EBioMedicine 51 (2020) 102588

Contents lists available at ScienceDirect

EBioMedicine

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

Commentary

The new era of advanced placental tissue characterization using MRI texture analysis: Clinical implications

Valeria Romeo, Simone Maurea*

Department of Advanced Biomedical Sciences, University of Naples "Federico II", Via S. Pansini, 5, 80131, Naples, Italy

ARTICLE INFO

Article History:
Received 27 November 2019
Accepted 28 November 2019
Available online xxx

In this issue of *EBioMedicine*, Qingxia Wu and colleagues propose an integrated clinic-radiomic model combining clinical factors such as maternal age, previous caesarean delivery and hemoglobin value, with radiomic magnetic resonance (MR) features of placenta extracted by T2 weighted images to predict the risk of post-partum hemorrhage (PPH) in pregnancies [1]. Two patient populations from two different hospitals were used as training ($n = 207$) and validation ($n = 91$) set, respectively. In particular, the radiomic features of placenta showed a strong correlation with estimated blood loss (EBL). The authors observed a good performance of this clinic-radiomic model in both patients with and without placenta previa (PP), suggesting that it could be applied for all patients who underwent MR for PPH prediction.

The placenta plays a crucial role during pregnancy, fulfilling a large number of functions that extend well beyond nutrition and respiration and also include endocrine and immune system regulations [2]. Among placental abnormalities, placenta previa (PP) and placenta accreta spectrum (PAS) disorders are mainly encountered. PP is a low-lying placenta completely or partially covering the internal cervical ostium in which a high risk of PAS is associated with increased occurrence of PPH during the delivery. Additional risk factors for PAS are represented by the presence of uterine scars for previous caesarean sections and/or uterine procedures; in this regard, the lack of re-epithelialization around the uterine scars may alter the placental/myometrial interface, with trophoblasts becoming hypertrophic and increased in numbers with reduced spiral artery remodeling. The prediction of PPH, as well as the early detection of PAS, is fundamental for determining the most appropriate surgical management and preventing blood loss during the delivery; for this purpose, the prenatal imaging characterization of placental tissue abnormalities is clinically mandatory.

In this setting, MR imaging is increasingly widely used in modern obstetrics when the risk of fetal abnormality is high. At present, its use is limited to that of a problem-solving tool to evaluate placental invasion, especially in cases of inconclusive ultrasound findings and posterior or lateral placenta locations. In particular, in order to detect PAS disorders, T2-weighted MR images are qualitatively assessed according to the occurrence of several abnormal signs [3–5]. Since a specific expertise is required for MR images interpretation, quantitative methods to analyze placental tissue on MR images are welcome and may be helpful to detect placenta abnormalities [6]. In this regard, a quantitative radiomic approach to assess placental tissue has been proposed using texture analysis (TA), and artificial intelligence (AI) techniques, mainly through machine learning (ML) applications. TA provides a quantitative analysis of placental heterogeneity through the quantification of gray-level patterns and pixel inter-relationships within the image, while ML approaches identify the most relevant textural features as well as the most accurate algorithm for the detection of placental abnormalities. Recent studies have investigated this issue demonstrating that a radiomic approach is able to identify placental tissue abnormalities underlying PAS disorders in patients with PP [7–10]. Different approaches have been used, including: (1) a ROI-based analysis employing first, second and higher order TA features, showing an accuracy of 98.1% using the k-nearest neighbors classifier [7]; (2) a method employing second and higher order TA features extracted from the whole placenta showing an accuracy of 0.98 in predicting invasive placentation using a gradient boost classifier. Fractal analysis was also used along with TA features to differentiate PAS from normal placenta [10]. Finally, Haralik TA features extracted from 4 ROIs placed over different areas of placental tissue were used with a logistic regression model to predict PAS cases requiring caesarean hysterectomy in a high risk population with an accuracy of 80% [9].

In this context, the multicenter study reported by Qingxia Wu and colleagues describes an additional clinical application of an integrated clinic-radiomic model to predict the risk of post-partum hemorrhage (PPH) in pregnancies, confirming the emerging role of the radiomic method to analyze MR images. The authors built radiomic, clinical, radiological and clinico-radiological and clinico-radiomic models to predict the risk of PPH. Shape and higher order TA features were extracted from the whole placenta and uterine cervix then employed to build the radiomic model using the support vector machine algorithm with a radial basis kernel for risk prediction of PPH. Among the different models, the clinic-radiomic one, combining both clinical factors and radiomic

DOI of original article: http://dx.doi.org/10.1016/j.ebiom.2019.11.010.
* Corresponding author.
E-mail address: maurea@unina.it (S. Maurea).

https://doi.org/10.1016/j.ebiom.2019.11.049

features, resulted in the highest AUC of 0.888 and 0.832 in the training and validation cohort, respectively, being able to identify more than 91% of patients with PPH.

Since PPH is one of the leading causes of maternal complications and mortality worldwide, its prediction antenatally rather than intrapartum is helpful for delivery planning, facilitates transfusion requirements and decreases maternal complications. In this regard, the possibility to quantitatively characterize placental tissue in patients with PAS disorders seems to be very attractive.

In conclusion, wide methodological developments are occurring in placental MR techniques including the proposal of radiomic using AI techniques. Additional similar experiences are welcome to validate and standardize this new approach for MR imaging analysis.

References

[1] Wu Q, Yao K, Liu Z, Li L, Zhao XWS, et al. Radiomics analysis of placenta on T2WI facilitates prediction of postpartum haemorrhage: a multicentre study. EBioMedicine 2019. doi: 10.1016/j.ebiom.2019.11.010.

[2] Guttmacher AE, Maddox YT, Spong CY. The human placenta project: placental structure, development, and function in real time. Placenta 2014. doi: 10.1016/j.placenta.2014.02.012.

[3] Elsayes KM, Trout AT, Friedkin AM, et al. Imaging of the placenta: a multimodality pictorial review. Radio Graph 2009. doi: 10.1148/rg.295085242.

[4] Romeo V, Sarno L, Volpe A, et al. US and MR imaging findings to detect placental adhesion spectrum (PAS) in patients with placenta previa: a comparative systematic study. Abdom Radiol 2019. doi: 10.1007/s00261-019-02185-y.

[5] Maurea S, Romeo V, Mainenti PP, et al. Diagnostic accuracy of magnetic resonance imaging in assessing placental adhesion disorder in patients with placenta previa: correlation with histological findings. Eur J Radiol 2018. doi: 10.1016/j.ejrad.2018.07.014.

[6] Siauve N. How and why should the radiologist look at the placenta. Eur Radiol 2019. doi: 10.1007/s0033.

[7] Romeo V, Ricciardi C, Cuocolo R, et al. Machine learning analysis of MRI-derived texture features to predict placenta accreta spectrum in patients with placenta previa. Magn Reson Imaging 2019. doi: 10.1016/j.mri.2019.05.017.

[8] Sun H, Qu H, Chen L, et al. Identification of suspicious invasive placentation based on clinical MRI data using textural features and automated machine learning. Eur Radiol 2019. doi: 10.1007/s00330-019-06372-9.

[9] Do QN, Lewis MA, Xi Y, et al. MRI of the placenta accreta spectrum (PAS) disorder: radiomics analysis correlates with surgical and pathological outcome. J Magn Reson Imaging 2019. doi: 10.1002/jmri.26883.

[10] Chen E, Mar WA, Horowitz JM, et al. Texture analysis of placental MRI: can it aid in the prenatal diagnosis of placenta accreta spectrum. Abdom Radiol 2019. doi: 10.1007/s00261-019-02104-1.