A new way of presenting diagnostic imaging studies in surgical planning

Authors’ Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
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Article history: Received: 20.07.2018 Accepted: 05.11.2018 Published: 15.01.2019

ABSTRACT:
Technological advancement, availability and common use of diagnostic imaging slowly but consistently leads to a change in its nature from being additional studies to becoming the basis for diagnostic process and treatment planning especially in complex cases that require surgical treatment. CT angiography study presentation using the illusion called “Pepper’s Ghost” in comparison to a three-dimensional printout and regular CT scan has been made to point out the relevance of research and implementation of new technologies in the diagnosis and surgical planning. Our image, despite being far from ideal and being just an illusion of a hologram, was more appealing and detailed to surgeons in comparison to a printed 3D model and standard CT angiography displayed with Osirix software. In order to change the existing methods of presenting imaging studies, it is advisable to use latest technologies, and among those currently available, ones based on virtual or mixed reality deserve special attention.

KEYWORDS: diagnostic imaging, surgery, virtual reality, 3D printing, holography

INTRODUCTION
Today, imaging examinations constitute an inseparable element of diagnostics, and often form part of the therapeutic method, as is the case in interventional radiology. The universality and availability of studies such as magnetic resonance imaging or computed tomography have resulted in patients being prepared for surgical procedures to perform extensive imaging diagnostics, aimed at providing the best qualification for treatment, selecting the optimal approach as well as planning the surgical procedure.

Despite the significant technological progress that has taken place in recent years, little has changed in the field of imaging technology used in pre-surgical procedures. Methods such as roentgenography, ultrasonography or transmission tomography and nuclear magnetic resonance were introduced in the second half of the twentieth century and although they are still being improved and enhanced with new functions, they still present the results of research in the form of two-dimensional cross sections in everyday practice. In recent years, more and more publicity is gained by new, generally available technologies, disseminated initially as a form of entertainment, and penetrating into various branches of medicine, such as three-dimensional printing.

The most popular use of this technology in medicine today is the planning of surgical procedures based on three-dimensional models, attempts to print organs for transplantation and production of personalized prostheses 1–6. While in the case of manufacturing organs or prostheses, the need to obtain a physical object justifies the use of this technique, in the case of planning operational procedures, the time needed to create a model and the appropriate print configuration, the cost of the device, and above all the time of the printing process itself are significant drawbacks to this technology. Other technologies, quite common and developed today, which are used in medicine are virtual and mixed reality technologies 7.

PURPOSE
The intention of this work based on a problematic clinical case is to present the use of a well-known and long-available technique referring to the so-called augmented reality for the presentation of imaging data in comparison to 3D printing and classic CT scans presentations to justify the direction and need to implement new technologies for imaging in the 21st century medicine.

PEPPER’S GHOST: HISTORICAL LÉGERDEMAIN, A MODERN ILLUSION
In the 1850s, inventor Henry Dircks developed a device called “Fantasmagoria” used for theatrical performances. This solution, although very effective, due to the applied technical solutions required a thorough reconstruction of the theater where it would be used, and therefore, has not found a practical application. In 1862 John Henry Pepper came to aid; delighted with the invention, he found a way to simplify it, and it began to be used in performances. The illusion was named “Pepper’s ghost” after John Henry Pepper. 8, 9. The whole concept is based on the use of the phenomenon of refraction and, due to its simplicity, efficiency and low cost, it is easy to implement, which is why it is often used for personal entertainment, e.g., in the form of small projectors or mass during plays or concerts 7.

A NEW WAY OF PRESENTING IMAGE DATA
On July 2, 2017, the 1st Department of General and Transplant Surgery and Nutritional Treatment of the Medical University of Lublin admitted a patient with a diagnosed renal cell carcinoma to broaden the diagnosis and plan further therapeutic treatment. During hospitalization, a computed tomography examination with renal
COMPARISON AND LIMITATIONS

For comparative purposes, an available computed tomography examination using Osirix software was presented, followed by a presentation of a printed three-dimensional model. Next, an angiographic study in the form of a “hologram” was shown. In the opinion of surgeons of the 1st Department of General and Transplant Surgery and Nutritional Treatment at the 4th National University of Medical Sciences in Lublin, the “hologram” was the most transparent and contributed the most to planning of the operative procedure. Compared to the three-dimensional print, it was more detailed both in the scope of kidney and tumor morphology as well as vascularization.

As far as the technical and economic aspects are concerned, it is worth considering the following factors: printing 3D models requires quite expensive equipment, the right skills and experience in creating a pattern, setting the appropriate printing parameters depending on the type of filament used, or the model’s detailedness and ultimately, long print time counted in hours. The presentation of imaging studies in the form of Dircks’ phantasmagoria requires a projector, the construction of which was outsourced to an external company for less than PLN 300. It takes about 15–20 minutes for a radiologist to prepare material for the projection using the DICOM station, and twice that much for the final conversion using a commonly available software such as PowerPoint. As far
as limitations are concerned, it should be emphasized that only a printed model is able to reflect the true three dimensions, whereas the reflection on the projector still remains a 2D projection only giving the illusion of holography.

CONCLUSION

The use of a long-known invention to present imaging research in a new way primarily aims to show the legitimacy and benefits of using visualization technologies, such as virtual or augmented reality, now so widely available for entertainment purposes. Despite many reports on the use of 3D printing technology in the diagnosis and planning of operating procedures, due to its costs, time and the issue of obtaining a material model, it might not prove to be an accurate application of this technology in each case as, for example, its use to create transplantation organs. Three-dimensional presentation of imaging studies in the form of holograms or mixed reality due to short preparation time, the ability to store in digital form and use “on demand” at any time, including in the operating theatre during surgery, seems to be a better direction for the development of imaging in medicine.

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A new way of presenting diagnostic imaging studies in surgical planning; Pol Przegl Chir 2019: 91 (3): 1–4; DOI: 10.5604/01.3001.0012.7271 (Advanced online publication)

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Cite this article as: Alzubedi A., Kusz M., Kuczyńska M., Białek W., Bicki J., Rudzki S.: A new way of presenting diagnostic imaging studies in surgical planning; Pol Przegl Chir 2019: 91 (3): 1–4; DOI: 10.5604/01.3001.0012.7271 (Advanced online publication)