

[03-023]

Evolution of Care in the Post-MOMS Era: A Decade of Single-Center Experience Comparing Fetal Repair versus Postnatal Closure of Myelomeningocele

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Introduction: The Management of Myelomeningocele Study (MOMS) demonstrated short-term benefits of fetal myelomeningocele (MMC) repair. However, long-term outcomes from contemporary clinical practice remain incompletely characterized.

Objectives: To compare surgical, neurological, and functional outcomes in patients undergoing fetal versus postnatal MMC closure over a ten-year period at a single center.

Methods: This retrospective cohort study included patients with MMC who underwent fetal or postnatal closure at the Children's Hospital of Philadelphia between 2013 and 2023. Clinical outcomes were assessed through early childhood.

Results: Among 795 patients screened for MMC, 377 met inclusion criteria. Of these, 279 (74%) underwent fetal repair and 98 (26%) underwent postnatal closure. 334 patients (89%) had neonatal care at our institution (236 fetal surgery and 98 postnatal). Gestational age at the time of delivery was lower in the fetal group than the postnatal closure group (35.2 ± 2.7 versus 37.5 ± 2.6 weeks, $p < 0.01$). Compared with MOMS, the percent of patients delivered at < 30 weeks gestation decreased (13% to 5%), and the percent delivered at ≥ 35 weeks increased (54% to 63%). In this modern cohort, shunt rates improved in the fetal cohort compared with MOMS (24% vs. 40%, $p = 0.02$), while the postnatal closure group showed no difference (91% vs. 82%, $p = 0.07$). As expected, the modern cohort demonstrated improvement in functional level relative to the anatomic defect compared to MOMS patients (≥ 2 -level improvement in 40% vs. 22%, $p < 0.01$), irrespective of closure type. Tethered cord release was more common following fetal repair (19% vs. 6%, $p < 0.01$).

Conclusions: Fetal MMC repair is associated with reduced shunt dependence and improved functional neurological level. Findings from this modern cohort demonstrate improved outcomes compared to the MOMS trial. As surgical care continues to innovate, institutions should continue to collect long-term outcomes data and compare results with both historical and contemporary cohorts.

[03-024]

Sequential Analysis of Operative Times and Perinatal Outcomes in Fetoscopic Myelomeningocele Repair

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Background: Prior studies have demonstrated that fetoscopic myelomeningocele (fMMC) repair is safe. We evaluated the institutional learning curve regarding operative times and its impact on maternal and obstetric outcomes.

Methods: We analyzed 21 sequential laparotomy-assisted fMMC repairs. Simple linear regression was used to evaluate surgical time trends. Associations with clinical outcomes were assessed using Pearson correlations.

Results: Mean total surgery time was 4.4 hours, including 2.7 hours for active fetal intervention. Total time trended downward by 1.6 minutes per case ($r=-0.18$, $p=0.436$), driven by a significant reduction in access time of 1.3 minutes per case ($r=-0.49$, $p=0.024$). Average gestational age (GA) at delivery was 34.5 weeks, with 55% PPROM rate. Longer total surgery time ($r=-0.650$, $p=0.002$), specifically fetal closure ($r=-0.647$, $p=0.002$) and neural placode release ($r=-0.522$, $p=0.018$), strongly correlated with earlier GA at delivery. A high safety profile was demonstrated, with no uterine ruptures or maternal and child mortalities. Among infants reaching 1-year follow-up ($n=17$), the ventricular shunt rate was low overall at 12%.

Conclusion: Sequential fMMC analysis demonstrated a clear learning curve, resulting in faster overall operative times. Prolonged fetal intervention duration correlated with earlier delivery, underscoring that operative efficiency is critical to optimizing gestational outcomes.

[03-025]

From Repair to Re-tethering: Defining the burden of tethered cord syndrome and spinal inclusion cyst formation following fetoscopic myelomeningocele closure

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Introduction: The incidence of tethered cord syndrome (TCS) and spinal inclusion cyst (SIC) after open fetal repair for myelomeningocele (MMC) may reach up to 25-30%, while limited data exist following fetoscopic MMC (fMMC) repair. The objective of this study was to explore the incidence of TCS and SIC in children who underwent fMMC repair.

Methods: This single-center retrospective study included pediatric patients who underwent fMMC repair using a cryopreserved decellularized human umbilical cord matrix allograft duraplasty. Patients with at least 12-month follow-up were assessed for TCS, SIC, and surgical detethering. Secondary outcomes included ambulatory status, neuromonitoring changes, surgical complications, and shunted hydrocephalus.

Results: Among 96 patients included, 14(14.5%) developed TCS and 18(18.8%) had SIC on imaging. The rate of shunted hydrocephalus was 40.6%. Eight patients required surgical detethering at a mean age of 54.8 ± 25.3 months. The most common indication for surgery was progressive gait disturbance. Intraoperative neuromonitoring remained stable in all cases.

Discussion: In this cohort, TCS following fMMC repair occurred less frequently than previously reported. Only a subset required surgical detethering. These findings suggest that while TCS remains a potential long-term sequela, its clinical impact may be less significant after fetoscopic repair. Long-term follow-up remains essential for further prognostication.

[03-026]**From Safety to Efficacy: An Update on Phase 2 of the Cellular Therapy for in Utero Repair of Myelomeningocele (CuRe) Trial****David Rosas**

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Prenatal repair of myelomeningocele reduces the need for ventriculoperitoneal shunting but yields limited improvements in motor function, with most patients unable to ambulate independently. Studies in a fetal ovine model demonstrated that placenta-derived mesenchymal stem cells (PMSCs) seeded on an extracellular matrix (ECM) can enhance neurological recovery. We evaluated the safety and early outcomes of this cell-based therapy as an adjunct to prenatal repair. We conducted a phase 1, single-arm, first-in-human study at the University of California, Davis, enrolling women carrying fetuses with myelomeningocele between 19–26 weeks' gestation. A phase 2 trial is ongoing. During in utero repair, a single dose of allogeneic PMSCs seeded on a collagen-based ECM is applied to the defect. As of May 2026, 22 patients have been treated. The first six procedures were performed between June 2021 and December 2022, followed by enrollment of 16 additional patients. Infants were delivered at a median gestational age of 34+5 weeks. All neonates had intact repair sites without CSF leak, infection, or abnormal tissue growth. Postnatal MRI demonstrated reversal of hindbrain herniation and no tumor formation. No cell-related adverse events were identified. PMSC-augmented prenatal repair continues to demonstrate a favorable safety profile, with ongoing evaluation of efficacy outcomes.

[03-027]**Interim Update from the HUC-FICS Phase III Trial: Fetoscopic In-Utero Spina Bifida Repair Using a Cryopreserved Human Umbilical Cord Meningeal Patch****Ramesha Papanna**

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Background: Prenatal spina bifida repair improves motor outcomes versus postnatal repair, but open hysterotomy carries significant maternal morbidity and preterm delivery risk. The HUC-FICS trial (NCT06042140) evaluates fetoscopic closure with a cryopreserved human umbilical cord (HUC) patch as a regenerative meningeal cover, building on preclinical work showing arachnoid regeneration, reduced cord tethering, and prevention of Chiari II malformation.

Methods: HUC-FICS is a single-arm Phase III trial under an FDA Investigational Device Exemption with NIH R01 support. Patients meeting standard eligibility for in-utero myelomeningocele repair undergo fetoscopic closure with HUC patch coverage at mid-gestation. The primary outcome is independent ambulation (≥ 10 unassisted steps) in 60% of patients at 30 months. Follow-up extends to 60 months, including motor, cognitive, developmental, and radiologic tethering assessment.

Results: Our group has performed 160 in-utero spina bifida repairs; 80 of a planned 100 patients are enrolled in the trial, with no fetal or perinatal losses.

Conclusion: Fetoscopic in-utero spina bifida repair with a cryopreserved HUC meningeal patch is safe and feasible at scale, with no perinatal mortality to date. Follow-up through 60 months will define durable neurodevelopmental benefit versus current standard of care.

[03-028]

ROBOTIC PLATFORMS IN FETAL SURGERY: A Comparative Analysis on Fetoscopic Spina Bifida Repair Simulation.

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Background: Robotic surgery could advance fetal interventions, but current systems are not designed for the intrauterine environment. This study compared two robotic platforms, Symani and Versius, in a simulated fetoscopic myelomeningocele repair and sheep models to assess feasibility, strengths, limitations, and key requirements for future robotic-fetal surgery.

Methods: In a simulation-based study, three experienced fetal surgeons from the United States, Chile, and the United-Kingdom independently performed standardized fetoscopic myelomeningocele repairs using both robotic systems. Qualitative assessment focused on feasibility, precision, dexterity, visualization, ergonomics, workflow efficiency, port size compatibility, and instrument suitability. Both platforms were also compared with the current fetoscopic technique, emphasizing access requirements, membrane safety, instrument handling, and procedural flow.

Results: Both systems were technically feasible but showed distinct profiles. Symani offered superior precision and compatibility with smaller ports, supporting delicate neural dissection. However, it was limited by instrument versatility for handling larger sutures.

Versius provided enhanced 3D-visualization, dexterity, and ergonomics, improving complex maneuvering, but required larger ports. Compared with standard-fetoscopy, both improved precision and control but added challenges in access size, instrument compatibility, and procedural complexity.

Conclusion: Robotic-assisted fetal surgery is feasible, but dedicated miniaturized platforms optimized for membrane safety, imaging, and multifunctional instrumentation are still needed.

[03-029]**Establishment of a large-animal model in ovine spina bifida through the PASTURES consortium****Michael Beninati**

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We describe the development of a novel large-animal model for the study of spina bifida, integrating genetic discovery with innovation in fetal surgery.

Spina bifida is a multifactorial disorder influenced by genetic and environmental factors, yet current models fail to reliably reproduce human disease or predict clinical outcomes. To address these gaps, we established a naturally occurring ovine model supported by a multi-institution consortium.

Initial cohorts demonstrated analogues of the human phenotype, including Chiari malformation and hydrocephalus, with affected lambs undergoing advanced imaging, postnatal repair, and tissue analysis. Genomic and epigenetic studies across more than 190 specimens identified heritable factors and candidate chromosomal loci, supporting a strong genetic contribution to disease.

Most recent aggregated breeding data suggest an incidence of open fetal neural tube defects approaching 18% in the flock. To date, our team has performed 2 feasibility studies of prenatal repair; one utilizing an open uterine approach and the second a novel single-port fetoscopic entry. We endeavor to advance fetal surgical training, explore innovative approaches, and strive towards advances in human application.

This consortium represents a unique opportunity to advance mechanistic understanding, refine fetal surgical strategies, and ultimately improve prevention and treatment of spina bifida.

[03-030]

Postnatal Spinal Cord and Lower Back Growth in Healthy Lambs: A Reference for Prenatal Spina Bifida Repair

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Background. Ovine in-utero spina bifida repair outcomes have been limited to one week of age. Understanding postnatal ovine vertebral and cord growth is essential for longer-term studies.

Methods. Eight control lambs underwent serial lumbar MRI at 1, 3, and 6 months. Vertebral height, disc height, and cord cross-sectional area were measured at L1 through L7. Conus tip was scored on an ordinal scale where each unit equals one-third of a sacral vertebra. L1 to conus distance was measured along the column and the cord.

Results. Per-vertebra height grew from 14.5 to 27.4 mm. Total lumbar column length rose from 102 to 191 mm, an 87 percent increase. Growth was biphasic at 4.2 and 1.4 mm per month per vertebra in the first and second intervals, roughly 30 to 50 times reported human values. Conus ascended by 0.56 sacral vertebra between months 1 and 3, with no further movement. Cord to column ratio fell from 0.97 to 0.94, an 11.3 mm column over cord differential.

Conclusion. Sheep exhibit postnatal conus ascension of half a sacral vertebra complete by three months, establishing baseline characteristics for the in-utero spina bifida repair model and defining the window for interpreting tethering outcomes.

[03-031]

Deconvolution of Amniotic Fluid Transcriptomes Suggests Cell-Type and Transcriptomic Signatures in Myelomeningocele

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Objectives: We investigated whether amniotic fluid samples from myelomeningocele (MMC) cases differ in cell-type composition compared to controls, and whether adjusting for these differences reveals biologically meaningful transcriptomic patterns.

Methods: Amniotic fluid bulk RNA data from MMC cases and controls, and single-cell RNA-seq reference data, were obtained from the Gene Expression Omnibus. Cellular composition was inferred using CIBERSORTx. Differential expression was assessed using multivariable models adjusted for cell-type composition. Functional enrichment was assessed using Gene Ontology (GO) and Reactome pathway analysis, alongside gene set enrichment analysis (GSEA).

Results: Deconvolution suggested differences in cell-type composition between MMC and controls, notably in stromal and myeloid cell populations. Four major cell types were retained for downstream analyses. Differential expression identified BCL10 and OPA1 upregulation and SKI downregulation, genes mapping to GO processes related to neural tube development. NAMPT and NMNAT3 upregulation was linked to nicotinate metabolism and NAD⁺ biosynthesis. GSEA supported altered metabolic pathway activity.

Conclusion: Exploratory cell-type-adjusted analysis suggests metabolic and developmental pathways as features of MMC-associated transcriptomic changes, complementing previous findings of neuronal injury and inflammatory signatures in unadjusted analyses. These findings highlight the potential utility of compositionally-aware transcriptomic analyses in fetal biomarker discovery and understanding of disease mechanisms.

[03-148]

Perinatal Mental Health Program in the Colorado Fetal Care Center

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Background: Perinatal mental health (PMH) conditions are a leading cause of mortality (Miller 2026), with increased prevalence in pregnancies complicated by fetal anomalies (Dempsy 2021, Kim 2022). In 2023, we introduced integrated psychiatric services (IPS) into the Colorado Fetal Care Center (CFCC). The current study investigated the frequency of psychiatric medication initiation at CFCC. **Methods:** Retrospective chart review of 92 CFCC patients seen for IPS between 1/1/2023-12/15/2025. Descriptive statistics were calculated to summarize participant characteristics and study variables. Associations between categorical variables were evaluated using chi-square or Fisher's exact tests. **Results:** 39% of patients were referred to IPS prenatally, while the remaining (61%) occurred postnatally. A broad spectrum of fetal diagnoses were represented; 42% were cardiac-related, 12% received fetal therapy, and 22% resulted in stillbirth or neonatal death. The rate of any mental health diagnosis increased from 82% to 97% after IPS evaluation. 61% initiated new medication. Fetal diagnoses did not impact the initiation of new medication (all $p>0.05$). **Conclusion:** Our study showed an unexpectedly high rate of mental health diagnoses compared to other studies showing 15-32% perinatal mental health burdens (Liseth 2024, Hansen 2025, Kim 2022). Medication initiation was common, suggesting the important role of IPS in supporting patients.