Cost-effective and adaptable cataract surgery simulation with basic technology

Dr Simerdip Kaur, Miss Amy-Lee Shirodkar, Mr Mayank A. Nanavaty, Mr Michael Austin.

Introduction

Regular and repetitive surgical simulation plays a vital role in cataract surgery microsurgical skills training. Nevertheless, despite the great strides in advancing the quality of simulation modalities, barriers still exist which include trainee motivation, practicality of undertaking the simulation training, constraints on protected learning time and the lack of a simulation training culture[1]. To remove these barriers, one method would be to use high-fidelity, low-technology and low-cost microsurgical simulation techniques for cataract surgery that are easily reproducible and accessible to all trainees and trainers. To date, whilst several such techniques have been described, very few have been validated. Recognising this deficiency and the potential benefits of such a training tool, we designed a cost-effective and easily adaptable cataract surgery simulation technique video using basic technology. We subsequently carried out a subjective validation study to primarily assess its face and content validity as well as perceptions of microsurgery simulation training in Ophthalmology.

Method

We devised and filmed a range of simulation techniques that mimic steps of phacoemulsification cataract surgery using various 'everyday' basic materials. This includes 5 grapes, 1 small cheese disc, a packet of 12 lozenges and instant jelly mix, which in our example totalled approximately £1.50. Additional equipment required are an operating microscope, phacoemulsification machine for irrigation and aspiration and disposable surgical instruments. This video was combined in a 'parallel' fashion with live cataract surgery so that all steps of surgery were simulated. Subsequently, we distributed an online subjective validation questionnaire on Google Forms with the embedded simulation video in a generic invitation that was forwarded via email and/or text messages/WhatsApp messenger amongst Ophthalmologists of all grades within our regions (Kent, Surrey & Sussex, London and Wales Postgraduate Deaneries).

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Correspondence
Mr Mayank A. Nanavaty, MBBS, DO, FRCOphth, PhD
Sussex Eye Hospital, Brighton & Sussex University Hospitals NHS Trust, Eastern Road, Brighton, BN2 5BF.
Telephone number: 01273 606126
Email address: mayank.nanavaty@nhs.net

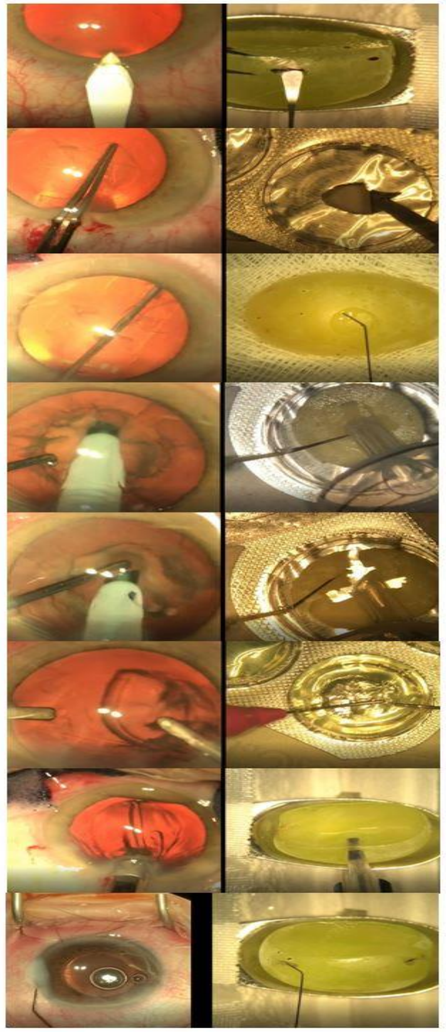


Figure 1a. Incision practice on grape

Figure 1b. Capsulorhexis on aluminium foil of lozenge packet

Figure 1c. Hydrodissection practice on grape

Figure 1d. Nucleus sculpting practice on cheese disc within lozenge packet

Figure 1e. Nucleus cracking practice on cheese disc within lozenge packet

Figure 1f. Bimanual irrigation/aspiration practice on jelly-filled lozenge packet

Figure 1g.Viscoelastic & IOL insertion practice on grape using wick dyed in iodine

Figure 1h. Corneal wound hydration practice on grape

Figure 1. Various steps of cost-effective and adaptive phacoemulsification technique using basic technology

Results

Face validity: Sixty-six (99%) participants agreed that the explanations in the video were clear and 53 (79%) concurred with the realistic feel of simulated technique. Instrumentation and adaptations demonstrated were deemed user friendly and conducive to replicate by 99% participants.

Content validity: Sixty (90%) of participants agreed the techniques described in the video reflected the technical skills required to train cataract surgeons. Forty-nine (74%) agreed that the simulation techniques were relevant for acquiring other generic and transferable microsurgical and manual dexterity skills.

61 (91%) participants agreed that simulation training is a mandatory requirement part of the OST curriculum. 59 (89%) participants agreed that the frequency of simulation training should occur at least 30 minutes once a week, using real instruments and an operating microscope. 55 (83%) participants felt the approach taken in the video could be extended to simulate other aspects of cataract surgery e.g. suturing, using a vitreous cutter and similarly another 50 (74%) participants felt the approach taken in the video could be extended to assess aptitude for microsurgery e.g. accurate placement of fine instruments, demonstration of appreciation of depth, and hand-eye-microscope coordination.

Discussion

Multiple validation studies have been conducted on virtual reality simulators for cataract surgery however their use is often limited by high cost and limited availability whilst non-virtual reality cataract simulation studies are few and far in between with limited data on their validity[2,3]. Coupled with the negative effects of the COVID-19 pandemic on access to simulation centres and routine, supervised cataract surgery[4,5], healthcare systems are now faced with a backlog resulting in a high pressure environment to deliver pre-COVID-19 levels of clinical activity which will inevitably compromise training needs further going forward. Furthermore, the existing challenges of outsourcing of routine cataract cases away from training hospitals has an additional negative impact on trainees access to surgical training[6,7]. Our cataract simulation model has been positively validated and can be carried out frequently, regularly and locally in every unit for training purposes without significant costs and we encourage Ophthalmologists of all grades to actively participate in simulation practice.

Conclusion

This study demonstrates the use of a low-tech and low-cost cataract simulation model that is cost-effective, acceptable, and adaptable as the simulation techniques are deemed high fidelity, repeatable, bears resemblance to and corresponds well with the exactness to live cataract surgery.