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The Use of Tissue-Selective Ultrasonic Aspirators in the Surgical Treatment of Brain and Spinal Cord Tumors

Beyin ve Omurilik Tümörlerinin Cerrahi Tedavisinde Doku Seçici Ultrasonik Aspiratörlerin Kullanılması

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ABSTRACT

Aim: Ultrasonic surgical aspirators are surgical instruments operated with high frequency sound waves. The brain and/or spinal cord tumors can be removed safely with minimal damaging to neurovascular structures by using tissue-selective ultrasonic aspirators. Besides its benefits to the patient, by shortening the duration of operation, it may also provide cost savings in terms of hospital management. The aim of this study is to evaluate the utility and feasibility of ultrasonic aspirator in central nervous system tumors.
Material and Methods: Forty patients who apply to the Department of Neurosurgery at Duzce University Medical Faculty between March 2013 and September 2017 due to brain or spinal cord tumor and operated for a brain or spinal cord tumor were included. Ultrasonic aspirator was used during the operations, and duration of operations were recorded.
Results: The total operation time was compared between the groups that their operations performed by using ultrasonic aspirator and by not using it. The mean operation time was significantly higher in the group performed operations by using ultrasonic aspirator (253.8±87.5, 195.4±48.7, p=0.014). Whereas ultrasonic aspirator usage did not change the duration of operation in patients with glioblastoma (237.8±56.3, 235.5±31.9, p=0.689).
Conclusion: Technological instruments, that become a part of surgical treatment, are devices that ensure maximum efficiency with minimum damage. However, these devices require prior training on how to use them. Training of healthcare staff in the use of ultrasonic aspirator is very important. Further studies are needed following the training of the assistant healthcare staff in this subject.
Keywords: Brain tumor; spinal cord tumor; ultrasonic aspirator.

ÖZ

Amaç: Ultrasonik cerrahi aspiratörler yüksek frekanslı ses dalgaları ile çalışan cerrahi aletlerdir. Tümör cerrahisinde dokuya seçici ultrasonik aspiratörlerin kullanılması ile normal nöral dokuya en az zarar verecek şekilde beyin ve/veya omurilik tümörlerinin güvenle çıkartılması mümkündür. Ameliyat süresinin kısalması ve hastaya sağladığı yararların dışında hastane işletmesi açısından da maddi tasarruf sağlanmasını mümkün kılabilir. Bu çalışmanın amacı santral sinir sistemi tümörlerinde ultrasonik aspiratörün yarar ve uygulanabilirliğini değerlendirmektir.
Gereç ve Yöntemler: Mart 2013 ve Eylül 2017 tarihleri arasında beyin veya omurilik tümörü nedeniyle Düzce Üniversitesi Tıp Fakültesi, Beyin ve Sinir Cerrahisi Anabilim Dalına başvuran, beyin veya omurilik tümörü nedeniyle ameliyatı yapılan 40 hasta çalışmaya alınmıştır. Ameliyat sırasında ultrasonik aspiratör kullanılmış ve ameliyat süreleri kaydedilmiştir.
Bulgular: Ameliyatları ultrasonik aspiratör kullanılarak yapılan grup ile ultrasonik aspiratör kullanmadan yapılan gruplar arasında toplam operasyon süresi karşılaştırılmıştır. Ultrasonik aspiratör kullanılan grupta ortalama ameliyat süresinin anlamlı düzeyde yüksek olduğu tespit edilmiştir (253,8±87,5; 195,4±48,7; p=0,014). Oysa ultrasonik aspiratör kullanımının glioblastoma tanılı hastalarda ameliyat süresini değiştirmediği tespit edilmiştir (237,8±56,3; 235,5±31,9; p=0,689).
Sonuç: Cerrahi tedavinin bir parçası haline gelen teknolojik aletler, en az hasar ile maksimum verim alınmasını sağlayan cihazlardır. Ancak bu cihazlar nasıl kullanılacakları konusunda önceden eğitim gerektirirler. Ultrasonik aspiratör kullanımında yardımcı sağlık personelinin eğitimi çok önemlidir. Bu konuda yardımcı sağlık personelinin eğitiminin ardından yapılacak daha fazla çalışmalara ihtiyaç vardır.
Anahtar kelimeler: Beyin tümörü; omurilik tümörü; ultrasonik aspiratör.

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INTRODUCTION

Ultrasonic surgical aspirators are surgical instruments operated with high frequency sound waves, with the use of sound waves which are effective on the surface they contact during the brain surgery, they can only prevent the destruction of tumor tissue, normal brain tissue and vascular structures. The vibrations created by the device divide the tumor tissues into small pieces and then absorb the pieces and completely eliminate the tumor tissue (1-4). In the surgical technique, tumoral tissue should be removed during tissue excision without damaging the surrounding normal tissues and with minimal bleeding. With the ultrasonic aspirator tissue technology, increasing the selectivity during the removal of tissues enables the maximum extraction of tumor tissue from the surgical field (1,2). The device, which provides more control to the surgeon during the dissection of sensitive tissues, provides the opportunity to choose according to tissue with its high amplitude adjustment. With this technology, which is widely used in surgery, the operation time gets shorter, blood loss during surgery and complications may decrease (5). Therefore, it allows to minimize the possible problems during and after the surgery.

In the neurosurgery practice, Cavitron Ultrasonic Surgical Aspirator (CUSA) Excel + ultrasonic aspirator device is used to protect high-strength tissues such as vein and neural tissue during the resection of low-strength tissues such as tumors (6-8).

The aim of this study is to evaluate the usefulness, usability of ultrasonic aspirator in central nervous system tumors and to evaluate whether it has made a difference in terms of patient's operation time.

MATERIAL AND METHODS

In this study, 40 patients who apply to the Department of Brain and Nerve Surgery at Duzce University Medical Faculty between March 2013 and September 2017 due to brain or spinal cord tumor and operated for a brain or spinal cord tumor were evaluated. This study was prospectively conducted and was approved by the Abant Izzet Baysal University Ethics Committee (2013/02). Patients with brain or spinal cord tumor whose consent had been taken were included in the study. Patients with advanced cardio-pulmonary insufficiency who cannot get anesthesia, inoperable brain or spinal cord tumors were excluded from the study. During the operation, care was taken not to differentiate in terms of age and sex when selecting patients with and without CUSA.

The duration of operation of the patients included in the study, whether there is a vascular pathology in and around the operation region after the operation, whether ultrasonic aspirator is used during tumor resection, whether there is a change in the duration of operation and damage to the surrounding tissue between the patients with which ultrasonic aspiration has been used and with which it has not, both being histopathologically same, are investigated. CUSA Excel + Integra tips containing Tissue Select feature and enabling to use three different types of hand applicators have been used in different diameters, lengths and geometries, depending on the type of operation.

Statistical Analysis

Normality assumption for continuous data were examined by Shapiro-Wilk test, and Independent samples t test was used to compare two study groups with and without ultrasonic aspirator for data with normal distribution, while Mann-Whitney U test was used to compare these two groups for data with non-normal distribution. Descriptive statistics were expressed as mean±standard deviation and median (minimum-maximum), where appropriate. Categorical data such as gender and Glioblastoma diagnosis were analyzed with Chi-square test and summarized as frequency and percentages. Statistical significance level was accepted as $p<0.05$, and statistical analyses were done using SPSS v.20.0 statistical package.

RESULTS

A total of 40 patients were included in the study; 23 (57.5%) were males and 17 (42.5%) were females, aging between 18 and 82 (mean 56.9±17.4). Ultrasonic aspirator was used in 20 patients and in 20 of them it was not used. The age of the patients with ultrasonic aspirator was between 18 and 57 years and the mean age was 51.7±19.6 years. The age of the patients without ultrasonic aspirator was between 33 and 82 years and the mean age was 61.1±13.4 years. There were 11 (55.0%) males and 9 (45.0%) females in the ultrasonic aspirator group; while 12 (60.0%) male and 8 (40.0%) female patients were in the ultrasonic aspirator group (Table 1). No statistically significant difference was found between the two groups in terms of age and sex (p=0.091, p=0.749 respectively). When total operation time between 20 patients with ultrasonic aspirator group and 20 patients without ultrasonic aspirator was compared, in the ultrasonic aspirator group, median operation time was 233 minutes (minimum 120, maximum 475 minutes) and the mean duration was 253.8±87.5 minutes. In the group that did not use ultrasonic aspirator, median operation time was calculated as 199 minutes (minimum 85, maximum 275 minutes) and the mean time was 195.4±48.7 minutes (Table 2). The mean operation time was significantly higher in the ultrasonic aspirator group (p=0.014).

Table 1. Age and sex in groups with and without CUSA

	CUSA (+) (n=20)	CUSA (-) (n=20)	p
Age (year)	51.7±19.6	61.1±13.4	0.091
Sex			
Male	11 (55.0%)	12 (60.0%)	0.749
Female	9 (45.0%)	8 (40.0%)	

CUSA: Cavitron Ultrasonic Surgical Aspirator

Table 2. Comparison of operation times (minutes) in groups with and without CUSA

Operation time	CUSA (+) (n=20)	CUSA (-) (n=20)	p
Mean±SD	253.8±87.5	195.4±48.7	
Median	233	199	**0.014**
(Min-Max)	(120-475)	(85-275)	

CUSA: Cavitron Ultrasonic Surgical Aspirator, SD: Standard Deviation, Min: minimum, Max: maximum

When glioblastoma was compared, 9 (%45.0) patients' pathology were glioblastoma in the ultrasonic aspirator group and 6 (%30.0) patients' pathology were glioblastoma in the group without ultrasonic aspirator. There was no statistically significant difference between two groups in terms of glioblastoma case (p=0.327). When the operation time of glioblastoma cases in ultrasonic aspirator used and unused groups was compared (Table 3), the duration of operation in the ultrasonic aspirator group was minimum 185 minutes, maximum 360 minutes, median time was 220 minutes and mean time was 237.8±56.3 minutes; in the group that did not use ultrasonic aspirator, the operation time was minimum 190 minutes, maximum 275 minutes, median time was 234 minutes and mean time was 235.5±31.9 minutes and it was found to be not statistically significant (p=0.689).

Table 3. Comparison of operation times (minutes) for glioblastoma cases in groups with and without CUSA

Operation time	CUSA (+) (n=9)	CUSA (-) (n=6)	p
Mean±SD	237.8±56.3	235.5±31.9	
Median (Min-Max)	220 (185-360)	234 (190-275)	0.689

CUSA: Cavitron Ultrasonic Surgical Aspirator, SD: Standard Deviation, Min: minimum, Max: maximum

DISCUSSION

CUSA is a device that was started to use in the 1970s. Malhotra et al. (9), one of the first research groups, investigated whether ultrasonic aspirated tissue can be used for histopathological studies and obtained accurate results in all resected tumors. Similar findings were made by Blackie and Gordon (10) who investigated tumor tissue fragments from 17 resections and were able to give the correct diagnosis for all aspirated specimens. Nowadays, it is used safely in brain tumor resection (6-8,11).

In the surgical technique, tumoral tissue should be removed during tissue excision without damaging the surrounding normal tissues and with minimal bleeding. With the ultrasonic aspirator tissue technology, increasing the selectivity during the removal of tissues enables the maximum extraction of tumor tissue from the surgical field and with this technology, the operation time gets shorter, blood loss during surgery and complications may decrease (1,2,5) Thus, it will be possible to minimize the possible problems during and after the surgery.

With the vibrations which ultrasonic aspirator created, it divides the tumor tissues into small particles, then absorb the pieces and completely eliminate the tumor tissue. In our study, it was seen that CUSA Excel + ultrasonic aspirator device can provide protection of highly resistant tissues such as vein and neural tissue during resection of low resistant tissues such as tumor.

In cases with selective ultrasonic aspirator, it was observed that tumor tissue could be removed at maximum level without damaging normal tissue and vascular tissue. However, it is fixed by surgical experiences where the tumor tissue is removed by dissection, normal brain tissue can be damaged. Some authors have reported that they provide important information about the vessels that feed the tumor especially in intracranial meningiomas and accordingly, the resection of the tumor may be better, thus it can reduce postoperative morbidity (1-5,12,13).We experienced the benefit of the ultrasonic aspirator for the protection of normal vascular structure in meningioma cases and the intraoperative monitoring of the structure of the nutrient vessels.

Technological tools that become a part of surgical treatment are the devices that provide maximum efficiency with minimum damage. However, the practical use of these devices requires a learning curve, which enables the instrument to use in what type of surgeries, how often the instrument will be used, how the instrument operates, and the correct assessment of the data provided by this technology. In our study, the duration of operation in cases with ultrasonic aspiration was found to be significantly higher than those were not used. One of the reasons for this, and perhaps the most important one, was the fact that the auxiliary health personnel did not know exactly how to install the device. The installation sequence is required before the operation of the device, and even if the staff are trained to do so, there is a need for repeated training when new assistive personnel are involved in the operation of each new case, which creates difficulties in practice. As surgeons should give full attention to surgery during surgery, during the installation, the auxiliary health personnel should be able to perform the set up and operation control sequence and in the event of any disruption they should be able to correct the problem. We believe that this period may be shortened if the continuity of the trained assistant personnel is ensured.

In conclusion, the aim of tumor surgery is to remove all of the tumoral tissue with minimal damage to the surrounding tissue, and the removal of the tumoral tissue with the use of ultrasonic aspirator, thus less bleeding, shortening the duration of anesthesia and shortening the length of hospitalization in the postoperative period reduces the total cost. Training of assisted health personnel is very important for the use of ultrasonic aspirators.

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