Assessing the Educational Impact, Learner Perspectives and Transfer of Learning of an Advanced Cadaveric Surgical Simulation (CADSIM) Programme

Jordan Fletcher[1], Marina Yiasemidou[2], David Roberts[3], Chandra Shekhar Biyani[3,4]*, Paul Renwick[5] and Athur Harikrishnan[6]

[1]Clinical Research Fellow, St Mark's Hospital, London, UK

[2]NIHR Academic Clinical Lecturer, University of Hull, ST7 Colorectal Surgery, Bradford Teaching Hospitals, UK

[3]Co-Director CADSIM, University of Leeds, Leeds, Senior Lecturer in Anatomy, Head of Division, Division of Anatomy, Leeds Institute of Medical Education, School of Medicine, UK

[3,4]Consultant Urologist, St. James's University Hospital, Leeds. Co-Director CADSIM, University of Leeds, Leeds, UK

[5]Consultant Vascular surgeon, Hull and East Yorkshire Hospitals NHS Trust, Hull. Head of School of Surgery, Health Education Yorkshire and the Humber, Leeds Office, Willow Terrace Road, University of Leeds, Leeds, UK

[6]Consultant Colorectal Surgeon, Sheffield Teaching Hospitals, Sheffield, UK

Abstract

Surgical training has undergone a paradigm shift as the acquisition phase of surgical skills has transitioned from the operating theatre to the simulation lab. Several factors have led to this shift; including reduced operative volumes, the need for competence-based curricula and ethical concerns in relation to patient safety. Yorkshire and Humber School of Surgery launched CADSIM- an advanced cadaveric operative simulation program- in order to address the education needs of senior surgical trainees. This study aims to evaluate the learner experience of CADSIM cadaveric workshops and explore how the training may have been utilized in clinical practice and impacted operative confidence. Eight surgical trainees were invited to take part in the qualitative study. One-to-one interviews were conducted to evaluate the usefulness and utilisation of the cadaveric training. Four key themes were identified: (1) confidence (2) experimentation (3) feedback and supervision and (4) anatomical and environmental fidelity. It is likely that cadaveric training may improve confidence and interactions with trainers.

Key words

Simulation, Cadaveric, Qualitative, Surgery

Introduction

Cadaveric training is often considered the 'gold standard' of surgical simulation. However, there is a trade-off between fidelity and frequency of training [1]. Cadavers, by their very nature, are a highly limited resource owing to the expense and number of bodies donated. The widely held view amongst both trainees and trainers that cadaveric simulation represents the gold standard is primarily predicated on superficial realism. As the closest mimic of live human-tissue, it is understandable that this has become somewhat synonymous with quality [2]. The deliberate practice is a conceptual framework characterised by the repetition of focussed tasks distributed in time with ongoing feedback and means to monitor outcomes [3]. Given the scarcity and expense of the resource, cadaveric simulation can only offer isolated training. Therefore, it seems unlikely that it will significantly contribute to skill mastery, given our current understanding of skill acquisition. Nevertheless, surgeons

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consistently rate the training to be of high value and superior to other simulation modalities [4].

The majority of the literature has examined cadaveric training largely through a positivist lens using a quantitative methodology [5]. In one recent systematic review evaluating the educational impact of cadaveric training in 51 studies across 69 interventions were identified [5]. Using Kirkpatrick's four-level training evaluation model, the majority of studies examined the first level of learner reaction/opinion [6]. Five studies have attempted to measure learner knowledge. Al Jamal, et al. compared cadaveric models against a cheap home-made low fidelity trainer and found while both improved an objective knowledge score, cadavers were not superior to low-cost model [7]. Several randomised studies compared cadaveric simulation with no simulation and subsequently assessed trainee performance using a virtual reality whole procedure simulation [8-10]. Such studies are limited in that they only demonstrate some form of practical training is superior to no practical training.

A limited number of studies have examined the construct validity of cadavers as a simulation tool. Martin, et al. investigated the impact of cadaveric training on emergency trauma emergency procedures such as chest drain insertion, endotracheal intubation and venous cutdown and reported training can transfer into the clinical environment [11]. By confining our analysis to mainly technical skill acquisition, we may ignore other potential benefits of cadaveric training. One of the central aims of this project was to explore the benefits using a qualitative approach. While using cadavers as a means of acquiring technical competence is essential, we may be overlooking other significant aspects of the training and how it is subsequently transferred into the clinical environment. As previously stated, the overwhelming majority of studies evaluating cadaveric simulation have employed purely quantitative approaches or assessments of subjective value. The value of this training might reach beyond this narrow framing. Through an exploratory approach, we investigated how this training was perceived and crucially identified how this may transfer back into the clinical environment in ways outside technical skill.

Materials and Methods

This project was conducted with UK General Surgical specialist registrars who have attended the Yorkshire and Humber School of Surgery centralised *cad*averic *sim*ulation training programme (CADSIM). This project explores the experience of general surgical trainees participating in the Yorkshire and Humber School of Surgery cadaveric training programme CADSIM.

The study is subjective and seeking an in-depth understanding of the potential benefits of the training programme for individual surgeons at different stages of training. Our objectives were

1. What are the perceived benefits of cadaveric training for higher general surgical trainees?

2. How did attendance impact the trainees subsequent practice?

3. How does cadaveric training meet their perceived training needs?

The primary purpose was to understand how cadaveric simulation was beneficial with emphasis on the transfer back into the clinical environment from a qualitative perspective. The aim was not to try and quantify utility but understand the meaning surgical trainees derive from cadaveric training. Previous work has focussed on assessing the impact on performance via scoring systems or clinical outcomes via complication rates, operative times etc. Consequently, "value" has been defined within the confines of this quantitative framing, emphasising the research over the learner.

For a study of this nature, it was necessary to select a methodology that would facilitate the collection of high-resolution data. One-to-one interviews were selected as this would enable an in-depth exploratory study of how and why cadaveric training was useful and utilised. Semi-structured interviews were used, consisting of open-ended questions to ensure that specific topics were addressed with a degree of flexibility to enable participants to develop themes. Semi-structured interviews allowed surgeons to build their narratives and allow for alterations of lines of questioning to explore better-unexpected points of view pertinent to objectives (Supplementary file Appendix 1).

Recruitment and data sampling

We adopted a pragmatic approach to the sampling method. There is variation in the characteristic of the surgeons attending the courses including; gender, ethnicity, operative experience, level of seniority when they attended the course, subspecialty interest, time from attendance to interview and previous simulation experience. Ideally, the sample would be reflective of the wider subject population. Stratified sampling was considered, however, after reflection considered to be unfeasible. We felt the response rate would be poor and therefore, convenience sampling was used with the acceptance that this may possess certain limitations. Furthermore, despite the potential differences in delegates, we felt they still represented a homogenous population in that they were all general surgical trainees.

Respondents were recruited via an invitational email with attached information sheet sent out via the central Yorkshire and Humber School of Surgery to previous CADSIM delegates. Eight respondents were recruited to the study and signed the written consent form. The original intention was to conduct the interviews in person. However, as researcher (JF) moved away from the area during the study period, this was not possible. Interviews were conducted over Skype instead. Data collection took place from January - December 2019 with concurrent transcription and data analysis. Transcribing the data allowed adjustment of the subsequent interviews to reflect the emerging themes. As a qualitative study, the sample did not strive for statistical adequacy but instead judged by the quality of data produced. No pilot interview was conducted on this basis as our primary concern was recruitment. The eventual eight responders that were interviewed met the lower end of our target of 8-12 interviews and likely reflected the point of data saturation with limited new information offered by the last interview.

Transcription and data analysis

Interviews were transcribed verbatim from the audio into Microsoft Word files. We utilised high-quality audio recording, therefore, ensuring the audio was high complete, with correspondingly small amounts of lost sound. By transcribing in the week following the interview and referring to contemporaneous notes, we were able to ensure the accuracy of the transcription and also identify flaws in questioning. An example transcript can be seen in the Supplementary file Appendix 2.

Data analysis

Interview transcripts were analysed using NVivo 12 software. Basic thematic analysis was utilised. Thematic analysis has been defined as a method for recognising and reporting patterns in qualitative data [12]. We selected this method as it would allow us to elicit the trainee experience and how they derived meaning from the training programme. A systematic framework was employed for descriptive analysis [13]. We primarily utilised a data-driven inductive approach in which themes were derived from the data themselves. Data were coded without attempting to fit any pre-conceived coding frame. The themes were generated to some extent about the research questions reflecting at least partially a deductive approach. Using Creswell and Poth [14] approach, we generated between 40-66 codes per interview. We chose to code each interview sentence by sentence utilising descriptive terms used by the participant before looking for the wider meaning to group each code into categories and eventual themes.

Data presentation

Participants were anonymised and labelled 'Interview 1-8' in chronological order. Using the NVivo software package, direct quotes were labelled as 'nodes' (which can be considered synonymously with a data code). Each code was given a descriptor, which enabled clear justification and reasoning in support of codification decisions made. The software enabled the visual display of data which helped discern the underlying meaning. Throughout the contemporaneous coding process, codes were consolidated and reorganised until the significant themes in the data began to emerge.

Data storage

University of Leeds protocols were followed for data storage. No written information was kept or stored with all documents and audio files stored electronically on the University of Leeds M-drive.

Ethics

The research and development team at Leeds University Teaching Hospital NHS and Sheffield Teaching Hospitals NHS Foundation Trusts determined the project was a service evaluation and so Research and Development (R&D) approval were not necessary. Proportional ethical approval was obtained from the University of Leeds. The voluntary nature of the study was emphasised to mitigate any risk of coercion. Ethical concerns relating to trainees not wishing to speak critically about the training programme or CADSIM proved to be ill-founded. Similarly, the interviews were open, honest discussions, and trainees did not appear to be reticent about discussing any struggles/difficulties they may have experienced during their training.

Results

In this study, many important benefits of cadaveric training were identified. Four key themes were identified with patient safety and dedicated training time pervading through each. Each theme was discussed by responders to a greater or lesser extent demonstrating heterogeneity in trainee experience with some considerable overlap and interrelatedness between distinct thematic groupings. Themes were developed from the expressed subjective lived experience of participants rather than any external factors. The demographics of the responders are summarised in (Table 1).

Thematic Analysis

Confidence

Interviews highlighted that confidence was a vital issue for several responders. The following descriptive codes were generated: anxiety, gaps in training, expectations, mental block, putting yourself forward, preparedness and pushing your limits. Confidence may impact how trainees interact with their trainers and subsequently, their resulting experience. Responders attached high value to the confidence they obtained through attending the course, in particular, P4: *P4 "But for someone like me who does have confidence issues sometimes I think the cadaveric simulation's fantastic."* Cadaveric training may help instil this confidence by enabling a change in perspective, particularly for novel procedures or rarely encountered scenarios and help bridge the gap between theory and practice. *P4 "And it is like okay right it really is as simple as everyone says. So, I think it allows you to get that little bit of confidence perhaps that you wouldn't get or that experience that you wouldn't get in the real-life situation."* *P6 "So, I guess it kind of... I guess from a confidence point of view it does help with procedures where you're not going to be performing them on a regular basis."* This belief may help trainees push beyond previous limitations. The experience of having done something in the cadaveric lab can instil a degree of self-belief in one's abilities.

P4 "So, even the lap that I did on xxxxx course I'd never really dissected around the hiatus before. I'd seen it done a million times, one or two people had let me have a little go at it, but I'd never really done it. But then next time I went to do a fundo after that cadaveric course one of the consultants just left me to it. And I was, right, okay, come on you have done this before, and I did actually manage to do it. And I did the fundo without him scrubbing up." Through cadaveric training, this responder was now able to perform steps of an operation having felt unable/ not offered the opportunity before attending. Cadaveric rehearsal in this situation engendered a sense of self-belief to push through previous barriers.

Table 1: Summary of participants demographics.

No.	Sex	Training Level	Specialist Interest	Time since attending the course	Courses attended	Experience in procedures before attending	Served as faculty on CADSIM?
1	M	ST7	Colorectal	Two years	Emergency HPB Laparoscopic Nissen's (Upper GI)	Assisted	No
2	M	Post CCT	Upper GI	One year	Emergency HPB Lap Nissen's	Performed	Yes
3	M	Post CCT	Colorectal	Two years	Laparoscopic Colectomy and Anterior resection Rectal prolapse (Colorectal	Performed	Yes
4	F	ST7	Upper GI	One year	Laparoscopic Nissen's (Upper GI), Emergency HPB, Trauma	Performed for Upper GI -No previous for Trauma	No
5	F	ST4	General (HPB)	One year	Colorectal x2, Emergency HPB x 2	Assisted	No
6	M	ST5	Upper GI	<1 year	Emergency HPB and Whipple's, Trauma	None-Assisted	No
7	M	ST7	Colorectal	Two years	Laparoscopic Hernia	Performed	No
8	F	ST7	Colorectal	Three years	Vascular	Assisted	No

The knowledge that you can do something from concrete experience likely engenders the confidence to persevere when encountering difficulty in the clinical environment. When a trainee struggles in an operation and asks for help it is usual that the consultant will take over and likely complete the procedure. Cadaveric training may, therefore, facilitate trainees to obtain more from training lists by enabling a transformative experience by breaking previous "mental blocks". P4 describes such an experience: *JF "Do you think it just gets over a mental block that you are able to push yourself that little bit further than you would do before getting scared?" P4 "That's exactly what I think it is. It's certainly for me it's that mental block of thinking I've never done this before what the hell am I going to do if I have to do it in a real-life situation."*

Meyer and Land characterised the conceptual gateway as akin to a portal to a new way of thinking. In their definition, the threshold concept transforms the learners understanding or perception to allow a shift in subjectivity. This transformation usually involves troublesome knowledge- in this scenario performance of a step in the procedure previously unobtainable. The learning threshold can extend beyond conceptual or procedural knowledge but involve a complex interaction between perceptions of identity and the customs of a community of practice [15,16]. By enabling the learner to breakthrough thresholds, cadaveric training may contribute to a broader ontological shift as one assumes the identity of a competent surgeon. On this point O'Sullivan, et al. observe *"Transformation learning involves deep, structural shift in the basic premises of thought, feelings and action"* [17].

It was interesting to note that the benefits of this confidence may not be restricted to just improvements in knowledge or reductions in anxiety, but also in how subsequent interactions with trainers are conducted. Several responders noted how they felt more able to put themselves forward in the clinical environment after cadaveric training: *P8 "It's quite interesting because I think after the course, I actually felt a lot more confident, because, in my head, I thought right, okay, I've actually done a fem-pop start to finish…"* Surgical training occurs in a complex psychosocial environment.

Meyer and Land argue that a community of practice often has unspoken ways of thinking and practicing. In their conception of learning thresholds, the ontological shifts conceptual or otherwise elicit transformation in the sense of self. In a series of interviews with London based surgeons of various levels of seniority and gender, Meyer and Land articulated a set of ontological credentials required of the community of practice-namely, resilience, ability to handle pressure and confidence [16]. By engaging in cadaveric training with the associated boost in confidence described trainees might be better placed to put themselves forward. As P8 described:

P8 "And, in fact, I remember telling my consultant that oh, look, I went to a cadaveric course, I actually did do this. So, I think it also helps the clinician, or your consultant, believe that you've got… the concept, you felt more able to put yourself forward to do more and maybe get more out of the placement." Notably, the two participants who articulated the benefits of confidence were females. This observation was noticed during the analysis phase and therefore, not explored in the interviews. Surgery, despite some progress, remains a male-dominated domain. It is well established in several fields that women are more likely to suffer from low confidence and imposter syndrome [18,19]. It would be interesting in future work if there were a gendered element to the confidence aspect of simulation.

Gaps in training

A sub-theme within confidence relates to perceived gaps in training that were met by cadaveric training that perhaps highlight some ideal applications within surgical education. P4 expressed concerns regarding a lack of experience during their training: *P4 "…you do have to do that to get the numbers. Like there's talk about work time restrictions and stuff, this is reality and you just can't get the experience within the allotted time, it's just rubbish."* Trainees approaching the end of their training were more acutely aware of gaps in knowledge or experience with the realisation they would soon be expected to 'deal' with them solo. *P4 "If you get to senior trainee and you've never done these things and you're thinking, God, I'm going to be a consultant soon I really need to be able to do*

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it." Particular anxiety related to low frequency/rare high-pressure emergency situations that may be encountered. The typical example given was trauma-based surgery, e.g. stab wounds with major vessel injury, splenectomy, hepatic and chest/cardiac Trauma. P5 *"Then things like the emergency stuff needs to be taught the whole way through, I think again. And whether you use a mixture of cadavers and work lab type stuff, because the problem with emergency stuff is that none of us see it very often."* P8 *"Because you're suddenly expected to do something that you rarely do, do it very quickly, and very well. I think, in that case, simulation is very good."*

These cases are thankfully relatively rare, meaning the majority of trainees outside highly specialised centres would have limited experience in dealing with these scenarios. The issue is any general surgeon in the country may receive that "nightmare call" and be required to provide emergency damage control surgery (e.g. resuscitative thoracotomy, splenectomy, packing the liver) before transfer to a tertiary centre for definitive treatment [20]. P3 described such an experience: P3 *"I was in xxxxx, and while the Royal College course does a course on thoracotomies, I'd never done it, but I'd just read books and always petrified … about the case where you have to do a clamshell And lo and behold in Sheffield, the day I asked a thoracic surgeon about how they would approach a chest trauma, we had one come in and we had to do a thoracotomy in A&E. And I probably will never ever do that again, but it would just be nice to have seen the dynamics of how the chest moves or how do you rotate the lung and…"*

Patients who have sustained such injuries are usually admitted in extremis and extremely unwell. Consequently, there is an expectation (entirely justifiably) that these cases are consultant-led. The opportunity for training in such high stakes, high-stress situations with a critically ill patient in which minutes and seconds have profound consequences are limited. It appears cadaveric training in these areas may be particularly valuable in functioning as a bridge to practice from basic theoretical knowledge: P1 *"And it takes the pressure out having done it before and then being able to do it in a less pressured scenario I think is really, really, helpful where you can ask questions."* P4 reiterates this cognitive gap between theory and practical application: P4 *"so I'm kind of thinking, right, well I'm going to get to be a consultant in less than, well, just over a year's time and I'm never going to have done a splenectomy… So, obviously you're in the cadaveric lab and Mr xxxxx says, well, just have a go. So, you put your hand behind it, and you grab the spleen and pull it out. And it's like okay right it really is as simple as everyone says."* P8 *"…it was nice to actually get some preliminary hands-on exposure in a cadaveric setting, so that you felt more confident to perform in a pressurised situation when you're finally the person doing the operation, getting a chance to do the operation."*

Cadavers seem an ideal modality for acquiring an appreciation of these necessary technical skills given the paucity of clinical opportunities. We already recognise the role of regular simulation-based training for emergencies through mandatory courses such as ATLS (advanced trauma life support) and ALS (advanced life support). The inherent anatomical fidelity of cadavers allows a useful insight into the actual mechanics and dissection technique that are needed in trauma situations. A detailed understanding of the tissue planes and anatomical configuration is a baseline requirement. P1 *"But the thing is I think every training thing is the same as when you do ATLS it has a life span. And so, if you're doing things like Trauma I think you have to do it frequently to have the skills.*

This testimony gives better insight into how frequently to provide training. We know from motor acquisition literature that newly learnt skills are subject to rapid decay if not used. Given the paucity of trauma cases, the opportunity to utilise trauma manoeuvres in the clinical environment will be few and far between. Trainees are already required to renew their ATLS accreditation every three years. Similarly, individuals may benefit from repeat attendance on an annual basis to maintain their knowledge and confidence to execute life-saving interventions. There are limitations of this particular cadaveric training in that they fail to recreate the specific context where these skills would be applied. We will revisit this issue in the next theme of experimentation.

Experimentation

Experimentation represented a key theme identified in the interviews. The following descriptive codes were identified: safe environment, more time, allowed to do more, explore new areas, knowing your limits and deepening your understanding. Time and patient safety were observed to be important factors facilitating experimentation by many responders. Time restrictions and patient safety appear to be significant barriers to gaining operative experience in the clinical environment. One trainee observed it is the most likely reason an operation may be taken over by a consultant. P5 *"there are no time pressures, because I think when you're a junior trainee the most likely reason why someone will take over a procedure from you. It's if they feel that you're not making sufficient progress, whereas in the cadaveric, it doesn't matter if you're taking your time to do something properly."* The time and space facilitated by the cadaveric training may also help foster a more in-depth understanding. This understanding may be especially pertinent for senior trainees: P7 *"So, that's really helpful. The fact that you can go through the procedure in a longer timeframe, which allows for better understanding and better learning throughout the operation or procedure, as well. So, those would be my main points of benefit."* Even experienced senior registrars performing procedures frequently in the clinical environment noted the benefits of being able to experiment and trial new approaches. Through experimentation, trainees may be able to gain new insights into why specific techniques work as opposed to merely following senior direction when in theatre: P3 *"It gives you just that little bit of higher-level thinking, that you're not just being told what to do, you can practice a little bit with different things that different people have done……But again, that forum allows you that flexibility to do something differently and understand why is it that we set up things in a certain way… It gives you just that little bit of higher-level thinking, that you're not just being told what to do, you can practice a little bit with different things that different people have done."*

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The safety of the environment appears to be a double-edged sword. Safety has its advantages but fails to recreate the psychological stress of operating. Overall, several responders emphasised how this allowed free experimentation and crucially the ability to make mistakes: P1 *"So, I think it's really useful. It's a really safe place to do things that you either don't do very often or to do things new or to do things differently."* However, one participant was slightly more conflicted in the usefulness of the comparatively "lower-stakes" of cadaveric training espousing both the benefits: P6 *"Time and space to make mistakes, time and space to move things around in the way you wouldn't do normally."* And potential drawbacks: P6 *"So you can make bold cuts, you can make bold incisions, you can put big stitches in. All these things are easier if you're not dealing with the consequences."*

While the realism offered by CADSIM cadaveric training is high from a haptic and aesthetic perspective, it lacks the social and psychological dimensions in the current course formats. This lack of contextual realism relates to the issue of authenticity, which can potentially influence how this training is subsequently incorporated into practice. Some evidence suggests that learning transfer is better predicted by progressive cognitive and psychological complexity [21]. There is a difference performing a skill in the calm and safe confines of the simulation lab versus the relative chaos of the operating theatre. Other surgical educators have utilised more immersive experiences in order to better integrate technical skill with human factors [22]. CADSIM courses in general surgery have yet to incorporate such elements.

The ability to make mistakes was viewed as essential to subsequent practice: *Me "It's interesting you mention the ability to actually make the mistake. Why do you think that's important, as opposed to being prevented from doing it?"* P7 *"I think you remember them more. So, when you make a mistake yourself and see the mistake, you then drive the potential consequences. If you are in a situation during a live operation and you're heading towards a mistake, you may not actually appreciate that you would have made that mistake."* Making a mistake may leave a more indelible impression, with the benefit that no patients are harmed in the process. In Kolb's classic active experiential learning cycle, active experimentation and concrete experiences are drivers for reflection and subsequent new or modified conceptualisation.[23] Cadaveric training can enable such experience that can alter understanding: P3 *"Whilst you can make mistakes… You're taking away the harm to the patient, but you're taking away the fact that you've done something bad or wrong… but then it's there for everyone to see. It's not like a computer programme where you click wipe and it's gone, it's in front of you, and depending on the attitude of the trainee, that could be used in a very useful way to teach and reinforce how important certain sorts of dissection techniques are, etc."* An interesting parallel with virtual reality simulators is drawn. This participant feels mistake in the cadaver may carry more significant impact owing to its permanency. This may help explain the general preference for cadaveric over virtual reality as a simulation modality [24].

The safety of the simulated environment allowed trainees to push themselves and experiment with new approaches to problems previously encountered. P2 describes a scenario of being able to overcome a limitation: P2 *"I used to struggle doing that step in real life and I chickened out or felt less confident and asked the boss to do that step for me, whereas in the CADSIM course I practiced that a few times and I felt more confident and worked out a way that would make it easier to do both, making each of your working instruments and… Yes, I thought that was one of the things that I definitely took back to my day to day… The live operating."* Drawing on Kolb, trainees are able to engage in experiential learning that that can be taken back into their practice. This experimentation does not seem as possible in the clinical environment. The anatomic fidelity enables individuals to obtain insights into how tissue moves in relation to certain manipulations. Or to put in the word of P1 "how much you can get away with": P1 *"But when you do it in a cadaver and you can actually see how much you can get away with in terms of your force and movements and dissection. And it does give you a bit more confidence taking that away and then doing it on a regular basis."*

Fear of making a mistake or damaging the patient can be limiting in terms of advancing operative skill. In this scenario, cadaveric training may represent a form of scaffolding. The concept of scaffolding is closely related to the Vygotsky theory of the "zone of proximal development" (ZPD) [25]. Vygotsky argues that through a dynamic relationship with a trainer the learner engages with recursive increasingly independent task performance. The ZPD can be thought of as the point of struggle and is dependent on external action. Tasks need to be of a level of difficulty to provide a challenge, however not so difficult as to preclude success [26].

It is possible cadaveric training enables trainees to occupy this zone to a greater extent as P7 describes: P7 *"Because there's often periods of uncertainty, which are demonstrable when you watch someone operate and they're unsure about what they're doing…and therefore, are stopped from operating. That doesn't happen as much in cadaveric simulation."* Similarly, P5 noted you were more likely to be allowed to struggle by trainers: P5 *"you feel like the faculty are more willing to let you struggle and take the time doing things because that's a dedicated teaching environment with no consequence, rather than having an actual live patient under whilst you're learning"* Within this Vygotskian conceptualisation of learning the point of struggle is crucial to learning. If a trainer takes over too readily at this point trainees may plateau in terms of progression towards independent practice. Scaffolding, as defined by Wood, et al. is predicated on the idea of 'contingent instruction' [27]. Help should only be provided when needed. Simulation provides a safe dedicated space where the zone of proximal development can be occupied, and learners can practically solve problems.

Feedback and supervision

It is well recognised that feedback is a crucial aspect of effective learning. Detailed and timely feedback are central to competency-based curricula and help narrow the gap between current and desired performance. The evidence of what constitutes effective feedback is broad without recognised

guidelines. However, the consensus opinion indicates feedback should ideally be based on direct observation, conducted in a conducive environment and directed on specific skills in a non-judgemental fashion [28,29]. Feedback can prompt reflective practice and enable new vital insights. During the data analysis it became apparent that one of the most valued aspects of CADSIM was the feedback and supervision. The following descriptive codes were identified: better feedback, contemporaneous, focus on trainee, lack of distractions, patient safety, mentoring, dedicated trainers and relaxed trainer. It appears that the character and quality of feedback received during the CADSIM courses was perceived as better than in the clinical environment. Participant 1 notes: *P1 "You get watched a lot more closely, feedback compared to when you're operating on a patient the feedbacks much better. You'd think it'd be the other way around. Really you'd get more feedback when you're doing a live operation"*

It appears as though in this dedicated teaching environment trainers are more focussed on education when outside concerns are no longer a factor. It is interesting to observe that P1 felt the level of observation was paradoxically closer within the confines and relative safety of the cadaveric simulation. While the behaviour of consultants varies considerably between individuals, the observation that you will frequently be left to "get on with it" resonates with our experience. Other interviewees had a similar perception with respect to the quality of feedback: *P2 "The difference between real-life operating is that there's less scope for real-time feedback… so, it's a much more constructive, comprehensive feedback environment… Then having someone there deliberately critiquing everything and that's exactly what they're there for, without the added stress of we have to deliver the perfect operation…"*

A recurrent theme that pervades this study is the difference between training in the simulated environment versus in theatre on live patients. While the emphasis has often been placed on the trainee this appears to also affect the trainer as well resulting in a new relationship dynamic. It is likely the behaviour and attitude of trainer's changes with the environment. The quality of training- as perceived by the trainees- appears to be superior in certain scenarios. Ende (1997) [30] wrote that the role of teaching in the actual inpatient clinical environment is one of the most challenging in medical education- citing the unpredictability, disease severity and tendency to lecture rather than engage in interactive discourse.

The operating room can be inherently stressful even for an experienced consultant [31]. Ensuring patient safety, dealing with challenging technical scenarios can elicit considerable stress and may not be conducive to training. Its unsurprising that when the time constraints and patient safety concerns are obviated there is a focussed primacy of the trainer role as described by P2: *P2 "In the clinical environment patient safety is obviously the number one concern…And I think, secondly, is that the course is there for learning, it is not there for anything else; therefore, the person that's there is 100% in tune and geared with their trainer hat on"* This insinuates that trainers may adopt different roles that are situation dependent. The

comparisons of trainer behaviour in the clinical and simulated environment were highlighted by P4. They observed the difference between a trainer they worked with during a clinical placement versus on a CADSIM course: *P4 "I think the boss is less stressed because the training can't kill the patient… Whereas he has been a tutor on one of these courses and he was a lot more chilled out and a lot more relaxed… He really does like his teaching it's just a shame that he can't really teach very well in a real-life situation."*

This idea of altered behaviour in trainers was reiterated by P7: *P7 "I think they are perhaps also more relaxed because of the fact that they, too, would share many of those pressures that you have as a trainee in the live operating setting and I don't think they're there… Indeed. And I think there's a personality shift that happens when you're outside the work environment and people become much more amenable to training"* This highlights some potential advantages of cadaveric simulation that would not necessarily be detected through a quantitative research paradigm. Other participants noted a change in focus from trainers: *P8 "…a lot more focus is on how you perform… So, their concentration is divided, and they may not... You are not really a priority in that situation."* The cadaveric environment seems to be more conducive to providing real-time feedback. For learners attempting to nuance skills and perfect techniques this may be crucial: *P7 "… A lot of it is more contemporaneous when you go through it in a cadaveric simulation because you can stop at certain points and get feedback there and then, rather than having feedback at the end of an operation"*

Trainees frequently express displeasure with the quality and volume of constructive critical feedback received. Jensen, et al. (2012) previously highlighted the discrepancy in the perception of educational feedback given in the operating room [32]. Faculty believed they had provided an appropriate amount, a view that was not shared by the corresponding trainees surveyed [31]. An additional unplanned benefit of the training programme was the networking potential. Participants highlighted the opportunity to establish working relationships with senior surgeons around the region. P1 observed: *P1 "… that consistency and that relationship you build up with the trainer and the confidence that you have in a trainee and trainer is very important… So, certainly it gives you a wider view. I think all these opportunities of training and good networking events is not something I'm particularly strong at… But I think they are good chances to get to know other people on the programme and the trainers."* By working with trainers in a more informal environment, professional mentoring relationships may be developed that can be transferred back into the real world. Social dynamics have important consequences for trainees. This may have certain advantages for training in the clinical environment for consistency of training: *P1 "I think particularly for me I was lucky that the trainer was there, and he'd seen me do it on a cadaver and then I've been able to do it in real life under supervision with the same trainer."*

P2 *"Because there were so many different Faculty members there with direct experiences, they shared their approach, and then being mentored one to one on these courses was very useful"*

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P7 *"The fact that you can go through the procedure in a longer timeframe, which allows for better understanding and better learning throughout the operation or procedure, as well."*

Anatomical and environmental fidelity

Much has been written on fidelity in simulation. As previously discussed, this is a complex multi-dimensional construct. It became clear the anatomical fidelity was considered an important aspect of the cadaveric training. As with most of the themes there is a reciprocal relationship between fidelity and other themes. The following codes were identified: anatomical dissection, anatomical exploration, improved understanding, surgical anatomy and tissue fidelity. Trainee's highly valued to the opportunity to dissect anatomy. Many noted the gulf between 2D textbook images and the real patient anatomy: *P6 "how you get over that initial moving from 2D anatomy within a book, and reading steps, to actually understanding 3D anatomy. And I think it's hugely important that we make the most of our theatre time… "…The variation in anatomy, how you go hunting for anatomy in... Because it's not obvious. It doesn't look like it looks in a textbook."*

The anatomical fidelity was crucial for this purpose: P2 *"these are cadavers, so the anatomy, the variation, and so on, are just like real life."* The dissection aspect of the course appeared to meet a previously unmet learning need. P5 noted that anatomical dissections were a highly valuable exercise: P5 *"getting the opportunity to just do a bit more dissection and a bit more... Because a lot of us haven't done much dissection yet. Obviously, it's great having the fresh frozen cadavers, but I think there's probably quite a lot of surgical training to be gained from just doing small dissections."*

This observation may help clarify the role of cadaveric training in surgical education. Many educators are now questioning the role of anatomic dissection in the undergraduate curriculum [33]. With the development of 3D virtual modelling as well as pre-dissected cadaveric prosections, basic anatomical concepts could be taught to undergraduates as effectively by alternative methods [34]. Dissection may be better aligned with the learning objectives of surgeon and better serve postgraduate education [35]. Surgeons described gaining a more in-depth understanding of operative anatomy which cannot be obtained via textbook that can aid real world dissection decision making: *P2 "Because it then helps you with the anatomical decisions making, the decision process, just like how you would do or perform when you are operating"*

Deepening anatomical understanding may be one of main benefits specific to cadaveric dissection. It is here where the authenticity of the tissues and visual appearance that closely mimic real life are crucial. Patient safety is again a factor that helps elucidate how cadaveric training is unique. Trainees are afforded the opportunity to explore areas they otherwise would not venture- known colloquially as 'tiger country'. *P5 "I actually did that course, and I thought the best thing about it was the ability to dissect down onto the celiac trunk."* In the clinical environment much emphasis is placed on staying away from such structures. A classic example would be avoiding

the ureter during a procedure to remove a portion of colon (colectomy) or the common bile duct during removal of the gallbladder (damaging either is considered disastrous). In the cadaveric lab this is no longer factor allowing free exploration allowing trainees to obtain better spatial awareness and indicator of safe versus dangerous dissection: P8 *"I think dissecting of the ureter, for example, in an anterior resection. That might be very helpful. Because that is quite difficult to teach someone if they're not aware of where the ureter sits"* They go on to emphasise a point previously highlighted earlier of knowing limits and how far to "push it". In this way experimentation and anatomical fidelity are reciprocal and synergistic: P8 *" But if you've not ventured far enough and you've just been told to stay away, you don't really know how far you can really push it. So, I think if you know the anatomy well, and I think that's where cadaveric simulation comes into it because you get time to spend with something that's so close to a real patient, then you're more likely to become a better operator."*

A better appreciation of 3D anatomy specific to procedural steps is similarly cited: P5 *"…doing your Pringle manoeuvre and things like that, they're all 3D. You can't... It's very difficult to visualise just from a textbook how you actually do it, and where the spaces are."* P5 *"And especially things like HPB, where you're not necessarily able to see what your box can see when you're doing resection. It's quite useful actually having the time"* P6 *"So obviously when you're doing the operation you often can't see it because it's covered. When you do it on a cadaver you can take the time to expose it, to see how close you are, so you can consider how your manoeuvres help you avoid crucial structures, I guess."* Previous authors have struggled with the idea of reconciling the cadaveric training with the dominant theory used to explain mastery of performance- that of deliberate practice [36]. The value of simulation is often defined within these terms.

Deliberate practice attempts to explain superior performance via engaging in highly structured activities with the defined goal of task improvement. Deliberate practice is characterised by well-defined objectives, with focussed task repletion distributed in time with a means of measuring outcomes [37]. By this definition CADSIM does not meet these criteria. The benefits appear to be less tangible in this narrow quantitative sense. It would be unfeasible in reality to allow the serial repetitions required by deliberate practice- both in terms of cost and number of bodies. Does attending a single isolated course dramatically improve technical skill? Probably not. This was highlighted by P8 who felt cadaveric training was not necessarily as useful for advanced procedures regularly performed in clinical practice where repeated clinical exposure was key: P8 *"The thing with anterior resections, I think, is that you build your training in laparoscopic surgery and spatial awareness over a long period of time before you actually get to do an anterior resection… So, I don't know whether there is any value in using simulation there "*

Discussion

This research sought to elucidate the perceived benefits of attending cadaveric training as part of higher surgical

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training in general surgery. Furthermore, we sought to understand how this training may have been integrated with or influenced their subsequent clinical practice. Responders were extremely positive about the experience of cadaveric training. The qualitative approach of semi-structured data produced some useful rich data in relation to how and why the courses may have been beneficial. Safety and dedicated training time were highlighted as key differences to the clinical environment that helped shape a unique learning environment and pervade through the themes identified in this study. Many of the benefits of cadaveric training perceived by trainees are predicated on these two pre-requisites. The central findings of this study can be summarised as follows.

1. What were the benefits of cadaveric training?

It is likely the benefits of cadaveric training are not just linked to improving technical ability. The quantity and quality of feedback received was a key aspect. We know feedback is something not only highly valued but an essential aspect of effective learning. Faculty were perceived to be better trainers in this dedicated setting due primarily to being free from competing concerns relating to stress, patient safety and operating room logistics. Furthermore, the open forum in which to ask 'stupid questions' or gather group opinion on challenging scenarios was also deemed beneficial.

The experiential aspects of cadaveric training were also a commonly cited benefit. Experimentation with different approaches to current difficulties cast the cadaveric simulation lab as a problem-solving arena. Trainees described how they could try new techniques without the safety and time limitations imposed by the clinical environment. The haptic fidelity of human tissue was important to responders in gaining an insight into what dissection techniques were effective and safe. Multiple responders recounted how they attended with specific difficulties and were able to work out solutions. Permission to make mistakes represents an extension of this. The desire to deliver a perfect operation and anxieties pertaining to causing patients harm can be barriers to progression in surgical skill. Overly tentative dissection can cause a failure to progress and subsequent intervention from seniors. Cadaveric can represent a form of difficult learning that promote new understanding through trial and error.

Furthermore, it is likely that trainees can gain new experiences that would not be afforded to them in the clinical environment. This was especially evident with emergency procedures. The anatomical fidelity was rated as important in deepening the understanding of both specific procedures but especially surgical anatomy. Several responders recounted the disconnect between anatomical textbooks and the reality they face in theatre. The opportunity to perform dissection and explore areas usually 'off-limits' seemed to be important in re-conceptualising their 3D spatial awareness of human anatomy. Cadaveric training facilitated new understanding of operative steps understood conceptually.

The training met some important unmet needs within the current programme. Commonly cited was emergency procedures rarely performed within their usual job. This relative inexperience was a source of acute anxiety for several

responders particularly those nearing the end of their training and the prospect of becoming consultants with the extra responsibility that entails. The ability to get a practical sense of anatomy and mechanics of key operative manoeuvres was deemed to be of high value. In this arena cadaveric training is likely at its most useful as the fidelity of the simulator is of crucial importance. Cadavers represent the only modality where these rare high-pressure skills can be taught owing to the paucity of clinical opportunities.

2. How is cadaveric training being transferred into clinical practice?

Operative confidence in surgical trainees has been observed to be low [10,28]. The lack of operative experience is commonly cited as one of the central issues. One of the often-cited benefits of simulation training is improved confidence. Our subjective feedback reflects this trend with the majority of attendees agreeing/strongly agreeing with attendance on the course improved their perceived confidence. However, self-reported confidence can be misleading. One study noted that ultra-realistic simulations might result in overconfidence in student and over-estimation of their competence [38].

Confidence was a vital theme identified that potentially has subsequent implications for clinical practice. This corroborates what is commonly cited in the surgical simulation literature. While attending a one-off course is unlikely to result in tangible improvement in surgical skill improving confidence appears to have other multifaceted benefits. Confidence may change how trainees project themselves during subsequent interactions with trainers. Furthermore, cadaveric training was stated to promote shifts in perception. Success in the cadaveric setting instilled a degree of self-belief that enabled them to overcome previous limitations rather than seeking help. Cadavers were often viewed as bridge to practice either by providing a deepening understanding or a conceptual overview.

There were multiple instances of trainee taking away specific technique's or technical tips that they have subsequently utilised in the clinical environment. It would be difficult to extrapolate such reports beyond individuals. It was characteristic that different responders had differing learning objectives from the outset and were able to take away different aspects of utility. The perception that cadaveric training is of maximum benefit for senior trainees may be erroneous. The potential in surgical anatomical education was highlighted. Registrars early in their training would likely gain benefit from cadaveric dissection courses to aid with improving anatomical understanding. This may help narrow the gap between highly stylised textbook anatomy and real-world surgical anatomy.

Many described the training promoting new ways of thinking, a deeper appreciation of why things were done a certain way after discussion or experimentation. This may enable more flexible adaptive skills that allow trainees to better react to new or challenging operative situations. It was encouraging that senior trainees attending procedural courses had a subsequent clinical placement to utilise aspects of the training. As we know from motor skills acquisition

literature, skills can be subject to rapid decay with no outlet for practice [39]. It therefore likely that specific courses such as Trauma would require frequent renewal if the benefits were to be maintained.

Implications for CADSIM.

- Cadaveric training should likely be offered throughout higher surgical training resources permitting. The emphasis and learning objectives should be adjusted to reflect the differing learning objective of participants

- Outlet for subsequent application of skills is perceived as very important

- Simulation for rarely performed emergency procedures would benefit from annual/repeat sessions

- The benefits of cadaveric training likely extend beyond skill acquisition and relate to impact on trainee confidence and interactions with faculty

Conclusions

This is a small study so may have failed to capture all the main themes. While the sample size was concluded to be adequate there is a significant heterogeneity in the responders in terms of seniority, specialty interest, duration since attendance and the specific course attended. While we were able to ascertain general themes with respect to the study question, a stratified sampling to adequately represent different demographics may have enabled better comparison. Does the perception of cadaveric training change with time? Should course design be modified to meet evolving learning needs throughout the training programme? It is difficult to draw any conclusions from this data. Admittedly, this was not the intended focus and could be addressed in future work.

It would have been interesting to interview the faculty to ascertain their views on benefits of cadaveric training and compared to the trainees. Given the faculty are responsible for the design and implementation of these courses their perception of the trainee's learning needs is critically important. Incongruence in this area, particularly with respect to the aims and subsequent expected benefits may lead to courses not maximizing the resource. As previously stated, similar work with surgical trainers will be an interesting comparative study in the future. Further future evaluations should evaluate learners at different stages along with comparisons between specialties.

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Supplementary File

Appendix 1: Sample of questions for semi-structured interviews

- Can you tell me about your surgical background?

   o Potential prompting: What year of training are you?

   o What is your intended subspecialty?

- Which CADSIM course did you attend and when?

   o Have you previously engaged with simulated cadaveric training? If yes then what?

   o Have you used any other forms of simulation previously? Which?

- Prior to attending the course had you performed the simulated procedure on a live patient? Roughly how many times?

- What was your overall impression of the course?

- What was the most useful aspect and why?

- What was the least useful aspect and why?

- What challenges do you face currently face in acquiring operative competence?

- Did attending CADSIM improve your operative confidence and preparedness for theatre?

- Did participating in CADSIM influence your current operative technique or clinical practice? If it hasn't what factors prevented this transfer of learning?

- Did you have the opportunity to utilise any of the taught skills/ procedure in subsequent clinical placements?

- What are the benefits/drawbacks of cadaveric training over other simulation modalities they may have encountered?

- From your perspective what are the limitations of cadaveric simulation?

- Has your perceptions on cadaveric training changed since attending the course?

- When should cadaveric training be offered during the training programme and why?

- How could the courses be changed to better meet your learning needs?

Appendix 2: Sample transcript

#6

Speaker Key:

JO: Me

PC: #6

JO: Okay, hi. So I'll just state for the camera, I'm Jordan, and if you could just state your name and level of training?

PC: So xxxx ST5, Yorkshire deanery. My specialist interest is esophagogastric surgery.

JO: Okay. And which cad sim courses did you attend?

PC: So I've done the upper GI, mixed, or bariatric and hiatal work course, and the cadaveric HPB course as well.

JO: And roughly when did you attend those courses?

PC: Approximately two and four months ago. So both this year.

JO: So pretty recently, cool. Okay. And is this your first experience with cadaveric training?

PC: No.

JO: No? Which other courses have you previously attended?

PC: So as far back as 2012 I've been to cadaveric simulation training courses in the North West deanery, that were specifically

for core surgical trainees. And I think that's probably about it. I've got a little bit of experience delivering cadaveric hernia course as well that we've delivered in Sheffield.

JO: Okay. And okay, so Newcastle have... They have quite a well-established surgical training centre under [unclear], don't they?

PC: That's North East, we're North West, which is Manchester. Yes.

JO: Okay. And apart from cadaveric, have you experienced any other forms of surgical simulation?

PC: Yes. So obviously I've used a variety of different box trainers. I have a box trainer for laparoscopic skills. I've been to wet labs, we have a very good wet lab series in Sheffield still, and then I think I've used some of the simulators, electronic simulators, as well. Although I haven't got huge experience with those.

JO: Sorry, I lost you briefly for sound there, you'd got some experience with what? Just that last sentence.

PC: Just some experience with sort of electronic simulators, proper video game type simulators.

JO: Oh, the kind of virtual reality ones.

PC: That's right. So very limited.

JO: So you've had quite a wide range of experience with most of the techniques then. And prior to attending the courses had you performed any of the procedures that were simulated on live patients before?

PC: Yes. All of them.

JO: All of them? Okay.

PC: Sorry, all of the upper GI. So the bariatric ones and the hiatal work. And then I'd assisted on probably all of the HPB surgeries as well.

JO: Okay. So for the upper GI ones were you the kind of primary surgeon on those procedures or were you just doing elements of them? So say for a Nissens [?], were you doing it kind of skin-to-skin, or were you just doing elements?

PC: Yes. So a mixture. I've done a few, a couple, of Nissens, almost skin-to-skin, and a couple of bypasses skin-to-skin, but before that mostly just doing elements really. Yes.

JO: That's good. That's quite advanced for an SD5. Or have you previously done other work or are you just happened to get in a good run?

PC: Quite lucky to have some really good trainers throughout my time. I've done two years out doing research, so I guess I've done... Been around a little bit more than some of the other junior registrars. So I've done a little bit extra. But yes, probably it's more to do with your trainer, especially at that stage, whether you're actually the one doing the operating. Your trainer's often the one just telling you what to do, so yes.

JO: Yes. So what were your overall impressions of the courses you attended?

PC: So, excellent. Yes, brilliant. They're a really, really good education resource, I think.

JO: What would you consider the most useful aspects of attending?

PC: So I think it's the time to consider the anatomy and manoeuvres that you perform when you're doing an operation. And to consider how they're related to the other parts, or the relevant anatomy around there. That's probably the biggest advantage of cadaveric simulation I find.

JO: Okay.

PC: So to just give an example of that, you know, if you're doing a Nissens, being acutely aware of how close you are to the thoracic and abdominal aorta, and being able to visualise that when you're doing the operation. So obviously when you're doing the operation you often can't see it because it's covered. When you do it on a cadaver you can take the time to expose it, to see how close you are, so you can consider how your manoeuvres help you avoid crucial structures, I guess.

JO: Okay. So you're kind of delving into territory that you wouldn't ordinarily encounter in a normal operation because there's no safety concerns?

PC: Yes.

JO: And how about the overall structure of the course? Like I think where at least when I was running it, the Nissens course was largely all action. Is that something you favour or would you have preferred more kind of technical discussion?

PC: So that's a very good question. I think you probably... I probably get a little bit more out of it, with a bit more technical discussion. That being said, the opportunity to really just get your hands on with the cadavers, and actually improve your

technique and... I think is probably the most valuable thing. It makes probably having a bit more technical section to it, would perhaps help consolidate it a little bit more. But I guess it sort of depends on what job you're doing at that time.

JO: Yes. Are there certain things that you think cadaveric training provides that it isn't provided with other forms of training?

PC: Yes. Time and space to make mistakes, time and space to move things around in the way you wouldn't do normally.

JO: Okay. And what do you find are the kind of main challenges you face in gaining operative [?] competence in your kind of current job, or in the kind of current training programme as it stands?

PC: So consistency is always the biggest challenge. Consistency of trainer. Where I currently work we're not sure of operating at all, so we don't struggle for numbers, I don't struggle for theatre time. But with the frequency of on-calls, the on-call, how heavy the on-calls are, it can be difficult to get consistency of trainer/trainee relationship to make sure you really progress.

JO: Okay. How do you think...? Do you think these courses can help address some of that, or is that just something that can't really be...? It's just a kind of by-product of the job and something that can't really be avoided?

PC: So I think these courses can... They go a huge way to helping get people over the hump of understanding operations to start with. So they're really helpful in a lot of the basics. And then sometimes they're really helpful in really refining some of the more complex parts of operations, and the more complex anatomy as well. So I think they're hugely valuable, but they're most valuable when they tie into what you're currently doing.

JO: There's kind of two points that are interesting there. One, going back to one of the first points you made in regards to getting over the initial hump of operation, do you feel that these courses should be offered at a certain time in a kind of training programme, or training...

PC: Yes. So I've sort of got... We're actually... So I'm part of one of the upper GI... [Unclear] trainee group committee, and we're actually developing some courses looking at relatively early stage registrars doing complex resections, and how you get over that initial moving from 2D anatomy within a book, and reading steps, to actually understanding 3D anatomy. And I think it's hugely important that we make the most of our theatre time.

And so there's a lot of things you can learn out of theatre, but aren't well taught. So I think cadaveric simulation has a huge role to help in that, to really make the most of training opportunities once you get into theatre.

JO: So just to kind of... I don't want to put words in your mouth, but is that alluding to a means of kind of getting a better appreciation of, well, realistic anatomy?

PC: Yes, absolutely. Yes. The variation in anatomy, how you go hunting for anatomy in... Because it's not obvious. It doesn't look like it looks in a textbook.

JO: No. Do you think that that's one of the main benefits of cadaveric courses?

PC: Yes, absolutely. And if they tie in then it's hugely beneficial, I think, in training. Or it can be.

JO: And that kind of brings me onto, like, the second point, you're talking about tying in. Did you have an opportunity to utilise the skills you were taught in a real clinical environment, and if so, how?

PC: So no. But they've tied in with some of the experience I've already had, and I'm very... I'm a clear [sound slip] forward. And so it's been hugely helpful for me to consider... To be thinking about how they tie in, into how I want to do an operation. And how I want to do, for example, the Nissens, that kind of thing.

JO: And is that just due to the fact that you can experiment to some extent? Like there is margin for error. Did you find that you had the opportunity to experiment during the course.

PC: Yes, absolutely. So had the opportunity to... Just things as simple as stitching, to think about how you're going to do a stitch. How you might do it more easily. And have a go at redoing things, where you've struggled a little bit, and a few technical tips in... Often it's just a little manoeuvre to get you enough room to do a little, you know, to put the right stitch in.

Sometimes you can... When you're being told what to do, intraoperatively, you can follow instructions, but having the chance to think about it, both on the trainer's side, and the trainee's as well. When you've got that extra bit of time to sort of properly pause, before each step, I think that really helps with your understanding.

JO: And do you think that attending the course has impacted your confidence operatively in any way?

PC: I don't think so. I think there were probably specific things I'm happier with. So I've not done any higher training in HPB. I've helped on a few resections here and there, when they've been short. But I've not actually done an HPB job. We did some real basic liver mobilisation stuff, and that's certainly helped me and given me confidence about some of the basic liver mobilisation and how straightforward it is.

JO: Was that the kind of basic, you know, opening emergency course run by Mr xxx where they go through, like, kind of

Kocker's manoeuvre and liver mobilisation. I don't know if that...

PC: Yes, I don't think he... I think he calls it... He just calls it... It's just an HPB course, and... But he does all these sort of basic manoeuvres, how to do a Pringle's. He then talks about some liver trauma. It's exactly that. And it's given me quite, you know, not necessarily... Not had a chance to put it into action, but certainly given me more confidence around the liver. In how I'd access it better and mobilise it better.

JO: Yes. Because I guess that's, like, quite a few people do say that... One of the things I like is that a cadaver lets you do something maybe that you ordinarily we're not going to be doing liver packing, we're not going to be doing these things. Or if we are it's going to be once in a blue moon. So I guess it kind of... I guess from a confidence point of view it does help with procedures where you're not going to be performing them on a regular basis.

PC: Yes. Absolutely. Yes.

JO: How often do you think these courses should be offered to someone like yourself? Is this something that you're happy to go on once, and that's it, or do you think would you prefer it if they were offered on kind of an annual thing where you go along and do slightly different things each time? How do you think an optimal training programme should be designed?

PC: So I mean, there's... How often do I think we should be able to get to it, and then sort of an optimal training programme, is a slightly different question, I guess.

JO: Yes, the old multiple questions thing, sorry.

PC: Yes. I think realistically it would be good if you could attend more than... Each one more than [sound slip] some progression built into that. You know, if you're thinking about...

JO: Sorry, we just dropped out. Was that you should ideally... Can you just repeat that last bit?

PC: Yes, so I think ideally you'd be able to go on each course more than once throughout your six years, particularly the ones that were of specific interest and relevance to you. And so you can progress yourself. And also refresh as well. In an ideal world I think you'd have more formal cadaveric simulation programme that really built on specific skill sets and gradually built you up throughout the course of your training. But, you know, that's an entirely different...

JO: So you'd prefer it if it was more kind of went from... I mean, go from absolute basics at core training, and then you just gradually go on more and more advanced courses as you progress?

PC: Yes. And I think broadly we try and do that in Yorkshire. And I think that's what Mr xxxxx idea is with a lot of his wet labs and cadaveric stuff. I think that is kind of built into it.

JO: Yes, I think there's a difficulty in getting people to attend. I think that's the only... I think when you try to, when you specify, I think they've tried to specify certain people who they think would derive most benefit from it, based on specialist interest and level of seniority. But then obviously the rota gets in the way, so certain people can't attend, and then we have situations where only three people turn up to a course, which is a bit of a shame.

PC: Yes, absolutely. When you look at the cost of these courses as well. And if you were to do a course elsewhere, it's an unbelievable shame that people don't make the effort or can't go. Whichever of those it is.

JO: Are there any...? I mean, what were the least useful aspects of the training?

PC: So I think there's always... Well there was nothing that was particularly stands out as being completely useless. There are always small things in terms of setup and wasted time during the day that could be better. But I really can't think of anything that was particularly useless. You know, they were all appropriate procedures, for sort of my level of training, and there was nothing...

You know, even if it was something I'd done before, it was... There were always things that were useful. So I can't particularly...

JO: How does cadaveric training compare to, say, other training modalities, simulation modalities, you've used? So in comparison to, say, virtual reality, the kind of more bench-top models, animal tissue?

PC: So I think, you know, cadavers give you the appreciation of the whole operation, and ergonomics of an operation. And all the steps required to do an operation. All the other things you've mentioned, you know, even the virtual reality simulators, I've not had massive experience with them, but I think they're very much, the ones I've been on, which are a bit old now, but they're all really limited.

I think you tend to find ways of almost cheating the system with virtual reality simulators.

JO: That's interesting. So you're actually learning to kind of perform the virtual task rather than having...

PC: Yes.

JO: You don't think it necessarily transfers into the real environment?

PC: No. Absolutely not. And the movements, some of the movements on the ones I've been on, the movements aren't right. So the laparoscopic stuff, just the fine movements aren't quite right. The tension's not right. The manoeuvres to improve, they're all just a little bit off. And they don't really... They're good for understanding the broad steps of an operation, but not necessarily the feel and the touch that's required to perform an operation.

Wet lab stuff, I think, has a really good role for specific steps. So it's brilliant for anastomoses. You know, it's really good for doing a variety of different techniques and improving your technique, improving your speed. But again, [sound slip] ergonomically it's so different to doing an actual operation.

JO: So just kind of distilling that, it's really the realism, but also the kind of operative flow that's the main advantages in your eye?

PC: Yes, I think so. Yes.

JO: And it sounds as though having had previous cadaveric experience your perception wouldn't have changed. Do you think there are any barriers to offering more cadaveric simulation, in your opinion?

PC: Money.

JO: Yes. That's always there. Well, the advantage, to be fair, the advantage of the Thiels is because they can be reused, there's a moment of... They are quite cost-effective. So you know, if you centralised... I mean, would you be prepared to, say, have your kind of study budget reduced, but you're, say, offered three courses a year, would that be something you'd...?

Would you prefer to have the kind of autonomy to just select, I want to go on this course, and have the deanery pay for it, or would you rather have it so that the deanery offers more courses but you don't have choice, let's say?

PC: So, I mean, our study budget is cut, so, to run all these courses. So I'm probably happy that it's cut to run the courses. I think they're very good value for money. In terms of, you know, I've been on a couple this year, and I would have been on a third if it hadn't been cancelled at fairly short notice. And you'd never have got three cadaveric courses were in a [sound slip] sort of local training. At all.

So I'm probably overall very happy for them to use part of the study budget for that specifically. Whether or not I'm happy every year, I guess, is a different question. But it's been appropriate for me now.

JOIs there anything that could be done to maximise how this training can be kind of transferred back into your clinical practice? Is there anything that could be altered to make it of more value to you?

PC: Yes, so I think the course materials could be, you know, they were sort of... One we were sent out PDFs on the day, for one of them. For the OG one. I've not had anything for the HPB one

JO: Was that the blue book, for the OG? For the upper GI one?

PC: It was just a PDF. Just sent us an email as a PDF. So we've not actually... Didn't get any course materials on the day for either of them.

JO: Okay.

PC: And I think if they'd been gone out beforehand, not everyone looked at them, but some people do. They're there as an aid memoire. You know, you look at any model of long term learning, you need to be able to have another look. Particularly if, like me, you're not currently doing NHPB or an OG job.

JO: So it's more just kind of about the logistics? Did you read the book afterwards?

PC: The OG one I did, yes.

JO: Any good?

PC: Yes, it was all right.

JO: Right. Have you got any kind of final thoughts about cadaveric training in general and how it can kind of influence your practice? Or any suggestions?

PC: No, nothing in particular, I don't think. Nothing that springs to mind.

JO: Are there any particular limitations to cadaveric training in your eyes? Is there anything that it can't really do or it shouldn't attempt to do?

PC: Yes, I think it's almost limited by the safety net it offers. So the cadavers don't bleed, and they don't die if you fuck up. Excuse my language on your recording, sorry about that.

JO: It's all right, we can cut it out.

PC: But that's a big deal. You know, when you're doing a major operation, an operation's easy if you're not dealing with the consequences of it. Of it going wrong. So you can make bold cuts, you can make bold incisions, you can put big stitches in. All these things are easier if you're not dealing with the consequences. So while cadaveric work is always good, it never really replicates the importance of getting it right, and it never really replicates quite, you know, the same confidence you get from operating on people.

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JO: [Overtalking] isn't it? Because on one hand... No, no, no, I meant with the cadavers, because it's like on one hand the lack of danger leads to experimentation, which is good for the maybe early stage training, but ultimately it's going to be a poor substitute, so maybe should just be seen as a continuum.

So you go from... There's seems to be maybe an ideal when you're just starting to learn the procedure, and then once you're kind of doing it in real people, then maybe cadaveric training's served its purpose.

PC: Sometimes. Though sometimes it's good to refine your techniques. You know, it's good if you're trying to... If you're wanting to have a look at how something works slightly differently, or if you just want to... You want to just maybe alter your techniques slightly. I think there is definitely a role, when you already know an operation, because you also then understand the cadaver better.

JO: One, to experiment [sound slip] different ways of doing...?

PC: Yes, experiment a little bit. But it's most useful, or it's most useful when you're first learning a technique. Definitely.

JO: Okay. I think that's probably covered everything. Any final thoughts or...?

PC: No.

JO: No? Well thanks as lot for agreeing to be interviewed, I'll...

PC: Yes, no worries, Jordan.

JO: Cheers, I'll stop recording.

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