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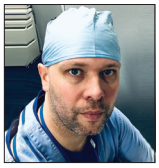
Original Article

Ergonomics of surgical microscopes for the sitting position as determined by ocular-corpus length

Felix Goehre[1], Christopher Ludtka[2], Stefan Schwan[3]

[1]Department of Neurosurgery, Stroke Center, Bergmannstrost Hospital Halle, Halle, Saxony-Anhalt, Germany, [2]Department of Biomedical Engineering, University of Florida, Gainesville, Florida, United States, [3]Department of Design and Prototyping, Fraunhofer Institute for Microstructure of Materials and Systems, Halle, Saxony-Anhalt, Germany.

E-mail: *Felix Goehre - felix.goehre@bergmannstrost.de; Christopher Ludtka - cludtka@ufl.edu; Stefan Schwan - stefan.schwan@imws.fraunhofer.de



***Corresponding author:**
Felix Goehre, MD, PhD,
Department of Neurosurgery,
Stroke Center, Bergmannstrost
Hospital Halle, Merseburger Str.
165, Halle-06112,
Saxony-Anhalt, Germany.

felix.goehre@bergmannstrost.de

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ABSTRACT

Background: The sitting position is favorable for microsurgical procedures applied to posterior midline pathologies in both the supra- and infratentorial regions. The dimensions of the microscope corpus affect the device's comfort and handling in the hands of the microneurosurgeon for such procedures. A shorter microscope corpus provides more favorable intraoperative ergonomics for surgical practice.

Methods: Evaluation of the most comfortable microscope for its application in microsurgical procedures in the sitting position as determined by ocular-corpus length.

Results: Six modern surgical microscopes were tested and evaluated regarding their ocular-corpus lengths and working distances: the Mitaka MM90, Zeiss Kinevo 900, Zeiss Pentero 900, Leica M530, Zeiss Neuro NC4, and Möller-Wedel Hi-R 1000. The ocular-corpus lengths vary between 270 and 380 mm. The Mitaka MM90 microscope has the shortest ocular-corpus length at 270 mm.

Conclusion: The ocular-corpus length determines the predominant part of the lever arm, which affects the fatigue of the surgeon. By virtue of its short ocular-corpus length, the Mitaka MM90 is currently the most favorable microscope for microsurgical procedures using a sitting position.

Keywords: Ergonomics, Microscope, Microsurgery, Ocular-corpus length, Sitting position

INTRODUCTION

The sitting position is favorable for microsurgical procedures applied to posterior midline pathologies with supra- or infratentorial localization.[2,4-10] In general, working with outstretched arms is exhausting,[3] especially for prolonged periods of time, as is required for certain procedures, even if there is an armrest to support the lower arm or wrist [Figure 1]. The possibility of flexion in the elbow joint helps to reduce strain and increase comfort when working with the arms held forward. However, the need for arm extension depends on the ocular-corpus length of the neurosurgical microscope being used. A shorter microscope corpus provides more favorable intraoperative ergonomics for surgical practice and can improve the device's comfort of use and handling in the hands of the microneurosurgeon. In particular, the ocular-corpus distance determines the length of the load arm, while the insertion points of the muscles determine the length of the effort arm; these are given anatomically, in the application of the law of the lever [Figure 2].

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The aim of this report is to evaluate the most comfortable microscope for its application in microsurgical procedures in the sitting patient position, as determined by ocular-corpus length.

MATERIALS AND METHODS

The currently most frequently used neurosurgical microscopes were evaluated: specifically, the Mitaka MM90, Zeiss Kinevo 900, Zeiss Pentero 900, Leica M530, Zeiss Neuro NC4, and Möller Hi-R 1000. To that end, a horizontal microscope position was established, and the ocular-corpus length measured [Figure 3]. The working distances were given by the manufacturers.

RESULTS

Six modern surgical microscopes were tested and evaluated regarding their ocular-corpus lengths and working distances. The measurement data from the Mitaka MM90, Zeiss Kinevo 900, Zeiss Pentero 900, Leica M530, Zeiss Neuro NC4, and Möller-Wedel Hi-R 1000 microscopes are given in [Table 1]. The ocular-corpus length varies between 270 mm and 380 mm. The useable working distance regarding the optical focus is between 200 mm and 625 mm. The Mitaka MM90 microscope has the shortest minimal working distance (ocular to the surgical field) at 470 mm [Figure 4].

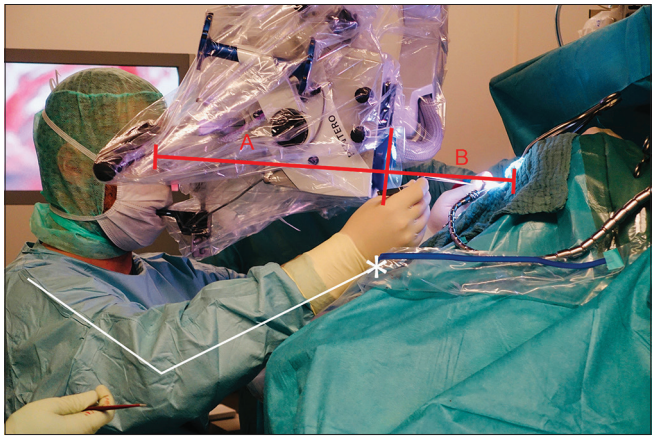

Figure 1: Intraoperative photograph of the Zeiss Pentero 900 in the horizontal position. This photograph demonstrates the important aspects during microsurgical procedures in the sitting position that determines the comfort level of the acting neurosurgeon, such as wrist support (asterisk), flexion of the elbow joint (white line), and the significant influence of the ocular-corpus length of the microscope (A) on the length of the load arm (A + B; red line).

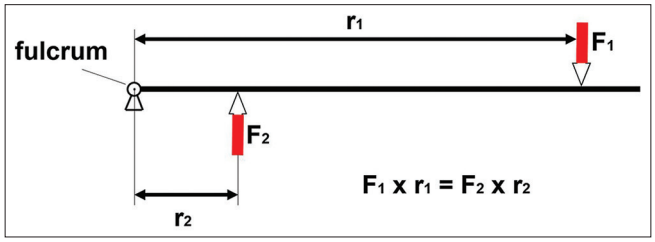

Figure 2: Schematic drawing of a one-sided lever (F_1, load [gravity]; r_1, length of the load arm; F_2, effort [arm strength]; r_2, length of the effort arm).

DISCUSSION

The sitting position is favorable for the microsurgical treatment of supra- and infratentorial pathologies.[2,4-10] Working with elevated and outstretched arms is demanding for the acting surgeon, especially for prolonged or technically complicated procedures. For these types of procedures, avoiding or mitigating increasing physical fatigue is critical for the surgeon to make the precise and finely controlled movements required during surgery, even after several hours of continuous operation. Flexion of the

Figure 3: Example measurement of the ocular-corpus length with a folding ruler.

Figure 4: The Mitaka MM90 demonstrates the shortest ocular-corpus length in the horizontal position, at 270 mm.

Table 1: Ocular-corpus lengths and working distances of common surgical microscopes.

Microscope	Ocular-corpus length	Working distance (corpus to the surgical field)	Minimal working distance (ocular to the surgical field)
Mitaka MM90	270 mm	200–600 mm	470 mm
Zeiss Kinevo 900			
(Tiltable tube)	340 mm	200–625 mm	540 mm
(Foldable tube)	310 mm	200–625 mm	510 mm
Zeiss Pentero 900			
(Tiltable tube)	340 mm	200–500 mm	540 mm
(Foldable tube)	310 mm	200–500 mm	510 mm
Leica M530 OHX	330 mm	225–600 mm	555 mm
Zeiss Neuro NC4	380 mm	200–420 mm	580 mm
Möller-Wedel Hi-R 1000	370 mm	218–509 mm	588 mm

elbow joint shortens the lever arm, reducing torque on the shoulder and alleviating the strain on the proximal arm muscles.

The maximum possible degree of elbow flexion is governed by the ocular-corpus length as well as the space required to insert the relatively long microsurgical instruments through the surgical corridor to access, for example, the pineal region [Figure 1]. Continuing this example, instruments for operations in the pineal region are often up to 230 mm in length. If we remind ourselves that the functional human arm length is approximately 649 mm, with a variance between 599 mm (5% confidence interval) and 701 mm (95% confidence interval)[1] and that a large portion of this functional arm length is already necessary for the proper handling of these instruments based on the lower bound of their working distance ranges as detailed by manufacturers, the ocular-corpus length is the determining factor for the possible degree of flexion in the elbow joint and therefore the overall ergonomics of microscope operation. In comparison with other tested microscopes, the Mitaka MM90 has a length advantage of 40 mm, with an approximately 12% shorter ocular-corpus length and therefore has a significant advantage compared to the others with regard to surgical ergonomics. The described shortening of the lever arm by reduction of the ocular-corpus length results in a significant decrease in the required lifting force, which leads to slower fatigue of the arm and shoulder muscles.

CONCLUSION

According to the law of the lever, a significant shortening of the length of the load arm while maintaining the length of the effort arm can significantly reduce the fatigue of the shoulder muscles. By virtue of its short ocular-corpus length, the Mitaka MM90 microscope is currently the most favorable microscope for microsurgical procedures using a sitting position. The construction of compact microscopes is ergonomically desirable for microsurgery using a sitting position.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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