

Elastography and placenta: a systematic review

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Objective

In clinical practice, the mechanical properties of the placenta are not explored. A few rheological studies describe the mechanical behavior of the placenta, but these works mainly concern automobile safety and the issue of placental abruption, without any clinical implication about pregnancy itself. However, placental elasticity and viscosity could be modified in case of complicated pregnancy. Elastography is a relevant tool for studying the biomechanical properties of a tissue, and some teams have already applied it for placental exploration. More and more articles report comparative results about placental elasticity in case of complicated and uncomplicated pregnancy. For that reason, we propose a systematic review of the literature about the use of placental elastography.

Methods

All types of study were investigated: randomized trials, cohort study, case-control, retrospective studies, clinical cases. Animal studies were also selected. For human placenta, ex vivo (delivered placentas) and in vivo (pregnant women) studies were considered. To select articles in this review, there was no restriction based on the gestational age of the examination. The research was conducted on different databases: Medline (Pubmed), Embase, and Cochrane Collaboration. The quality of the studies was assessed using the QUADAS-2 tool.

Results

Of 80 references identified, 22 reported an ultrasound (US) elastographic study (from 2012). To date, no study using Magnetic Resonance Elastography (MRE) has been published. Among 22 articles about elastography, 2 reports were animal studies (18 pregnant and 21 pregnant baboons), 4 were ex vivo studies (242 placentas) and 16 were studies in pregnant women (1285 women). US methods were heterogeneous: static elastography in 4 cases, radiation force in 17 cases (8 articles with SWE, 9 articles with ARFI), and SWAVE (shear wave absolute vibro-elastography) in one case. In our review, 1070 pregnant women have been exposed to radiation force (SWE or ARFI) in vivo. The explored pathologies were as follows: preeclampsia (PE) in 6 reports (220 placentas), placenta previa or accreta in 3 reports (28 placentas), gestational diabetes in 2 reports (54 placenta), Intrauterine Growth Restriction (IUGR) in 2 reports (63 placentas), rhesus alloimmunization in one report (30 placentas), premature delivery in one report (10 placentas), and "structural" abnormalities of the fetus in one article (40 placentas). Twelve studies reported comparative results. Most results showed an increase value of YM and SWS in case of placental insufficiency. In studies about PE, mean Young's modulus (YM) values ranged from 7.01 kPa to 21 kPa and average shear wave speed (SWS) ranged from 1.34 m/s to 2.10 m/s. For normal placentas, mean YM values ranged from 2.53 kPa to 7.84 kPa, and mean SWS values ranged from 0.84 m/s to 1.59 m/s. In case of IUGR, ex vivo analyses found an increase in SWS values compared to normal placentas (1.94 m/s $\pm$ 0.74 vs 1.31 m/s $\pm$ 0.35). The in vivo studies also found an increase in SWS and YM values compared to normal placentas (1.28 m/s $\pm$ 0.39 vs 0.98 m/s $\pm$ 0.21 respectively, and 28 kPa vs 6 kPa respectively). Regarding the quality, we note that the operators were never blind to the diagnosis. Only six articles report histopathological examinations. Measurements have been performed during the third trimester (7 reports), the second trimester (5 reports), or both (7 reports). But no quantitative study has been conducted during the first trimester. To date, no difference in elasticity as a function of gestational age has been demonstrated. Regarding the expression of the results, we note that ex vivo studies reported SWS in m/s, and never YM in kPa. Of the 12 studies reporting quantitative results in vivo, 7 articles reported SWS in m/s and 5 reported YM in kPa. In most studies, posterior placentas were excluded from the analysis. In addition, none of the studies that conducted multiple placental measurements found anatomical variations in elasticity, either between the central region and the edge, or in the thickness of the placenta.

Conclusion

Many studies have been conducted about placental elastography since 2012. These studies suggest an increase in YM and SWS values in case of PE or IUGR. However, these are mainly preliminary studies, with heterogeneous methods, variable expression of results and a level of evidence generally low. The placenta is a relevant model for exploring the physical links between viscoelasticity and perfusion data.