus Disease 2019 (COVID-19) in Healthcare Settings https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html, accessed on 3rd of June, 2020.

11) COVID-19: infection prevention and control guidance; Public health England, accessed via https://www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control on 3rd of June 2020

12) Rational use of personal protective equipment for coronavirus disease (COVID-19) and considerations during severe shortages Interim guidance 6 April 2020. WHO ref : WHO/2019-nCov/IPC_PPE_use/2020.3. Accessed via who.int/publications-detail/rational-use-of-personal-protective-equipment-for-coronavirus-disease-(covid-19)-and-considerations-during-severe-shortages

13) Wu P, Duan F, Luo C, et al. Characteristics of Ocular Findings of Patients With Coronavirus Disease 2019 (COVID-19) in Hubei Province, China. JAMA Ophthalmol. 2020;138(5):575–578. doi:10.1001/jamaophthalmol.2020.1291

14) Ma, D., Chen, C., Jhanji, V. et al. Expression of SARS-CoV-2 receptor ACE2 and TMPRSS2 in human primary conjunctival and pterygium cell lines and in mouse cornea. Eye 34, 1212–1219 (2020). https://doi.org/10.1038/s41433-020-0939-4

15) George M, Alexander A, Mathew J, Iyer A, Waterval J, Simon C, Marchioni D, Maire R. Proposal of a timing strategy for cholesteatoma surgery during the COVID-19 pandemic. Eur Arch Otorhinolaryngol. 2020 May 15:1–5. doi: 10.1007/s00405-020-06037-0. Epub ahead of print. PMID: 32415348; PMCID: PMC7225247.

16) Chang AA, Bank A, Francis IC, Kappagoda MB. Clinical exophthalmometry: a comparative study of the Luedde and Hertel exophthalmometers. Aust N Z J Ophthalmol. 1995;23(4):315-318. doi:10.1111/j.1442-9071.1995.tb00182.x

17) Handbook of Optical Design, Third Edition By Daniel Malacara-Hernández, Zacarías Malacara-Hernández. CRC press, Taylor & Francis group, 2013, New York. Pages 442 – 446

18) A Practical Guide to Experimental Geometrical Optics By Yuriy A. Garbovskiy, Anatoliy V. Glushchenko, Cambridge university press, Cambridge, United Kingdom, 2017. Page 110

19) Workman AD, Welling DB, Carter BS, et al. Endonasal instrumentation and aerosolization risk in the era of COVID-19: simulation, literature review, and proposed mitigation strategies [published online ahead of print, 2020 Apr 3]. Int Forum Allergy Rhinol. 2020;10.1002/alr.22577. doi:10.1002/alr.22577

20) Frazier KM, Hooper JE, Mostafa HH, Stewart CM. SARS-CoV-2 Virus Isolated From the Mastoid and Middle Ear: Implications for COVID-19 Precautions During Ear Surgery. JAMA Otolaryngol Head Neck Surg. Published online July 23, 2020. doi:10.1001/jamaoto.2020.192

21) Heikkinen T, Thint M, Chonmaitree T. Prevalence of various respiratory viruses in the middle ear during acute otitis media. N Engl J Med. 1999;340(4):260-264. doi:10.1056/NEJM199901283400402

22) Wiertsema SP, Chidlow GR, Kirkham LA, et al. High detection rates of nucleic acids of a wide range of respiratory viruses in the nasopharynx and the middle ear of children with a history of recurrent acute otitis media. J Med Virol. 2011;83(11):2008-2017. doi:10.1002/jmv.22221

23) Yiannakis CP, Sproat R, Iyer A. Preliminary outcomes of endoscopic middle-ear surgery in 103 cases: a UK experience. J Laryngol Otol. 2018;132(6):493-496. doi:10.1017/S0022215118000695

24) Tarabichi, M, Ayache, S, Nogueira, JF, Al Qahtani, M, Pothier, DD. Endoscopic management of chronic otitis media and tympanoplasty. Otolaryngol Clin North Am 2013;46:155–63

25) Tarabichi, M. Transcanal endoscopic management of cholesteatoma. Otol Neurotol 2010;31:580–8

26) Cohen MS, Landegger LD, Kozin ED, Lee DJ. Pediatric endoscopic ear surgery in clinical practice: Lessons learned and early outcomes. Laryngoscope. 2016;126(3):732-738. doi:10.1002/lary.25410

27) Schilder AG, Marom T, Bhutta MF, et al. Panel 7: Otitis Media: Treatment and Complications. Otolaryngol Head Neck Surg. 2017;156(4_suppl):S88-S105. doi:10.1177/0194599816633697

28) Baysal E, Erkutlu I, Mete A, et al. Complications and treatment of chronic otitis media. J Craniofac Surg. 2013;24(2):464-467. doi:10.1097/SCS.0b013e318271046a

29) Hashemi H, Fotouhi A, Yekta A, Pakzad R, Ostadimoghaddam H, Khabazkhoob M. Global and regional estimates of prevalence of refractive errors: Systematic review and meta-analysis. J Curr Ophthalmol. 2017;30(1):3-22. Published 2017 Sep 27. doi:10.1016/j.joco.2017.08.009

30) Smith S, Kozin ED, Kanumuri VV, et al. Initial Experience with 3-Dimensional Exoscope-Assisted Transmastoid and Lateral Skull Base Surgery. Otolaryngol Head Neck Surg. 2019;160(2):364-367.doi:10.1177/0194599818816965

31) Minoda R, Miwa T. Non-microscopic Middle Ear Cholesteatoma Surgery: A Case Report of a Novel Head-Up Approach. Otol Neurotol. 2019;40(6):777-781. doi:10.1097/MAO.0000000000002276

32) Guidance for undertaking otological procedures during COVID-19 pandemic, ENT UK, accessed on 6th of June, 2020 via https://www.entuk.org/guidance-undertaking-otological-procedures-during-covid-19-pandemic-0

33) Guidance for Return to Practice for Otolaryngology-Head and Neck Surgery. The AAO-HNS accessed via https://www.entnet.org/content/covid-19-resource-page on 6th of June, 2020

Iyer, A. , Tikka, T., Calder, N., Qamar, S. N. and Chin, A. (2020) Effect of personal protection equipment (PPE) and the distance from the eye piece of surgical microscope on the field of vision; an experimental study. *Otology and Neurotology*, (doi: 10.1097/mao.0000000000002989)

Table 1

This shows the mean difference in the field of vision in both vertical and horizontal fields of view in three magnification levels when compared to the reference which is no PPE in the first group or no distance rings in the second group of measurements. The standard deviation and percentage reduction along with p values are also shown.

Table 2

This table shows the distance from the cornea of the surgeon to the edge of the eyepiece when wearing various PPE and using the microscope in focus. There was a wide range when using small goggles and also when using only face shields and this was statistically significant (goggle p= 0.033, face shield p=0.001) with more distance causing a decrease in the field of vision.

Iyer, A. , Tikka, T., Calder, N., Qamar, S. N. and Chin, A. (2020) Effect of personal protection equipment (PPE) and the distance from the eye piece of surgical microscope on the field of vision; an experimental study. *Otology and Neurotology*, (doi: 10.1097/mao.0000000000002989)

Figure 1

A. Surgeon wearing a large vistamax goggles & FFP3 mask measuring the field of view

B. PPE from left to right small goggle, face shield, FFP3 mask, large vistamax goggles

C. Graph paper with solid central lines and the electronic caliper

D. Arrows show 10 mm carbon fiber distance rings attached to eyepieces.

Figure 2

A) Measurement of the eye relief distance using the exit pupil

B) 1. Real image 2. Field diaphragm 3. Eye relief 4. Exit pupil

Iyer, A. , Tikka, T., Calder, N., Qamar, S. N. and Chin, A. (2020) Effect of personal protection equipment (PPE) and the distance from the eye piece of surgical microscope on the field of vision; an experimental study. *Otology and Neurotology*, (doi: 10.1097/mao.0000000000002989)

Figure 3

Mean differences and 95% confidence intervals (CI) in the x-axis when using PPE and the three levels of magnification on the Y-axis. The large CI was noted in the small goggle group and when using only face shield perhaps due to the use of spectacles by 2 of the participants and also pressing hard on the face shield by some participants. The correlation with increasing distance with reduction of field of view is statistically significant with use of goggles p= 0.033 and only face shield p=0.001.

Figure 4

Mean differences and 95% confidence intervals (CI) in x-axis with increasing distance in both the horizontal and vertical axis and the three levels of magnification on the Y-axis. The large CI was noted in the distance group between 15 and 20 mm. There was no correlation between the use of corrective spectacles