INTRODUCTION

Effective training to develop microsurgical skills requires at least 2×–5× magnification of the surgical field. Traditionally, surgical loupes and operating microscopes have been used; however, their high cost and limited accessibility are barriers to regular and consistent microsurgical training, particularly outside of the operating room or laboratory. The portability and accessibility of smartphones, as well as their ability to magnify, illuminate, and record videos, give this ubiquitous device the potential to serve as a valuable tool for microsurgical training outside of the operating room.

The variety and variability of smartphones, however, bring about differences in their magnification levels. For example, the numerical magnification scale that appears when zooming, if present at all, is, in fact, inconsistent between different smartphones. Moreover, differences in distance from the smartphone to the surgical field cause further inconsistency in magnification such that the magnification advertised is rendered meaningless. This standardization is imperative for microsurgical training because it would allow for reliability of (1) calibration to different magnification levels during training; (2) training in resource-challenged environments and home-based simulations; and (3) standardization of assessments of past performances to track progress. With these goals in mind, we sought to develop an effective calibration tool that ensures accurate magnification levels so that smartphone-based microsurgical training can be performed reliably with any device and in virtually any surroundings. (Plast Reconstr Surg Glob Open 2020;8:e2918; doi: 10.1097/GOX.0000000000002918; Published online 18 June 2020.)
the upper-left corner that needs to be viewed on the smartphone screen to perform the calibration. The calibration ruler is placed on the surface of the smartphone and is used to line up the edges of the calibration box image on the smartphone camera screen to the magnification level desired (Fig. 2).

The setup is performed in 5 steps as follows:

1. Place the smartphone on a stable base at a height of approximately 7–12 cm (a stack of textbooks can be effective because it can withstand adjustments during the setup and allow for magnification to be changed at any time without affecting the balance of the smartphone; magnification can be further adjusted by altering the number of textbooks, as fewer textbooks equal greater magnification). The stack can be slightly slanted (Fig. 2) for greater workspace while still allowing the camera to magnify and capture the surgical field.

2. Activate the smartphone video mode and adjust the camera image by zooming in and out such that the calibration box can be viewed on the smartphone screen.

3. With the calibration grid placed below the practice suture material and the calibration ruler placed on the smartphone, line up the edge of the calibration box image on the smartphone screen to the line marked “0” on the calibration ruler.

4. Adjust the image on the smartphone such that the width of the calibration box image on the smartphone screen matches the desired magnification level on the calibration ruler.

5. Proceed with microsurgical training.

**DISCUSSION**

This calibration tool is an important adjunct to smartphone-based microsurgical skills training, which is a modern approach to skills development that has been previously described.1–5 This tool was found to be effective in various smartphone models, including iPhone, Samsung, and Motorola models. Initial calibration takes approximately 1–2 minutes and then can be used throughout whatever training session the trainee chooses to perform.
(ranging from simple knot tying to full simulations of microvascular anastomoses).

This tool provides a simple way to obtain standardized calibration to different magnification levels. This is especially important because different smartphones display diverse magnifications, even if manually set to the same magnification level and placed at the same distance from an object. We found that the embedded numerical magnification scales, if present at all, were nonstandardized and, in fact, inconsistently accurate. Therefore, we created an effective method to standardize smartphone-based magnification to optimally practice microsurgical simulation techniques.

Using a smartphone is especially advantageous for several reasons. The ubiquity of the smartphone allows for its use in microsurgical training programs. The ability of the smartphone to record video allows users not only to review past performance results but also to store and transmit video files that instructors can access for assessment and coaching. Its use is particularly valuable in environments with limited access to resources or for self-directed training at home with a deliberate practice tailored to the trainee’s specific needs. Home-based microsurgical training is especially relevant in the era of restricted work hours, which limit the time trainees can spend practicing microsurgical techniques in the clinical setting. Smartphones offset this challenge by helping meet the demands for training outside of the clinical setting and allow trainees to learn basic microsurgical skills under conditions they choose, which often avoids the pressures commonly associated with hospital-based training.

One limitation compared with the use of standard surgical magnification (microscope or loupes) for training is that these devices allow for 3-dimensional magnification, while smartphone-based magnification provides only a 2-dimensional image (similar to laparoscopy). Nonetheless, continued practice could improve the ability to discern the depth of structures. Furthermore, by training in a more challenging environment, it becomes easier to perform the same skills when the 3-dimensional magnification is used in a live patient setting.

CONCLUSIONS

This report highlights the development of a simple yet effective calibration tool for the standardization of smartphone-based magnification. In doing so, a significant obstacle to the use of smartphones for microsurgical training has been eliminated.

Peter W. Henderson, MD, MBA
Division of Plastic and Reconstructive Surgery
Department of Surgery
Icahn School of Medicine at Mount Sinai
10 Union Square East, Suite 2L
New York, NY 10003
E-mail: peter.henderson@mountsinai.org

REFERENCES

1. Malik MM, Hachach-Haram N, Tahir M, et al. Acquisition of basic microsurgery skills using home-based simulation training: a randomised control study. J Plast Reconstr Aesthet Surg. 2017;70:478–486.
2. Huotarinen A, Niemelä M, Jahromi BR. Easy, efficient, and mobile way to train microsurgical skills during busy life of neurosurgical residency in resource-challenged environment. World Neurosurg. 2017;107:358–361.
3. Perry D, Albert M, Akyurek M. Use of smartphone cameras for simplified and cost-effective video recording of microvascular techniques. Plast Reconstr Surg. 2015;135:941e–943e.
4. Kim DM, Kang JW, Kim JK, et al. Microsurgery training using a smartphone. Microsurgery. 2015;35:500–501.
5. Choque-Velasquez J, Colasanti R, Collan J, et al. Virtual reality glasses and “eye-hands blind technique” for microsurgical training in neurosurgery. World Neurosurg. 2018;112:126–130.