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Role of intrapartum ultrasound in modern obstetrics – current perspectives and literature review

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Abstract

For many years, the progress of labour has been traditionally evaluated almost exclusively by transvaginal digital assessment which, by its very nature, is an imprecise and, above all, subjective examination. Appropriate assessment of foetal head station and position in the birth canal is of critical importance for predicting further progress and safe completion of labour by instrumental or surgical intervention. In view of the deficiency of diagnostic methods available in the delivery room, attempts are undertaken to introduce intrapartum ultrasound performed using a transabdominal suprapubic or transperineal approach as a useful diagnostic tool. The examination is performed at the patient's bedside, using a portable ultrasound unit equipped with a convex probe. The method comprises a range of parameters, of which the most common are the angle of progression (AoP), foetal head direction, head-perineum distance or midline angle (MLA). Intrapartum sonography yields an array of data to evaluate with a high degree of precision the foetal head position and station in the birth canal. Intrapartum ultrasound may prove a very useful method complementing traditional obstetric examination in a number of clinical situations such as prolonged delivery and lack of certainty as to the way to end the labour. Increasingly, attention is being drawn to the role of the examination in predicting the efficacy of induction of labour, serving as visual bio-feedback to increase the effectiveness of maternal pushing or accurately identify the beginning of labour. It has been highlighted that intrapartum ultrasound is easy to use, painless, and reproducible. Also, the method does not require specialist training. Despite promising research results and the development of recommendations on the application of the method, there is still insufficient evidence to elaborate definite algorithms for the interpretation of results, based on which clinical decisions could be made.

Introduction

More than half a century has passed since Ian Donald began his pioneering research into the use of ultrasound in pregnant women^(1,2). Since then, ultrasonography has systematically grown in relevance in gynaecological and obstetric practice, acquiring the status of an effective

diagnostic method. The role of ultrasound examinations in various gynaecological and obstetric applications has been consistently growing, which naturally entails an improved experience in the use of the technique, the interpretation of images, and the performance of a range of procedures (e.g. amniocentesis or cordocentesis) under ultrasound control.

The only place where ultrasonography has not, as yet, found widespread applications is the delivery room.

Traditional assessment of labour progress

Labour management has changed little over the past decades, and it is still based on transvaginal digital examination which, by definition, is subjective and hence associated with a high rate of error. The learning curve for performing manual obstetrical examination according to conventional textbooks is long⁽³⁾. While the assessment of cervical dilation does not usually pose major problems, the exact determination of foetal head position and station in the birth canal may be problematic even for specialists with long obstetric experience.

In studies based on birth simulators, cervical dilation was determined precisely only in 56% of transvaginal digital assessments. What is more, the number of errors made by the same examiners exceeded 50%⁽⁴⁾. In other studies, using a model made of soft materials to make it more realistic, cervical dilation was assessed correctly only in 19% of simulated examinations⁽⁵⁾. The accuracy of obstetric examination also depends on the experience of the clinician. One study found that the estimation of cervical dilatation performed by obstetricians with extensive experience were consistent with the findings obtained by a beginner physician in less than half of all examinations⁽⁶⁾.

As shown in the literature, the assessment of foetal head station in the birth canal is equally problematic to the examining physicians. In studies using a birth simulator, one in three obstetricians erroneously assessed foetal head position⁽⁷⁾. Sherer *et al.* compared the accuracy of foetal head position assessment by transvaginal digital examination and transabdominal ultrasound. Consistent findings were obtained in only 35% of patients in the second stage of labour⁽⁸⁾, and in 24% of parturient women in the active phase of labour defined as cervical dilation of at least 4 cm⁽⁹⁾. Based on the same method, other authors obtained the following results: 65% in the second stage, and 31% in the first stage of labour. It was also noted that the assessment of foetal head position in the birth canal was impossible in as many as 60% of patients in the first, and 30% of patients in the second stage of labour^(10,11).

Some researchers evaluated the accuracy of transvaginal digital examination in determining the position of foetal head in the birth canal. One of the studies found that the occiput posterior position was identified in 10%, whereas in fact it was only present in 3% of cases. In 12% of cases, the midwives participating in the study were unable to determine the position of foetal head at all⁽¹²⁾. Other authors show that errors in the assessment of foetal head position are three times more common with the foetus in the occiput posterior position⁽¹⁰⁾. The findings presented above – combined with the fact that the delivery of foetus in the occiput posterior position is usually longer, and more

frequently represents an indication to perform an obstetric intervention – provide additional evidence that transvaginal digital examination is characterised by low reliability and limited utility.

The problem grows in importance especially when over the course of labour doubts arise as to the dynamics of its progress. An accurate and quick decision on how to end the labour, made at the appropriate stage, is crucial both to maternal and foetal health. Rapid advancements in medicine have confronted obstetricians with a growing need to objectify the diagnostic tools used during labour and delivery. One attempt to address this need is the proposed application of intrapartum sonography.

Application of intrapartum ultrasound

Intrapartum ultrasound (labour ultrasound) is a type of ultrasound assessment performed during labour which, by measuring a set of parameters, aims to evaluate spatial relationships between the head of the foetus and the birth canal – including foetal head position, attitude, and station. Intrapartum sonography is performed using a transabdominal approach or, alternatively, ultrasound images are obtained by placing the probe between the patient's labia. The latter type of examination is referred to as translabial ultrasound or transperineal ultrasound (TPU). In both examination types, images are obtained in the sagittal or transverse planes⁽¹³⁾.

Intrapartum sonography does not require an advanced ultrasound system. Preferably, the ultrasound unit should be a compact, portable device equipped with a rechargeable battery for quick start-up and temporary operation without connection to an external power supply. The examination is performed using a low-frequency (<4 MHz) convex-type probe generating images in 2D presentation. Intrapartum ultrasound is a typical bedside examination (Fig. 1).

Recent years have brought considerable interest in intrapartum sonography, resulting in a number of studies evaluating the application of the method to better assess the progress of labour and make correct clinical decisions. The available study data were compiled in the form of guidelines drawn up by the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG), an international association of sonography experts⁽¹³⁾. The Practice Guidelines outline the clinical situations which may represent indications for performing ultrasound evaluation in labour. They include slow progress or arrest of labour; suspected foetal head malpresentation, or the need to ascertain foetal head position and station before considering or performing instrumental vaginal delivery. Among multiple parameters, the Practice Guidelines highlight the special role of the angle of progression (AoP), head–perineum distance (HPD), head direction (HD) and midline angle (MLA).

The angle of progression (AoP), also referred to as the angle of descent, is the angle between the long axis of the



Fig. 1. Transperineal ultrasound

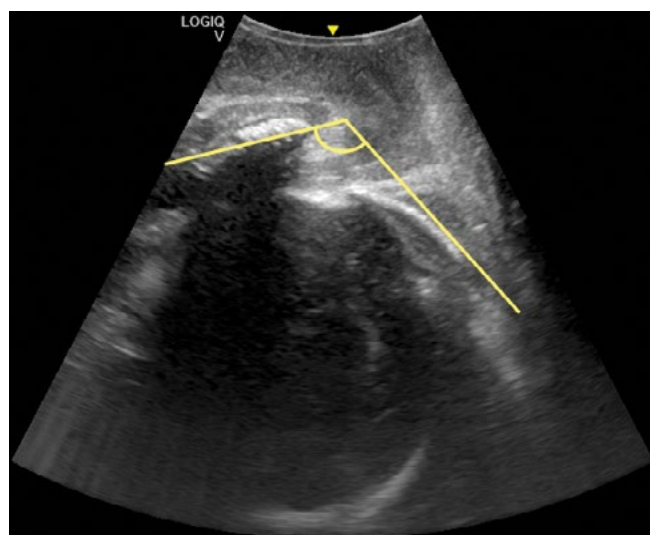


Fig. 2. TPU scan with marked angle of progression (AoP)

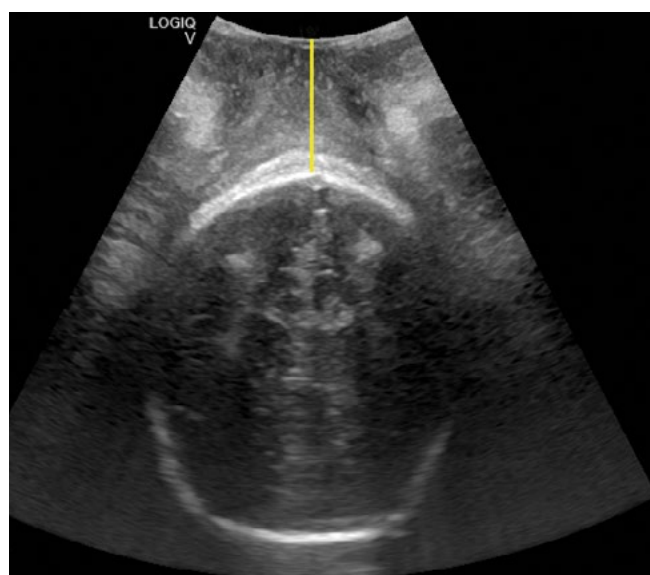


Fig. 3. TPU scan with yellow line marking the distance between foetal skull and maternal perineum (HPD)

symphysis pubis and the line extending tangentially from its most inferior edge to the foetal skull⁽¹⁴⁾ (Fig. 2). It is, as yet, the most thoroughly investigated parameter of TPU, characterised by high accuracy and repeatability^(15–17). It has also been found that foetal head station at the level of the interischial line corresponds to an AoP of 116°⁽¹⁸⁾, which is extremely useful information for the clinician managing the delivery.

Similarly to the AoP, the head-perineum distance (HPD) is a parameter determined from the transperineal approach. However, unlike the AoP, it is measured in the frontal (rather than sagittal) projection. The HPD is defined as the shortest distance from the outer bony limit of the foetal skull to the maternal perineum⁽¹⁹⁾ (Fig. 3).

It has been shown that based on the above parameters objective conclusions can be drawn about foetal head station in the birth canal, which is of particular significance for predicting the progress of labour and determining the patient's mode of delivery – instrumental or Caesarean section – if arrest of labour is diagnosed. A number of authors agree that the AoP > 120° is associated with the highest probability of spontaneous vaginal delivery^(14,18,20,21). For the HPD, the correlation has been confirmed for values less than 40 mm⁽²²⁾.

Midline angle (MLA) is a parameter evaluated, similarly to the HPD, in the frontal projection. It is defined as the angle between the anteroposterior axis of the maternal pelvis and the midline of the foetal brain visible as a hyperechogenic line interposed between the two cerebral hemispheres⁽²³⁾ (Fig. 4). A change in MLA value reflects the turns the foetal head makes when negotiating through successive sections of the birth canal. In combination with the parameters defining the foetal head station, it accurately reflects the position of the head in the birth canal, so that if instrumental delivery is considered necessary, the obstetrician has access to valuable tips on how to effectively apply tractions to repair the abnormal birth mechanism.

The head direction (HD) is the angle between the longest recognisable axis of the foetal head and the long axis of the pubic symphysis (Fig. 5). Depending on the values of the angle, different categories of the parameter are distinguished:

- *head up* – when the angle is equal to or greater than 30°,
- *horizontal* – when the value of the angle is between 0 and 29°,
- *head down* – when the angle is less than 0°.

The change in the direction of foetal head as it descends in the birth canal reflects the orientation of the lead point along the curved axis of the birth canal – from turning “downward” through the horizontal direction to turning “upward”⁽²⁴⁾.

Similarly to the MLA, the HD result makes it possible to determine with a high degree of accuracy the safety, difficulty and successful outcome of instrumental vaginal delivery^(18,24). Foetal head direction “head up” combined with the

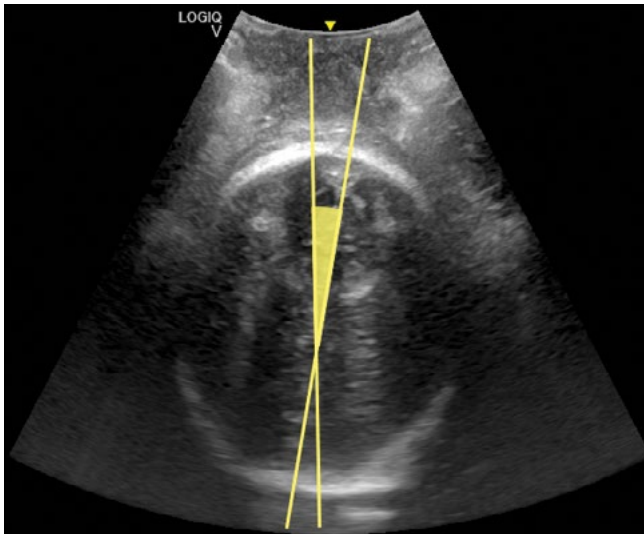


Fig. 4. TPU scan with marked midline angle (MLA)

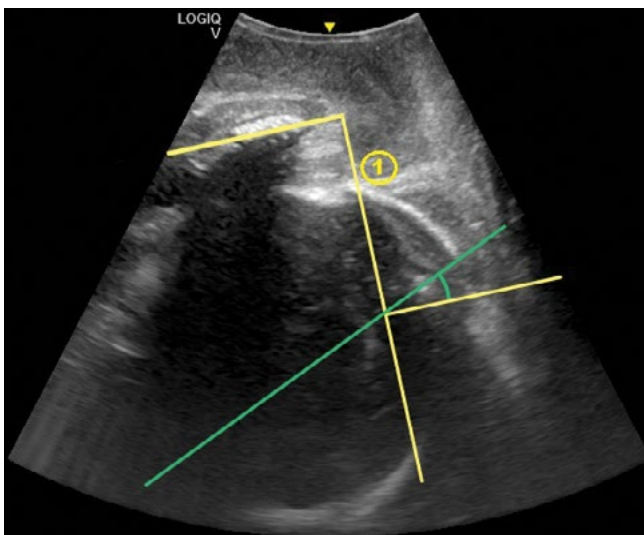


Fig. 5. TPU scan with visible subpubic line (1) and angle determining head direction (HD)

MLA of less than 45° represent a good prognostic factor for the successful use of vacuum extraction or forceps⁽²⁵⁾.

Over the past year, a number of promising study findings have been reported on the application of intrapartum sonography, providing a set of reliable data justifying widespread use of the method in the delivery room.

Problems in the second stage of labour

One of the situations which may raise considerable diagnostic doubts even in experienced obstetricians is unduly prolonged second stage of labour, when the key issue becomes the assessment of chance of natural delivery, so that a risky medical intervention can be avoided. Dall'Asta *et al.*⁽²⁶⁾ evaluated the benefit of a range of TPU parameters including the AoP, MLA, HPD,

and the head-symphysis distance (HSD, not discussed above), in the prediction of the mode of delivery among women diagnosed with failure to progress in the second stage of labour. The authors found that the only independent predictors of spontaneous vaginal delivery were the MLA and HSD (ROC of 80% and 74%, respectively). These findings shed new light on the benefits of the HSD, whose diagnostic benefit has not, as yet, been demonstrated scientifically with a sufficient degree of reliability.

Although the ISUOG Practice Guidelines indicate how the findings obtained by intrapartum ultrasound can be useful in the objective qualification of patients for instrumental delivery, much research is still focused on attempts to identify precise cut-off points for different parameters in order to support clinicians in the decision-making process. This is because an erroneous choice of the above procedures in the second stage of labour is associated with potentially the highest number of complications, both maternal and foetal. In one large analysis, comprising a total of 116 instrumental deliveries, it was shown that the AoP value of at least 138.7° and 160.9° (measured between and during uterine contractions, respectively) was associated in a significant manner with the highest rate of successful instrumental deliveries⁽²⁷⁾. Based on various sources, the AoP assessment is a good predictor (80–87% probability) of a successful attempt to perform instrumental delivery^(27,28). Another study, which assessed the HPD, found that the duration of vacuum extraction was the shortest in the group of patients with the greatest difference between the HPD values measured during uterine contraction and relaxation⁽²⁹⁾.

Applications of intrapartum ultrasound in the perinatal period

In the recent period, intrapartum ultrasound has been expanding its scope to include the perinatal period. This is because of a number of new publications addressing the issue of prediction of the mode of delivery even before the spontaneous or induced start of labour. Such prediction would significantly improve the quality of perinatal care through the early identification of patients who do not have a good chance of natural (vaginal) delivery. A prospective study evaluating the TPU parameters before the induction of labour in pregnant women at term showed that in addition to variables including maternal age or history of natural vaginal delivery, only the AoP was a significant independent prognostic factor for labour induction⁽³⁰⁾. Another study, involving a total of 250 patients, assessed the HPD under similar conditions. The authors observed that a cut-off of ≤ 5.5 cm for the foetal head-perineum distance was associated with the highest predictability (sensitivity 97%, specificity 88%) of the successful outcome of induction⁽³¹⁾. Serial measurements of the TPU parameters – particularly the AoP – performed during labour induction can also be used as an objective method for recognising ineffective induction and lack of labour progress earlier than

indicated by traditional transvaginal digital examination⁽³²⁾. Despite these optimistic results, the AoP has been shown to be of little value in predicting the delivery mode in patients undergoing induction of labour. At present, there is no sufficient evidence to show that incorporating measurements of this parameter into routine assessment determining the ending of pregnancy would help to identify patients in whom labour induction proves ineffective^(30,33).

Also, there have been interesting attempts to use the TPU parameters in the evaluation of indications for the hospitalisation of patients presenting with contractile activity. One study, performed on a small group of patients (57), showed that in the vast majority of cases (96.5%), a decision to admit pregnant women at term to hospital due to labour was possible based solely on the TPU findings which were consistent with the results of manual gynaecological examination. The authors ventured the conclusion that TPU performed before admitting a patient makes it possible to avoid up to 90% of transvaginal digital examinations⁽³⁴⁾. The method could be particularly useful in cases of false labour, when the patient frequently undergoes a number of unnecessary transvaginal digital examinations.

Intrapartum ultrasound and the comfort of women in labour

Other benefits of intrapartum sonography are also increasingly brought into focus. For example, TPU performed during maternal pushing has a positive impact on the effectiveness of contractions, and can be used as a visual biofeedback contributing to a shorter duration of labour⁽³³⁾. Another important aspect that needs to be taken into account relates to the discomfort and pain experienced by patients who are made to undergo a series of transvaginal digital examinations in labour. In a study where the progress of labour was assessed both traditionally (*per vaginam*) and by means of intrapartum sonography, a survey of patients' opinions and experiences revealed that 87% of them would prefer to be examined solely by transperineal ultrasound during their next birth⁽³⁵⁾. Obstetricians have an equally favourable opinion of the method. A survey of physicians participating in a course on the applications of intrapartum ultrasound showed that after completing the course more than twice as many participants as before the training were convinced of the usefulness of the method for evaluating foetal head station in the birth canal. In addition, the number of participants claiming that TPU is a complex examination decreased significantly⁽³⁶⁾.

Conclusions

The arguments in favour of incorporating intrapartum ultrasound into regular obstetric practice are manifold. Initial studies have shown that intrapartum sonography is a more accurate method for the assessment of

foetal head position than routine transvaginal digital examination.

Expanding the scope of gynaecological examination to include TPU findings may aid in the selection of mode of delivery, support the clinician in making safe decisions, and provide guidance on the need to perform operative delivery in the presence of the most experienced obstetrician, with the operating room ready for use in case of an emergency.

A number of arguments speak for integrating intrapartum ultrasound into routine clinical practice. Firstly, the examination is easy to perform⁽³⁶⁾, and yields repeatable results⁽³⁷⁾. It does not require advanced medical equipment and, as long as a portable ultrasound system is available, intrapartum sonography is an easily accessible, rapid bedside examination producing results in less than a few minutes. The time necessary for learning the method and achieving precision in its application is considerably shorter than in the case of gynaecological examination⁽³⁸⁾, and the reliability of results does not depend on the level of experience in performing ultrasound examinations⁽¹⁷⁾. Intrapartum sonography is a painless examination^(39,40) and, in the opinion of patients, it is a highly acceptable form of monitoring the progress of labour, which enhances pregnant women's trust towards medical professionals⁽⁴¹⁾. Secondly, intrapartum ultrasound is useful from the viewpoint of medical and legal issues involved in obstetric interventions. Supplementing medical records with objective intrapartum ultrasound findings in the form of scan may help prove the validity of actions taken during labour⁽⁴²⁾. It is hoped, though there is no evidence yet, that the use of intrapartum ultrasound will reduce the frequency of performing transvaginal digital examinations⁽³⁴⁾, and hence contribute to lowering the risk of intrauterine infections.

However, there are still many obstacles hindering the incorporation of results obtained by intrapartum ultrasound into routine labour management algorithms. Even though numerous studies have shown the method to be very precise, it is still not clear which of the parameters has the greatest clinical significance, or whether a more accurate approach would be to use the results obtained for several parameters – and if so, which ones. Furthermore, there are no recommendations as to when precisely intrapartum ultrasound should be performed during labour to yield the greatest diagnostic benefit. Attempts are also ongoing to identify the values of cut-off points for different parameters to assist obstetricians in making reliable clinical decisions. Answering these questions would require extensive randomized studies conducted in large groups of women in labour, which, given the complex nature of childbirth, might be difficult to achieve. Nevertheless, when learning this new method, it is worthwhile to look for correlations, comparing the results of own manual gynaecological examinations with TPU findings. Validation of the use of ultrasound techniques during labour, which was presented in

the ISUOG Practice Guidelines⁽¹³⁾, creates a solid basis for collecting own observations and experiences related to the use of the method. In the future, such data may lead to the development of universally valid recommendations improving the quality of care provided to women in labour.

Conflict of interest

Authors do not report any financial or personal connections with other persons or organizations, which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

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