Goldmann Applanation Tonometry Training: Past, Present, and Future

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BACKGROUND

Goldmann Applanation Tonometry (GAT), the gold standard technique for intraocular pressure measurement, was developed in the 1950s by scientist Hans Goldmann.[1] GAT utilizes the Imbert-Fick Principle, where intraocular pressure equals the contact force required to flatten, divided by the contact area on an infinitely thin-walled sphere.[2] An unskilled practitioner can cause harm to a patient during the performance of GAT by potentially causing corneal abrasions, incorrect IOP measurements, or risk of cross infection.[3] Numerous other techniques have been developed, such as Tonopen, Ocular Blood Flow tonograph (OBF), Non-Contact Tonometer (NCT), and Transpalpebral Tonometer, due to the complicated technical aspects of GAT. However, GAT remains the most accurate IOP check technique across ophthalmology practices, as the interobserver reliability is lower for other techniques.[4] While GAT is the gold standard for IOP measurement; it also requires a high skill of operation; thus, appropriate training is critical.[5] Present-day training requires a courageous volunteer to act as a patient. Physical models acting as artificial globes have been developed for training but require materials that may not be easily accessible and have associated costs.[6] To advance training in the modern age, we developed an online application that mimics the steps of GAT and is free to use for trainees at gatsim.com.

METHODS

```
gatScreen.lens.updatePosition();

 if (gatScreen.lens.loc.s > 5 && (
   Math.abs(gatScreen.lens.vel.x) > 1e-8 ||
   Math.abs(gatScreen.lens.vel.y) > 1e-8)
 ) {
   if (!creatingCornealAbrasion) {  // Don't create a duplicate message for the same
abrasion
     creatingCornealAbrasion = true;
     displayOnConsole("Corneal abrasion! Don't move while on the cornea.");
   }
 } else {
   creatingCornealAbrasion = false;
 }
```

Figure 1: Corneal Abrasion JavaScript Code

A website was created using HTML and JavaScript ES6, tested on Google Chrome version 103.0, and hosted on GitHub. The code is publicly available at https://github.com/ryerrabelli/TonometrySimulation.

RESULTS

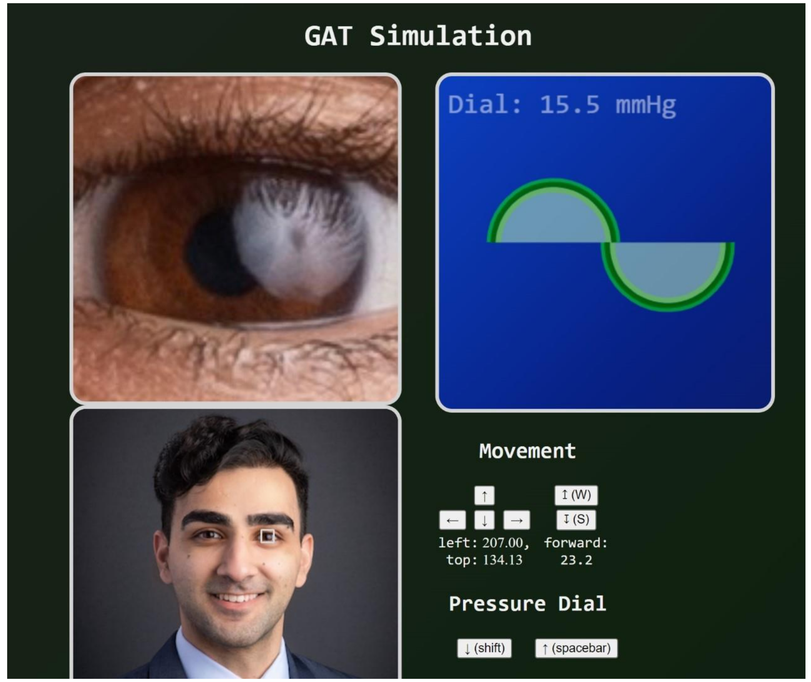

Figure 2: Goldmann Applanation Tonometry Simulator Version 004

We developed an online application that mimics GAT's steps and is free to use for trainees at gatsim.com. Trainees can now train on our model before seeing patients, which may ultimately improve outcomes. To our knowledge, this is the first time an online simulation of Goldmann Applanation Tonometry has been developed. This will allow individuals to train and learn the mechanics of GAT via an easy-to-use online application. We hope such technology will improve the skills of trainees, hasten the time to reach expertise, and minimize potential patient complications.

DISCUSSION

Modern training for GAT is not risk-free. Various instructors, videos, and protocols are available online for trainees to learn GAT. The Standard Operating Procedure (SOP) at the Moorfields Eye Hospital is another helpful source of information regarding GAT and its associated steps.[7] Physical models of artificial globes have been described, but they require materials that may be inaccessible.[6] To address these problems, we developed an online program that simulates the GAT procedure and can be used by trainees anywhere in the world at no cost. Future directions for the GAT technique may include a continued emphasis on user-controlled interaction and comparison studies between students trained in GAT and students trained in traditional methods.

CONCLUSION

GatSim is a free online simulator that helps trainees practice GAT. GatSim uses keyboard and mouse controls to mimic the GAT instrument's mechanics, so trainees can learn how to use the device before measuring on a patient's eye. We hope the application will improve training efficiency and reduce potential adverse events.

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