

The Ethical Challenges of Artificial Intelligence in Plastic Surgery

Os desafios éticos da inteligência artificial na cirurgia plástica

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Rev Bras Cir Plást 2025;40:s00451807751.

Abstract

Introduction Artificial intelligence (AI) has been growing around the world and in Portugal due to the rapid progress of technology. Its use raises important ethical questions; therefore the establishment of ethical standards is essential for an adequate and lasting application of AI. The present article aims to explore the role that AI may have in plastic surgery as well as the ethical issues that may arise due to its use.

Objective To investigate the barriers to the introduction of AI in the field of plastic surgery. The subsidiary objective is to address the ethical aspects related to this topic.

Materials and Methods Between December 2023 and February 2024, we conducted a search on the PubMed/MEDLINE and Science Direct databases for articles that answered the research question. All titles and abstracts found were systematically evaluated. Those that were considered relevant were later read in full to be compared with the inclusion and exclusion criteria. For each of the studies, a table was created with the authors, the place and year of publication, and the conclusions.

Results We selected eight articles that enabled us to discuss several points, namely: the consequences of the use of AI in plastic surgery in terms of data protection, privacy, equity, and transparency of algorithms.

Conclusion Being aware of the barriers and ethical dilemmas that arise when using AI in plastic surgery is essential for quality clinical practice. Recognizing and addressing these barriers earlier makes it possible to legislate and regulate this surgical field with technological advances to maintain safety in clinical practice and patient confidence.

Keywords

- ▶ artificial intelligence
- ▶ ethics
- ▶ plastic surgery
- ▶ privacy
- ▶ technology

Resumo

Introdução A inteligência artificial (IA) tem crescido no mundo e em Portugal devido ao rápido progresso da tecnologia. A sua utilização levanta questões éticas importantes; portanto, é fundamental que haja normas éticas para uma adequada e duradoura aplicação da IA. Este artigo visa explorar o papel que a IA poderá ter na cirurgia plástica, assim como as questões éticas que poderão surgir devido ao seu uso.

received
September 4, 2024
accepted
November 16, 2024

DOI <https://doi.org/10.1055/s-0045-1807751>.
ISSN 2177-1235.

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Thieme Revinter Publicações Ltda., Rua Rego Freitas, 175, loja 1, República, São Paulo, SP, CEP 01220-010, Brazil

Palavras-chave

- cirurgia plástica
- ética
- inteligência artificial
- privacidade
- tecnologia

Objetivo Investigar as barreiras à introdução da IA no campo da cirurgia plástica. O objetivo subsidiário é abordar os aspectos éticos relacionados a esta temática.

Materiais e Métodos Entre dezembro de 2023 e fevereiro de 2024, realizou-se uma busca na base de dados PubMed/MEDLINE e Science Direct por artigos que respondessem à pergunta da investigação. Todos os títulos e resumos encontrados foram sistematicamente avaliados. Aqueles que foram considerados relevantes foram posteriormente lidos integralmente para a confrontação com os critérios de inclusão e de exclusão. Para cada um dos estudos foi realizada uma tabela com os autores, o local e o ano de publicação e as conclusões.

Resultados Foram selecionados oito artigos que permitiram discutir vários pontos, nomeadamente: as consequências do uso da IA na cirurgia plástica em termos da proteção de dados, da privacidade, da equidade e da transparência dos algoritmos.

Conclusão Ter conhecimento das barreiras e dilemas éticos que surgem no uso da IA torna-se indispensável para uma prática clínica de qualidade. O reconhecimento e a abordagem mais precoce dessas barreiras possibilita a legislação e a regulamentação dessa área cirúrgica com os avanços tecnológicos, para que se mantenha a segurança na prática clínica e a confiança dos pacientes.

Introduction

Artificial intelligence (AI) encompasses the creation of machines capable of performing tasks that normally require human intervention, dating back to the 1950s. Furthermore, research into AI is highly specialized and technical, drawing largely on principles of logic, knowledge, planning, education, communication, image and physical manipulation. This domain is typically classified into two categories:

First, applied AI is more prevalent and consists of intelligent systems designed to perform specific tasks, such as autonomous driving. It is often called weak or narrow AI.

Less common, Generalized AI involves systems with the ability to handle multiple tasks and resolve multiple obstacles or unusual situations. These systems are called robust. Currently, there are no examples of robust AI, as the field is still evolving and expanding.

The first AI healthcare system introduced in the early 1980s, MYCIN, was designed to distinguish between various bacterial infections. Later, in 2005, the first neural network algorithm estimated recovery time from burns in plastic surgery, which triggered significant advances in the application of AI in this field. Over the last decade, in fact, AI has made notable progress in plastic surgery, especially after the implementation of facial recognition algorithms and Deep Learning techniques. Three-dimensional (3D) models for presurgical planning were also introduced, along with various applications in maxillofacial surgery, namely the use of digital images and 3D photographs to predict surgical outcomes. These programs, made up of algorithms, are capable of recognizing patterns in large sets of data.¹⁻⁴

Plastic surgery is reconstructive par excellence and refers to a variety of operations carried out with the aim of repairing or restoring parts of the body so that they have a normal appearance or to improve a certain structure or

anatomy that is already normal. These procedures are highly specialized.⁵ Furthermore, plastic surgery collaborates, sometimes across interpenetrated borders, such as otorhinolaryngology, neurology, ophthalmology, stomatology, orthopedics, vascular surgery, surgical pediatrics, dermatology and endocrinology. But also, in addition to all this, by applying the same scientific basis of lifting flaps and training in careful tissue handling, it can offer a different, more harmonious or rejuvenated appearance to the entire human body, from head to toe.⁶ This type of surgery raises a considerable ethical problem: the balance between the risks and benefits of operations without functional benefit.⁵

Current Application of AI in Plastic Surgery

Efficiency in the workplace: AI offers a simple and straightforward solution to improve the efficiency of medical practice and reduce administrative burdens such as documentation, using, for example, voice recognition algorithms. Additionally, natural language processing (NLP) powered conversational agents have shown promise in assisting patients with appointment management, triage, and medical advice.

Preoperative decision making: Facial plastic surgery presents unique challenges, but AI systems can take advantage of large databases to inform preoperative decisions. Machine learning programs can analyze extensive data sets to identify patterns and trends, helping to predict outcomes and identify risk factors. While developing AI models for facial plastic surgery requires addressing significant anatomical variations between individuals, promising advances have been made in predicting surgical outcomes and complications.

Postoperative results: The objective assessment of postoperative outcomes in plastic surgery is limited, but AI has the potential to create more standardized assessment methods. Algorithms such as neural networks can accurately predict perceived age reduction after facelift and simulate

post-operative results virtually before the procedure. These tools offer valid methods for determining postoperative results and allow for preventive adjustments to surgical plans to optimize results.

Surgical training and research: AI-based simulations offer valuable tools for surgical training, analyzing surgical videos to identify technical weaknesses and predict outcomes. Additionally, it can aid research by encouraging new ideas for systematic reviews and providing a starting point for further investigation. As these algorithms evolve, they have the potential to improve the quality of surgical training and accelerate research efforts in plastic surgery.¹

Medical Ethics and AI

The introduction of algorithms into clinical practice is also fraught with potential ethical-legal implications. Who should be held responsible if an algorithm makes a mistake with serious consequences. There are clear pathways to regulatory approval of new medicines and devices, but algorithms pose new challenges.³ In this sense, advocates of AI in patient care agree that any use must be informed by the same ethical principles that govern traditional care provided by humans; however, this issue is complicated by the fact that the increasing involvement of advanced technology in healthcare presents unique questions that may not be fully answered by traditional ethical principles.¹

Responsibility principle: Responsibility entails individuals and organizations being held accountable for their actions and circumstances, both morally and legally. This includes social responsibility, especially in the context of AI in medicine, where technologies must be developed and used responsibly to maximize benefits for patients and society. This principle aligns with fundamental bioethical principles in medicine.^{7,8}

Privacy principle: Respecting individuals' right to privacy is crucial, especially in the age of AI and Big Data. It involves safeguarding both extrinsic and intrinsic data and ensuring compliance with regulations like the General Data Protection Regulation (GDPR).^{9,10}

Equity principle: The principle of equity emphasizes justice in the application of technologies like Machine Learning and Big Data in medicine. It involves recognizing and mitigating bias and discrimination, particularly against marginalized groups.^{11,12} In addition to these principles, in the particular case of plastic surgery, issues related to the perception of beauty must also be considered. The search for beauty drives many patients to opt for aesthetic procedures. The AI systems, in particular Machine Learning programs, have been developed to interpret facial attractiveness based on photographs and recommend surgical plans. However, the objective assessment of beauty through these systems can be problematic, as they tend to elevate certain qualities as superior, defining the "perfect face". This can result in the undervaluation of features considered beautiful in different cultures or ethnicities, contributing to a decrease in diversity in perceptions of beauty, as AI-based measurements are only quantifiable representations of opinions, subject to subjec-

tivity and cultural influences. Therefore, the use of AI in plastic surgery raises ethical concerns about the impact on the diversity of beauty perceptions and conformity to cultural and ethnic standards.^{1,4}

Transparency and integrity principle: Ensuring transparency and integrity in AI systems is vital. Algorithms should be explainable, and decisions should be understandable and trustworthy to those affected.^{13,14}

Patient Autonomy: Patient autonomy is fundamental in healthcare, but AI presents challenges to informed decision-making and consent. It's crucial to maintain transparency and obtain patient consent in the use of these models to protect patient rights.¹⁵

Objectives

To investigate the barriers involved in the introduction of AI in the field of plastic surgery. Furthermore, we aim to address the ethical debates related to this topic.

Review Question

What are the ethical challenges posed by the integration of AI technologies in the field of plastic surgery and how have these challenges been addressed in the literature?

Materials and Methods

Data Search and Study Selection

In this study, we searched databases published in English and Portuguese in PubMed and Science Direct from December 2023 to February 2024. The combination of Medical Subject Heading (MeSH) and keywords was developed to conduct the search with Boolean operators. Synonyms or abbreviations that were considered appropriate were added to the search terms. The search terms were adapted to each database.

In the PubMed/MEDLINE database, the search was carried out using the following combination of terms and subsequently combined with the Boolean operator AND. The first set of terms was: *Intelligence, Artificial OR Computational Intelligence OR AI OR Computer Vision OR Knowledge Representation*. The second set was: *Plastic Surgery OR Esthetic Surgery OR Reconstructive Surgery OR Cosmetic Surgery*.

In the Science Direct database, the search was carried out using the following terms: *artificial intelligence AND aesthetic medicine OR plastic surgery*.

Study Selection

The research question was constructed using the Population, Exposure, and Outcomes (PEO) tool that focuses on nonnumerical information or qualitative research. In the present study, Population/Participants refers to users interested in or undergoing plastic surgery and plastic surgeons; Exposure to AI in plastic surgery; and Outcomes/Results to barriers and ethical aspects found from included studies.

Therefore, this study's investigative question was: "What are the ethical challenges posed by the integration of AI

technologies in the field of plastic surgery and how have these challenges been addressed in the literature?"

Selection Criteria

Regarding the inclusion criteria, only articles that were in English or Portuguese were selected, with a publication date from 2018 onwards in PubMed and Science Direct, which were filtered only by clinical trial, clinical study, case report, case series and observation study at PubMed; and research studies and case reports at Science Direct. Studies that specifically address the integration of AI in plastic surgery and that discuss ethical challenges related to its use were also included.

In the exclusion criteria, all articles that were in a language other than those mentioned in and those that had a publication date before 2018 were rejected. Studies involving participants not directly relevant to plastic surgery or AI. Furthermore, studies that do not explicitly discuss ethical challenges, dilemmas, or related concerns. Finally, nonpeer reviewed sources and reviews, meta-analyses, and grey literature.

Each of the two researchers reviewed the titles and abstracts of the retrieved articles that met the above criteria. Articles with clear ineligible factors were rejected. The same two researchers then examined the full text of these articles to assess their eligibility for inclusion. All discrepancies were resolved by consensus.

Data Extraction

The information in ► **Table 1** was extracted from each study: article information including authors, title and year of publication, aim of the study, country of origin and the details about where it was published.

Assessment of Study Quality

We used the Hawker et al.¹⁶ scale to assess the quality of the studies selected. The scale consists of nine items covering the following dimensions: title and abstract; introduction and data; methodology and data; sampling; data analysis; ethics and bias; results; transferability and generalization; and implications and applicability. The score ranges from 0 to 36, with higher values indicating better quality. In this study, 29 was the average score.

Data Synthesis and Analysis

Our qualitative inquiry into the ethical challenges of artificial intelligence in plastic surgery involved a thematic analysis approach. We systematically examined and interpreted the textual data gathered from the selected studies, aiming to identify recurrent themes and ethical concerns. These themes were then organized into meaningful categories that reflect the complex and evolving ethical landscape of AI integration in plastic surgery. To enhance the rigor and trustworthiness of our findings, we engaged in constant comparison and employed established qualitative analysis techniques, including the framework proposed by Hawer et al.

Member checking and peer debriefing were employed as validation strategies to ensure that our interpretations accu-

rately captured the nuances and depth of the ethical challenges discussed in the literature.

Results

Literature Search and Selection of Studies

The search in the electronic database PubMed/MEDLINE with the sets presented previously resulted in 3,034 results. Subsequently, the 2018 to 2024 search filter was applied in order to obtain only articles included in this time period. Thus, 1423 articles that were not available were excluded, leaving 1,611. Using the Portuguese and English language filter, the eligible articles were reduced to 1,555. Of these results, only 93 corresponded to the type of study intended (clinical trial, clinical study, case report, case series, and observation study) and were, therefore, evaluated according to the title and abstract.

In addition to the PubMed/MEDLINE platform, a search was also carried out in the Science Direct electronic database, where 3,325 articles were obtained. In a similar way to the process referred to in the previous database, the 2018 to 2024 search filter was applied to obtain only articles included in this time period, leaving 1,745. Still using the Portuguese and English language filter, the eligible articles were reduced to 1,742. By applying filters regarding the type of publication (research studies and case reports), 678 results were obtained, which were subsequently analyzed according to their title and abstract.

Of the 771 articles (93 from PubMed and 678 from Science Direct) one was excluded for being in duplicate, leaving 770 articles for screening according to title and abstract. Of these, 715 were excluded because they were not considered relevant to this study or because they were not original, leaving 55 articles for full reading. After reading the 55 articles in full, 8 studies met the inclusion criteria and were used in this Systematic Review. The reason that led to the exclusion of the 47 articles is presented in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart, in ► **Fig. 1**.

Discussion

Once the articles were selected, they were carefully studied, so this discussion will be carried out in topics so that the main contents investigated are highlighted.

Preoperative Decision Making

Of the eight articles chosen, three of them can be included in this section, as they investigate the applicability of AI in different presurgical contexts.

In the research, by using pre- and postoperative facial images, the appearance prediction system based on deep learning. The system managed to predict the postoperative appearance of blepharoptosis surgery with high precision and satisfaction, offering patients the opportunity to better understand the expected change and to alleviate preoperative anxiety, and obtaining better procedure results. While the ability to improve surgical outcomes is promising, it is

Table 1 Data extracted from each study and quality assessment

Article	Author	Publication	Year	Conclusions	Assessment of quality
A Fully Automatic Postoperative Appearance Prediction System for Blepharoptosis Surgery with Image-based Deep Learning ¹⁷ (cross-sectional study)	Sun et al.	<i>Ophthalmology Science</i>	2022	A deep learning system was created to predict the postoperative appearance of blepharoptosis, achieving good objective and subjective results. It can also help patients better understand the expected changes, relieving anxiety. It is crucial to ensure that these AI models are validated in diverse populations, considering racial differences in eyelid anatomy.	30
An attempt to analyze facial photographs of patients with jaw deformity using artificial intelligence ¹⁸ (cohort study)	Kato	<i>Journal of Oral and Maxillofacial Surgery, Medicine, and Pathology</i>	2023	AI assessment for orthodontic surgery for mandibular deformities has had accurate results in the general population but was not consistent in the patients evaluated here. AI assessment is a Black Box, and its details are unknown. Future improvements require more patients, improved imaging methods, and assessment of loss of function.	26
Artificial intelligence for objectively measuring years regained after facial rejuvenation surgery ¹⁹ (retrospective study)	Elliott et al.	<i>American Journal of Otolaryngology</i>	2023	AI networks are capable of accurately and objectively evaluating perceived age reduction after facelift surgery. However, results may not accurately reflect results for men and subjects of different racial backgrounds.	28
A comprehensive evaluation of ChatGPT consultation quality for augmentation mammoplasty: A comparative analysis between plastic surgeons and laypersons ²⁰ (cross-sectional study)	Yun et al.	<i>International Journal of Medical Informatics</i>	2023	When hypothetical ChatGPT breast augmentation queries were scored using validated tools, plastic surgeons consistently scored lower than laypeople in most domains, and scores varied even more across question categories. This highlights the limitations of existing tools to directly assess the quality of healthcare consultations with AI. It is crucial to develop assessment tools that can evaluate the quality and appropriateness of this new form of online health information.	31
Estimating apparent age using artificial intelligence: Quantifying the effect of blepharoplasty ²¹ (retrospective review of clinical files; observational study)	Goodyear et al.	<i>Journal of Plastic, Reconstructive & Aesthetic Surgery</i>	2023	The deep learning algorithm used in this study was accurate and reliable in estimating age from facial photos. This model identified patients as having a lower predicted age after blepharoplasty. This study highlights its potential to provide quantitative evidence on the rejuvenating effects of blepharoplasty.	31

(Continued)

Table 1 (Continued)

Article	Author	Publication	Year	Conclusions	Assessment of quality
Face comparison analysis of patients with orthognathic surgery treatment using cloud computing-based face recognition application programming interfaces ²² (retrospective study)	Akgün et al.	<i>American Journal of Orthodontics and Dentofacial Orthopedics</i>	2023	Although the similarity rates of pre- and postsurgical photographs were high in the study, it is concluded that automatic facial recognition had difficulties with the effects of routine orthognathic surgeries. Biased results from application programming interfaces can cause both patient victimization and misuse. This information is important, especially for specialists working in criminal units and forensic medicine specialists.	29
Plastic Surgery and Artificial Intelligence: How ChatGPT Improved Operation Note Accuracy, Time, and Education ²³ (prospective study)	Abdelhady et al.	<i>Mayo Clinic Proceedings: Digital Health</i>	2023	ChatGPT has demonstrated efficiency and accuracy in preparing operative notes, benefiting modern plastic surgeons. This tool allows you to save time, increases knowledge about surgical procedures, and generates personalized and safe operative notes in accordance with current guidelines. There are legal and ethical concerns related to the use of AI in healthcare, such as data privacy and the protection of patient information, but the authors considered that the current use of ChatGPT in this study is not in conflict with the GDPR.	28
Applying artificial intelligence to assess the impact of orthognathic treatment on facial attractiveness and estimated age ²⁴ (retrospective longitudinal cohort study)	Patcas et al.	<i>International Journal of Oral and Maxillofacial Surgery</i>	2019	While clinicians can benefit from AI-based assessment in treatment planning, it will never replace the patient's own perceptions and expectations, which remain of primary importance. The clinicians' responsibility is to inform the patient honestly and realistically about the aesthetic result, so as not to raise illusory expectations.	30

Abbreviations: AI, artificial intelligence; GDPR, General Data Protection Regulation.

crucial to ensure that AI models are validated across diverse populations, considering racial differences in eyelid anatomy. External validation is essential to mitigate algorithmic bias and ensure that predictions are accurate and reliable for all patients, regardless of their ethnicity.¹⁷

Another study¹⁸ evaluated the possibility of establishing a new discrimination method, determining whether surgical treatment could be carried out through AI analysis, assisting clinical centers without dedicated equipment or specialists who excel in their analysis, as well as nonmedical institutions. Despite the high accuracy of the assessment made by the AI in determining the need for surgery in these cases, the lack of clarity regarding the reliability of their responses and

the underlying data used to support them constitutes an ethical concern. The opaque nature of these systems, often called Black Box, raises questions about their reliability and potential biases. Furthermore, the variability of results based on the specifications of the computer used highlights the need for more in-depth investigations in this area.¹⁸

One tool considered very promising for improving scientific literacy is ChatGPT, an NLP AI model. As such, its usefulness was investigated by evaluating responses to questions simulating breast augmentation consultations using previously existing online information assessment tools. Assessing the quality of the generated responses represents a fundamental ethical issue.

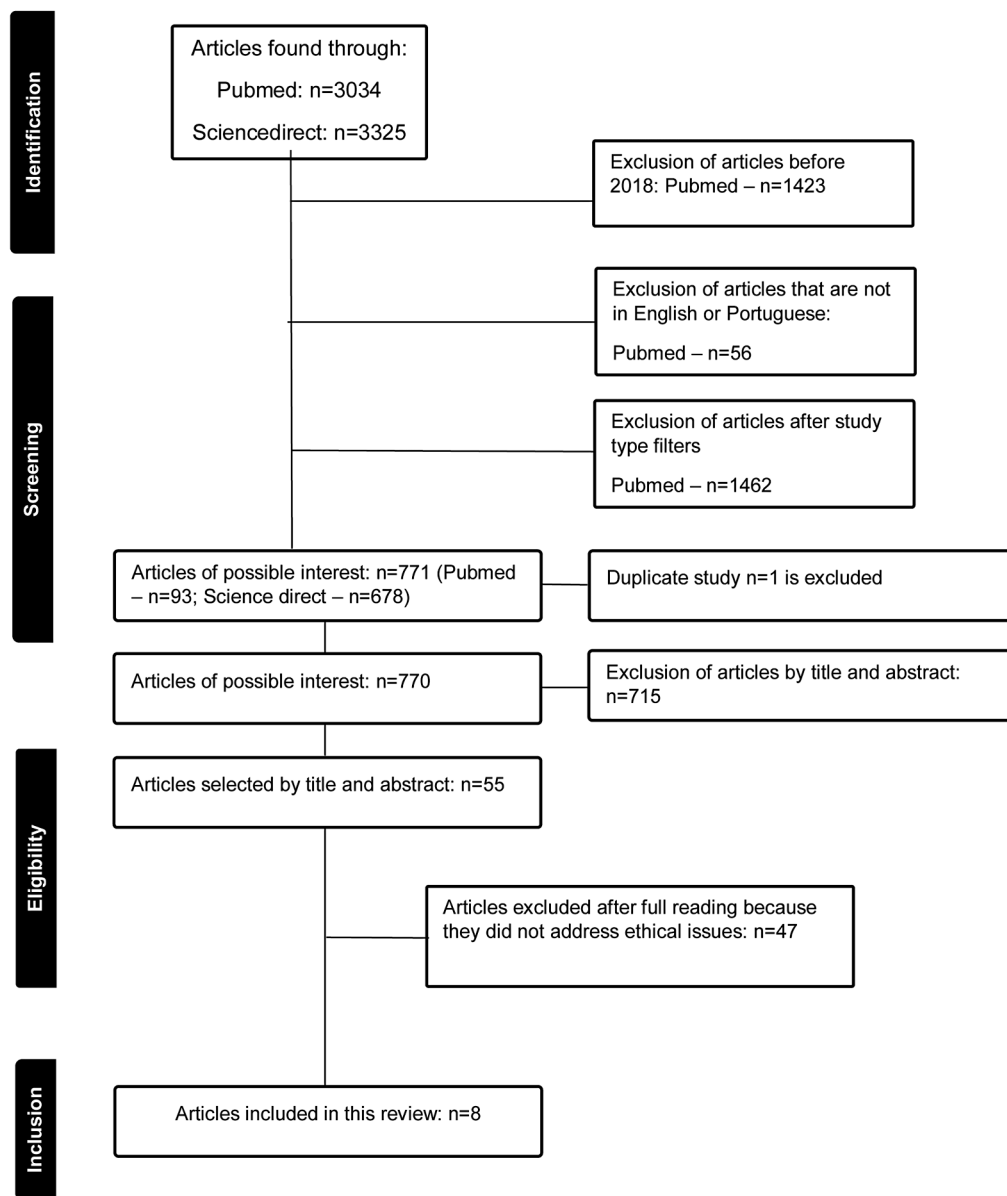


Fig. 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram of the study selection process.

When trying to apply conventional online health information assessment tools, such as the CDC Clear Communication Index (CDC-CCI) and the Journal of the American Medical Association's (JAMA) benchmark, it was realized that these tools were not suitable for evaluating AI-based responses, which do not provide references or attributions like traditional information. This lack of transparency and traceability raises ethical questions about responsibility and accountability for content provided to patients. Furthermore, the application of assessment tools such as Patient Education Materials Assessment Tool (PEMAT) has revealed additional challenges such as the lack of relevant contact elements for AI responses, highlighting the urgent need to develop ethical methods to assess the quality and reliability of the generated health information. These ethical issues are crucial to ensuring that patients receive accurate, transpar-

ent and reliable information when making decisions related to plastic surgery, thus protecting their rights and well-being.²⁰

Postoperative Results

Another four of the selected articles focused on surgical results and their implications.

These facial recognition systems play a vital role in security measures, and are gradually becoming more integrated into everyday devices, such as smartphones and banking systems. However, its increasing use, particularly in airports and in everyday life, poses ethical challenges for patients undergoing jaw surgery or other facial changes.

Biometrics is, then, a technological domain focused on the analysis of unique physical and behavioral characteristics of individuals for security and identification purposes.

Biometric recognition systems go through phases of data acquisition, feature extraction, matching and decision making, through the use of fingerprints, facial features or iris patterns. They collect, process, and store facial data, comparing input data with stored data for recognition.²²

Research has revealed that routine orthognathic surgeries can interfere with automatic facial recognition due to changes in facial features, despite high similarity scores between pre- and postoperative photographs.²² It is up to orthodontists and maxillofacial surgeons to advise patients about the necessary adjustments to their biometric information, such as identity cards or passports, as well as unlocking their cell phone or bank accounts after surgery. However, misleading results from this type of software can lead to victimization or misuse of patients, thus raising concerns about the security of private data. This information is also important for criminal investigators and forensic experts, as individuals may explore maxillofacial and orthognathic surgery to avoid detection by selective facial recognition programs. Forensic anthropologists must also consider the impact of orthognathic surgery on skeletal measurements and analysis, potentially affecting assessments of sex, age, height, and racial origin based on craniofacial characteristics. Therefore, in light of ethics, it is important to consider the responsible and accurate use of facial recognition technology in various areas.²²

One could not address the results of plastic surgery without the topic of rejuvenation and beauty arising. This was mentioned in three articles with different surgical procedures and techniques, namely facelift, orthognathic surgery, and blepharoplasty, regarding their influence on rejuvenation and attractiveness.

An individual's perception of age plays an important role in their well-being, especially in the context of self-idealization and social interaction. As a potential clinical tool, AI can determine age accurately and objectively.^{19,24} According to the research carried out, it appears to be a promising tool for overcoming the subjectivity and human variability of the concept of beauty and age, making an assessment of facial attractiveness.

Although it is admittedly very difficult to quantify beauty, AI allows, from a single facial image, to evaluate attractiveness, characterizing the attractiveness of specific facial features and their combinations (an inherently inaccurate process, whether human or automatic). Furthermore, the assessment of these traits can be used to calculate the individual's apparent age, a clinical result particularly relevant in facial rejuvenation surgery. The use of an algorithm based on a convolutional neural network trained on large volumes of data that reflects relevant opinions may, in fact, prove useful in the objective and reproducible interpretation of facial appearance, as well as apparent age, a task in which the reference human nature is clearly outdated. Furthermore, AI would allow surgeons to predict the outcome of surgical interventions based on the appearance of patients. Consequently, it would eliminate the subjectivity inherent in planning and possibly obtain more favorable aesthetic results.^{21,24}

However, studies consider that the factor of beauty variability is not completely overcome by the use of AI. It is important to critically examine the data sources to assess facial attractiveness. One of the studies evaluated this issue by defining this concept as "social attractiveness", that is, the ability to create interest and desire in today's global society. They were based on ratings obtained on a dating website, validated and improved with medical images, thus training the algorithm to discern the facial qualities that cause interest and desire in observers, and concluded that the score proposed by AI is, without a doubt, an appropriate tool to reflect social opinion about the patients treated. Their premise is that the result of treatment should not be measured by specific panels (or historical and cultural definitions of attractiveness), but by the way society views aesthetic results.

In the context of the study on orthognathic treatment, the use of data from dating platforms was also considered more appropriate. However, in both cases, it is possible to reflect and raise questions about the adequacy and representativeness of these data. Facial attractiveness is influenced by subjective and cultural aspects, and using data from a single source may not fully capture this complexity. Therefore, one should carefully consider how data are interpreted and applied in clinical practice. Furthermore, it is essential to recognize the limitations and biases associated with the use of AI in aesthetic assessment. For example, a lack of diversity in the patient sample may affect the generalizability of results, especially for patients of different ethnic and gender backgrounds. It is noteworthy that AI can have a limited view of facial aesthetics, focusing on specific characteristics that may not fully reflect individual's preferences.

They also consider that, although doctors can benefit from AI-based assessment when it comes to treatment planning, it will never replace the patient's own preferences and goals, which remain of primary importance. The doctor's responsibility is to inform the patient honestly and realistically about the aesthetic result, so as not to create illusory expectations, respecting their autonomy and informed consent.^{19,21,24}

Efficiency in the Workplace and Education

In surgical practice, operative notes are crucial for medical documentation, information exchange, communication between healthcare professionals and also serve as a legally binding document. Errors or omissions in these notes can have serious implications for patient care and result in misunderstandings. The absence necessary information about surgical interventions can result in incomplete medical notes, additional doubts in future surgical procedures, and potential medicolegal repercussions.

They used ChatGPT, which has demonstrated effectiveness in analyzing huge sets of text data and finding solutions through processing massive databases, being considered a cost-effective solution in healthcare systems financed by public funds. It was able to generate customizable, efficient, and secure notes that comply with current medical guidelines and that can be integrated into electronic health record

systems currently used in hospitals. Thus, it is an advantageous tool for modern plastic surgeons, allowing them to invest their time in updating and deepening their surgical knowledge.

In this investigation, some legal and ethical concerns were raised around the use of AI in healthcare, such as data privacy and the protection of patient information. However, it was considered that the use of ChatGPT, in the way it was done, did not conflict with the current GDPR and data management rules, as no patient information was added to the platform and only surgical steps were generated. This tool can offer valuable insights and helpful suggestions, but its knowledge is restricted by limited access to patients' case notes and data. This includes information about previous treatments, underlying medical conditions, and specific details of the surgical procedure. This limitation raises important ethical questions about the accuracy and reliability of medical notes generated by ChatGPT. Without fully understanding the patient's clinical context, there is a risk that this information will be inaccurate, incomplete or even inappropriate for treating users. This can lead to suboptimal clinical decisions or failure to provide adequate health care.

However, they admit that the platform's continuous implementation in the users' healthcare process raises concerns, namely access to the software with sensitive user data, which could be a risk to confidentiality and privacy, in addition to negatively affecting users' trust in healthcare providers.²³

Conclusion

The results presented in this systematic review were obtained through an adequate research strategy, article selection, and data extraction. Heterogeneity was observed in the ethical challenges identified, enriching the discussion regarding the explored issues.

With technological advances and great discoveries within the new field of AI, an exponential increase in studies developed in this area has emerged in the last year. This is a very recent, complex, and still unknown topic, which is why there is a need for in-depth and continued studies on how far AI can go in the field of plastic surgery, and what its current and long-term ethical implications are.

In all selected studies, AI proved to be an advantageous tool in assisting plastic surgeons in their clinical practice regardless of the phase of the surgical treatment process in which it was implemented. This is very promising in the field of plastic surgery, where predictions through facial and body profiles, as well as the need for an objective assessment of surgical results, constitute unique application points.

An important discussion then arises, regarding the ethical implications of the nonhuman influences of computing in an area that, although based on scientific objectivity and biological facts, is also driven by unique and incomparable human characteristics. The concerns raised in this research

were mainly: data privacy, patient autonomy, equity bias, transparency, and accountability of the algorithm.

Legislation and regulation are developing more slowly than this technology, so it is imperative to learn about this topic as early as possible and proactively promote discussions about ethical and regulatory dilemmas. In fact, this review revealed that more research is needed on the ethical challenges of applying AI in plastic surgery, as data on this issue is scarce.

Additional investigations are crucial to promote efforts aimed at increasing transparency in AI algorithms, shedding light on their decision-making process, as well as to further establish robust quality assurance mechanisms, which is imperative to ensure the ethical integrity and reliability of their diagnostics and treatment modalities. These initiatives aim to not only improve healthcare professionals' understanding of how AI systems work, but also strengthen patient trust and ensure ethical and responsible clinical practice.

Strengths and Limitations

By following the PRISMA protocol for study selection, data extraction and synthesis, this review aims to minimize bias, thus increasing the reliability of the findings. Through the synthesis of evidence from multiple studies, we could conduct a more robust overview of the ethical challenges and considerations in precision medicine applied to oncology. Even more, the systematic approach followed while conducting the review ensures transparency in the selection and evaluation of studies.

Nevertheless, the included studies may vary in methodologies, populations and setting, leading to heterogeneity, thus increasing the complexity of synthesizing findings and interpreting results. Also, the research for this review was quite limited as few articles were found that met the objective of this work (ethical challenges). Many of the articles found to be of possible interest were review articles that were not included.

Ethics Declaration

No primary data were collected in this study. Ethical approval and consent to participate do not apply, according to legal regulations, consent for publication is also not applicable.

Authors' Contributions

FVP: methodology and writing – original draft. AGA: final manuscript approval and writing – review & editing.

Financial Support

The authors declare that they did not receive financial support from agencies in the public, private or non-profit sectors to conduct the present study.

Conflict of Interests

The authors have no conflict of interests to declare.

Acknowledgments

The authors would like to thank all those who have contributed to and provided information for this article.

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