JPRAS Open 39 (2024) 89–92

Contents lists available at ScienceDirect

JPRAS Open

journal homepage: www.elsevier.com/locate/jpra

Short Communication

The future of artificial intelligence in facial plastic surgery

Mariella Fortune-Ely[a,*], Mohit Achanta[a], Marie S.H. Song[b]

[a] *Imperial College Healthcare NHS Trust, Department of Otolaryngology, Head and Neck Surgery, Imperial College Healthcare NHS Trust, Charing Cross Hospital, Fulham Palace Road, London, W6 8RF, United Kingdom*

[b] *Guys and St Thomas NHS Foundation Trust, St Thomas Hospital, Westminster Bridge Road London, SE1 7EH, United Kingdom*

ARTICLE INFO

Article history:
Received 17 October 2023
Accepted 26 November 2023
Available online 1 December 2023

Keywords:
Facial plastic surgery
Artificial intelligence
Machine learning

ABSTRACT

The role of artificial intelligence is emergent in facial plastic surgery. It offers specialists a potentially precise and efficient method of understanding our technical skills and pathways, and their impacts on patient outcomes and error rates. Algorithms have given life to personalised pre-operative assessment, surgical planning and outcome simulation, and post-operative monitoring. Despite these benefits, limitations at this time include the ethical acquisition of large datasets, biases produced by human input and trust in novel technologies. Careful consideration should be given to the role artificial intelligence may play in shaping the patient-surgeon relationship in the near future.

© 2023 The Authors. Published by Elsevier Ltd on behalf of British Association of Plastic, Reconstructive and Aesthetic Surgeons. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)

Introduction

Artificial Intelligence (AI) has gradually been implemented in medical research and clinical practice across specialities. It harnesses the power of computers to analyse large volumes of data and make predictions via pattern recognition. Basic disciplines of AI such as machine learning, deep learning,

* Corresponding author at: Department of Otolaryngology - Head and Neck Surgery, Imperial College Healthcare NHS Trust, Charing Cross Hospital, Fulham Palace Road, London, W6 8RF, United Kingdom

E-mail address: m.fortune-ely@nhs.net (M. Fortune-Ely).

https://doi.org/10.1016/j.jpra.2023.11.016
2352-5878/© 2023 The Authors. Published by Elsevier Ltd on behalf of British Association of Plastic, Reconstructive and Aesthetic Surgeons. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)

natural language process (NLP), and facial recognition are currently being used in plastic surgery for surgical planning, image analysis and postoperative monitoring. Facial plastic surgery (FPS) relies on clinical expertise and artistic vision to restore form and function to the face. AI has the potential to provide technical support to enhance these skills, making it an important tool for facial plastic surgeons of this generation to be aware of.[1]

Applications on the horizon

AI may provide a novel way for surgeons to monitor outcomes. Deep learning algorithms such as Convolutional Neural Networks (CNN) mimic the learning ability of neurons to recognise, differentiate, and assign value to specific data signals. By collecting over a million facial images, CNNs can recognise lines, shapes, colours, and textures to detect subtle changes in facial proportions and symmetry.[2] Elliot et al. used FaceX (a CNN), to assess post-operative success by calculating the age reduction achieved in 226 patients following rhytidectomy surgeries. FaceX estimated age based on pre-operative photographs with 96% accuracy. Follow-up images were taken at three and twelve months postoperatively and the software calculated an average age reduction of three years across various surgical techniques, including deep plane, SMAS-plication, fat graft, blepharoplasty, browlift and platysmaplasty. There was no statistical difference between interventions, and no technique was seen to be superior in restoring youthfulness in this study.[2] CNNs trialled on larger cohorts can enable surgeons gain more informed consent from their patients by comparing large-volume outcomes to their patients' needs.

Rhinoplasty is popular and challenging procedure in FPS, and significant aesthetic and functional impacts are seen with subtle alterations to nasal structures. Machine learning models are able identify that geometric facial features such as larger nasofrontal and nasolabial angles are associated with increased attractiveness following a cosmetic rhinoplasty. This information can be coupled with 3D modelling to aid surgical planning. Similar machine learning algorithms can be trained to recognise various surgical techniques and simulate their outcomes.[3] The healing process following rhinoplasty may also be modelled using AI.[1] This helps surgeons understand the impact of their techniques in more detail, enabling patients to be more involved in decision making, and is likely to improve post-operative satisfaction.

Monitoring free-flaps is a key part of post-operative care in reconstructive microsurgery, and is a resource intensive task as it requires the use of an ultrasound doppler probe and a practitioner familiar with its use. Resources may be better allocated with the guidance of machine learning models that help to analyse post-operative free flap viability in reconstruction for facial skin cancers. Hung et al. established a prediction model which detects the arterial and venous insufficiency in clinical photographs of free-flaps to 98.4% accuracy. This could reduce the use of portable dopplers, allowing initial assessment to be carried out at centres with less equipment and specialised staff.[4]

NLP algorithms can recognise and understand language in text and voice recordings. Text recognition can analyse electronic patient records to draw conclusions with existing large-volume data. The capability to quickly understand timelines, benefits and complication rates empowers surgeons to understand where to improve their practice. This can be used to highlight patients who may be at higher risk group for certain operations, augmenting the preoperative assessment process and allowing for more informed decision making on procedure for surgical management.[5]

Limitations of artificial intelligence in FPS

For an AI system to produce representative and accurate results, an up-to-date and high volume data set is required. An example is the collaborative National Surgical Quality improvement program, which includes over 700 hospitals in America.[6] There are several ethical considerations in gaining informed consent for the storage and distribution of personal data. The European Union's data protection act, the GDPR, is not incompatible with the use of big data in AI. However, due to the complex and evolving nature of data handling for use in AI, and constant evolution of GDPR policy, there is larger role for political authorities to outline the responsibilities of stake holders.[6]

Developing the training data for AI requires human input, naturally introducing the risk of bias. Patcas et al. used CNNs to calculate improvements in facial attractiveness following FPS, using a dataset of "$>$13,000 facial images with $>$17 million ratings for attractiveness" taken from dating sites.[7] However, perceived social attractiveness is impacted by racial and gender biases, and ethnically diverse facial features are likely to be under-represented in facial recognition and machine learning models of AI due to pre-existing socio-economic and cultural barriers. Cosmetic facial plastic populations already contain a disproportionately low number of Black patients, which may be due to cultural influences and different aesthetic ideologies.[8] Whilst this constitutes a useful source of data for some populations, it is subject to the bias created by current trends, and the variation in beauty standards amongst different cultures and races.[9]

New ideas

As evidenced, AI has myriad applications in the surgical world. NLPs and machine learning may guide clinicians in providing more detailed counselling to patients pre-operatively. Automated and personalised post-operative simulations could be available to patients peri–operatively, reducing the mystery and anxiety surrounding surgery. Personalised simulations could be combined with 3D printing to produce scaffolds for reconstructive procedures. The increasing burden of administrative tasks contributes to burnout amongst physicians. If the power of AI can be harnessed to improve this, we may improve our doctors' wellbeing, efficiency and retention. However, caution is needed not to allow technology to impact the patient-surgeon relationship. This is especially critical in a speciality such as reconstructive plastic surgery, where trust is a key factor in establishing positive patient outcomes.[10]

Conclusion

The use of AI remains in its early stages in FPS, and clinicians should take the time to understand these evolving technologies and how they may impact practice. Surgeons should seek opportunities to collaborate with data scientists to guide its development to optimise surgical time and patient outcomes, and potentially reduce the burden of repetitive administrative tasks. Gaining patient perspectives and improving national awareness of the increasing capabilities of AI in FPS will be necessary in taking shared decisions and deciding its role in the surgical journey. AI should continue to advance the capabilities of the speciality and complement our surgeons experience rather than replace it.

AI statement

N/A.

Ethical approval

Not required.

Funding

There are no sources of funding to declare.

Presentations

This work has not been presented at meetings.

Declaration of Competing Interest

The authors declare no conflict of interest.

References

1. Souto Valente D. Porto Alegre of, Antonio Carlos Berta R. Artificial intelligence in plastic surgery. *Mathews J Dermatol*. 2023;7(1):20 Available from:. doi:10.30654/MJDE.10020.
2. Elliott ZT, Bheemreddy A, Fiorella M, Martin AM, Christopher V, Krein H, et al. Artificial intelligence for objectively measuring years regained after facial rejuvenation surgery. *Am J Otolaryngol - Head Neck Med Surg*. 2023;44(2).
3. Eldaly AS, Avila FR, Torres-Guzman RA, Maita K, Garcia JP, Palmieri Serrano L, et al. Simulation and artificial intelligence in rhinoplasty: A systematic review Springer; 2022:2368–2377.
4. Huang R.W., Tsai T.Y., Hsieh Y.H., Hsu C.C., Chen S.H., Lee C.H., et al. Plastic and reconstructive surgery advance online article. Available from: http://journals.lww.com/plasreconsurg
5. Jarvis T, Thornburg D, Rebecca AM, Teven CM. Artificial intelligence in plastic surgery: Current applications, future directions, and ethical implications. *Plast Reconstr Surg Glob Open*. 2020;8(10):E3200.
6. Sartor Giovanni, European Parliament. European Parliamentary Research Service. Scientific Foresight Unit. The impact of the General Data Protection Regulation (GDPR) on artificial intelligence : Study. 84 p.
7. Patcas R, Bernini DAJ, Volokitin A, Agustsson E, Rothe R, Timofte R. Applying artificial intelligence to assess the impact of orthognathic treatment on facial attractiveness and estimated age. *Int J Oral Maxillofac Surg*. 2019;48(1):77–83.
8. Alotaibi AS. Demographic and cultural differences in the acceptance and pursuit of cosmetic surgery: A systematic literature review. *Plast Reconstr Surg Glob Open*. 2021;9(3):E3501.
9. Rokhshad R., Keyhan S.O., Yousefi P. Artificial intelligence applications and ethical challenges in oral and maxillo-facial cosmetic surgery: A narrative review. Vol. 45, Maxillofacial Plastic and Reconstructive Surgery. Springer; 2023.
10. Kern E, Friedman O. Avoiding the unhappy patient by building rapport in the internet age. *Facial Plast Surg*. 2019;35(2):210–213.