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A New Neurosurgical Instrument: A Micro-Vibrato-Dissector

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ABSTRACT:

OBJECTIVE: We developed an instrument (a dissector tool with micro-vibrating system) to make make brain tissue dissection easy and safe.

Method: We used this instrument and conventional technique to dissect 18 fresh cadaver sheep brains (9 of them were dissected by the vibrating-dissection technique and the remaining 9 with a conventional dissector). Dissection and separation were graded as poor, moderate and good. A poor grade was scored as 1, moderate as 2, and good as 3.

RESULTS: The mean dissection score was 2.55 ± 0.52 in the vibrato-dissection technique and 1.55 ± 0.52 in the conventional technique. The vibrato-dissection technique was superior to the conventional technique for dissection and separation of brain tissue in fresh cadaver sheep brain. The differences between these two groups were statistically significant.

CONCLUSION: We developed a new instrument to dissect brain tissue during brain surgery. We used this instrument experimentally to dissect and separate brain tissue in cadaver sheep brains. We found that this is superior to conventional dissection and separation techniques. Our recommendation is to use this instrument to dissect and separate diffuse brain tumours in microsurgical operations.

KEY WORDS: Micro-vibrato-dissector for microsurgery, Brain dissection, Brain separation.

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INTRODUCTION

Dissection and separation of brain tissue is a general technique commonly used in neurosurgical operations. Three delicate membranes over the brain should be opened to access intrinsic brain lesions after creating a proper craniotomy in the skull. Intrinsic brain lesions can be grouped as focal, infiltrative and diffuse. The term diffuse intrinsic brain tumours can be used to describe diffuse tumours within the brain parenchyma. Proper dissection and separation of these types of lesions are difficult because of their invasive characteristics (1, 2, 3, 5). On the other hand, the brain tissue may be functionally separated as eloquent and non-eloquent areas depending on the functional characteristics. Dissection and separation for reaching down to the lesions should pass along the non-eloquent routes as much as possible to preserve brain function. It is necessary to keep in mind that dissection and separation techniques should be minimally invasive and minimally traumatic to the brain tissue.

Some dissection techniques described in neurosurgical practice are sharp, blunt, and a micro balloon to facilitate proper dissection of lesions (1, 2, 3, 4, 5). In the sharp dissection technique, micro-scissors are used for gentle dissection. In blunt dissection, the tip of a bayonet

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forceps, a micro-balloon, and water-jet are used with or without cotton paddies (1, 2, 3, 4, 5). In our daily practice, we generally use a combination of blunt and sharp techniques using micro-scissors, bipolar forceps, cotton paddies, and dissectors. It is very clear that the membranes over the brain such as pia mater and arachnoid mater should be opened by using micro-scissors. After opening these coverings, the brain tissue should be dissected and separated with blunt dissection because of the soft characteristics of brain tissue. All techniques including minimally invasive techniques have some advantages and disadvantages in different aspects (1, 2, 3, 4, 5).

We hypothesised that micro-vibration can facilitate gentle dissection of the brain and may be used especially for diffuse lesions seated within the brain tissue. For this purpose, we developed and designed a new micro-instrument, a micro-vibrato-dissector, for dissection of the brain tissue and separation of lesions from the healthy brain areas. Brain tumours have different cellular and extra-cellular architecture from brain tissue. At the same time, the biomechanical properties of the lesions such as plasticity and elasticity are different from the brain. The response of a tumour to the micro-vibration may therefore be different. Collapse of the extra cellular space may be possible after application of the force generated from the micro-vibrato-dissector. Pushing off the tumour tissue with micro-vibrato-dissector may dissect more than with a simple dissector.

In this preliminary experimental study, we evaluated the capability of micro-vibrato-dissector in fresh cadaver sheep brains.

MATERIAL and METHODS

In this experimental study, 18 fresh cadaveric sheep brains were used for evaluation of the capability of the micro-vibrato-dissector in the dissection of brain tissue. Figure 1 A and B show the prototype of micro-vibrato-dissector produced by Aygun surgical instruments Co. Inc. Figure 3 A and B schematically show the mechanical and electrical parts of the instruments. We divided 18 cadaveric brains into two groups depending on the techniques used for dissection. A classical dissection technique was used for Group I (nine brains) Figure 3 A and a vibrato-dissection technique by using the micro-vibrato-dissector for Group II (nine brains) (Figure 3 B). After opening the pia-arachnoid membranes by using a no. 15 blade, a conventional dissector (Group I) or micro-vibrato-dissector (Group II) was used to dissect and separate the brain tissue. Dissection and separation were graded as poor, moderate and good depends on the examiner's evaluation and consideration. A poor grade was scored as 1, moderate as 2, and good as 3. The Mann-Whitney-U test was used for statistical analysis and $p< 0.01$ was considered meaningful.

RESULTS

In Group I (conventional technique), the total dissection score was 15. The total separation score was determined to be 13 in the same group. In Group II (micro-vibrato-dissector), the total dissection score

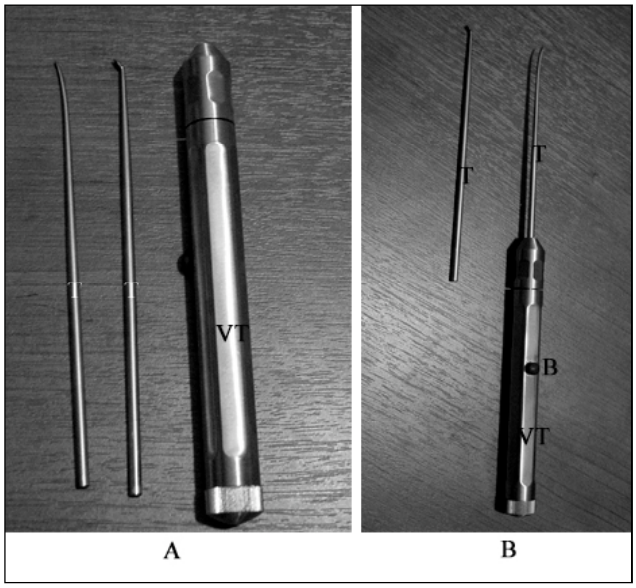

Figure 1 A, B: This figure shows a prototype of micro-vibrato-dissector produced by Aygun surgical instruments Co. Inc. (T; Tip of the instrument, VT; Vibrating tool and Battery Cap, B; On/Off button).

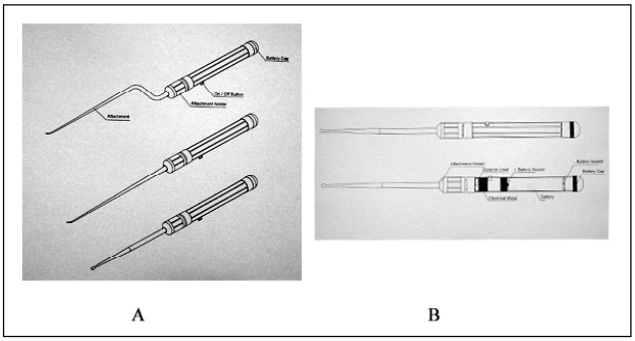

Figure 2A, B: This schematic figure shows mechanical and electrical parts of the instruments.

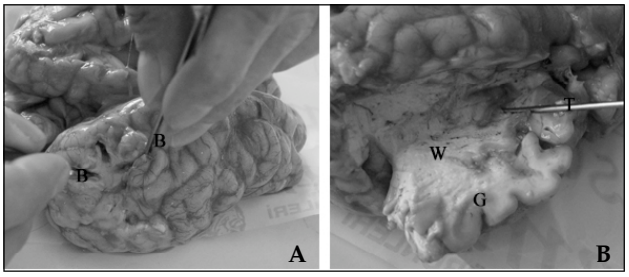

Figure 3 A,B: A. Dissection of fresh cadaver ship brain with the conventional technique (B: Bayonet forceps) **B.** Dissection and separation of ship cadaver brain using the micro-vibrato-dissector (W: white matter, G: Gray matter, T: Tip of the instrument).

was found to be 23. In the same Group, the total separation score was 22. In Group I, the mean dissection score was 1.55 ± 0.52. The mean separation score was 1.44 ± 0.52 in the same group. In Group II, the mean dissection score was 2.55 ± 0.52. In the same Group, the mean separation score was 2.44± 0.52. Separation and dissection scores are shown in Table I. Separation and dissection scores of the micro-vibrato separator group was found to be 39% better to those of the conventional dissection group. Differences between these two groups were statistically significant.

Table I: Separation and dissection scores of Group I and Group II.

Parameters	Group I (Conventional Technique) (n = 9)	Group II (Micro-vibrato-dissector) (n = 9)
Total Dissection Score	15	23
Total Separation Score	13	22
Mean Dissection Score	1.55 ± 0.52	2.55 ± 0.52
Mean Separation Score	1.44 ± 0.52	2.44 ± 0.52

DISCUSSION

The human brain is a delicate structure with specifically cumulated cells located within the cranium. This special and delicate cell and fibre system is covered by three layers of membranous structures called meningeal tissues. It is essential to open these structures before starting the operation for lesions seated within the brain parenchyma. Scissors and a no. 15 blade are used to open the dura mater. Opening of arachnoid mater is a little bit different from the other layers. A specific arachnoid knife, micro-scissors, no. 15 blade or micro-forceps may be used to opening the arachnoid mater. Pia mater is especially important in the splitting of neural structures. This area will be the gate for reaching down to the pathology seated deep in the brain. The brain parenchyma includes neuronal and supporting cells and axonal fibres. The surgeon should take care to preserve neuronal and other cells in the brain during the surgical intervention.

Dissection and separation are extremely important in the removing of brain lesions. In the literature, some methods had been described for this purpose (1, 2, 3, 4, 5). These methods aimed maximal protection of normal brain tissue and maximal and separation of pathologic tissues from the normal neuronal tissue (1, 2, 3, 4, 5). In this study, we used a new instrument, a micro-vibrato-dissector for dissection and separation of lesions within the brain. We used fresh cadaver sheep brains in the evaluation of the feasibility of this instrument.

The system has two different parts. The first part is the vibrato-generator, an electrical part that converts electrical power into vibration (150-250 Hz). The second part is a metallic micro-dissector. The system utilizes the rapidly-vibrating blunt metallic tip of the instrument for dissection of the brain tissue. A diapason is a simple model for this instrument. The arms of a diapason produce vibration. The electronic vibration generator rapidly vibrates the tip of the metallic dissector and the vibration force separates cells with dissection of extracellular space (separation of axons, dendrites, and extracellular matrix proteins).

Vibration is transmitted in two different ways, by air transmission and tissue transmission. The effects of micro-vibration on the brain tissues are distortion, separation, compression, and fragmentation. The tissue response to vibration may be different depending on the tissue characteristics. The composition of the extracellular matrix proteins, cell composition, and water content may be responsible for this response. Tumors and brain tissue will therefore give different responses to the vibration effect.

In the conventional technique, the tip of bipolar forceps, cotton paddies, the tip of aspirator, and

metallic dissector are used for tissue separation and dissection. The hand movements with different amplitudes separate brain tissues. With the micro-vibrato-dissector, the amplitude of movement of an instrument is smaller than with conventional techniques.

This experimental study showed that the capability of micro-vibrato-dissector was superior to that of conventional techniques for the dissection and separation of brain tissues. We believe that this technique can be used in clinical cases during dissection of brain tumors. Further experimental and clinical studies are necessary for detailed evaluation.

In conclusion, the newly designed micro-vibrato-dissector instrument may be a useful tool in brain surgery for the separation and dissection of brain lesions.

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