

# ORIGINAL ARTICLE

## Impact of practice on goat's eye on surgical skill development in sophomore ophthalmology residents

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### Abstract

**Introduction:** Acquisition of clinical and practical skills is one of the highly critical and sensitive aspects of medical education, particularly in the areas related to surgical specialties. Moreover, one of the most important procedural strategies regarding educational medicine is the acquisition of practical skills in various psychological domains. Regarding this, the present study aimed to delineate the effects of practicing on goat's eye for the residents expected to perform their first surgery on human eyes.

**Methods:** This applied study was conducted on all the sophomore residents (n=8) of the Ophthalmology Department of Isfahan University of Medical Sciences, Isfahan, Iran, using a pre-experimental design. The procedures were instructed to the residents through three stages in the wet lab according to a protocol. After the completion of the second stage, the residents gained their first experience of performing surgery on human eyes in the operating room under the supervision of junior and senior residents and the attending specialist. At this stage, in case further experience was required, the resident could start practicing on goat's eyes in the wet lab upon prior coordination. At the third stage, the residents received instructions and practiced more advanced techniques. After this stage and upon the entrance of the residents to the operating room, the 3<sup>rd</sup> and 4<sup>th</sup> year residents and the attending specialists were surveyed regarding the performance of the 2<sup>nd</sup> year residents in nine fields in accordance with the aims of the study. In addition, the 2<sup>nd</sup> year residents completed a self-evaluation checklist. The data were analyzed in SPSS software, version 16.

**Results:** The results revealed that practicing before surgery on the human eye resulted in the reduction of surgical errors (45%), surgical speed and proficiency (20%), and stress and hand tremors (35%) during the first surgical experiences. According to the 3<sup>rd</sup> and 4<sup>th</sup> year residents, the practices and instructions provided before the wet lab had a positive effect on decreasing the levels of stress and surgical error during the first surgical experiences of the 2<sup>nd</sup> year residents. The attending specialists believed that the wet lab experience could have a positive effect on all aspects of surgery, including mental, emotional, and practical factors. Nonetheless, some 3<sup>rd</sup> and 4<sup>th</sup> year residents believed that the wet lab could not provide circumstances identical to the conditions experienced in the operating room. Therefore, the effects of practicing in the wet lab on surgical speed, proficiency, stress, and surgical error were believed to be less significant.

**Conclusions:** Overall, the study showed that repeated practice sessions on goat's eye in the wet lab under the supervision of 3<sup>rd</sup> and 4<sup>th</sup> year residents and attending specialists could not only have positive effects on some practical, mental, and attitudinal indices but also improve the knowledge of the residents.

**Key words:** Education, Goat's Eye, Resident, Surgery, Wet Lab



## Introduction

Skill training has an essential share in medical education. The acquisition of clinical and practical skills is one of the highly critical and sensitive aspects of medical education, particularly in surgical specialties. Moreover, one of the most significant procedural strategies regarding educational medicine is the acquisition of practical skills in various psychological domains (1). The skills that a specialist possesses are strongly related to the methods and amount of education she/he has received and practiced during the educational period of medical practice (2).

The acquisition of skills and experimental aspects is a dynamic process in which the learner gradually learns through applying logical reasoning to the accumulated experiences on a day to day basis. However, the first experiences can occasionally lead to irreversible consequences for patients (3). Based on the evidence, in 85% of cases, residents gaining advanced experience through educational surgical procedures make errors that have, in some cases, caused irrecoverable damages to the patients.

Regarding this, the attending specialists always seek for ways to simulate the operating room (OR) experience in order to prevent such errors. However, given the costliness of these simulations, universities have to discontinue these projects (4). Moreover, simulation-based learning has been so costly that the majority of universities have been oriented toward adopting animal eyes in the wet labs for students' primary surgical experiences (5). According to the literature, the use of wet labs is an appropriate educative surgical method to practice and learn before the OR experience that can help develop surgical proficiency, especially in the residents of surgery (6-7).

Wet labs provide a safe and stress-free environment in which the residents of surgery can familiarize themselves with surgical techniques and gain the needed confidence to perform surgery on humans. Special instructions are provided for the residents in the wet labs; moreover, they can learn about the multitudes of surgical tools available in this setting (8).

The delicate structure of the eye tissues and the small size of the anatomical parts of the eye all underscore the necessity of acquiring surgical proficiency in the residents of surgery before performing surgery on actual human eyes. In other words, to perform a multi-stage cataract procedure, residents should gain the needed skills in the wet labs by performing the procedure on simulated eyes or animal eyes that have an

anatomical resemblance to the human eye. Studies have shown that practice sessions and skills acquired in the wet labs by residents have decreased the number of errors occurring during human surgeries by 10% (9-16).

On the other hand, the residents of surgical fields, in which the acquisition of the required skills for performing surgical procedures is of utmost importance, are faced with much stress and anxiety that can increase the risk of irrecoverable errors (17). Given the ultimate goals of education and learning, the empowerment of medical students and residents has a positive effect on maintaining and enhancing public health (17).

The implementation of a safe procedure on patients by the attendance of a specialist is a major educational goal. Alongside this, teachers have frequently attempted to provide appropriate conditions for eye simulation, such as the use of animals eyes (e.g., cows, pigs, sheep, and goats). In the universities across the world, pigs' eyes are widely available as they have a similar anatomical structure to the human eye (18-19).

The acquisition of the first experiences of surgical procedures using similar models (i.e., animal models) is a method that has been able to decrease surgical risks and errors in human patients. Moreover, the use of these animal models facilitates the reduction of the stress level of residents in their first experiences of performing surgery on human eyes and the improvement of their sense of confidence and motivation.

Consequently, the establishment of a specific program with clear objectives will elevate the educational system and methods. With this background in mind, the present study was conducted to investigate the effects of an appropriate method in the clinical training of the residents of ophthalmology surgery and fix the observed inadequacies during the process.

## Methods

This applied study was conducted on sophomore residents (n=8) of the Ophthalmology Department of Isfahan University of Medical Sciences, Isfahan, Iran, using a pre-experimental design. The interventions have been implemented since February 2017 and continue to the present time. During this period, the researchers have enquired about the efficacy of the wet lab in line with the current research objectives.

The study population consisted of all 2<sup>nd</sup> year residents (n=8) participating in the educational intervention. After the completion of the third stage of the intervention, the participants filled out

a self-evaluation questionnaire upon performing at least three surgical procedures on human eyes in the OR. Furthermore, 3<sup>rd</sup> year (n=8) and 4<sup>th</sup> year (n=8) residents of the ophthalmology department and the corresponding attending specialists of the OR completed a surveying checklist (similar to the self-evaluation form of the 2<sup>nd</sup> year residents).

The latter survey was performed to assess the performance of the 2<sup>nd</sup> year residents in their first experiences of surgery on human eyes. A total of 70 forms were completed by junior and senior residents given that each 2<sup>nd</sup> year resident was evaluated by three higher-level residents, as well as the attending specialist.

The data collection tools comprised of three survey forms each of which included nine items. The participants were asked individually to score each of the items on a 5- point Likert scale (completely disagree=1 to completely agree=5). This form was confirmed to be valid by three faculty members and two residents of the ophthalmology department. The reliability of the checklist was also tested through administering it to five residents, rendering a Cronbach's alpha coefficient of 0.75. The forms had similar contents and were designed with two contexts in mind to be completed by an observer and a supervisor of the performance.

The study was conducted in the wet lab and the OR of Feiz medical and educational center specializing in eye diseases affiliated to the Isfahan University of Medical Sciences. The residents were evaluated for 3 months at specified intervals. According to the literature, six stages are required to establish a wet lab. These stages include the establishment of appropriate physical conditions, presence and support of the faculty members of the ophthalmology department and an office worker who is persistent and informed, provision of appropriate eye models or simulated eyes, adoption of an appropriate method for fixing the eye while

practicing surgery, preparation of the eye in the sense of inducing cataract in the eye under study, and financial support for the preliminary costs of running the wet laboratory and its machines, as well as usable materials including the simulated eyes or eyes of animals.

At first, the researcher coordinated with the hospital officials and the ophthalmology department in February 2018 for a room in the Feiz Medical and Educational Ophthalmology Center in which the wet lab instruments could be designed and set. The required facilities were transferred after setting up the cabinets, electricity and telephone systems, and plumbing, cooling, and heating equipment in the room (Table 1).

The researchers used the goat's eye because of its similarity with the human eye. Investigations of different databases, including the PubMed, and search engines regarding wet labs revealed that researchers had reached different conclusions about the type of simulated eye for practicing in the wet lab. This was the beginning phase of deciding on the type of eye most similar to the human eye, which can be available in Islamic countries.

As the evidence indicates, the pig's eye is used as the most similar eye to the human eye and is regarded as an appropriate reference in wet labs (20-21). Nevertheless, in a study carried out in India, it was shown that the goat's eye was an appropriate option for practicing purposes in the wet labs (22). In another study performed by Mohammadi in the Eye Research Center in Iran, sheep's eye was suggested as an appropriately similar model to the human eye (23). In the current study, goat's eyes were adopted given their simple accessibility and cost-effectiveness, as well as more similarity with human eyes.

To provide the eyes, the slaughterhouse (in Khomeini Shahr, 80 km to Isfahan) was asked to totally extract the eyes from the animal's eye orbit, along with the surrounding fat, without the eye

**Table 1: Facilities and equipment required for a wet laboratory**

Row	Item
1	Surgical microscope with a teaching tube (Topcon trademark)
2	Fico ARC machine
3	Microwave
4	Trypan Blue
5	An extra set, including blepharostat, tying, Westcott scissors, corneal scissors, forceps, and ...
6	Phacoemulsification sets, including blepharostat, chopper, irrigation and aspiration system, phaco tip, Sinsky hook, tooth forceps, and pencil capsule
7	Surgical instruments, including knife 2/3 and 15 degrees, suture (0.6, 0.7, and 10.0), sterile insulin syringe, and gel
8	Bed and suitable sandals
9	Small fridge
10	Safety box
11	Yellow bucket (for infectious waste)

**Table 2: Practicable procedures in the wet lab**

Row	Procedure
1	Correct scrubbing and handwashing
2	Familiarity with the eye surgery
3	Learning how to adjust the microscope
4	Learning how to insert stab
5	Learning how to wash the anterior chamber
6	Gel injection and dyeing of the anterior capsule
7	Performing a rhexis (capsulorhexis)
8	Performing phacoemulsification
9	Irrigation and aspiration
10	Intra-ocular lens
11	Stromal hydration
12	Eye stitching

surface being touched. The eyes were transferred to the wet lab in a cold container at  $-2^{\circ}\text{C}$ . Notably, the slaughterhouse was visited every day by the researcher to supervise the process of eye preparation and ensure that they are completely intact and immediately placed in appropriate conditions in 1/3 and 2/3 sera at  $-2^{\circ}\text{C}$ .

The eyes were used in the wet lab on the same day. The maximum time interval from the moment the eye was extracted from the socket of the animal skull until it was used in the wet lab was 10 h. The eyes were transferred in such conditions in order to prevent the cornea from getting opaque or dry and preserve maximum similarity to the human eye needed in the wet lab.

It is worthy of note that all these procedures (Table 2) were taught to the residents in three separate stages. In this regard, items 1-3 were taught to the residents by a 3<sup>rd</sup> year resident in the first 2 weeks of the educational program. In addition, items 4-6 were instructed by 3<sup>rd</sup> and 4<sup>th</sup> year residents in two sessions with a one-week interval.

In the first session of the educational program, the higher grade residents performed the procedure on the eye model as an example for the 2<sup>nd</sup> year residents to follow. By observing the procedure, they attempted the procedure under the supervision of the higher grade resident. There was a one-week interval before the second session during which the 2<sup>nd</sup> year residents had the opportunity to study the topic and review it in their minds.

The 2<sup>nd</sup> year residents performed the 4<sup>th</sup>-6<sup>th</sup> procedures under the supervision of higher grade residents in the second session. After this stage, the newly trained residents practiced the procedures on their own or with their colleagues in the wet lab. After acquiring the required skills, they were permitted into the OR to hold the scalpel and perform the surgery on the human eye under the supervision of attending specialists, as well as 3<sup>rd</sup>

and 4<sup>th</sup> year residents according to the rotation schedule of the OR.

During this period, if it was sensed or observed (whether by the 2<sup>nd</sup> year residents themselves or by the attending specialist or higher grade residents) that there is a need for more practice in the wet lab, coordination was immediately made for the 2<sup>nd</sup> year residents to have more practice sessions on goat's eyes.

Regarding the third stage of the educational program, after the target residents had practiced in the OR for 2-3 sessions and performed the practices specified in the first stage, they were again met at the wet lab (according to a written schedule). This meeting was aimed at both solving the problematic issues and getting trained on procedures 7-11 (based on Table 2).

Subsequently, they started practicing on goat's eye and reiterated the previous procedures on humans under the supervision of higher-grade residents and the attending specialist. The survey forms were completed by the study group after the end of stage 3. The collected data were analyzed in SPSS software, version 16. Notably, the intervention used in this study was the routine education delivered to all residents of surgery in the hospitals affiliated to the Isfahan University of Medical Sciences.

## Results

As seen in Figure 1, the 2<sup>nd</sup> year residents believed that the exercises performed on animal eyes in the wet lab could have a positive effect on the residents' confidence (65%), surgical proficiency (70%), motivation while operating on the human eye (80%), satisfaction with operation (70%), self-esteem (55%), and mentality towards surgical operation and mental ability in performing surgical operation (80%). In their opinion, however, these exercises were of a lower effect on surgical error (45%), agility (20%), and stress and hand tremors while operating for the first time (35%; Figure 1).

In the same vein, the supervising residents maintained that the exercises performed on animal eyes in the wet lab had a positive effect on confidence (85%), surgical proficiency (95%), reduction of surgical errors (85%), motivation while operating on the human eye (80%), satisfaction while operation (70%), self-esteem (85%), and positive mentality and ability in performing the surgical operation (100%) in the 2<sup>nd</sup> year residents. Nevertheless, these pre-operative exercises had a weaker effect on agility (40%) and stress and hand tremor while operating on the

human eye for the first time (40%; Figure 2).

As depicted in Figure 3, in some cases, the attending specialists had different opinions from those of junior and senior residents regarding the wet lab. In this regard, the attending specialists believed that practicing on animal eyes had a

positive effect on confidence (80%), surgical proficiency (85%), surgical error (50%), motivation while operating on the human eye (85%), satisfaction with operation (70%), self-esteem (95%), and positive mentality and ability in surgical operation (100%) in the 2<sup>nd</sup> year residents.

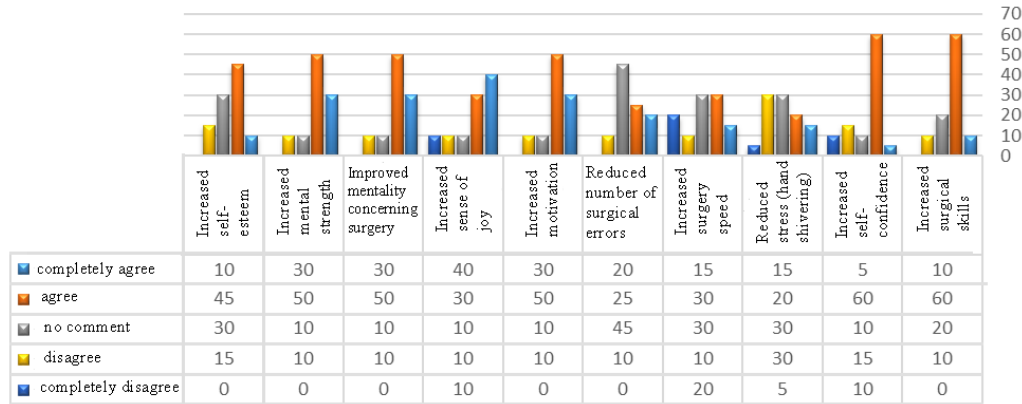


Figure 1: Self-assessment of sophomore residents about the efficacy of first experience with surgery on goat’s eye

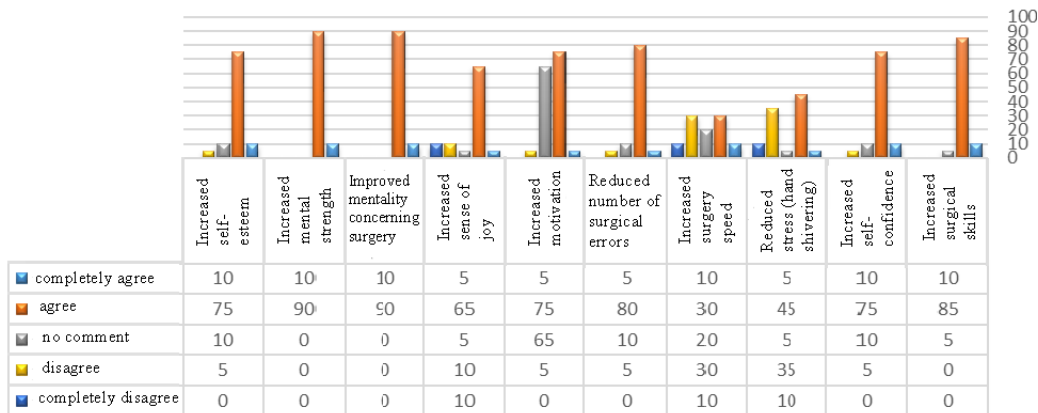


Figure 2: Assessment of junior and senior residents’ viewpoints about the efficacy of the first surgical experience of sophomore residents on goat’s eye

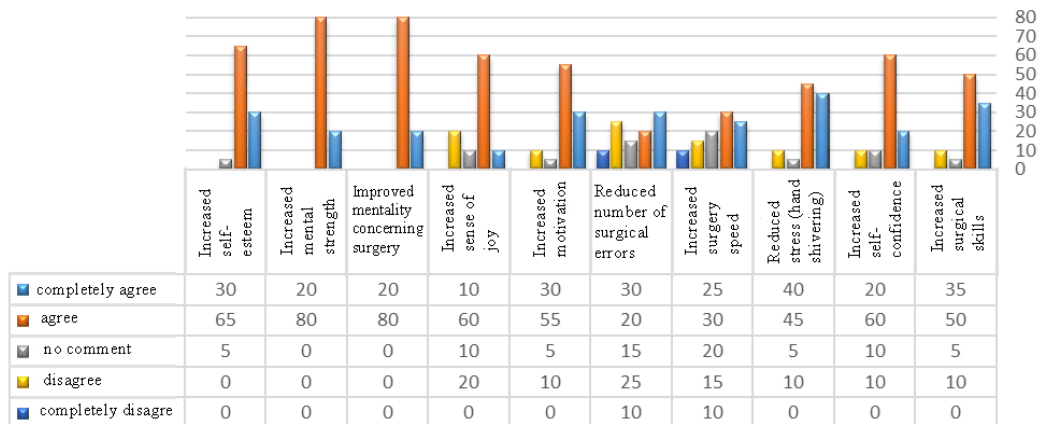


Figure 3: Assessment of attending specialists’ viewpoints about the efficacy of the first surgical experience of sophomore residents on goat’s eye

Moreover, the specialists assumed that the pre-operative exercises had a significant impact on agility (55%) and stress and hand tremors (85%) during the first operation on human eyes.

## Discussion

Many studies have been published regarding the importance of surgical simulation exercises. The results of all of these investigations are indicative of an improvement in the learners' surgical proficiency in real-life situations and on humans (10-12). Based on the residents' self-evaluation, the implementation of these exercises prior to OR experience on humans had weaker effects on surgical error (45%), agility (20%), and stress and hand tremors (35%) during the first surgical experience.

Similar studies on practicing with the pig's eye have shown that such practices before surgical operation on the human eye reduced the residents' surgical errors by ten times and increased the required confidence for operation on human eyes (14, 16).

In similar studies (8, 22-25), 80% of the ophthalmology residents stated that the practice and acquisition of the skills required for operation on animal eyes in the wet lab positively contributed to all dimensions of operation on human eyes. When questioned about whether the instruments available at the wet lab were sufficient and appropriate, 60% of the residents stated that goat's eye had many similarities to human's eye. They also affirmed that the instruments in the wet lab were appropriate for surgery.

Overall, studies have shown that wet labs have positive effects by facilitating the implementation of simple, safe, and cost-effective education through which the residents can acquire the skills needed for eye surgery.

Although most of the 3<sup>rd</sup> and 4<sup>th</sup> year residents in the present study did not have the wet lab experience, they stated that the exercises and instructions provided before the wet lab could positively affect their performance, stress, and error. The attending specialists believed that the wet lab could have positive effects on mental, emotional, and professional aspects. Nonetheless, some higher-level residents maintained that the wet lab cannot render a completely similar condition to that of the OR and that practically, it has a lower effect on agility, error, and stress.

The results of a quasi-experiential study conducted in 2018 on interns showed that the students trained in skills laboratory had a higher scientific ability and confidence than those going

through traditional methods when present at the patient's bed in real-life clinical settings (18). In a study addressing the medical students' evaluation of the quality of education provided at the clinical skills laboratory in Gilan, Iran, the results showed that most of the students were not satisfied with the quality of the education provided. However, they rated such centers as highly effective in preparing the students for subsequent presence in real-life clinical circumstances (17).

While wet labs play an important role in educating eye surgery residents, there are limitations in collecting the eye samples, which are completely identical to the human eye in anatomical structure. Differences in the frontal chamber, corneal structure, thick and elastic capsule, and big soft lenses are some of the variations present in the eyes similar to the human's eye. Despite such limitations, the wet labs are regarded as the most essential and practical alternatives for surgical exercises before operating the human eye.

## Conclusions

As the findings indicated, repeated practice in the wet lab under the supervision of higher-level residents and attending specialists can have very positive effects on some professional, mental, attitudinal, and even knowledge-based indices. Consequently, it is recommended to increase the efficiency of these laboratories by extending practice sessions and opportunities.

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## Conflict of Interest

This study does not have any conflicts of interest with any organization or institution.

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