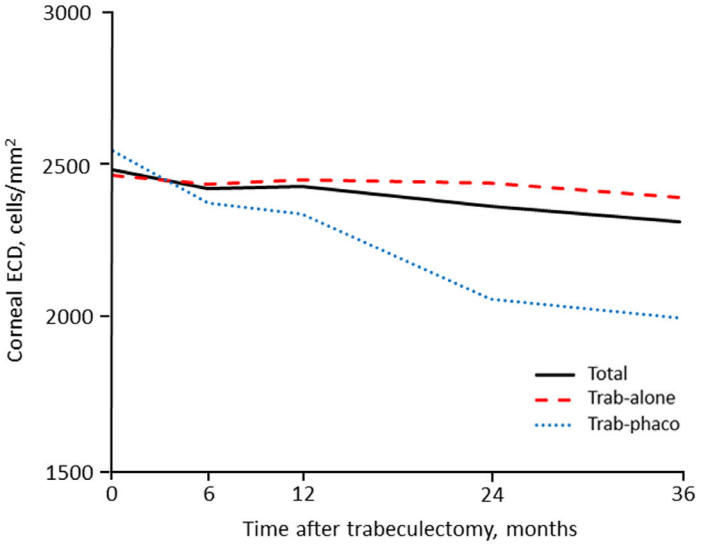

	Preoperative	6 months	12 months	24 months	36 months
Total	2,484 ± 321	2,425 ± 358	2,429 ± 386	2,367 ± 477*	2,317 ± 481*
Trab-alone	2,468 ± 334	2,438 ± 346	2,452 ± 358	2,443 ± 396	2,395 ± 400
Trab-phaco	2,547 ± 261	2,376 ± 413	2,339 ± 486	2,062 ± 648*	2,001 ± 646*

Fig. 1. Mean corneal ECD following trabeculectomy. *p < 0.05 compared with baseline.

(Fig. 1). In the trab-phaco group, the corneal ECD was 2,547 ± 261 cells/mm^2 before surgery; then, it decreased significantly to 2,001 ± 646 cells/mm^2 at 36 months after surgery (21.7% loss; $p < 0.01$) (Fig. 1). The corneal ECD loss was significantly greater in the trab-phaco group than in the trab-alone group (21.7% loss vs 2.8% loss; $p < 0.01$) at 36 months after surgery. We analysed the determinants of corneal ECD loss in the trab-phaco group. Age, type of glaucoma, preoperative corneal ECD, postoperative IOP, the length of time between trabeculectomy and phacoemulsification, the surgical time of the phacoemulsification and postoperative shallow anterior chamber were considered as possible determinants of the severity of corneal ECD loss at 36 months after surgery. The multivariate analyses using multiple linear regression models (stepwise selection) demonstrated that exfoliation glaucoma was significantly associated with the severity of corneal ECD loss ($p < 0.01$). The exfoliation glaucoma and lens extraction with phacoemulsification after trabeculectomy increased the rate of corneal ECD loss. The corneal ECD should be carefully assessed after trabeculectomy, especially in patients with exfoliation glaucoma and requiring cataract surgery.

References

Arimura S, Miyake S, Iwasaki K et al. (2018): Randomised clinical trial for postoperative complications after Ex-PRESS Implantation versus trabeculectomy with 2-year follow-up. Sci Rep **8**: 16168.

Higashide T, Nishino T, Sakaguchi K, Yamada Y & Sugiyama K (2019): Determinants of corneal endothelial cell loss after trabeculectomy with mitomycin C. J Glaucoma **28**: 61–67.

Hirooka K, Nitta E, Ukegawa K & Sato S & Kiuchi Y (2019): Effect of trabeculectomy on corneal endothelial cell loss. Br J Ophthalmol Bjophthalmol-2018-313417.

Kim MS, Kim KN & Kim C (2016): Changes in corneal endothelial cell after ahmed glaucoma valve implantation and trabeculectomy: 1-year follow-up. Korean J Ophthalmol **30**: 416.

Lee GY, Lee CE, Lee KW & Seo S (2017): Long-term efficacy and safety of ExPress implantation for treatment of open angle glaucoma. Int J Ophthalmol **10**: 1379–1384.

Zarei R, Zarei M, Fakhraie G et al. (2015): Effect of mitomycin-C augmented trabeculectomy on corneal endothelial cells. J Ophthalmic Vis Res **10**: 257–262.

Received on April 13th, 2020.
Accepted on July 2nd, 2020.

Correspondence:
Masaru Inatani
Department of Ophthalmology
Faculty of Medical Sciences
University of Fukui
Fukui
Japan
Tel: +81 776 61 8400
Fax: +81 776 61 8131
E-mail: inatani@u-fukui.ac.jp

Postmortem conjunctival and nasopharyngeal swabs in SARS-CoV-2 infected and uninfected patients

Matthias Fuest,[1] Peter Boor,[2] Ruth Knuechel,[2] for the DeRegCOVID[3] Peter Walter[1] and Sabine Salla[1,4]

[1]Department of Ophthalmology, RWTH Aachen University, Aachen, Germany; [2]Department of Pathology, RWTH Aachen University, Aachen, Germany; [3]German Registry of COVID-19 Autopsies (DeRegCOVID), RWTH Aachen University, Aachen, Germany; [4]Cornea Bank, RWTH Aachen University, Aachen, Germany

doi: 10.1111/aos.14559

Dear Editor,

Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) was declared a global pandemic by the World Health Organization (WHO) on March 11, 2020.

Although the main mode of SARS-CoV-2 transmission is respiratory, studies have suggested that exposure of unprotected eyes to the virus may cause infection (Lu et al. 2020; Ulhaq & Soraya 2020). Macaque's conjunctiva inoculated with SARS-CoV-2 led to the replication of the virus in ocular and nasopharyngeal tissue with the development of a mild interstitial pneumonia (Deng et al. 2020).

Ocular manifestations, such as epiphora, conjunctival congestion or chemosis have been described to occur more frequently in patients with severe

Table 1. Characteristics and conjunctival (COS) as well as nasopharyngeal (NPS) swab results of the 23 SARS-CoV-2 positive deceased.

Case	Gender	Age (years)	Death to swab time NPS and COS (hr)	Result COS postmortem	Result NPS postmortem	Time Last NPS premortem (hr)	Result last NPS premortem
1	W	75	21.6	Negative	nd	42.22	Negative
2	M	83	116.32	Negative	nd	163.29	**Positive**
3	M	89	97.92	Negative	Negative	50.62	Negative
4	M	58	27.45	Negative	**Positive**	138.00	**Positive**
5	M	76	24.55	Negative	nd	71.21	**Positive**
6	M	75	10.42	Negative	nd	36.21	Negative
7	M	76	29.92	Negative	**Positive**	42.11	**Positive**
8	W	62	11.88	Negative	nd	10.36	Negative
9	W	75	14.48	Negative	nd	7.27	**Positive**
10	M	85	63.78	Negative	nd	17.55	**Positive**
11	M	71	64.92	Negative	nd	29.29	Negative
12	M	61	18.40	Negative	Negative	289.02	Negative
13	M	66	16.25	Negative	nd	80.55	Negative
14	M	61	14.35	Negative	Negative	218.98	Negative
15	M	86	8.20	Negative	**Positive**	115.13	**Positive**
16	M	75	42.17	Negative	Negative	96.40	Negative
17	W	50	70.00	Negative	Negative	378.83	**Positive**
18	M	88	10.17	Negative	**Positive**	89.18	**Positive**
19	W	64	7.58	Negative	Negative	117.58	**Positive**
20	M	66	16.97	Negative	Negative	174.10	Negative
21	M	73	68.55	Negative	Negative	55.72	Negative
22	W	68	21.25	Negative	Negative	242.02	Negative
23	W	68	16.75	Negative	Negative	168.27	**Positive**

All these SARS-CoV-2 patients were diagnosed by premortem positive NPS. The two columns to the right show the test results and the time before death of the last premortem NPS taken. nd = not done. Positive swab results are highlighted in bold.

systemic manifestations (Wu et al. 2020).

A recent meta-analysis found ocular manifestations among SARS-CoV-2 patients in 2–32%, with an overall pooled prevalence of 5.5% (Ulhaq & Soraya 2020). The specifity of ocular tissue/fluid in detecting SARS-CoV-2 was very low in comparison with standard sample collection from nasopharyngeal swabs (NPS) (Ulhaq & Soraya 2020).

Corneal donation and transplantation are disrupted by concerns of SARS-CoV-2 tissue contamination and transmission. To date, no data are available on the postmortem prevalence of virus RNA in ocular and pharyngeal tissue in SARS-CoV-2 patients.

In March 2020, the German Federal Institute for Vaccines and Biomedicines (PEI) recommended adjustments to donor screening due to SARS-CoV-2. Accordingly, in a prospective cohort study, potential corneal donors (uninfected with negative premortem NPS) in our institution had postmortem conjunctival (COS) and NPS taken starting March 17, 2020. In addition, we sampled deceased SARS-CoV-2 positive patients, with at least one positive premortem NPS (Table 1). The institutional review board of the University Hospital Aachen (EK 098/20) approved the study. All research adhered to the tenets of the Declaration of Helsinki. Informed consent was given by next of kin. Swabs were placed immediately into a sterile transport tube containing 2–3 ml of sterile saline and analysed by reverse transcriptase–polymerase chain reaction (RT-PCR; SYNLAB, Leverkusen, Germany).

All values are given as mean ± standard deviation (range min–max).

Because of the limited number of patients and swab results, we decided to share our findings as a descriptive statistic for continuous variables. Categorical variables were compared using the Fisher exact test. A p-value of <0.05 was considered statistically significant (IBM SPSS Statistics for Windows, Version 25, Armonk, NY, USA: IBM Corp).

Included were 70 eyes of 35 SARS-CoV-2 uninfected deceased (mean age 71 ± 10 (41–81) years, 46% females, death to swab (DTS) time 29.1 ± 16.2 (8.9–70.7) hr) and 46 eyes of 23 SARS-CoV-2 positive deceased (Table 1; mean age 72 ± 10 years, 30% females, DTS time 34.5 ± 30.6 hr). The uninfected and infected group did not differ significantly in gender ($p = 0.28$), age ($p = 0.7$) or DTS time ($p = 0.4$).

SARS-CoV-2 RNA was not detected in any postmortem NPS or COS in the uninfected group. In the SARS-CoV-2 group, four out of fourteen SARS-CoV-2 postmortem NPS were positive but no virus RNA was detected in postmortem COS (Table 1). DTS time in the positive postmortem NPS cases was 18.9 ± 11.3 (8.2–29.9) hr. Table 1 also displays the latest premortem NPS of the SARS-CoV-2 positive deceased, taken at 114.5 ± 96.3 (7.3–378.8) hours before death. They were positive at 96.1 ± 41.2 (42.1–138) hr before death in all four patients, that also had a postmortem positive NPS. However, in 36% of positive premortem NPS, no postmortem NPS was acquired.

In this study, we observed that all postmortem COS were negative for SARS-CoV-2, even in cases, where the postmortem NPS was still positive. The absence of virus RNA in our postmortem swabs agrees with the literature on premortem samples, where only 3/315 COS = 0.95% (compared to NPS 604/849 = 71.1%) were positive even in symptomatic eyes, indicating that the human conjunctiva is not a typical site of SARS-CoV-2

replication (Lu et al. 2020; Seah et al. 2020; Ulhaq & Soraya 2020). Further studies are needed to investigate, whether other ocular structures, e.g. vitreous or iris, are more suitable to detect SARS-CoV-2 pre- and post-mortem. In summary, our data indicate, that neither postmortem COS nor NPS can reliably exclude donors with SARS-CoV-2, particularly, when the last positive premortem NPS was obtained 90 hr or more before death.

The authors thank all medical and scientific staff, who treated the patients, took samples or analysed them, the Covid-19 Aachen Study (COVAS) Steering Committee, and the RWTH Centralized Biomaterial Bank (cBMB) for their support. The DeRegCOVID is supported by the Federal Ministry of Health of Germany (2520COR201).

References

Deng W, Bao L & Gao H et al. (2020): Ocular conjunctival inoculation of SARS-CoV-2 can cause mild COVID-19 in Rhesus macaques. bioRxiv. https://doi.org/10.1101/2020.03.13.990036

Lu CW, Liu XF & Jia ZF (2020): 2019-nCoV transmission through the ocular surface must not be ignored. Lancet **395**: e39.

Seah IYJ, Anderson DE, Kang AEZ, Wang L, Rao P, Young BE, Lye DC & Agrawal R (2020): Assessing viral shedding and infectivity of tears in coronavirus disease 2019 (COVID-19) patients. Ophthalmology **127**: 977–979.

Ulhaq ZS & Soraya GV (2020): The prevalence of ophthalmic manifestations in COVID-19 and the diagnostic value of ocular tissue/fluid. Graefes Arch Clin Exp Ophthalmol **258**: 1351–1352.

Wu P, Duan F, Luo C, Liu Q, Qu X, Liang L & Wu K (2020): Characteristics of ocular findings of patients with coronavirus disease 2019 (COVID-19) in Hubei Province, China. JAMA Ophthalmol **138**: 575.

Received on May 25th, 2020.
Accepted on July 3rd, 2020.

Correspondence:
Matthias Fuest, MD
Department of Ophthalmology
RWTH Aachen University
Pauwelsstrasse 30
52074 Aachen
Germany
Phone: +49 241 80 88192
Fax: +49 241 80 82408
Email: mfuest@ukaachen.de

Telementoring and remote training in the present era

Ann Sofia Skou Thomsen[1,2,3] and George M. Saleh[4,5]

[1]Department of Ophthalmology, Rigshospitalet – Glostrup, Denmark; [2]Department of Ophthalmology, Zealand University Hospital, Næstved, Denmark; [3]Copenhagen Academy for Medical Education and Simulation, Centre for HR, Capital Region of Denmark, Denmark; [4]Moorfields Eye Hospital, City Road Campus, London, UK; [5]National Institute for Health Research, Biomedical Research Centre at Moorfields Eye Hospital, The Department of Education, The UCL Institute of Ophthalmology, London, UK

doi: 10.1111/aos.14581

Editor,

Access to surgical teaching and expertise can be challenging at the best of times but in the era of COVID-19 and social distancing how can we ensure its delivery? This pandemic has seen a raft of innovative solutions emerge, in both the clinical and educational spaces, that may well lay the foundations for the future.

Telementoring is the use of information technology to provide real-time guidance despite different geographical locations (Huang et al 2019), and the concept dates back to the mid-1990s (El-Sabawi & Magee 2016). The effectiveness of surgical telementoring compared with on-site training has been reported in systematic reviews, where comparable safety and efficacy profiles between the two techniques were found (Bilgic et al 2017; Erridge et al 2019). So why has deployment to date largely focused on remote or rural areas and been so poorly adopted?

The answer is primarily tradition. The legal, ethical and cost issues melted away within weeks of the pandemic commencing, and it has rapidly become apparent over the last few months that it is more rather than less time efficient. Lacking infrastructure has also become a somewhat redundant argument given that a plethora of technologies already existed but were poorly utilised by healthcare as whole. In the last few weeks, the authors have used a combination of tele-education and tele-medicine platforms including AttendAnyWhere (Attend Anywhere, Australia), WhatsApp (WhatsApp Inc., US), Zoom (Zoom Video Communications, Inc., US), Teams (Microsoft, US), Cisco Webex (Cisco Systems, Inc., US), Lifesize (Lifesize, Inc., US), FaceTime (Apple Inc., US), Skype (Microsoft, US), GoToMeeting (LogMeIn, Inc., US), Google Hangouts (Google, US) and these, in turn, are but a small sample of the available options.

Beyond traditional teaching using video, the last few months have seen various interactive solutions from tele-appraisal to supervision during tele-consultations (where the trainer, trainee and patient video conference from disparate respective locations). Surgical training has also adapted, with socially distanced training on the Eyesi simulator (VRmagic, Haag-Streit Diagnostics, Switzerland) and HelpMeSee (HelpMeSee, Inc, US), via a live video feed, streamed through a laptop, along with a webcam capturing the trainees hand movements and general environment. While it is clear that some enthusiasm for the 'tele-revolution' is clearly present, not all teaching will ultimately convert to this modality.

Telehealth does, however, have great potential for unifying differing locations and accessing specialist educators much further afield. This means that 'dialling' into highly specialized multidisciplinary meetings, obtaining second opinions rapidly and better integration of primary-secondary-tertiary care through these systems may all become possible. Additionally, one of the core purported aims, that of training in remote and developing world locations, will become more attainable if this practice becomes more commonplace.

John F Kennedy once remarked that when written in Chinese, the word 'crisis' is composed of two characters —one representing danger and the other representing opportunity. At this juncture, there appears to be the means, the technology and the need to rapidly evolve our utilisation of remote training and telementoring. To what extent it becomes integral to our practice is yet to be determined but in all probability it will have a much greater role in the near term and more distant future.