Transcervical chorionic villus sampling model

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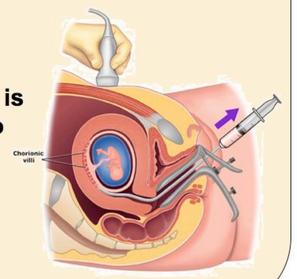
Abstract

Transcervical chorionic villus sampling (CVS) is a prenatal diagnostic procedure that involves extracting placental tissue from the uterus of a pregnant woman in her first trimester of pregnancy. A model has been designed to facilitate training of doctors to improve their CVS technique, and thereby increase the safety of patients. This model is constructed out of ultrasound permeable material, and accurately depicts the constraints placed on the doctor during the CVS procedure. When viewed under ultrasound, the model generates an image that would be produced by an actual patient.

Background

CVS extracts genetic material from the placenta of a fetus, which is used in prenatal diagnosis of genetic disorders such as Down syndrome, Tay-Sachs disease and Sickle-cell disease [1].

There are two methods of CVS, a transabdominal and a transcervical approach. The transcervical approach is preferred if the placenta is posterior to the amniotic sac in the uterus [2].



Risks associated with CVS are birth defects, miscarriage, infection and bleeding [2].

Motivation

CVS provides an earlier diagnosis than amniocentesis, which is performed later (16-20 weeks) in the pregnancy [1].

Performing the transcervical CVS procedure requires skill. To obtain the placental sample, a thin catheter is guided through the vagina and cervix, which is very thin and rigid. Elaborate techniques must be used to carefully guide the catheter to the placenta sample. [2]

With the help of this model, doctors will be able to practice transcervical CVS and perfect their technique to a point where there is decreased risk of miscarriage to the patient.

Client Requirements

- Rigid and restrictive cervical canal with accurate dimensions and feel
- General vaginal opening to limit the doctors movements
- Accessible uterine cavity to place placental sample
- Liquid interface to simulate amniotic fluid
- Cervix and uterus must be penetrable to ultrasound waves

Existing Devices

Figure 2- Shown to the right is a gravid uterus model that was used by doctors to asses the learning curves of CVS and amniocentesis trainees. The sphere shaped model was created from various foams and rubbers that mimicked the abdominal wall. Inside, the cavity is filled with water to simulate amniotic fluid, and contains two artificial placentas. [3]

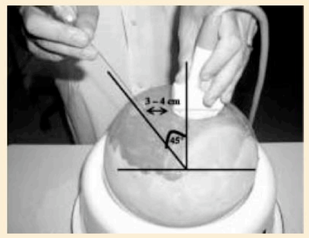


Figure 3- Shown to the left is a fetal ultrasound phantom used to practice anatomical examinations and estimate gestational age. The external casing is made from PVC and ABS, while the tissue mimicking material is created from various proprietary gels. [4]

Final Design

- High quality EcoFlex silicone
- Ultrasound capable
- ABS plastic casing and support frame
- ABS plastic elbow design for placental support and water reservoir
- Life-like cervical interface
- Vaginal obstruction for life-like test
- Easy maintenance and cleaning
- Aqueous interior to simulate amniotic sac

Figure 4- Final design
- 10 cm vaginal obstruction
- 6 cm long, 2mm diameter cervical canal
- 400 cc uterus

Ultrasound Testing

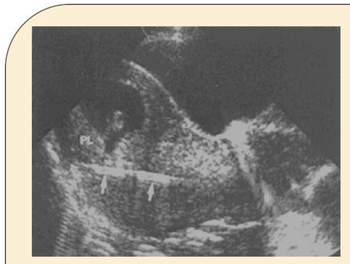


Figure 5- Ultrasound image of actual procedure. Catheter, point of entry, and placenta are all visible

Figure 6- Ultrasound image of model with water to simulate amniotic fluid. Catheter, point of entry, and placenta are all visible

Budget

ABS Plastic ≈ $74.91
EcoFlex 00-30 Silicone ≈ $114.68
Miscellaneous Materials ≈ $17.84
Total ≈ $207.43

Future Work

- Add anterior extension to the box in order to restrict doctor's movements
- Develop method to prevent water loss via cervix
- Develop method to adjust cervix-uterus angle
- Incorporate amniotic sac that does not cause ultrasound interference

Acknowledgements

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References

[1] Wilson, D. (2000). Amniocentesis and chorionic villus sampling. *Curr. Opin. Obstet. Gynecol.* 12:81-86.
[2] Jenkins, T.M., & Wapner, R.J. (1999). First trimester prenatal diagnosis: Chorionic villus sampling. *Semin. Perinatol.* 23: 403-413.
[3] Nizard, J., Duyme, M., & Ville, Y. (2002) Teaching ultrasound-guided invasive procedures in fetal medicine: Learning curves with and without an electronic guidance system. *J Ultrasound Obstet. Gynec.* 19: 274-277.
[4] http://cirsinc.com/068_ultra.html