Scholar: Pilot and Validation Studies ISSN: 2689-7644
Volume 5 Issue 1 Pages: 22 – 25 DOI:10.32778/SPVS.71366.2024.46

A novel simulation model for teaching the removal of an embedded corneal foreign body: A pilot study

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Keywords: Simulation model, embedded corneal foreign body, Newport eye model

Abstract:

Introduction:

It is estimated that of the 3.9 million annual emergency department visits in the United States are for ocular trauma, with a fair proportion related to the extraction of an embedded corneal foreign body. The procedure is considered well within the scope of emergency medicine specialists. Emergency medicine texts describe the procedure in varying degrees of detail and technique. However, much of the training is still relegated to the now archaic concept of "see one – do one – teach one." Essentially, it is taught, if at all, on the job and not in school. A review of the relevant literature has uncovered several attempts at developing simulation models to enhance educational efforts. However, the models are costly, difficult to reproduce, and not sufficiently realistic. This impedes the abilities of students to combine their clinical knowledge with clinical skill practice. Students at our university do not receive hands-on training with the use of a slit lamp. Therefore, they need classroom-based opportunities to practice a procedure they may need to do in the real world.

Methods:

We developed a new simulation model that utilizes inexpensive, easy-to-acquire items that can facilitate and augment the educational process of teaching the removal of an embedded corneal foreign body, using a hard-boiled egg as the eye. Ten second-year medical students were taught how to use the slit lamp and then performed corneal foreign body removal with our novel method and then through the previously published Newport Eye Model method. Afterwards, they completed a brief survey of both techniques, their realism, and effectiveness.

Results:

Upon completion of this education and training, 100% of the learners favored the experimental model over the previously published Newport Eye Model to teach corneal foreign body removal during simulation education.

Conclusion:

It is proposed that this simulation model, another extension into the growing field of simulation medicine, will not only broaden the psychomotor skills of emergency medicine specialists for ophthalmologic emergencies, but it will also enhance patient safety. This training is inexpensive, expeditious, and easily reproducible and should be tested among more students and faculty to gauge their responses. Medical faculty, especially primary care physicians, should be educated with regards to using a slit lamp and simulation education.

Article History: Date received: 04/19/2024 Date revised: 08/19/2024 Date accepted: 08/20/2024
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Introduction:

Annually, approximately 3% of all Emergency Department (ED) visits in the United States are related to ocular trauma.[1] Ocular injuries are the most frequent cause of non-congenital monocular blindness in both children and adults.[2] From a study of ocular injuries presenting to the emergency department in Central Spain, men were more vulnerable to trauma, primarily superficial foreign bodies.[3] That is not an insignificant amount when one considers that in 2023 there were 139.8 million emergency department visits.[4] An ophthalmologist experienced in ocular traumatology is not always available. Therefore, every emergency physician should be familiar with the basic evaluation, triage, and management of ocular trauma.[5] Therefore,

it is incumbent upon all emergency physicians and their mid-level providers to develop the knowledge, fine motor skill control, and excellent hand-eye coordination to remove an embedded corneal foreign body safely using a slit lamp. However, while a review of major medical texts presents cursory descriptions of the removal of a corneal foreign body, there is scant information on the technique itself.[6,7]

Other texts and publications go into greater detail and offer variations of foreign body removal which only serve to underscore the inherent complexity and potential danger of the technique.[8-11] The concept of removing a corneal foreign body can cause a certain amount of anxiety to both patient and practitioner. For hospitals, there is emphasis on patient safety and cost containment. One method to address these goals is the development and utilization of simulation techniques in medical education. Educational models like the Newport Eye Model have been described in the published literature, but they often involve preparation and materials that are time-consuming, not readily available, and/or costly.[11,12] Additionally, these models may negate the importance of the hand-eye coordination required when one is trying to remove the foreign body using a slit lamp.[12,13]

Methods:

This study was approved the University of Toledo IRB; #: 302033-UT. The purpose of this research is to demonstrate to and teach students a novel simulation medical technique, as well as the previously published technique of the Newport Model, on how to remove an embedded corneal body safely. This novel simulation model, as opposed to other published simulation techniques, is meant to be simple, easy to assemble, and inexpensive. It is also meant to encourage the use of the slit lamp in emergency medicine.

Equipment:

Egg(s), dental pick (Optional: 23-gauge needle/syringe; cotton swab), needle (23-gauge), skewer, adhesive tape, and whole peppercorn

Procedure:

1) Eggs were boiled in the standard fashion for twelve minutes. They were allowed to cool and refrigerated until used.
2) Break up one to two whole peppercorns to a rough consistency, creating remnants of various sizes and shapes.
3) Apply crushed peppercorns on the hard-boiled egg surface after the shell is removed. One egg may be used for multiple learners during one session.
4) Skewer egg. Tape the skewered egg model to both the chin brace and forehead brace attachments on the slit lamp.
5) Adjust the slit lamp to the lowest magnification to accommodate the learner to the image.
6) Increase the magnification to the desired level and using the dental pick, needle or swab, remove the embedded peppercorn from the surface of the egg.

This method was then compared to a facilitated variation of the Newport Eye Model previously described.[13] Following the training and the corneal foreign body removal using the egg method and Newport Eye method, the students completed a brief survey that assessed their comfort level as well as the realism, efficacy, and usefulness of each method.

Results:

Prior to the slit lamp and foreign body removal education and training, eight of the ten students (80%) indicated they were uncomfortable using the slit lamp. Afterwards, all ten students felt the training was effective or very effective (see table 1). All ten students felt the egg model would be more frequently used for teaching corneal foreign body removal, the easier model to construct, and the less costly model to construct compared to the Newport Eye Model. All students rated the realism of the egg model as moderately realistic or very realistic.

All students rated the effectiveness of the egg model effective or very effective and felt the egg model would be useful for training health care providers in foreign body removal from the eye. Nine of the ten students (90%) felt the egg model was more effective or much more effective than the

Newport Eye Model, with the remaining student rating each method as equally effective.

Table 1: Rating of training and model effectiveness and realism

	Rating				
Question(s)	**1**	**2**	**3**	**4**	**5**
Pre-training comfort level with slit lamp	8	0	2	0	0
What is your post-training comfort level in using a slit lamp?	0	0	0	5	5
How comfortable would you be performing slit lamp evaluation and foreign body removal on a patient?	0	0	2	7	1
How likely would you use the slit lamp in evaluating patients because of this training?	0	0	1	6	3
How well do you feel the exercise measured your ability to find and remove small objects using the slit lamp?	0	0	1	5	4
How would you rate the realism of the egg model?	0	0	1	7	2
How would you rate the effectiveness of the egg model?	0	0	0	7	3
How would you compare the effectiveness of the egg model with the Newport method?	0	0	1	7	2

Ratings (1-5): The higher the score the better. Score of 3 indicated no preference or unsure

Table 2: Rating of utility, construction, and teaching use

	Response	
Question(s)	**Yes**	**No**
Do you feel the egg model would be useful for training health care providers in foreign body removal from the eye?	10	0
	Egg	**Newport**
Which model would you feel would be the easiest to construct?	10	0
Which model would you feel would be the least costly to construct?	10	0
Which model would you feel would be the most frequently used for teaching?	10	0

Post simulation questions on overall impressions

Discussion:

The purpose of this paper is to assist the educator with a simple, inexpensive, easily reproducible technique that could teach the healthcare learner how to remove an embedded corneal foreign body safely using a slit lamp and a variety of removal devices. This model also lends itself to demonstrating the corneal defects that may occur when using these devices, ophthalmic burr included.

The peppercorn was chosen as a foreign body because it can easily be crushed to form pieces of varying sizes, approximating the size and shape of foreign bodies typically found in the eye. However, other substances may be tested at the discretion of the educator.

One serendipitous discovery was that dental picks (Sunstar G*U*M Soft-Picks) worked well with foreign body removal and was used during simulation educational sessions in lieu of a needle. The filaments at the end of the pick were helpful and the pick itself was found to be firm but malleable, which added to teaching in a safe environment.

Next Steps:

It is the responsibility of the educator to integrate this model into the overall educational requirements associated with the proper examination of the eye before and after the foreign body removal (viz. visual assessments, Seidel's sign, anesthetics, etc.). One limitation of this model was that the fluorescein dye stained the entire surface of the egg and was unable to be irrigated off to any appreciable degree. Therefore, use of fluorescein and a Wood's lamp to detect a corneal defect was not very satisfactory.

In addition, the Newport Eye Model was somewhat problematic in terms of time to develop and to insert onto a slit lamp compared to the UTMC Egg Model. However, the use of an inverted gelatin mold, as a take-off on the Newport model, was found to be beneficial in demonstrating the technique prior to using the slit lamp. Another preliminary technique that was suggested by the learners was to use a half-egg impregnated with peppercorns for practice purposes.

Conclusion:

The authors believe that this simulation device is feasible as an educational instrument for healthcare students. Participants found the model

instructive and superior to traditional models for training how to remove embedded corneal foreign body. It also has the potential to be a source of education not only for traditional healthcare practitioners, but in the event of a prolonged catastrophic event (such as pandemic). Larger studies are needed and compared with real life outcomes.

Author Contributions:
Dr. Rega was the principal investigator. He created the egg model, acquired the slit lamp from the emergency department, and provided the education to the medical students. Dr. Fink administered the survey to the medical students, performed the data entry and analysis, and assisted writing the manuscript. Both authors contributed to review of the manuscript.

Potential Conflicts of Interest Disclosures:
The authors disclose that there were no conflicts of interest or financial support in the development of this project. All data is authentic and accurate.

Funding Sources: None.

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