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PROSPECTIVE ANALYSIS OF THE APPLICABILITY OF ARTIFICIAL INTELLIGENCE IN SURGICAL PROCEDURES

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Abstract: Considering the advance of technology, Artificial Intelligence (AI) is about to become a revolution in the scientific approach to medicine. More specifically, Machine Learning is projected as the future of medical practice, even if it requires a responsible doctor to handle it. In this context, surgery is a promising area for this application. The aim of this study was to present the state of the art, in the form of a scoping review, on the application of machine learning techniques in surgical procedures. The analysis concluded that the application of Artificial Intelligence underpins and complements a surgeon's skills and possibilities. However, these technologies need to be disseminated, experimented with, studied and explored in order to move from a potential application (for the most part) to a well-founded one.

Keywords: Surgery; Artificial Intelligence; Machine Learning.

INTRODUCTION

Artificial Intelligence is defined in the field of research as the study of intelligent devices capable of maximizing the applied area (PO-OLE et al., 1998 apud BINI, 2018), having its term presented for the first time in a lecture by John McCarthy in 1956 at Dartmouth College (BINI, 2018). Since then, medicine has been highlighted as a promising area for application (YU; BEAM; KOHANE, 2018), with technological developments ranging from traditional electrocardiograms to, more recently, the application of these, approved by the US Food and Drug Administration in 2018, in Apple Inc. watches (FINGAS, 2018; VICTORY, 2018).

Widespread in Neurology, Radiology, Ophthalmology, Cardiology and Gastroenterology (TOPOL, 2019), the application in surgical areas began and has been preserved as robotic assistance, capable of facilitating processes and procedures, still requiring a surgeon to control it (YU; BEAM; KOHANE,

2018). This application has been restructured in more recent studies, which propose targeting a subdivision of Artificial Intelligence, Machine Learning, more specifically Deep Learning (LECUN; BENGIO; HINTON, 2015). Regardless of the type of application, even though this technology is promising, it still faces some problematic points: 1) bioethics, which limits its applicability to decision support (KOIMIZU; NUMAJIRI; KATO, 2019), 2) data security, 3) defects and 4) the doctor-patient relationship - one of the reasons why medical schools still teach the use of the stethoscope for examining the precordium, even though it only collects 75-80% of the information generated by a Doppler echocardiogram (MILLER; BROWN, 2018).

Thus, even though its performance in human-machine collaborative tasks has been proven and can positively impact the broad medical scenario (MILLER; BROWN, 2018), as well as being characterized as a fundamental technology in the future scenario of medical practice (RAJKOMAR; DEAN; KOHANE, 2019), little has been said about its application in aesthetic-surgical procedures, more specifically regarding its acceptability.

METHODOLOGY

This study is a literature review, carried out by means of a *Scoping Review*, as proposed by the *Joanna Briggs Institute* (JBI). The search for studies used the PICO strategy - Patient, Intervention, Comparison, Outcome, where P: Surgery, I: Machine Learning, C: Blank, O: Application. Thus, the following guiding question was formulated: "What is known in the literature about the applications of machine learning in surgical procedures?". For the search in the databases consulted, the following controlled descriptors and logical operators were used: "(Surgery) AND (Applications) AND ((Machine Learning) OR (Artificial Intelligence))"

The searches were carried out on the PubMed database. Research conducted in English was included. Papers from gray literature were not considered. The articles were searched for between March, April and May 2021, when all the publications were accessed.

In the first phase, the titles, abstracts and keywords of each study were read in order to select those that answered the research question. In the next phase, the articles were read in full, all of which answered the research question and were defined as the sample for this review (Figure 1). In the end, there were a total of 10 studies. The researchers themselves extracted the data from the selected articles. To show the results, the articles were numbered from 1 to 10 (Figure 1).

RESULTS AND DISCUSSION

The sample consisted of 10 studies, all of which (100%) were found through PubMed. The studies were separated by name, authorship and year of publication in Table 1. Most of the studies are recent, often from 2019 onwards, with an emphasis on 2020 (50%).

In this literature review, it was found that developments in technology applied to the health sector have offered great opportunities to enhance surgery. The advance of Big Data on the world stage allows the ability to promote and predict the results of different procedures and treatments, as well as improve clinical decisions (LIANG et al., 2020) based on so-called Machine Learning, a subdivision of Artificial Intelligence, evidenced in supervised and unsupervised machine learning.

Supervised learning consists of predicting a dependent variable from an independent variable. In other words, the machine works with a system of inputs and outputs (YU; BEAM; KOHANE, 2018); at the same time, unsupervised learning configures a system with learning autonomy, with several applicable algorithms, being at the frontier of Machine Learning knowledge, characterizing the

new branch of study in the area, Deep Learning (LECUN; BENGIO; HINTON, 2015).

In practice, this branch can be seen in what is called “deepfakes”, the autonomous generation of videos and images that can be applied to Plastic Surgery. From a photographic sample, it is possible to synthesize graphic results, modifying expressions and body movements in a precise way, which are shown to be indistinguishable from real images, providing an opening for simulations of operative results in Aesthetic-Surgical Procedures (BURLINA et al., 2019; CRYSTAL et al., 2020). In Italy, a device that makes use of the aforementioned principle is already capable of processing wound images using algorithms, achieving an accuracy of 94% (FARINA; SECCO, 2017).

The implementation of Artificial Intelligence can also help in the decision-making process for breast implants (KIM et al., 2019), make procedures safer by designing higher quality implants (MOELLHOFF; GIUNTA, 2020), and enable a personalized approach for each individual (KIM et al., 2019). In this way, intraoperative visualization using Machine Learning could also corroborate breast surgeries based on possible implant positions and their respective results (KANEVSKY et al., 2016).

Also with regard to Aesthetic Surgical Procedures, using the supervised form of Machine Learning, a subjective autonomous beauty classifier, using 165 images of female faces considered attractive by a limited human independent sample, was configured to determine the most attractive facial features, and could correlate them with post-operative targets. With these results, a predictive analysis could be made that could estimate the outcome of the Procedures (GUNES; PICCARDI, 2006; KANEVSKY et al., 2016).

To get to the point of a clinical and surgical application based on scientific evidence, it is necessary to cross barriers imposed by bioethics, since a biased view can be created, not promoting objectivity in the medical sector.

ID	Title	Year	Author
1	Artificial Intelligence in Plastic Surgery: Applications and Challenges.	2020	Liang X, Yang X, Yin S, Malay S, Chung KC, Ma J, Wang K.
2	Artificial Intelligence: Applications in orthognathic surgery.	2019	Bouletreau P, Makaremi M, Ibrahim B, Louvrier A, Sigaux N.
3	Artificial Intelligence in Plastic Surgery: Current Applications, Future Directions, and Ethical Implications.	2020	Jarvis T, Thornburg D, Rebecca AM, Teven CM.
4	Current applications of artificial intelligence for intraoperative decision support in surgery.	2020	Navarrete-Welton AJ, Hashimoto DA.
5	Role of Artificial Intelligence (AI) in Surgery: Introduction, General Principles, and Potential Applications.	2020	Mangano A, Valle V, Dreifuss NH, Aguiluz G, Masrur MA.
6	Artificial Intelligence in Cornea, Refractive Surgery, and Cataract: Basic Principles, Clinical Applications, and Future Directions.	2021	Rampat R, Deshmukh R, Chen X, Ting DSW, Said DG, Dua HS, Ting DSJ.
7	Applications of Machine Learning Using Electronic Medical Records in Spine Surgery.	2019	Schwartz JT, Gao M, Geng EA, Mody KS, Mikhail CM, Cho SK.
8	The applications of machine learning in plastic and reconstructive surgery: protocol of a systematic review.	2020	Mantelakis A, Khajuria A.
9	Machine learning: principles and applications for thoracic surgery.	2021	Ostberg NP, Zafar MA, Elefteriades JA.
10	Machine learning applications to enhance patient specific care for urologic surgery.	2021	Doyle PW, Kavoussi NL

Table 1: Title, year and authorship of the selected studies

Source: Author (2021)

Since beauty standards are subjective, once they have been evaluated by machines, they would use those programmed data sets and would not be free of bias, implying a possible disturbance of the patient's autonomy in decision-making (KOIMIZU; NUMAJIRI; KATO, 2019). Another issue is the possibility of moving towards a lack of cultural identity and diversity: the globalization of algorithms could create an unconscious supremacy of a specific region, modifying the cultural values of other countries (FAYEMI, 2018; KOIMIZU; NUMAJIRI; KATO, 2019).

In addition to ethical barriers, information security is also seen as a problem. Big Data, when it comes to computer data, is fully exposed in an environment where security has not yet been fully implemented. Personal and intimate data is vulnerable and at risk of being used illegitimately (BRUNDAGE et al., 2018). It should also be borne in mind how recent these uses of Machine Learning in Medicine are, since, as they are still under development, they are susceptible to defects and imperfections, which can lead to harm to patients (TOPOL, 2019).

It can be concluded that the potential application of Artificial Intelligence underpins and complements the skills and possibilities of a Surgeon; however, for the benefit of patients, these technologies need to be disseminated, experimented with, studied and explored. This would take us from a potential application to a well-founded application (LIANG et al., 2020).

FINAL CONSIDERATIONS

The aim of this study was to map knowledge on the subject, seeking to identify gaps and clarify the concepts involved. The most recent studies were analyzed and it became clear that the application of Artificial Intelligence underpins and complements a surgeon's skills and possibilities, maximizing their advantages and minimizing their disadvantages. Furthermore, it is crucial to point out that the development of machine learning models for surgical procedures requires a wide variety of data and training to deal with real-world variables. Finally, although there is a growing trend towards technology in healthcare services, the incorporation of these innovations into current routines faces significant limitations, which need to be discussed in the near future.

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