How can artificial intelligence (AI) transform ultrasonography for regional anesthesia and pain management?

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Ultrasound is a well-recognized tool for regional anesthesia and tailored pain management. It offers real-time imaging of patient's anatomy and provides guideline for needle insertion with precision. Though, its accuracy highly relies on operator's skill and experience. The incorporation of Artificial Intelligence (AI) into ultrasound modality has transformed the field by upgrading the explication of images including tumor detection, segmentation and classification by inculcating the Convolution Neural Networks (CNNs) which is a type of deep learning.

Incorporation of AI in ultrasound can efficiently detect the abnormalities, thus improving the diagnostic accuracy. It is done by training the neural networks with data sets containing images with both normal and abnormal anatomical structures. Deep learning algorithms (CNN's) improve the clinical efficiency by employing algorithms trained on large data sets for making identification and diagnosis more precise.[1] Complications like vascular puncture or nerve damage can be eliminated or at least reduced if anesthetists use AI-powered image identification to label vasculatures, nerves, and other important characteristics.

Anesthetic procedures can be made more precise and accurate with the help of AI automation, because it can guide the clinician about the precise insertion point and allow tracking the correct needle path and its target. Anesthesia procedural time can be reduced by AI automation because it provides guidelines about optimal needle insertion depths and angles thus helping health care practitioners and also enhancing the patient's safety.[2] This advanced technology can be especially valuable in demanding conditions where old surface land markings are not appropriate to use.

Newly trained Sonologists with less experience can get help of AI incorporated sonographic machines for making expert decisions and diagnoses thus reducing operator inefficiency which is a significant drawback, this can improve their knowledge and working skills considerably. AI is improving the current workflow environment by providing young practitioners with real time practice help for making accurate decisions.[3] To improve the knowledge about regional anesthesia and pain management, artificially intelligent deep learning systems are providing training aids, customized teaching programs and automated tests.

By automating time-consuming processes like image collection, labeling, and documentation, AI integration with patients' genetic coding, clinical data and imaging modalities can assist in improving workflow. Anesthesiologists can concentrate on clinical decision-making by using AI-driven software (i.e., U-Net, a widely used CNN architecture) to optimize ultrasound machine settings based on patient characteristics and procedure requirements.[4] In non-availability of human experts AI systems are revolutionizing the medical setups by eliminating the malpractice, reducing the artifacts and making the rapid and accurate diagnoses.

There are many ethical considerations that should be kept in mind when incorporating artificial intelligent models to current workflow systems, the most important one is the patients' private data that is not allowed to share by approval authorities. If diverse data is not allowed to share with neural networks, then decisions made by AI models will be biased. Moreover, it should be well-defined who will be responsible for the errors and mistakes made by AI models, there should be an expert human opinion over automated generated detection or decisions particularly in case of serious illness conditions like carcinomas.[5]

AI has the capability to bring revolution in the field of anesthesia and interventional pain management procedures by improving image interpretation, automated needle guidance, limited operator dependency and increasing workflow efficiency. Although there are barriers to get control, continuous research and technical advancements will speed up the effective incorporation of AI into clinical setups, ultimately improving patient outcomes and procedure safety.

Conflict of interest

The author declares that there was no conflict of interest.

Author's contribution

Qurba Kiran has been the sole author of this manuscript.

REFERENCES

1. Mervak BM, Fried JG, Wasnik AP. A review of the clinical applications of artificial intelligence in abdominal imaging. Diagnostics. 2023;13(18):2889. [PubMed] DOI: 0.3390/diagnostics13182889

2. Swain BP, Nag DS, Anand R, Kumar H, Ganguly PK, Singh N. Current evidence on artificial intelligence in regional anesthesia. World Journal of Clinical Cases. 2024;12(33):6613. [PubMed] DOI: 10.12998/wjcc.v12.i33.6613

3. Secinaro S, Calandra D, Secinaro A, Muthurangu V, Biancone P. The role of artificial intelligence in healthcare: a structured literature review. BMC medical informatics and decision making. 2021;21:1-23. [PubMed] DOI: 10.1186/s12911-021-01488-9

4. Bowness JS, Metcalfe D, El-Boghdadly K, Thurley N, Morecroft M, Hartley T, Krawczyk J, Noble JA, Higham H. Artificial intelligence for ultrasound scanning in regional anaesthesia: a scoping review of the evidence from multiple disciplines. r J Anaesth. 2024;132(5):1049-1062. [PubMed] DOI: 10.1016/j.bja.2024.01.036

5. Mennella C, Maniscalco U, De Pietro G, Esposito M. Ethical and regulatory challenges of AI technologies in healthcare: A narrative review. Heliyon. 2024;10(4):e26297. [PubMed] DOI: 10.1016/j.heliyon.2024.e26297