

A radiomics and deep learning fusion model based on placental ultrasound images for predicting early-onset fetal growth restriction

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The fusion model showed the strongest and most stable prediction across gestation, with performance peaking at 21-24 weeks.

BACKGROUND

- Early-onset fetal growth restriction (eoFGR) is closely linked to placental dysfunction and adverse perinatal outcomes.
- Conventional ultrasound growth assessment may identify disease only after fetal growth has already diverged.

OBJECTIVE

To evaluate whether combining placental ultrasound radiomics and deep learning features can predict eoFGR earlier, and to determine how performance changes across gestation.

STUDY OVERVIEW

170

fetuses evaluated in a prospective study

Placental B-mode ultrasound images were acquired at three predefined gestational windows. Radiomics, deep learning and fusion models were evaluated using an independent testing set.

11-14 w

Early gestation

21-24 w

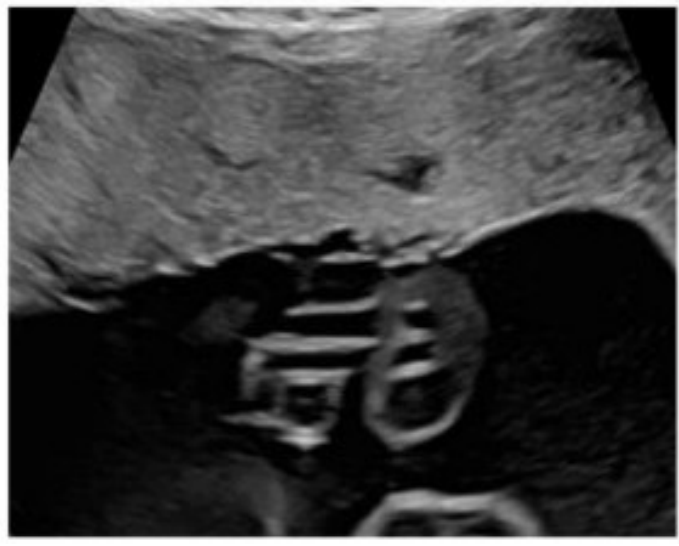
Mid gestation

28-32 w

Late gestation

Each gestational window was analyzed independently.

PLACENTAL ULTRASOUND



B-mode image



Manual ROI

IMAGE INPUT

Representative placental B-mode image and manually outlined region used for image-based feature extraction.

METHODS AT A GLANCE

1

Longitudinal ultrasound

Placental B-mode images acquired at 11-14, 21-24 and 28-32 weeks.

2

Two feature streams

Handcrafted radiomics features and features learned by pretrained convolutional neural networks.

3

Three model families

Radiomics (Rad), deep learning (DL) and deep learning radiomics fusion (DLR).

4

Independent evaluation

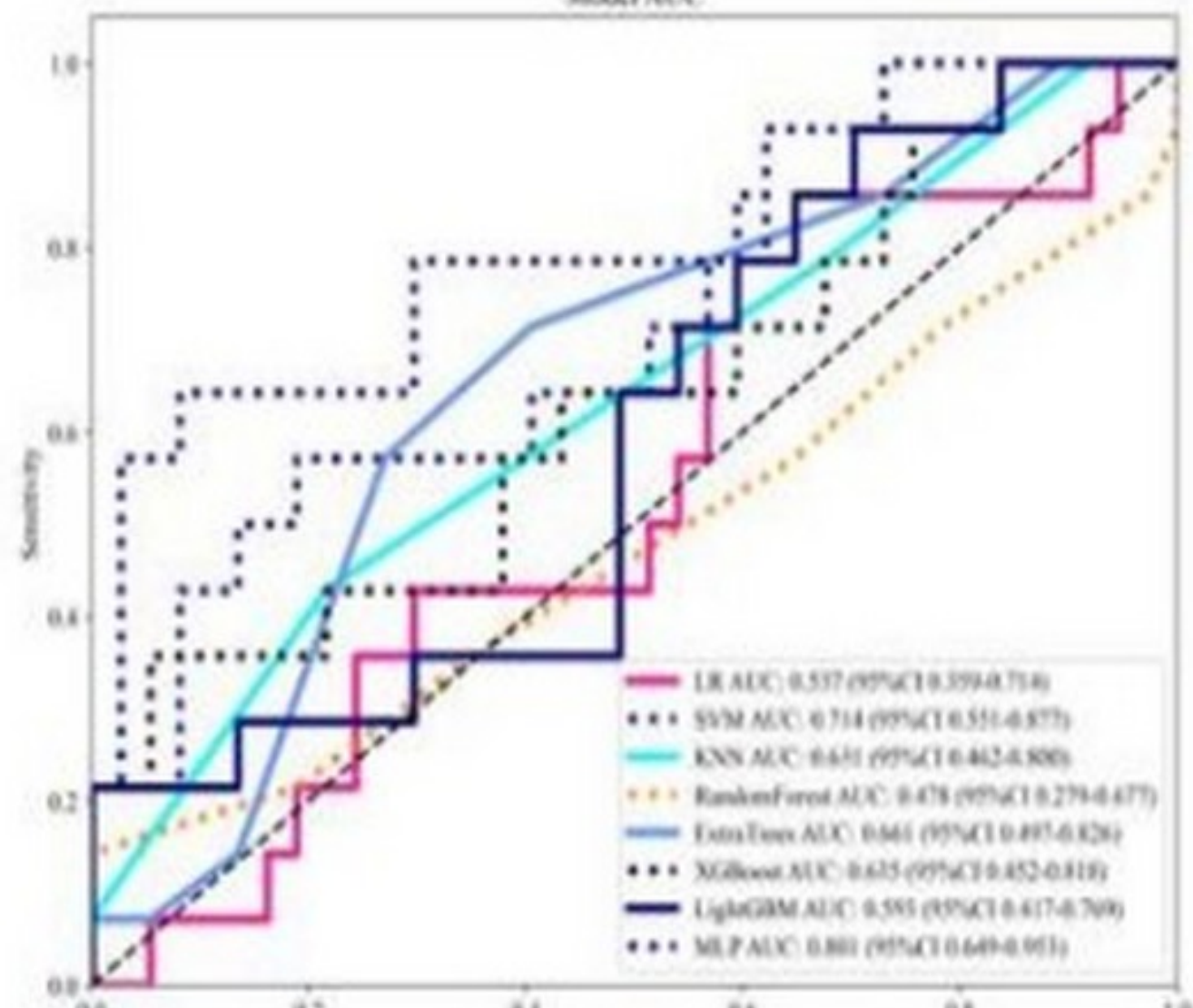
Predictive performance assessed in an independent testing set for each gestational window.

FUSION STRATEGY

Complementary handcrafted and learned image features were integrated to improve the stability of eoFGR prediction.

KEY RESULTS

The DLR model achieved the highest predictive performance at all three gestational windows.



Representative DLR ROC/AUC curves

11-14 weeks

0.817

DLR testing AUC

21-24 weeks

0.825

Highest performance

28-32 weeks

0.799

DLR testing AUC

Standalone deep learning models showed overfitting, with testing AUCs below 0.76 across the three windows.

CONCLUSION

The DLR fusion model provided superior and stable eoFGR prediction across gestation, with 21-24 weeks identified as the optimal prediction window.

These findings support a non-invasive, gestational-age-aware approach to early risk identification.