

Microsurgery Arena: A New Device to Develop Microsurgical Skills

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Summary: Simulation in microsurgery is an important pillar of training and maintenance of surgical skills. Between learning microsurgical skills and mastering them in clinical practice, the usefulness of low-fidelity simulators for improving microsurgery skills has been well documented. Nowadays the in vivo models represent the gold standard of microsurgical training; however, their use implies difficulties and limitations. We developed a portable, low-cost, and modern device to help trainees to practice at their convenience to maintain their microsurgical suturing skills. By using CAD and 3D printer designs, we developed a “microsurgery trainer” that contains a middle section with eight projections with holes, arranged as a circle. The idea is to pass the microsuture—preferably 7/0 or 8/0 sutures—in a clockwise manner—with the needle passing from “out to in” and “in to out” through each hole. This allows the trainee to use his/her wrist to be flexible and achieve better control over the micro needle. Studies evaluating the potential of such a device in shortening the learning curve are needed and will be crucial to define whether the “microsurgery arena” will help trainees to obtain better outcomes in microsurgical practice. (*Plast Reconstr Surg Glob Open* 2021;9:e3782; doi: 10.1097/GOX.0000000000003782; Published online 19 August 2021.)

Simulation in microsurgery is an important pillar of training and maintenance of surgical skills,¹ with in vivo models representing the gold standard of microsurgical training. However, taking into consideration the three R principles (replace, reduce, refine), the high costs of animal labs, and the need to set up dedicated training centers, their use implies difficulties and limitations.² Recently, low-fidelity non-biological simulators have gained recognition due to their ability to circumvent some of these problems,³ and a variety of ex vivo

simulators (either organic or synthetic)⁴ have been developed. However, these are expensive and generally focused on anastomosis-related technique only, with difficulty in quantifying progress during their use.

When training on simulators, hand coordination moving a surgical instrument in different directions implies the recruitment and use of different muscles and wrist flexibility. Indeed, the same technical gesture can have different degrees of difficulty depending on the position in the space, the angle and the direction in which it is performed. To tackle this aspect of training, we developed an innovative, low-cost, portable and reusable device, based on our previous experience with “round-the-clock” training exercises.^{5,6} This device aims to help trainees practice at their convenience and improve fluidity and coordination as a crucial complement to ex vivo or in vivo exercises, being used as a trainer, a warm-up, and an assessment tool.

The device (international patent) consists of two parts, entirely developed by CAD and produced by 3D printing technologies. The design is characterized by a circular base housing the “arena,” and a middle circular section with eight cone-shaped projections with a centripetal

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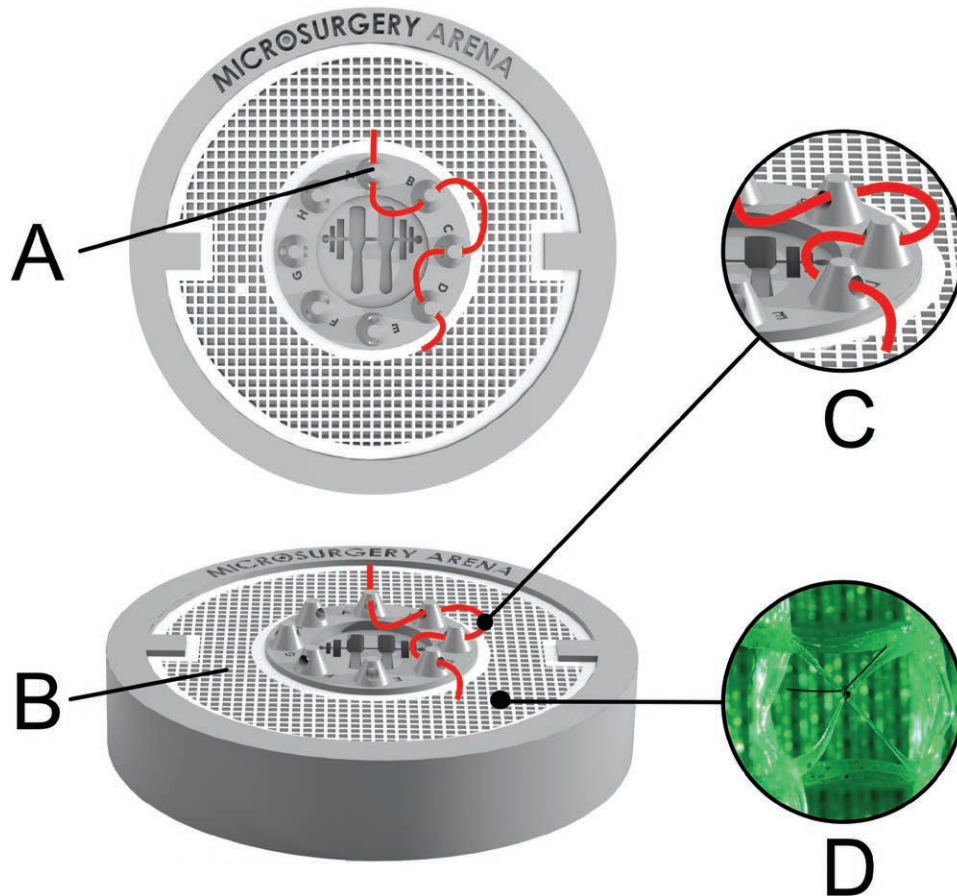


Fig. 1. Representation of the device. A, The central arena containing the conical projections used in the slalom exercise. B, The interchangeable multilayer elastic mesh used to perform the tie-the-knot exercise. C, The closeup of the slalom exercise. D, A microscopic view of the mesh sutured with an 8-0 microsuture in the tie-the-knot exercise.

through-hole (Fig. 1A). The central section is surrounded by an interchangeable multilayer elastic mesh (Fig. 1B). We have designed two exercises made to train different kinds of movements: the “slalom” and the “tie-the-knot” exercises. (See Video [online], which demonstrates the exercise that can be performed with the Microsurgery Arena. Slalom exercise: the needle is passed out-to-in and in-to-out through the eight holes and the trainees must work against the timer with precise movements to prove their dexterity and speed in relation to the angle of movement. Tie-the-knot exercise: designed to improve suturing passages and knot tying under tension.)

In the slalom exercise, a microsuture is passed in a clockwise manner with the needle passing “out-in” and “in-out” through each hole, as fast as possible (Fig. 1C). The inner middle circular section is designed to develop needle coordination in space along different directions, demanding different wrist orientations.

The elastic 3D-printed silicone mesh surrounding the central area allows trainees to exercise tying a knot with a microsuture under tension, while making a “secure” knot. (Fig. 1D). The entire device is anchorable to any dry and flat surface through a reusable and patented adhesive disk, to allow the execution of exercises in a stable manner. In

addition, the modular structure also allows replacing the mesh with other exercise meshes, transforming the device into an exercise playground capable of meeting the needs of different microsurgical disciplines.

Although this device is not meant to outplay the actual gold standard for microsurgery, we believe that it could help improve microcoordination, finger/wrist flexibility, and better control over the microsurgery needle and the microsurgical knots, training movements in a lo-fi standardized scenario. It can be a valuable ally to microsurgical skill maintenance to be put beside in vivo and ex vivo training.

Studies evaluating the potential of such a device in shortening the learning curve are needed and will be crucial to define whether the multiple appealing features of the Microsurgery Arena will translate into better initial microsurgical training, faster trainee progression and, ultimately, better outcomes in microsurgical practice.

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