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The Benefits of Neuronavigation, Associated with Magnetic Resonance and Computerized Tomography, in Skull-Encephal Surgeries

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Abstract

The neuronavigation technique consists of an image guided surgery system through the neuronavigator, which assists the neurosurgeon in the approach of tumors and other lesions in brain surgeries. Thus, the present article aims to highlight the benefits of neuronavigation in these surgeries, associated with imaging tests such as magnetic resonance imaging (MRI) and computed tomography (CT), which will allow greater accuracy along with a more encephalic brain mapping detailed. The research had a qualitative character, through a bibliographical survey related to the proposed theme. It was possible to conclude that the neuronavigator, associated with the aforementioned imaging exams, became paramount in assisting the neurosurgeon during intracranial surgery, making it less invasive and safer for the patient.

Keywords: *neuronavigation; brain tumors; magnetic resonance imaging; computed tomography; surgery.*

Introduction

Malignant neoplasm is characterized by the uncontrolled and disordered increase of abnormal cells in the body, which can spread in tissues and organs of various parts of the body, beyond the place of origin. Brain tumors can be benign or malignant. The malignant tumor may be primary or secondary, depending on the site of origin of the cell involved. Benign tumors are cells that grow slowly and resemble those of normal tissue (1).

There are several factors that can lead to the development of brain tumors, such as: heredity, lifestyle, radiotherapy and occupational exposure. When the individual begins to develop brain cancer, some symptoms appear, such as: nausea, vomiting, mental confusion, blurred vision, mood swings and drowsiness. However, in order to combat the evolution of these tumors, the patient may undergo some treatments such as surgical, chemotherapeutic and/or radiotherapy (2).

In the search for greater efficacy and safety for the patient, several researches were done and equipment developed with the intention of making brain surgery more precise and less invasive. Thus, the neuronavigator has become an innovation in tumor resection surgery, being an equipment that uses images generated by magnetic resonance imaging (MRI) and computed tomography (CT), to create a three-dimensional image of the brain, becoming a great ally of the neurosurgeon, because with the use of this technology, the surgical procedure tends to be safer, reducing the risk of lesions in important areas of the brain (2).

The purpose of this study was to perform a literature review on the benefits promoted by neuronavigation, associated with magnetic resonance imaging and computed tomography, in brain surgeries.

Method

This research had a qualitative character, as it evaluated, through a bibliographical survey, articles that addressed the neuronavigation, associated to MRI and CT, in dryness of brain tumors. For this, a search was made on databases such as PubMed, Google Academic and Scielo, of scientific articles related to the technique between the years 2000 and 2018. The inclusion criteria used were the following descriptors: neuronavigation, resection of tumors, magnetic resonance imaging (MRI), computed tomography (CT) and encephalic surgeries in English, Portuguese and Spanish; and the exclusion criteria were: articles that related the neuronavigation technique with other pathologies and/or other imaging tests; and articles published before the year 2000.

Discussion

Encephalic Surgeries

Brain surgery is an alternative treatment for some pathologies in the brain of individuals of all ages. According to Guilherme (3), "the oldest and safest documentation of this type of procedure is skulls from the Neolithic period (about 10.000 years)."

Neurosurgery is directed at the treatment, diagnosis and rehabilitation of patients with central nervous system (CNS) injuries. Brain surgery allows several surgical procedures, such as: resection of tumors, removal of a sample of the tumor for diagnosis, application of drugs, radiosurgery, among others (4). This type of therapeutic intervention is considered a high risk, and may present complications such as: bleeding, infection or anesthesia, and a worrisome post-surgical aspect is cerebral edema. To minimize this risk, medications are given daily after surgery. The surgical procedure will depend on the location of the tumor, which may affect speech, motor coordination, vision and memory, among others (5).

Technological improvements in brain surgeries arose, studies were developed, equipment created and procedures established, so that these surgeries were minimally invasive. Neuroanatomical knowledge was essential for the injured area to be reestablished, with the minimum of possible functional loss. In recent years, modern encephalic surgery has used essential equipment to aid surgeries, such as: the microscope, the endoscope, the neuronavigator, the neurophysical monitoring, and the intraoperative resonance, in order to minimize the aggression to the organism (6).

Neuronavigation

The evolution in medical imaging techniques has led to significant advances in brain surgeries. The combination of imaging exams such as CT, MRI and neuronavigation systems provided the neurosurgeons with the ability to accurately visualize the location of the pathology to be excised, facilitating the establishment of the best technique to reach the tumor, injury of the functional neural tissue, avoiding damage during removal and/or resection, and benefiting minimally invasive surgery (4,7).

The neuronavigator consists of a computational workstation for recording images and physical spaces, an intraoperative tracking device and a screen for displaying images. The system provides real-time information on the locations of surgical instruments, and is based on infrared beams. Universal adapters with infrared markers are inserted into surgical instruments, endoscopes and operation microscopes. This system of guided surgery uses images extracted from the patient through MRI and CT to reassemble, through software, a three-dimensional (3D) image of the area where the intervention will take place. In this software it is possible to manipulate the reconstructed images and relate the lesion to the anatomic planes, aiding in the preoperative planning and the surgical procedure itself (2,8).

In the system of image-guided surgery, the professional Technologist in Radiology acts in obtaining the images through the MRI and CT equipment, contributing in the preoperative planning, in the proper surgery, and in the postoperative, when the final evaluation will be performed of the patient.

According to Edmundo (2), "its use is consecrated in surgeries for resection of brain tumors, especially gliomas, considering that greater tumor cytorreduction and preservation of eloquent areas are obtained in surgeries with a neuronavigator."

Hwang and Ho (9) performed a study to describe a minimally invasive endoscopic transfenoidal surgical treatment for clivary tumors. Three men, aged 43 to 66 years, underwent a transnasal endoscopic transnasal approach guided by a neuronavigator for the resection of clivary tumors. The result was a reduction in the patient's discomfort, an acceleration in recovery and, consequently, a reduction in hospitalization time, concluding that neuronavigation is a viable and minimally invasive alternative in the surgical intervention of clivary tumors.

Guo et al. (10) used intraoperative magnetic resonance imaging (iMRI) associated with neuronavigation with the objective of maximizing the resection of brain tumors of 44 patients, adjacent to the optical radiation. Analysis of this study resulted in a decrease in gliomas by 5.3% and there was no residual tumor among non-gliomas. The visual field improved in 5 cases (11.4%), there was no change in 36 cases (81.8%), and in only 3 cases (6.8%) there was worsening of the neurological deficit, and it was concluded that, when associating iMRI with neuronavigation, the rate of resection of brain lesions increased in most patients, without visual impairment.

Giselle et al. (11) used the combined navigation to tractography for the resection of brain tumors. This study aimed to evaluate the possible benefits of neuronavigation associated with tractography during surgical procedures in children. Sixteen patients with intracranial lesions were submitted to surgery guided by neuronavigation, between 2011 and 2014. Twelve patients had lesional resection and four were submitted to biopsy. In both procedures, there was no mortality, not even new neurological deficits. The authors concluded that the navigation allows to integrate and to understand the correlation between data obtained pre and intraoperative, increasing the capacity of the precise location with the tractografia, reducing the morbidity and mortality of the patients.

Rashid et al. (12) performed a study with the objective of evaluating 143 patients, between 2011 and 2014, who underwent encephalic surgeries without the neuronavigator. It was possible to conclude that, in developing countries, where more than half of the surgeries are performed without the use of the neuron navigator, the results are still satisfactory, however, excellent results can be obtained by the modern technologies of neuroimaging and neuronavigation.

Shushan Sang et al. (13) performed a long-term clinical evaluation with the objective of analyzing functional neuronavigation in brain glioma surgery in adult patients. The researchers evaluated 375 cases of individuals with cerebral glioma undergoing microsurgical treatment from 2011 to 2017. Among them, 142 patients underwent surgery using functional neuronavigation and the other 233 underwent the operation using preoperative MRI, without functional neuronavigation. The study confirmed that the application of neuronavigation in resection of gliomas in adult patients can improve postoperative quality of life and prolong the life of the patient.

Muhammad Irshad et al. (14) conducted a study with the objective of determining the frequency of gross total resection in intra-axial brain tumors with the aid of neuronavigation, evaluating 78 patients from 2014 to 2015, being 41 males and 37 female. Thirty-two men and twenty-nine women had complete resection of the tumor. Thus, the study concluded that neuronavigation is a useful technique for a significant improvement in total resection in cranio-encephalic tumors.

Li Zhibao et al. (15) developed a study with the objective of evaluating a new technique in brainstem surgery where 40 patients with brain stem tumor underwent a mapping of the corticospinal tract guided by neuronavigation. The study resulted in better preservation of motor function after resection of the tumor in the mentioned region, and it is important to consider that the guided mapping by neuron navigation not only reduced the difficulty of the surgery, but also promoted a significant improvement in its effectiveness.

Based on the previously mentioned studies, it can be verified that the neuronavigation used in intracranial surgeries presents advantages, such as: the ease in the accomplishment of the surgical planning; the reduction in the risk of intraoperative lesions and surgical invasiveness; the decrease in surgery time, hospitalization and postoperative recovery; increased treatment effectiveness, surgical safety and precision; and the possibility of showing the neurosurgeon in real time the exact location of the instrument during the procedure (16,17). On the other hand, a disadvantage of this equipment is not being able to have a real-time update of the current intracranial situation, because during the intervention the brain can move, a condition called brain shift.

When there is trepanation of the skull and dura mater, there is a change in the intracranial physical environment, due to the outflow of cerebrospinal fluid, air entering and other regional modifications in the shape of the cerebral lobes. With this, there is modification in the initial position of the brain. Other situations may also lead to brain shift, such as the progression of tumor resection, patient movement, internal hemorrhage, surgical target size, and tumor location. Thus, preoperative planning will undergo changes, reducing navigation accuracy during the procedure, and altering spatial information (4,18,19). Another disadvantage of the equipment is its high cost in Brazil; and the inviability of the use of iRMI technology by patients with some metallic device that may be influenced by the magnetic field generated by MRI, and it is necessary to obtain the images through CT (4,16,20,21).

Conclusion

The present study demonstrated that neuronavigation, associated with MRI and CT, has benefits in intracranial surgeries for the resection of tumors and associated brain lesions.

This work becomes relevant for explaining a topic that has little literature, but presents high value for the scientific community, benefiting the health professional and the patient from the use of the technique of neuron navigation associated with the imaging, reducing the time duration of the surgical intervention and hospitalization, facilitating postoperative and, consequently, patient recovery, being precise, effective and not invasive.

References

[1] Câncer Benigno e maligno (Hospital Israelita Albert Einstein). Brasil: Lucíola de BP. (ultima atualização 06/2013). Disponível em https://www.einstein.br/noticias/noticia/câncer-benigno-maligno.

[2] Edmundo LRP, Daniella BR, Alzira LG, Lorena OL, Maria LCV. Neuronavegação em neurocirurgia. Arquivo Brasileiro de Neurocirurgia. 2014; 33(4):340-6.

[3] Guilherme CR. Das trepanações pré-históricas à neuronavegação: evolução histórica das contribuições da neuro anatomia e das técnicas de neuro imagem à prática neurocirúrgica. Arquivo Brasileiro de Neurocirurgia. 2006;25(4):166-175.

[4] Correa AK, Vivas AOA, Sabater NJ M, Neurosurgery and brain shift: review of the state of the art and main contributions of robotics. *TecnoLógicas*. Vol.20, No. 40, pp.125-138, 2017.

[5] Técnicas para retirada de tumores no cérebro estão cada vez mais precisas e com risco menor de danos. Brasil: Ivan Drummond, Jornal Estado de Minas. (ultima atualização 12/2015). Disponível em: https://www.uai.com. br/app/noticia/saude/2015/12/05/noticias-saude,186610/tecnicas-pararetirada-de-tumores-no-cerebro-estao-cada-vez-maispreci.shtml.

[6] Cirurgia cerebral minimamente invasiva. Brasil: Neurocirurgia. (ultima atualização 03/2015). Disponível em: https://www.neurocirurgia.com/content/cirurgia-cerebral-minimamente-invasiva.

[7] Wirtz CR, Albert FK, Schwaderer M, Heuer C, Staubert A, Tronnier VM, Knauth M, Kunze S. The benefit of neuronavigation for neurosurgery analyzed by its impact on glioblastoma surgery. Neurol Res. 2000 Jun;22(4):354-60. PubMed PMID:108 74684

[8] Hartmut K. Gumprecht, Darius C. Widenka, Ch ristianto B. Lumenta; Brain Lab VectorVision Neuronavigation System: Technology and Clinical Expe riences in 131 Cases, *Neurosurgery*, Volume 44,Issue 1, 1999, Pages 97–104.

[9] Hwang PY, HO CL. Neuronavigation using an image-guided endoscopic transasal-sphenoethmoidal approach to clival chordomas. Neurosurgery. 2007 Nov;61(5 Puppl 2):212-7; discussion 217-8.

[10] Guo CS, Xiao LC, Yan Z, Fei W, Bao KH et al. Intraoperative High-Field Magnetic Resonance Imaging Combi ned With Fiber Tract Neuronavigation-Guided Resection of Cerebral Lesions Involving Optic Radiation. Neurosurgery, Volume 69, Issue 5, 1 November 2011, Pages 1070–1084.

[11] Giselle C, Filipe K, Lucas L, Ricardo R, Sidnei E et al. Tractografia e Neuronavegação. Revista Brasileira de Neurologia e Psiquiatria. 2014;18(2):177-187.

[12] Rashid MU, Junaid M, Bukhari SS, Afsheen A. Short term outcomes following surgery in brain tumours sans neuronavigation. Journal Of Pakistan Medical Association. 2018;68(2):170-174.

[13] S Sang, ShushanWanggou, SiyiWang, ZaibinLin, XueleiJiang, NianYe, Ningrong et al.Clinical long-term follow-up evaluation of functional neuronavigation in adult cerebral glioma. World Neurosurgery, Volume 0, Issue 0.

[14] Muhammad I; Ch Ali M; Muhammad A. Frequency of gross total resection in intra-axial brain tumors with help of neuronavigation. International Surgery Journal, [S.l.], v.5, n.8, p.2712-2716, july 2018. ISSN 2349-2902.

[15] Li Z., Wang M., Zhang L., Fan X., Tao X et al. Neuronavigation-Guided Corticospinal Tract Mapping in Brainstem Tumor Surgery: Better Preservation of Motor Function. (2018) *World Neurosurgery*, 116, pp. e291-e297.

[16] Cirurgia e imunoterapia combinadas no tratamento tumores cerebrais. Brasil: Setor Saúde. (última atualização 07/2016). Disponível em: https://setors aude.com.br/cirurgia-e-imunoterapia-combinadas-no-tratamento-de-tumores -cerebrais/.

[17] Neuronavegador é utilizado pela primeira vez com sucesso na Santa Casa BH. Brasil: Grupo Santa Casa BH. (ultima atualização 07/2017). Disponível em: http://www.santacasa bh.org.br/ver/neuronavegador_%C3%A9_utilizado_pela_primeira_vez_com_sucesso_na_santa_casa_bh.html.

[18] Man Ning Wang, Zhi Jian Song; Classification and Analysis of the Errors in Neuronavigation, Neurosurg ery,Volume 68, Issue 4, 1 April 2011, Pages 1131–1143.

[19] Dorward NL, Alberti O, Velani B, Gerritsen FA, Harkness WFJ, Kitchen ND, et al. Postimaging brain distortion: magnitude, correlates, and impact on Neuronavigation. Neurosurg Focus. 1999;6(3):E6.

[20] Ressonância Magnética-Riscos, contraindicações e vantagens. Brasil: Pedro Pinheiro. (ultima atualização 10/2017). Disponível em: https://www.mdsaude.com/2014/10/ressonancia-magnetica.html.

[21] Cirurgia de Epilepsia e Neuronavegação. Brasil: Ricardo Centeno – Liga Brasileira de Epilepsia. (ultima atualização 01/2007). Disponível em: http://epilepsia.org.br/material-didactico/lassei/cirurgia-de-epilepsia-e neuronavegacao/

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