A New Model for Teaching Corneal Foreign Body Removal

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ABSTRACT

Objective: To determine whether a skills laboratory for corneal foreign body and rust ring removal improves self-assessed skill and confidence.

Methods: A prospective trial was conducted as part of the didactic curriculum of a university-based residency program in emergency medicine (EM). A convenience sample of 26 EM residents and five fourth-year medical students participated. The skills laboratory used model corneas made by coating 3.2-cm glass spheres with a 1–2-mm film of paraffin. Foreign bodies were simulated by embedding small pieces of metal into the paraffin. Rust rings were simulated by dipping a hot, straightened paper clip into a rust-colored crayon and then into the paraffin. The model eyes fit into a life-sized model of a human head. Participants removed the foreign bodies and rust rings under supervision, using the slit lamp. Each participant anonymously completed a questionnaire before and after participating in the skills laboratory. The questionnaire recorded educational level, previous experience, and self-assessed comfort and skill levels (0 = lowest, 10 = highest).

Results: Most (66%) of the participants had not previously removed a corneal foreign body; 86% had not previously removed a rust ring. On a ten-point scale, the median comfort level for removing a foreign body rose from 2 to 7, and the self-assessed skill level rose from 1 to 7 (p = 0.0001). Similar improvements in self-assessed comfort and skill levels were seen for rust ring removal.

Conclusions: Participation in this skills laboratory significantly improved the self-reported comfort and self-assessed skill levels in removing corneal foreign bodies and rust rings. This technique provides useful practice of a fine-motor procedural skill requiring eye–hand coordination prior to supervised application of these skills in clinical practice.

The best way to remove a corneal foreign body or rust ring is under slit-lamp magnification. This technique requires fine-motor skills and eye-hand coordination, the acquisition of which requires practice. We developed a new model to teach these skills to resident physicians and tested the model's effect on the residents' self-assessed skill and confidence.

METHODS

Study Design and Setting

This was a prospective trial of an in-vitro experimental model conducted as part of the teaching curriculum of a university-based residency program in emergency medicine (EM). Evaluation of educational effectiveness was by pre- and postcourse participant survey.

Participants

The study used convenience sample of 26 EM residents (11 PGY1, eight PGY2, and seven PGY3) and five fourth-year medical students rotating through the university ED. The study was approved by the East Carolina University Institutional Review Board.

Intervention: Skills Laboratory Model and Equipment

This foreign-body skills laboratory was included in an interactive teaching session covering eye problems commonly seen in the ED. The teaching session complements a separate didactic lecture. The instructor for the laboratory (PEA) is residency-trained and board-certified in EM.

The one-hour teaching session included several skills stations, which covered the removal of corneal foreign bodies and rust rings, glaucoma, herpes simplex and ultraviolet keratitis, bacterial and chemical conjunctivitis, central retinal artery and retinal vein occlusion, globe perforation, hyphema, lens dislocation, and retinal detachment. At the foreign-body skills station, the participants were given 10 minutes total to remove one foreign body and one rust ring using the model. Each participant visited the foreign-body skills station only once.

The stated objectives of the foreign-body skills station were to familiarize the participants with the mechanics of the slit lamp and with the effect of high magnification on apparent hand tremor and instrument size, and to improve the eye-hand coordination required for removal of corneal foreign bodies.

To create the foreign-body skills station, a model of a human face was made by laminating fiberglass casting tape (Scotchcast Plus Orthopedic Products, 3M Health Care, St. Paul, MN) over a Styrofoam wig stand. A head was made out of 1/4-inch plywood, using coronal and sagittal sections of the wig stand as templates (Fig. 1). Model eyes were made by gluing 3.2-cm glass marbles to 1/2-inch dowels, then dipping the marbles into melted paraffin. The model eye was held in place with a wedge, but could alternatively be held in place with a common spring clamp found in hardware stores.

Corneal foreign bodies were made by snipping off small pieces of metal from an 18-ga copper wire. Pieces of a uniform size were then embedded into the cooled paraffin "cornea" so that the surface of the metal snippet was even with the surface of the wax. Rust rings were simulated by dipping a hot, straightened paper clip into a rust-colored crayon and then into the paraffin (Fig. 2).

The participants used an 18-ga hypodermic needle attached to a 5-mL syringe barrel to remove the corneal foreign body. An electric burr was used to remove the rust ring (Algerbrush Rust Ring Remover, Katena Products Inc., Denville, NJ).

Outcome Measures

After giving verbal informed consent, 26 EM residents and five medical students participated in the foreign-body skills station. Each participant anonymously completed a self-administered questionnaire before and after participation. The questionnaire was developed by the authors to evaluate this laboratory and was not validated in any other setting. The questionnaire re-
corded educational level, previous experience, comfort level, and self-assessment of skill level.

For comfort level, the scale was from 0 (very uncomfortable) to 10 (very comfortable). For skill level, the scale was from 0 (no appreciable skill) to 10 (skill considered adequate to do the procedure without supervision or backup).

Analytical Methods

Data are reported as medians with interquartile ranges. Self-assessed comfort and skill levels before and after the laboratory (paired data) were compared using the Wilcoxon signed-ranks test (SAS Institute Inc., Cary, NC). The $\alpha$ error was set at 0.05.

RESULTS

Only two participants had removed more than one corneal foreign body and none of the participants had removed more than one rust ring. Prior to the laboratory, the majority of the participants were uncomfortable performing these procedures and rated their skills as inadequate.

The median comfort level (followed by interquartile range in parentheses) for removing corneal foreign bodies rose from 2 (0–6) to 7 (5–9) ($p = 0.0001$), and the median skill level rose from 1 (0–5) to 7 (5–9) ($p = 0.0001$). For removing a rust ring, the median comfort level rose from 0 (0–3) to 7 (5–9) ($p = 0.0001$), and the median skill level rose from 0 (0–3) to 7.5 (5.5–8.5) ($p = 0.0001$).

DISCUSSION

Although the risks of penetrating the cornea are small, it is important to ensure that the attending and resident physicians can perform these procedures safely and effectively. The patient may develop or express a lack of confidence, which can inhibit the attending physician from giving clear instruction and may constrain the resident from asking clarifying questions. When using the slit lamp to remove a corneal foreign body for the first time, the resident may be surprised at the degree of magnification of his or her instrument, the change in the depth of field, and the exaggeration of hand tremor, and may therefore be hesitant to proceed. The alternative of practicing ophthalmologic procedures on cadavers is suboptimal because of the loss of intraocular pressure and because of the related logistic issues.

Models and manikins are used successfully in teaching specific manual skills such as CPR and endotracheal intubation. There are also manikins for teaching venipuncture, placement of urinary catheters, and emergency childbirth. To our knowledge, there has been no report of a model designed to teach skills related to slit-lamp-aided corneal foreign body or rust ring removal.

We tried several other ocular models before settling on cooled paraffin over marbles. The corneas of pig eyes were too rubbery to allow insertion of the foreign bodies. Gelatin was too hard. We did not evaluate beeswax as an alternative to paraffin, although this substance is quite sticky. We used marbles rather than prosthetic glass eyes in our model because marbles are more readily available and much less expensive. Because the purpose of this laboratory was to teach the fine-motor skills needed to remove foreign bodies and rust rings, anatomic landmarks were not considered essential.

LIMITATIONS AND FUTURE QUESTIONS

Our model fosters an uninhibited exchange between the attending and resident physicians and allows the resident to acquire skills with the equipment in a comfortable, nonthreatening environment. We measured self-assessed skill levels rather than actual clinical skills, which is a limitation of the study. Two factors made us choose this strategy. First, to test the model's ability to improve clinical skills, a control group of residents would need to clinically remove a corneal foreign body without first going through the skills laboratory. This raises a number of ethical dilemmas; it is unlikely that residents would voluntarily forgo an educational opportunity their peers found useful or that patients would consent to participate in such a study. Second, while fairly common, corneal foreign bodies and rust rings are not seen frequently enough to facilitate such a study.

Another theoretical limitation of the study is the fact that we tested the model on residents from only one program. However, we believe that our residents do not differ from the residents in other programs in ways that would preclude generalization of our findings. While we found that resident physicians and medical students found the model useful, future studies could be done to quantify an objective parameter such as size...
of defect in the wax cornea after removing a corneal foreign body or the number and size of "stray" scratches on the wax cornea. Use of these objective measures might permit an objective measure of instrument dexterity that would complement the subjective impression of the student or overseeing faculty member.

Although the residents noted their postgraduate year of training and their prior experience removing foreign bodies on their questionnaires, the numbers were too small to stratify on these variables. With larger numbers of participants, the impact of the skills laboratory on participants as a function of different levels of training and prior experience could be determined. If considered valuable by experienced clinicians who may see this condition on an infrequent basis, the model could be used for continuing medical education.

CONCLUSION

We describe our experience with a skills laboratory that increased the self-assessed skill level and comfort level of the participants. While it does not replace the need for supervised removal of a corneal foreign body or rust ring from a patient's cornea under slit-lamp magnification, it prepares the participant to do his or her first removal with more skill and confidence.

REFERENCES


ANNOUNCEMENT

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