How to Organize Affordable Microsurgical Training Laboratory: Optimal Price-quality Solution

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Summary: Today, microsurgery is an integral part of plastic surgery, maxillofacial surgery, hand surgery, and neurosurgery. More and more surgical procedures are accompanied by microsurgical intervention. Long training is required to develop the necessary skills for fine work with microsurgical instruments and delicate tissues under magnification. We suggest a methodology as to how to organize an inexpensive microsurgical training laboratory with minimal investment. Suggested guidelines provide information about cost-effective ways of arranging a comfortable training environment. An adapted stereoscopic microscope allows working with a wide range of magnification and focus distance. An ergonomic working position is set up by adjustable handmade table and chair. For performing basic microsurgical manipulations, a set of four instruments and inexpensive suture materials are used. A total amount of 323.5 USD was spent to purchase all of the necessary components for the microsurgical laboratory. The described components are available worldwide regardless of manufacturers. We suggest an inexpensive way to arrange a microsurgical laboratory. This approach is especially beneficial for students and residents from low-income countries. (Plast Reconstr Surg Glob Open 2021;9:e3791; doi: 10.1097/GOX.0000000000003791; Published online 13 September 2021.)

INTRODUCTION

The low availability of operating microscopes and instruments still creates a serious limitation for novice trainees because of their expense. In our article, we suggest a complete step-by-step approach as to how to organize an affordable microsurgical training laboratory. This includes the assembly and set up of an accessible stereoscopic microscope, which also allows for performing microsurgical manipulations1,2 on living biological models.

MATERIALS AND METHODS

We performed an extensive search in leading global and local online stores (Amazon, AliExpress, Wildberries, etc) using the following search terms: “stereomicroscope,” “jeweler’s microscope,” “microsurgical instruments set,” and “microsurgery thread.” The aim of this search was to identify the optimal consensus between the price and quality of required microsurgical items.

RESULTS

Microscope

There are many high-quality microscope models from various brands available on the market (Carl Zeiss, Leica, Olympus). However, their prices are too high and do not allow the student or the resident to afford them (eg, Zeiss OPMI Pico techno microscope costs nearly 17,000 USD). Only highly equipped institutions could purchase such equipment for training purposes. We set up an inexpensive microscope that is suitable for basic microsurgical manipulations. Our hand-made magnification system is based on a microscope that is widely used by jewelers and electronics engineers: Eakins trinocular stereomicroscope with a 10× eyepiece (original magnification: 7×–45×; working distance: 100 mm; field of view: 28.6 mm) (Fig. 1). The microscope has a third scope, which allows for attaching the DSLR camera adapter from different manufacturers (Canon, Nikon). This feature gives the opportunity to demonstrate and record the manipulation process. Recorded videos are useful for monitoring training progress and consultations with the mentor. A 56 LED intensity-adjustable ring lamp is used as an illuminator.

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These limitations are dealt with using a 0.3× reduction auxiliary lens (Fyscope). The reduction lens brings the magnification parameters closer to those of a real surgical microscope. The lens reduces the magnification capacity by 70% and increases the working distance 2.87 times (100–287 mm). (See Video 1 [online], which displays the rat femoral artery model for microsurgery skills training. This video displays an end-to-end anastomosis on a rat femoral artery, using the halving technique. The anastomosis is made using our handmade microscope.) (See Video 2, which displays the patency assessment on a rat femoral artery model. This video demonstrates how several tests should be performed to assess the patency and tightness of the anastomosis. The Acland test is one of the widely used assessment methods.)

The stand of the microscope should cover a large working area, be flexible in all dimensions, and securely attach to the table. A monitor desk mount stand is perfectly fit for these purposes. The microscope head holder is fixed to a stand with a handmade adapter, which, in turn, attaches to a universal VESA mount adapter (Fig. 1, Table 1).

Working Space

Only a comfortable working environment allows for enduring many hours of training. It has been proven that working space ergonomics influence the outcomes of surgical procedures. There is a high incidence of musculo-skeletal injuries among microsurgeons because of their intensive working rhythm. The cervical spine is affected the most. That is why all parts of the workspace must be personally adjusted.

We assembled our table from a local furniture store (IKEA). The table includes four adjustable legs, with a height accommodation rate from 67 to 107 cm and a metal tabletop (150 × 75 cm). We bought the legs and tabletop separately, and the total price for this configuration was 52 USD.

The chair should have armrests. But in practice, such specialized microsurgical chairs are expensive (Salli Expert costs 1500 USD). We suggest using a chair with a comfortable back and with a wide range of height adjustment (46–57 cm). The adjustable chair in synergy with an adjustable table allows achieving an optimal working position. We purchased a chair from a local furniture store for 37 USD. For forearm support, we used rollers made from surgical drapes (pillows) or rice packets (Fig. 2). The training conditions can be adapted both for individual work and for working with an assistant.

Instruments

During the first steps in microsurgical skills training, there is no need to buy an expensive branded instrument. Basic sets of microsurgical instruments are widely available on global online stores. A basic set includes four instruments (tissue forceps, suture forceps, straight scissors, and needle holder). (See Video 3 [online], which displays end-to-end anastomosis on a chicken femoral artery using our handmade microscope. Chicken thighs and wings are good models to start mastering the basic principles of tissue handling.) They are available at a price starting from

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**Table 1. Magnification System Price List**

| Parts                            | Price $ (USD) |
|----------------------------------|---------------|
| Microscope (head, head holder, LED ring) | 139$          |
| Lens 0.3×                        | 27$           |
| Handmade adapter                 | 12.5$         |
| Desk mount stand                 | 15$           |
| Total                            | 193.5$        |
23 USD. A vessel flushing system can be assembled from an IV catheter, syringe, and soft tube (Fig. 2).

Suture Materials

In microsurgery, monofilament nylon or polypropylene threads from 8-0 to 12-0 are used. Suture material can be obtained from hospitals when it is expired. It can also be ordered online, where the average price for 10 pieces of taper two-needle 8-0 nylon threads is 18 USD (less than 2 USD per unit). We advise to purchase two-needle thread because it could be cut and used as a separate more convenient thread unit (Table 2).

DISCUSSION

Residents should have ad libitum access to a training laboratory or there should be a schedule of classes where residents can train under the supervision of a mentor. According to a survey by the American Association of Reconstructive Microsurgeons, 42% of residents did not have permanent access to microsurgical laboratories during their studies. However, there are hospitals with a well-established training system, where, throughout the learning period, residents receive graduated experience in microsurgery.

Microsurgery is a rapidly growing surgical discipline. It is not necessary to have expensive facilities or simulators to acquire good microsurgical skills. Modern microsurgical courses are held all over the world and provide highly organized and advanced education. These courses provide a great opportunity for developing and improving microsurgical skills. However, they are not regular and still expensive. For the average price of one course, the trainee could purchase 3–5 microsurgical kits with all of the equipment described above.

CONCLUSIONS

We suggest an inexpensive way to set up a microsurgical laboratory. In total, 323.5 USD was spent on all acquisitions. Most of the expenses went to purchase a high-quality and practical magnification system, which is fundamental to the arrangement of a microsurgical laboratory. Considering the difference in exchange rates and pricing policy of the same supplier in different countries, it is accepted that the total amount of expenses could vary within an additional 50 USD from the aforementioned price.

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