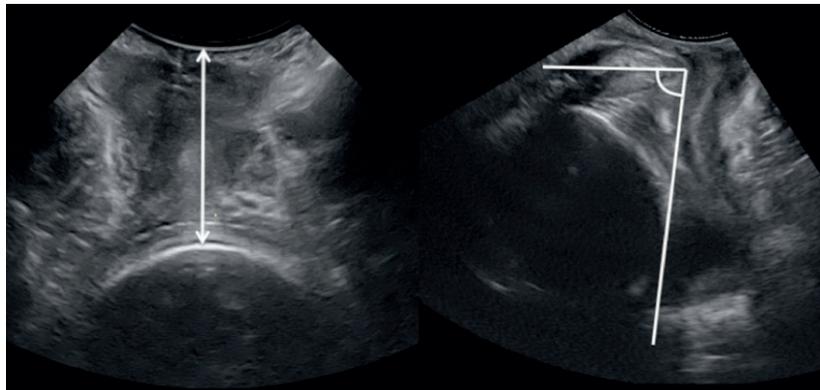Erik Andreas Torkildsen

Ultrasound &
prediction of prolonged labor

Thesis for the degree of Philosophiae Doctor

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Ultrasound & prediction of prolonged labor

Labor has traditionally been evaluated by clinical examination and palpation. This is a subjective method with great variation between clinicians. The diagnosis may be uncertain, and many women with prolonged labor ends with cesarean section. One of the main goals in obstetrics should be more objective examinations and better diagnostic tools. Transperinal ultrasound has been shown to be a precise tool in examination position of the fetal head in the birth canal, and has been shown to be a precise and reproducible method for predicting operative delivery.

The main purpose of the thesis was to evaluate transperinal ultrasound methods in 2D and 3D in nulliparous women undergoing labor in the active phase of the first stage of labor and with labor dystocia. Labor dystocia were diagnosed according to World Health Organization by using the WHO partograph.

Study 1
The aim of the study was to ascertain if head–perineum distance (HPD) and angle of progression (AoP), measured with two-dimensional (2D) and three-dimensional (3D) transperineal ultrasound, could predict labor outcome in nulliparous women with prolonged active phase of the first stage of labor. Both methods measure fetal head descent. HPD is defined as the shortest distance from the fetal scull to the perineum, and AoP is defined as the angle between a line through the central core of the pubic symphysis and a line tangential to the fetal scull. This was a prospective observational study of 110 nulliparous women with singleton in cephalic presentation at term.
Cesarean section was performed in 25% of the women. Areas under the ROC curves for prediction of vaginal delivery were 81% (95% CI, 71–91%) ($p<0.01$) and 76% (95% CI, 66–87%) ($p<0.01$) for HPD and AoP, respectively, as measured by 2D ultrasound, and 66% (95% CI, 54–79%) for digital assessment of fetal station ($p=0.01$). 93% gave birth vaginally with an HPD ≤40 mm, while only 18% gave birth vaginally when HPD was >50 mm. 87% gave birth vaginally when AoP was ≥110°, while only 38 % gave birth vaginally when AoP was <100°.
The conclusion was that HPD and AoP measured with 2D or 3D ultrasound could predict labor outcome, with similar predictive values for both techniques.

Study 2

The aim was to study intraobserver repeatability and intermethod agreement between 2D and 3D transperineal ultrasound measurements assessing fetal head descent in nulliparous women with prolonged active phase of the first stage of labor. 106 nulliparous women were examined with HPD and AoP. A single obstetrician performed all the acquisitions, and another obstetrician analysed the acquired 2D images and 3D volumes blinded to clinical assessments and labor outcome.

The repeatability coefficient was ±4.1 mm in 2D acquisitions and ±1.7 mm in 3D acquisitions of HPD. The intraclass correlation coefficients (ICC) were 0.94 for 2D and 0.99 for 3D measurements. The AoP repeatability coefficients was ±6.7° using 2D and ±5.7° using 3D ultrasound and ICCs were 0.91 and 0.94, respectively. The intermethod ICC for HPD in 2D vs. 3D acquisitions was 0.95 and for AoP it was 0.93; the intermethod 95% limits of agreement were −5.8 mm to +7.2 mm and −8.9° to +13.7°, respectively. Cohen's kappa for 2D vs. 3D acquisitions was 0.85 using 40 mm as a cut-off level for HPD and 0.79 using 110° as cut-off level for AoP.

The conclusion was that for one ultrasound operator the intraobserver repeatability and agreement between 2D and 3D ultrasound methods in prolonged active phase of the first stage of labor were good. Given that 2D methods are simpler to learn and can be analysed quickly online, 2D equipment might therefore be preferred in the labor room.

Study 3

The aim was to examine how well ultrasound-assessed occiput posterior (OP) position or high sagittal (HS) position in 105 nulliparous women with a prolonged active phase of the first stage of labor could predict a vaginal delivery.

Eleven (27%) of 41 fetuses in OP position at the time of inclusion were born in OP position. Ten (24%) of the 41 fetuses in OP position at inclusion were delivered with cesarean section compared with 15/64 (23%) fetuses in other positions (p=0.91). Twenty-eight fetuses were in sagittal position and 12 in HS position, assessed with ultrasound at the time of diagnosed prolonged labor. Seven (58%) of 12 in HS position delivered vaginally and five (42%) had a caesarean section (p=0.89). The time difference in labor outcomes was not significantly different between groups.

The conclusion was that ultrasound-assessed OP position or HS position could neither predict vaginal delivery nor the duration of labor in nulliparous women with a prolonged first stage of labor.

Study 4

The aim was to analyse the relationship between ultrasound parameters: head–perineum distance (HPD), angle of progression (AoP), intrapartum transperineal ultrasound (ITU) head station, and head–symphysis distance (HSD), and compare them with digital palpation.

106 3D volumes acquired from nulliparous women were analysed. There was a good correlation between ITU head level and HPD ($r = 0.71$), ITU head level and HSD ($r = 0.74$) and HSD and HPD ($r = 0.75$). Clinically assessed level compared with ITU head level showed only moderate correlation ($r = 0.52$). Cervical opening showed weak correlation with ITU head level ($r = 0.30$). The conclusion was that the ultrasound parameters showed a high degree of correlation with each other, but only moderate correlation to vaginally palpated fetal head station.

Main conclusion:
Head–perineum distance (HPD) and angle of progression (AoP) measured by 2D or 3D ultrasound can be used as an objective method to determine fetal head descent and predict labor outcome in nulliparous women with prolonged active phase of the first stage of labor. The predictive values for the methods were similar. Both intraobserver repeatability and agreement between 2D and 3D ultrasound methods were good. Ultrasound assessed occiput posterior position or high sagittal position does not predict vaginal delivery or the duration of labor in nulliparous women with a prolonged active phase of the first stage of labor. The 'take home message' for clinicians is that diagnosing high sagittal position in a nulliparous woman with prolonged first stage labor should not necessarily suggest the need for cesarean section. Ultrasound parameters are more reproducible than digital vaginal palpation and should be considered if there is uncertainty about birth progress, or the vaginal examination is impaired.

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Papers:

1) Torkildsen, E.A., Salvesen, K.Å., Eggebø, T.M.
Prediction of delivery mode with transperineal ultrasound in women with prolonged first stage of labor.
Ultrasound Obstet Gynecol. 2011 Jun;37(6):702-708.

2) Torkildsen, E.A., Salvesen, K.Å., Eggebø, T.M.
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3) Torkildsen, E.A., Salvesen, K.Å., von Brandis, P., Eggebø, T.M.
Predictive value of ultrasound assessed fetal head position in primiparous women with prolonged first stage of labor.
Acta Obstet Gynecol Scand. 2012 Nov;91(11):1300-1305.

4) Tutschek, B., Torkildsen, E.A., Eggebø, T.M.
Comparison between ultrasound parameters and clinical examination to assess fetal head station in labor.
Ultrasound Obstet Gynecol. 2013 Apr; 41(4): 425–429

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Supervisors:
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Dissertation took place at the main auditorium,
Stavanger University Hospital, Stavanger, Norway
Friday, September 20th 2013 at 12:15 p.m.

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