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ORIGINAL ARTICLE

Live orthopaedic trauma streaming: the use of virtual live streaming technology in surgery to improve orthopaedic training post COVID-19

Francesca Hill,[a,*] Benjamin Davies,[b] Emma Theobald[c] and Samirul Imam[c]

[a]*East Suffolk and North Essex NHS Foundation Trust, Colchester Hospital, Colchester, UK;* [b]*Peterborough City Hospital, Peterborough, UK;* [c]*East Suffolk and North Essex NHS Foundation Trust, Ipswich Hospital, Ipswich, UK*

**Corresponding author at: Department of Trauma & Orthopaedics, Turner Road, Colchester, CO4 5JL, UK. Email: frankie_hill@hotmail.co.uk*

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Abstract

Background: The aim of this study was to assess a variety of issues related to the perceived effects of the COVID-19 pandemic on medical student learning experiences. We aimed to assess the use of surgeon's-eye view live surgical streaming to increase exposure to orthopaedic surgery and improve learning opportunities for junior medical professionals. This would allow us to explore the perceived barriers to surgical training using novel teaching techniques. **Methods:** A pair of surgical glasses with inbuilt two-way communication was used to live stream surgical cases to a seminar room. The seminar room was set up for the learners to watch the live streaming surgery and they were supported by a suitable knowledgeable tutor (orthopaedic registrar or consultant) who could provide real-time support. Pre and post live screening learner questionnaires were used to assess the aims of the session. Learners included junior medical professionals [senior medical students, foundation year (PGY1-2) and senior house officers (PGY2-4) doctors] in training. **Results:** There was an improvement in the understanding of the surgical anatomy and key steps for the procedure in question. The session also helped to ease perceived fears around the operating theatres, and we observed a marked increase in confidence to attend in-person theatre sessions following the live streaming. **Conclusions:** Streaming of surgery with live interaction with learners can provide an alternative safe environment to provide junior medical professionals with experience of operating theatres in trauma and orthopaedics. Additionally, it can allow for greater numbers of observers for the surgical procedure. Whilst it cannot replace the importance of 'actual' theatre exposure, it can provide a pathway to improve learners' confidence and knowledge surrounding the orthopaedic profession.

Keywords: *training; live surgery; trauma; orthopaedics; COVID-19; education*

Introduction

COVID-19 has had a profound impact on access to surgical training in the UK.[1,2] A combination of social distancing and restrictions in surgical cases reduced the number of available opportunities for medical students and junior medical trainees to gain hands on clinical experience.[3] A lack of elective operating in conjunction with aerosol generating procedures further exacerbated this problem. The Trainee Survey Report published in May 2021 by The Joint Committee on Surgical Training (JCST) highlights the significant effects COVID-19 has had on the ability to provide effective training, and states 'there is no case that is not a training case' in an attempt to establish an effective training recovery plan.[4]

We aimed to assess the perceived effect of these changes in 'normal' working on junior medical professionals [medical students, foundation year (PGY1-2) and senior house officer (PGY2-4) doctors] and whether the use of live surgical streaming could enhance learning opportunities and help transform every case into a training case.

The use of video-streaming surgery has been previously explored both in surgical fields and in general medical education; however, it appears through literature searches that

there has been limited use in orthopaedics. A literature review by Carerra et al. in 2019[5] looking into the use of Google Glasses analysed the results of 37 articles, none of which pertained to their use in orthopaedics as a subspecialty. The most common applications were in general surgery, neurology and urology. Performing a PubMed search using the key terms 'orthopaedics' and 'live streaming surgery' only produced one publication, in which Hiranaka et al.[6] aimed to explore the feasibility of streaming technologies for knee arthroplasty, but did not analyse the quality of the training provided. Therefore, we wished to assess whether this modality of surgical exposure provided a viable alternative to previous models of teaching surgery both in increasing exposure and in improving experiences in the theatre environment. Fernando et al.[7] have shown that feeling welcome in theatre, adequate surgical view, and familiarity with the staff and environment all impact upon the willingness of junior medical professionals to participate. We looked to assess whether this style of teaching could be used to break down some of these barriers that prevent students from attending theatres.

Materials and methods

A 2-day pilot program incorporating four sessions of trauma operating was conducted. A range of common trauma procedures were streamed during these sessions, including dynamic hip screw fixation of an intertrochanteric hip fracture, open reduction and internal fixation (ORIF) of a distal humerus, ORIF of a mid-shaft clavicle fracture, manipulation and k-wire fixation of a paediatric supracondylar elbow fracture, ORIF of proximal ulnar and radial head replacement, and a hip hemiarthroplasty (Table 1).

Cases were live streamed using the Stryker Instant Remote Interactive Support IRIS camera headset[8] (Fig. 1). The headset provides a two-way audio and visual communication system between the wearer and remote viewers. This allows colleagues to ask questions, and direct the surgeon with visual cues and annotations to the heads-up display within the surgeon's view without restricting it. The use of the IRIS camera and a surgeon's-eye view provides a unique experience for learners that cannot be replicated with previously used similar cameras, e.g. Go Pro, or theatre light cameras.

Table 1. Procedures streamed during 2-day pilot programme

Procedures performed
Dynamic hip screw
ORIF distal humerus
ORIF mid-shaft clavicle
MUA and k-wire fixation of supracondylar fracture
ORIF proximal ulnar and radial head replacement
Hip hemiarthroplasty

The headset was worn by the primary surgeon in the operating theatre with a live stream viewed in a seminar room in which the learners were based (Fig. 2). The learners comprised junior medical staff (PGY1–4) and medical students on placement within the Trauma and Orthopaedic Department.

Unique to these sessions was the use of an educational facilitator, who was present in the seminar room to help direct discussion and field questions. This was typically a higher orthopaedic trainee. They had the ability to directly communicate with the operating surgeon and cut the live feed if necessary.

Pre- and post-session learner questionnaires were used to assess the aims of the session: knowledge, ability and confidence in the operating theatre. The two questionnaires were composed of questions allowing a combination of 'blank space' and 5 point Likert scale responses. The questions were designed to determine the barriers to the participants attending theatre, and to assess the impact that the teaching session had on them and their confidence in surgical procedures. Additionally, further questions assessed the participants' perceived effect that the COVID-19 pandemic had had on their experiences and ability to attend theatre, and the effects on achieving their surgical curriculum expectations.

Ethics and consent

No ethical approval was required for this study as per UKRI Medic Research Council, NHS Health Research Authority.

Figure 1. Stryker IRIS headset to allow video and audio link between surgeon and audience.

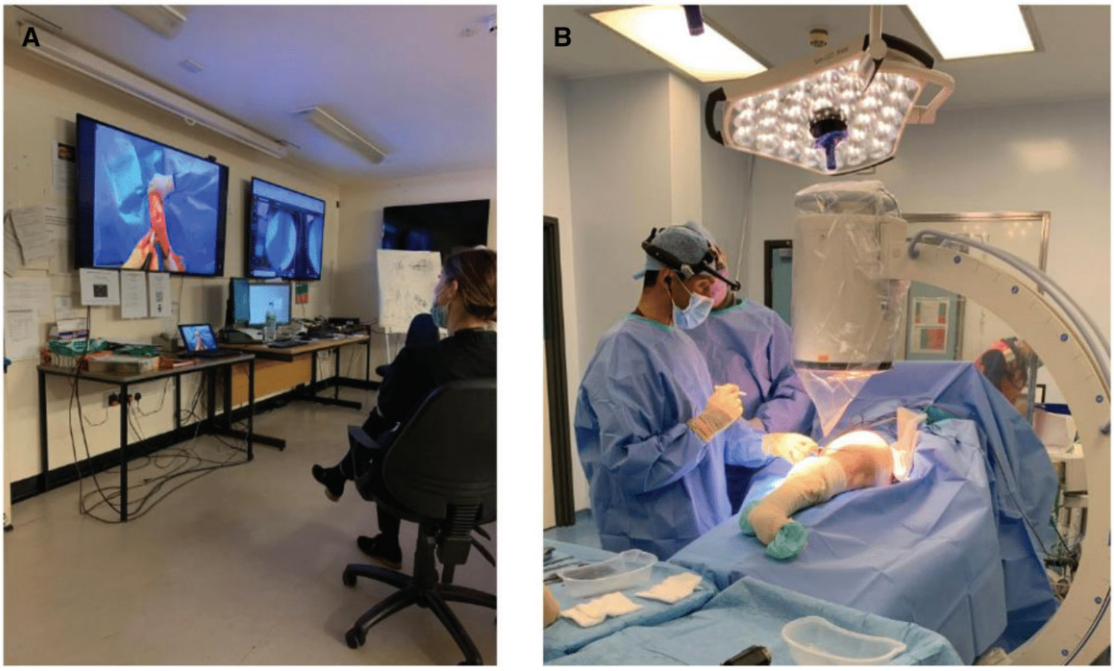

Figure 2. Surgeon live streaming procedure to learners. (A) Participants watching the live stream remotely; (B) theatre suite showing primary surgeon wearing the streaming headset.

All patients were appropriately counselled and consented prior to inclusion in the project. No video footage was recorded or stored.

Patient consent for filming during theatre was taken using Trust Digital Photography and Imagery forms prior to the-atre and stored in patient notes. No patient identifying im-agery was transmitted over the live feed at any stage. Participants authorised their feedback to be used in the study by completing the questionnaires but these contained no identifiable information.

Results

A group of 23 learners participated over the 2-day pilot scheme. They ranged from medical students to ST2-level ju-nior doctors; a breakdown is shown in Table 2.

Their prior surgical experience was assessed based on previ-ous attendance in theatres. There was a clear divide with 13 learners (57%) attending less than 5 times, 9 learners (39%) attending more than 15 times and 1 non-responder (Fig. 3).

Two responses were excluded from further analysis due to incomplete questionnaire feedback. The overall response rate was 91%. Informal feedback from learners following the session was generally positive with many people comment-ing on how enjoyable they found it and requesting further sessions in the future.

Table 2. Breakdown of level of medical training of the 23 participants

	Number of learners
Medical student	4
Foundation year 1 (PGY1)	4
SHO (including foundation year 2, 3, ST1 and ST2) (PGY2–4)	15

The responses to the questions are shown in Figs 4–11.

We have explored specific feedback and results for each question/statement in more detail in the sections below.

Question/Statement 1: I am gaining appropriate exposure in theatre for my current training level (Fig. 4)

The majority of learners (57%, 13/23) felt they were getting appropriate exposure to theatre for their training level.

Question/Statement 2: My surgical experience is meeting my curriculum requirements (Fig. 5)

The majority of responses stated were neutral or positive that surgical experiences were meeting curriculum requirements.

Question/Statement 3: How confident are you in the key steps of the procedure and relevant anatomy (pre- and post-screening) (Fig. 6)

Only 3/21 (14%) of learners felt they were 'somewhat confident' in the key steps of the procedure to be observed and 0% felt they were 'very confident'. This was also reflected in their subjective responses. Learner responses in the post-session questionnaire showed a statistically significant ($P = 0.0001$, paired t-test) improvement in their perceived understanding of anatomy and key surgical steps, with all learners rating their confidence as either 'somewhat confident' or 'very confident' (21/21, 100%).

Question/Statement 4: I feel more confident in this setting to ask questions about surgical procedures (Fig. 7)

We found that 86% (19/22) of learners 'agreed' or 'strongly agreed' that they were more confident asking questions in this setting as compared to in a theatre environment.

Question/Statement 5: I feel more confident to discuss this procedure with a patient or relative (post-screening) (Fig. 8)

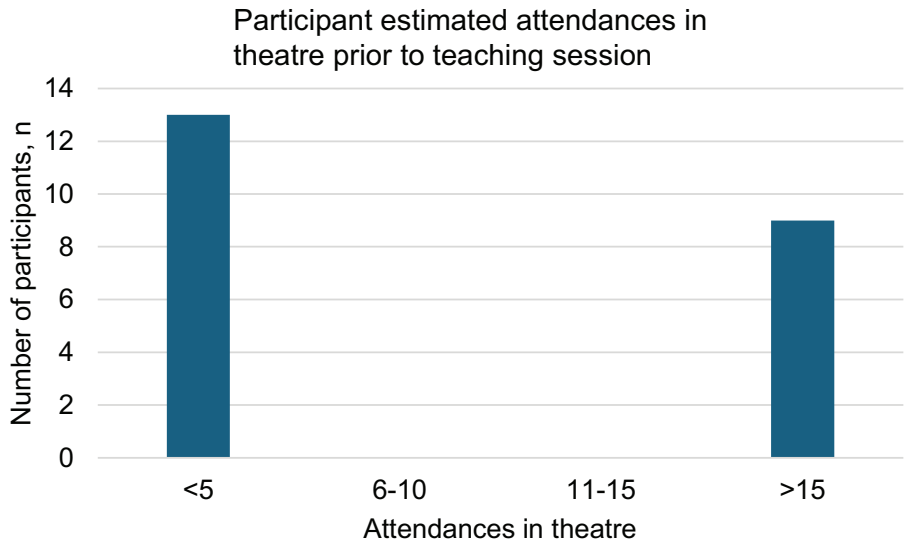

Figure 3. Estimated number of theatre attendances by each learner prior to live screening session.

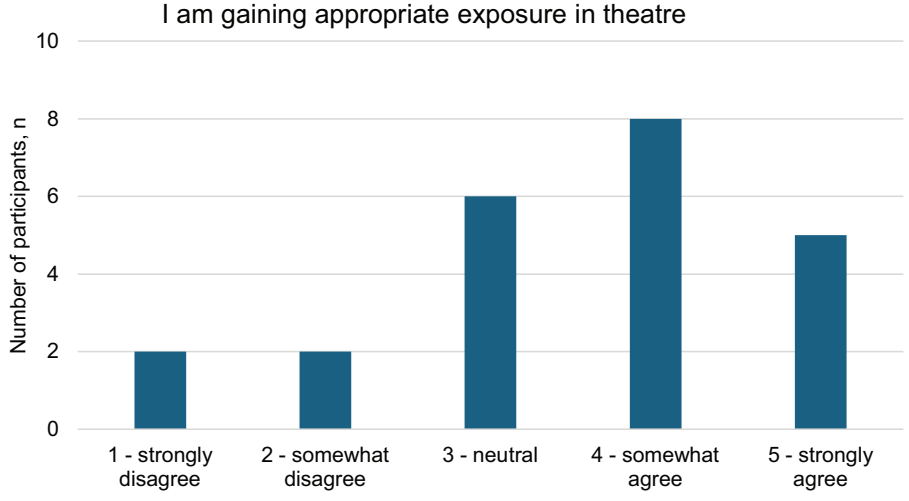

Figure 4. Level of theatre exposure compared with learner's expectations.

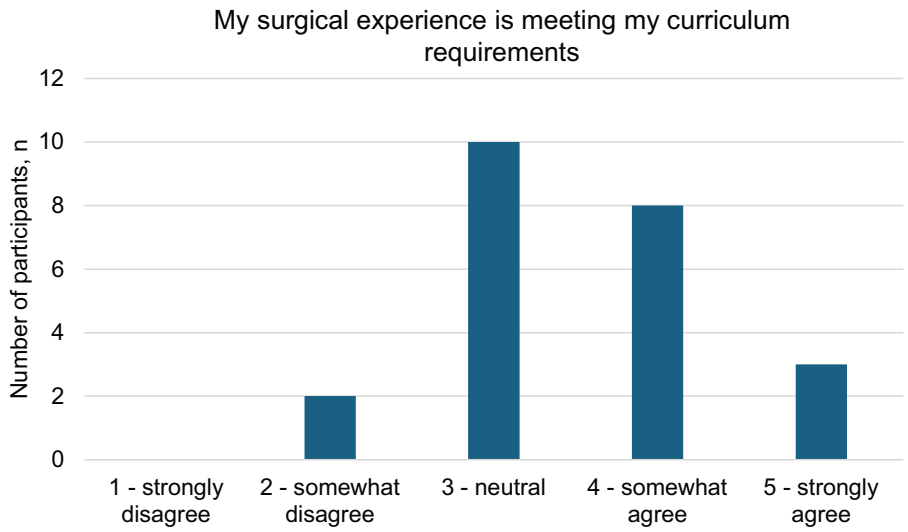

Figure 5. The extent to which learners feel their current training program and surgical experience is meeting the requirements of their curriculum.

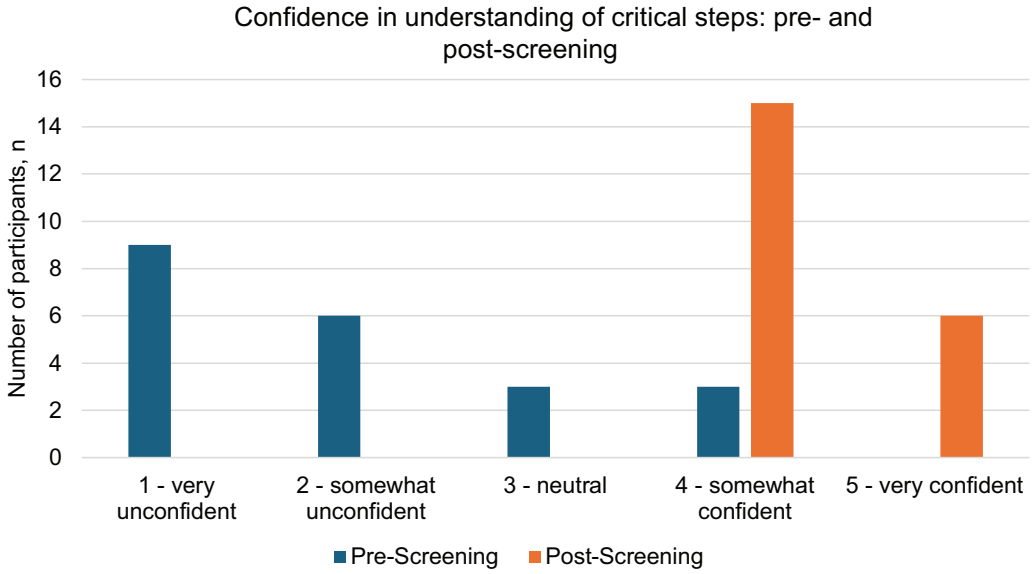

Figure 6. Comparison in the understanding of the critical steps of the procedure observed, pre and post live streamed session.

Participants felt that their improved understanding of the procedure put them in a better position to explain to patients and relatives about the procedure the patient would be about to undergo, with 76% (16/21) of learners feeling somewhat or strongly confident to do so.

Question/Statement 6: I feel more confident to attend in person operating lists (post-screening) (Fig. 9)

The vast majority of learners, 81% (17/21), felt that following the session they would be more confident in attending an operating list in person.

Subjective responses

The reoccurring themes of perceived barriers to attending theatre were those of time constraints (10 responses), ward

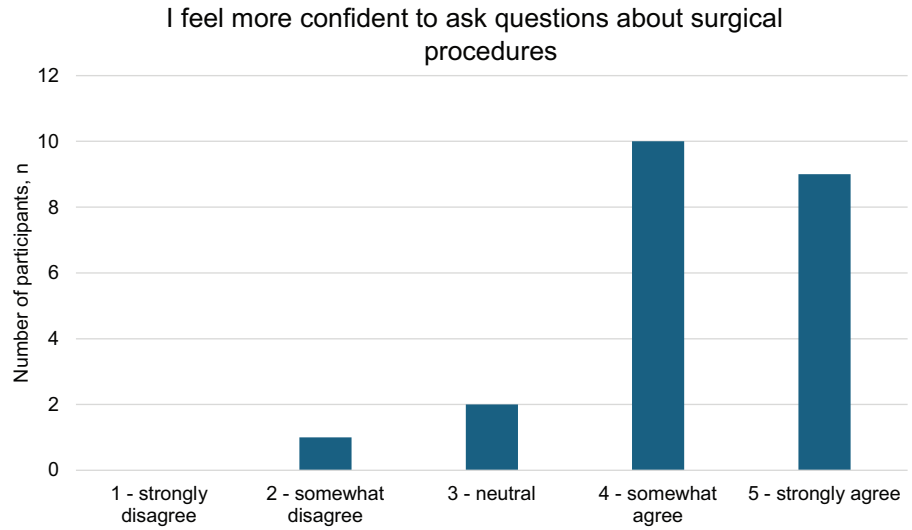

Figure 7. Confidence levels of the learners to ask questions related to the surgical procedure after the live streamed session.

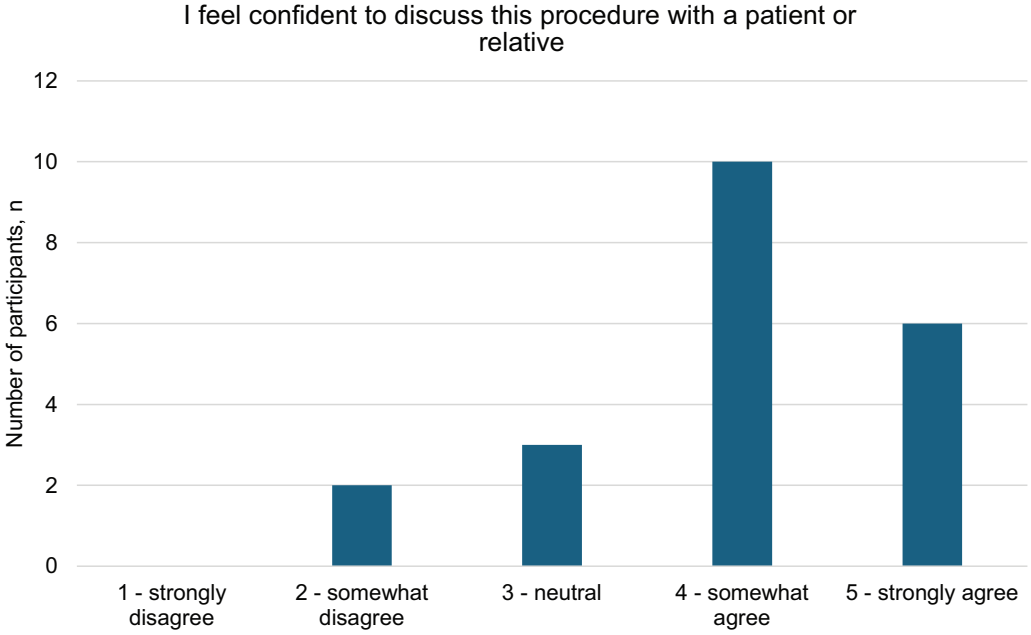

Figure 8. Confidence levels of the learners to discuss the procedure with patients and relatives after the live streamed session.

commitments (9), and lack of confidence in skills and knowledge (3) (Fig. 10). Learners were surveyed on areas for improvement of the session as summarised in Fig. 11. The most common responses were related to audio and visual quality during the initial session which were improved upon in future sessions with adjustments to camera settings. There were also comments relating to scheduling, which will be addressed with the use of formal timetabling and integration into their training programme in the future. Overall, however, the majority of feedback received was positive. A summary of positive comments and common themes can be seen in Fig. 12.

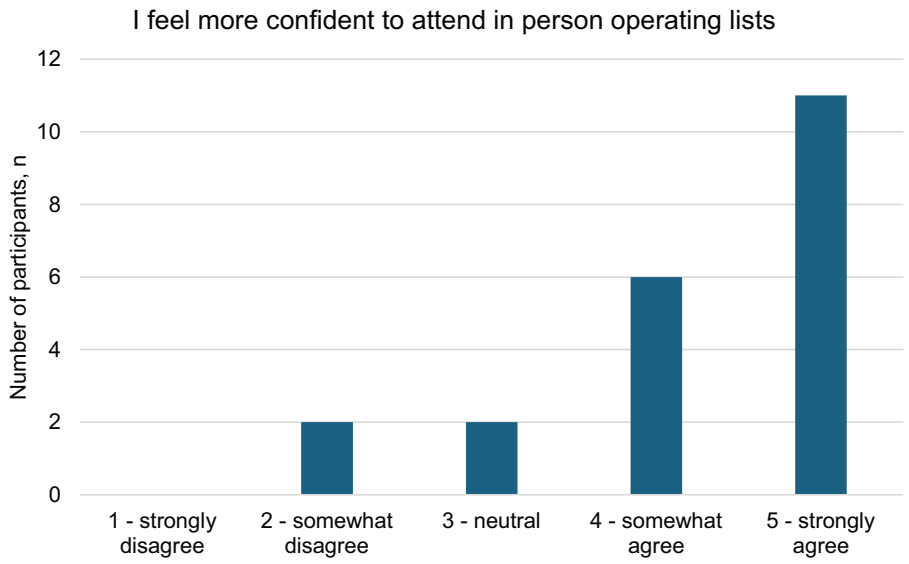

Figure 9. Confidence of the learners to attend in-person theatre sessions following the live streamed session.

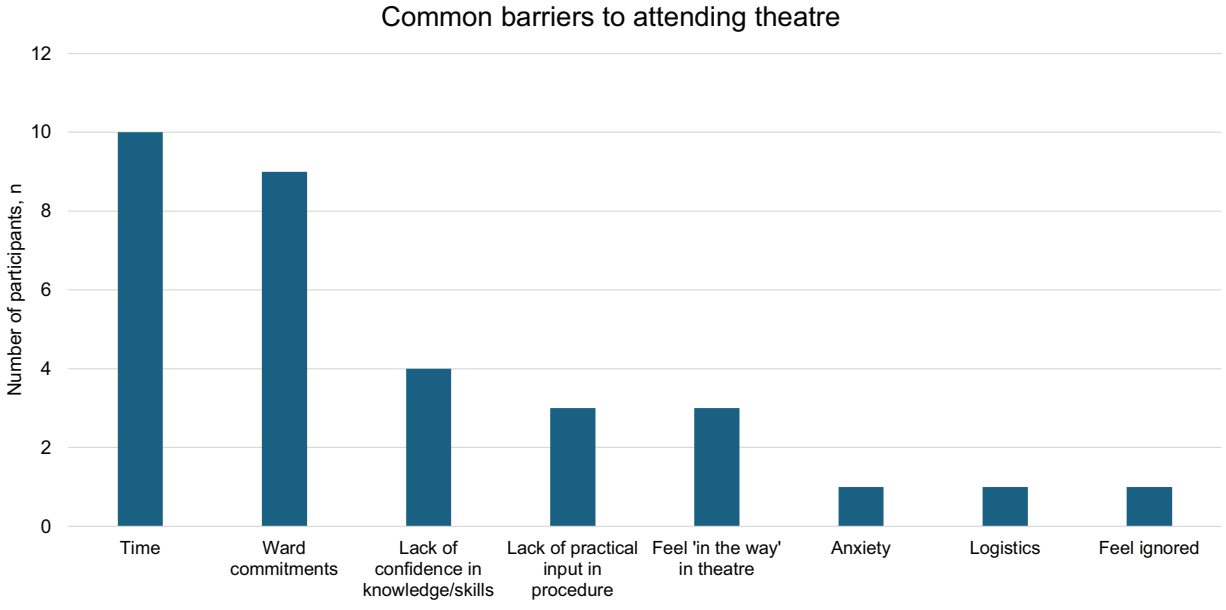

Figure 10. Common barriers cited as reasons to not attend in-person theatre sessions.

Informal surgeon feedback gathered with regards to the headset found it to be lightweight and comfortable. The view of the surgical field remained unhindered, and having a single peer to communicate with and vet questions prevented significant distraction. The short battery life of the device caused some setbacks in the initial session but this was rectified with the use of a lightweight battery pack, which gave us a significantly longer streaming time.

Discussion

This pilot teaching project appears to have improved the surgical experiences of junior medical staff during their

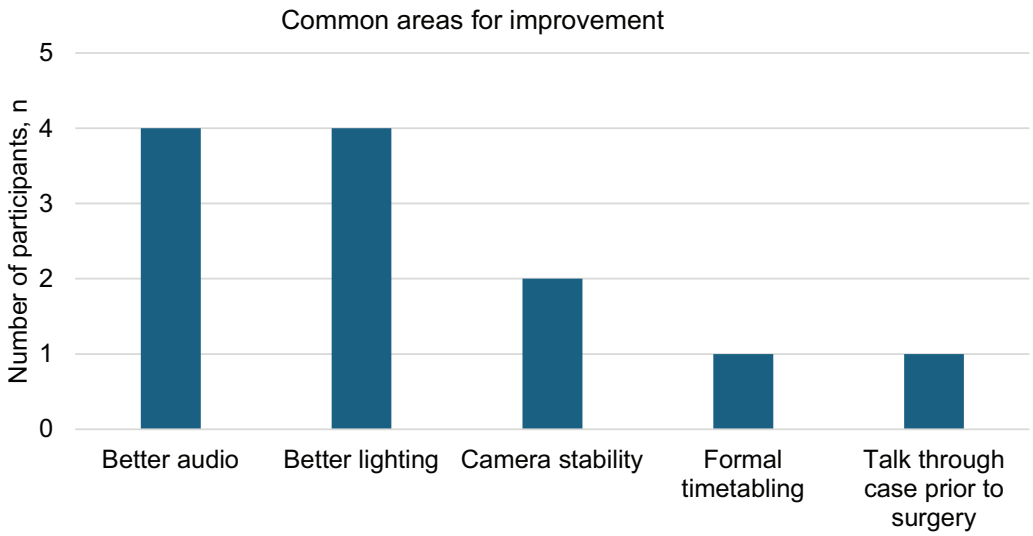

Figure 11. Common areas for improvement of the live streaming session.

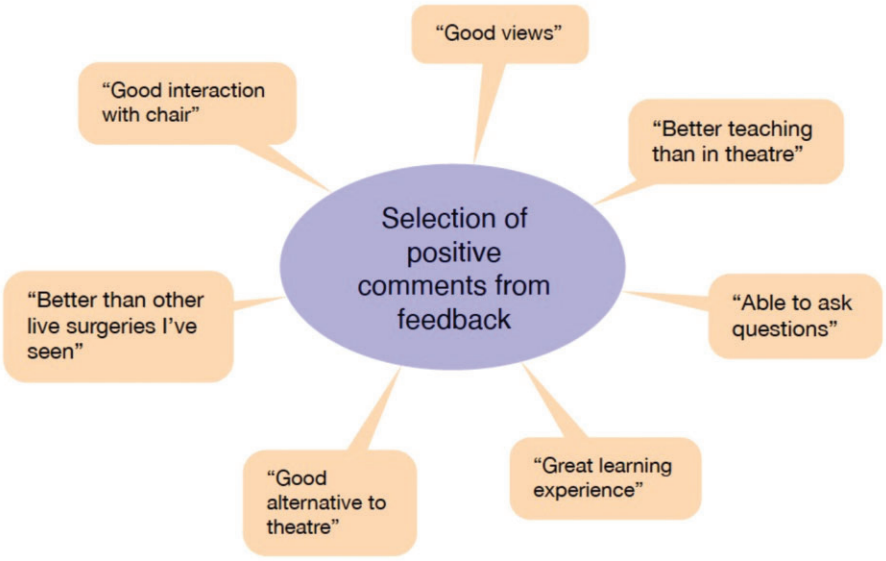

Figure 12. Positive comments received from the learners during the live sessions.

trauma and orthopaedics placement. It helped increase clinical knowledge regarding anatomy, surgical approaches and surgical indications. It is interesting, however, that, even though this project was born from the reported reduced surgical exposure during the pandemic, an unexpectedly large proportion of respondents (48%) felt that, despite the impact of COVID-19 and other discouraging factors, they were still getting adequate surgical exposure to meet their curriculum requirements. This, however, may be explained by the relatively junior level of the learner cohort. Previous literature on reduced surgical experience was primarily derived from higher-level surgical trainees.

By providing a more accessible theatre experience for junior medical professionals through this novel technique, this programme helps improve their confidence in surgical

procedures and understanding of the theatre environment and etiquette.

In addition, students and junior doctors gained confidence and reduced anxiety levels to attend 'in-person' theatre sessions. A literature review of medical student teaching in the theatre environment by Croghan et al.[9] found that fear of appearing incompetent and anxiety around 'looking like a fool' were common and were barriers to effective learning. The live stream sessions provided a less intimidating environment to allow for open communication between teachers and learners. Fig. 8 highlights particularly the increase in confidence in the ability to discuss cases with patients and relatives. This is a key skill of junior doctors. Having this knowledge, therefore, gives junior medical professionals the opportunity to enhance their communications skills including involvement in a consenting process, which is an important component of the Foundation Programme Curriculum[10] (FPC4) and an essential skill in development and progression within surgical training.

One particularly useful aspect of the sessions was the provision of a knowledgeable teacher, which is believed to have had a two-fold effect. Firstly, the learners benefitted, by increasing their confidence in asking questions and allowing discussion and teaching about the case without the disruptions that can occur to the surgeon when operating. Responses suggested that medical students and junior doctors felt more confident to ask questions related to key steps of surgery and anatomy, away from the direct pressure of the operating theatre, in this style of teaching session. This increased confidence may have also been helped by the peer teacher in the room with the learners (orthopaedic registrar, rather than a consultant grade teacher). Secondly, it also provided the teacher with invaluable hands-on teaching experience. This is already an essential part of the surgical curriculum for higher surgical training, but a report into improving surgical training by the Royal College of Surgeons in 2015[11] showed that there was a discrepancy in the quality of teachers available, often due to lack of available teaching opportunities to surgical trainees.

Although this project has not directly assessed whether surgical attendance ultimately increases in real time, it highlights the potential that this modality of teaching has. Fig. 9 serves as a good indication that live streaming of surgery will not detract from students and juniors' experiences by discouraging in-person attendance, but instead enhances their learning opportunities. In fact, we are hopeful that sessions like this one will combat some of the negative perceived factors that prevent students and junior medical staff attending theatre. This means that junior medical staff on orthopaedic placements will be more confident in attending theatre and develop skills in theatre etiquette, scrubbing and surgical skills including the art of assisting.

Unexpected responses were in the perceived adequacy of exposure to theatres for the training level of the learners. Anecdotally, it has been widely reported that exposure to theatre was poor. This response may have been a reflection on the timing of the sessions (summer months, when COVID-19 restrictions were reducing). Additionally, it may have been a problem with the wording of the question. What an uninterested party would define as appropriate would be different from that considered appropriate to a junior doctor wishing for a career in surgery. This may also reflect the wide range of training levels in the learning group and the variety of specialty interest.

To further explore this project, developing more robust objective data would build a stronger business case to introduce this technology into formal teaching programs. To achieve this, a prospective randomised study comparing the aims of outcomes between traditional learning methods and the live orthopaedic trauma streaming (LOTS) methods could be trialled on medical students and foundation doctors. This could be achieved in a relatively short space of time, due to the rotating nature of students and doctors throughout the training programme. Computerised cognitive assessments using a pictorial representation of key steps of common procedures would be a simple but interactive way to engage learners and assess their skill set. The use of saw bone workshops allows for the assessment of practical hands-on skills that are directly applied to orthopaedic surgery. Formative assessments of dexterity, technique, speed and correct application of surgical skills could be measured in a randomised study between traditional didactic teaching sessions vs the LOTS technique.

Further work assessing the long-term benefits and a potential role for the use of the LOTS technique in higher surgical training is required. It would be useful going forward to assess whether this increase in confidence is maintained over the course of a placement (4 months) and beyond for junior training levels and medical students. Although the study showed an increased confidence of learners after their teaching session, it is important to ensure that this knowledge is carried through into their future practice. For more senior surgical trainees, the use of this technology to provide regional and national training is a real possibility, and this pilot study has allowed us to explore this possibility in our Trust. As well as using it in the form of live teaching sessions with a knowledgeable teacher, it could also be used as a training tool for trainees to receive live feedback during

operating. As a result, we could see a real-time increase in the number of cases performed with the supervisor unscrubbed (STU) and further capture the JCST's drive for all cases to be effective teaching cases. The ability to stream infrequent and subspecialist cases to increase exposure for local, regional, or even national or international trainees could play a major role in higher surgical training. This technology is also feasible not only for orthopaedic surgeons but other surgical specialities as well. COVID-19 has highlighted the importance of novel methods of teaching and interest in virtual learning is being thoroughly explored in undergraduate and postgraduate medical education.

Conflict of interest

The authors report no conflict of interest.

Data availability

The data supporting the findings of this article are available from the corresponding author on request.

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