

Intrapartum sonography of fetal head in second stage of labor with neuraxial analgesia: a literature review and possible medicolegal aftermath

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Abstract. – **OBJECTIVE:** Intrapartum ultrasound (IU) is a valid support to obstetric management of fetal head progression in the second stage of labor in nulliparous with neuraxial labor analgesia (NLA). Nulliparous with NLA may have a prolonged the second stage of labor. The aim of this literature review was to evaluate the mode of delivery, as well as maternal and fetal morbidities associated with missed progression of fetal head detected with IU in the second stage of labor in nulliparous women with NLA.

MATERIALS AND METHODS: The literature review was performed using PubMed, Cochrane, Medline, EMBASE, Scopus, Google Scholar and book chapters searches to identify relevant articles from 2001 to 2019, evaluating the mode of delivery and morbidities of the second stage of labor. Search terms used were "Intrapartum ultrasound", "dystocia", "prolonged labor", "neuraxial analgesia", "persistent occiput posterior position", "asynclitism", "second stage of labor", "medico-legal aftermath". Prolonged second stage was defined as three hours and more. Retrospective case series of women with prolonged second stage of labor with NLA were identified. The primary outcome was the incidence of operative vaginal delivery (OVD) and cesarean delivery (CS).

RESULTS: The use of NLA may determine a prolonged second stage of labor (PSSL). IU when compared to the traditional vaginal digital examination (VDE) demonstrated the highest degree of diagnostic accuracy.

CONCLUSIONS: The use of IU during NLA can aid in the diagnosis of fetal head progression, station or malposition and malrotation, alerts obstetrician on the possibility of dystocic labor, in-

dicating to stop the drug administration in NLA and shift to OVD or CS. Extending the second stage of labor beyond current American College of Obstetricians and Gynecologists (ACOG) recommendations is beneficial. The ISUOG guidelines recommended the clinical application of IU to diagnose the persistent occiput posterior position (POPP) and asynclitism (A) in dystocic labor and produce photographic evidence of the case. Maternal and neonatal complications, medicolegal consequences and litigation can decrease if the IU device is used as good practice.

Key Words:

Intrapartum ultrasound, Dystocia, Prolonged labor, Neuraxial analgesia, Persistent occiput posterior position, Asynclitism, Second stage of labor, Medico-legal aftermath.

Abbreviations

IU: Intrapartum Ultrasound, NLA: Neuraxial Labor Analgesia, OPP: Occiput Posterior Position, OAP: Occiput Anterior Position, OTP: Occiput Transverse Position, OVD: Operative Vaginal Delivery, CS: Cesarean Section, POPP: Persistent Occiput Posterior Position, PSSL: prolonged second stage of labor, CSE: Combined Spinal Epidural Analgesia, LDLA: Low Doses Labor Analgesia, VDE: Vaginal Digital Examination, SD: Spontaneous Delivery.

Introduction

Labor pain is a complex phenomenon influenced by multiple physiological and psychosocial factors,

and its intensity can vary greatly¹. NLA is a central nerve block technique widely used in labor for obtaining pain relief²⁻⁶. Analysis of trials conducted after 2005, showed that NLA had no impact on the risk of OVD or CS, because in modern NLA, low doses of local anesthetics and opioids are used^{7,8}. Nulliparous with NLA may have a prolonged second stage and labor management can be difficult^{9,10}. The second stage of labor is defined as the time period between complete cervical dilatation and delivery of the fetus. Prolonged second stage for nulliparous with LA is defined as more than three hours by ACOG¹¹. A recent study suggested that obstetrician should extend the time limit to permit the vaginal delivery by one hour over ACOG recommendation limit¹². In recent reviews^{13,14}, authors specifically chose to examine the cohort of nulliparous with NLA, because this technique is known to be a risk factor for prolonged second stage and increase of neonatal and maternal morbidities. IU is a valid support to obstetric VDE because it allows obtaining objective and reproducible data about station, progression and position of fetal head and can help to make the best clinical decision in case of dystocic labor¹⁵. During the prolonged labor, obstetrician should identify the cause of missed progression of the fetal head and the level of the fetal presenting part. This evaluation is of utmost importance in order to decide whether it is possible to have spontaneous birth (SD) or it is necessary to carry out an OVD or CS. Our main goal was to evaluate, by review of the literature, incidence of OVD and CS in nulliparous women with LA in PSSL. Secondly, we have aimed to prove that the use of an IU device is a valid support to obstetric VDE in order to evaluate the PSSL.

Materials and Methods

We searched the online scientific literature databases including Cochrane, PubMed, Medline, Embase, and Google for the key words 'second stage', 'intrapartum ultrasound', 'dystocia', 'labor analgesia', 'low doses labor analgesia', 'prolonged labor', for the pertinent studies published between 2005 and 2018. Prolonged second stage of nulliparous with LA is defined by ACOG as lasting more than three hours from full dilatation¹¹. In this literature review, we specifically chose to examine the cohort of nulliparous with NLA because this technique is found, in some studies, to be a risk factor for prolonged second stage that

increase OVD and CS, as well as neonatal and maternal morbidities^{13,14}. The IU device is a valid support to obstetric VDE, because it allows to obtain objective and reproducible data about station, progression and position of fetal head and can help to make the best clinical decision in case of dystocic labor¹⁵. In case of prolonged labor that may happen during NLA, obstetricians should identify the cause of the failed progression of the fetal head and the level of the fetal presenting part. This evaluation is paramount to decide if it is possible to have SD or is necessary to carry out an OVD or CS. Case series and retrospective cohort studies including women with singleton gestation, vertex presentation and detailed data of timing of second stage of labor in NLA, evaluated with IU were reviewed. There are relatively few published randomized trials on PSSL^{12,15}. Exclusion criteria were: case control studies, not relevant outcomes, papers that did not differentiate between nulliparous and multiparous women, papers that did not stratify results by epidural status, papers using a different definition of prolonged second stage. Case control studies were excluded because they did not reflect the true incidence of finding cohort. Authors (BR, MA, KKM, ZS, ME) screened all abstracts and manuscripts independently. Retrospective studies and case series with PSSL in women with and without NLA and its consequences controlled with IU were identified. We included manuscripts with > 50 cases of PSSL to reduce publication bias. In each article reporting cases of PSSL, the details of analgesia, labor and use of IU tool were recorded. The methods section of each article was evaluated for gravity, parity, epidural status, postpartum hemorrhage, third or fourth grade of laceration, neonatal and maternal outcome.

Results and Discussion

Labor pain is the most severe pain that women can experience during their lives, and the possibility to obtain pain relief should be part of obstetric good practice¹⁶. NLA has to be considered as a gold standard in obtaining pain relief. Some studies^{13,14} have found that NLA can be a risk factor for PSSL and increase neonatal and maternal morbidities. Gimovsky et al⁹ showed that out of 5350 nulliparous women, 76,3% had NLA, whereas 11,5% of that same group experienced a prolonged second stage of labor. Incidence of CS in women with NLA was 19,8%

and 80,2% had a vaginal delivery. Pizzicaroli et al¹⁵ demonstrated that NLA influences the duration of the second stage of labor and the initial progression and rotation of the fetal head through the birth canal, but not the kind of delivery. Patients that underwent NLA presented with increased duration of the second stage of labor, with mean values of Angle of Progression (AoP) significantly higher and Midline Angle (MLA) significantly lower for each interval studied – compared to patients without analgesia. AoP, Head Symphysis Distance (HSD), and MLA are translabial parameters for evaluating the progress of labor and can help clinicians to make the best clinical decisions in case of dystocic labor. It has been found that NLA had a significant effect on the increase of AoP values ($p = 0.024$). NLA did not increase the number of OVD, CS, or POPP of fetal head, but it caused a significative PSSL. With regards to the relationship between LNA and transperineal ultrasonographic parameters, they found that analgesia correlated with significantly higher mean values of AoP and significantly lower values of MLA. Extending the length of labor in nulliparous women with singleton gestations and NLA in second stage decreased the incidence of CS by slightly more than one-half, compared with ACOG guidelines. In a very interesting randomized controlled trial, Gimovsky et al¹² affirm that extending the time of second stage of labor for one more hour beyond current ACOG guidelines recommendations in women with LNA, decreased incidence of CS from 43,2% to 19,5%. This practice can be obtained only in uncomplicated labor and using IU for better clinical valuation.

Recent clinical trials^{17,18} have found that using low doses of local anesthetics (LDLA) in NLA is not associated with prolonged second stage of labor and operative delivery. More recently, it has been demonstrated that¹⁶⁻²¹ a regimen of LDLA will preserve maternal mobility (mobile epidural), reduce vaginal operative deliveries and does not cause dystocia. In addition, the synergy between opioid and local anesthetic medications allows for dose-reduction of both drugs, minimizing hemodynamic effects and placental drug transfer²²⁻²⁷. The Task Force of the American Society of Anesthesiologists (ASA) also recommended using dilute concentrations of local anesthetics with opioids to produce as little motor block as possible²⁴. The administration of NLA should be evaluated by both gynecologists and anesthesiologists in order to figure out

optimal personalized doses and obtain the best clinical outcome with patient satisfaction²⁰. Carseldine et al²¹ assessed in a double-blinded prospective cohort study the impact of OPP in the second stage of labor on operative delivery. The primary outcome was OVD or CS. A total of 68% women in the OPP group vs. 27% in the OAP group had OVD. CS was performed in 37% in OPP vs. 5% in OAP group ($p < 0.001$). The OPP had a longer second stage (mean 2 h 59 minutes vs. 1 h 54 minutes; $p = 0.001$). They confirmed, through logistic regression, that OPP, nulliparity, abnormal second stage, cardiotocography and NLA, were independent predictors for operative delivery. The IU device is a valid support to obstetric semeiotics, because it enables specialists to obtain objective and reproducible data about station, progression and position of fetal head, and can help to make the best clinical decision in case of prolonged second stage of labor¹⁵. Various trials^{12-15,28} about the use of IU during labor and delivery were performed in NLA. Many studies²⁸⁻³¹ demonstrated IU's higher degree of accuracy in order to diagnose the fetal head position, station, and internal rotation in the maternal pelvis during labor, in comparison to VDE. Similarly, different trials report the superior diagnostic value of IU in the malpositions³¹ and malrotations³², during the dystocic labor and delivery, especially in OPP³³ and asynclitism³⁴. The frequency of OPP in labor is approximately 20% and, of this, 5% remain posterior until the end of labor. These posterior presentations are associated with higher rates of CS and OVD³⁵. Manual rotation of a posterior position in order to rotate the fetus to an anterior position has been proposed in order to reduce the rate of OVD^{35,36}.

Simkin³³ has described nine prevailing concepts that guide labor and birth management with an OPP. In their study they have found that 30% were OPP at the onset of labor and 8% remained OPP at birth. Conversely, approximately 30 to 40% of all babies born in an OPP were occiput anterior position (OAP) at the onset of labor. They have also reported that fetal position changes are common during labor. Out of the fetuses that were OPP, 80% turned to OAP or occiput transverse position (OTP) and 5.4% turned to OPP on delivery. When the authors compared fetal position at delivery in nulliparous labors with and without NLA, 12.9% of fetuses were OPP in women with NLA vs. 3.3% in those without ($p = 0.02$). These authors confirm that ultrasound is generally considered to be the gold standard in

determining fetal position. This finding signifies that fetuses whose mothers do not receive an NLA are more likely to rotate spontaneously to OAP. They find also that position and movements in labor facilitate rotation of the OPP. If OPP can be identified and corrected manually, it might spare the mother and baby from OVD or CS.

Maroni et al³⁷ affirmed that NLA did not affect the second labor stage dynamics. They divided the patients into two groups depending upon epidural administration and they performed NLA after the onset of active labor. The reported loading dose they used was 20 ml of 0.1% levobupivacaine or ropivacaine with 0.30 mcg sufentanil and analgesia was maintained until delivery with top up bolus (10 mL low-dose) of the same drugs administered on demand by the anesthetist.

In case of fetal and maternal complications, the diagnosis with IU under NLA is a key factor when it comes to allege liability of obstetricians and anesthesiologists. Broadly speaking, courts in most countries tend to rule against doctors and health facilities when documented exculpatory evidence is not produced. Dystocia, diagnosed by IU in patients under NLA, represents an important aspect in litigation arising from maternal and fetal neonatal complications and other medico legal issues. Furthermore, the use of IU in patients under NLA and the adherence to guidelines and good practices in labor may play an important role in controversial claims, in that they may prove first the accuracy of diagnosis and obstetrical decision and secondly that complications unrelated to malpractice have occurred³⁸. In fact, the use of IU in labor and the photographic documentation of head dystocia represent a proof of mechanical dystocia rather than NLA dystocia. In particular the photographic IU documentation of fetal head dystocia in the birth canal constitutes an important evidentiary element in medical liability lawsuits, and may provide the proof that dystocia was caused by malpresentation and malrotation³⁹.

A most important question about NLA is dystocia and some studies, which relied on IU, described mechanical and dysfunctional dystocia. In fact, Malvasi et al⁴⁰ concluded that LNA initiated early during labor and using LDLA does not increase the rate of dystocic labors. Occiput transverse position (OTP) with anterior or posterior asynclitism does not seem to be promoted by drugs or technique-related mechanisms, but rather might be the consequence of fetal head-pelvic disproportion and should be

distinguished from “pharmacological dystocia” provoked with overdose of NLA.

Lieberman et al⁴¹ conducted a prospective cohort study on 1562 women to evaluate changes in fetal position during labor by using serial IU, and to determine whether NLA is associated with a higher rate of abnormal fetal head position at delivery. Regardless of fetal head position at enrollment, the most of fetuses were OAP at delivery (enrollment position: OTP 78%, OPP 80%, OAP 83%, $p = .1$). Women receiving NLA did not have more OPP at the enrollment (23.4% NLA vs. 26.0% no NLA, $p = .9$), but did have more OPP at delivery (12.9% NLA vs. 3.3% no NLA, $p = .002$). Lieberman et al⁴¹ concluded that fetal position changes are common during labor, with the final fetal position established close to delivery. They demonstrated that a strong association of NLA with fetal OPP at delivery represents a mechanism that may contribute to lowering the rate of SVD consistently observed with NLA. Fitzpatrick et al⁴² in a prospective observational study comprising 246 women with OPP in labor during a 2-year period, compared that segment with 13543 contemporaneous SD with OAP. They evaluated the influence of intrapartum POPP of the fetal head in women with NLA on delivery outcome and anal sphincter injury. The incidence of POPP was significantly greater among primiparas (2.4%) than multiparas, and was associated with significantly higher incidences of prolonged pregnancy, induction of labor, oxytocin augmentation of labor, NLA use, and prolonged labor. Only 29% of primiparas vs. 55% of multiparas with POPP achieved spontaneous vaginal delivery, and the malposition was associated with 12% of all CS. POPP was also associated with a seven-fold higher incidence of anal sphincter disruption. The authors concluded that POPP contributed disproportionately to OVD and CS. The authors also reported that NLA use was not related to the malposition. Malvasi et al⁴³ also confirmed that LDLA did not increase OPP but reduced the descent of the fetal head in the pelvis slowing down the delivery. NLA was performed by LDLA using combined spinal epidural analgesia (CSE) technics in L3-L4 intervertebral space (L3-L4). In subarachnoid space, a mixture of ropivacaine 0.02% with 0.3 mcg/ml of sufentanil (5 ml) was administered, whereas ropivacaine 0.07% with 0.5 mcg/ml of sufentanil (5 ml) was administered in epidural. Maintenance of analgesia was managed with top up of 10-15 ml of ropivacaine (0.07-0.15%),

mixed with 0.5 mcg/ml of sufentanyl, related to the stage of labor and the degree of pain. The path to performing a good NLA, according to these authors, is to use CSE, LDLA and top up use to avoid dystocia, which was caused only by pelvic disproportion, and not by analgesic drug use. Gizzo et al⁴⁴ pointed out that the significant request rate of analgesia already at first stage of labor in OPP and posterior spine was 61,4% vs. 14,7% ($p < 0.001$), but these authors do not describe the analgesia dosage in NLA. They find that the fetal OPP during labor is associated with some unfavorable events, such as PSSL need for OVD, increased CS rate, and analgesia request rate. Although the OPP fetus usually rotates to OAP, this often occurs after many hours and efforts to address a painful, exhausting, and non-progressing labor. The study's findings show that the performance of NLA could play a beneficial role in promoting vaginal delivery when the fetus is OPP, facilitating the fetal pelvic progression and reducing the likelihood of dystocia. This concept may be based on the assumption that NLA induces pain relief and pelvic muscles relaxation, so it would reduce the resistance, facilitating the fetal engagement to the maternal pelvis. The role of OPP in increasing maternal pain is demonstrated by the high rate of requested analgesia. The above-mentioned article also asserts that reduced mobilization during NLA could have a negative influence on the possible intrapartum fetal head rotation, and rotation is facilitated by maternal mobilization during labor. The increased OPP rate among pregnant women receiving NLA may represent a mechanism by which NLA can be considered a risk factor for OVD and CS. But they confirmed, as did many other studies^{37,40-44}, the beneficial effects of NLA in reducing the intrapartum CS rate and its related complications. Youssef et al⁴⁵ evaluated in a prospective observational study whether the fetal head-symphysis distance (HSD) measured by three-dimensional transperineal IU during the active second stage may be a predictor of the need for operative delivery. Seventy-one nulliparous women at term in active second stage of labor were included in this study. The authors compared HSD between women with spontaneous vaginal delivery and those with operative delivery. Logistic regression was used to identify independent variables associated with OVD. Of the women included, 81.7% had SVD and 18.3% underwent OVD. Women with SVD had shorter HSD than women in the OVD group at T1 ($p < 0.001$), T2 ($p < 0.001$) and T3 ($p = 0.025$).

Receiver operator characteristic curves revealed accuracy values of 81.0%, 87.9% and 77.6% in the prediction of OVD at T1, T2 and T3, respectively. The authors concluded that the IU measurement of HSD in the second stage of labor could be used to predict OVD. Sainz et al⁴⁶ evaluated the inter- and intra-observer correlation of the different intrapartum-transperineal-ultrasound-parameters (ITU), which included (Angle of progression, AoP), progression-distance (PD), head-direction (HD), midline angle (MLA) and head-perineum distance (HPD) with contraction and pushing. Twenty-eight nulliparous women at full dilatation under NLA were evaluated. The authors performed a transperineal IU evaluating AoP and PD in the longitudinal plane, and MLA and HPD in the transverse plane during uterine contraction with pushing. IU has an adequate intra- and inter-observer correlation for its use with contraction and pushing under NLA. This study affirms that IU is reproducible during uterine contraction with pushing in NLA, and this technique is useful to evaluate the difficulty of vaginal delivery and whether it is necessary to practice OVD or CS. Despite, the authors did not describe the management of NLA doses that were administered in all the patients.

Sherer et al⁴⁷ investigated intrapartum assessment of the fetal head engagement by comparing transvaginal digital and transabdominal IU determinations. Two hundred and twenty-two consecutive parturient ($n = 222$) in labor > 37 weeks' gestation with normal singleton cephalic-presenting fetuses and with either ruptured or intact membranes were included in the study. Transvaginal digital examinations were performed by either attending physicians or senior residents and were followed immediately by transverse suprapubic sonographic assessments by a single ultra sonographer. Overall, transvaginal digital examinations were consistent with ultrasound determinations with a raw agreement rate of 85.6%. When stratified according to parity, the raw agreement rate for nulliparous patients was 81.5%, and for multiparous patients it was 90.3%. The NLA significantly increased the rate of concordance in the complete group and among multiparous but not among nulliparous patients. The authors concluded that the results of their study demonstrate a high rate of concordance (85.6%) between IU determination and VDE of fetal head engagement.

As a part of good practice in medicine, Malvasi et al⁴⁸ and Zaami et al⁴⁹ reported and confirmed the

importance of IU device in the diagnosis of fetal and maternal complications, including uterine rupture, in parturient in labor and especially in dystocic labor. Furthermore, the use of IU in patients under NLA and the compliance with guidelines may be instrumental for operator defence in malpractice and liability claims. Scholars^{38,39} affirm that the main advantages of using IU include: improvement of fetal head's malposition diagnosis, prevention of maternal and fetal complications of childbirth due to the use of forceps or vacuum extractor (OVD), a more accurate planning of CS, a proof of professional correctness as a good practice.

Recently, Ghi et al⁵⁰ published the IU guidelines and proposed the level of evidence regarding the use of ultrasound in labor to provide guidance to practitioners on when ultrasound in labor should be used and how the sonographic findings may affect labor management. They do not imply or suggest that ultrasound in labor is a necessary standard of care. Importantly, maternal and neonatal complication and medico legal liability have been found to decrease with the use of IU devices^{51,52}. In these guidelines, there was no assessment as to the level of importance of NLA.

Conclusions

IU represents an important diagnostic tool in labor and delivery, and with this technique, gynecologists can improve the diagnosis of fetal head position in comparison to VDE. The use of IU during neuraxial analgesia can aid in the diagnosis of fetal head malposition and malrotation, alert obstetrician as to the possibility of dystocic labor, indicate the need to discontinue drug administration in NLA and shift to OVD or CS. The reduction of dystocia misdiagnosis by using IU has modified CS and OVD rates. Furthermore, the use of IU devices can improve the detection of fetal head position, progression and internal rotation. On the contrary, the administration of NLA in dystocic prolonged labor, in second stage, without a diagnosis of malpresentation, worsens labor and delivery, increasing the likelihood of dystocia. It is necessary to moderate drug use in correlation with IU diagnosis of dystocic labor and delivery. Some scholars find that extending the second stage of labor in women with LA beyond current ACOG recommendations can decrease the incidence of CS and OVD, as long as this practice occurs only in uncomplicated labor. The ACOG

obstetrics guidelines report that the delivery from complete dilatation must be concluded in two hours without LA or in three hours with LA, but when gynecologist diagnosed the malpresentation of fetal head through IU, especially in case of POPP and A, it is necessary to proceed to the delivery and avoid waiting the standard two or three hours recommended by ACOG guidelines. Another important question, especially during complications, is the role of NLA and the incidence of obstetric factors. Therefore, if the prolongation of the second stage of labor takes place beyond the currently accepted windows in order to achieve a vaginal delivery resulting in serious neonatal complications, it cannot be viewed as a good practice. Use of IU tool in this case can help to make solid clinical decisions and be a part of good medical practice, avoiding related medico-legal liability claims. The use of NLA may bring about a prolonged second stage of labor. According to the period of labor during which analgesia has to be performed, different combinations of drugs can be used. There is no consensus in the literature as to the effects of analgesia on the progress of labor. Some authors suggest that NLA results in an increase in the duration of the second stage of labor and in the incidence of OVD or CS, as well as in POPP at birth. However, the cited recent trials of Shen et al¹⁷ and Wang et al¹⁸ did not confirm these findings, especially the modern NLA use LDLA and 'personalized analgesia', without causing the motor block and allowing mobility to the parturient. However, only some studies with IU report connection with NLA; therefore, further trials are needed in order to determine the role of NLA in dystocic delivery and in the routine clinical use of IU during labor. Given the lack of thorough studies providing detailed clinical data and the widespread use of NLA, a determination of the optimal length of the second stage is needed.

Conflict of Interests

The Authors declare that they have no conflict of interests.

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