Ergonomics-Based Positioning of the Operating Handle of Surgical Microscopes

Satoru Shimizu, M.D.
Department of Neurosurgery, Yokohama Brain and Spine Center, Yokohama, Japan

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To change the optic axis of surgical microscopes, the operating handle (OH) is commonly used.

However, its manipulation with one hand while the other applies suction requires force, especially when the OH is used to swing the optic axis toward the surgeon and when it is moved laterally or medially.

These fatigue-inducing physical issues may be elicited by the non-ergonomic handling of the OH, and are apparent in mechanically counterbalanced devices harboring heavy lens tubes.

To optimize the ease of OH manipulation we developed ergonomic criteria for the positioning of the OH.
Ergonomics-based positioning of the OH

Ergonomics-based positioning of the OH aims at strengthening the surgeon’s grip and arm rotation when moving the microscope laterally or medially.

The grip strength is increased when the wrist is in a less ulnar deviation, in neutral position, and when the tension of the finger flexor muscles and their angle of pull is in balance (*Pryce: J Biomechanics* 13: 505, 1980).

**Ergonomics-based wrist position**

- Tendon of Finger Flexor
- Flexor Digitorum Superficialis & Profundus
As the wrist deviates from the neutral position, the grip strength decreases due to excessive extension of the finger flexor muscles whose overlapping myosin- and actin filament layer is less and rubbing of the flexor tendons on the border of the carpal tunnel (Armstrong: J Biomechanics 11:119, 1977); the grip strength at 30° of ulnar deviation is 9% less than in the neutral position (Pryce: J Biomechanics 13: 505, 1980).

Non-ergonomics-based wrist position
The torque of external rotation of the arm to move the microscope laterally is greater when the arm is in abduction (Left) than when it is not (Right). The torque at 45° abduction is 11% higher than without abduction due to the distribution of the infraspinatus- and teres minor muscles (Soderberg: J Orthop Sports Phys Ther 8:518, 1987). The muscles that connect the scapula and the humerus are stretched and can increase tension when the humerus is in abduction.

![Ergonomics-based arm position](image1)

![Non-ergonomics-based arm position](image2)
On the other hand, the torque of internal rotation of the arm to move the microscope medially is not increased when the arm is in abduction (Soderberg: *J Orthop Sports Phys Ther* 8:518, 1987).

Arm abduction may assist in moving the microscope medially by producing the force of adduction to push the floating OH inferomedially.
Therefore, we advise positioning the OH so that the wrist is at less ulnar deviation and the arm is abducted. The risk of tenosynovitis associated with ulnar deviation (Nunez: J Neurosurg 69:436, 1988) may be reduced by this optimal positioning of the OH.
Use of ergonomics-based positioning of the OH

We tested the value of the ergonomics-based positioning of the OH in 8 male surgeons with 8 - 20 years of experience (mean 14 years).

They were not aware of being filmed during the surgical procedures.

They held the OH of a mechanically counterbalanced surgical microscope, the OPMI Neuro/NC4 (Carl Zeiss AG, Germany), in the right hand at a 0 - 17° (mean 11.3°) ulnar deviation on the initial optic axis (the principal axis during the procedure), and at -5 - 20° (mean 7.5°) of abduction.

Examples of the surgeon’s preference of the OH

- Handle swung toward the surgeon
- Ulnar deviation
- w/o abduction
- w/ abduction
They were instructed to hold the OH at as little ulnar deviation as possible on the initial optic axis, and at more than 10° abduction; all required correction for ulnar deviation and/or abduction.

After the procedure they reported their experience when holding the OH as instructed.

Correction of the angle of ulnar deviation and abduction ranged from 0 to 9° (mean 4.3°) and from 10 to 22° (mean 15.8°), respectively.

Of the 8 surgeons, 6 reported a lower degree of arm fatigue; one noticed no change and the other was unable to judge.

All found that when swinging the optic axis toward the surgeon, difficulty in gripping the OH was reduced, and all reported that their hold on the microscope was firm when it unexpectedly became unbalanced upon transposition of accessory scopes.
Conclusion

We discussed the optimal ergonomics-based positioning of the OH for microsurgery.

Although our simple modification of the preoperative surgical microscope setup lessened subjective fatigue in 6 of 8 surgeons, the objective effect remains unknown.

Further studies using quantitative measures, e.g. electromyography, a motion-capture system, and a dynamometer, are needed to establish specific ergonomics for the optimal manipulation of the OH during microsurgery.