002

DEVELOPMENT AND VALIDATION OF A FETAL 3D SURGICAL SIMULATOR: IMPLICATIONS FOR MINIMALLY INVASIVE *IN UTERO* GASTROSCHISIS REPAIR

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Aim of Study: We have reported the clinical benefits of fetal minimally invasive surgery (MIS) in attenuating preterm labor, uterine morbidity, and subsequent C-sections, which are associated with open fetal surgery. Other non-lethal diseases may also benefit from fetal MIS, such as gastroschisis. 3D printing allows the creation of lifelike human models. Altogether, the aim of this study is developing and validating a 3D fetal MIS model to test an *in utero* procedure for gastroschisis repair.

Methods: A 3D reconstruction of a uterus and fetus with gastroschisis (based on a mid-gestation fetal MRI) was optimized (3D Slicer) and rapidly prototyped using a next-gen Lazarus 3D printer. A four-step MIS procedure (evaluation of fetus, evaluation of bowel, reduction of bowel, coverage of defect) was designed and time-tested in three cohorts repeated in triplicate (fetal/neonatal surgeons, residents, and students, n=6/group). A ten question post-trial validation survey was administered to the participants. Data is presented as mean +/-SD, analysis by ANOVA, post-hoc Tukey HSD, $p<0.05$.

Main Results: All procedures were completed successfully (n=54). Operative time was significantly related to surgical training level (fetal/neonatal surgeons 125s+/-29s, residents 141s+/-30s, students 376s+/-107s; $p<0.05$) with sequential attempts yielding significant rates of improvement in all cohorts. All surgeons reported that the model 1) is an accurate tactile and visually representative model, 2) adequately assessed technical skills required for the procedure, and 3) would be a valuable training tool. The cost for this model was $68.69/trial and can be refurbished/reused for $200.

Conclusion: Our data supports construct, content, and face validity of a novel 3D fetal surgical simulator. This model is more cost effective than animal models in developing fetal techniques and seems to be more representative of the human disease. With the attenuation of maternal-fetal risk observed in fetal MIS, *in utero* therapies for gastroschisis may be considered.