

Technique

Early experiences with a novel (robot hand) technique in the course of microneurosurgery

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Abstract

Background: The physiologic tremor may cause difficulties in microsurgery, in spite of using armrest. The new (robot hand) technique consists of the I-III finger support, which holds the instruments on Bethlehem (ANDAN BT, Budapest, Hungary) bridge above the operation area, which reduces the tremor at the end of the instruments.

Methods: Exact measurement of tremor reduction was performed. Last year, 23 microsurgical cases were operated on by the robot hand technique.

Results: The tremors of the operating hand and the number of complications have decreased effectively.

Conclusion: By this technique, the microsurgical work has become more precise.

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Keywords:

Bethlehem®; I-III fingertip support; Medical robotics; Micromanipulation; Microneurosurgery; Revascularization; Robot surgery

1. Introduction

The precise microsurgical work can be complicated when more than 15 to 20 magnification is necessary (microvascular procedures, transsulcal approaches, removal of tumor of speech motor area, microsuture during revascularization, intramedullary tumor removal, etc). One of the obstructive problems is the physiologic tremor. Although the tremor is hardly visible with the naked eyes, by 10× magnification, it is clearly noticeable. The tremor depends on personal sensibility and skills while holding the microinstruments (Fig. 1, upper part) [3,4].

All these facts prove that our hands still have not reached enough the possibilities given by microscope.

One of the problems with personal sensibility and skills originate from the fact that between the operation point and the last supporting point (end of IV-V fingertip), the carpal joints transmit micromovements (tremors) that cause tremors at the end of microinstruments. The I-III fingertip support technique consists of support of I-III fingertip on the crossing bridge (Bethlehem® bridge) above the operating (working) point (Fig. 1, lower part) [1,2]. The end of the bridge rests on

the cushions that are fixed on the edge of the exposure. The bridge is necessary because the closest fixed points on the skull or on the well-known armrest devices are too far to balance and drive the instruments to the operating point only by the fingertip. The robot hand technique could be applied at different approaches (Figs. 2-5). Because of the I-III fingertip support (robot hand) technique by Bethlehem® bridge, the tremors of the operating hand are reduced [1,2].

2. Method

The effectiveness of the robot hand technique was proved by the exact measuring of the reduction of tremor (Fig. 7) and the historical control analysis of 23 microsurgical operations for the last year.

To measure the difference between the traditional and the new method, we tracked the instrument tip movements. The subject was asked to hold the tip of the instrument above a fixed point with visual control under the microscope with 20× magnification. On a distance of 5 mm from the tip of the instrument, an adhesive retroreflective marker (2 mm in diameter) was fixed. The position of the marker was registered in a 100 × 72-mm field of view in the infrared range with the real-time passive marker-based analyzer of movement (PAM) [5] at a sampling rate of 50/second.

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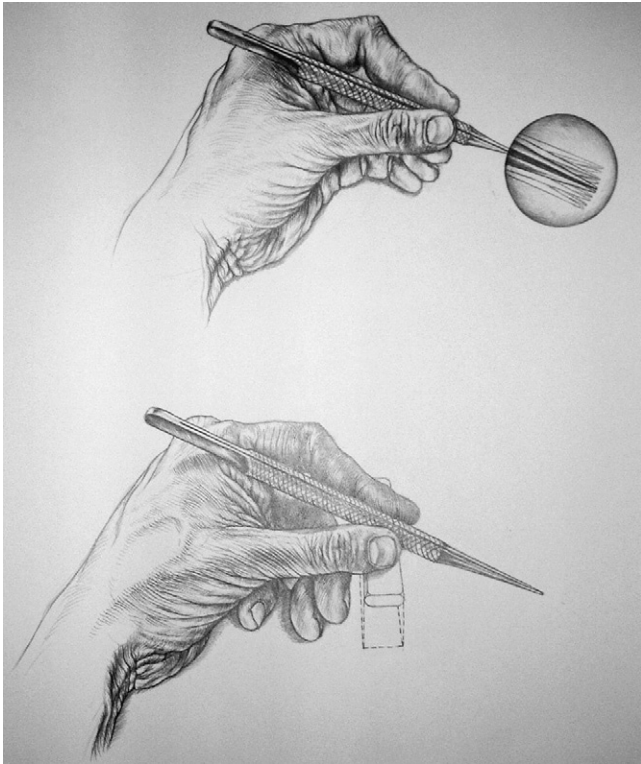


Fig. 1. There is a shift caused by the tremor at the end of the microinstruments, by the traditional technique (upper part). The I-III fingertip support technique by the Bethlehem® bridge reduces the tremor at the end of microsurgical instruments (lower part).

Coordinates of the marker positions, evaluated from the images, were recorded by a 2-dimensional analyzer.

The digital camcorder was positioned on the axis of the forearm of the subject; the elevation angle was approximately perpendicular to the instrument axis. The markers X and Y position data were then processed with the MATLAB

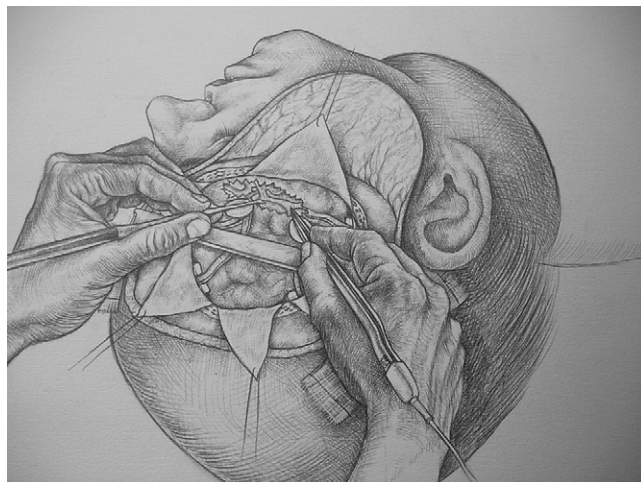


Fig. 2. The application of robot hand method in the course of pterional approach.

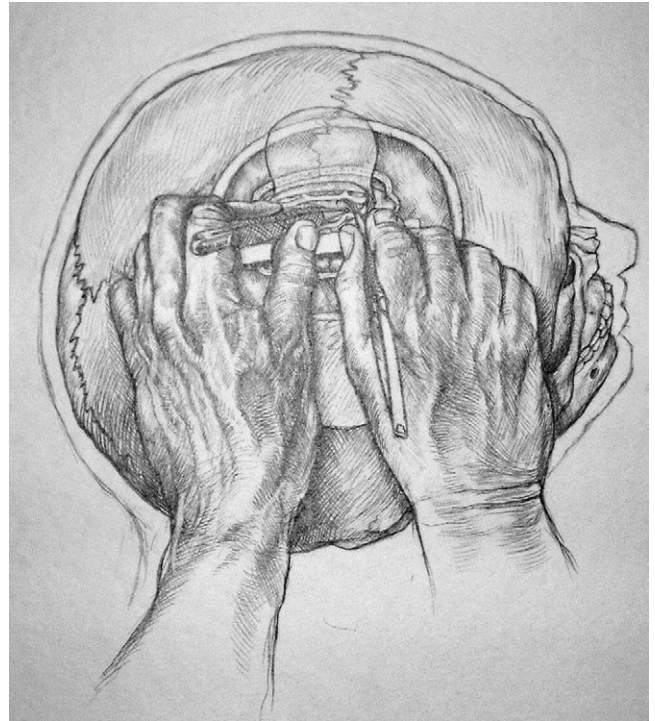


Fig. 3. The application of robot hand method in the course of parasagittal approach.

7.1 (The Math Works, Inc, Natick, MA, USA). The marker trajectories and displacement data concerning the 2 methods of holding the instrument were compared.

We compared the results of 23 similar (type and size of pathology, localization, preoperative neurologic state, age) operations performed earlier (2005–2007) by the same surgeon (first author) by traditional microsurgical technique.

Preoperative neurologic condition was similar in each group of patients (moderate neurologic deficit or no deficit).

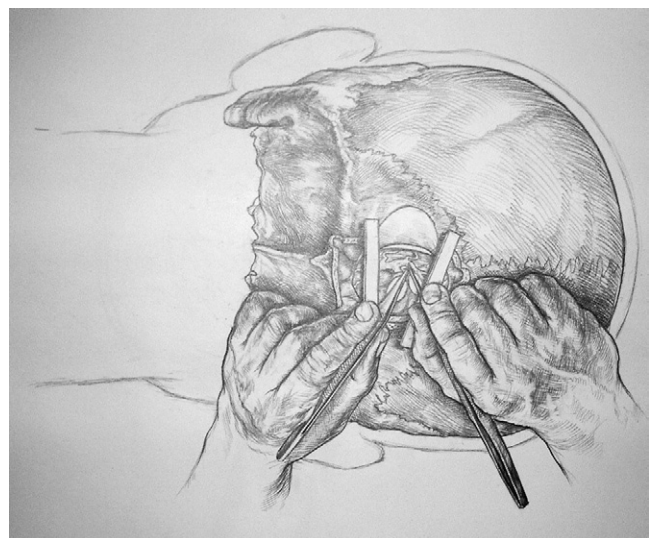


Fig. 4. The application of robot hand method in the course of supratentorial occipital approach.

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