ANALYSIS OF CONTRAST-ENHANCED ULTRASOUND USING FLUID DYNAMIC

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ABSTRACT

Recent developments in contrast-enhanced ultrasound (CEUS), associated with image processing techniques allow analysing blood perfusion of various organs. A new kinetic analysis is proposed in order to quantify the velocity amplitude of the bolus arrival using a fluid dynamic model. The efficiency of proposed methodology is evaluated *in-vivo*, for the classification of placental insufficiency (control versus ligature) of pregnant rats from DCEUS.

1. INTRODUCTION

Contrast-enhanced ultrasound (CEUS) is a non-invasive imaging technique extensively used for blood perfusion imaging of various organs [1]. This modality is based on the acoustic detection of gas-filled microbubble contrast agents used as intravascular flow tracers. Recent efforts aim at quantifying parameters related to the enhancement in the vascular compartment using time-intensity curve (TIC), and at using these latter as indicators for several pathological conditions [2]. However, this quantification is mainly hampered by two reasons: first, the quantification intrinsically solely relies on temporal intensity variation, the explicit spatial transport of the contrast agent being left out. Second, the exact relationship between the acquired US-signal and the local microbubble concentration is hardly accessible. In this study, we introduce the use of a fluid dynamic model for the analysis of dynamic CEUS (DCEUS) [3], in order to circumvent the two above-mentioned limitations. A new kinetic analysis is proposed in order to quantify the velocity amplitude of the bolus arrival.

2. RESULTS

Fig. 1 reports typical microbubble transport fields obtained from two dynamic contrast-enhanced experiments (one clip was selected in the control and one in the ligature population, respectively). The estimated microbubble transports are visually larger for the control population (Fig. 1a-c) as compared to the ligature population (Figs. 1d-f). The spatio-temporally averaged microbubble transport amplitude was significantly higher (p-value=1.1×10^{-3}, AUROC=0.93) in the control group (9 rats) than in the ligature group (11 rats) .

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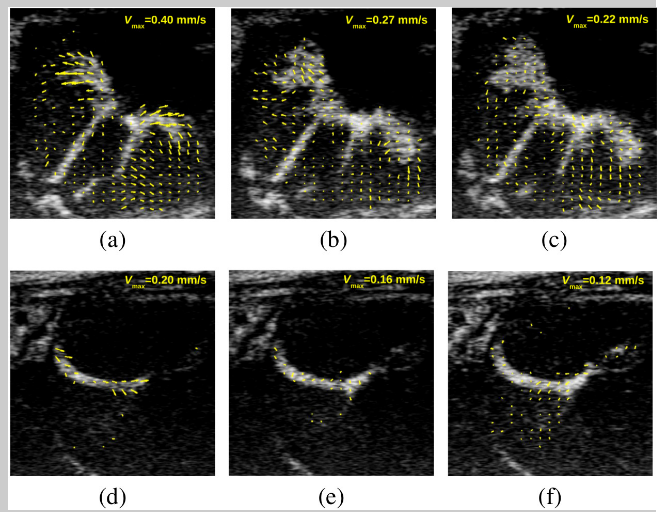

Fig. 1. Example of microbubble transport estimates from the DCEUS of two rats using the proposed approach. The first and the second rows display results associated to a control and a ligature rats, respectively. The 1^{st}, 2^{nd} and 3^{rd} columns display DCEUS images acquired 10 s, 15 s and 20 s after microbubble arrival, respectively.

3. CONCLUSION

This study introduces the use of a fluid dynamic model for the analysis of DCEUS. The proposed classification criterion, estimated from DCEUS echography, was demonstrated to be a good binary classification criterion for ligature/non-ligature rat placentas. Our methodology opens great perspectives for the evaluation of the proposed technique for the clinical diagnostic of obstetrical disorders.

4. REFERENCES

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