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1 The Philosophy of Microsurgical Practice: Four Founding Principles Inherited from the Great Thinkers

Evgenii Belykh and Peter Nakaji

Abstract
The philosophy of microsurgical training is underpinned by four essential principles: (1) close replication of the microsurgery environment results in familiarity and ease with actual procedures; (2) repeated practice of the same techniques builds muscle memory and enhances mindfulness; (3) thoughtful preparation and rehearsal; and (4) training on increasingly more complex microsurgical tasks builds higher level skill and aids progress through the stages of competence. These principles encompass the essence of how well-planned, deliberate, thorough, and repeated microneurosurgical practice within a laboratory setting can improve the operative skill set of the neurosurgeon. Such training facilitates the refinement of the manual skills needed by neurosurgeons not only to enhance their professional ability but also to treat their future patients, whose welfare rests in their hands.

Keywords: anastomosis, bypass, competence, deliberate practice, mindfulness, movements, philosophy, practice, training

1.1 Introduction

Cerebrovascular surgeries are challenging and may be viewed as battles of a neurosurgeon against the pathology, with the battlefield being the most complex and precious area of the body—the human brain. Our way of thinking about and preparing for complex cerebrovascular surgeries and bypass procedures in particular, interestingly, is in line with classical philosophical teachings. At its finest, the art of microsurgery is an endeavor illustrating the pinnacle of human skill. Guiding principles borrowed from the military strategist and philosopher Sun Tzu, Taoism philosopher and moralist Chuang Tzŭ, and innovator and pioneer in industrialization Henry Ford underpin our view on the philosophy of microsurgical training. The following four principles will help to navigate the trainee through microsurgical training and form a framework that can aid in the production of better trained, more confident, and more competent neurosurgeons.

1.2 Principle One: The Terrain

"The natural formation of the country is the soldier's best ally."

—Sun Tzu

The trainee should always seek to expand his or her understanding of the landscape of microsurgical approaches. Our mind is limited by conceptions of what is possible and what is not possible in a particular clinical situation, what is acceptable and what is unacceptable, and what is reversible and what is irreversible. Most of the limits in our mind are psychological, practical, economic, or aesthetic in nature and are flexible, while others, like physiological and anatomical boundaries, are more rigid. However, even technical and physiological boundaries that are perceived as absolute are mostly due to the gaps in our knowledge of surgical anatomy or lack of awareness of new techniques or technologies. There are many neurosurgical centers that have various visions relating to the uses and utility of cerebrovascular bypasses. Still, the first principle, the knowledge of neuroanatomy, remains perpetual and foundational. Understanding of natural "narrow passes," "accessible grounds," safe zones, and the normal and pathological locations of the vasculature grants the surgeon confidence and creates comfortable terrain for work with cerebral arteries and for performing bypasses in the service of the treatment of cerebrovascular diseases.

The environment and models for microsurgical training ideally should be as close to real conditions as possible, especially during the final stages of training. This facility with simulated surgery allows the trainee to face challenges and take advantage of the terrain presented by patients' anatomy in performing microsurgical approaches.

1.3 Principle Two: The Movement

"A deal of poverty grows out of the carriage of excess weight."

—Henry Ford

Dynamic stereotypes developed in our unconscious minds are potentially more powerful than those in our conscious minds. Complex, rapid, and accurate instrument manipulation in the hand of an expert neurosurgeon constitutes a dynamic stereotype that can be divided into several simpler acts or moves. Many movements, especially for the early trainee, are inefficient; they have "excess weight" that makes the performance "poor." Creating a new dynamic stereotype for microsurgery is difficult, but unlearning old, inefficient stereotypes is sometimes even more difficult. Learning a new, efficient, dynamic stereotype requires disassembly of the old stereotype and stepwise assembly of a new one.

For neurosurgeons who will specialize in microsurgery, frequent and repeated practice in the laboratory will ingrain the specialized habits required for microanastomosis so that the individual steps of an operation can be done by rote, without hesitation. With repeated practice of separate steps, the subconscious soon realizes what must be delivered to meet the desired goals. As these steps blend together, the process becomes increasingly fluid, which allows the surgeon to concentrate on higher level functions: the conscious mind of the surgeon is free to focus on decision-making and adapting the procedure to the particular needs of the individual patient, as dictated by anatomy and the clinical situation.

Having done the necessary work to make the basic processes of microsurgery comfortable and automatic allows the surgeon

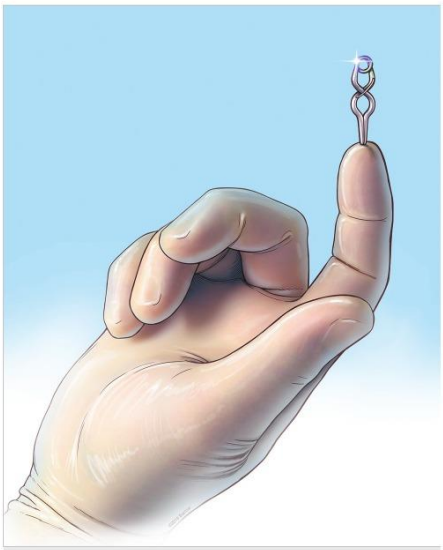

Fig. 1.1 Balancing an aneurysm clip on the tip of the finger. An artistic metaphor for the complete concentration and accuracy required for mastering microneurosurgery.

to relax mentally and physically and thereby to experience less personal stress, which by extension will ease the inherent stress of the operation for the support staff (▶ Fig. 1.1). A more relaxed operating team works together more smoothly and dispatches minor irregularities in the procedure with ease.

1.4 Principle Three: The Preparation

"The general who wins the battle makes many calculations in his temple before the battle is fought. The general who loses makes but few calculations beforehand."

—Sun Tzu

Achieving a heightened state of mindfulness does not come simply from believing in it or willing it. It is a state gained through disciplined practice. Yet the fundamental skills of microsurgery should not be developed and acquired while working on patients. The neurosurgeon should emulate the musical performer, who does not make an audience endure endless rehearsals, or the bomb squad that defuses live bombs only after practicing endlessly on fake ones. The neurosurgeon should refine and maintain these skills through practice in preparation for surgery on patients. As Anders Ericsson and colleagues[1,2] have noted, deliberate practice improves performance in the individual operation being practiced and strengthens one's overall surgical skill set. Few if any would question this assertion, which is supported by ample evidence.[3,4]

Accurately and rapidly anastomosing the thinnest and smallest of blood vessels in the human brain is a daunting endeavor and should be regarded with appropriate gravity. Dissecting the perforators off the dome of a ruptured aneurysm is an act of fortitude and precision conducted a fraction of a millimeter away from human tragedy. Yet these and other microsurgical techniques are much more than mere physical acts. Just as peak athletic performance is as much mental as it is physical, microsurgery also requires a mindset that is developed by years of rigorous discipline and preparation, calm equanimity, and mindfulness. The microsurgery operating suite has no room for anxiety, distraction, or agitation. The surgeon must be completely present and fully aware.

Extensive practice leads to a high level of reproducibility, which yields superior results that, in turn, build confidence and create an upward spiral of success.

1.5 Principle Four: Complete the "Four Stages of the Fighting Rooster"

"Chi Hsing Tzŭ was training fighting cocks for the prince.
At the end of ten days the latter asked if they were ready. 'Not yet', replied Chi; 'they are in the stage of seeking fiercely for a foe'.
Again ten days elapsed, and the prince made a further enquiry. 'Not yet', replied Chi; 'they are still excited by the sounds and shadows of other cocks'.
Ten days more, and the prince asked again. 'Not yet', answered Chi; 'the sight of an enemy is still enough to excite them to rage'.
But after another ten days, when the prince again enquired, Chi said, 'They will do. Other cocks may crow, but they will take no notice. To look at them one might say they were of wood. Their virtue is complete. Strange cocks will not dare meet them, but will run'."

—Chuang Tzŭ

Any new skill develops through four main stages: unconscious incompetence, conscious incompetence, conscious competence, and finally unconscious competence (▶ Fig. 1.2).[6] Awareness of these stages helps individuals to understand their personal position on the learning curve and to visualize the skills that they will need to acquire in their career several years ahead. They can thereby anticipate possible mistakes and be prepared mentally for the arduous process of complex microsurgical skill acquisition. Concordant with the views of contemporary psychology, these four stages of skill acquisition are nicely illustrated by the ancient Chinese parable about the training of the fighting rooster.[5,7]

In the first stage, the trainee knows the strokes and techniques of a microanastomosis and even performs it decently on the mannequin. The trainee often thinks that he/she is ready to perform the procedure on patients in every situation. However, the trainee has not experienced the real conditions of surgery. In imaginary battles, the trainee wins imaginary victories. The trainee may not care who or what the patient is, as all cases look similar.