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CREATION AND DEVELOPMENT OF AN IMMERSIVE VIRTUAL TOOL IN COLORECTAL CANCER

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ABSTRACT

Colorectal cancer screening is essential for the prevention and effective treatment of this disease. Virtual Gut is a technology that allows users to virtually explore the inside of the gut, identifying polyps and early stages of cancer. Objective: In this article, we will discuss the creation and development of the technology, its benefits, and the implications for public health. Methods: Users use special glasses to view 3D images, allowing for detailed exploration. The system is based on real data from colonoscopies and MRIs, ensuring accuracy and realism. Results: An experiment tool, called "Intestúnel", was developed using 3D glasses, which allows exploring the interior of the large intestine through VR. In addition, health education using technology also has a positive impact on schools, medical schools, and communities. Conclusion: A virtual tool was developed and made available that allows visualization in three dimensions, making it possible to simulate the interior of a human large intestine in a detailed and realistic way. In the same light, by emphasizing its portion of the colon and rectum with the presence of polyps in various stages of cancer, the same applies to the understanding of colorectal cancer.

Keywords: Virtual Reality in Medicine. Colorectal Cancer. Medical Education. Medical Technology. Quality of Life.

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Revista ARACÊ
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INTRODUCTION

Technology, widely present in today's society, has been radically revolutionizing the vast field of human relations, which directly reflects on the resizing of doctor-patient relationships, the organization of health systems and professional improvement. In addition, the population, in general, has used technological artifices to acquire knowledge and values, which influence their conception of health and, in a peculiar way, the recognition of the importance of using prevention.

Virtual Reality (VR) is a powerful tool that has been increasingly used by the medical field in recent years. It has been used mainly in surgical training, specific laparoscopic procedures and is effective for anatomical representations, through the transformation of 2D radiological images into 3D models, through thresholdization, segmentation and import into the VR interface at an affordable cost (AMMANUEL, et al; 2019). The growing intersection between technology and healthcare has driven the development of innovative tools for disease diagnosis, treatment, and prevention.

Colorectal cancer is a disease that affects the large intestine, being one of the main causes of morbidity and mortality worldwide. In terms of epidemiology, it is more common in developed countries, but it is becoming a growing concern in developing regions due to changing lifestyles. Risk factors include a family history of colorectal cancer, older age, a high-fat and low-fiber diet, a physical inactivity, obesity, and smoking. Early diagnosis and access to health care play a key role in reducing the morbidity and mortality associated with colorectal cancer. (SANTOS, et al; 2024).

In view of this scenario, this study aims to discuss the benefits and challenges of the use of virtual reality, through a device that simulates the interior of the intestine, which enables the detailed visualization of colorectal polyps in different neoplastic stages. This tool's main objective is to assist in medical education, raising awareness of the population about colorectal cancer and training health professionals, contributing to the improvement of the diagnosis and treatment of the disease. The three-dimensional and realistic visualization of anatomical structures and pathologies is fundamental for teaching and learning in various areas of health. A recognized practice in aviation, it represents the possibility of subjecting individuals to situations that simulate real practice, bringing benefits in the learning of technical skills, crisis management, leadership, teamwork and clinical reasoning, among others. (BRANDÃO, et al; 2014).

Revista ARACÊ
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VR, by offering an immersive and interactive experience, overcomes the limitations of traditional teaching methods, such as anatomical models and two-dimensional images. There have been reports of the development of virtual reality glasses since 1950, however, in the early 2010s, a new generation of immersive glasses emerged with initiatives from Apple, Microsoft and Oculus. (GUSMÃO, et al; 2022).

In addition, simulating medical procedures in a safe and controlled virtual environment allows healthcare professionals to acquire skills and knowledge more efficiently and effectively.

METHODOLOGY

This is a descriptive study focused on the area of technological innovation, carried out from July to November 2024 in partnership with the Institute of Teaching, Research and Innovation of the League Against Cancer (LIGA) and the Startup Immersive Virtual Experience in Health (EVIS). The development of the game was based *on Design Thinking* in the generation and improvement of ideas.

Design Thinking is based on the principles of empathy, integrative thinking, optimization, experimentation, and collaboration. This model of thinking helps and enables the development of innovative tools. This study contains four stages of ideation that make Design Thinking viable, namely: problematization, ideation, search and development. These are steps that go through the process from the identification to the eradication of problems. The team responsible for developing the tool was composed of two software developers, a 3D modeler and a general practitioner. The other professionals, among whom coloproctologists stand out, played a guiding role in making the experience more reliable.

In a first meeting, following the first stage of problematization, the problems were delimited through a literature search where studies were identified that brought difficulties observed in the practical scenario related to the reliable visualization of anatomical structures, not only for students and health professionals, but also for the population in general. Among the difficulties encountered, the limitations in anatomical representations in new teaching technologies stand out, which, despite making learning more playful, through a virtual trip, have a veracity below that offered by traditional teaching with cadavers (CONTREIRAS, 2013).

Revista ARACÊ
ISSN: 2358-2472

Then, the ideation and search stage began to solve problems with the ideation of the tool, with the use of 3D glasses responsible for presenting several virtual environments for those who are using it and the construction of the software. In it, the Blender software was used to carry out the 3D modeling, which is used to create visualizations of three-dimensional spaces and static images, in addition to allowing the application and adjustment of materials to its models, providing a realistic look.

Blender is a developer distributed under the General Public License (GPL), which means that it is open source software and can be freely modified and redistributed, compatible with "Windows", "macOS" and Linux platforms. 3D modeling is done with polygonal modeling, digital sculpting, and curve-based modeling tools. In the context discussed here, modeling technology was fundamental to achieve a structure and coloration similar to reality. The animation is carried out under traditional, rigging, keyframe, physics-based support, and simulations of rigid and molecular body dynamics. Regarding rendering, Unreal Engine introduced Nanite technology, which allows the use of high-fidelity geometries and Lumen, as well as a dynamic and realistic global illumination system, which provides cinematic graphics, was introduced by the "Unreal Engine 5" version.

To structure the classification of the lesions, the book "Coloproctology: Principles and Practices" by José Joaquim Ribeiro da Rocha was used, in which chapter 21 stands out, which discusses malignant neoplasms of the colon and rectum. In addition, technical follow-up visits to colonoscopies were carried out, in which the team answered questions related to how to make the environments more realistic. Thus, associated with the images and information present in the book, it was possible to provide enough information to the developer, which made it possible to represent images with color and texture close to reality. In addition, in order to facilitate the understanding of students and other users of the tool, a classification by color was performed, differentiating polyps from a neoplasm. Thus, green encompasses adenomatous polyp, sessile polyp (flat) and pedicled polyp. Red, in turn, was intended for cancer in early and advanced stages.

RESULTS

Thus, a tool called "Intestunnel" was developed, which allows students and users in general to visualize and navigate through the interior of a large intestine, with the use of

Revista ARACÊ
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movement controls, enabling the manipulation, transport and recognition of polyps, which are properly identified with colors and legends.

For this, the student needs to turn on the virtual reality glasses, adjusting it to be comfortable on their head. It is important that before starting, the user must make sure that he is in a large space free of obstacles, as well as the controls need to be paired with the virtual reality glasses. Students need to understand the dynamics of the specific buttons and gestures of each control, as they have different functions, such as pressing, pointing, grabbing and releasing.

When directed to the virtual environment, it is not necessary to log in with the user to have access, just make sure that the place has mobile internet such as *wifi* to establish the connection. Then, the first screen that will appear to the user will be that of a healthy intestine, with its anatomy, texture and appearance in three dimensions faithful. The content of the simulation was based on images provided in the medical literature and visits of the development team to colonoscopies, as well as contact with a team specialized in the procedure. In this way, users of the tool can identify and navigate through the structure, selecting different stages of polyps and neoplasms, recognizing their form of installation and their appearance in the organ.

The experience begins in the cecum (Figure 1) and progresses through the other structures, namely, ascending colon, transverse colon, descending colon, sigmoid and rectum, going from a healthy intestine to one compromised by cancer, highlighting the changes and impacts of the disease. In addition, the lesions represented are organized according to their degrees of proximity to malignancy, ranging from sessile and pedicled polyps (Figure 2), through early cancer (Figure 3) to advanced cancer (Figure 4), following the classification with the colors green and red mentioned above

Revista ARACÊ
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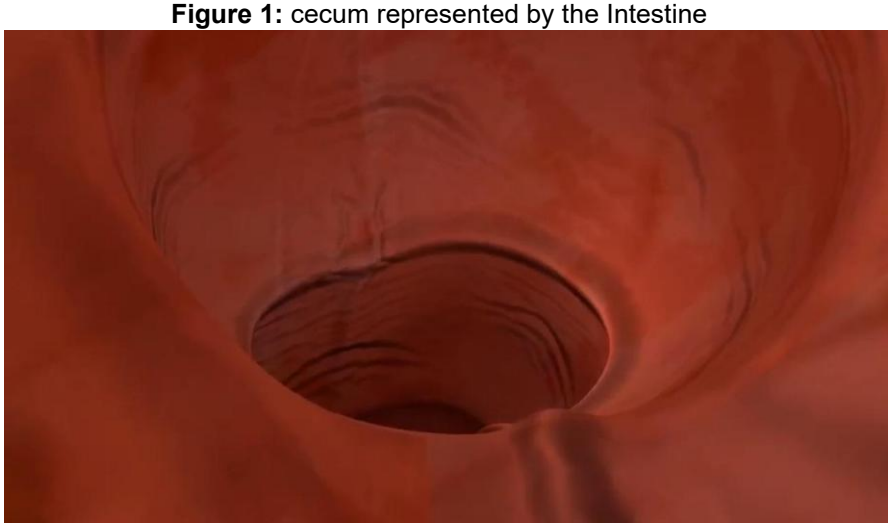
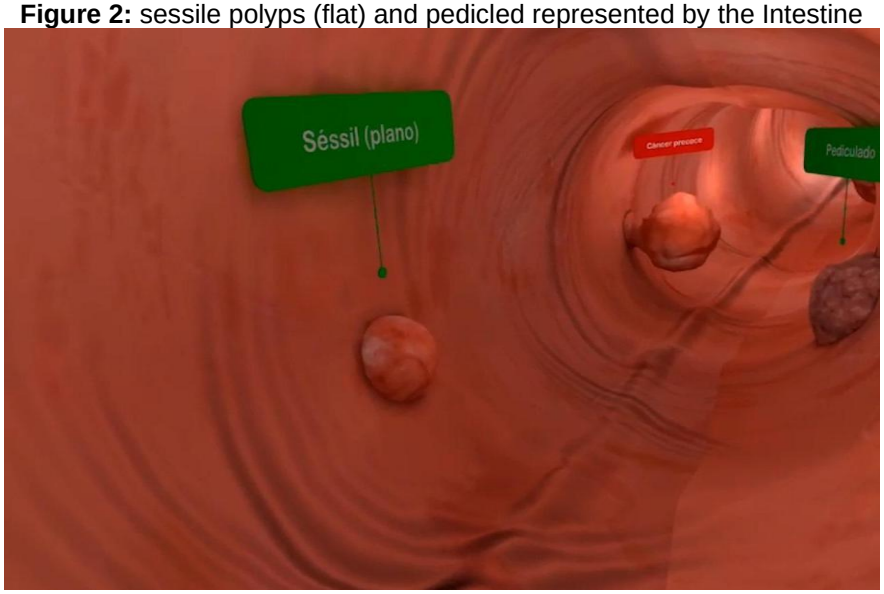
Figure 1: cecum represented by the Intestine



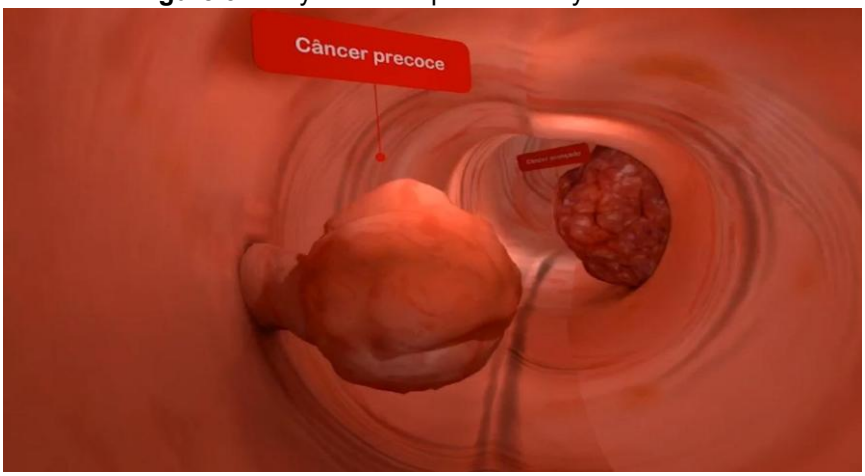
Source: EVIS (2024).

Figure 2: sessile polyps (flat) and pedicled represented by the Intestine



Source: EVIS (2024)

Figure 3: early cancer represented by the Intestinal



Source: EVIS (2024)

Revista ARACÊ
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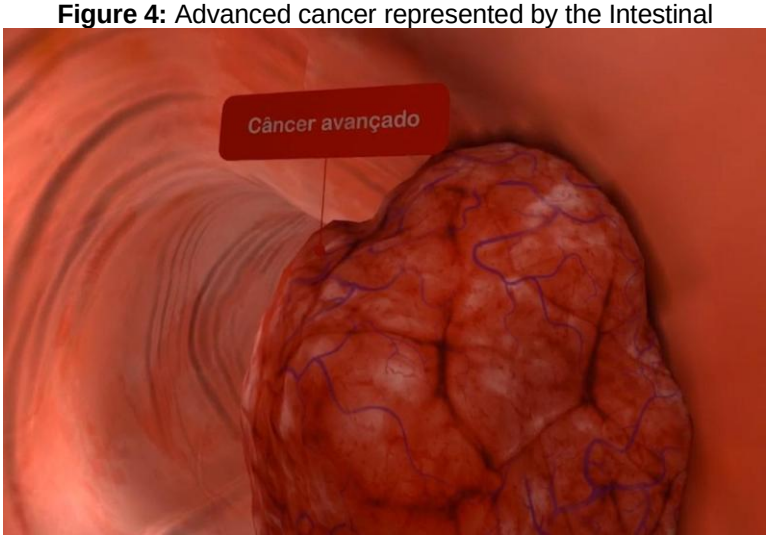
Figure 4: Advanced cancer represented by the Intestinal



Source: EVIS (2024)

DISCUSSION

The construction of a virtual reality software focused on the representation of organs and systems presents itself as an innovative strategy in the educational field, offering an immersive approach to learning and visualization of pathological structures. This technology can expand the technical knowledge of health professionals and students, providing recognition and understanding of neoplastic lesions, as well as being used to raise awareness of colorectal cancer among the general population. In addition, colorectal cancer is highly treatable when detected early, which makes screening a valuable tool for health. (PINHEIRO, et al; 2024).

Tools of this type offer professionals and students active, collaborative and interactive learning, fostering imaging mastery. When used as an information resource for the population, virtual reality contributes to diagnosis and early intervention, being a strong ally to the improvement of the epidemiological scenario. Thus, this technology, in addition to presenting itself as a strong ally of traditional teaching, supports the continuous improvement of the quality of care and the well-being of patients in the colorectal cancer scenario (PARK, et al; 2023).

In addition to the "Intestúnel", there are other virtual and augmented reality tools used in medical education and awareness about colorectal cancer. For example, "VR Colonoscopy" is a similar technology that allows 3D visualization of the inside of the colon. While "VR Colonoscopy" also offers an immersive experience, "Intestúnel" stands out for its intuitive interface and the use of real data from colonoscopies and MRIs, providing superior realism. However, it is important to consider the integration of artificial intelligence

Revista ARACÊ
ISSN: 2358-2472

technologies in the "Intestúnel" to improve the automatic detection of polyps and other anomalies, which is already a feature present in some competing tools.

Another relevant technology is the "Colonoscopy Simulator," which uses augmented reality to train health professionals in colonoscopy procedures. Unlike "Intestúnel," which focuses on visualization and public education, "Colonoscopy Simulator" is aimed at the technical training of professionals. The combination of the two approaches can be beneficial, allowing for both hands-on training and public awareness. By comparing the "Intestúnel" with other available tools and identifying areas for improvement, this technology stands out for its potential to evolve and offer significant benefits for both health education and colorectal cancer awareness and prevention.

In the same vein, the use of AI algorithms to assist in the automatic detection of polyps and other anomalies increases diagnostic accuracy, incorporates gamification elements to make the experience more engaging and educational for users, and allows the development of versions of the "Test" for different devices, such as smartphones and tablets, expanding access to technology. Establishing partnerships with medical institutions to continuously validate and improve the tool based on clinical feedback and create regularly updated educational modules on new advances in colorectal cancer research and treatment is also pertinent.

It is also worth noting that colonoscopy is the gold standard for detecting colorectal cancer and its precursors, however, several studies have shown a significant error rate in the detection of polyps, as well as showing the occurrence of cancers years after the exam (WANDERS, et al; 2015). In addition, evidence shows that most cases of colorectal cancer (CRC) after screening colonoscopy are attributable to undetected lesions and/or incomplete polypectomy. The Adenoma Detection Rate (ADT) is defined by the prevalence in which at least one adenoma is found in screening colonoscopies of asymptomatic patients at usual risk for CRC, and is an important indicator of the quality of colonoscopies of a colonoscopist or a colonoscopy service (COELHO, et al; 2021). Therefore, expanding technologies such as the "Intestúnel", developing improvement studies, will provide improvements in the quality of colonoscopies, increasing ADT and having direct impacts on the early diagnosis of colorectal cancers.

Revista ARACÊ
ISSN: 2358-2472

CONCLUSION

Therefore, the present study demonstrates the feasibility and potential of virtual reality as an effective tool for health education, specifically in the context of colorectal cancer. The immersive virtual experience developed provided a detailed and interactive visualization of the interior of the intestine, allowing a deeper understanding of the anatomy and pathologies related to colorectal cancer.

Thus, immersive virtual experience technology not only revolutionizes the way we treat and educate about Colorectal Cancer, but also opens up new perspectives for a future where technology and healthcare go hand in hand for the greater good. In addition, this technology can be adapted to other areas of health, such as the teaching of anatomy and physiology, rehabilitation and the treatment of chronic diseases.

Revista ARACÊ
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