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Artificial neuronal networks in fetoscopic laser surgery for twin-to-twin transfusion syndrome

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Objective

This study aimed to develop a neural network framework for real-time placental vessel segmentation during fetoscopic laser photocoagulation to treat Twin-to-Twin Transfusion Syndrome (TTTS), with a focus on identifying both large and tiny vessels accurately and efficiently. The framework also utilized novel data augmentation approaches to improve model generalization and avoid artifacts during segmentation.

Methods

The neural network was trained on a large-scale dataset of video frames from 18 independent fetoscopic procedures and evaluated on a multi-center external dataset of video from 24 in-vivo procedures. A total of 42 patients undergoing fetoscopic surgery for TTTS were included, with procedures performed in six European fetal surgery centers.

Results

The proposed neural network significantly outperformed state-of-the-art methods in placental vessel segmentation performance, achieving a real-time processing speed suitable for interactive use during live surgery. The framework also demonstrated high accuracy in identifying small vessels, potentially reducing the rate of missed vessels during surgery.

Conclusion

The developed neural network framework can assist surgeons in real-time vessel segmentation during fetoscopic laser surgery for TTTS. The ability to precisely outline small vessels could improve surgical outcomes and decrease the rate of complications associated with missed vessels (like Twin Anemia Polycythemia Sequence). The framework's performance and efficiency make it a promising tool for clinical use.