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Shaping Perceptions and Inspiring Future Neurosurgeons: The Value of a Hands-On Simulated Aneurysm Clipping Workshops at a Student-Organized Neurosurgical Conference

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Abstract

Objective Early exposure to niche specialities, like neurosurgery, is essential to inform decisions about future training in these specialities. This study assesses the impact of a hands-on simulated aneurysm clipping workshop on medical students' and junior doctors' perceptions of neurosurgery at a student-organized neurosurgical conference.

Methods Ninety-six delegates were sampled from a hands-on workshop involving hydrogel three-dimensional printed aneurysms clipping using surgical microscopes. Consultant neurosurgeons facilitated the workshop. Changes in delegates' perceptions of neurosurgery were collected using Likert scale and free-text responses postconference.

Results Postworkshop, 82% of participants reported a positive impact on their perception of neurosurgery. Thematic analysis revealed that delegates valued the hands-on experience, exposure to microsurgery, and interactions with consultant neurosurgeons. Thirty-six of the 96 delegates (37.5%) expressed that the workshop

Keywords
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dispelled preconceived fears surrounding neurosurgery and improved understanding of a neurosurgeon's day-to-day tasks. Several delegates initially apprehensive about neurosurgery were now considering it as a career.

Conclusion Hands-on simulated workshops can effectively influence medical students' and junior doctors' perceptions of neurosurgery, providing valuable exposure to the specialty. By providing a valuable and immersive introduction to the specialty, these workshops can help to dispel misconceptions, fears, and apprehensions associated with neurosurgery, allowing them to consider the specialty to a greater degree than before. This study of a one-time workshop cannot effectively establish its long-term impact on said perceptions, however.

Introduction

Today, neurosurgery remains one of the most competitive specialities for residency training in most parts of the world.[1] If medical students wish to pursue such a competitive specialty, they need early exposure to make an informed choice to commit themselves.[2,3] In the United Kingdom, aspiring neurosurgeons must demonstrate a rich portfolio of extracurricular achievements to highlight dedication and insight into the specialty.[4] Often, the achievements required to secure a neurosurgical training position take several years. Concomitantly, medical schools worldwide are adopting a generalist approach which often results in limited exposure to specialized fields such as neurosurgery.[5,6]

Alternative avenues have emerged to offer exposure to niche specialities underrepresented in medical school curriculums. These include elective clinical placements, student-selected components (SSCs), and intercalated degrees.[7–11] Recent literature highlights the utility of neurosurgical conferences organized by medical student specialty interest groups or student "neuro societies" in increasing student exposure, improving confidence, and generating interest in niche specialities.[12–15]

Simulation is increasingly being utilized in medical education.[16] Simulation tools such as advanced patient simulators (Sim-Man) for medical emergencies, fundoscopy models, urine catheterization, intravenous venepuncture/cannulation, and Arterial Blood Gas (ABG) models are all well established and highly rated by medical students for improving their confidence prior to clinical placements.[17–21] Simulation has thus shifted the paradigm of practical teaching from "see one, do one, teach one" to "see one, practice as many times as you like, do one, teach one" for the interest of both the doctor and the patient. These, however, are examples of simulations for everyday tasks that nearly all medical students will undertake as newly qualified doctors and so should be well versed in. Beyond preparing students for common clinical procedures, simulation may be an important tool that, to an extent, compensates for inadequate clinical exposure for niche specialities. Simulating a range of complex subspecialist procedures in the right environment and manner may provide students with a broad insight and appreciation of the field; a student neurosurgical conference is an ideal platform to host a hands-on neurosurgical simulation workshop for medical students for this purpose. Simulation through a hands-on workshop is one understudied platform to increase students' exposure toward neurosurgery. As such, the Glasgow Neuro Society sought to provide such an opportunity to medical students and junior doctors through their 10th Anniversary International Conference.

A hands-on aneurysm clipping microsurgery workshop was planned and run during this student-led conference with the hope of providing medical students and junior doctors with an opportunity to learn more about neurosurgery, including the challenges of its practice. The aim of this article is, thus, to report on the impact of the said workshop on medical students' and junior doctors' perceptions and exposure to neurosurgery to determine if this is a viable simulation for replication and expansion on similar platforms for a similar audience in future.

Materials and Methods

Setting

The simulated aneurysm clipping workshop was conducted as part of the 10th Anniversary Glasgow Neuro conference, held at the Royal College of Physicians and Surgeons of Glasgow on November 5, 2022. The conference comprised five talks by neurosurgeons and neurologists and three hands-on workshops. A total of 120 delegates attended the event.

Workshop

A hands-on microneurosurgical workshop designed to simulate aneurysm clipping was created for the conference, emphasizing microsurgery and hand-eye coordination. As this workshop was intended for medical students and junior doctor delegates, the simulated session was simplified to provide a broad and straightforward microsurgery experience rather than specific technical nuances.

Preoperative computed tomography angiograms of patients with anterior/posterior circulation aneurysms were imported as DICOM files into the software Meshmixer (owned by Autodesk, San Francisco, California, United States) (►**Fig. 1A**)by Ashraf and Ismahel. The authors then simplified the model such that only the anatomical region of the circle of Willis harboring the aneurysm and directly adjacent vessels (to maintain simplicity whilst maintaining a degree of realism) were considered for final printing (►**Fig. 1B**). The model was then sent to industry partner Organ Like Ltd (Inverness, Scotland, United Kingdom) who technically

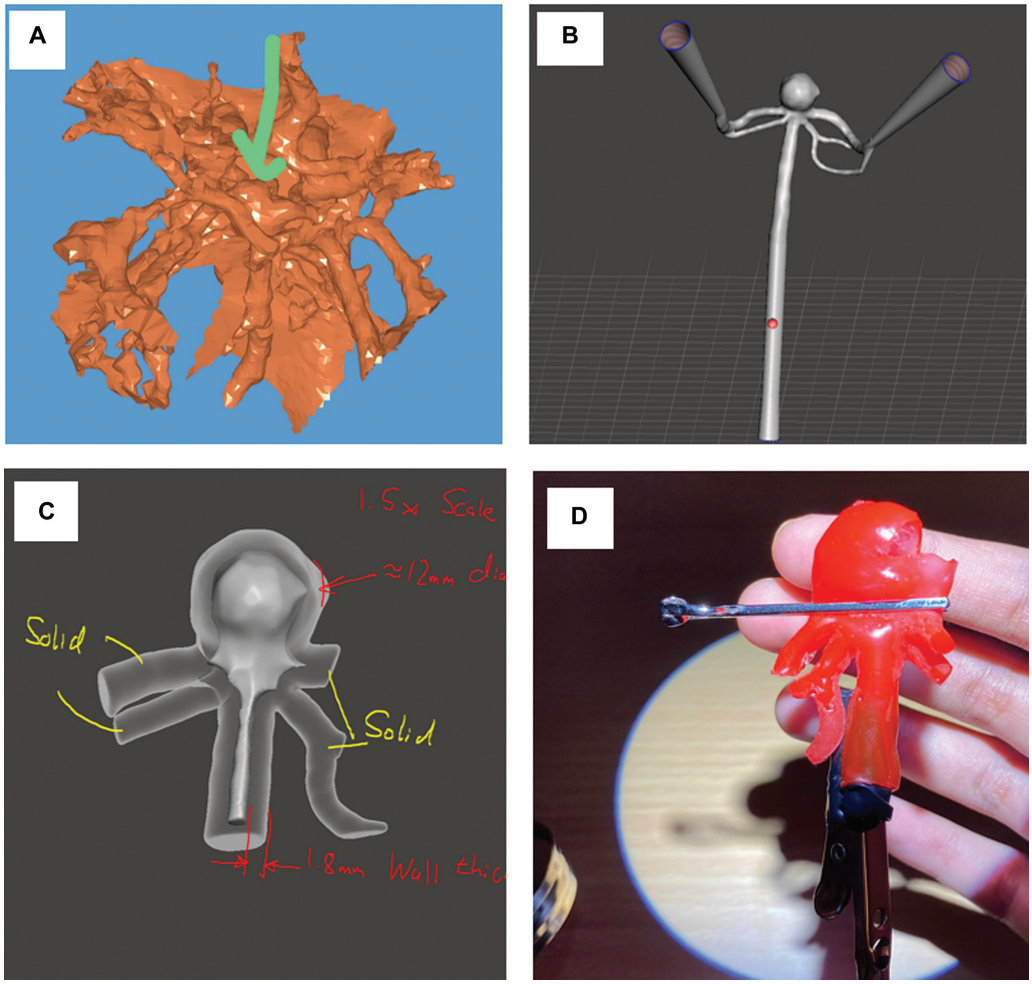

Fig. 1 Aneurysm model development. A preoperative computed tomography (CT) angiogram of a patient with anterior/posterior circulation aneurysms (**A**) was simplified to expose the basilar tip aneurysm of interest, and directly adjacent vessels (**B**). The model (**C**) required technical adaptations to make suitable for three-dimensional (3D) printing due to the small size. A finalized aneurysm model (**D**) printed using hydrogel material, with an aneurysm clip around the neck.

adapted it to be suitable for printing using their propriety hydrogel material (►**Fig. 1C**). The finalized aneurysm models are depicted in ►**Fig. 1D**. The average diameter of the dome of aneurysm models was 16 mm, with a range of 14 to 18 mm across all the aneurysm models used. This was chosen so that the hydrogel walls would have a thickness of at least 2.1 mm, making it possible to print these models without them becoming fragile or collapsing after printing. This also allowed them to withstand repeated clipping and reclipping as this workshop was run three times in total. Each model had a height of 35 mm, and a width of 25 mm. They were mounted on the day of the workshop using MAG01 soldering "helping hands" from Mercury.

The authors partnered with companies Carl Zeiss UK, Ltd, who provided the Zeiss OPMI Pico surgical microscopes, each equipped with side teaching arms (►**Fig. 2E**), and B. Braun, who provided a range of Aesculap Yasargil aneurysm clips (of varying diameters) and clip applicators as part of their demonstration pack for the YASARGIL Aneurysm Clip System. This included the standard and fenestrated silver aneurysm clips, as well as the classic and minimally invasive clip applicators. Both applicators possessed a low-profile, bayonet-shaped design to visualize the aneurysm more easily when clipping. Hemostatic forceps were also provided. Owing to the flexible nature of the aneurysm models, any of the provided clips could be used.

An illustration of the finalized practical workshop at the conference is shown in ►**Fig. 2**. Six simulated aneurysm clipping stations ran simultaneously, with consultant neurosurgeons facilitating each station. Each station consisted of one neurosurgeon, one aneurysm model mounted on Mercury MAG01 soldering helping hands, one hemostatic forceps, three aneurysm clips (2 standard and 1 fenestrated), and three aneurysm clip applicators (2 classic and 1 minimally invasive). One B. Braun representative was also present for the workshop to clarify the type of aneurysm clips and clip applicators used. Each station accommodated between six to eight delegates. Within a 1-hour workshop, there were 40 delegates distributed over six stations approximately—the first 10 minutes comprised of a consultant teaching microscope etiquette and aneurysm clipping technique. Consultants were instructed to provide clinical context to delegates regarding the general use of the microscope and basic microneurosurgical practical skills from their experience. Given the complexity of aneurysm clipping in real-life and that most participants were still in

Fig. 2 Overview of workshop being conducted at the Royal College of Physicians and Surgeons of Glasgow by the neurosurgical faculty of the Institute of Neurological Sciences in Glasgow. (**A**) A delegate engaged in the workshop. (**B**) Mr Samih Hassan, Consultant Neurosurgeon and Skull Base Lead demonstrating the use of the microscope. (**C**) Two delegates engaged in the workshop simultaneously—a logistical benefits of coobservation tube/side teaching arm (Carl Zeiss UK Ltd). (**D** and **E**) An overview of stations each hosting 6–8 delegates. Visiting faculty photographed (**D**) include Professor Michael Lim (Chairman Stanford Neurosurgery) and Professor Gail Rosseau (George Washington University/ Barrow Neurological Institute). Pictures attached with participant consent.

their undergraduate training, a workshop that was simple, yet informative to pique their interest in the procedure and specialty to learn more about them in their spare time going forward was preferred, limiting the technical nuance that would provide a more accurate picture of the specialty. As an introduction to the specialty, such a limitation was acceptable and clearly communicated to the participants during the workshop.

Survey Evaluation

Attendees were surveyed after the workshop to record demographic information and evaluate the impact of the aneurysm clipping workshop according to the following domains, using a 5-point Likert scale:

- Introduction to neurosurgical technique.
- Basic use of the operating microscope.
- Oversight and communication from the neurosurgical workshop facilitator (a consultant neurosurgeon—the senior authors of this article).
- Altered perception of neurosurgery/understanding of what a neurosurgeon does.

Five free-text questions were posed to attendees to explore a detailed opinion regarding the impact of the simulated workshop on their views of neurosurgery and the microsurgical procedures associated with it (see ►**Table 2**). These questions were:

1. How did the simulated microscopic aneurysm clipping workshop impact your view of neurosurgery?
2. How has the simulated microscopic aneurysm clipping workshop increased your understanding of how neurosurgeons operate?
3. How has the simulated microscopic aneurysm clipping workshop impacted your understanding of the use of surgical microscopes?
4. How much exposure has your medical school given you toward neurosurgery and how has the workshop improved your awareness of neurosurgical procedures?
5. Has your perception of neurosurgery changed through the simulated workshop?

Four to five main themes were extrapolated for each question based on participant responses, and each response was categorized according to the most appropriate theme for that question. Complex responses which contained several themes were categorized into more than one theme if appropriate. Thus, one participant's response may contain several themes.

Statistical Analysis

Responses were collected using Google Forms. Continuous variables were presented as mean ± 2 standard deviations or median + interquartile range (IQR) per the Shapiro–Wilk test. Categorical variables were expressed as counts with percentages. Likert scales were displayed as a stacked chart with percentages. Thematic analysis was conducted on the free-text questions. All statistical analyses were conducted using RStudio statistical package version 4.2.2 (RStudio, PBC, Boston, Massachusetts, United States).

Results

One hundred twenty delegates attended the conference, of which 96 completed the feedback form (response rate of 80%). The baseline characteristics of the study cohort are shown in ►**Table 1**. The list of free-text questions and respective thematic analysis is shown in ►**Table 2**.

Data Demographics

The respondent cohort comprised 89 (93%) medical students, including those undertaking an intercalated degree (an optional intermediary year where students take a year out of medical school to obtain a science degree) and 7 (7%) junior doctors at varying stages of their careers (i.e., foundation program doctors, core trainees, and prespecialty clinical fellows). Seventy-four percent of respondents were women ($n = 71$), and the median age was 20 years (IQR 19–24 years). Most respondents ($n = 76$, 79%) were from the University of Glasgow, with the remaining respondents comprising delegates from various institutions across the United Kingdom. The most common grade of attendees were 4th-year medical students ($n = 26$, 27%), followed by first- and second-year medical students ($n = 20$ each, 21%). The vast majority of participants had a limited understanding of neurosurgery ($n = 84$, 87.5%) with only 12 participants (of varied training backgrounds) knowing "a lot (Likert scale 4/5)" or "almost everything (Likert scale 5/5)." This lends nuance to the demographics of the population, in which a preclinical medical student could have had more exposure to neurosurgery than a foundation year 1 doctor.

Quantitative Accomplishments

►**Fig. 3** depicts each question with an accompanying Likert scale response breakdown. Following the workshop, most medical students either agreed or strongly agreed that the aneurysm clipping workshop was a good introduction to neurosurgical techniques (86%) and that the aneurysm clipping workshop provided a good interaction and insight into the use of an operating microscope (95%). Similarly, 90% of delegates agreed or strongly agreed that using three-dimensional printed hydrogel-based aneurysms provided a more realistic and positive simulation experience. Ninety-five percent of delegates either agreed or strongly agreed that the oversight by a consultant neurosurgeon (as facilitator) was beneficial. As a result, delegates had their preconceived fears surrounding neurosurgery alleviated through discussions with said facilitators ($n = 36$, 37.5%, ►**Table 2**). Their understanding of neurosurgeons' roles, responsibilities, and day-to-day tasks had also deepened through this ($n = 32$, 33.3%, ►**Table 2**). Finally, 82% of delegates either agreed or strongly agreed that the workshop positively impacted their view of neurosurgery (as a specialty).

Perception Transformation

Thirty-six of the 96 responses (37.5%) reported alleviation of hesitations and fears regarding neurosurgery, attributing this to the enhanced clarity provided by the workshop and, subsequently, a shift in their viewpoints from averse to interested. This hesitation or fear may have been partially due to the lack of exposure to neurosurgery as a specialty among medical students as mentioned by half of all respondents ($N = 48$, 50.0%). Additionally, participants gained a deeper understanding of neurosurgical techniques, the use of surgical microscopes, and the crucial roles and responsibilities of neurosurgeons. Furthermore, the workshop transformed the perception of neurosurgery for many attendees

Table 1 Baseline demographic characteristics of the study cohort ($N = 96$)

Age (y)	Median = 20, interquartile range = 19–24
Sex	Female = 71, Male = 25
Institution $N = 96$ (%)	
University of Glasgow	76 (79.2)
Glasgow Caledonian University	2 (2.1)
University of Dundee	2 (2.1)
University of Edinburgh	2 (2.1)
University of Manchester	2 (2.1)
New College Lanarkshire	2 (2.1)
University College London	1 (1)
University of Newcastle	1 (1)
Kings College London	1 (1)
University of Liverpool	1 (1)
NHS Great Glasgow and Clyde	6 (6.3)
Year of study/grade Number of delegates ($N = 96$) (%)	
First year medical student	20 (20.8)
Second year medical student	20 (20.8)
Third year medical student	10 (10.4)
Fourth year medical student	26 (27.1)
Fifth year medical student	9 (9.4)
Intercalating BSc/MSc student	4 (4.2)
Foundation Year doctor and above (e.g., House Officer/Intern)	7 (7.3)

from fear or intimidation to interest and excitement ($n = 38$, 39.6%), resulting in a higher likelihood of considering it as a future specialty ($n = 11$, 11.5%). This practical simulation workshop, alongside the insights shared by neurosurgeons, helped to establish a more accurate and informed perception of neurosurgery among medical students and junior doctors, regardless of their prior exposure to the field.

Equipment Manipulation

The workshop excelled in providing delegates with opportunities to handle equipment like the surgical microscope, the aneurysm clip applicator, and the clips used in the clipping of aneurysms. Twelve delegates (12.5%) reported that the workshop had improved their ability to handle such equipment, as well as their hand-eye coordination. Eighteen of them (18.8%) had a greater understanding of the need for dexterity, stability, and coordination when performing neurosurgical techniques. Twenty-five (26.0%) delegates had their awareness enhanced with respect to the use of a surgical microscope in neurosurgical theaters and 20 (20.8%) mentioned that the workshop provided a means for them to gain exposure and experience with respect to the use of surgical microscopes. Fifty-five delegates (57.3%) commented that this hands-on experience improved their confidence in using neurosurgical equipment in future. This could potentially help them in neurosurgical rotations in future, should they decide to pursue the specialty further.

The Interpersonal Neurosurgeon

Another theme that was discussed by delegates was the interpersonal skills that a neurosurgeon possesses. Through their discussion with the facilitators (consultant neurosurgeons), 7 of 96 delegates (7.3%) felt it significant to mention how the workshop had elevated their understanding of a neurosurgeon's role in a team and how teamwork was necessary to provide prompt and effective care to patients. A further 5 of 96 delegates (5.2%) developed a deeper understanding of the teamwork between two neurosurgeons to operate both sides of a surgical microscope in neurosurgical procedures at the same time. Patience was another important quality to have, which 7 delegates (7.3%) gained a better sense of appreciation for.

The Future of Neurosurgery

Six delegates (6.25%) were now cognizant of the interdependent nature between neurosurgery and technology through using the surgical microscopes in the workshop. The practice's augmentation by technology has positively influenced

Table 2 Free-text questions and their accompanying thematic analysis with each theme obtained from each question

Themes		*N*
How did the simulated microscopic aneurysm clipping workshop impact your view of neurosurgery?	Alleviation of hesitations and fears about Neurosurgery through enhanced clarity of what the field entails, changing viewpoints from averse to interested	36
	Improvement of neurosurgical techniques, handling of equipment and hand-eye coordination	12
	Appreciation of roles and responsibilities of neurosurgeons, including degree of risk and difficulty involved	10
	Fidelity and quality of experience provided much insight into specific neurosurgical procedures (i.e., aneurysm clipping)	4
	Increased knowledge in neurovascular anatomy, their pathological mechanisms and the surgical techniques used to treat them.	3
How has the simulated microscopic aneurysm clipping workshop increased your understanding of how neurosurgeons operate?	Appreciation of day-to-day tasks and responsibilities of Neurosurgeons	22
	Appreciation of interdependent nature between Neurosurgery and Technology (e.g., use of microscope)	6
	Improved understanding of the need for neurosurgeons to be dexterous, stable and possess good coordination in neurosurgical techniques	18
	Elevated understanding of a neurosurgeon's role in a team and the need for teamwork between them and nurses to provide prompt and effective care	7
	Deepened understanding of the need for patience and practice to improve one's own skillset to the level of that of a neurosurgeon.	7
How has the simulated microscopic aneurysm clipping workshop impacted your understanding of the use of surgical microscopes?	Enhanced awareness of how they operate and their use in neurosurgery	25
	Improved understanding of the need for coordination and an understanding of one's own position with respect to the patient's anatomy	5
	Provided a means to gain exposure and experience with using a surgical microscope	20
	Increased understanding of the teamwork required by two neurosurgeons to synchronously and simultaneously operate both sides of the microscope	5
	Gained a sense of appreciation for the depth perception that the microscope lends the user through using two eyepieces and the need to know one's own inter-eye distance	6
How much exposure has your medical school given you toward neurosurgery and how has workshop improved your awareness of neurosurgical procedures?	Medical schools do provide a foundation in neuro-anatomy and pathology	6
	Most medical schools give little to no exposure to neurosurgery as a specialty	48
	The exception lies in those who have pursued Neurosurgery as a SSC or Elective, who have had some prior exposure to Neurosurgery	2
	The workshop has vastly improved an understanding of neurosurgical procedures and reinforced understanding of neuro-anatomy and pathology	3
	The hands-on experience improved confidence in using neurosurgical equipment in future	55
Has your perception of neurosurgery changed through the simulated workshop?	Change of neurosurgical perception from one of fear or intimidation to one of interest and excitement	38
	By clarifying nature of the field and their prospective roles in it, participants are now more likely to consider it as a future specialty	8
	The augmentation by technology (e.g., microscope) has positively influenced their anticipation of workload in neurosurgery, therefore its consideration as a future specialty	3
	Having neurosurgeons discuss a career in neurosurgery and the various neurosurgical techniques they use greatly clarified and reinforced these new, more accurate perceptions of neurosurgery among medical students	2
	Attendees with a good understanding of neurosurgery who did not previously consider it as a future specialty were still unlikely to consider it in future, but gained a greater sense of appreciation for those in the field	1

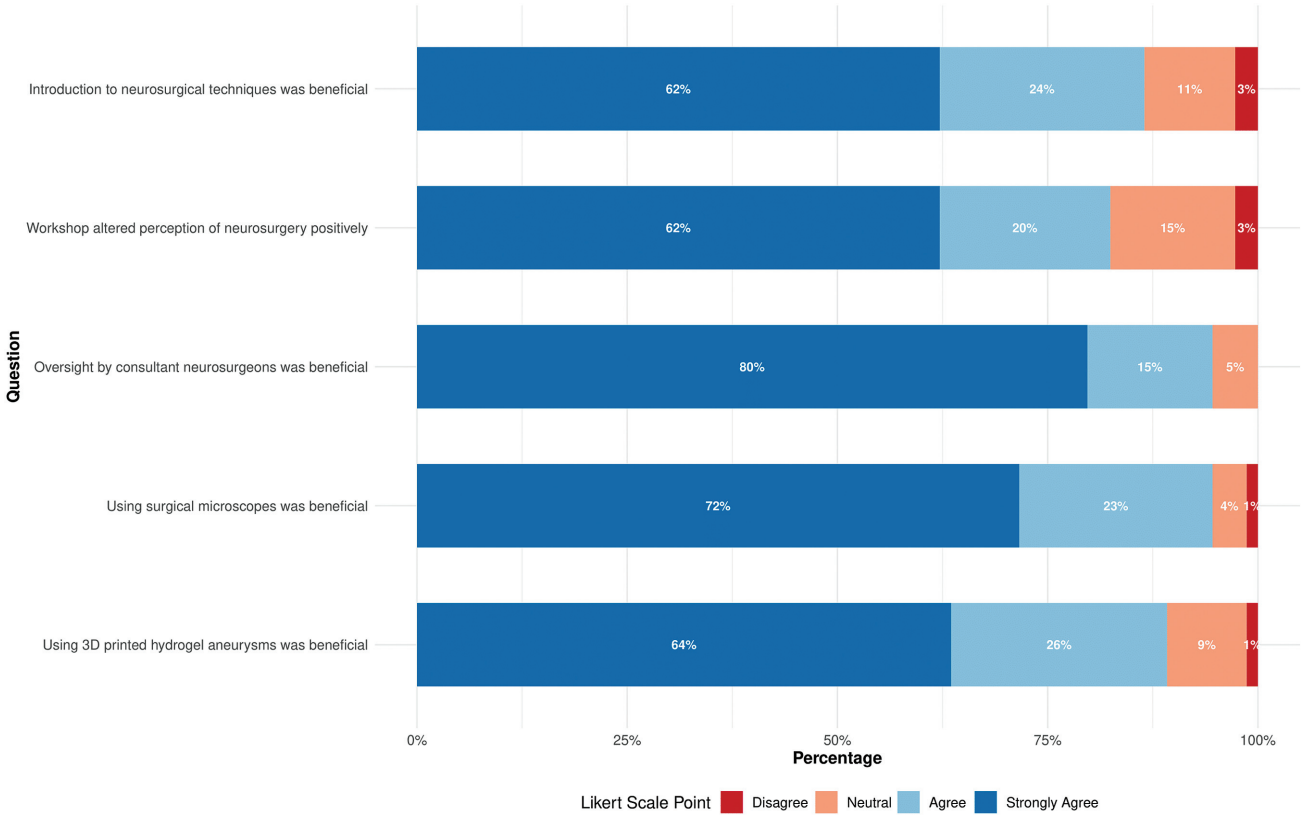

Fig. 3 Stacked bar chart showing the percentage of participant ($n = 96$) responses to various aspects of the aneurysm clipping workshop using a 5-point Likert scale (no recorded responses were "strongly disagree").

the anticipated workload of neurosurgeons by some delegates ($N = 3$, 3.1%), which positively influenced their consideration of neurosurgery as a future specialty. In fact, this positive influence can be attributed to the following:

- The alleviation of prior apprehensions to the consideration of neurosurgery as a potential future specialty ($N = 36$, 37.5%) in addition to enhanced clarity about what neurosurgery entails
- A greater appreciation of day-to-day tasks and responsibilities of neurosurgeons ($N = 22$, 22.9%) as well as the degree of risk and difficulty involved ($N = 10$, 10.4%)
- The improved confidence of delegates in using neurosurgical equipment through taking part in this hands-on workshop ($N = 55$, 57.3%)
- The notable change in their perception of neurosurgery from one of fear or intimidation to one of interest and excitement ($N = 38$, 39.6%)

To add to this, having neurosurgeons discuss a career in neurosurgery and the various neurosurgical techniques that they use greatly clarified and reinforced these new, more accurate perceptions of neurosurgery among medical students ($N = 2$, 2.1%). This also similarly reinforced the conviction in one (1.0%) particular delegate with a good understanding of neurosurgery but who was unlikely to consider it that this was not for them. They had a greater sense of appreciation for those in the field, however.

While this in no way conclusively proves that these delegates will go on to become neurosurgeons, the data are reassuring in terms of what it has done for the perception of neurosurgery among medical students and junior doctors going forward.

Discussion

Early exposure to niche specialities, like neurosurgery, is essential to inform decisions about future training in these specialities. The adoption of a generalist teaching approach in medical schools globally and the political pressures that influence medical school curricula have led to decreased clinical exposure to neurosurgery.[5,6] Indeed, 48 responses stated that medical school does not provide adequate exposure to neurosurgery. This agrees with published statistics in the United States, wherein 62% of medical schools do not have a formal neurosurgical curriculum, and 59% of deans surveyed in one study felt that neurosurgery rotations are unnecessary for students.[22] Similarly, in the United Kingdom, 28% of medical school administrations do not think any neurosurgical teaching should be in a medical degree.[6] This conflicts with British Neurosurgical Training Program Directors, who, in a national survey, strongly felt their field should be represented in the undergraduate curriculum.[6] In addition, there are repeated calls in the literature from both the United States and the United Kingdom to allocate more time toward neurosurgical teaching in medical school, ideally as a nationally standardized curriculum.[6,23,24]

Arguably, the gold standard opportunity to provoke or further develop a preexisting interest in neurosurgery is

mandatory clinical placements, ensuring clinically varied exposure to the specialty. Ideally, a placement would integrate medical students into a neurosurgical department allowing insight into the specialty clinically, academically, and personally as students interact with registrars/residents and consultants. However, from a pragmatic point of view, as medicine vastly expands, it is unlikely that niche surgical specialities will gain any significant representation in medical school curricula. This must be respected as curriculums must represent specialities by their relative importance. Additionally, most medical students, who are already pushed for time and knowledge, do not wish to become neurosurgeons.

Several alternative avenues have emerged in the literature to compensate for the lack of exposure to clinical neurosurgery in medical school. Student-organized national conferences expose medical students and junior doctors to neurosurgery and provide significant networking opportunities.[12–14] Additionally, e-modules, SSCs (protected study blocks in U.K. medical schools where the student proposes a placement), and elective clinical placements are all viable options.[7–11] Tiefenbach et al[11] found that medical students reported that research SSCs improved their knowledge of neurosurgical procedures and pathologies and offered them meaningful networking opportunities with their local departments.[11] Despite this, the authors noted that two-thirds of medical students do not feel SSCs and research projects provide an accurate insight into what the specialty entails.[11] This is unsurprising, as many medical students actively pursue a research-focused SSC rather than a clinical attachment.[11] Publications and presentations are highly sought-after for neurosurgical residency in the United Kingdom, explaining this propensity for research. Without a clinical focus thus, SSCs may not be suitable for delivering undergraduate neurosurgical teaching.

Alternatively, undergraduate conferences organized by student interest groups are specifically designed to expose medical students and junior medical professionals to a broad overview of the specialty through clinical and research-focused lectures by consultants, paired with seminars, career advice sessions, and neurosurgical procedural workshops to showcase the clinical, academic, and personal workload neurosurgery entails.[12–15] Student conferences provoke interest and curiosity and give insight to medical students who are undecided regarding their career path, allowing them to make an overall informed decision regarding their career.[12–15]

While simulated hands-on workshops have previously been utilized in student conferences, their impact on delegate perceptions of the specialty has not been explored in literature. From studies evaluating the simulation of common clinical procedures, the benefits of simulation in medical education include improved medical students' knowledge, confidence, management skills, and satisfaction.[16] Simulation has allowed the production of realistic hands-on aneurysm clipping workshops.[25–27] These simulation models mimic all the major steps, including craniotomy, tissue dissection, and aneurysm occlusion. Some reported simulation models have had motors attached which mimic blood flow through the aneurysm model and make the vessel more volatile.[25–27] However, the reported simulation workshops are appropriate for postgraduate residents. Our workshop was designed for medical students and junior doctors; therefore, the station was simplified to provide a broad and straightforward microsurgery experience rather than the specific technical nuances of clipping aneurysms. The limitations of time and setting in which the workshop was conducted further support this decision. The low fidelity of this workshop and its potential impact on the participants' perceptions of neurosurgery was communicated and clarified during the workshop so as to mitigate the false impression of simplicity that such a workshop might lead one to believe about aneurysm clipping. There was no requirement to perform a craniotomy or dissect tissue, but participants were briefed that steps such as these needed to be taken before and after the crucial step of clipping an aneurysm. Similarly, delegates were not exposed to complex vasculature or dynamic blood flow, making the workshop easier to produce and suitable for medical students.

This workshop still proved to be challenging to many participants, with 10 of them (10.4%) recognizing the difficulty and degree of risk that comes with the roles and responsibilities of neurosurgeons. The crux of the workshop being the delegates' use of the operating microscope and aneurysm clipping device; this exposed them to the hand-eye coordination that is required in neurosurgery and the narrow operating corridors that neurosurgeons frequently have to work within. This provided insight into the craft aspect of neurosurgery and demonstrated to junior medical professionals the foundation of microneurosurgery. However, without long hours in cadaveric laboratories to train hand-eye coordination and to gain experience and learn the surgical approaches necessary to perform these procedures from start to finish, the reality of neurosurgery remains elusive and something to be realized by those who strive to learn more about the field. Forty-eight out of the 96 delegates (50.0%) lamented about their medical schools giving them little to no exposure to neurosurgery to be able to bridge this gap. For now, this workshop hopes to have increased the number of such aspiring medical professionals.

Crucially, our workshop was facilitated by consultant neurosurgeons. The facilitator was responsible for engaging with delegates and contextualizing the simulated experience with clinical relevance. Likert responses revealed that 95% of respondents supported the utilization of consultant neurosurgeons as facilitators (►**Fig. 3**). This engagement between the facilitator and delegates sparked discussions surrounding the clinical practice and alleviated the preconceived fears surrounding neurosurgery ($n = 36$, ►**Table 2**). These discussions also improved the understanding of a neurosurgeon's roles, responsibilities, and day-to-day tasks, aiming partly to dispel neurophobia ($n = 32$, ►**Table 2**). "Neurophobia" is a term used to describe the fear and lack of confidence felt by medical students and doctors toward neural sciences, including clinical neurology and neurosurgery.[28,29] Neurophobia has been extensively studied and is attributed to the perceived difficulty of clinical neurosciences, often considered the most challenging component of the medical curriculum.[28,29] This perception is partly rooted in inadequate preclinical teaching and limited clinical exposure.[28,29]

Following the workshop, 82% of participants (►**Fig. 3**) felt it had positively impacted their perception of neurosurgery. This finding underscores that simple simulated hands-on exposure and teaching from relevant professionals in the neuro field can help combat neurophobia. By dispelling misconceptions, such a workshop may attract high-quality, initially, skeptical applicants who possess the potential to excel as future neurosurgeons. This is demonstrated in our thematic analysis, where 12 responses now consider neurosurgery a future specialty. "Now" emphasizes that the focus of this question was on neurosurgery being a newly considered specialty to think about for future specialization where it was not previously. This does not reflect a definite decision to go into neurosurgery, but our workshop was successful in having at least 12 of our participants adding neurosurgery to their list of future specialities to think about for specialization.

Only three responses (►**Table 2**) reported an appreciation for neurovascular anatomy, aneurysm pathology, and insight toward the specific neurosurgical procedure being simulated due to the workshop. This finding is unsurprising as the workshop was intended to provide an overview of the use of the microscope, microsurgery, hand-eye coordination, and appreciation of the narrow operative field common to most neurosurgical procedures. In essence, it provided a broad, holistic overview of operative neurosurgery. This is supported by 90 and 95% of attendees, who felt positively about using hydrogel models and surgical microscopes, respectively. Hydrogels have emerged as an exciting new tool in surgical simulation and have been validated for vascular anastomosis simulation training for junior surgical trainees.[30] This is the first article that reports their use in the context of surgical simulation for medical students.

This study has its limitations. As with sampling those undertaking neurosurgical SSCs, selecting delegates who participated in a hands-on workshop at a student-organized neurosurgical conference introduces a selection bias. However, we believe this issue is less prominent for conferences and workshops than for self-proposed placements. Electives and SSCs demand considerable planning and organization, suggesting that individuals who arrange these might have a more substantial preexisting interest in neurosurgery. In contrast, for conferences and workshops, the responsibility of the organization lies with the student interest group or committee, reducing the likelihood of selection bias. The study will also have challenges in terms of reproducibility. The human resources, funding, and partnerships needed to organize such an interactive workshop are considerable. Not all student neurosurgical interest groups may have the capacity to provide this. Printing was sponsored by a specialist company, OrganLike, which utilized hydrogels, an expensive material. Furthermore, Zeiss sponsored six operating microscopes shipped from Germany, for the workshop. Moreover, six consultant neurosurgeons were required on the day as facilitators for each station, ensuring an optimal facilitator-to-delegate ratio. However, this also necessitated the involvement of 40% of the neurosurgical faculty in Glasgow, which may not be feasible for all institutions. Smaller, less supported institutions would be less able to conduct similar workshops. This limits the outreach and population size of such a workshop and study. We see now how this can be described as a challenge to be overcome for future workshops of the same type as opposed to a limitation of the study itself.

Conclusion

This study demonstrates the value of hands-on simulated workshops in potentially influencing medical students' and junior doctors' perceptions of neurosurgery as a specialty. While it cannot definitively conclude that they will become neurosurgeons in future, they will now consider this specialty in greater detail than they had before. The positive impact on their understanding and interest in neurosurgery and an appreciation of basic neurosurgical techniques highlights the importance of incorporating such workshops in neurosurgical conferences and events for students. This increased exposure to neurosurgery at an early stage in one's medical training is vital to allow for greater consideration of the specialty in future. Despite the challenges and resources required, we encourage neurosurgical interest groups and conference organizers to strive to include hands-on simulated workshops with engaging expert facilitators to provide attendees with a comprehensive and insightful experience. Further research is needed to assess the long-term impact of these workshops on attendees' career choices and the overall improvement in the representation and understanding of neurosurgery within the medical community.

Ethical Approval

Questionnaire utilized was anonymous and all respondents provided informed consent to use their data for publication.

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Conflict of Interest

None declared.

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