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EDITORIAL

New Paradigms in Reconstructive Microsurgery Education

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Metrics

Microsurgery is a highly specialized group of techniques conducted under the magnification of a microscope. It is possible to divide these techniques in 3 main branches: vascular, nervous, and lymphatic. It is a fundamental technique in surgical specialties such as plastic surgery, vascular surgery, and maxillofacial and head and neck surgery.[1] In the field of plastic surgery, microsurgery involves the transfer of tissue from one part of the body to another for wound coverage, reconstruction secondary to tumor resection or trauma, and, more recently, for extremity and face allotransplantation. It has become an indispensable routine part of reconstructive surgery in almost all plastic surgery units around the world. Furthermore, the applications for this type of surgery are constantly increasing. To determine just how much academic productivity in these fields has increased in recent years, we performed a systematic search in MEDLINE and Pubmed Central. We used *microsurgery* (Mesh) terms and subspecialties such as plastic surgery, neurosurgery, head and neck surgery, maxillofacial surgery, vascular surgery, and ophthalmology from 1990 to 2015. Figure 1 shows how from 2000 onwards, this growth was exponential, proving to be particularly prominent in neurosurgery, vascular surgery, and plastic surgery (Fig. 1).

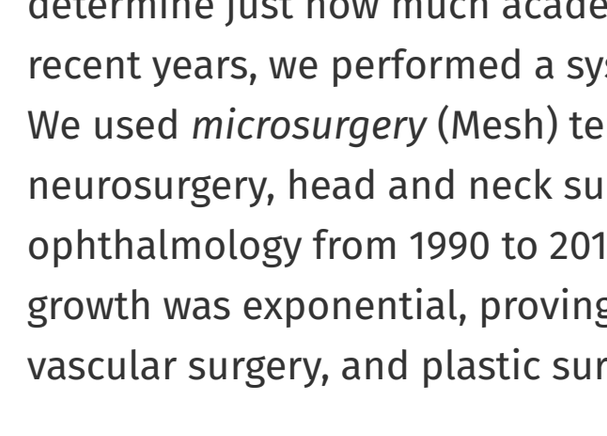

FIGURE 1: Academic productivity in microsurgery from 1990–2015.

Microsurgical procedures, however, are highly complex and time-consuming procedures, requiring great manual dexterity, fine visual motor coordination, a steady and fluid technique, and the ability to solve complications encountered intraoperatively. Mastery of all these skills is not generally achieved during residency programs for surgical programs owing to limitations in time, resources, and opportunities to practice microsurgical technique in clinical settings.

Today, the current situation is that there are important growth and development of the techniques and applications of microsurgery in all of the fields of surgery as well as an increase of demand of microsurgery in superspecialized hospitals and also in regional hospitals, but, on the other hand, there is not a balanced increase of learning programs to educate surgeons in this field in both developed and emerging countries.

TRAINING SOURCES IN MICROSURGERY

For the reasons outlined previously, there is much potential for technical skills, such as vascular anastomosis and flap raising, and nontechnical skills, such as decision-making, situational awareness, communication and teamwork, and leadership, to be included in surgeons' training.[2] A variety of microsurgical fellowships and training courses have been established in different centers and countries aiming to meet this goal.

Fellowships

Because the ultimate goal of the microsurgical training is to achieve clinical competence, clinical fellowships have been specifically developed for this purpose. However, these microsurgical fellowship positions are scarce because of the intense nature of the fellowship training, whereby fellows undergo not only additional training but also an apprenticeship that enables them to learn from the knowledge of a mentor.[3–6]

To determine the availability of such programs, we conducted a search for fellowships in plastic surgery offered around the world. These are depicted in Table 1, which shows a positive correlation between developed countries and the number of fellowships available. The opportunities for surgeons from developing countries to attend such courses are scarce.

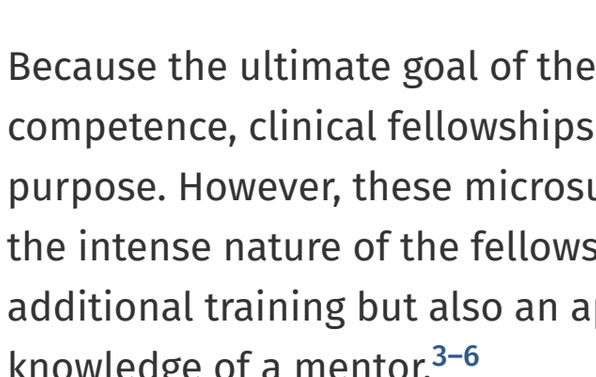

TABLE 1: Fellowships Available Worldwide Compared With Total Population

Microsurgery fellowships across the world are highly heterogeneous. One reason for this is the wide and diverse range of surgical fields, varying from hand surgery to breast or head and neck reconstruction. Standardization is therefore difficult to address. Applicant selection also varies. In few countries like United States and Canada, there is a national matching system to select applicants, whereas in others there are no entry requirements and selection is based almost exclusively on a personal interview. Lack of consensus regarding assessment of competency after completion of the fellowship is another issue of concern. The content of the training programs, the duration, and the trainee-to-trainer ratio also varies significantly from one center to another. Appropriate evaluation of the trainees after completion of the training program could be an important factor to ensure consistent and effective training, enabling participants to achieve appropriate levels of competency. A systematic evaluation using a measurable approach of the acquired skills may show the weak points of each of them. Rather than relying on an apprenticeship model of learning, some authors hypothesize[7] that microsurgical training can be broken down into components that can be evaluated and measured. Several tools with different scales are used to assess acquisition of skills. Surgical performance can be rated using item task-specific checklist and a global rating scale (GRS).[8] When used by trained assessors, GRS demonstrates good reliability and validity. Grober et al[9] developed a GRS for microsurgery. Temple and Ross[10] developed the University of Western Ontario Microsurgery Skills Acquisition/Assessment instrument that included the knot tying and anastomosis modules containing 3 categories with 5-point Likert scales. In United Kingdom, the Joint Committee on Surgical Training (http://www.jcst.org) acts as an advisory body to develop quality assurance in surgical training. The structured assessment of microsurgery skills is an appropriate instrument because it covers the core components of microsurgical skills. Selber et al[7] created a scale for systematic evaluation of the surgical training programs including 12 items grouped into 4 main categories of microsurgical skills: dexterity, visuospatial ability, operative flow, and judgment. Ideally, the assessment of the microsurgical skills with the aforementioned scales should be performed under experimental or in vivo models and in the clinical setting because the main goal of these training programs is to gain competency in the clinical setting. Among the fellowships included in the current study, only some of them included an exit examination to evaluate the acquired knowledge, but the skills evaluation remained unclearly stated.

Training Courses

Microsurgery is more than an advance course of microsurgical technique, but it is mandatory to achieve and establish a refined microsurgical technique to face the clinic reconstructive challenges.

Models of microsurgery training around the world have a similar basic curriculum but differ considerably concerning methods, contents, and continuous development. The median duration of most courses is 40 hours, ranging from 20 to 1950 hours.[3] In all of them, it seems that introductory videos and short lectures are used to give students the basic knowledge to perform microsurgery for the first time. Exercises are introduced with increasingly levels of difficulty.[11,12]

Microsurgeons who want to further develop their skills are encouraged to take the advanced courses given in all of these microsurgical schools. In advanced courses, trainees review and update fundamental microsurgical techniques and learn additional microsurgical techniques specific for specialties. It has been calculated that it is necessary to perform at least 120 hours of hands-on experience to acquire the skills necessary to guarantee successful results in microsurgery. Current theories support the idea that practice of a space activity with periods of rest (distributed practice) consolidates learning better than practice delivered in continuous blocks with no rest between (massed practice).[13] In some countries, in a significant number of laboratories, training today is conducted using nonliving models in view of recent restrictions with live animals and microsurgery simulation based on chicken wings, grape skin, rat cadavers, and plastic simulation materials,[14,15] which are particularly useful at a beginner stage when students need to acquire basic knowledge regarding use of the surgical microscope and practice handling instruments and small suture techniques.[16] Using nonliving animals at the beginning of microsurgical learning decreases the number of living animals used for training purposes and give more confidence when working in animal model.[17] However, the rat model remains indispensable model for an advanced microsurgical courses. Rat model offers to the student the advantage of working with the most accurate simulator of real microsurgery. The student can work from the easiest practices up to the most sophisticated ones, such as face transplant or lymphatic surgery. The rat is still one of the most versatile models in microsurgery.

There is a clear limitation in these courses: in most of them, it is not possible to acquire the dexterity needed to perform a microsurgical procedure, because they are simply an introduction to microvascular suture technique; on the other hand, a proper clinical training is mandatory to achieve this aim.

New Educational Model in Microsurgery: University Degree in Reconstructive Microsurgery

The development of perforator microsurgery and our growing knowledge of anatomical variability imply the need for new models of learning. Classic dissection courses are still essential, but the most efficient model of microsurgical learning today is probably perforator flap courses in in vivo animal model. Based on this assumption, in 2006, a group of European microsurgeons founded a master class at the Covidien European Training Center in Versailles (France) where they developed a dissection course on perforator flaps in the Meshian pig model. After several editions and with the awareness of the need for clinical immersion periods to train new microsurgeons, the idea of a new educational program was born.

The concept of European School of Reconstructive Microsurgery was founded in 2008 to design the International Master's Degree in Reconstructive Microsurgery program. Its aim was to provide advanced quality training in microsurgery with a clearly defined professional specialization. The program then offers comprehensive, specific microsurgical training in breast surgery, brachial plexus surgery, hand surgery, head and neck reconstruction, limb salvage, genitourinary, and supermicrosurgery.

It is delivered in a modular format (11 modules) and has a total duration of 2 years. The first 6 modules consist mainly of specific clinic modules; they also include practical sessions of live surgery conducted as an introductional course. These practical modules are essential because there is general agreement about the usefulness of courses in flap raising and microvascular experience before starting free flap transfer on a clinical case.[18] Then, 4 modules of laboratory workshop (small animal model, live animal model, and cadaver workshop) and a microsurgery course in a laboratory setting are also considered requirements in the early stages of training.[1,19]

The first 10 modules are held at various locations in Europe; each module is held in a recognized center in the field that corresponds. The last module[4] is the longest period of training; it is a clinical immersion module and can be carried out at several possible microsurgery departments around the world such as Taipei Chang Gung Memorial Hospital (Taiwan), New York University Medical Center (United States), Queen Victoria Hospital (United Kingdom), Helsinki University Hospital (Finland), and Tokyo University Hospital (Japan) (Fig. 2).

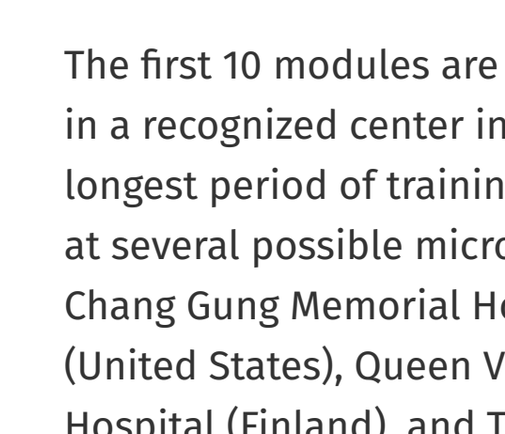

FIGURE 2: Microsurgery clinical departments in collaboration with European School of Reconstructive Microsurgery.

Because motivation to want to specialize in microsurgery differs, we consider that it is ideal to design an educational itinerary to fit the needs of each student. One advantage of the master's training program is that it can be individually tailored. Clinical immersion is adapted so that each student can achieve high level of expertise in the fields chosen providing a full, flexible, and blended educational program that allows surgeons at different stages of knowledge and expertise to acquire their desired goals. It is not always possible for surgeons to participate in a clinical immersion program for 1 or 2 years as is contemplated in fellowship programs. Shorter periods can be compatible with jobs in regular clinical practice. According to Chan et al,[1] exposure to 10 to 25 microsurgery cases per year are needed to maintain technical skills, whereas 25 to 50 cases per year are considered "excellent" exposure. During the clinical immersion in the master's degree, microsurgery trainees can be involved in 60 to 150 microsurgical cases depending in the length of the clinical immersion. This body of knowledge should include essential nontechnical skills. Planning the various steps of an operation involving microsurgery, selecting patients, organizing and monitoring the theatre team, and maintaining the flow of the operation to postoperative care are all crucial skills that should be included as part of the specialist knowledge. Nicholas et al[20] classified the nontechnical skills for surgeons into 4 categories: decision-making, situation awareness, communication and teamwork, and leadership. Training programs should provide variation of cases to help develop these skills. Microsurgery gives rise to many unexpected complications, and the surgeon, supported by the team, should be comfortable and capable of solving these.

Candidates who successfully complete the full course are awarded an official master's degree recognized by the Universitat Autonoma de Barcelona with 90 European Credits Transfer System (1 European Credits Transfer System = 25 hours in student's work). To qualify for this degree, trainees must attend all the modules, pass the practical assessment, complete the clinical immersion, and present a research project.

This new line of education allows surgeons to learn from the body of knowledge that their mentors have acquired over their long career and to share their new experiences with other surgeons in their same situation. Each student is assigned a professor who acts as mentor during the second stage of the master. A mentor's task is to guide in the learning of research methodology within the European framework and to facilitate the opportunity to prepare their doctoral thesis (PhD) in Europe.

It is an added bonus that students acquire knowledge from different perspectives owing to the variability of the European system. It allows to know different health and learning systems.

An online campus has been established to promote debate among the faculty and students and to provide a platform to discuss key subjects within each surgical specialty. Articles, videos, formative evaluation tests, study cases, and crossfire debates are presented. It is similar to Plastic Surgery Education Network but with the advantage that allows interaction between students, alumni, and teachers to create a community that is the essence of the European School of Microsurgery. This community works together not only during the training period but also shares experience, knowledge and advancement. For this purpose, every 5 years, an Update Symposium is held in partnership with the industry to improve the educational system, innovations, and new techniques.

We consider that these goals can only be achieved by creating transversal, multicenter, and coordinated programs to guarantee the same level of excellence for all students. Learning on our own in the theater, faced directly with real patients, cannot be the optimal setting for learning environment. Just as the European Board Examination in Plastic Surgery (organized by European Board of Plastic Reconstructive and Aesthetic Surgery) is intended both as a quality mark and to help in the balance of standards in Europe, a quality mark is also needed in microsurgical education. In this regard, the combined efforts of prestigious European microsurgical schools provide students with optimal levels of teaching.

In June 2015, The European Federation of Reconstructive Microsurgery Societies (http://www.efsm.eu) adopted this educational program as the recommended model within the European Union framework.

After 6 editions of this master, 130 surgeons have been trained from 25 different countries. The clearest proof that the system works is that most of these alumni have developed microsurgery in places where it was nonexistent (Costa Rica, Colombia) or in countries where microsurgery was only held in specialized centers and now it has spread in regional hospitals (Spain, Italy, Austria).

CONCLUSION

Microsurgery is one of the most demanding skills in the field of surgery. Training in this field remains a challenge in view of the misbalance between the supply and the demand in the developing countries. Facilities should be provided to extend training to countries with a higher demand, regardless of their developmental status. New educational formulas are needed to meet current demands. The program developed and proposed by the European School of Microsurgery Reconstruction is a formula worthy of consideration.

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