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Hybrid Workshops During the COVID-19 Pandemic—Dawn of a New Era in Neurosurgical Learning Platforms

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■ **BACKGROUND:** During the COVID-19 pandemic, disruption of surgical hands-on training has hampered the skills acquisition by budding neurosurgeons. Online and virtual classrooms have not been able to substitute the hands-on experience and learning via direct interaction with senior colleagues. To overcome these challenges, we organized a hybrid workshop where simulation-based learning modules, and direct and virtual interaction with surgeons during live surgeries or didactic lectures were utilized to help delegates in understanding the nuances of neurosurgery.

■ **METHODS:** A 3-day hybrid workshop was held in March 2021, which was attended by 133 delegates. A structured questionnaire was utilized to record their feedback.

■ **RESULTS:** An overwhelming majority of the respondents (94.1%, n = 64) found hybrid conferences to be better than an online conference. Most of the respondents (88.3%, n = 60) rated the utility of direct face-to-face interaction to be more satisfying as compared with online interaction with faculty during a webinar. Again, many the respondents (86.8%, n = 59) believed that similar hybrid events will be the new normal given the current situation of COVID-19 pandemic. A large majority (88.2%, n = 60) of the respondents reported that they will prefer a hybrid event over an online conference.

■ **CONCLUSIONS:** In this era of the COVID-19 pandemic, “hybrid” microneurosurgery workshops offer unique opportunities to enhance surgical skills acquisition by

hands-on simulation-based learning and observing live surgical demonstrations, apart from 2-way interactions with experts under one roof. This may be a stepping stone for what lies ahead in the future of neurosurgical training.

INTRODUCTION

The COVID-19 pandemic, besides testing the competence of health care systems worldwide, has left a gaping hole in the medical education and skills training of residents and fellows, especially in surgical specialties.¹⁻⁵ While delivery of knowledge has been compensated to a large extent by online teaching and webinars, the domain of surgical skills development remains unanswered to a great extent. Various infrastructural changes done in order to combat the challenges posed by the COVID-19 pandemic have seriously hampered the neurosurgical residency training program.^{1-3,5-8} This has led to substantial changes in the time-tested and stringent resident training programs throughout the world.⁹⁻¹¹ In many British Commonwealth countries, where neurosurgical residency programs are of 2–3 years duration (after post-graduation) the problem has been accentuated, as over a year has been lost.^{6,12-19}

As David Rockefeller once famously said, “If necessity is the mother of invention, discontent is the father of progress”. This has been proven correct, as the negative impact on many training programs necessitated development of many novel and innovative ways of teaching residents. The silver lining has been the timing of

Key words

- COVID-19
- Conference
- Hands-on training
- Hybrid
- Resident training
- Workshop

Abbreviations and Acronyms

MSNW: Microneurosurgery Workshop

PPE: Personal protective equipment

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the pandemic, when technology and telecommunication have advanced at their summit and have been exploited to their maximum.²⁰⁻²³

Tenure of the residency training program is fixed and, due to the reallocation of residents to COVID designated areas, their skills acquisition in a super-speciality surgical branch such as neurosurgery has been severely impacted. Other contributory factors that have impacted their training include reduced number of neurosurgical procedures (specially at the peak of the pandemic), rationed personal protective equipment (PPE) usage, disallowing second assistants from scrubbing in, and a near complete cessation of physical teaching exercises and academic activities. Recent papers have documented the impact of training in nearly 33% to 74% of their respondents during this pandemic.^{1,3,12,13,24-27}

In this paper, we discuss an innovative method of imparting both skills and knowledge to neurosurgical trainees during the height of the pandemic. We discuss the challenges faced and the lessons learned in organizing a hybrid workshop with dual virtual and physical participation. We report a replicable model to conduct integrated simulation, skills, and operative hybrid workshops for continued medical education and academic extravaganza in surgical specialty, along with feedback of delegates and suggestions for other neurosurgical programs to follow.

METHODS

Study Design

We conducted a 3-day hybrid Microneurosurgery Workshop (MNSW) in February 2021 in New Delhi, India (**Supplemental file 1**). The first day of the workshop targeted the psychomotor domain and included hands-on workshops on various simulation models, to teach stereotactic biopsy, microvascular anastomosis, use of ultrasound, Cavitron ultrasonic aspirator, high-speed drill use, and achieving thrombosis in difficult cases. The following 2 days included live telecast from 2 operating rooms, along with presentation of unedited operative videos by the senior neurosurgeons, didactic talks, and “How I Do It” sessions by faculty and residents. The workshop also included presentations by world-renowned neurosurgeons, who delivered the Sarveshwari Oration via Zoom tele-conferencing app (Zoom Video Communications, San Jose, CA), while Professor P. N. Tandon’s oration was addressed physically to the audience. Talks and orations were transmitted live on YouTube (Google, Mountain View, CA) and surgical cases were transmitted “live” to the audience in the conference hall from the operation rooms due to ethics concerns. A 2-way communication between delegates and the operating team allowed step-by-step teaching, real-time clarification of doubts, and in-depth understanding of operative nuances. A survey-based descriptive cross-sectional study was conducted following the MNSW among the delegates who attended it (**Figure 1**).

Steps Taken to Reduce Risk of Spread of Infection

All delegates from external programs who were participating physically (n = 133) were allowed to enter the workshop area only after production of either a negative COVID-19 reverse transcription polymerase chain reaction report (within 48 hours) or production of a COVID-19 vaccination certificate. The delegates

were divided into multiple small groups (n = 8) to avoid overcrowding and follow social distancing norms. This also helped us in providing adequate training exposure to each delegate by a rotation policy during the hands-on workshop modules. The conference was organized in 3 parallel seminar halls with live telecast of the main academic activity in all the conference halls. COVID-19 safety protocols such as wearing N95 masks, regular hand sanitization, and social distancing were strictly adhered to. Frequent use of disinfectants for cleansing of workstations to reduce risk of cross-infection was also undertaken. Senior neurosurgeons who were in vulnerable age groups and had comorbidities participated in virtual mode only (n = 11).

Questionnaire Content and Validation

The survey was conducted among the attendees present physically using the Google Forms online application regarding their experience of attending this hybrid event. Five independent neurosurgeons working elsewhere, and not part of the study, performed a face and content validation of the survey questionnaire. The relevance of each question was marked individually on a scale of 1–4. Using validation feedback, we calculated the Item Content Validity Index and Scale-Level Content Validity Index, both of which conferred a satisfactory value of 1.²⁸ The link to the questionnaire was circulated among the attendees via e-mail. The questionnaire has been provided as **Figure 1**. The survey questionnaire graded the usefulness of various components of the hybrid workshop on a 5-point Likert scale. The structured questionnaire consisted of 17 questions pertaining to the usefulness of various components of the hybrid workshop. The responses were tabulated and analyzed using Excel 2016 (Microsoft Corp, Redmond, WA). Plots were generated using R version 4.0.3 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Sixty-eight delegates responded to the survey. We had a good response rate (72%). Most of the respondents (86.8%, n = 59) were attending such a hybrid event for the first time (**Figure 2A**). Most of the respondents (77.9%, n = 53) perceived that the risk–benefit ratio of attending conferences was acceptable despite the ongoing pandemic. The majority of delegates who responded to the survey (88.2%, n = 60) were satisfied with COVID-19 safety protocols followed during the conference (**Figure 2B**).

Comparison With Online Conferences

An overwhelming majority of the respondents (94.1%, n = 64) found hybrid conferences to be better than an online conference (**Figure 3A**). Most of the respondents (88.3%, n = 60) rated the utility of direct face-to-face interaction to be more satisfying than online interaction with faculty during a webinar. Again, a large number of the respondents (86.8%, n = 59) believed that similar hybrid events will be the new normal given the current situation of the COVID-19 pandemic (**Figure 3B**).

Usefulness of Conference and Workshops

Most of the respondents (92.6%, n = 63) rated their experience of attending the MNSW to be 4 or 5 on a Likert scale, with 5 being

Feedback Form MNSW20201

* Required

1. Name

2. Institute

3. Have you ever attended hybrid conference earlier? *
Mark only one oval.
 Yes
 No
4. Do you think hybrid conference is the future? *
Mark only one oval.
 Yes
 No
5. Is hybrid conference better than an only online event? *
Mark only one oval.
 Yes
 No

Figure 1. Survey questionnaire used to assess the feedback of the respondents. (Continues)

6. How do you rate the utility of the direct face to face interaction versus online interaction with faculty during a webinar? *
Mark only one oval.
1 2 3 4 5
Unsatisfactory Extremely satisfactory
7. Compared to direct OT telecast, how will you rate your experience of presentation of unedited videos and discussion by the operating surgeon? *
Mark only one oval.
1 2 3 4 5
Unsatisfactory Extremely satisfactory
8. Compared to edited videos, how will you rate your experience of unedited videos and talks? *
Mark only one oval.
1 2 3 4 5
Unsatisfactory Extremely Satisfactory
9. Did you find the resident video presentation as useful? *
Mark only one oval.
1 2 3 4 5
Not at useful Extremely useful

Figure 1. Continued.

highly satisfied (Figure 4). The proportion of respondents who found the ultrasound and biopsy workshops to be highly useful (4 or 5 on a Likert scale, with 5 being highly satisfied) was 67.7% (n = 46) and 69.1% (n = 47), respectively. A large majority (88.2%, n = 60) of the respondents reported that they will prefer a hybrid event over an online conference, motivated by their experience of attending the present hybrid MNSW conference (Figure 3C).

Presentation of Surgical Videos

All of the respondents (100%) found the presentation of unedited videos by the senior neurosurgeons to be an effective way of learning and way forward in an era where the number of surgeries assisted by trainees is gradually waning. A significant number of respondents found these to be even better than the presentation of edited videos (83.8%, n = 57) and live telecast of surgery from the operation room (85.3%, n = 58). The residents also presented short surgical videos of the cases at which they had assisted,

ranging from simple bedside procedures such as lumbar puncture to more complex skull base and vascular neurosurgical procedures such as high flow bypass for complex aneurysms, and so forth. Most of the respondents (72.1%, n = 49) found this exercise to be quite useful.

DISCUSSION

Most of the respondents were attending a hybrid event for the first time. Most of the participants responded that they would prefer a face-to-face interaction with presenters and unedited video presentations, which are missing in webinars. Simulation workshops were also liked by the attendees as they could receive supervised hands-on experience on simulation models. Most of the participants felt that they could understand the nuances of surgeries well due to the interactive nature of the program where they could even acquire new skills on simulation base models.

Impact of COVID-19 on Neurosurgical Training

COVID-19 has presented unique challenges for people in every walk of life. The challenges faced by surgical residents are significant as their careers may be impacted because of the pandemic

10. Did you feel, COVID protocols were followed in letter and spirit? *

Mark only one oval.

Yes

No

11. How much you were hesitant in attending the workshop due to COVID? *

Mark only one oval.

1 2 3 4 5

Very Scared Not at all scared

12. Rate your overall experience of MNSW 2021 *

Mark only one oval.

1 2 3 4 5

Very poor Exceptionally good

13. Did you find ultrasound workshop useful *

Mark only one oval.

1 2 3 4 5

Not at all Exceptionally useful

Figure 1. Continued.

during their residency tenure. Reallocation of resources has led to significant decrease in elective neurosurgical procedures, which varies from center to center depending on the “load” of COVID-19 patients apart from health infrastructure availability. A reduction of up to 99.5% in the elective surgeries after the onset of COVID-19 pandemic has been reported in the literature.^{1,12,15-17} Moreover, the double scrubbing of residents/fellows in the operating room was stopped initially in order to limit the risk of spread of COVID-19 and conserve PPE for COVID-19 patients.¹³ There was a significant decrease in the working hours of the residents, which also resulted in a decrease in case discussions and other academic activities.^{16,29} Moreover, neurosurgical residents had to provide care to COVID-19 patients. The rate of this activity varied considerably, from 35.1% to 91.1%, depending on the health infrastructure in each country.^{15,16} All these factors led to a significant decrease in the amount of operative exposure of residents.

Use of Innovative Teaching Methods to Improve Learning by Neurosurgical Trainees

Many attempts have been made to overcome the challenges faced by residents. These include virtual rounds, online teaching

14. Did you find Biopsy station useful *

Mark only one oval.

1 2 3 4 5

Not at all Exceptionally useful

15. Quality of surgical Cases /discussions - Rate your experience *

Mark only one oval.

1 2 3 4 5

Very Poor Exceptionally good

16. Based on your experience of MNSW2021, will you be motivated to attend another HYBRID conference in future or you will prefer an online only conference? *

Mark only one oval.

HYBRID

ONLINE only

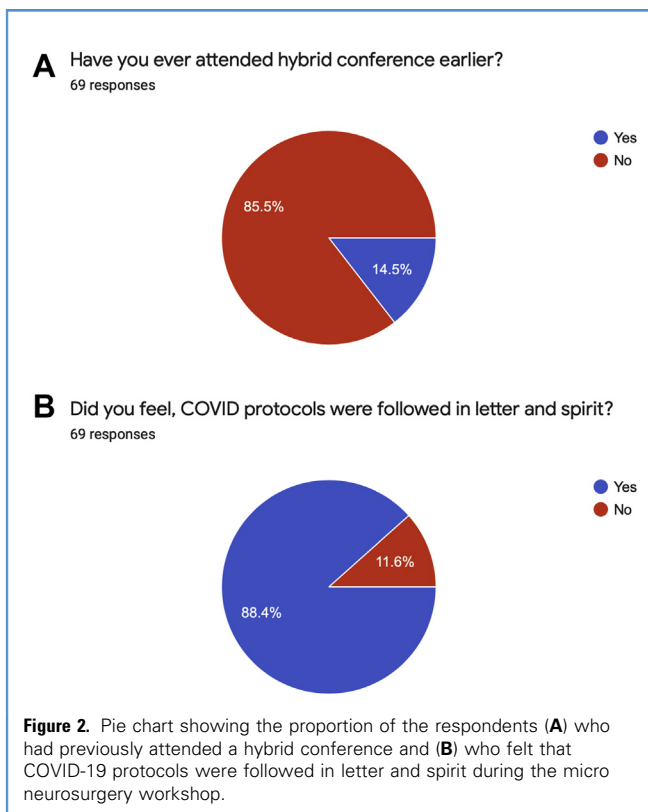
Not sure

17. List the shortcomings of the workshop ?

18. Suggestions for improvement?

Figure 1. Continued

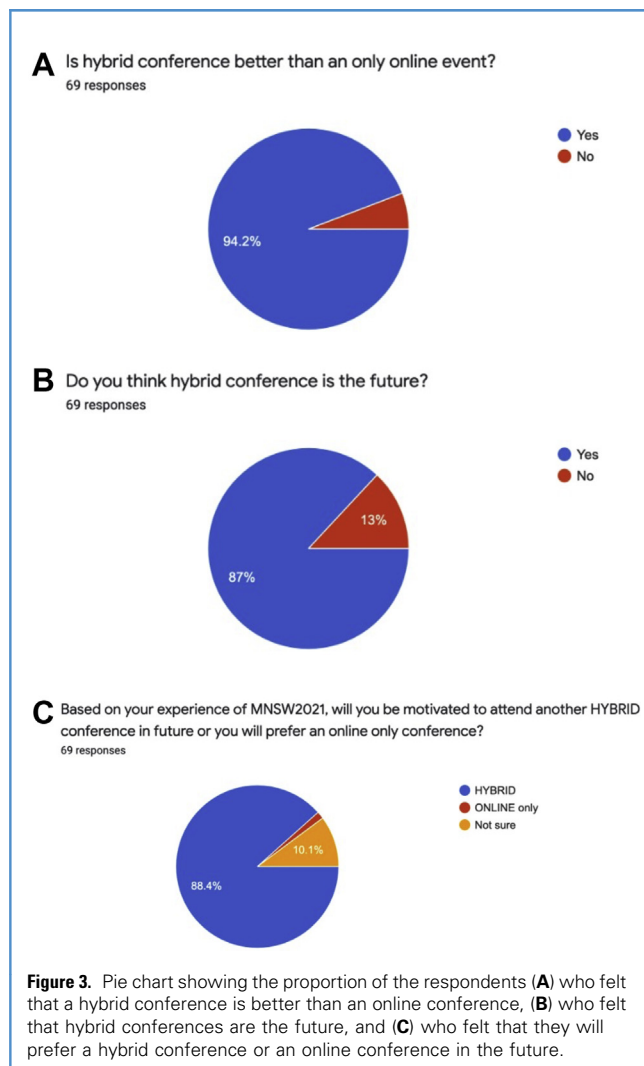
programs in place of face-to-face teaching sessions, and webinars. However, these steps do not cover for the compromise in the operative exposure. The residents must operate or assist a certain number of cases to show proficiency on program completion.¹⁶ Hence, the decrease in the number of operative cases poses a unique challenge for the surgical residents as well as their program directors.³⁰ None of the above innovative teaching methods can compensate for the loss of operative hands-on exposure. This led us to the idea of conducting a hybrid event where simulation stations helped delegates in gaining hands-on experience; a mix of online and physical lectures (Figure 5) along with live demonstration of surgical cases provided them with an opportunity to interact with masters in the field and learn basic surgical skills.



Challenges and Solutions Implemented for Organizing the Workshop

We faced many unique challenges in organizing this hybrid event due to the COVID-19 pandemic as well as because such an event was being organized for the first time at our institute. First, we planned the MNSW when the number of cases had decreased after the first wave of the COVID-19 pandemic in our city and country. We planned the MNSW only 1 month before the event—unlike the other events, which are planned 5–6 months in advance—as it was difficult to predict when the number of COVID-19 cases would rise. We actively used social media platforms like Facebook, WhatsApp groups, and e-mails to various heads of the departments of neurosurgery across the country to spread the awareness about this unique workshop. We tried to focus on young residents/fellows and under-training neurosurgical residents.

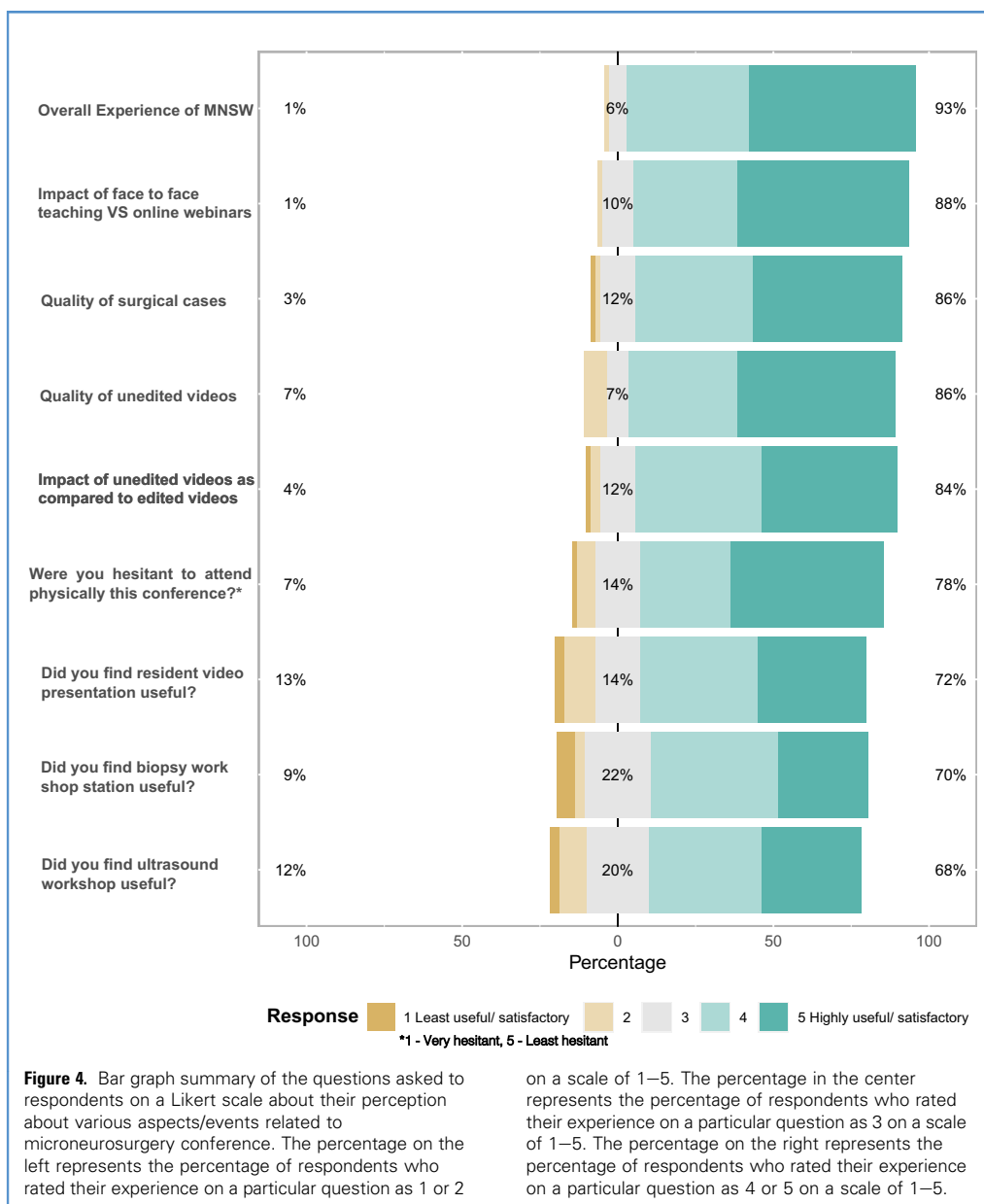
Apart from the dedicated audiovisual management team for the transmission of the live surgeries from the operating rooms to conference halls, we also arranged for the live transmission of didactic lectures and video presentations on YouTube. Live surgeries were not transmitted on social media platforms due to ethics concerns. Additionally, we used online virtual meeting platforms such as Zoom and Google Meet for oration and talks



delivered by the overseas faculty. The industry sponsors were involved using both virtual and physical platforms to ensure appropriate communication with the delegates and display of their products. Some of the talks were pre-recorded and were played repeatedly for different and small groups of targeted audiences.

We allowed only 45 or so delegates from outside of our institute and all (42) residents of our training program were allowed to participate. All the faculty members ($n = 25$) were actively involved in the teaching program, which involved both physical and virtual lectures and demonstration of operative techniques and simulation exercises.

We undertook following steps to increase the utility of the workshop for the residents:



■ We created simulation stations (Figure 5) for teaching on first day of the workshop:

- Stereotactic biopsy using frameless and frame-based navigation systems on a phantom skull.
- Ultrasound use in neurosurgery was taught on a novel low-cost model conceptualized and developed in-house. International faculty with expertise in the field of intraoperative use of ultrasound interacted with the delegates in virtual mode on Zoom, while delegates were in the conference hall. This faculty member also taught use of contrast-enhanced

ultrasound in neurosurgery, which is an upcoming intra-operative imaging modality.

- Use of Cavitron ultrasonic surgical aspirator was taught on various simulation models utilizing fruits, sheep brain, and so on.
- Microvascular anastomosis was taught on silastic sheets, silicone tubes, and chicken wings, depending upon the expertise of the delegates.
- Insertion of cervical C1, C2, and subaxial screws was taught on saw-bone models.



- Achieving thrombosis in difficult situations was taught in virtual mode by our faculty by showing pre-recorded videos and physically discussing the nuances of various hemostats and their usage in different clinical situations with available delegates.

Although the results are encouraging, hybrid workshops are only an inferior substitute to hands-on surgical training in these desperate times. Increasing the duration of specialty training may be considered to minimize sending out of semi-skilled specialists into the community for an independent practice.

Future Steps to Improve Hybrid Workshops

Video chats are poor alternatives for in-person interaction, future workshops may see more virtual reality–based technology use to improve the one-to-one conferencing experience of delegates. Improvement in software and hardware to integrate movements of limb, eye, and face by tracking them can also improve users' experience. Haptic simulators can also be utilized to create skill stations for teaching a particular surgery.

Holographic video calling is likely to be utilized in future to enable speakers and delegates to feel as if they are interacting in real life, with just a glass shield separating them, though they

might be in different countries or cities. The 3 important breakthroughs that are going to make this possible are: ability to capture real-time images of people in 3-dimensional format, compressing these data to transfer on existing networks, and then decoding and rendering it viewable using 3-dimensional image displays. Google's Project Starline and Microsoft's Mesh Platform are being developed for this kind of calling and future conferences may see their utilization for the first time.³¹

The hands-on workshop could have been conducted on the third day (rather than the first day) to reinforce the concepts learned in lectures and during live operative demonstrations. Future meetings can be conducted on a larger scale with physical stations at different institutes and the virtual component centrally organized. This would have a wider reach and participation. It would also make sense to televise the surgery of a learner with real-time critical appraisal by an expert. It would highlight the usual problems that the residents face and provide them with ways to handle these problems.

Limitations

The survey questions could have been marked after each activity/lecture (rather than at the end) to minimize recall bias. We could not survey the trainees who attended the workshop on online platforms like YouTube and so forth. The study design could be

comparative with virtual and physical meetings in other groups. This would better determine the impact of various types of meetings.

CONCLUSIONS

Knowledge acquisition and skills training have become the Achilles heel of neurosurgical residency and fellowship programs across the world in the COVID-19 era. Multiple innovative solutions including online teaching exercises and webinars using virtual platforms have taken care of continued medical education of neurosurgical fraternity, breaking geographic barriers. A hybrid microneurosurgery workshop offers unique opportunities to enhance surgical skills acquisition by hands-on simulation-based learning and observing live surgical demonstrations, apart from 2-way interactions with experts in the field under one roof. Despite the challenges faced while organizing, the feedback from the attendees was overwhelmingly positive. This may be a stepping stone for what lies ahead in the future of neurosurgical training modules, especially during the COVID-19 era.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Kanwaljeet Garg: Data curation, Formal analysis, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Shashwat Mishra:** Writing – review & editing. **Amol Raheja:** Writing – original draft, Writing – review & editing. **Satish Verma:** Writing – review & editing. **Vivek Tandon:** Conceptualization, Project administration, Validation, Writing – original draft, Writing – review & editing. **Siddharth Agrawal:** Writing – review & editing. **Ashish Suri:** Supervision, Writing – review & editing. **P.S. Chandra:** Supervision, Writing – review & editing. **Francesco Prada:** Writing – review & editing. **Franco Servadei:** Writing – review & editing. **S.S. Kale:** Supervision, Writing – review & editing. **Padma Srivastava:** Supervision, Writing – review & editing.

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