Review Article

Ophthalmic surgery teaching

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Abstract: The outcomes of modern ophthalmic surgery, especially cataract surgery, continue to improve and patients now realistically expect an excellent and speedy outcome with good vision and few complications. Social and regulatory demands for greater transparency and accountability in medicine have increased, highlighting a fundamental ethical tension in medical education—balancing the needs of trainees (who have not yet mastered the technique) to gain experience by performing surgery, with patient safety and the needs of the public to be protected from risk. Patient safety and well-being are the paramount considerations in any training program and must be the first consideration in program design. A variety of different educational strategies, each implemented with the aim of improving operative skills assessment and teaching, has recently been described in the literature. Effective use of these educational tools, combined with a structured approach to teaching and providing meaningful feedback, could improve outcomes, decrease complications and improve the quality and efficiency of surgical training in ophthalmology. Supervisors must assess their teaching style and communication, as being a good surgeon does not necessarily make a good trainer. Open disclosure must be given to patients about who will be performing the surgery, and communication during surgery between supervisors and trainees must be clear, respectful and appropriate.

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Introduction

Technological and surgical developments within ophthalmology have resulted in constantly changing competencies demanded of trainee surgeons (1). More broadly, there are significant educational challenges teaching surgery on live patients including ethical concerns; the nature of ophthalmic microsurgery and the operating suite environment; and dealing with complications. As such, a surgical training program must provide a balance between the need for trainees to gain surgical competency whilst simultaneously ensuring patient safety and well-being. Within the context of the trainee surgeon, understanding general principles of surgery and developing insights into how best to advance their skills, knowledge and professional behaviour as well as refining a team-based approach to work within theatre is essential to the progression through the stages of expertise. This review discusses these challenges from the perspective of both the supervising and trainee surgeon.

Understanding adult learning

Ophthalmology trainees are adults with postgraduate experience and accordingly can be expected to be both independent and self-directing (2). It would be remiss however to suggest that training will proceed without any issues or at consistent rates across students. The goal of

Table 1 Levels of expertise and stages of learning

Stage of learning	Characteristics
Novice	Rigid adherence to taught rules or plans
	Little situation perception
	No discretionary judgement
Advanced beginner	Guidelines for action based on attributes or aspects
	Situational perception still limited
	All attributes and aspects treated separately and given equal importance
Competent	Sees action at least partly in terms of longer term goals
	Conscious and deliberate planning
	Standardized and routine procedures
Proficient	Sees situations holistically rather than in terms of aspects
	Sees what is most important in a given situation
	Perceives deviations from the normal pattern
	Decision-making less labored
Expert	No longer relies on rules or guidelines
	Intuitive grasp of situations based on deep tacit understandings
	Analytical approach only used in novel situations or when problems occur
	Vision of what is possible

Modified with permission from: Roberts TV, Gustavs J, Mack HG. Becoming an expert: a review of adult learning theory and implications for vocational training in ophthalmology. Clin Exp Ophthalmol 2012;40:519-26.

training ophthalmic surgery is to provide a strong platform of technical skills concurrent with a broader awareness of the dynamic nature of the procedure and the operating theatre environment. A basic understanding of adult learning theory may prepare surgeons more appropriately with how to think about their interaction with trainees and how to develop the optimal pathway towards competency within ophthalmic surgery (2). Adults learn in four ways: through immediate concrete experience (affective mode); through observation and reflection (perceptual mode); through abstract conceptualisation (thinking mode); and through active experimentation (behavioural mode) (3). Learning styles will differ between individuals and may reflect personality and level of experience or understanding (4). Any program should ideally be flexible enough to recognise the variability this involves and provide support based on actual level of both expertise and understanding. Individual trainees progress through stages from 'novice' to 'expert' at different speeds and will exhibit different attributes and insight depending on the stage. Trainees at the earlier stages are typified by 'rule governed behaviour' where they need a detailed plan to know how to continue as they are dealing with unfamiliar contexts and problems, whereas more experienced trainees have a broader understanding of a clinical situation and can make more intuitive, holistic decisions (5) (*Table 1*).

In the novice stage, the surgeon performs the critical portions of the operation and explains each step to the trainee. As the trainee becomes more experienced, they are actively guided through the critical portions of the procedure until they are able to perform these parts independently with the surgeon only needing to provide passive skilled assistance, intervening only when necessary. At the most advanced level, the trainee performs the operation independently with the surgeon present only to guarantee patient safety (6). Support should be gradually removed based on actual level of performance rather than through minimum procedure counts allowing progression

of independence.

Surgical training

Surgical competence is a fundamental component of teaching programs and an increasing number of papers have addressed the validity of training and assessment, particularly the benefits of wet-lab experience and simulation-based teaching in enabling trainees to develop surgical knowledge and attitudes and learn and practice surgical skills prior to performing any new surgical procedure (1,7,8). The level of disclosure, informed consent and degree of consultant supervision are more complex when a trainee, who has not yet mastered the technique, performs a procedure. Whilst most teaching occurs during live surgery, other teaching tools are valuable and should be used prior to live surgery (7).

There is no perfect training system at this time (9). The evolution in surgical education highlights the many difficulties and frustrations of the traditional model for teaching. The majority of microsurgical procedures involve one operating surgeon and one assistant surgeon ("driver-passenger" model). Trainees operating on live patients require close supervision by an experienced ophthalmic surgeon and trainer. Typically, a junior trainee commences by performing part of a procedure, with responsibility and independence gradually increasing as the trainee gains confidence and surgical competence.

A limitation from a teaching perspective is that the supervising surgeon cannot physically help and guide the hand of the trainee, for example during creation of the capsulotomy, the trainee is either observing or performing the capsulotomy. There is a limit to 'skill acquisition' gained by simply observing, and errors occurring in the earlier stage of surgery (e.g., wound construction, capsulotomy) lead to complications or difficulty with other parts of procedure downstream. Even a small mistake in judgement or technique may result in sequential adverse outcomes ("it only gets worse") with a greater risk of increasing complications when a trainee performs the surgery (10). This is amplified in trainees who may still lack the ability to anticipate the increased surgical complication risk during the procedure itself (11). Rather than starting a trainee at the beginning of a case, it can be safer and more confidence building to introduce the trainee to surgery at the end of the case. For example, during cataract surgery the trainee can gain confidence in intraocular manipulation performing irrigation-aspiration after the surgeon has already implanted the intraocular lens.

Studies have shown that the rate of complications is related to surgeon experience (12). Most trainees are likely to reach the minimum number of cataract procedures required by the training program, however, the experience and confidence levels in dealing with complex cataract surgery and complications may be limited (13). Whilst safety for the patient is of upmost importance, appropriate exposure to management of complications that do occur during surgery is also required. This must be weighed with the experience of the trainee, as complex cases with difficult to manage complications should not be expected to be managed by a trainee early in their surgical career. By the same token, not having experience managing complex situations could lead to gaps in practical surgical experience, leaving trainees underprepared to deal with situations in the future. Balancing this surgical training and patient safety for surgery is difficult and emphasis on safe outcomes for the patient should be expected. The use of simulation or virtual reality based training methods may ameliorate this concern, however, this remains a possible shortcoming of existing traditional training programs. Patients should be informed prior to surgery at the time of consent that their surgery will be performed by a trainee. This may include a discussion about the varying levels of trainees as well as how this may change the extent that the trainee participates in the procedure.

Ophthalmic surgical procedures, especially cataract surgery, can have a rapid turnover between cases, limiting discussion opportunities during and after surgery. This places an additional responsibility on the supervisor to communicate effectively. This remains a significant skill in itself and will impact the training process. Establishing competency in the supervising surgeon's ability to teach can be improved by having a relevant framework for teaching supervising surgeons (7). This in turn standardises early teaching methods for introducing trainees to phacoemulsification surgery, and improve the ability of surgeons to pass down their clinical knowledge and competency to junior staff more effectively. This may also have the added benefit of directly increasing patient safety, by ensuring that safe early surgical techniques and considerations are taught in a consistent manner across surgical networks as well as between supervising surgeons.

Defining outcomes and competencies

There are significant differences in the length and structure

Table 2 First-year wet lab outcome goals

To demonstrate fine motor and proprioception skills while operating under the microscope
To demonstrate proficiency in working in a small surgical field as both a surgeon and assistant using the microscope
To list the differences in phacoemulsification machines and the settings for each machine
To describe the pedal settings on a phacoemulsification machine and demonstrate the use of the pedal for the microscope
To list the various types of ophthalmic sutures and needles
To demonstrate ability to pass corneal, scleral, and simulated conjunctival or skin sutures for closure
To demonstrate performance of adequate corneal, scleral and skin incisions for cataract, glaucoma or plastic surgeries using a cadaver or animal eye

of fellowship training and the minimum number of surgical procedures undertaken during ophthalmic training (14). Although this will be guided by variations in healthcare delivery systems and the different needs of the respective populations, it suggests a need to further review individual training systems.

Under the traditional apprenticeship model of surgical training, "see one, do one, teach one" has been the principle applied in passing down operative techniques from one generation to the next. Generationally, most of the surgeons now in training roles were taught in this way, and in turn expect trainees to develop similarly by accepting increased responsibility as they progress through their years of training. Traditionally, trainees were expected to perform a minimum number of procedures under supervision, with experience and volume of surgery considered a surrogate for competence. A weakness of this system is that experience per se does not necessarily reflect competence and skills. Assessment tools and defined curricula and outcomes have been developed to better allow the supervising surgeon to objectively assess the trainee's competence in performing a specific procedure (15,16). This allows surgical training to be individualised for the trainee's stage of training, guiding the trainee toward benchmarks of patient care and surgical skills, and other core competencies (17). Ideally, curricula can be adapted and remain flexible enough to provide a comprehensive and optimal surgical teaching experience (7). For example, the ICO Ophthalmology Surgical Competency Assessment Rubrics (ICO-OSCARs) are standardised, validated behavioural and skill-based rubrics which are available on-line in multiple languages and free of charge (18). Trainees can also use these rubrics as a tool to better gauge their own performance. A structured surgical curriculum allows the supervising surgeon to guide the trainee regarding what specific technique to focus on and master during their current surgical term (e.g., draping, corneal incisions, phacoemulsification sculpting) and decreases the rate of complications such as posterior capsular tear and vitreous loss (19,20). Once competency has been achieved, the trainee then moves on to the next skill. It is important to identify trainees who are struggling to achieve basic skills, as this can lead to a vicious circle with surgeons less inclined to allow them to participate in surgery, further exacerbating their lack of confidence and skills. It is helpful to outline the teaching plan for the term and how feedback will be given, so both trainer and trainee have the same expectations (21) (*Table 2*). It is worth noting that the use of a structured assessment of technical skills is not seen as a universal requirement for training, particularly within cataract surgery. Previously almost two-thirds (63%) of respondents did not believe the use of an assessment tool would improve the outcome of surgical training with less than one-third considering the use of these tools (22).

Non-technical skill development: importance of cognitive experience

The role of cognitive skills such as situation awareness, task management and decision-making are crucial in a trainee's development. Although many assessment tools focus primarily on technical skills, the mark of a proficient surgeon includes not only mastery of the technical elements but also an ease and efficiency of movement and a situational awareness that promotes the efficiency of the entire surgical team. Many complications are due to poor-decision making, rather than a lack of technical skills, and these need to be taught and assessed in parallel with the technical aspect of surgery (11). Many trainees are overwhelmed by having to master both cognitive and physical aspects of surgery, and cognitive teaching is often best done in a tutorial setting or

Table 3 What if …? Examples of situation awareness and decision making scenarios

Unstable zonules
Vitreous loss
Wound leak
Capsular tear
Iris prolapse
Dropped nucleus
Corneal burn

wet-lab. For example, potential problems arising from a small capsulotomy may not be considered by the trainee during surgery if they are solely focused on successfully completing an intact capsulotomy. "What if…?" tutorials present different clinical scenarios which require the trainee to think through his or her response, which in turn helps develop situational awareness and decision-making surgical acumen (*Table 3*).

Preoperative discussion and planning

Meeting with trainees before surgery to discuss the operating list, understand their level of experience, clearly identify learning objectives and expectations, and how you will communicate together during surgery (especially if the patient is awake), has been shown to greatly improve the intraoperative learning experience for surgical trainees, improve communication styles between surgeon and trainee, and decrease idle and unstructured conversation (23).

The introduction of a preoperative risk stratification system based on standard preoperative patient parameters would appear to reduce the rate of intraoperative complications and remains a further option for training schemes albeit this is likely covered informally in many cases (24). An additional use for a stratification system is the potential to allocate surgical cases more appropriate to trainee experience. This may be limited however by the flexibility and availability of trainee programs.

A postoperative debrief to review the case, preferably on the day of surgery but definitely within one week, helps provide the trainee with immediate feedback, which in turn helps guide their learning process (25). Identifying learning objectives and expectations (of both trainee and surgeon) is important as trainees may become frustrated if they believe they are capable of performing more parts of the procedure but are not allowed to. This requires careful management, particularly with more junior trainees, as they have less insight into their surgical skills and competence (26).

Communication

A team meeting prior to surgery with all surgical, nursing and anaesthetic staff discussing the list has been shown to improve safety and quality of care (27). Each surgeon has their own personality and style of communicating with trainees and others in the operating theatre, and this often becomes subconscious after many years of practice. The terminology used between surgeons may also differ, leading to intraoperative confusion about what certain terminology may mean. Structured and well-established terminology for the movement of instruments in the eye, pedal positions as well as microscope adjustments should be established prior to operating with new trainees to lessen the confusion that may arise during surgery. Additionally, ensuring that patients are well informed prior to surgery that there will be communication between the surgeon and the trainee may also help reduce concerns or anxieties that the patient may have during the procedure.

Trainees may disagree with teachers with respect to the frequency that intraoperative feedback is required (28). It is important, therefore, to think about how feedback and guidance is given during live surgery, as both positive feedback and negative feedback have a significant impact on trainees (29,30). Comments may be considered tough, but fair, by the consultant, but can be seen as unjustified, undermining and bullying by the trainee. Positive feedback helps learning and increases the motivation and performance of surgical trainees, whereas negative feedback can have a detrimental effect on a trainees' performance and well-being. Feedback is best done directly one-on-one with the trainee during or immediately after the case (31). This initial conversation should be followed up during the next week in the clinic or before the next list, often with an assessment tool to help provide formative feedback and documentation. The use of video assessment, if available, represents a further opportunity for quantifiable discussion. Many ophthalmic procedures are now performed under assisted local anaesthesia with the patient sedated but awake during surgery. Unlike surgery under general anaesthesia, the awake patient is more aware of their environment, what is occurring, and any conversations, particularly those between the surgeon and trainee and any others in the operating theatre (32). This raises challenges, especially in balancing commitments to

Table 4 Suggested strategies in developing ophthalmology teaching programs

Investigate 'best practice' programs
Formalise 1st year program
Improve on historical, but *ad hoc*, approach
Emphasise importance of cognitive skill development
Web-based tutorials
College certification of wet-lab competency
Pre-empt Medical Board legislation mandating compulsory wet-lab training

teaching with our duty to reassure and comfort the patient (7). The development of deliberate communication habits whether during the procedure or following is essential.

Conclusions

There remains no perfect training system for trainee ophthalmologists undertaking surgery (*Table 4*). A combination of lectures, wet-lab and simulation training can optimise the technical and surgical skills prior to surgery; however, there remains no replacement for undertaking the surgery process itself. The use of assessment tools or criteria can support the progression of the surgeon from novice to expert; however, constructive feedback either during or after surgery will strengthen the learning experience. Supervisors must continue to critically assess their teaching style and communication, as being a good surgeon does not necessarily make a good trainer. Patient safety and well-being are the paramount considerations in any training program and must be the first consideration in program design. Open disclosure to patients about who will be performing the surgery and clear and appropriate communication during surgery are key factors.

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Footnote

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