Research Square

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The Sonopartogram: Ultrasound Assessment of the First Stage of Labor versus Vaginal Examination – A Prospective Comparative Study

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Research Article

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Abstract

Background

Vaginal examination (VE) is the reference method for monitoring labor, but it is subjective, operator-dependent, uncomfortable, and carries an infectious risk. Transperineal ultrasound (TPU) offers a non-invasive alternative. The aim of this study was to describe ultrasound aspects of labor parameters, compare them with clinical examination, and propose a “sonopartogram”.

Methods

This prospective, double-blind, comparative study was conducted over 5 months (February–June 2025) at Nabeul regional Hospital, Tunisia. We included 85 women with singleton pregnancy, cephalic presentation, term ≥ 37 weeks, and early labor. Before each routine VE, a TPU was performed to measure cervical length (CL), cervical dilatation (CD), head-perineum distance (HPD), posterior cervical angle (PCA), and fetal head position. Agreement was analysed by Bland-Altman, correlation by Pearson’s R, and qualitative concordance by Cohen’s kappa.

Results

Among the 85 women, ultrasound images were obtainable in 100% of cases for CL, CD, and HPD. For CL, good agreement was found (bias − 0.05 cm; R = 0.7). For CD during the active phase, the anteroposterior diameter showed excellent correlation (R = 0.93; bias 0.07 cm). For HPD, concordance was satisfactory, especially during the active phase. Fetal head position was poorly determined by VE (failure rate 86%, error 36%), while transabdominal ultrasound was the best method. A two-phase sonopartogram (latent and active) was developed.

Conclusion

Transperineal ultrasound is reliable, reproducible, and non-invasive for monitoring the first stage of labor. The proposed sonopartogram could become a valuable tool in Tunisian maternity units.

Introduction

For decades, vaginal examination (VE) has been the only means of monitoring labor progress. It remains the reference examination for assessing cervical effacement, position, dilatation, as well as fetal head descent and rotation. The results are recorded prospectively on a partogram initially proposed by Friedman EA in 1954 [1–3]. In African hospitals, the partogram was adapted as recommended by Philpott RH et al. in 1972 [4]. It is a simple, low-cost tool with a good cost-effectiveness ratio, and it has

reduced the frequency of prolonged labor, postpartum hemorrhage, uterine rupture, puerperal infection, and maternal-perinatal morbidity and mortality .

However, clinical examination has limitations. Several studies have reported its subjective, operator-dependent nature with significant inter-examiner variability. This uncertainty can increase patient stress and lead to lack of confidence in the examiner [5]. Moreover, VE can be uncomfortable, especially if repeated, in the absence of analgesia, or in cases of a history of psychological trauma. VE also increases the risk of chorioamnionitis and shortens the latency phase in preterm premature rupture of membranes [6].

The World Health Organization (WHO) has recommended limiting the number of VEs during labor and starting the partogram at 3 cm, reserving examination in the latent phase for particular situations (induction, artificial rupture of membranes, or epidural analgesia) [7]. However, these “particular” situations are far from exceptional; the current induction rate in developed countries is estimated at 13–20% .

To overcome the limitations of clinical examination, the ultrasound approach for labor monitoring has emerged. Different tools (2D and 3D ultrasound), different routes (transabdominal, transvaginal, transperineal), and various algorithms have been evaluated, but no consensus has been reached. The 3D approach has the main disadvantage of being ill-adapted to the delivery room, complex, and poorly reproducible [8].

Primary objective:

To describe the ultrasound features of the most important parameters during the first stage of labor.

Secondary objectives:

- To perform a comparative analysis between ultrasound parameters and the reference clinical examination.
- To develop an ultrasound partogram or “sonopartogram” adapted to our maternity units.

Methods

2.1. Study Design

A prospective, double-blind, comparative study.

2.2. Setting

Department of Obstetrics and Gynecology, Nabeul regional hospital, Tunisia (level 2B maternity unit, 3300 deliveries/year). The study period was from February 1 to June 1, 2025.

2.3. Participants

Eighty-five consecutive parturients were included according to the following criteria: singleton pregnancy, gestational age between 37 and 42 weeks, cephalic presentation, clinically normal pelvis, and early labor defined by regular painful uterine contractions associated with cervical changes [9].

Non-inclusion criteria: twin pregnancy, pathological pelvis, gestational age < 37 weeks, non-cephalic presentation, contraindication to vaginal delivery.

Exclusion criteria: refusal to participate, unavailability of the ultrasound operator.

2.4. Variables

The primary outcome was agreement between TPU and VE for measuring cervical dilatation. Secondary outcomes included cervical length, head descent (head-perineum distance), posterior cervical angle, fetal head position, and feasibility of the sonopartogram.

2.5. Data sources / measurement

Data were collected prospectively. Each parturient underwent TPU (low-frequency probe 3–5 MHz, Toshiba SSA-510 A and Logic 3 Expert) immediately before each routine VE performed by the midwife. The time between the two examinations was less than 5 minutes. Ultrasound parameters were:

- Head-perineum distance (descent) according to Dimassi et al. [10]. Figure 1A illustrates the methodology adopted for the placement of the ultrasound probe. Figure 1B and Fig. 1C show an example of the [P-P] distance measured during our work and a demonstrative image of the obtained section, respectively.
- On the same image used to measure the [P-P] distance, the operator noted the presence or absence of a chignon (caput succedaneum) as well as possible overlapping of the skull bones, as shown in Fig. 2A and Fig. 2B. These signs could also be visualised on another section, for example on a sagittal section (Fig. 2C).
- Here, the probe was placed in the sagittal plane between the labia majora as shown in Fig. 3A; vertical and lateral movements together with fine angulations were performed until a satisfactory image of the cervix (internal os, external os and cervical canal) was obtained. On the same section, the pubic symphysis, the fetal head and the lower part of the lower uterine segment were observed (Fig. 3B, 3C)
- Posterior cervical angle (PCA) according to Rane et al. [11]. Using the same methodology as for the measurement of cervical length and on the same image, we used the method previously described by Rane SM et al. to measure the posterior cervical angle (PCA). This represents the angle formed by the posterior lip of the cervix. We therefore developed a score according to the measured angle: for an angle < 90°, the score was 0; for an angle between 90° and 120°, the score was 1; and for an angle > 120°, the score was 2.

- Cervical dilatation (CD): during the latent phase, measurement of anteroposterior diameter (APD), transverse diameter (TD), and their mean; during the active phase, measurement of APD according to Hassan et al. [12]
- Fetal head position by TPU then transabdominal ultrasound [13]

Clinical examination followed WHO recommendations [7] and data were recorded on a standard partogram [14].

2.6. Bias

The study was double-blind (the ultrasound intern was unaware of the VE result, and the midwife was unaware of the ultrasound measurements). The very short interval between examinations limited bias due to labor progress. The ultrasound operator was a non-specialist intern to reflect real-life practice.

2.7. Study size

Among the 85 included women, 183 pairs of examinations (clinical + ultrasound) were analysed, averaging 2–3 pairs per patient.

2.8. Continuous variables

Quantitative variables (CL, CD, HPD) were expressed as means ± standard deviation. Qualitative variables (cervical position, fetal head position) were expressed as frequencies and percentages.

2.9. Statistical methods

Analysis was performed using XLSTAT 2026. Agreement between the two methods was studied using Bland-Altman analysis [15] and correlation using Pearson's R [16]. For qualitative variables, Cohen's kappa coefficient was calculated [17]. A p-value < 0.05 was considered significant.

Results

Participants

A total of 85 women who completed follow-up were included in the final analysis. Their baseline sociodemographic and obstetric characteristics are presented in Table 1.

Table 1
Characteristics of parturients (N = 85)

Variable	Value
Age (years), mean ± SD	29.4 ± 5.2
Nulliparous, n (%)	45 (53%)
Multiparous, n (%)	40 (47%)
Gestational age at delivery (weeks), mean ± SD	39.1 ± 1.3
Vaginal delivery, n (%)	67 (78.8%)
Caesarean section, n (%)	18 (21.1%)
Total number of VEs, mean (min-max)	18 (10–33)

Descriptive Data

Ultrasound enabled a consistent and detailed assessment of cervical changes and fetal head progression during labor.

The mean cervical length was 1.04 cm (range: 0.15–2.69 cm). In women with intact membranes, the cervix showed a progressive morphological evolution, changing from a T shape to a Y shape, then to a V shape, and finally to a U shape. After membrane rupture, a characteristic “double superimposed V” pattern was frequently observed.

Cervical dilatation was successfully assessed in all patients. During the latent phase, cervical opening was initially visualized at the internal os and progressively extended toward the external os.

The progression distance of the fetal head was measurable in all cases, with continuous visualization throughout labor progression.

Outcome Data

Agreement between transperineal ultrasound (TPU) and vaginal examination (VE) was evaluated for the main labor parameters.

Regarding cervical length, good agreement was observed between the two methods, with a slight systematic bias of − 0.05 cm and limits of agreement ranging from − 0.86 to 0.76. Correlation was moderate ($R = 0.70$; $p < 0.0001$).

For cervical dilatation, agreement varied according to the stage of labor. During the active phase, bias was minimal (0.07 cm), with limits of agreement ranging from − 1.26 to 1.40 and a strong correlation ($R = 0.93$; $p < 0.0001$). During the latent phase, ultrasound-measured diameters (anteroposterior, transverse,

and mean diameters) showed good agreement with vaginal examination. Overall, cervical dilatation demonstrated excellent correlation between the two methods (R = 0.96; p < 0.0001).

Assessment of fetal head descent showed satisfactory agreement between the two techniques, with greater accuracy during the active phase and narrower limits of agreement.

The agreement between transperineal ultrasound and vaginal examination for the main labor parameters is summarized in Table 2.

Table 2
Agreement between transperineal ultrasound and vaginal examination

Parameter	Bias (95% CI)	Limits of agreement	Pearson's R	P
Cervical length (cm)	−0.05 (−0.13; 0.03)	]−0.86; 0.76[	0.70	< 0.0001
Cervical dilatation – active phase (APD, cm)	0.07 (−0.08; 0.22)	]−1.26; 1.4[	0.93	< 0.0001
Cervical dilatation – overall (cm)	0.23 (0.15; 0.31)	]−1.26; 1.4[	0.96	< 0.0001
Head-perineum distance – active phase (cm)	−0.12 (−0.31; 0.07)	]−1.50; 1.26[	0.88	< 0.0001

Main Findings

Ultrasound assessment of cervical position (PCA) showed poor agreement with vaginal examination (kappa = 0.24), suggesting limited reliability of clinical assessment for this parameter.

Regarding fetal head position, vaginal examination showed a high failure rate (86%) and a diagnostic error rate of 36%. In comparison, transperineal ultrasound demonstrated high reliability, with no diagnostic errors. Transabdominal ultrasound appeared to be the most reliable method, with a very low failure rate and the highest diagnostic consistency.

The performance of the different methods for determining fetal head position is presented in Table 3.

Table 3
Performance of methods for determining fetal head position

Method	Failure rate (%)	Error rate (%)
Vaginal examination (overall)	86%	36%
Transperineal ultrasound	41%	0%
Transabdominal ultrasound	3.5%	0%

Additional Analyses

Based on the combination of morphological and quantitative ultrasound parameters, two sonopartogram models were developed, one for the latent phase and the other for the active phase of labor. These models integrate cervical morphology, cervical dilatation, fetal head descent, and fetal head position. The proposed sonopartograms are presented in Figs. 4–7 of the manuscript.

Discussion

Key results

In this prospective study, we demonstrated that TPU is reliable for measuring cervical length, cervical dilatation, and fetal head descent, with excellent correlation compared to VE, particularly during the active phase of labor. Fetal head position remains difficult to determine by the transperineal route, but transabdominal ultrasound is an excellent alternative.

Results in the context of existing literature

Our results are consistent with those of Hassan et al. (2013), who showed that ultrasound APD is reliable for measuring CD. The superiority of TPU over transabdominal ultrasound for measuring CL was reported by Dimassi et al. (2016) [18]. Assessment of descent using HPD has been validated by several authors. The poor agreement for cervical position (PCA) is consistent with the work of Rane et al. [11] and Eggebø et al. [19]. Finally, the inability of VE to correctly determine fetal head position has already been highlighted .

Strengths and limitations

Strengths: prospective double-blind study, use of standard equipment (accessible in Tunisia), non-specialist operator (reflecting real-life practice), very short interval between examinations.

Limitations: modest sample size (85 patients), single-centre, limited number of ultrasound examinations per patient (2–3), lack of multiple operators (no inter-observer variability study). Generalisability is limited to level 2B maternity units.

Interpretation

Our findings support the use of TPU as an objective, non-invasive tool for monitoring labor. The proposed sonopartogram could advantageously replace the classical partogram, pending validation by multicentre randomised studies including more patients and operators.

Conclusion

This prospective study confirms that transperineal ultrasound is a simple, reproducible, non-invasive, and reliable method for monitoring the first stage of labor, with excellent agreement with clinical examination

for cervical length, cervical dilatation, and fetal head descent. Fetal head position is best determined by transabdominal ultrasound. The proposed “sonopartogram” is a practical prototype adapted to Tunisian maternity units. Large-scale randomised multicentre studies are needed before widespread implementation.

Declarations

Ethics approval and consent to participate

This prospective study was approved by the local institutional ethics committee. Written informed consent was obtained from all participants prior to inclusion in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Funding

The authors received no specific funding for this work.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors’ contributions

HS contributed to data collection and manuscript drafting. MT contributed to study design, data analysis, and manuscript revision. All authors read and approved the final manuscript.

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19. HASSAN* WA, EGGEBØ†‡ T, FERGUSON§ M, GILLETT¶ A, STUDD** J. D. PASUPATHY¶and C. C. LEES*†† The sonopartogram: a novel method for recording progress.

Figures

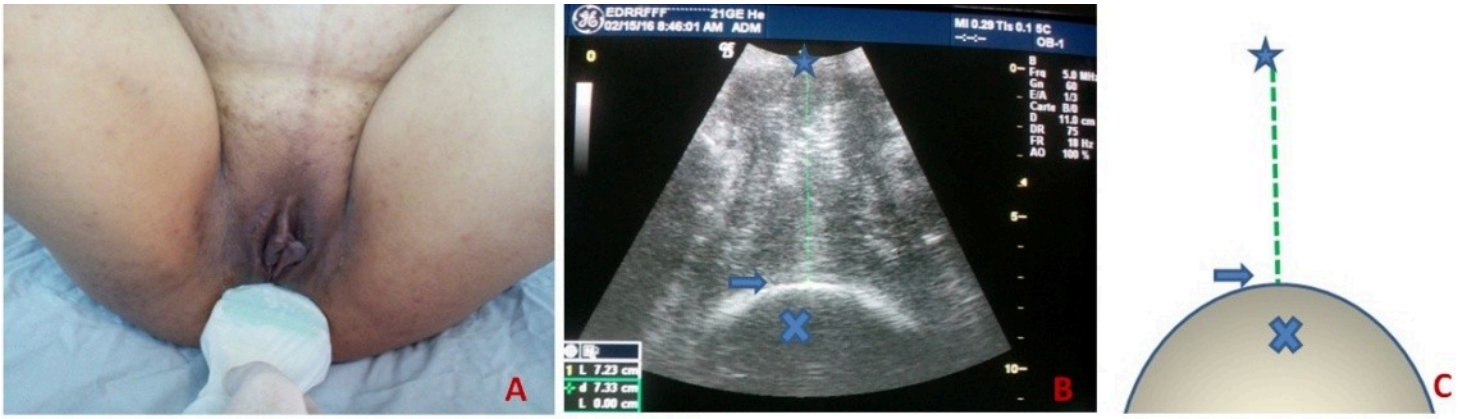


Figure 1 : Mesure de la distance périnée-présentation fœtale (P-P) :
la distance [P-P] est réalisée verticalement (pointillés verts) en prenant comme référence le début de l'insonation pour la limite proximale (étoile) et la table externe du crane fœtal (flèche) pour la limite distale. La tête fœtale est indiquée par une croix.
A= *position de la sonde: la sonde est placée horizontalement au niveau de l'espace anovulvaire.*
B= *Distance périnée-présentation fœtale [p-p]= 72.3 mm.*
C= *image démonstrative de la coupe obtenue .*

Figure 1

See image above for figure legend.

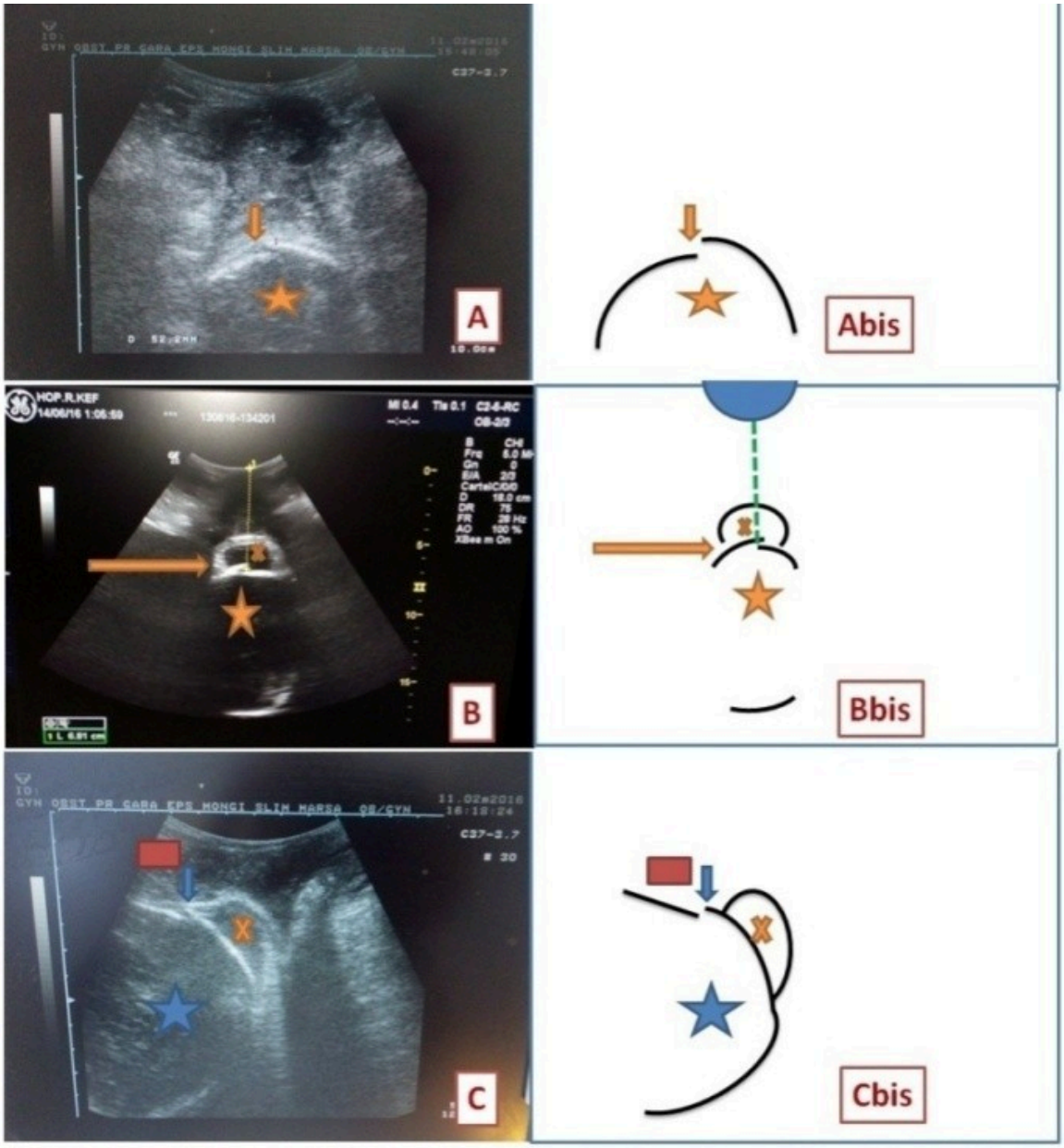


Figure 2 : **Chevauchement des os du crane et la présence d'une bosse sérosanguine par échographie transpérinéale.**

A: *coupe transversale périnée-présentation foetale montrant le chevauchement des os du crane (flèche) . La tête fœtale est représentée par une étoile.*

Abis: *image démonstrative de la coupe A.*

B: *coupe transversale périnée-présentation foetale montrant le chevauchement des os du crane et une bosse séro-sanguine (croix) . La distance [P-P] est indiqué par une ligne en tirets.*

Bbis: *image démonstrative de la coupe B.*

C: *coupe sagittale montrant à la fois un chevauchement des os du crane et une bosse sérosanguine*
La symphyse pubienne est représentée par un rectangle.

Cbis: *image démonstrative de la coupe C.*

Figure 2

See image above for figure legend.

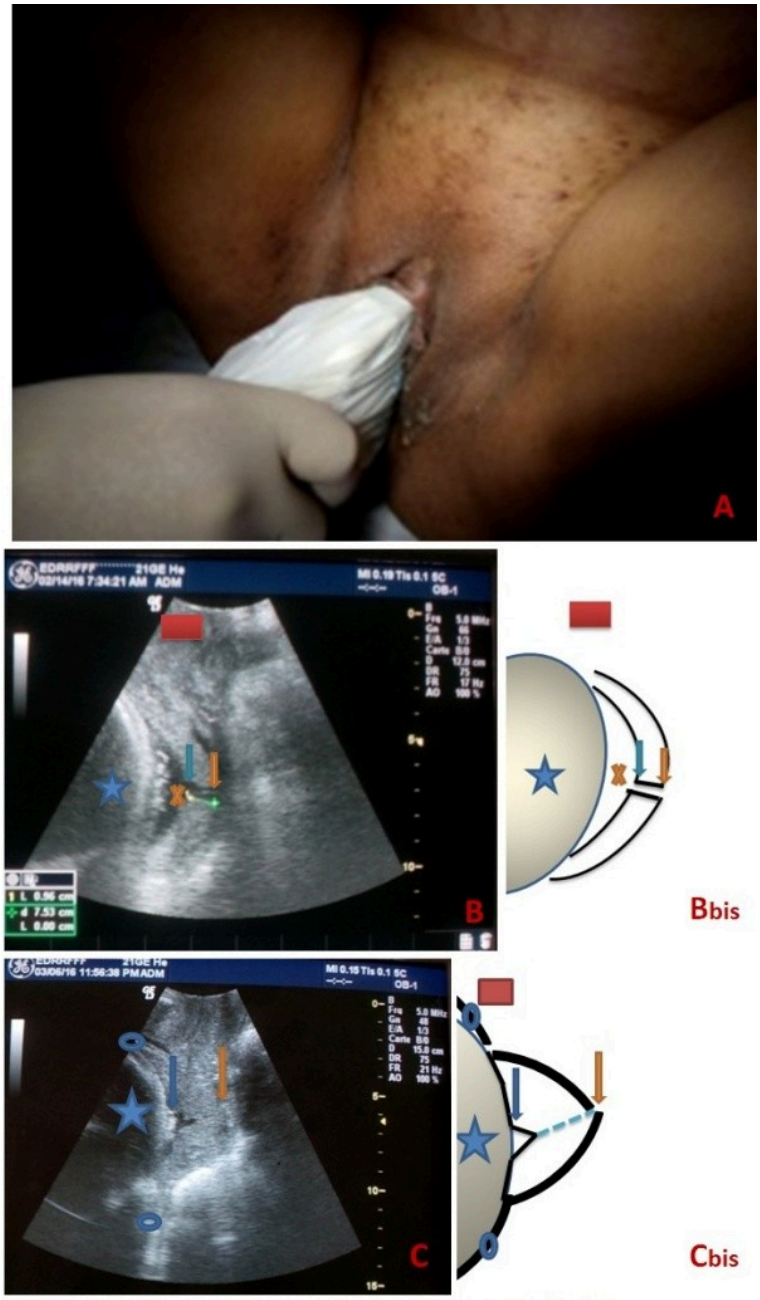


***Figure 3. M*esure de la longueur du col par voie transpérinéale .**
A: *Position de la sonde: la sonde est placée sagittalement entre les grandes lèvres.*
B: *Longueur cervicale (pointillés vert) = 9.6mm. Sur cette coupe, on objective l'orifice interne (flèche bleue) et externe (flèche orange); la symphyse pubienne (rectangle); la tête fœtale (étoile) et le liquide amniotique (croix) entre la présentation fœtale et l'orifice interne du col .* ***Bbis:*** *image démonstrative de la coupe B.*
C: *Coupe sagittale du col, on objective l'orifice interne et externe; la symphyse pubienne; la tête fœtale et la partie inférieure du segment inférieur (cercles).* ***Cbis****: image démonstrative de la coupe C. Le canal cervical est représenté par une ligne bleue en tirets.*

Figure 3

See image above for figure legend.

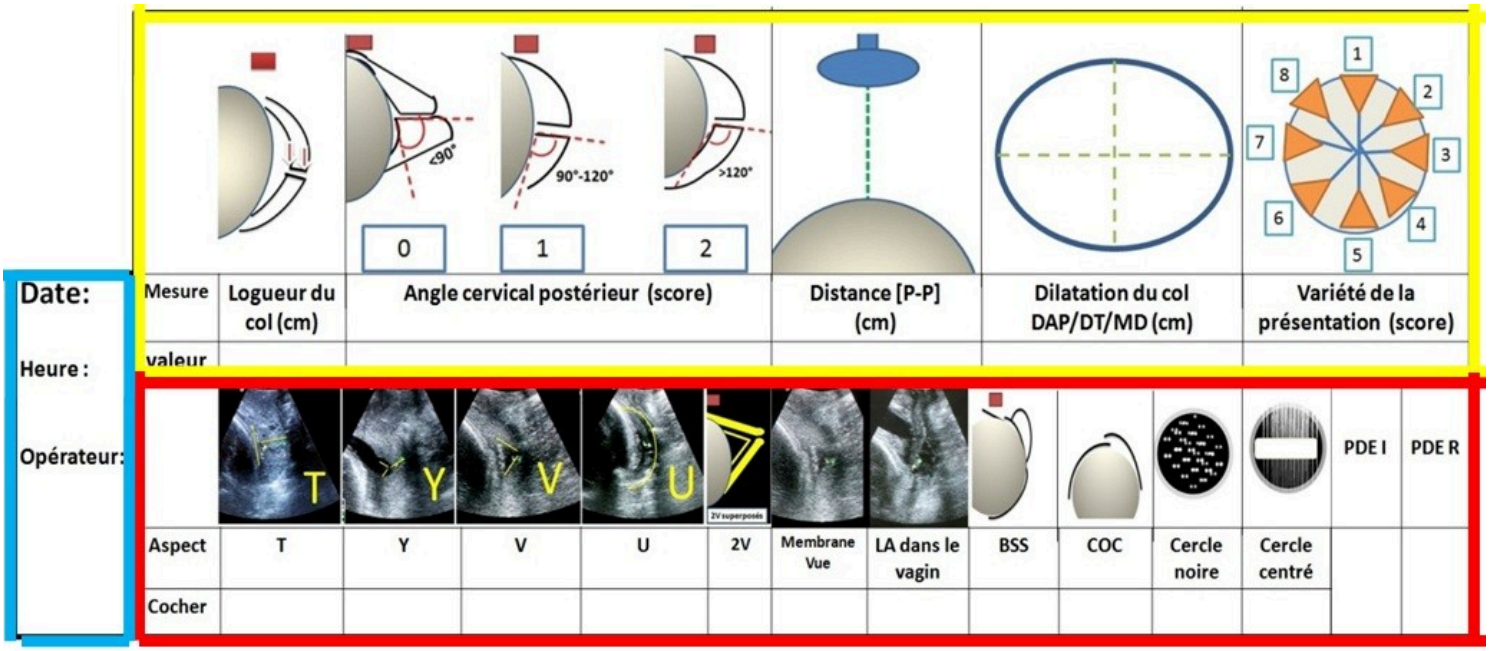


Figure 24 : Modèle de partogramme échographique 2D transpérinéal durant la phase de latence.

Figure 4

See image above for figure legend.

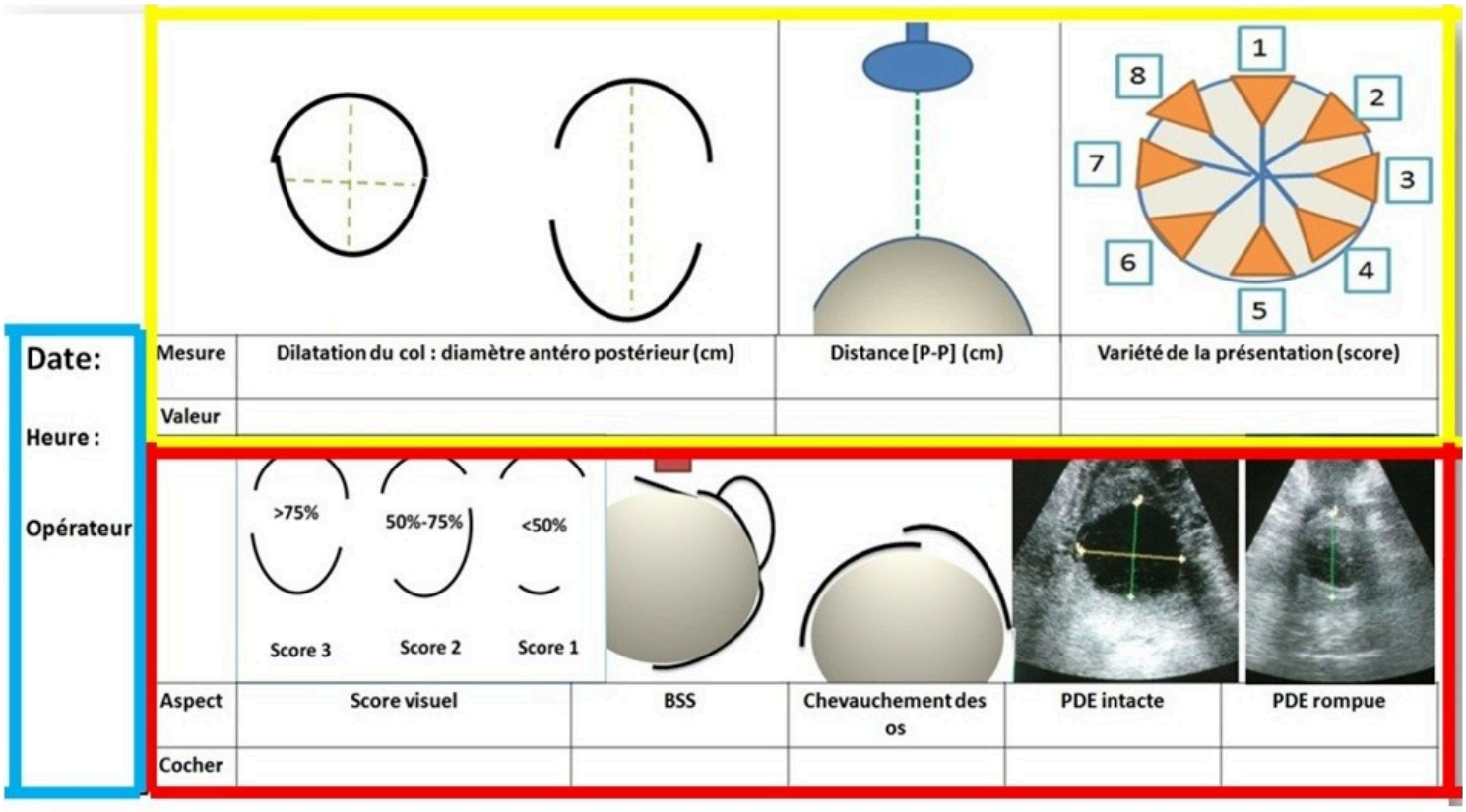


Figure 25 : Modèle de partogramme échographique 2D transpérinéal durant la phase active.

Figure 5

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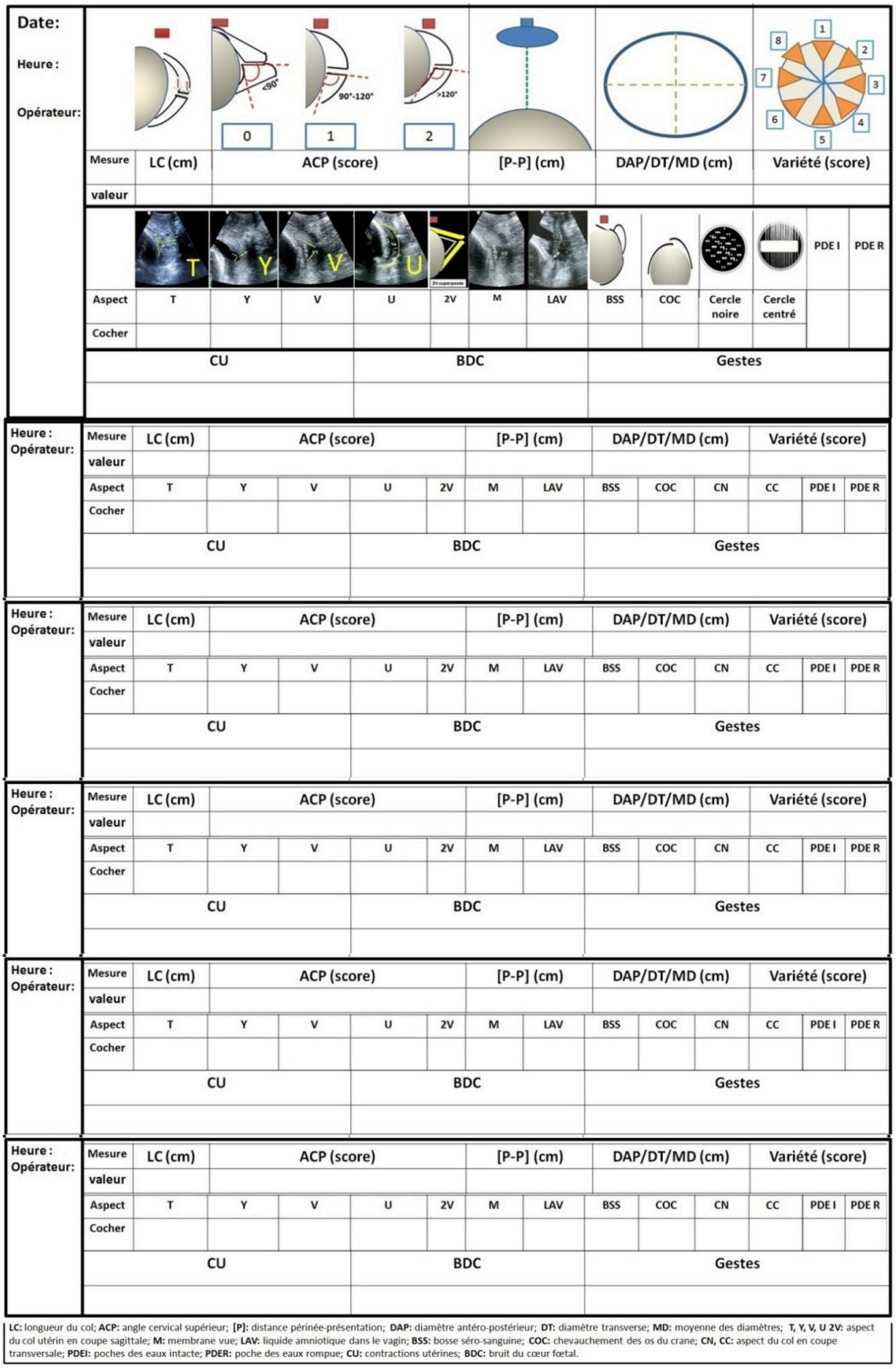


Figure 26: page 1 du partogramme échographique : phase de latence.

Figure 6

See image above for figure legend.

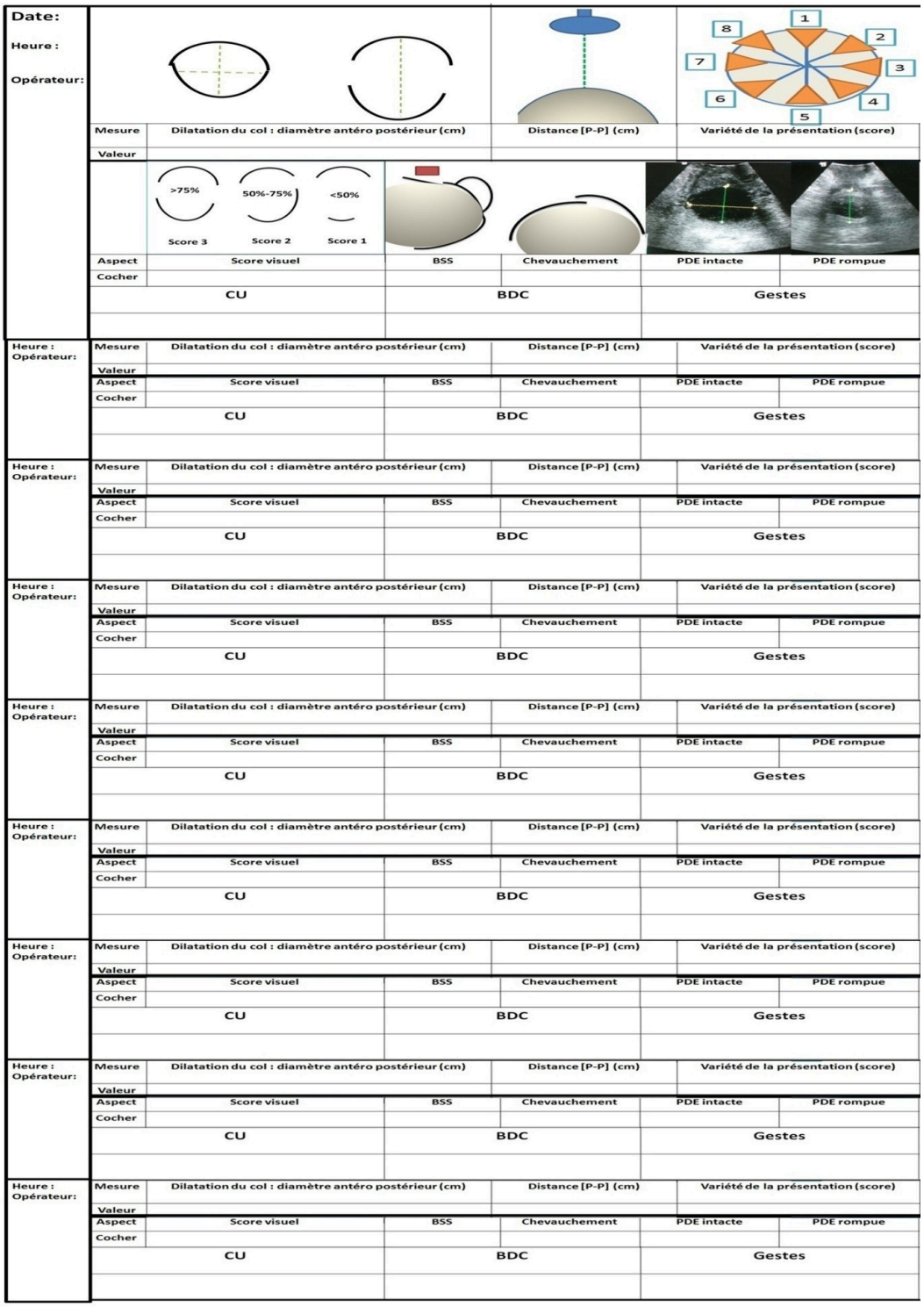


Figure 27: page 2 du partogramme échographique : phase active.

Figure 7

See image above for figure legend.