BIOMECHANICAL EFFECTS OF CESAREAN SECTION SCAR ON SECOND TRIMESTER PREGNANCY

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Introduction:

The leading causes of injury in pregnant women are motor vehicle crashes, falls, and domestic violence. Scars in the uterus can result from previous injury or from prior cesarean section (CS), and such scars increase the risk of uterine rupture during a subsequent pregnancy. Globally, 21% of babies are born via CS, a rate that is estimated to become 29% by 2030. The underlying mechanism by which uterine rupture is caused by previous scarring is unknown but clearly a biomechanical consideration. As pregnancy is a protected environment, and there are no good animal models for human pregnancy, research on this topic has been limited. However, it is now possible to use *in silico* methods to study the altered biomechanical environment of the pregnant uterus, including scar tissue.

Objective:

The objective of this work is to develop a second trimester maternal anatomy model with a CS scar to explore how CS scar presence affects maternal tissue loading.

Methodology:

A parametric approach for generating SolidWorks models of the pregnant uterus and cervix was utilized, using average measurements from 17-20 weeks gestation. As some CS scars develop niches (defects in the CS scar in the uterine myometrium), models of the CS scar with and without a niche were developed. Fetal membranes, a supporting abdomen, and isthmus were added, and discretized geometries setup for finite element analysis in FEBio Studio. Physiologically inspired boundary, loading, and contact conditions were applied. The stiffness of the cervix and CS scar were varied to explore the effects of tissue stiffness on average 1st principal in the combined cervix–isthmus proximal intrauterine face proximal face and CS scar.

Results:

As the scar stiffness increased, the average 1st principal Lagrange strain in the scar decreased. Average 1st principal Lagrange strain in the combined cervix–isthmus proximal intrauterine face remained largely unchanged with increasing scar stiffness, with slight decreases for scar + niche models and slight increases for scar only models. Independent of scar stiffness, the scar + niche model with a compliant cervix had the largest average 1st principal Lagrange strain in the scar and combined cervix–isthmus proximal intrauterine face. Notably, similar average 1st principal Lagrange strain values were found in the scar only model with a compliant cervix as the scar + niche model with a stiff cervix and CS scar.

Conclusions:

This work demonstrates interesting relationships between cervical stiffness, CS niche presence, and tissue strain. We found similar scar average 1st principal Lagrange strain values in the scar only model with a compliant cervix and the scar + niche model with a stiff cervix and CS scar. This highlights the importance of considering both the geometric and intrinsic material properties when assessing structural function, as both can result in compromised performance.

This modeling approach, based on real pregnant uterine geometries at different gestational ages of pregnancy, can be tailored to study other problems in injury biomechanics. This approach, examined here for CS scar presence, provides a necessary starting point for future computational studies of injurious events in pregnancy.

Insert one figure or table to support your work (optional):