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Slit lamp examination during COVID-19: Where should the protective barrier be?

Rashim Mannan, Archna Pruthi, Rouli Sud[1], Sumeet Khanduja[1]

Purpose: The aim of this study was to describe a poly-vinyl chloride air condition (PVC AC) curtain shield placed at the intervening space between the chin rest and the illuminating and optical arm of the slit lamp microscope (distal barrier) instead of the present position at the oculars (proximal barrier) to guard against severe acute respiratory syndrome Coronavirus 2. This experimental study was done to validate and compare the protection offered by the conventional breath shields and the one described by us in a simulated environment. **Methods:** In this experimental study, 12 puffs of fine mist were sprayed over a period of 1 minute using "magenta-colored dye" and "cyan-colored dye" for analyzing proximal barrier and distal barrier respectively. To access the amount of contamination of the slit lamp, caused by sprayed "magenta" and "cyan" colored dye, we covered the entire slit lamp with appropriately sized white-colored cotton sheet. The stained sheets were individually photographed and then the images were first cropped, then color threshold adjusted and then converted to binary and finally fraction of surface area stained was calculated using the ImageJ software. (P_n Surface Area $_{\text{magenta fraction}}$ (%) during analysis of "proximal barrier" and P_n Surface Area $_{\text{cyan fraction}}$ (%) during the analysis of "distal barrier", where P_n refers to various parts of slit lamp. **Results:** The entire surface area of the cloth covering the slit lamp was 9912.45 cm^2. The surface area of the cloth which was stained when using the "proximal barrier" was 567.50 cm^2 whereas when using the "distal barrier" was 222.93 cm^2. When using proximal barrier, 97.71% of the staining was present on the slit lamp base, viewing arm, illumination arm and the pivot of the slit lamp. While using the distal breath shield no parts of the viewing arm, illumination arm, the pivot or the mechanical base with joystick were stained. **Conclusion:** The novel PVC AC curtain shield provides better barrier against the simulated contaminated stream of patient's breath directed towards the working parts of the slit lamp as compared to conventional slit lamp oculars mounted breath shields.

Key words: Breath shields, COVID-19, distal barrier, parts of slit lamp, proximal barrier, slit lamp examination, transmission

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The spread of Coronavirus Infectious Disease 2019 (COVID-19) is caused by severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2), via respiratory droplets has been confirmed.[1] Under hospital settings the spread of COVID-19 can occur in the following scenarios:

1. Airborne transmission in setting of aerosol-generating procedures (AGPs).[2] These include positive-pressure mechanical ventilation, tracheal intubation, chest physiotherapy, nebulizer treatment, sputum induction and bronchoscopy, procedures performed in ICU or OT settings.[3]

2. Droplet contamination: Respiratory droplets generated by coughing, sneezing, or talking, are large particles, having a diameter greater than 5 μm. These do not remain suspended in the air for long, fall to the ground rapidly after being produced and are usually dispersed over short distances.[4] Transmission can occur directly when these respiratory droplets reach susceptible mucosal surfaces, such as in the eyes, nose or mouth and can also happen indirectly; when hands come in contact with contaminated surfaces and subsequently touch the face.[5]

In the present times of COVID-19 pandemic, the proximity of an ophthalmologist to the patient during slit-lamp examination along with the high level of SARS-CoV-2 shedding in the upper respiratory tract, even among pre-symptomatic patients is responsible for the transmissibility of COVID-19[6,7] and entails the need for extreme caution to be taken by ophthalmologists while performing this previously seemingly innocuous examination.

Besides wearing adequate personal protective equipment (PPE), ophthalmologists also need to have a barrier between themselves and the patient so as to impede these airborne droplets. A number of barriers are being proposed presently which include a) Built-In acrylic breath shields[8]/

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add-on universal acrylic breath shields,[9] b) self-made or customized acrylic/X-Ray film breath shield shields[10] and c) a wide (210 × 297 mm) flexible polyvinyl chloride (PVC) plastic sheet breath shield.[11] We believe that the small size of these breath shields and their proximity to the ophthalmologist and not the patient may limit their "protective effect" in preventing the aerosols and droplets coming in contact with the examining ophthalmologist and those parts of the slit lamp that are frequently handled while examining patients. We propose shifting the location of the breath shield from its present position at the oculars (Proximal Barrier) to the intervening space between the chin area and the illuminating and optical arm (Distal Barrier) [Fig. 1] of the slit lamp microscope to provide greater protection to the slit lamp parts, table, ophthalmologist's hands and torso from getting directly contaminated by the patient's breath generated respiratory droplets. Hence, we undertook this experimental study to validate the protection offered by the conventional breath shields and the one described by us in a simulated environment.

Methods

Besides the financial constraints, India in a state of lockdown so as to mitigate the spread of COVID-19 there was a non-availability of resources[12,13] like 1) Digital high-vision, high-speed video and Laser system with vector analysis system,[14] 2) customized mannequins for simulating a patient and other an ophthalmologist seated across a slit lamp and 3) a tri-flow deep breathing lung exerciser or physiotherapy device along with a pump system to create an expiration system; hence we devised an alternative.

Enumeration of presently available breath shields (Proximal Barrier)

All the various breath shields being advocated presently represent "proximal barriers", i.e., barriers in close proximity to the examining ophthalmologist. They have a flat plate-like design made of acrylic/PVC with holes at upper end to allow for fitting of the ocular eye pieces, having dimensions ranging from 4 inches by 5 inches[8] to 7.5 inches by 8.5 inches[9,10] to 7.5 inches by 11.5 inches.[11] All these breath shields are inserted behind the viewing arm by dangling over the eye pieces[8-10] or by hooking between the oculars and the magnification changer[11] of the slit lamp, i.e. at the proximal end of the slit lamp or the end near to the examining ophthalmologist. [Fig. 1 inset].

Creation of new design (Distal Barrier)

We modified our slit lamp to insert a protective shield near the distal end of the slit lamp or the end farthest to the examining ophthalmologist, i.e. shield in close proximity to the patient's face This was done in the following manner:

a) Re-positioning of the supply cable to the slit lamp bulb: We removed the electric cable concealed within the hollow of the pipe skeleton of the chin rest and forehead tape assembly and exteriorized the connection between the halogen bulb and the power supply/rheostat of the slit lamp. This helped in creating a free space between the chin rest/fore head assembly and the illuminating arm of the slit lamp. [Fig. 2a]
b) Wooden blocks/Pedestals: The author, RM, cut 2 cubical wooden blocks of 8 inches^3 each. The centre of the block was excavated partially nearly 1.5 inch in depth with help of a chisel. A hole was drilled through the center of the chiseled area. These wooden blocks were then fixed to the slit lamp table top alongside of the guide-rail tracks of slit lamp's mechanical base in the intervening space between the chin rest/forehead assembly and the illuminating arm of the slit lamp with the help of screw passing through the hole within the chiseled area of the wooden blocks. These wooden blocks were meant act as pedestals [Fig. 2a].
c) Wooden frame: The author, RM, then fashioned 2 cylindrical wooden poles of a diameter which could easily fit within the gauged/chiseled area of the previously described wooden blocks/pedestals. In order to maintain the parallel space between the 2 wooden poles resting within the pedestals, the top end of these wooden poles were fixed with 2 flat rectangular wooden sticks, hence creating a "U-shaped" frame closed at its top end and open at its bottom end [Fig. 2b].

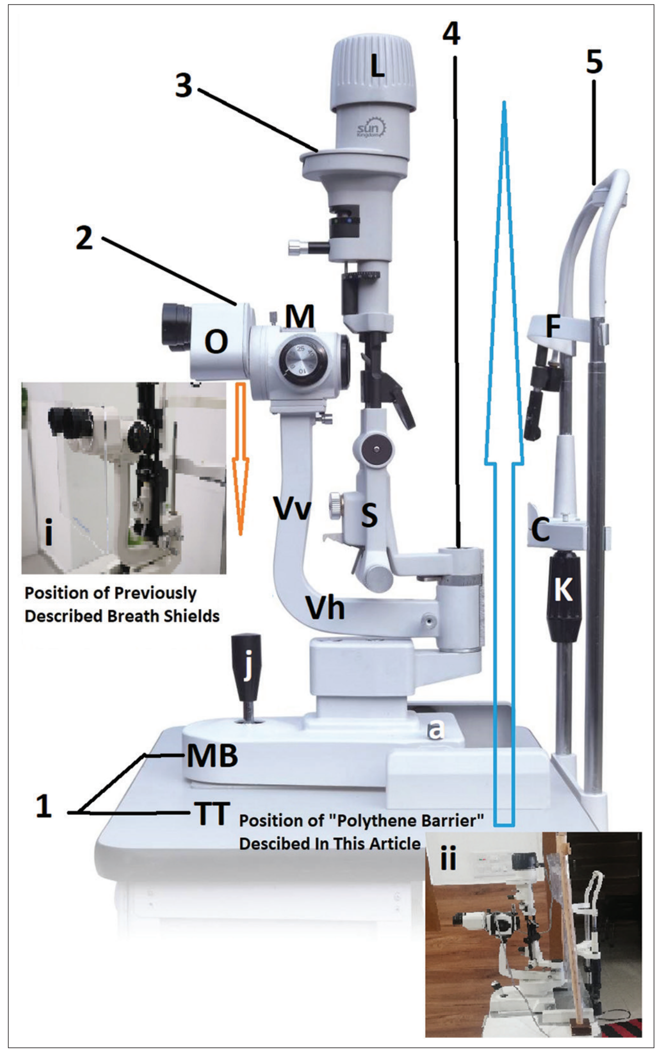

Figure 1: "Slit Lamp Base" [table top (TT), mechanical base (MB) joy stick (j)]; 2 "Viewing Arm" (Vv, Vh are vertical and horizontal parts of viewing arm respectively, oculars (o) plus magnification changer (M); 3 "Illumination Arm [light adjustment column (S), lamp housing (h); 4 is junction of viewing and illumination arms or "pivot (p) and 5 is "Patient Positioning Arm" elevation knob (K), chin rest (C) and forehead tape (F). Downward arrow and inset (i) is akin to breath shields which are inserted behind the viewing arm.upward blue-with inset (ii) represents novel concept of placement of breath shield

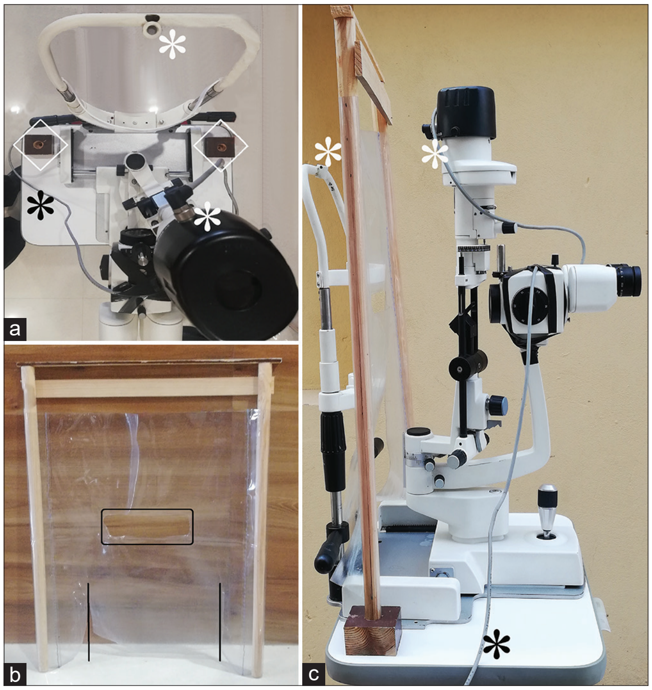

Figure 2: Placement of novel distal breath shield: "*" shows electricity cable exteriorization connecting bulb to rheostat. White squares (a) are grooved wooden pedestals, (b) shows wooden frame with PVC sheet *in situ* with central opening (black rectangle) and two relaxing cuts (blackline) for accessing elevation knob. (c) is side profile view of installed shield

d) Polythene Barrier: The author, AP, then cut a piece of transparent Poly-vinyl chloride curtain sheet PVC AC (5 mm thickness) of width 1 cm greater than the width of the "U-shaped" frame. The ends of the PVC AC curtain sheet were folded over and stitched which allowed the limbs of the "U shaped" frame or the wooden poles to slide into circular sheaths thus created. The length of this PVC AC curtain sheet was fashioned smaller than the height of the "U-shaped" frame so as to properly fit within the constraints of the "U-shaped" frame [Fig. 2b]. Fig. 2C shows the side profile view of the protection frame in its intended position.

Design analysis

I. "Respiratory Droplet/Aerosol" mediated contamination examination system [Fig. 3]:

In order to assess the amount of contamination of the slit lamp we covered the entire slit lamp with white colored cotton sheet. Pieces of white colored cotton cloth were cut according to the size of each part of slit lamp and then that particular part was covered over by the appropriate sized cotton cloth piece and the edges of that piece of cloth were approximated using a stapler, so that particular part of the slit lamp was completely and tightly draped.

First, after removing rail-guards and lifting the mechanical base (on which the joystick of the slit lamp is attached) of the slit lamp from the underlying tabletop, a piece of white colored cloth was draped over the slit lamp table. Secondly, the entire Illuminating arm of the slit lamp was draped in cotton cloth. And finally, the mechanical base along with the joystick and the visualizing arm of the slit lamp were covered with the white cotton cloth [Fig. 3a].

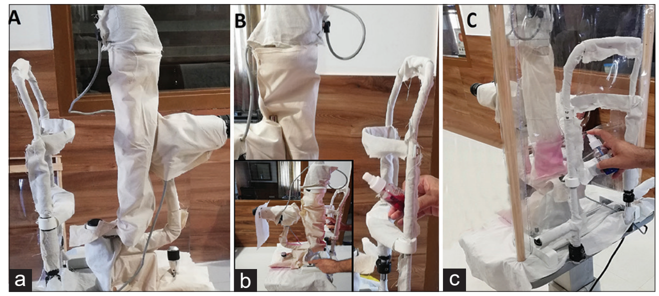

Figure 3: Methodology (a) shows slit lamp and its parts covered with pieces of white colored cotton sheet, representing entire surface area of the slit lamp. (b) shows a 50 ml fine mist spray bottle filled with magenta colored dye put on the chin rest of the slit lamp, with A4 sized white paper hung over the oculars representing the presently available acrylic breath shield (inset, image i); the mist simulates "Respiratory Droplet Like" Particles generated by the patient's breath. (c) shows a 50 ml fine mist spray bottle filled cyan colored dye being sprayed, with the novel polythene breath shield in place

II. "Respiratory Droplet/Aerosol" like generation system [Fig. 3b]:

Analysis of proximal barrier: We used a 50 ml fine mist spray bottle of a hand sanitizer and after emptying it we filled it half with water and then added 2 ml of "magenta colored dye" (Epson Ink Bottle, 664, Magenta, Seiko Epson Corporation, Suwa, Nagano, Japan) retrieved from the refilling well of a an ink-jet printer (Epson L365, Seiko Epson Corporation, Suwa, Nagano, Japan) available at the hospital premises. This magenta dye stained water filled mist spray bottle was put on the chin rest of the slit lamp making roughly an angle of 20 degree to the horizontal to simulate the expiration of air of the patient's nares.

In order to ensure that no air was trapped within the pipe of the spray delivery system of the bottle the spray nozzle was depressed 2-3 times before docking it on the chin rest platform. Keeping in mind that it roughly takes a minute to have a rough screening of anterior segment on a slit lamp examination, we pressed the nozzle 12 times over a period of 1 minute (1 spray every 5 seconds). Sprays were divided into 4 batches of 3 sprays each according to the positions of illumination arm and viewing arm with respect to each other plus an extra spray was done at the end [Fig. 3b]:

1) First batch signifying diffuse/direct focal examination of the right eye: viewing arm and illuminating arm in parfocal position with illuminating arm swung to the left by 20-30 degree, with the slit lamp viewing arm directly opposite to the supposed right eye position.
2) Second batch signifying diffuse/direct focal examination of the left eye: viewing arm and illuminating arm in parfocal position with illuminating arm swung to the right by 20-30 degree, with the slit lamp viewing arm directly opposite to the supposed left eye position.
3) Third batch signifying retroillumination examination of the right eye: viewing arm and illuminating arm in a confocal position with the slit lamp viewing arm directly opposite to the supposed right eye position.

4) Fourth batch signifying retroillumination examination of the left eye: viewing arm and illuminating arm in a confocal position with the slit lamp viewing arm directly opposite to the supposed left eye position. To simulate the presence of a proximal acrylic breath shield we dangled a A4 sized paper sheet of GSM 100 over the slit lamp oculars. The size of the A4 sheet of paper is 8.27 inches * 11.69 inches and represents the size of the largest commercially available shield. [Fig. 3b, inset i].

Analysis of distal barrier: As previously described, this time filled the bottle half with water to which we added 2 ml of "cyan colored dye" (Epson Ink Bottle, 664, Magenta, Seiko Epson Corporation, Suwa, Nagano, Japan) retrieved from the refilling well of a an ink-jet printer (Epson L365, Seiko Epson Corporation, Suwa, Nagano, Japan) available at the hospital premises. This cyan dye stained water filled mist spray bottle was put on the chin rest of the slit lamp and further steps were repeated as before. However, this time the PVC AC curtain sheet representing the "Distal Barrier" was put in place before initiating the spray. [Fig. 3c]

III. Photography of Equipment and Draped Cloth: At the end of the experiment the entire slit lamp and its immediate surrounding were photographed using a mobile phone camera. Thereafter the draped pieces of white cloth, now at places stained with "magenta colored dye"/"patient's breath" were removed from the slit lamp and arranged [Fig. 4] on the tiled floor as follows:
   a) Part 1; Slit Lamp base (a: tabletop, b: mechanical base with joystick and c: distal edge of mechanical base)
   b) Part 2; Viewing arm (a: mechanical column and b: oculars plus magnification changer with its base/bracket),
   c) Part 3; Illumination arm (a: slit/light adjustment column and b: lamp housing),
   d) Part 4; Pivot (which represents the junction of viewing and illumination arms)
   e) Part 5; Patient positioning arm (which includes from below to above, as follows: a: ledge, b: patient grab bars with railing, c: chin rest elevation knob with railing, d: chin rest and e: forehead tape with railing)

IV. Image Analysis of the Stained Cloth [Fig. 5]: The images of white cloth stained with "magenta colored dye" or "cyan colored dye", simulating patient's breath generated aerosols in 2 different settings (using "proximal barrier vs "distal barrier" respectively), obtained were analyzed using the ImageJ software (Java-based image processing program, National Institutes of Health (NIH), Bethesda, Maryland, USA and the Laboratory for Optical and Computational Instrumentation (LOCI), University of Wisconsin, Wisconsin, USA). For image analysis, the images were first cropped, color threshold adjusted and then converted to binary using the ImageJ software. Thereafter the measurements were done after setting the measurements to area fraction (P_n Surface Area $_{\text{magenta fraction}}$ (%) during analysis of "proximal barrier" and P_n Surface Area $_{\text{cyan fraction}}$ (%) during the analysis of "distal barrier", where P_n refers to Parts 1-5 of the slit lamp).

V. Measurement of Total Area Stained/Area of the Slit Lamp Contaminated by Patient's Breath: a) Calculation of the Entire Surface Area of Slit Lamp: All the pieces of white cloth used to cover the slit lamp were measured individually with the help of a measuring tape; this gave the actual measurement of each piece of cloth or the surface area of the particular part of the slit lamp (P_n Surface Area (cm^2), where P_n refers to Parts 1-5 of the slit lamp). The total surface area of the slit lamp was then calculated as follows: Surface Area $_{\text{total}}$ (cm^2) = P_1 Surface Area + P_2 Surface Area +… + P_5 Surface Area

b) Calculation of the "Magenta Dye Stained" Surface Area of Slit Lamp/Area of the Slit Lamp Contaminated by Patient's Breath (For Analyzing Proximal Barrier): From the P_n Surface Area (cm^2) obtained using measuring tape and P_n Surface Area $_{\text{magenta fraction}}$ (%) obtained using ImageJ software, we were able to back calculate true amount of "magenta dye stained" surface area of the different parts of the slit lamp, as follows:

P_n Surface Area $_{\text{magenta stained}}$ (cm^2) = (P_n Surface Area (cm^2) X P_n Surface Area $_{\text{magenta fraction}}$ (%))/100. By adding the values of the above obtained we were able to estimate the entire surface area of slit lamp that was "magenta dye stained", hence contaminated by "patient's breath", as below: Surface Area $_{\text{magenta stained}}$ (cm^2) = P_1 Surface Area $_{\text{magenta stained}}$ +…. + P_5 Surface Area $_{\text{magenta stained}}$

c) Calculation of the "Cyan Dye Stained" Surface Area of Slit Lamp/Area of the Slit Lamp Contaminated by Patient's Breath (For Analyzing Distal Barrier): From the P_n Surface Area (cm^2) obtained using measuring tape and P_n Surface Area $_{\text{cyan fraction}}$ (%) obtained using ImageJ software, we were able to back calculate true amount of "cyan dye stained" surface area of the different parts of the slit lamp, as follows: P_n Surface Area $_{\text{cyan stained}}$ (cm^2) = (P_n Surface Area (cm^2) X P_n Surface Area $_{\text{cyan fraction}}$ (%))/100. By adding the values of the above obtained we were able to estimate the entire surface area of slit lamp that was "cyan dye stained", hence contaminated by "patient's breath", as follows: Surface Area $_{\text{cyan stained}}$ (cm^2) = P_1 Surface Area $_{\text{cyan stained}}$ +…. + P_5 Surface Area $_{\text{cyan stained}}$

Results

The entire surface area of the slit lamp under study, Surface Area $_{\text{total}}$ (cm^2), was 9912.45 cm^2. The surface area of the slit lamp presumably contaminated by patient's breath (magenta dye stained), Surface Area $_{\text{magenta stained}}$ (cm^2), when using the "proximal barrier" was 567.50 cm^2 whereas the surface of the slit lamp presumably contaminated by patient's breath (cyan dye stain), Surface Area $_{\text{cyan stained}}$ (cm^2), when using the distal barrier was 222.93 cm^2.

The fraction of area contaminated by the patient's breath while using the proximal barrier (P_n Surface Area$_{\text{magenta stained fraction}}$) and fraction of area contaminated by the patient's breath while using the distal barrier (P_n Surface Area $_{\text{cyan stained fraction}}$) are tabulated in Table 1. and the actual or measured surface areas of different parts of slit lamp (P_n Surface Area) along with calculated surface area of magenta and cyan stained white cloth draping the slit lamp (P_n Surface Area $_{\text{magenta stained}}$ and P_n Surface Area$_{\text{cyan stained}}$ respectively) are tabulated under Table 2.

Discussion

Our study demonstrated that the amount of contamination of the slit lamp during the examination of the patient by simulated breathing was more while using a barrier at the proximal end (the end near to an ophthalmologist) as compared to using a barrier at the distal end of the slit lamp (the end farthest to the examining ophthalmologist, i.e. barrier in close proximity to the patient's end) (567.50 cm^2 vs 222.93 cm^2 respectively).

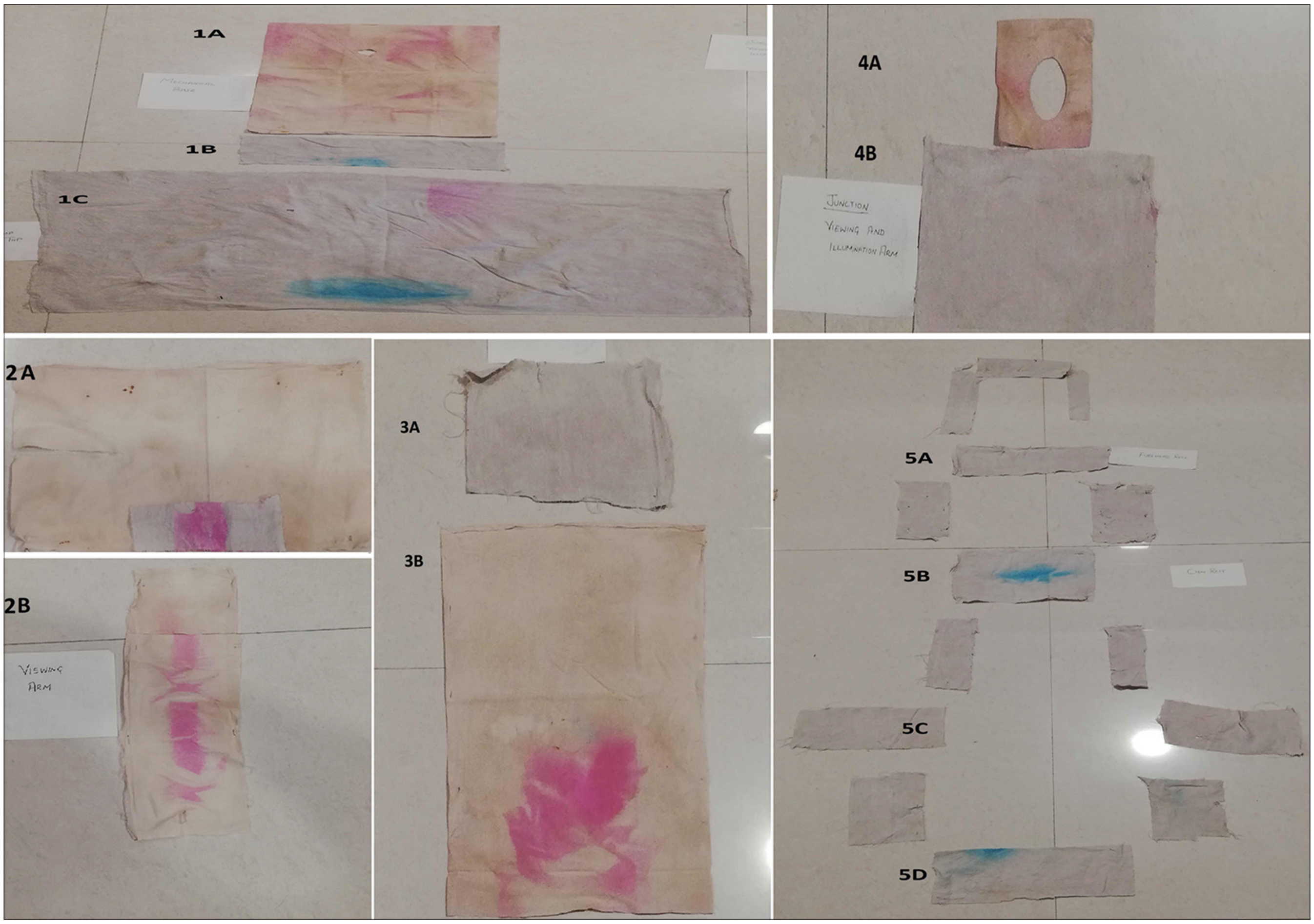

Figure 4: Contamination of various parts of the slit lamp. 1A, 1B and 1C are mechanical base, its front edge and the table top respectively. 2A, 2B are oculars and "viewing arm". 3A and 3B are "Illumination arm" and slit/light adjustment column. 4A, 4B are upper surface and the sides of the " junction of viewing and illumination arms and the parts of "Patient positioning arm" are draped by white pieces of cloth at forehead tape (5A), chin rest (5B), patient holding bars (5C) and the anterior edge plate (5D) of the skeleton of the metallic railings screwed into the table top of the slit lamp

A sub-analysis for assessing the efficacy of the proximal breath shield showed that although none (Zero %) of the Part 5 (Patient Positioning Arm) was contaminated when examining a patient with a proximal barrier in place, there was 100% contamination of the working parts of the slit lamp; Part 1, 2, 3 and 4 (Slit lamp base, viewing arm, illumination arm and the pivot respectively). In addition more than 90% of surface area of the slit lamp contaminated by the patient's breath was essentially those parts of the slit lamp with which the examining ophthalmologist is constantly in contact with (in order of their increasing frequency): a) table top of the slit lamp base (80.72 cm^2), mechanical column of the viewing arm (84.15 cm^2), the slit adjustment column of the illumination arm (156.61 cm^2) and the mechanical base with joy stick (204.31 cm^2) respectively. In addition, only 13.28 cm^2 of the proximal barrier (acrylic breath shield) was found to be contaminated which represented 2.29% of the entire contamination. Hence, 97.71% of the contaminations was subjected to Parts 1, 2, 3 and 4 (Slit lamp base, viewing arm, illumination arm and the pivot respectively) of the slit lamp.

The scatter pattern of contamination on the proximal barrier (acrylic breath shield) was primarily on the lower/inferior half of the barrier (triangular scatter pattern with the base down) (Fig. 6, hence establishing that the major onslaught of contaminating stream of breath was directed more inferiorly i.e. directed towards the hands, arms and torso of the ophthalmologist and not superiorly towards the ophthalmologists' face. A similar sub-analysis for assessing the efficacy of a distal breath shield (novel PVC AC sheet barrier) revealed that except for Part 1c (distal edge of the mechanical base of the slit lamp base, 13.36 cm^2), the rest 94.01% of surface area of the slit lamp contaminated by the patient's breath were essentially those parts of the slit lamp with which the examining ophthalmologist does not actively come in contact with while doing slit lamp examination. These parts in order of their increasing frequency were: a) ledge of the patient positioning arm (9.63 cm^2), chin rest (48.01 cm^2) and the table top of the slit lamp base (151.93 cm^2) respectively. About 25.86% of contaminated surface area (57.64 cm^2) of the slit lamp involved the Part 5 (Patient Positioning Arm) whereas out of the rest of 74.14% of the surface contaminated, more than 90.00% (91.92%) was represented by the distal part of the table top of the slit lamp base (Part 1a) whereas a mere 8.08% was the distal edge of mechanical base of the slit lamp base (Part 1c). Both these parts were adjacent to the Patient positioning arm of the slit lamp, directly under the lower end of the distal shield, receiving

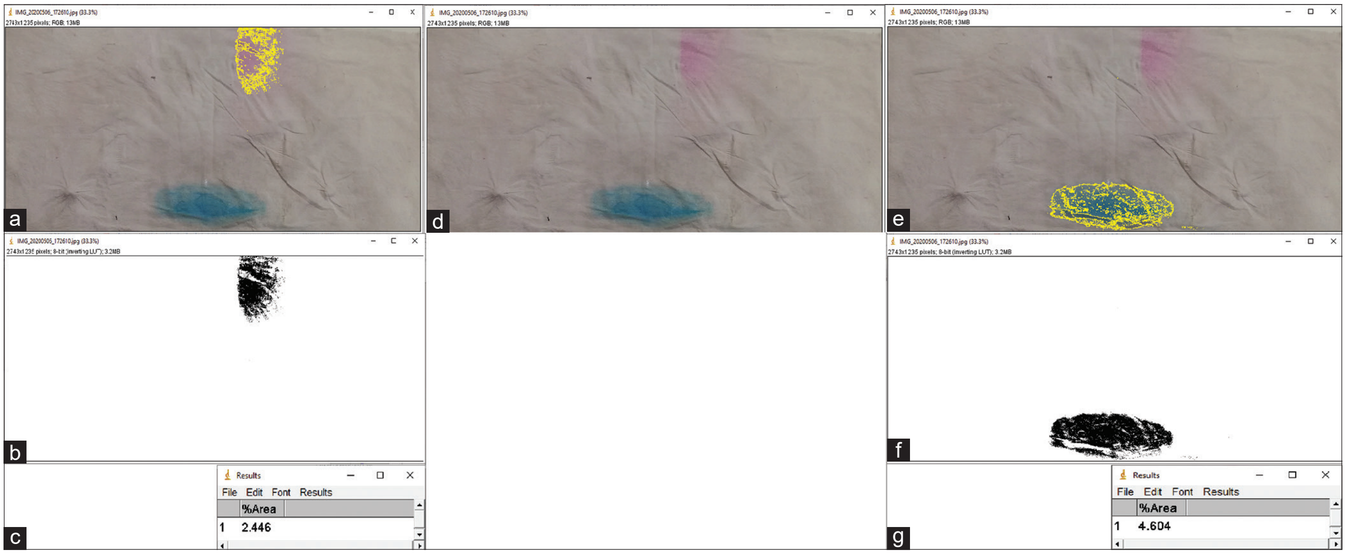

Figure 5: Percentage surface area contamination assessment using the ImageJ software. cropped image of cloth covering the table top part of the slit lamp (d);magenta and cyan stain represent area of contamination. Image (d) was color threshold adjusted (a), converted to binary (b) and measurements done after setting the measurements to "area fraction" and results (c) obtained [Pn Surface Area magenta fraction (%)]. (e-g) show assessment of percentage surface area contamination cyan colored dye expressed as [Pn Surface Area cyan fraction (%)]

Table 1: The fraction of area contaminated by the patient's breath while using the proximal barrier (P_n Surface Area $_{\text{magenta stained fraction}}$) and fraction of area contaminated by the patient's breath while using the distal barrier (P_n Surface Area $_{\text{cyan stained fraction}}$)

Part No.	Part Name		Fraction of Surface Area Stained (%)	
			Magenta Stained	Cyan Stained
1	Slit Lamp Base	a. Table Top	2.446	4.604
		b. Mechanical Base with Joystick	19.721	0.000
		c. Distal Edge of Mechanical Base	0.000	4.954
2	Viewing Arm	a. Mechanical Column	19.311	0.000
		b. Oculars plus Magnification Changer	3.526	0.000
3	Illumination Arm (plus)	a. Slit Adjustment Column	11.667	0.000
		b. Halogen Lamp Housing	0.000	0.000
4	Pivot (The Viewing and Illumination Arm Junction)		2.596	0.000
5	Patient Positioning Arm	a. Ledge	0.000	3.932
		b. Chin Rest Elevation Knob with Railings	0.000	0.000
		c. Patient Grab Bars	0.000	0.000
		d. Chin Rest	0.000	16.540
		e. Forehead Tape	0.000	0.000

the trickle of the cyan colored dye from above [Fig. 6]. None of the Parts 2, 3, 4 (Viewing arm, illumination arm and the pivot respectively) and Part 1b (mechanical base with joy stick) were contaminated by the patient's breath while using a distal breath shield (novel PVC AC sheet barrier), which was apparent by the absence of any cyan colored stain beyond the distal edge of mechanical base of the slit lamp base i.e. Part 1c [Fig. 6]. Both Parts 1a and 1c represent areas of the slit lamp not in the working domain of the examining ophthalmologist.

This shows that the distal barrier (novel PVC AC sheet barrier) proves to be an effective barrier against the major onslaught of contaminating stream of patient's breath directed towards the working parts of the slit lamp and hence provides protection for hands, arms and torso of the ophthalmologist doing the slit lamp examination as compared to the proximal barrier (acrylic breath shields), which fail in their endeavor of protecting the working parts of slit lamp and hence hands, arms and torso of the ophthalmologist [Fig. 6].

So, a distally placed shield effectively closes out any significant contamination of those working parts of the slit lamp which are actively engaged by the examining ophthalmologist, hence breaking the chain of contamination.

Our study has a few limitations which cannot be overlooked. First of the droplets and aerosols generated from a mist spraying bottle may not be a true mimic of the aerosols generated by patient breathing. Second the dilution of the dye used in our study for visualizing the aerosols was on the basis of subjective

Table 2: The actual or measured surface areas of different parts of slit lamp (P_n Surface Area) along with calculated surface area of magenta and cyan stained white cloth draping the slit lamp (P_n Surface Area $_{\text{magenta stained}}$ and P_n Surface Area $_{\text{cyan stained}}$ respectively) are tabulated under Table 2

Part No.	Part Name		Surface Area (cm²)	Surface Area Magenta Stained (cm²)	Surface Area Cyan Stained (cm²)
1	Slit Lamp Base	a. Table Top	3300.00	80.72	151.93
		b. Mechanical Base with Joy Stick	1036.00	204.31	0.00
		c. Distal Edge of Mechanical Base	269.75	0.000	13.36
2	Viewing Arm	a. Mechanical Column	435.75	84.15	0.00
		b. Oculars plus Magnification Changer	841.50	29.67	0.00
3	Illumination Arm	a. Slit Adjustment Column	1342.29	156.61	0.00
		b. Halogen Lamp Housing	378.35	0.00	0.00
4	Pivot (The Viewing and Illumination Arm Junction)		463.88	12.04	0.00
5	Patient Positioning Arm	a. Ledge	245.00	0.00	9.63
		b. Patient Grab Bars with Rails	613.40	0.00	0.00
		c. Chin Rest Elevation Knob with Rails	186.00	0.00	0.00
		d. Chin Rest	290.25	0.00	48.01
		e. Forehead Tape with Rails	510.28	0.00	0.00
Total surface area (cm²)			9912.45	567.50	222.93

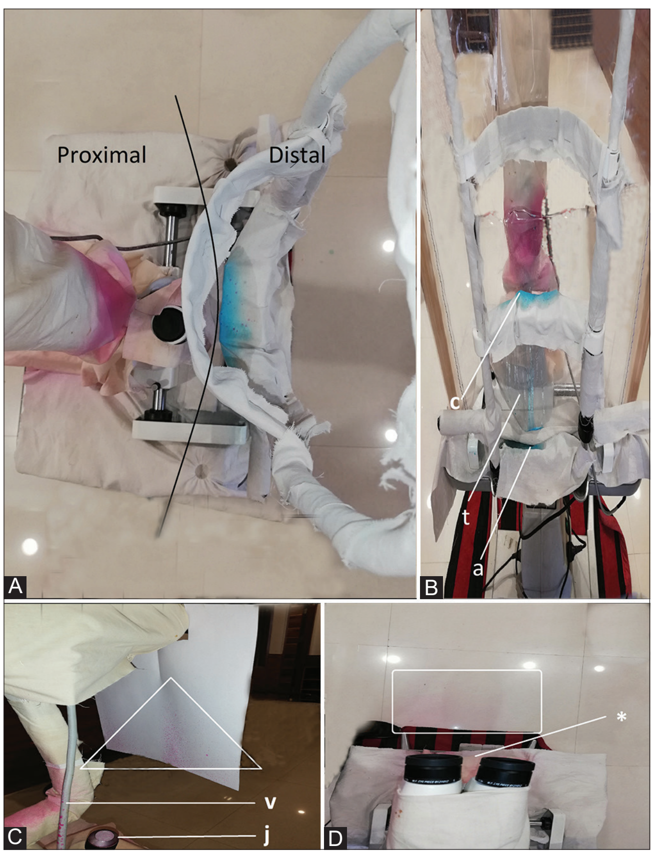

Figure 6: "A" shows divide in contamination area using distal barrier (cyan stain) and proximal barrier (magenta stain). "B" shows stains limited to the chinrest (c) ledge of patient position part and anterior edge of the base of the slit lamp (a) due to trickle (t) of cyan dye across the PVC sheet. "C" shows minimal protection by proximal barrier depicted by magenta spots on inferior half of paper sheet (bounded by triangle) with contamination occurring on the slit lamp viewing arm (v), joy stick (j) slit lamp table top (*) and floor below oculars (as shown bounded by a rectangle) in "D"

observation. Third the smaller droplets and aerosols which may have settled and colored the evaluation sheets may have been missed in the photograph due to the native ISO settings or camera's sensor resolution. Inspite of these limitations the results of the study do point towards a greater level of safety in using a distally placed shield compared to a proximal shield. There is an unmet need of a study using instruments with higher objectivity as high magnification high speed cameras which can detect even smaller volumes of aerosol spread and contamination.

Conclusion

In ophthalmic settings despite symptom based triage, we need to be cautious and examine each and every patient as if he or she is an asymptomatic transmitter of SARS-CoV-2 and hence the need for maximum protection of the examining ophthalmologist as well as the ophthalmic equipment which can be better provided by changing the barrier from proximal to a much distal position on the slit lamp.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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