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Bachelor-Thesis Medizintechnik

Influence of Foetal Movement on Pre-Term Rupture

Figure 1: Fetoscopy is an endoscopic surgical intervention for treatment of the foetus during pregnancy. This treatment creates the weak spot in the foetal membrane.

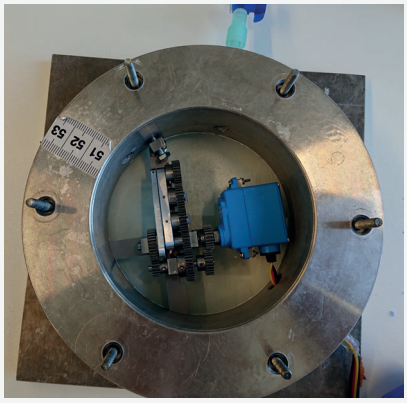

Figure 2: Emk-model implementation within the ex-vivo model. Also showing the free bottom space for a better view from the bottom up. There are only three wires connecting the servo to the outside shown in the under right side.

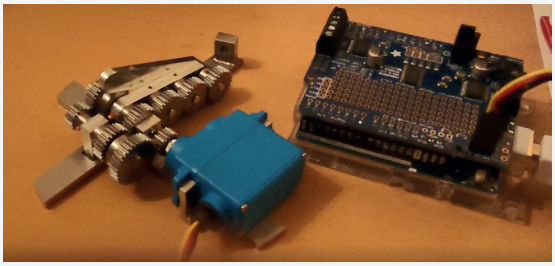

Figure 3: This picture shows the emk-model in its initial position in the left and the microcontroller + motor control unit in the right. The RC servo is the blue device mounted on the emk-model and connected to the motor control unit by a three wires.

Figure 4: Side view on the ex-vivo model and emk-model. It shows the moving range of the emk-model. The mechanical model leg moves with the angle of the gears.

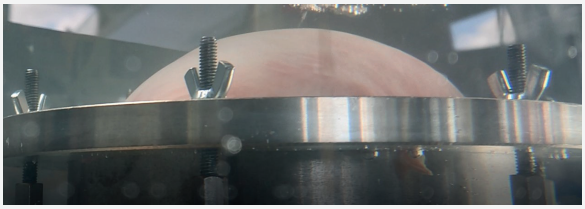

Figure 5: Punctured + untreated foetal membrane on the ex-vivo model inflated to an 40mm bulge before starting kicking sequence.

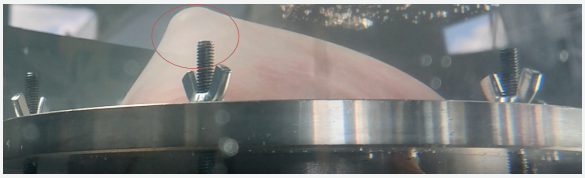

Figure 6: Punctured + untreated foetal membrane while running the kicking sequence. An extension of the foetal membrane through kicking is visible (see red circle).

Problem Formulation
Fetoscopy (see Figure 1) increases the probability of pre-term rupture of the foetal membrane and thus a pre-term birth of the baby. The reason is the puncture of the membrane which weakens the foetal membrane but is essential to access the amniotic cavity. Because of this weakness, KOVE Medical is developing a treatment.
The goal of this bachelor thesis was to develop an electro-mechanical-kicking device (emk-model) which simulates the foetal kicking to measure the stress resistance of the foetal membrane. This test device was integrated into the existing ex-vivo model of KOVE Medical to compare the punctured + untreated versus the punctured + treated foetal membrane by kicking.

Solution Concept
The device concept was created on the base of a preceding industrial project, which provided the specifications for this work, such as choice of foetal kicking, device size, matching within the ex-vivo model, automatized testing, sufficient device stability and functioning in a water pressure environment.

Methods
For a stable emk-model, the prototype was designed and manufactured out of stainless steel and aluminium alloy. The automated device steering was realised with a RC servo and a microcontroller, which regulates the rotation of the RC servo (see Figure 3).
The emk-model was inplemented into the ex-vivo model for testing (see Figure 2 and 4). Afterwards covered with a punctured foetal membrane and tightened by a flange and inflated the membrane to a 40mm bulge (see Figure 5).

Result Prototype
The developed emk-model was running and fitting into the ex-vivo model (see Figure 2). But not sufficiently stable due to the realisation with gears. There was too much clearance between two gears which leads to poor repeatability of the mechanical leg movement, and the chosen servo was not able to generate sufficient torque to stretch the foetal membrane to the desired extension of 13mm.

Result Membrane Testing
The membrane testing (see Figure 5 and 6) showed that the punctured + untreated foetal membrane was able to withstand 366 seconds, 203 kicks and an inner water pressure of 36mbar. Where the membrane ruptured immediately in second 366. On the other side the punctured + treated foetal membrane was able to withstand 383 seconds, 222 kicks and 39mbar water pressure. The rupture phase of the treated membrane was extended to a duration of 27 seconds until full rupture.

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