Development of a Low-Cost Pressure Mapping System for Early Detection of Ischemic Labor Injury, Towards Prevention of Obstetrhc Fistula

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Over two million women in sub-Saharan Africa live with obstetric fistula. During prolonged obstructed labor, the trapped fetal head compresses the soft tissue lining of the pelvis against bony structures. When compression exceeds 32 mmHg, blood flow is cut off and tissue begins to die. If undetected, this leads to fistula formation — an irreversible opening between the birth canal and the bladder or rectum. No affordable real-time tool currently exists to catch this before permanent damage occurs. FistulaGuard was built to close that gap. A silicone pelvic model embedded with sixteen force-sensitive resistors was constructed, with sensors placed at the urethro-vesical junction, mid-anterior wall, ischial spine level, and posterior rectovaginal wall. An Arduino Nano with a 16-channel multiplexer recorded compression at 10 Hz. All 16 sensors passed calibration with CV below 5% and R^2 above 0.90. Readings were validated against Vaginal Tactile Imaging data, achieving a correlation of r = 0.996. Across 420 simulated trials, the system reliably distinguished Normal Labor (15–28 mmHg intermittent), Warning (32–50 mmHg sustained), and Critical (above 50 mmHg sustained) conditions using pressure-time integral analysis. A prenatal risk model using symphysis-fundal height, maternal height, MUAC, parity, and estimated fetal weight achieved AUC = 0.842, enabling early identification of high-risk pregnancies before labor begins. FistulaGuard detects dangerous pelvic wall compression in real time, alerting providers before ischemia becomes irreversible. Paired with prenatal risk stratification, it offers a scalable, low-cost solution for fistula prevention where it is needed most.

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