

Automated assessment of fetal head station from transperineal ultrasound volumes acquired in labor

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Introduction

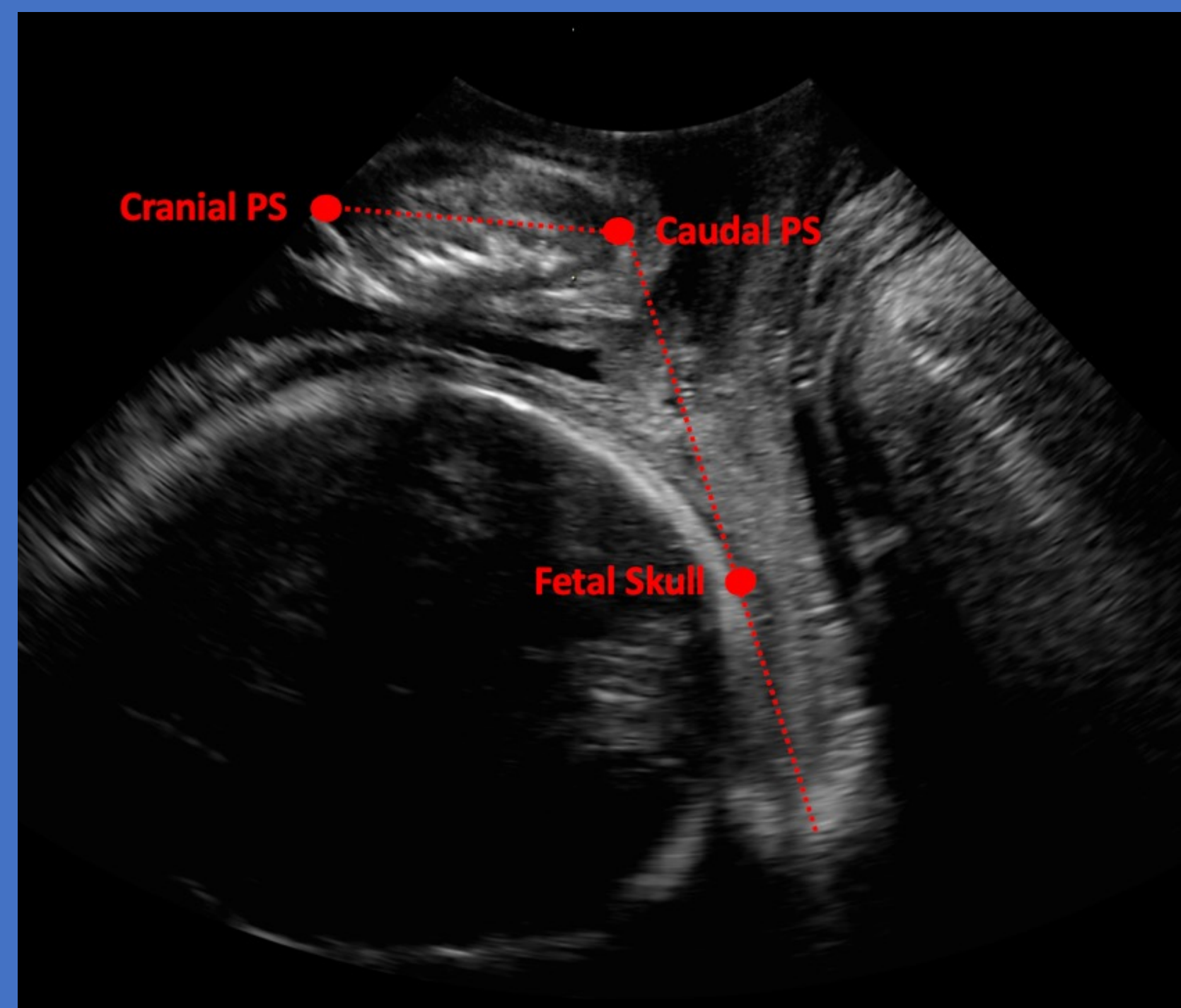
The **angle of progression (AoP)** is one of the best-studied sonographic markers of fetal head descent (**Figure 1**).

There is a **barrier to the uptake of intrapartum ultrasound** by obstetric caregivers. To **bypass the need for training**, several automated AoP measurement techniques have been developed, yet only focusing on **2D** images.

Identification of the **midsagittal plane**, i.e., encompassing the centre of the pubic symphysis, can be challenging because of its heterogeneous appearance.

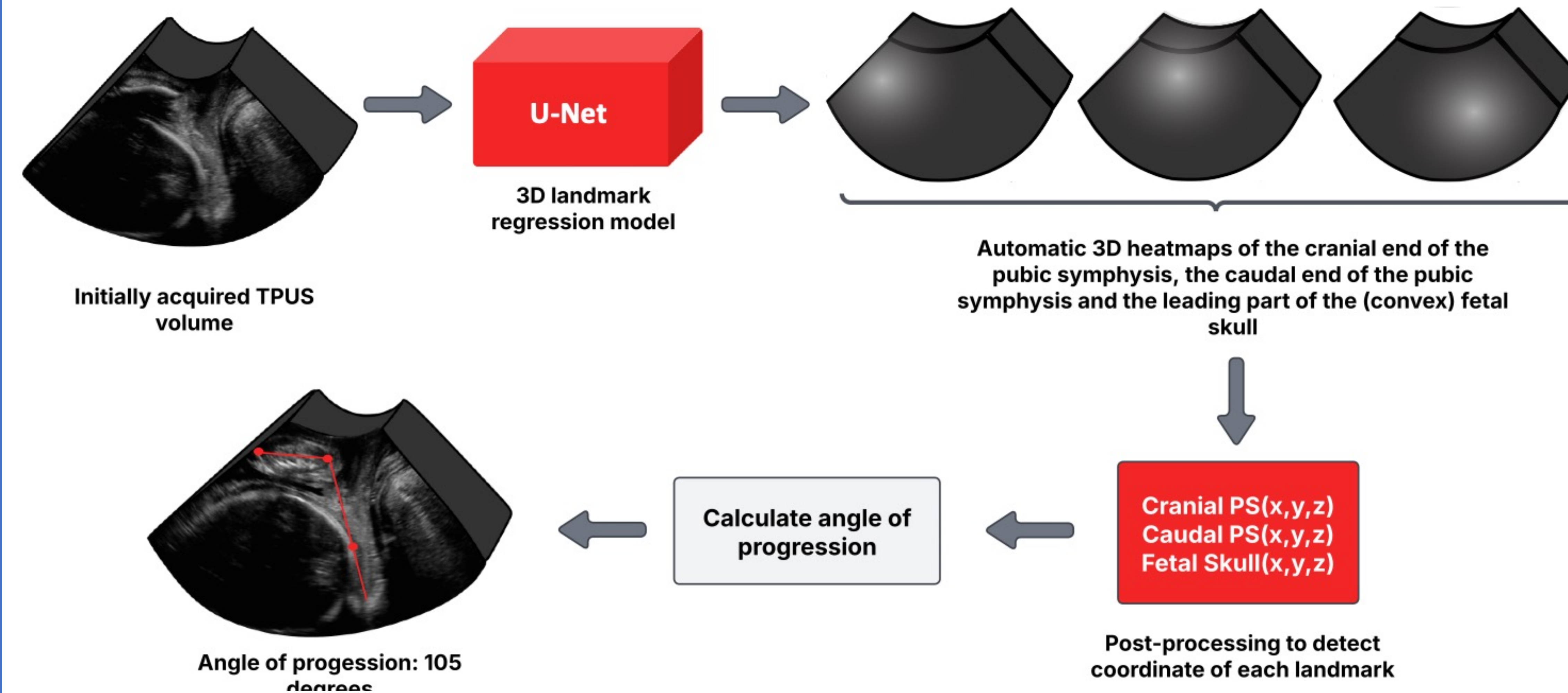
This study aimed to develop and test an artificial intelligence algorithm for automated assessment of the AoP from **3D** transperineal ultrasound (TPUS) volumes acquired in labour, bypassing the need for operator-dependent plane detection.

Figure 1: The AoP is defined as the angle between the cranial and caudal ends of the pubic symphysis, and the most leading part of the fetal skull in the maternal pelvis.



Methods

- ✓ **180 TPUS volumes** were acquired in **180 patients before the active phase of labour** as part of two prospective cohort studies conducted in UZ Leuven.
- ✓ Immediately after volume acquisition, the AoP was measured in B-mode imaging as per the ISUOG practice guideline on intrapartum ultrasound. This was considered the **ground truth**.
- ✓ A U-Net was trained for the automated recognition of the relevant AoP landmarks, with calculation of the AoP in a post-processing step. The pipeline is shown below:



- ✓ The **computer-determined AoP (AoP_d)** was compared to the **ground truth AoP (AoP_{GT})**
- ✓ An **intra- and inter-rater agreement study** was conducted to compare model performance to the variation observed within and between experienced IPUS practitioners.

Results

- ✓ The **mean AoP_{GT} of the test dataset** was **94.6°** (SD 11.4°, range 55.4°-117.0°)
- ✓ The **median absolute computer-observer difference in AoP values** was **4.9°** (IQR 7.8°, 95% CI 2.9°-7.1°).
- ✓ **On average, this corresponds to a < 1 cm difference in TPUS-determined fetal head station relative to the ischial spines.**
- ✓ **Intra-rater agreement:** ICC 0.98 (95% CI 0.97-0.98)
Median absolute AoP difference **2.8°** (IQR 3.8°, 95% CI 2.2°-3.3°).
- ✓ **Inter-rater agreement:** ICC 0.95 (95% CI 0.92-0.97)
Median absolute AoP difference **4.8°** (IQR 5.4°, 95% CI 3.6°-6.1°)

Conclusion

- ✓ The artificial intelligence algorithm results in a **reliable and operator-independent assessment of the AoP** from TPUS volumes acquired in labour.
- ✓ **Pending further validation**, it has the potential to facilitate the uptake of intrapartum ultrasound by obstetric caregivers with little experience in TPUS.