Painless childbirth? Epidural and spinal techniques in obstetric anesthesia

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Chapter 11

Summary and perspectives

In pregnant patients, when surgical interventions are needed or labour analgesia is requested, neuraxial techniques are preferred over inhalation and intravenous anesthesia whenever possible. Depending on the dose administered, epidural and spinal local anesthetics block sensory nerve transmission to provide analgesia or even complete anesthesia to the lower body. During surgical interventions, neuraxial anesthesia will avoid the need for general anesthesia and prevent the potential occurrence of airway problems which happen more often during pregnancy. As the LA doses needed to act at the neuraxial target are small and do not lead to clinically relevant plasma concentrations, they minimize fetal drug exposure. Opioids added to the LA solution facilitate reduction of LA doses and further improve analgesia. When long-acting opioids are incorporated in the spinal anesthetic mixture for cesarean delivery, postoperative pain relief is also optimized, which potentially contributes to the prevention of chronic postsurgical pain. And last but not at all least, as these techniques do not interfere with maternal awareness or consciousness, they allow the woman to participate and experience the birth of her child during cesarean delivery.

Potential disadvantages of neuraxial techniques

Motor block

Neuraxial techniques come with their own set of drawbacks, as not only sensory, but motor and sympathetic nerve fibers are affected. While motor block is beneficial during surgical procedures under spinal anesthesia, it could impair maternal pushing efforts during the second stage of vaginal delivery when epidural analgesia is used. Indeed, in the past, higher concentrated LA solutions correlated with increased instrumental delivery rates, which was attributed to maternal motor weakness. Whether direct interference with uterine contractility also contributed to this correlation, remains unknown as it is difficult to investigate using non-invasive uterine monitoring techniques. With the currently used low-concentrated epidural LA solutions there appears to be no longer an increased incidence of instrumental deliveries, but a slight prolongation of first and/or second stage of labour is still observed, and an increased association with oxytocin augmentation persists.

Postspinal hypotension

Neuraxial administered LA spreads cephalad, depending on technique and LA dose, which disrupts sympathetic neural transmission to a greater or lesser extent. The resulting maternal vasodilation and ensuing hypotension may cause nausea, dizziness, fetal acidosis and bradycardia, and in severe cases even lead to maternal cardiovascular collapse. During initiation of spinal anesthesia, patient-specific titration of the LA dose can mitigate this so-called postspinal hypotension, which affects up to 90% of women in absence of prophylactic measures such as fluid co-loading and vasopressor infusion.

Postdural puncture headache

One of the main original objections to spinal anesthesia was the severe postural headache which initially developed postoperatively in up to 40% of patients, which often lasted several

days and complicated recovery. Resulting from puncture of the spinal dura/arachnoid membrane with a sharp cutting spinal needle and the ensuing leakage of cerebrospinal fluid (CSF) into the epidural space, improved needle design has decreased the severity and reduced the incidence of PDPH after spinal anesthesia to around 1%. In obstetric anesthesia though, it remains a significant challenge, especially when epidural analgesia techniques are used, and the epidural needle is inadvertently advanced too far and accidentally penetrates the dura/arachnoid membrane.

Summary of studies in this thesis

This thesis includes various studies which address a few of the many questions related to spinal and epidural techniques in obstetrics. They investigate the benefits, challenges, or consequences of neuraxial anesthesia and analgesia , in order to contribute to improved anesthetic contribution in maternal clinical care.

In chapter 2 of this thesis, a novel monitoring technique to determine uterine activity, electrohysterography (EHG), is used to study the influence of epidural analgesia initiation on uterine contraction frequency during active labor. The new technique performs reliably, identifying a statistically significant but clinically irrelevant small decrease in contraction frequency. It demonstrates the potential value of electrohysterography monitoring in clinical obstetric practice and research and its applicability in investigating the effects of neuraxial analgesia techniques and other intrapartum interventions.

Chapters 3 and 4 study the incidence of chronic postsurgical pain (CPSP) after cesarean delivery, with or without the addition of intrathecal morphine to the spinal anesthetic mixture (chapter 3), and its potential association with postpartum depression (chapter 4). It is concluded that the addition of morphine does not prevent CPSP, but the pain is significantly associated with postpartum depression.

In chapter 5 a significant association is found between preoperative depression scores and the occurrence of postspinal hypotension during elective cesarean delivery. This raises the hypothesis that the mental status of the woman going into surgery may influence the severity of side effects of neuraxial procedures.

Chapter 6 describes a study to optimize the amount of LA in relation to height and weight for spinal anesthesia in short stature parturient undergoing a cesarean delivery. It turns out that in this specific population of short stature Nepalese parturients, only height was of importance in this respect.

Chapters 7-10 are centered around the EPiMAP[1] study, a prospective cohort study examining management practices and outcomes of Post-Dural Puncture Headache (PDPH) occurring after accidental dural/arachnoid puncture in obstetrics (chapter 8). EPiMAP also investigated factors associated with failure of the often-applied epidural blood patch to resolve PDPH symptoms, a previously unknown association with the level of the original dural/arachnoid breach surfaced (chapter 9). Chapter 7 provides a comprehensive review of post-dural puncture headache (PDPH) characteristics and evidence-based prevention and treatment approaches. Chapter 10 elaborates beyond current evidence, as the presumed underlying mechanisms of PDPH have never been clarified and are based on longstanding beliefs of CSF homeostasis which are currently being challenged by new insights.

Future perspectives

These studies contribute in various ways to our understanding of several aspects of neuraxial analgesia and anesthesia in obstetrics. They address diverse problems: from the use of EHG to identify changes in uterine activity during epidural labour analgesia, to factors influencing the development of chronic postsurgical pain, from reflecting on predictors of spinal anesthesia-induced hypotension, to a comprehensive exploration of PDPH mechanisms and therapies. While the findings contribute to current clinical knowledge, they also highlight important gaps and raise new questions relevant for obstetric anesthesia. Future studies must not only address these questions by building upon these specific findings, but also include recent evidence from other fields of medicine and especially from fundamental basic science.

Obstetric anesthesia is, like other fields of anesthesia and medicine, an ever-evolving art, with science and research continuously providing new insights to optimal anesthesia provision. This thesis shows this evolution through using novel clinical tools such as EHG and potential identification of a previously never observed association between mental status and postspinal hypotension. Yet, clinical anesthesia research unfortunately often fails to question the underlying established fundamental physiological assumptions. Instead, it builds upon age-old traditional theories, as illustrated by our critical examination of PDPH mechanisms which challenges conventional beliefs about CSF homeostasis. It takes years for new findings from adjacent medical fields to permeate anesthesia literature and textbooks, even when they challenge, contradict, and refute these established principles. Our findings on the relationship between postpartum depression and chronic postsurgical pain highlight the importance of multi-disciplinary perspectives. The scientific road ahead requires not only solid evidence but also a relentless cross-disciplinary curiosity that views limitations in contemporary research as invitations to explore unconventional hypotheses. Without this approach, we cannot explain phenomena like why the spinal level of an accidental dural puncture affects epidural blood patch success: a relationship for which current knowledge offers no explanation. Curiosity, together with critical appraisal of current and new understandings of underlying

1 European Practices in the Management of Accidental Dural Puncture

(patho)physiology, of newly developed diagnostic and therapeutic tools, and of contribution of artificial intelligence (AI), will lead to new hypotheses, research questions and eventually new insights in optimal safe clinical care while minimizing potential unintended consequences of our anaesthetic interventions.

Future perspectives in the Netherlands

Dutch obstetric anesthesia stands at a unique crossroads, shaped by our distinctive approach to childbirth compared to other countries. The emphasis on natural birth with minimal interventions, while valuable in many respects, faced scrutiny when 2008 data revealed elevated perinatal mortality rates relative to comparable health care systems. In response, the College Perinatale Zorg (CPZ) was established and the Integrale Zorgstandaard Geboortezorg was developed and implemented to enhance interprofessional collaboration. However, these initiatives insufficiently acknowledged contribution of anesthesiology in ensuring maternal safety, despite anesthesiologists' involvement in approximately 40 % of all deliveries. Subsequent advancements in obstetric anesthesia were mainly driven by efforts of a small but dedicated group of anesthesiologists who identified critical needs for improvement in training, simulation and collaboration, with active daily contribution on the labour ward only realised in the Sophia's Children Hospital of the Erasmus MC. The Dutch Society of Anesthesiology initially demonstrated limited recognition of the importance of enhanced collaboration but is now progressively assuming its responsibility in supporting and expanding these initiatives.

The optimization of obstetric anesthesia necessitates increased integration within clinical obstetric care, proactive participation in multidisciplinary consultations, intensified residency training and representation in key organisations such as the CPZ. Comprehensive evaluation of the quality of currently provided anesthesia services and identification of structural barriers are essential for determining areas in need of improvement. It is not a matter of more, but better provision of anesthesia care!

While these strategic efforts have yet to be initiated, a slow but gradual progress can be observed. Anesthesiologists increasingly contribute to the development of multidisciplinary obstetric guidelines, the first research program measuring quality and outcome measures in caesarean delivery has been established, educational opportunities in obstetric anesthesia are expanding, and anesthesiologists are assuming responsibility for patient education regarding anesthesia procedures and analgetic options.

These developments demonstrate a growing professional commitment to advancing the field of obstetric anesthesia. Main participants and stakeholders in obstetric care should join to address system deficiencies that compromise maternal clinical care. Resolution of financial constraints that impede consistent anesthesiology presence on labour wards, elimination of reimbursement structures that disincentivize appropriate anesthesia staffing,

and implementation of sustainable financial frameworks that acknowledge the critical role of anaesthesiologists in ensuring safe outcomes for both mothers and babies are imperative.

Only by true integration of anesthesiology expertise within the multidisciplinary obstetric care team the needed quality improvements in obstetric anesthesia can be achieved. It not only demands continuing dedication from specialized anesthesiology groups and increased support from professional societies, but also structural, financial and organisational reforms that will enable optimal participation in Integrated birth care.

In conclusion, the research presented in this thesis offers small building blocks toward optimizing obstetric anesthesia care. While continuous methodologically sound research is essential to expand our knowledge, systemic improvements are equally necessary to truly enhance the quality of anesthesia services in Dutch obstetric care. By advancing simultaneously scientific understanding and healthcare delivery we can work toward providing safer and more effective obstetric anesthesia for all women, also in the Netherlands.