CASE REPORT

Vitreous loss fire drills – ophthalmic simulation improves trainee surgical competence and confidence with posterior capsule rupture scenarios

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Ophthalmic trainees have reported limited exposure and low confidence regarding the management of cataract complications such as posterior capsule rupture (PCR) / vitreous loss (VL). This report evaluates the impact of a simulation-based educational training event on these concerns.

Introduction

Ophthalmic simulation training has been shown to result in safer cataract surgery outcomes, with demonstratable lower rates of posterior capsule rupture / vitreous loss (PCR / VL) for junior trainees [1]. Familiarity with surgical steps through repetitive simulation practice enables trainees to be competent in the operating theatre, and so ensures confidence [2]. While these concepts have been demonstrated with trainees performing routine surgical tasks in cataract surgery, they have not been explored with the management of surgical complications.

Clinical governance studies have identified low PCR / VL rates as an indicator of surgical competence, although this metric requires risk stratification adjustment if it is to be applied fairly and in context. Modern cataract surgery techniques have a low incidence of PCR / VL, often quoted as 1.92%, with a higher rate in specialty registrars compared to consultants (adjusted odds ratio 1.6) [3,4]. In a national trainee survey in 2021, only 50% of senior trainee ophthalmic registrars (ST6 and above) felt confident with managing PCR independently without senior support [5]. Furthermore, management of PCR / VL can require specific surgical skills and techniques which are not commonly used in routine cataract surgery, such as familiarity with 3-piece IOL usage or corneal wound suturing [6]. Lacking experience and exposure to these techniques can further contribute to low levels of competence and confidence amongst trainees. This is a patient safety issue, with a modern generation of ophthalmic trainees potentially having a gap in their knowledge and experience as they approach completion of ophthalmic surgical training.

To address this, we wished to evaluate the impact of a simulation-based 'vitreous loss fire drill' educational event on these concerns.

Methods

A mandatory educational vitreous loss fire drill was arranged for ophthalmic trainees in the West of Scotland region, including a pre-course knowledge transfer video and four practical simulation stations, including performing an anterior vitrectomy in a model eye, loading and inserting a 3-piece IOL, corneal cataract wound suturing, and communication skills training and debriefing. A pre- and post-course questionnaire of self-reported competence and confidence related to these tasks was undertaken (Likert scale 1-10 / see Figure 1). Junior registrars were defined as ST1-ST3 and senior registrars as ST4 and above. Statistical analysis was performed, and significance was determined using the Wilcoxon signed ranks test. The Scientific Officer for the West of Scotland Research Ethics Service confirmed that NHS ethical review was not required as it was a training exercise within the participants' professional role.

Results

Twenty-eight ophthalmic trainees participated in October 2022 (mean age 30 years (range 26-36); 15 male and 13 female). There were 14 junior trainees (four ST1, six ST2, four ST3) and 14 senior trainees (seven ST4, four ST5, one ST6, two ST7). All trainees completed the pre- and post-course questionnaire. Before participating in the PCR / VL fire drill, all trainees self-reported greater confidence and competence with corneal cataract wound suturing compared to anterior vitrectomy and 3-piece IOL usage. All junior trainees (ST1-3) self-reported low scores (<6) in confidence and competence in all the pre-course questions.

All participants reported significant improvements in competence and confidence following the PCR / VL fire drill training. Competence for technical skills was reported to have improved (with anterior vitrectomy techniques increasing from a median of 2 pre-course to 7 post-course ($p<0.00001$); with 3-piece IOL insertion techniques (median 3 to 7; $p<0.00001$) and with corneal cataract wound suturing (median 5 to 7; $p<0.00001$)).

Confidence levels were also reported to improve for all trainees following the educational session, including with performing anterior vitrectomy (from a median of 4.5 pre-course to 8 post-course; $p<0.00001$); 3-piece IOL techniques (3.5 to 8; $p<0.00001$) and corneal wound suturing (6 to 8; $p<0.00001$) (see Figure 2).

Subgroup analysis revealed that junior trainees reported greater mean improvements compared to senior trainees. These differences were statistically significant for competence with 3-piece IOL insertion techniques (4.4 for juniors vs. 2.7 for seniors ($p=0.02$)) and with corneal cataract wound suturing (2.62 juniors vs. 1.14 seniors ($p=0.03$)), but not for self-reported improvements in competence with anterior vitrectomy techniques (mean 4.1

Figure 1: Participant pre and post survey questions for vitreous loss fire drill simulation training.

	Question	Response
1	What is your age?	Free text
2	What is your current stage of training?	Free text
3	What is your gender?	Free text
	Pre Course	**Likert scale 1-10**
4	How confident are you in steps needed to undertake during anterior vitrectomy?	1 – "not confident at all"; 10 – "very confident"
5	How competent do you feel at performing an anterior vitrectomy?	1 – "not confident at all"; 10 – "can perform independently"
6	How confident are you with knowing when to insert a 3-piece IOL and the steps required?	1 – "not confident at all" 10 – "very confident";
7	How competent do you feel with inserting a 3-piece IOL?	1 – "not confident at all"; 10 – "can perform independently"
8	How confident are you with knowing how to suture a corneal wound?	1 – "not confident at all"; 10 – "very confident"
9	How competent are you at suturing a corneal wound?	1 – "not confident at all" 10 – "can perform independently";
	Post Course	
10	How confident are you in steps needed to undertake during anterior vitrectomy?	1 – "not confident at all"; 10 – "very confident"
11	How competent do you feel at performing an anterior vitrectomy?	1 – - "not confident at all"; 10 – "can perform independently"
12	How confident are you with knowing when to insert a 3-piece IOL and the steps required?	1 – "not confident at all"; 10 – "very confident"
13	How competent do you feel with inserting a 3-piece IOL?	1 – "not confident at all" 10 – "can perform independently";
14	How confident are you with knowing how to suture a corneal wound?	1 – "not confident at all"; 10 – "very confident"
15	How competent are you at suturing a corneal wound?	1 – "not confident at all"; 10 – "can perform independently"

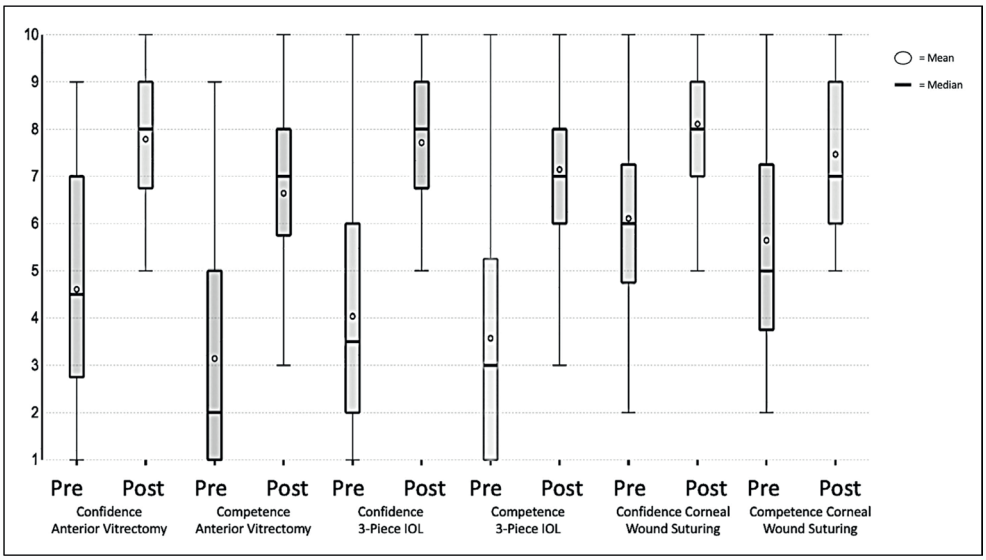
juniors vs. 3.1 seniors (p=0.13)). The mean improvements in all confidence scores were all statistically significant for juniors compared to seniors (anterior vitrectomy techniques – 3.9 juniors vs. 2.5 seniors (p=0.003); 3-piece IOL insertion techniques – 4.7 juniors vs. 2.7 seniors (p=0.008); and with corneal cataract wound suturing – 2.8 juniors vs. 1.2 seniors (p=0.01)).

Discussion

The purpose of a fire drill is to ensure familiarity with emergency procedures to increase the likelihood of a safer outcome from a high-risk situation. In modern cataract surgery, dealing with the uncommon but predictable complication of PCR / VL effectively should still result in a good visual outcome. To achieve this, PCR / VL needs to be correctly managed with the appropriate equipment available, as inappropriate surgical manoeuvres increases the risk of further consequences such as endophthalmitis (x8) and retinal detachment (x42) [4]. For this reason, having an 'AntVitKit' readily available should mean minimal delay or confusion regarding the location of an anterior vitrector, triamcinolone, acetylcholine and a 10-0 suture to address PCR / VL competently [7].

We have shown that a PCR / VL fire drill educational simulation-based event improves trainee surgical competence and confidence in these expected surgical tasks, and so reduced concerns through providing a knowledge base and relevant technical experience. Greater improvements in competence and confidence were reported for the less-commonly experienced tasks of insertion of 3-piece IOLs and anterior vitrectomy techniques, however these metrics also increased with corneal wound suturing. This was likely due to greater familiarity with corneal suturing amongst participants,

Figure 2 (below): Box and Whisker Graph showing confidence and competence scores for all trainees before and after the vitreous loss fire drill simulation training.



a skill which is taught on the basic micro-surgical skills courses undertaken by first year ophthalmic trainees.

It was encouraging to note that greater competence in all these surgical tasks was matched by increased confidence following this half-day educational session. Such simulation-based activities enable the development of essential skills required by the ophthalmic surgeon and could be expanded for other intra-operative surgical complications. Such events should not be limited to trainees, or run on an ad-hoc basis, but could be part of mandatory training in the future, as simulation enables safer skill transfer without any harm to patients at the point of learning [8-10]. Engaging with regular cataract complication simulation training should ensure competence and maintain confidence in the management of PCR / VL.

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