Editorial

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Artificial intelligence-powered intraoperative nerve monitoring: a visionary method to reduce facial nerve palsy in parotid surgery: an editorial

Tooba Ali, MBBS[a], Hibah Abid Imam, MBBS[a], Biya Maqsood, MBBS[a], Ifra Jawed, MBBS[a], Iman Khan, MBBS[a], Md Ariful Haque, MBBS, MD, MPH[b,c,d,*]

Due to the facial nerve's critical involvement in facial expression, sensation, and overall patient's quality of life, maintaining facial nerve function after parotid surgery is of the utmost importance. Despite the growing use of intraoperative facial nerve monitoring during Parotid gland surgery and advancements in preoperative radiological assessments, facial nerve injury (FNI) continues to be the most serious consequence of parotid gland surgery (PGS). Twenty to sixty-five percent of patients undergoing parotidectomy experience temporary facial nerve dysfunction[1], whereas 0–7% of patients experience permanent facial nerve dysfunction[1]. The facial nerve regulates the muscles that move the face and is closely connected to the parotid gland. Consequently, there is a risk of injury to the facial nerve from any surgical procedure in this location, which would have major functional and cosmetic consequences. Parotid surgical problems that result from facial nerve dysfunction can have both short-term and long-term effects. Acute facial paralysis can cause significant physical changes, psychological distress, difficulties swallowing, speaking, and closing one's eyes. Failure to maintain facial nerve function over time can result in contractures, reduced facial symmetry, and synkinesis (uncontrollable simultaneous movements of various facial muscles). Intraoperative monitoring, rigorous surgical methods, and thorough anatomical knowledge are necessary to maintain facial nerve integrity during parotid surgery. Therefore, ensuring the greatest outcome for patients after parotid surgery is still of utmost importance to adhere to patient-centred care principles and enhance their general quality of life. Conventional intraoperative nerve monitoring, which makes use of methods such as nerve stimulation and electromyography, is essential for procedures such as thyroid and parotidectomy. By enabling real-time monitoring of vital nerves, it improves patient outcomes by lowering the chance of nerve damage and surgical consequences, like facial weakness or vocal cord dysfunction, and enabling surgeons to make prompt adjustments to their technique. Most of the early papers on using facial nerve monitoring in parotid surgery were descriptive, giving a general summary of the technique and its possible advantages[2]. Since then, research has concentrated on case or historical controls in retrospective or prospective case series to assess the safety and effectiveness of nerve monitoring devices during parotid surgery. Numerous investigations have demonstrated that postoperative rates of facial paresis can be similar for patients undergoing intraoperative facial nerve monitoring and those who do not[3]. During parotid surgery, intraoperative facial nerve monitoring has many benefits. One benefit is that surgeons can prevent iatrogenic facial nerve injury by using real-time feedback on the location and functional state of the facial nerve[4]. On the other hand, traditional intraoperative nerve monitoring methods are also limited, as they offer indirect feedback through muscle responses, which may not reflect nerve integrity reliably[5]. Furthermore, traditional nerve monitoring methods involve invasive nerve stimulation, posing injury risks, and may not be suitable for cases with inaccessible nerves or patients with preexisting neurological conditions[6]. In a

HIGHLIGHTS

The study aims to:

- Improve intraoperative nerve monitoring (IONM): To continuously monitor the location and health of the patient's unique facial nerve network during surgery, a dynamic model of the patient's nerve network is developed using artificial intelligence algorithms.
- Prediction and prevention of nerve injury: By utilizing artificial intelligence, the research aims to reduce the danger of nerve injury by predicting possible problem regions based on the anatomy of each particular patient and taking preventative action.
- Enhancement of patient outcomes: In the end, the research aims to increase surgical safety and precision, reduce the incidence of postoperative Bell's palsy, and improve patient outcomes, including quality of life.

[a]Dow University of Health Sciences, Mission Road, Karachi, Pakistan, [b]Department of Public Health, Atish Dipankar University of Science and Technology, [c]Voice of Doctors Research School, Dhaka, Bangladesh and [d]Department of Orthopedic Surgery, Yan'an Hospital Affiliated to Kunming Medical University, Kunming, Yunnan, China

Hypothesis: By offering real-time monitoring, predictive capabilities, and the ability to leverage large datasets to improve surgical precision and patient outcomes, integrating AI-driven intraoperative nerve monitoring during parotid surgery will significantly reduce the incidence of facial nerve palsy.

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*Corresponding author. Address: Department of Public Health, Atish Dipankar University of Science and Technology, Dhaka, Bangladesh, Voice of Doctors Research School, Dhaka, Bangladesh, Department of Orthopedic Surgery, Yan'an Hospital Affiliated to Kunming Medical University, Kunming 1213, Yunnan, China. Tel.: +880 189 477 3747. E-mail arifulhaque58@gmail.com (Md A. Haque).

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recent study, authors examined the literature to develop standardized facial nerve monitoring (FNM) procedures for parotid surgery. These included general anaesthesia, FNM setup, application of stimulus currents, interpretation of electrophysiologic signals, prediction of the outcome of the facial expression, and pre-and postoperative assessment of facial expressions. Additionally, the scientists suggested a dynamic nerve network model that can forecast how tumour removal will affect a person's facial expressions[7]. During surgery, the dynamic nerve network model allows for accurate mapping of the facial neural structures, changes in the nerve routes, and real-time nerve health monitoring. This approach draws inspiration from well-established techniques in nerve monitoring and intraoperative imaging[8]. In recent years, the integration of artificial intelligence (AI) into the field of medicine has burgeoned, offering myriad benefits that are revolutionizing healthcare. AI's rapid integration into medicine has led to round-the-clock access to medical information via chatbots, early disease detection through electronic health record analysis, and improved surgical precision with AI-driven systems. This synergy between AI and human expertise reshapes healthcare for increased efficiency, patient-centred care, and effectiveness. However, with the combination of human medical expertise and AI-based nerve monitoring, the postoperative complications of facial nerve palsy (Bell's palsy) can be reduced to a great extent. In particular, the search to avoid postoperative Bell's palsy has been made easier because of the introduction of AI into parotid surgery. AI shows enormous promise for reducing this risk because it analyzes data in real-time and recognizes patterns[1]. Gathering high-resolution imaging data is the first step in AI-enhanced nerve monitoring during parotid surgery. The facial nerves of the patient can be precisely mapped anatomically using cutting-edge imaging methods like high-frequency ultrasound or intraoperative MRI. Following AI algorithms' processing of this data, a detailed and dynamic model of the nerve network unique to the patient's anatomy can be produced. The monitoring systems powered by AI used during surgery continuously monitor the position and condition of the facial nerves and notify the surgical team of any abnormalities. With this in-the-moment input, surgeons can fine-tune their procedures and prevent accidental nerve damage. Additionally, based on the patient's particular nerve arrangement, AI can anticipate possible issue locations, enabling preventative interventions. In this situation, AI's benefits go beyond real-time surveillance. Machine learning algorithms can analyze large datasets of surgical outcomes, which can spot trends that human surgeons would miss. This information can influence best practices, which can also help surgical procedures continue to advance. AI has a dual effect on nerve monitoring during parotid surgery: first, it lowers the risk of postoperative Bell's palsy, improving patient outcomes, and second, it increases the precision and safety of these delicate procedures[9]. With AI keeping an eye on the vital nerves, surgeons may securely manoeuvre the complicated anatomy of the parotid gland. Patients gain from lower dangers and a better possibility that their facial nerve function would remain intact following surgery. Medical AI and IONM integration can perform with expert-level accuracy and provide efficient care at scale[10]. AI is making breakthroughs in healthcare systems, from databases to intraoperative video analysis. Surgeons are in a strong position to contribute to the forthcoming phase of AI, which focuses on producing evidence-based, real-time clinical decision assistance to enhance patient care and surgeon workflow[11]. AI is becoming increasingly crucial for surgical decision-making to address various information sources, including patient risk factors, anatomy, disease, natural history, patient values, and cost, and help surgeons and patients predict the outcomes of surgical decisions more accurately[12]. AI-assisted surgery could direct a surgeon's tool during an operation and use information from previous procedures to impact the development of new surgical techniques. By giving surgeons real-time feedback on their performance, it has the potential to enhance surgical results significantly. The risk of complications during surgery can be minimized with this feedback, which can assist surgeons to perform more precise motions. Artificial intelligence can learn complicated, non-linear relationships between input variables and outcome labels by practicing on vast amounts of electronically recorded data. The technology can then make predictions using fresh, unused data. The competence of surgeons and the quality of patient care can both be enhanced by these accurate, interpretable, and risk-sensitive predictions[13]. On the contrary, there may indeed be hazards associated with using AI-based monitoring in surgical settings, such as parotid surgery, as our editorial discusses. The possibility of "false positives," in which an artificial intelligence system mistakenly detects an abnormality or situation that does not genuinely exist, is a serious worry. This can lead to erroneous information, resulting in needless procedures or changes to the surgical technique. Furthermore, there is a greater risk associated with an over-reliance on technology, whereby surgeons may have an unhealthy level of confidence in the AI system, which could result in complacency or a diminished value placed on their clinical competence. To reduce these dangers, it's imperative to strike a balance between using AI to improve decision assistance and preserving the vital role that a surgeon's judgment plays.

Conclusion

In conclusion, incorporating AI into parotid surgery is a game-changing strategy for the future of healthcare because it lowers the danger of facial nerve damage and improves overall patient outcomes. However, there are several factors to consider when assessing the viability and scalability of deploying AI systems in a broader healthcare setting. The capacity to use AI systems in various healthcare environments and patient demographics is essential to scalability. Ensuring AI systems can adjust to the fluctuations in surgical techniques, patient demographics, and healthcare infrastructure can be challenging. Scalability is also significantly influenced by the accessibility of resources and the incorporation of AI into current healthcare frameworks. Evaluating the viability of integrating AI smoothly into standard clinical operations is necessary to ensure practicality. Instead of upending current procedures, AI should improve productivity and decision-making. Practical AI integration requires addressing user training, interoperability with current systems, and reducing the impact on overall healthcare operations. Even while our article emphasizes the potential advantages of AI in parotid surgery, given the revolutionary nature of this technology, the broader scalability and applicability of AI in healthcare necessitate a thorough study of these complex issues. The goal of future research and development must be to simplify the use of AI such that it is both scalable and valuable for a variety of healthcare settings.

Future research directions

Although our work acknowledges the developing nature of this subject and cites numerous crucial areas for future research, it also looks forward to a hopeful future for AI in parotid surgery. To improve AI algorithms' accuracy and predictive power, ongoing optimization should be a top priority. This ongoing development is essential to maximize these algorithms' performance in real-world data and surgical results. Furthermore, research is required to harmonize data collection techniques and combine various datasets. Using this method will make it possible to create reliable AI models that can be used for various surgical circumstances and patient populations. Future studies should address issues with patient permission, data privacy, and the responsible use of AI in surgery by examining the creation of precise ethical norms and solid regulatory frameworks as AI becomes more incorporated into healthcare. To guarantee that surgeons and other medical practitioners are competent in AI tools, user-friendly interfaces and extensive training programs must be prioritized. Comprehensive cost-benefit assessments will be necessary to ascertain whether incorporating AI into parotid surgery is economically feasible in the long run.

To conclude, comprehensive clinical validation research is required to determine the effectiveness and safety of AI-assisted parotid surgery in actual clinical settings. This research must include prospective trials and comparison assessments with traditional procedures. To sum up, these avenues for future study represent a thorough plan to further the field of artificial intelligence in parotid surgery and encourage its possible use in general healthcare settings.

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