Simultaneous Bilateral Oculoplastic Surgical Simulation

Andre Ma
Prince of Wales Hospital https://orcid.org/0000-0002-0602-3479
Karen Kar Wun Chan
Prince of Wales Hospital
Hunter Kwok Lai Yuen
Hong Kong Eye Hospital
Kelvin Kam Lung Chong (chongkamlung@cuhk.edu.hk)
The Chinese university of Hong Kong

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Abstract

Purpose

The current crisis of COVID-19 has reduced training opportunities for many ophthalmology residents. This study describes a model of simultaneous bilateral cadaveric surgical simulation for oculoplastic trainees as means to maximise training outcomes in a time- and resource-limited setting.

Methods

A total of fourteen participants were included. Bilateral oculoplastic simulation were performed by two trainees assigned to a human cadaver at the same time. One participant started with transethmoidal endoscopic medial wall decompression over one side while another participant learned transcutaneous lateral wall decompression over the other eye, both under the direct supervision of a single experienced oculoplastic trainer. The number of orbital decompression surgeries performed, and participants' rating of their learning progress and satisfaction with this simulation model were reported.

Results

The fourteen participants included five ophthalmic residents (34%) and nine oculoplastic fellows (64%). Each participant completed one endoscopic medial and one lateral wall orbital decompression within 4 hours, hence a total four decompression surgeries was performed per human cadaver. Most (88%) participants agreed that simultaneous bilateral learning was preferred over the conventional and sequential unilateral simulation as it offered more hands-on time especially in a setting of limited time, cadavers and operative instruments. All (100%) would recommend fellow ophthalmic trainees to this type of simulation workshop.

Conclusion

In this pilot study, simultaneous bilateral surgical simulation using human cadaver maximises the individual learning opportunity and was well received by all participants. It is an effective and resourceful model especially useful for oculoplastic training.

Introduction

Traditionally, surgical training in ophthalmology relied on the apprenticeship model, where trainees learnt under the supervision of senior mentors.[1] This training process has changed radically in recent years. A shift in the balance between training and service delivery, and reduction in trainer-to-trainee ratio have reduced the training opportunities for ophthalmology trainees.[2] Increasing malpractice litigation, and the inherent risks and ethical concerns associated with inexperienced surgeons operating on patients, have also made this approach less tenable.[3]

The current situation of novel coronavirus (COVID-19) pandemic have further reduced training opportunities in ophthalmology.[4] Many hospitals have to cut down the number of elective procedures and non-emergency services in order to save personal protective equipment and to minimise the chance of cross-infection.[5–10] Manpower and resources in ophthalmology departments have been adjusted and redirected to cope with the increasing demand in services related to COVID-19.[11] Aerosol generating procedures, such as induction of general anaesthesia, endoscopic intervention involving suction over mucosal surface and high-speed instruments which include endoscopic medial orbital wall decompression and dacryocystorhinostomy have been reduced where possible.[4, 12] Corresponding training in oculoplastic surgery is therefore substantially affected.[13]

During the uncertain COVID-19 situation and the duration for which it will last, a strong demand for simulation training exists especially for oculoplastic surgery. Surgical simulation offers the obvious benefits of increased training opportunity and safety, which are highly sought after by ophthalmology trainees and oculoplastic fellows. There are various modalities of surgical simulation. Among them, human cadavers have been suggested to offer the best surgical simulation training by recreating an anatomically realistic operative experience.[14]

However, oculoplastic simulation workshop involving human cadavers have its own limitations, such as the cost and the condition of human cadavers, the availability of experienced mentors and surgical instruments, and time to complete complex oculoplastic procedures under supervision.

In this paper, we described simulation training on simultaneous bilateral two-wall orbital decompression using human cadavers. The use of this model is to optimise resource utilisation and maximise hands on opportunities for participants. The trainees' perception of this model were evaluated in terms of their immediate satisfaction and learning progress. To the best of our knowledge, this is the first paper reporting bilateral simultaneous oculoplastic simulation training on human cadavers.

Methods

Ethical approval on the use of human cadavers for surgical training and dissection was granted by the Faculty of Medicine, Chinese University of Hong Kong. The Department of Ophthalmology & Visual Sciences and the Department of Otorhinolaryngology, Head and Neck Surgery (ENT), The Chinese University of Hong Kong, collaboratively arranged human cadavers suitable for dissection and surgical training purposes. Human cadavers with previous head and neck dissections were included in our oculoplastic workshop, those that have undergone prior nasal procedures by ENT colleagues were excluded. There were a total of seven sets of endoscopic and high-speed instruments available for use on human cadavers.

The oculoplastic workshop took place on the morning of 5 December 2020. Before the training session, detailed information on the relevant oculoplastic surgical techniques were given to all participants. There were 14 hands-on participants and 8 assisting participants. 2 hands-on participants and 1 to 2 observers were assigned to each cadaver. Simultaneous bilateral orbital decompression were carried out under the

supervision of an experienced oculoplastic trainer. (Fig. 1) Transcutaneous lateral wall orbital decompression was performed in one eye while transethmoidal endoscopic medial wall orbital decompression was carried out in the contralateral eye. (Fig. 2)

Upon completion of training, all participants were asked to complete a questionnaire to evaluate the effectiveness of this model. The questionnaire was in the form of a 5-point Likert Scale.[15] A total of eighteen questions were included. (Table 1)

Table 1. Questionnaire on simultaneous bilateral oculoplastic surgical simulation on human cadavers

Surgical simulation using human cadaver increases my skills in using endoscopic instruments.	4/3/2/1/0
Surgical simulation using human cadaver increases my skills in carrying out surgical steps.	4/3/2/1/0
Surgical simulation using human cadaver increases my confidence in performing surgery in human patients.	4/3/2/1/0
Surgical simulation using human cadaver is similar to performing surgery in human patients.	4/3/2/1/0
I would recommend the cadaver workshop to oculoplastic surgeons before they begin operating on human patients.	4/3/2/1/0
Simultaneous 2-sided is preferred to sequential one-sided surgical simulation to allow participants more time for hands-on procedures.	4/3/2/1/0
Using cadaver specimen after head and neck dissection does not affect the quality of surgical simulation.	4/3/2/1/0
Endoscopic simulation is a valuable part for this workshop.	4/3/2/1/0
Use of high-speed instruments (saw, drill) is a valuable part for this workshop.	4/3/2/1/0
Plating and screwing is a valuable part for this workshop.	4/3/2/1/0
Inducing complications e.g. intracranial entry, extraocular muscle injury is a valuable part for this workshop.	4/3/2/1/0
Interacting with instructors is a valuable part for this workshop.	4/3/2/1/0
Which part(s) of the workshop is/are least useful?	4/3/2/1/0
Which part(s) of the workshop is/are most useful?	4/3/2/1/0
The duration of this workshop is appropriate.	4/3/2/1/0
The charge of this workshop is appropriate.	4/3/2/1/0
The set-up of this workshop is appropriate.	4/3/2/1/0
The organisation of this workshop is appropriate.	4/3/2/1/0

4 – Strongly agree; 3 – Agree; 2 – Neither agree nor disagree; 1 – Disagree; 0 – Strongly disagree

Results

There were a total of 14 hands-on participants, 8 observers and 7 experienced oculoplastic trainers. The hands-on participants consisted of five (36%) residents and nine (64%) oculoplastic fellows. The observers consisted of four (50%) residents and four (50%) fellows. A total of 14 transcutaneous lateral wall and 14 transethmoidal endoscopic medial wall orbital decompressions were completed on 7 human cadavers during the workshop period of 4 hours.

All participants (100%) agreed that surgical simulation using human cadavers increased their skills in endoscopic instruments (82% strongly agreed, 18% agreed), familiarising with various surgical steps (88% strongly agreed, 12% agreed) and improved their confidence in operating on patients (88% strongly agreed, 12% agreed). Most agreed that performing surgery on human cadaver was similar to that of real patients (94% strongly agreed or agreed, 6% neither agreed nor disagreed). Overall all participants recommended oculoplastic trainees to this simulation workshop before operating on patients (82% strongly agreed, 18% agreed).

Most participants agreed simultaneous 2-sided surgery is preferred over sequential 1-sided simulation as it offered more time for hands-on procedures (88% strongly agreed or agreed, 6 % neither agreed nor disagreed, 6% disagreed). All agreed that the use of endoscopic instruments, high-speed instruments (e.g. saw and drill), plating and screwing, and interaction with instructors were valuable parts of this workshop (88-94% strongly agreed, 6-12% agreed). In particular, the experience of inducing complications such as intracranial entry and extraocular muscle injury was valued by all (88% strongly agreed, 12% agreed).

All human cadavers involved in this study have undergone prior head and neck dissection by ENT colleagues the day before. Most participants agreed or strongly agreed (88%) that prior head and neck workshop did not affect the quality of their surgical simulation. All felt that the organisation, cost, and duration of this workshop were appropriate (79% strongly agreed, 21% agreed). Positive comments included valuable hands-on surgical experience and step-by-step guidance by experienced surgeons. No negative comment was noted.

Discussion

The COVID-19 pandemic has significantly reduced training opportunities for oculoplastic surgery. In order to learn complex surgical skills, high-fidelity simulation model such as human cadaver is needed. However, arrangement of a cadaveric simulation workshop does require a number of arrangement including operative equipment, workshop venue, trainers and human cadavers. Our model of simultaneous bilateral surgical simulation effectively doubled the hands on time for each participant. As one trainer supervised two orbital surgeries performed simultaneously, fewer trainers were needed. The cost of the workshop was further lowered by sharing one cadaver between two trainees, and with ENT surgeons who performed dissection training on other body parts. This model was well received and recommended by all participants.

An effective and resourceful model of simultaneous bilateral simulation

The idea of conducting simultaneous bilateral cadaveric simulation originated from simultaneous unilateral transethmoidal endoscopic medial wall and transcutaneous lateral wall decompression by two surgeons in patients with thyroid associated orbitopathy, which shortened the operative time and associated morbidity.[16]

Our study showed that simultaneous bilateral two-wall orbital decompression on a human cadaver is an effective and resourceful model for simulated training. In our findings, each trainee gained more time for hands-on and less time waiting in a given time. Simultaneous workshop allows four (2 medial and 2 lateral walls) decompression procedures in 4 hours as opposed to 2 in sequential setting. In addition, fewer trainers were required as one trainer was able to supervise two decompression surgeries concurrently. Importantly participant's subjective experience and technicality in learning was not significantly compromised as compared to the conventional practice of sequential simulated surgery.

Operative instruments such as endoscope, saw and drilling equipment were limited in their supply and time available for use. As transethmoidal medial wall and transcutaneous lateral wall decompression require different sets of operative instruments, simultaneous simulation of these procedures further optimised resource utilisation and created more training time for each participant.

Most participants (88%) agreed or strongly agreed that simultaneous 2-sided surgery is preferred over sequential 1-sided simulation as it offered more time for hands-on practice. No major concerns were reported. Most participants found the running of the simultaneous surgeries to be smooth, with sufficient operative field and space, and insignificant interruption caused by the contralateral surgery (e.g. use of high-speed instrument such as drilling). Most (94%) agreed that performing surgery on human cadaver in this setting was similar to that on real patients.

Human cadaveric simulation offers important surgical exposure

Although differences exist between operating on a cadaver and surgery in the operating theatre [17], there are many advantages of cadaveric simulation. The lack of bleeding in human cadaver eliminated the need for achieving haemostasis and the avascular simulation field likely reduced the operative difficulty, allowing trainees to focus more on other aspects of the procedure. Furthermore, participants reported a substantially different mindset when operating on cadavers. Trainees felt more at ease in exploring the human anatomy and the effects of their surgical instrumentation, with less concerns over inducing complications knowing that the experience of causing complications, such as intracranial entry or extraocular muscle injury, in this safe, consequence-free setting was an integral part of the learning process. All participants (100%) felt that learning from complications was a valuable part of this

workshop, highlighting that human cadaveric simulation is an important and unique source of surgical learning experience.

Optimise utilisation of human cadavers with other surgical disciplines

Further optimisation on the use of human cadavers were achieved through collaboration with the Ear, Nose and Throat (ENT) department. Cadavers with previous head and neck dissections were included in this oculoplastic workshop. Human cadavers that have undergone prior nasal procedures by ENT colleagues were excluded. Most participants (88%) agreed that head and neck dissection did not affect the quality of oculoplastic surgical simulation. In the future, additional collaborative sequential cadaveric use with other surgical disciplines such as neurosurgery, oral and maxillofacial surgery, or plastic surgery may also be considered to further optimise the training resources and lower the cost.

Positive responses from participants

All participants responded positively regarding this model of simulation. Simultaneous bilateral orbital decompression on human cadavers is an effective simulation model that led to the subjective improvement in trainees' endoscopic skills, use of high-speed instruments, familiarity with surgical steps, as well as confidence in operating on real patients. Simultaneous bilateral surgical simulation was well received and recommended as it led to a significant increase in hands-on exposure particularly in a time- and resource-limited setting.

Disadvantages and limitations of simultaneous bilateral surgical simulation

There were a few disadvantages regarding this model. The contralateral surgery may induce brief physical disturbances such as movement during lateral wall drilling or repositioning the cadaver head to introduce the nasal endoscope. These movements required neutralisation by the help of an assistant. Overall, most recalled insignificant interruption from the contralateral surgery. In addition, the operating space was limited as it had to accommodate two teams of oculoplastic surgeons and two sets of surgical instruments, which required organisation and coordination between the two teams. Occasionally, interruption may occur when there is physical blockage of the endoscopy monitor by the contralateral team, or misplacement or misuse of the fellow team's surgical instruments. This simultaneous bilateral arrangement is rarely encountered in real life practice and does require some initial adaptation. Lastly, sharing a mentor between two simultaneous surgeries meant that there were intermittent periods without direct supervision. However, the level of guidance was deemed to be sufficient and satisfactory.

This pilot study has some limitations. There was no objective assessment on the effectiveness in skill acquisition and no direct comparison with the conventional sequential model. Although the number of procedures performed has doubled compared to previous experience with no subjective compromise in its quality, future studies should consider a more robust method by including a sequential simulation

control with measurements covering the exact operative time and number, as well as an objective assessment of trainees conducted by experienced oculoplastic trainers.

Conclusion

In this pilot study, simultaneous bilateral orbital decompression on human cadavers was found to be an effective, practical and implementable simulation model for training. Participants have provided positive feedbacks and good learning progress. This model was recommended as it led to a significant increase in hands-on exposure which is particularly relevant in a time- and resource-limited setting during the COVID-19 crisis.

Declarations

Conflict of interest/ Competing interests

The authors have no conflicts of interest or competing interest to declare that are relevant to the content of this article.

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Author contribution

All authors contributed to the study conception, design, material preparation, data collection and analysis. The first draft of the manuscript was written by Andre Ma and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Data availability

The authors affirm that all data and materials support the findings of this study and comply with field standards. The authors confirm that all data are available within the article.

Animal Research (Ethics)

This study did not involve animal subjects.

Consent to Participate (Ethics)

Informed consent was obtained from all individual participants included in the study.

Consent to Publish (Ethics)

The authors affirm that informed consent for publication of the images in Figure 1 and 2 were obtained.

Ethics approval

The study was approved by the ethics committee of the Chinese University of Hong Kong and it was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki.

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Figures

Figure 1

Photograph taken during simulated simultaneous bilateral decompression. Mentor at the head of the dissection table supervising two participants on lateral wall decompression performed on the left side.

Figure 2

Photograph taken shortly after Figure 1. Mentor conveniently switched to attending the right-sided transethmoidal endoscopic medial wall orbital decompression while two participants continued on the left-sided transcutaneous lateral wall orbital decompression.