Comparison of rate of instrumental delivery with and without epidural analgesia

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# ABSTRACT

**Introduction**

Epidural analgesia is commonly employed for managing labor pain, but its influence on assisted deliveries and subsequent outcomes for mothers and infants remains debatable.

**Objectives**

Primary: To compare the rate of instrumental delivery with and without epidural analgesia in pregnant women in the labor room for vaginal delivery in a tertiary care hospital.

Secondary: To determine the effect of epidural analgesia on duration of labor, obstetric anal sphincter injury, neonatal outcomes (birth weight, APGAR scores, birth injury, NICU admission, shoulder dystocia),

**Materials and methods**

The present study after gaining approval from the institutional review board, enrolled all booked and unbooked, primigravidas and multigravidas, with a singleton pregnancy, aged 15-45 years, in the labor room for a vaginal delivery (with or without epidural analgesia) on a non-probability consecutive basis. All patients provided informed voluntary informed consent after they were informed about the pros and cons of participating in the study. The data was noted in a predesigned proforma.

**Results**

A total of 120 patients were enrolled in the study as per the inclusion criteria, of which 67 (55.8%) were given epidural analgesia. Induction of labor was done in 95% of the participants. Prolonged labor was reported in 27 mothers. Instrumental delivery was done in 30% of the mothers. Third degree OASI was reported in 5% of the mothers. One neonate had birth injury with sublegal haematoma, two had shoulder dystocia, and three were admitted to NICU. The epidural analgesia had significant odds to result in instrumental delivery, and prolonged second stage of labor.

**Conclusion**

The following study seeks to examine the complex relationship between epidural analgesia, assisted vaginal birth and its outcome on mothers and neonates. That epidural analgesia might contribute to higher levels of assisted deliveries stated that, yet there is a need to investigate the impact of epidural analgesia on certain maternal and neonate outcomes.

**Keywords**

Epidural analgesia, instrumental delivery, forceps delivery, vacuum delivery, obstetric anal and sphincter injury, APGAR scores, shoulder dystocia, NICU admission

# INTRODUCTION

The administration of epidural analgesia for pain relief during labor has been widespread, while its safety of epidural analgesia in relation to instrumental delivery rates and perinatal and maternal consequences remains a subject of debate. The studies identified found that epidural analgesia was associated with an increased risk of operative interventions, including surgical vacuum or forceps.(1) This could be attributed to the prolonged second stage of labor often observed in women who are given epidurals.(2) This second stage therefore tends to be longer because sensation and muscle strength in the lower part of the body may be affected hence inability to push during contractions. Besides, further, epidural can affect fetal positioning owing to the relaxation of the pelvic floor muscles which may result to complicated deliveries.(3)

As to maternal factors, women in epidurals are commonly associated with longer lengths of stay in hospitals than those who are not given epidurals.(4) This long stay could be due to a number of reasons which include: Most of these patients may require potential side effects such as hypotension, fever, or urinary retention to be closely monitored, and such complications have been found to affect women with epidurals most.(5) Furthermore, caesarean section births of instrumental type as a result of epidural usage may also be taken to be instrumental in increased recovery times and in turn longer hospital stays.

The effects on neonatal results are quite mixed. Several reports reveal no difference in the birth weight, the 1- and 5-minutes APGAR (Appearance, Pulse, Grimace, Activity and Respiration) scores and dystocia rates between epidural and no epidural groups.(6) Some studies show slightly higher NICU admission rates amongst the infants of women who had epidural.(7) In addition, they also established that the time spent in the Neonatal Intensive Care Unit (NICU) does not seem to be influenced by the use of epidural.(8)

1. **LITERATURE REVIEW**

## Instrumental delivery following epidural analgesia

Epidural analgesia is one of the most frequently used approaches in managing the pain at childbirth to help many women. But regarding the rates of instrumental deliveries, it elicited a lot of discussion and research in the given field of obstetrics. Forceps and vacuum extractions are sometime used to facilitate delivery because of complications that may arise during the process or pregnancy. Since epidural may be used during childbirth and is believed to be associated with the need for instrumental deliveries, the subject has garnered research attention, and investigations have been conducted in various aspects of the issue.

It is important that the cares of healthcare clinics in managing labor with epidural analgesia conducted by professionals in healthcare clinics who may be obstetricians, anesthesiologists especially. Guidelines and protocols for instrumental delivery following epidural analgesia

## Instrumental delivery rates after epidural analgesia: Are there regional variations?

During instrumental delivery after epidural analgesia, doing exactly what is stated in established protocols and guidelines is essential. If pregnancy has continued into the 42nd week, or if there has been a prolonged second stage of labor or fetal distress, forceps or vacuum extraction can be used (ACOG, 2019).(22) These methods are used when natural efforts to give birth are ineffective or when delivery needs to be swift for the good of the mother or fetus. Instrumental delivery is an option that must be discussed with complete consideration of both fetal and maternal factors, as well as the benefits and risks to the fetus associated with the procedure.

## Epidural analgesia and its impact on second stage of labor

Extensive study and debate has occurred in the field of obstetrics regarding the effect of epidural analgesia on the duration of the second stage of labor. Many studies have demonstrated that epidural analgesia prolongs the second stage of labor.

In an attempt to prevent probable negative effects on labor progression, contemporary low-dose epidural techniques have been developed and utilized. Compared to high-dose conventional approaches, these methods have been less impactful to labor duration. Epidural analgesia and event of obstetric anal and sphincter injury (OASI)

## Epidural analgesia and its effect on the post-partum haemaorrhage (PPH)

In these circumstances heightened risk of blood loss demands extra monitoring and action plans. In case of hemorrhage, medical professionals should be prepared for early interventions, such as active management of the third stage of labor involving controlled cord traction, uterine massage and preventive use of uterotonic.(58) Prevention of these actions can reduce occurrence and intensity of PPH in women with instrumental delivery after epidural analgesia.

Healthcare professionals should carefully assess the need for intervention, use the least traumatic methods available and be able to recognize and deal with potential complications in order to lessen such risks of instrumental delivery and epidural analgesia.

## Epidural analgesia and its effect on the maternal hospital stay

The debate and investigation of the effects of epidural analgesia on the length of maternal hospitalization is still ongoing. Several studies on this issue have produced quite different and even contradictory results, which is how complicated this issue is, and more research is required.

## Epidural analgesia and its impact on shoulder dystocia

Epidural analgesia studies suggest an increased chance the labor will be extended, and operative deliveries if given.(61) This connection has led to worry that the use of epidurals may have negative effects on the natural labor process. In a thorough meta-analysis, Johnson and colleagues (62) reported that women who received epidural analgesia had a significantly greater increase in second-stage duration than women who did not. It is an important finding that has clear implications for both mother and baby health, as longer labor increases the risk of complications and interventions.

## Epidural analgesia and its effect on the APGAR scores

The epidural analgesia versus neonatal outcome continues to be debated in obstetrics and neonatology, since the relationship of epidural analgesia and neonatal outcomes, especially APGAR scores, has yet to be determined. The APGAR scoring system was introduced by Dr. Virginia Apgar in 1952 to provide a standardized approach to determine the immediate health of a newborn during the first 1 and 5 minutes after birth. This assessment examines five crucial factors: Color of skin, heart rate, reflex irritability, muscle tone, and respiration. Each of the components is scored from 0 to 2, the maximum total is 10, and thus optimal health.

## Epidural analgesia and its impact on the neonatal birthweight

The primary use of epidural analgesia is to decrease pain and improve the childbirth experience for a mother. However researchers have also tested it in protocols to see if they can influence different neonatal outcomes, such as birth weight.

## Epidural analgesia and its effect on NICU admission and length of stay

The impact of epidural analgesia on newborn outcomes, specifically concerning admissions to the neonatal intensive care unit (NICU) and subsequent length of stay, continues to be a subject of debate and research in the medical community.

**MATERIALS AND METHODS**

## Objectives

The primary objective was to investigate the incidence of assisted vaginal delivery with and without epidural analgesia among women undergoing vaginal birth at a tertiary healthcare institution's labor and delivery department.

The secondary aim was to evaluate the impact of epidural analgesia on

* Neonatal outcome
* Duration of labor
* Obstetric anal sphincter injury
* Shoulder dystocia

## Operational Definitions

### Instrumental delivery

Assisted vaginal birth, which may employ vacuum extraction or forceps techniques.

### Obstetric anal sphincter injury (OASI)

Perineal lacerations are classified into four degrees:

* First-degree: Involves damage to the perineal skin and/or vaginal mucosa.
* Second-degree: Extends to the perineal muscles but does not affect the anal sphincter.
* Third-degree: Encompasses the anal sphincter complex and is further subdivided:
* Grade 3a: Affects less than half of the external anal sphincter (EAS) thickness.
* Grade 3b: Impacts more than half of the EAS thickness.
* Grade 3c: Includes damage to both the EAS and internal anal sphincter (IAS).
* Fourth-degree tear: Comprises injury to the anal sphincter complex (EAS and IAS) and the anorectal mucosa.

**Shoulder dystocia**

Vaginal cephalic delivery necessitating additional obstetric interventions to facilitate fetal extraction subsequent to head delivery and the failure of gentle traction. An objective diagnostic criterion of a prolonged head-to-body delivery interval exceeding 60 seconds has also been proposed.

**Stages of labor**

* The first stage of labor commences with regular uterine contractions and concludes with complete cervical dilatation at 10 cm.
* The second stage of labor encompasses the period from complete dilation of the cervix until delivery of the fetus.
* Prolonged second stage of labor is defined as a duration exceeding:
* 2 hours in primigravidas without epidural
* 3 hours in primigravidas with epidural
* 1 hour in multigravidas without epidural
* 2 hours in multigravidas with epidural

**Neonatal outcome included:**

* Newborn mass recorded in kg
* Evaluation of APGAR indicators at 1 and 5 minutes after birth (Appearance, Pulse, Grimace, Activity, Respiration)
* Incidence of birth trauma during delivery
* Shoulder dystocia
* Requirement for NICU care and length of hospitalization measured in days

### Gestational Diabetes

Pregnancy-related impaired glucose tolerance, identified through a 75 g oral glucose tolerance test (OGTT), is characterized by blood sugar levels reaching 92 mg/dl when fasting, 180 mg/dl after one hour, and 153 mg/dl after two hours. This condition is diagnosed when it first appears or is initially detected during gestation.

### Pregnancy Induced Hypertension

When blood pressure readings taken on two separate occasions, at least 4 hours apart, show a systolic pressure above 140 mmHg and a diastolic pressure higher than 90 mmHg.

### Preeclampsia/Eclampsia

Elevated blood pressure occurring after the 20th week of pregnancy, accompanied by signs of organ dysfunction, such as protein in the urine, low platelet count, or abnormal liver function tests.

## Materials and Methods

### Study Design

Cohorts of the study

* **Treatment group:** Women who experienced natural or vaginal births with the use of epidural analgesia
* **Control group:** Women who experienced natural or vaginal births without the use of epidural analgesia

### Setting

Agha Khan University Hospital, Department of Obstetrics and Gynecology.

### Duration of Study

6 months after approval of synopsis CPSP and ERC.

### Sample Size

The calculation of sample size was derived from a prior investigation. According to Khan KS et al., instrumental delivery rates were 50% in the epidural group and 25% in the control group.(69) The study's primary objective was to evaluate the difference in instrumental delivery rates between those who received epidural analgesia and those who did not. To detect a difference of 26% (50% vs. 24%) between the groups with 80% statistical power and 5% type I error rate, the study required a total of 106 pregnant women (53 per group) from the labor room who were undergoing vaginal delivery. However, considering the chances of non-consent, a total of 120 patients were enrolled for the study (60 per group).

### Sampling Technique

Non-probability, consecutive sampling

### Sample Selection

**Inclusion Criteria:**

• Pregnant females between 15 and 45 years old

• Cases that are both scheduled and unscheduled

• Singleton pregnancy

• Nulliparous and multiparous females

• Pregnant women in the delivery area who had a vaginal birth with epidural analgesia (study group)

• Pregnant women in the delivery area who had a vaginal birth without epidural analgesia (control group)

**Exclusion Criteria:**

• Instrumental delivery necessitated by fetal bradycardia

• Elective or emergency cesarean section

## Data Collection Procedure

The research project began after receiving approval for the study synopsis from the College of Physicians and Surgeons, Pakistan. Patients in the Aga Khan Hospital's labor room who underwent vaginal delivery, with or without epidural analgesia, were included in the study population, and based on predetermined inclusion criteria. A predesigned proforma was used to document participants' demographic information, the type of instrumental delivery performed, outcomes for newborns, and instances of obstetric anal sphincter injuries. The primary investigator was responsible for gathering all data for the study and noted in the pre-designed questionnaire (Appendix I).

## Data Analysis Procedure

All statistical analysis was done using SPSS 19.0 (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA). For categorical variables, including labor type, induction/augmentation method, instrumental delivery, instrument delivery type, post-partum hemorrhage, shoulder dystocia, birth trauma, obstetric anal sphincter injury, associated factors (GDM, PIH, Eclampsia/Pre-eclampsia), and NICU admission, frequencies and percentages were calculated.

**RESULTS**

As per the inclusion criteria, a total of 120 participants were enrolled in the study. The median (IQR) age of the study participants was 26 years (26-31 years). The median (IQR) BMI of all the participants was 27.47 kg/m2 (24.92-31.97 kg/m2) with median (IQR) height and weight of 1.58m (1.54 – 1.62m) and 68.0 (60.8 – 78.8 kg) respectively. In terms of comorbidities, GDM was reported as the most frequently occurring followed by others as displayed in **Figure R1**.

Of the total 120 patients, 67 (55.8%) were given epidural. Half of the participants had an induced labor (n=60, 50%), while the remaining had either augmented (n=35; 39.2%) or spontaneous labor (n=25; 20.8%). Majority of the participants (n=114, 95%) had to undergo induction of labor which included intracervical foley’s, prostaglandins (PGE2), oxytocin, and artificial rupture of membranes (ARM). The number of induction methods used on each participant is displayed in **Figure R2**. Thirty-six patients (30%) of the participants had instrumental delivery, i.e. vacuum (n=32/36, 88.9%) or forceps (n=4/36, 11.1%). The indications for the instrumental delivery are mentioned in **Figure R3**.The median (IQR) duration of stage 1 labor was 4 hours (3-5) hours. The duration of the second stage of labor ranging from less than 1 hour to more than three hours is shown in **Figure R4**. The majority of the patients had no event of obstetric anal sphincter injury (OASI) i.e. 77.5% (n=93) during the delivery. However, 18.3% (n=22) had first- or second-degree anal tear, and 5% (n=4) had third degree anal tears. Only 6 participants had suffered PPH(>500ml) during the process of giving birth and all of them were those who had also been given epidural. The median (IQR) maternal length of hospital stay was 3(3-3) days.

The descriptive statistics are shown in **Table R1**. The overall median (IQR) age of the study participants and those who were given epidural was 28.0 years (26.0 – 30.0 years). The overall BMI and the BMI of the mothers who were given an epidural were 27.8 (24.9-31.9) and 26.9 (23.9-31.3) respectively. In terms of comorbidities, GDM was the only comorbidity to be significantly different between those who were given an epidural and those who were not (p-value: 0.002).

The univariate logistic regression was performed to ascertain the effect of the use of epidural on the maternal and neonatal outcomes **(Table R-2)**. With a p-value of <0.25, instrumental delivery, prolonged labor, and presence of OASI were found to have an odd of 4.03, 6.40. And 0.553 to occur in the presence of administration of epidural analgesia. On multivariate analysis, epidural analgesia administration led to the events of instrumental delivery (aOR: 2.69), and prolonged labor (aOR: 4.55).

Figure R 1: Comorbidities in the study participants

Figure R 2: Number of induction methods used in participants

Figure R 3: Indication for instrumental delivery

Figure R 4: Frequency of various durations of second stage of labor

Table R- 1: Association of parameters with use of epidural analgesia

Table R- 2: Maternal and neonatal outcomes associated with epidural analgesia

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Unadjusted Odds ratio (95% CI) | p-value | Adjusted odds ratio (95% CI) | p-value |
| Instrumental delivery | 4.038 (1.649-9.885) | 0.002\* | 2.694 (1.098-8.002) | 0.032\* |
| Prolonged labor | 6.403 (2.054-19.965) | 0.001\* | 4.558 (1.394-14.901) | 0.012\* |
| OASI | 0.553 (0.233-1.312) | 0.179\* |  |  |
| Neonatal birth weight | 2.010 (0.537-7.529) | 0.300 |  |  |
| Shoulder dystocia | 0.788 (0.048-12.899) | 0.867 |  |  |

# DISCUSSION

This research offers crucial insights into labor and delivery among 120 participants, examining maternal characteristics, obstetric interventions, and neonatal outcomes. The demographics of the study population are represented by median age and median BMI of 26 years and 27.47 kg/m2, respectively; meaning this represents a relatively young and overweight population. Both age and BMI are significant in our modern obstetric challenges, in that there is a large effect on pregnancy outcomes and management.

This study group found Gestational diabetes mellitus (GDM) to be the most common comorbidity. This is consistent with previous research which has shown GDM is more common among overweight or obese pregnant women.(70) Since the high occurrence of GDM has great potential to affect maternal and fetal health, it is essential to screen for and manage the intolerance to glucose in pregnancy early.

This research highlights a significant trend in modern obstetrics: The vast overuse of labor induction (50%) and augmentation (39.2%). When practiced alongside other type of active labor management, these practices have stimulated the debate within the field of medicine on potential benefits and harms.(71) Induction techniques, as seen in Figure R2, are progressive in that several are employed in an attempt to initiate labor. This fit well with currently recommended approaches, including those of the American College of Obstetricians and Gynecologists (ACOG, 2019),(22) which call for a progressive increase in interventions depending on individual patient characteristics and response to treatment.

Rate of instrumental delivery (30%) observed is substantially higher than the global average of 10–15% reported in previous studies.(72) The frequency of this may be heightened by factors including the prevalence of epidurals (55.8%) and the existence of GDM.

The results from this research show a strong relationship between the use of epidural anesthesia and postpartum hemorrhage (PPH) with all six cases of PPHs occurring in patients who received epidural anesthesia during labor. This correlation is consistent with the previous studies indicating the possibility of epidural use as the reason for higher risk of PPH.(61) Consistency of this observation across several studies suggests that this relationship requires more investigation.

Birth outcome results of this study provide generally positive results for most deliveries. Most neonatal outcomes were good—there were no problems with all of the babies born alive. It is especially important that the percentage of live births is high and the proportion of complications is low, which indicates that particular obstetric care is practiced.(61) Additionally, the infrequency of birth injury and admissions to the neonatal intensive care unit (NICU) reinforces this conclusion, as evidence for quality care throughout childbirth.

Both scores at 1st and 5th minute post-birth were notably high, signifying successful immediate neonatal adaption to life outside womb.(76) APGAR score is used to assess newborn's heart rate, breathing effort, muscle tone, reflex irritability and skin color to provide a clue to the infant's post-birth condition. The consistently high scores of this research reflect well on both prenatal care and immediate postnatal management, in that most newborns demonstrated successful transition to extrauterine life. However, there was still one low APGAR score in the dataset that needs to be studied more carefully. While isolated cases of low APGAR scores can happen in perfectly orchestrated pregnancies and deliveries, it is important to look into this particular case to find out what could have been done differently, or what risk factors may have been missed. All together, these findings underscore the importance of dedicated prenatal care and clinical obstetric care in order to get good birth results.(59) Successful childbirth experiences result from consistent prenatal check-ups, appropriate maternal health interventions and the right execution of labor and delivery procedures.

These findings have important implications for obstetric care and labor pain management decision making. There is still a place for epidural analgesia — remaining one of the most popular, and most effective, methods of pain relief during the birth process — but these findings highlight the importance of weighing up the pros and cons when providing women with labor pain relief. Expectant mothers should be informed in discussions of informed consent the increased likelihood of instrumental delivery and prolonged labor versus the pain relief benefits of epidural analgesia. This could include, timing of epidural, dose or concentration of anesthetic or techniques for the second stage of labor in women with epidurals.

# CONCLUSION

In conclusion, this research provides a detailed description and analysis of the labor and delivery characteristics of a specific population and presents many important trends and relationships. Of particular note are the observations concerning epidural use, labor induction, and instrumental delivery, highlighting the importance of a personalized obstetric care approach. This study reveals the intricate relations of maternal phenotypes, obstetrical interventions, and child outcomes, which collectively indicate the need to consider a wide range of phenomena when making decisions in labor ward practice.

1. **FUTURE PERSPECTIVES**

Additional studies are needed to determine whether epidural use increases a woman's risk of postpartum hemorrhage and what factors might mediate that risk. The elements accounting for the high rate of assisted deliveries in this study group should be assessed. Further investigation should involve an in depth look at the connection between epidural use and newborn hospital stay, while controlling for possibly confounding variables. Further prospective research into the seeming protective effect of assisted delivery and pregnancy induced hypertension on prolonged second stage labor is recommended. Additional multi center studies are necessary to confirm these findings and evaluate their applicability to other populations.

# ABBREVIATIONS

ACOG: American College of Obstetricians and Gynecologists

APGAR: Appearance, Pulse, Grimace, Activity and Respiration

EAS: External Anal Sphincter

GDM: Gestational Diabetes Mellitus

IAS: Internal Anal Sphincter

NICU: Neonatal Intensive Care Unit

OASI: Obstetric Anal and Sphincter Injury

OGTT: Oral Glucose Tolerance Test

PPH: Post-Partum Hemorrhage

RANZOG: Royal Australian and New Zealand College of Obstetrics and Gynecology

RCOG: Royal College of Obstetricians and Gynecologists

RCTs: Randomized Controlled Trials

SOGC: Society of Obstetricians and Gynecologists of Canada

TENS: Transcutaneous Electrical Nerve Stimulation

1. **REFERENCES**

1. Anim-Somuah M, Smyth RM, Cyna AM, Cuthbert A. Epidural versus non-epidural or no analgesia for pain management in labour. Cochrane Database Syst Rev. 2018;5(5):CD000331.<https://doi.org/10.1002/14651858.CD000331.pub4>

2. Cheng YW, Shaffer BL, Nicholson JM, Caughey AB. Second stage of labor and epidural use: a larger effect than previously suggested. Obstet Gynecol. 2014;123(3):527-535.<https://doi.org/10.1097/AOG.0000000000000134>

3. Wong CA. Neuraxial Labor Analgesia: Does It Influence the Outcomes of Labor? Anesth Analg. 2017;124(5):1389-1391.<https://doi.org/10.1213/ANE.0000000000001867>

4. Liu ZQ, Chen XB, Li HB, Qiu MT, Duan T. A comparison of remifentanil parturient-controlled intravenous analgesia with epidural analgesia: a meta-analysis of randomized controlled trials. Anesth Analg. 2014;118(3):598-603.<https://doi.org/10.1213/ANE.0000000000000077>

5. Sng BL, Sia ATH. Maintenance of epidural labour analgesia: The old, the new and the future. Best Pract Res Clin Anaesthesiol. 2017;31(1):15-22.<https://doi.org/10.1016/j.bpa.2017.01.002>

6. Wang Q, Zheng SX, Ni YF, Lu YY, Zhang B, Lian QQ, et al. The effect of labor epidural analgesia on maternal-fetal outcomes: a retrospective cohort study. Arch Gynecol Obstet. 2018;298(1):89-96.<https://doi.org/10.1007/s00404-018-4777-6>

7. Greenwell EA, Wyshak G, Ringer SA, Johnson LC, Rivkin MJ, Lieberman E. Intrapartum temperature elevation, epidural use, and adverse outcome in term infants. Pediatrics. 2012;129(2):e447-454.<https://doi.org/10.1542/peds.2010-2301>

8. Hasegawa J, Farina A, Turchi G, Hasegawa Y, Zanello M, Baroncini S. Effects of epidural analgesia on labor length, instrumental delivery, and neonatal short-term outcome. J Anesth. 2013;27(1):43-47.<https://doi.org/10.1007/s00540-012-1480-9>

9. Lieberman E, O'Donoghue C. Unintended effects of epidural analgesia during labor: a systematic review. Am J Obstet Gynecol. 2002;186(5 Suppl Nature):S31-68.<https://doi.org/10.1067/mob.2002.122522>

10. Hodnett ED. Pain and women's satisfaction with the experience of childbirth: a systematic review. Am J Obstet Gynecol. 2002;186(5 Suppl Nature):S160-172.<https://doi.org/10.1067/mob.2002.121141>

11. Au-Yong PS, Tan CW, Tan WH, Tan KH, Goh Z, Sultana R, et al. Factors associated with an increased risk of instrumental vaginal delivery in women with epidural analgesia for labour: A retrospective cohort study. Eur J Anaesthesiol. 2021;38(10):1059-1066.<https://doi.org/10.1097/EJA.0000000000001439>

12. Hitzeman N, Chin S. Epidural analgesia for labor pain. Am Fam Physician. 2012;86(3):241-242

13. Walton P, Reynolds F. Epidural analgesia and instrumental delivery. Anaesthesia. 1984;39(3):218-223.<https://doi.org/10.1111/j.1365-2044.1984.tb07230.x>

14. Kaminski HM, Stafl A, Aiman J. The effect of epidural analgesia on the frequency of instrumental obstetric delivery. Obstet Gynecol. 1987;69(5):770-773.<https://doi.org/10.1097/00132582-198712000-00046>

15. Cammu H, Martens G, Van Maele G. Epidural analgesia for low risk labour determines the rate of instrumental deliveries but not that of caesarean sections. J Obstet Gynaecol. 1998;18(1):25-29.<https://doi.org/10.1080/01443619868217>

16. Rogers R, Gilson G, Kammerer-Doak D. Epidural analgesia and active management of labor: effects on length of labor and mode of delivery. Obstet Gynecol. 1999;93(6):995-998.<https://doi.org/10.1016/s0029-7844(98)00564-x>

17. Shen C, Chen L, Yue C, Cheng J. Extending epidural analgesia for intrapartum cesarean section following epidural labor analgesia: a retrospective cohort study. J Matern Fetal Neonatal Med. 2022;35(6):1127-1133.<https://doi.org/10.1080/14767058.2020.1743661>

18. Shinar S, Libresco G, Yogev Y, Ashwal E. 802: The effect of epidural analgesia on second stage length and delivery mode. American Journal of Obstetrics and Gynecology. 2019;220(1):S524.<https://doi.org/10.1016/j.ajog.2018.11.825>

19. Lurie S, Feinstein M, Heifetz C, Mamet Y. Epidural analgesia for labor pain is not associated with a decreased frequency of uterine activity. Int J Gynaecol Obstet. 1999;65(2):125-127.<https://doi.org/10.1016/s0020-7292(99)00005-3>

20. Lim MN, Ong S. Epidural anesthesia and uterine contractions. Int J Gynaecol Obstet. 2005;88(1):49-50.<https://doi.org/10.1016/j.ijgo.2004.08.014>

21. Berg TG, Rayburn WF. Effects of analgesia on labor. Clin Obstet Gynecol. 1992;35(3):457-463.<https://doi.org/10.1097/00003081-199209000-00005>

22. ACOG Publications: September 2019: Correction. Obstet Gynecol. 2019;134(5):1121.<https://doi.org/10.1097/AOG.0000000000003548>

23. Choudhary J, Sharma H, Acharya V. Maternal and fetal outcome in epidural analgesia study. International Journal of Reproduction, Contraception, Obstetrics and Gynecology. 2016:3547-3551.<https://doi.org/10.18203/2320-1770.ijrcog20163441>

24. Zhang J, Klebanoff MA, DerSimonian R. Epidural analgesia in association with duration of labor and mode of delivery: a quantitative review. Am J Obstet Gynecol. 1999;180(4):970-977.<https://doi.org/10.1016/s0002-9378(99)70669-1>

25. Leighton BL. The impact of neuraxial analgesia on the progress and outcome of labor. Techniques in Regional Anesthesia and Pain Management. 2003;7(4):197-203.<https://doi.org/10.1053/j.trap.2003.10.002>

26. Atkins KL, Fogarty S, Feigel ML. Acupressure and Acupuncture Use in the Peripartum Period. Clin Obstet Gynecol. 2021;64(3):558-571.<https://doi.org/10.1097/GRF.0000000000000636>

27. Chantigian RC. Non-pharmacological Methods for Pain Relief in Obstetrics. Clinics in Anaesthesiology. 1986;4(1):197-207.<https://doi.org/10.1016/s0261-9881(21)00286-x>

28. Ducrow M. The occurrence of unblocked segments during continous lumbar epidural analgesia for pain relief in labour. Br J Anaesth. 1971;43(12):1172-1174.<https://doi.org/10.1093/bja/43.12.1172>

29. Michael S, Richmond MN, Birks RJ. A comparison between open-end (single hole) and closed-end (three lateral holes) epidural catheters. Complications and quality of sensory blockade. Anaesthesia. 1989;44(7):578-580.<https://doi.org/10.1111/j.1365-2044.1989.tb11446.x>

30. Pan PH, Bogard TD, Owen MD. Incidence and characteristics of failures in obstetric neuraxial analgesia and anesthesia: a retrospective analysis of 19,259 deliveries. Int J Obstet Anesth. 2004;13(4):227-233.<https://doi.org/10.1016/j.ijoa.2004.04.008>

31. Sivaprakasam J, Purva M. CUSUM analysis to assess competence: what failure rate is acceptable? Clin Teach. 2010;7(4):257-261.<https://doi.org/10.1111/j.1743-498X.2010.00386.x>

32. Gu Y, Wang X, Zhu C, Min H, Zhang J, Mao L, et al. Effects of Acupoint Stimulation Combined with Low-frequency Pulsed Electrotherapy on Labor Pain in Women undergoing Trial of Labor: protocol for a stepped wedge cluster randomized controlled trial. Springer Science and Business Media LLC; 2023.

33. Cheng WJ, Hung KC, Ho CH, Yu CH, Chen YC, Wu MP, et al. Satisfaction in parturients receiving epidural analgesia after prenatal shared decision-making intervention: a prospective, before-and-after cohort study. BMC Pregnancy Childbirth. 2020;20(1):413.<https://doi.org/10.1186/s12884-020-03085-6>

34. Royal College of Obstetricians and Gynaecologists (RCOG). The Grants Register 2021: Palgrave Macmillan UK; 2020. p. 713-721.

35. Handbook for the development of evidenced-based guidelines and statement. Farquhar C, Wilson J, editors. Melbourne: Royal Australian and New Zealand College of Obstetrics and Gynaecology; 2023.

36. O'Mahony F, Hofmeyr GJ, Menon V. Choice of instruments for assisted vaginal delivery. Cochrane Database Syst Rev. 2010(11):CD005455.<https://doi.org/10.1002/14651858.CD005455.pub2>

37. 2023 Index of SOGC Clinical Practice Guidelines. Journal of Obstetrics and Gynaecology Canada. 2024;46(1).<https://doi.org/10.1016/j.jogc.2023.102335>

38. Altman MR, Lydon-Rochelle MT. Prolonged second stage of labor and risk of adverse maternal and perinatal outcomes: a systematic review. Birth. 2006;33(4):315-322.<https://doi.org/10.1111/j.1523-536X.2006.00129.x>

39. Maeda A, Suzuki R, Maurer R, Kurokawa S, Kaneko M, Sato R, et al. Physical and psychological recovery after vaginal childbirth with and without epidural analgesia: A prospective cohort study. PLoS One. 2023;18(10):e0292393.<https://doi.org/10.1371/journal.pone.0292393>

40. Sandstrom A, Altman M, Cnattingius S, Johansson S, Ahlberg M, Stephansson O. Durations of second stage of labor and pushing, and adverse neonatal outcomes: a population-based cohort study. J Perinatol. 2017;37(3):236-242.<https://doi.org/10.1038/jp.2016.214>

41. Cahill AG, Srinivas SK, Tita ATN, Caughey AB, Richter HE, Gregory WT, et al. Effect of Immediate vs Delayed Pushing on Rates of Spontaneous Vaginal Delivery Among Nulliparous Women Receiving Neuraxial Analgesia: A Randomized Clinical Trial. JAMA. 2018;320(14):1444-1454.<https://doi.org/10.1001/jama.2018.13986>

42. Souza JP, Miquelutti MA, Cecatti JG, Makuch MY. Maternal position during the first stage of labor: a systematic review. Reprod Health. 2006;3:10.<https://doi.org/10.1186/1742-4755-3-10>

43. Srivastava K, Sinha P, Sharma R, Gupta U. A comparative study of the effect of drotaverine hydrochloride with hyoscine butylbromide in first stage of labor. International Journal of Basic and Clinical Pharmacology. 2015:488-491.<https://doi.org/10.18203/2319-2003.ijbcp20150025>

44. Bakker W, Sandberg EM, Keetels S, Schoones JW, Kujabi ML, Maaloe N, et al. Inconsistent definitions of prolonged labor in international literature: a scoping review. AJOG Glob Rep. 2024;4(3):100360.<https://doi.org/10.1016/j.xagr.2024.100360>

45. Wilson SH, Wolf BJ, Bingham K, Scotland QS, Fox JM, Woltz EM, et al. Labor Analgesia Onset With Dural Puncture Epidural Versus Traditional Epidural Using a 26-Gauge Whitacre Needle and 0.125% Bupivacaine Bolus: A Randomized Clinical Trial. Anesth Analg. 2018;126(2):545-551.<https://doi.org/10.1213/ANE.0000000000002129>

46. Zhang D, Sun Y, Li J. Application of Dexmedetomidine in Epidural Labor Analgesia: A Systematic Review and Meta-Analysis on Randomized Controlled Trials. Clin J Pain. 2024;40(1):57-65.<https://doi.org/10.1097/AJP.0000000000001166>

47. Omote K, Iwasaki H, Kawamata M, Satoh O, Namiki A. Effects of verapamil on spinal anesthesia with local anesthetics. Anesth Analg. 1995;80(3):444-448.<https://doi.org/10.1097/00000539-199503000-00002>

48. Zimmer EZ, Jakobi P, Itskovitz-Eldor J, Weizman B, Solt I, Glik A, et al. Adverse effects of epidural analgesia in labor. Eur J Obstet Gynecol Reprod Biol. 2000;89(2):153-157.<https://doi.org/10.1016/s0301-2115(99)00191-8>

49. Randazzo S, Segal S. Does Labor Analgesia Affect Labor Outcome?: Elsevier; 2023. 455-465 p.<https://doi.org/10.1016/b978-0-323-77846-6.00052-5>

50. Sheiner E, Sheiner EK, Segal D, Mazor M, Erez O, Katz M. Does the station of the fetal head during epidural analgesia affect labor and delivery? Int J Gynaecol Obstet. 1999;64(1):43-47.<https://doi.org/10.1016/s0020-7292(98)00225-2>

51. Yuan J, Jin A, Shen J, Chen Y, Huang Q, Xiang H. Maternal intrapartum fever during epidural labour analgesia: Incidence and influencing factors. Int J Nurs Pract. 2024;30(1):e13188.<https://doi.org/10.1111/ijn.13188>

52. Lipps J, Lawrence A, Palettas M, Small RH, Soma L, Coffman JC. Interprofessional provider attitudes toward the initiation of epidural analgesia in the laboring patient: are we all on the same page? Int J Obstet Anesth. 2019;37:57-67.<https://doi.org/10.1016/j.ijoa.2018.08.007>

53. Zha Y, Gong X, Yang C, Deng D, Feng L, Luo A, et al. Epidural analgesia during labor and its optimal initiation time-points: A real-world study on 400 Chinese nulliparas. Medicine (Baltimore). 2021;100(9):e24923.<https://doi.org/10.1097/MD.0000000000024923>

54. Chestnut DH, McGrath JM, Vincent RD, Jr., Penning DH, Choi WW, Bates JN, et al. Does early administration of epidural analgesia affect obstetric outcome in nulliparous women who are in spontaneous labor? Anesthesiology. 1994;80(6):1201-1208.<https://doi.org/10.1097/00000542-199406000-00006>

55. Loewenberg-Weisband Y, Grisaru-Granovsky S, Ioscovich A, Samueloff A, Calderon-Margalit R. Epidural analgesia and severe perineal tears: a literature review and large cohort study. J Matern Fetal Neonatal Med. 2014;27(18):1864-1869.<https://doi.org/10.3109/14767058.2014.889113>

56. Bulchandani S, Watts E, Sucharitha A, Yates D, Ismail KM. Manual perineal support at the time of childbirth: a systematic review and meta-analysis. BJOG. 2015;122(9):1157-1165.<https://doi.org/10.1111/1471-0528.13431>

57. Halperin O, Noble A, Balachsan S, Klug E, Liebergall-Wischnitzer M. Association between severities of striae gravidarum and Obstetric Anal Sphincter Injuries (OASIS). Midwifery. 2017;54:25-28.<https://doi.org/10.1016/j.midw.2017.07.019>

58. Hersh AR, Carroli G, Hofmeyr GJ, Garg B, Gulmezoglu M, Lumbiganon P, et al. Third stage of labor: evidence-based practice for prevention of adverse maternal and neonatal outcomes. Am J Obstet Gynecol. 2024;230(3S):S1046-S1060 e1041.<https://doi.org/10.1016/j.ajog.2022.11.1298>

59. Thompson A, Yates-Doerr E. The measure of a mother. The Routledge Handbook of Anthropology and Global Health: Routledge; 2024. p. 89-103.

60. Burns R, Vadlamudi G, Ginsburg J, Velez L. The Fourth Trimester: Emergencies in the Postpartum Period. Emerg Med Rep 2024

61. Smith A, LaFlamme E, Komanecky C. Pain management in labor. Am Fam Physician. 2021;103(6):355-364

62. Johnson JD, Asiodu IV, McKenzie CP, Tucker C, Tully KP, Bryant K, et al. Racial and Ethnic Inequities in Postpartum Pain Evaluation and Management. Obstet Gynecol. 2019;134(6):1155-1162.<https://doi.org/10.1097/AOG.0000000000003505>

63. Deepak D, Kumari A, Mohanty R, Prakash J, Kumar T, Priye S. Effects of Epidural Analgesia on Labor Pain and Course of Labor in Primigravid Parturients: A Prospective Non-randomized Comparative Study. Cureus. 2022;14(6):e26090.<https://doi.org/10.7759/cureus.26090>

64. Wang L, Liu H, Duan Y, Cheng Q, Feng S. Analgesic Effects of Epidural Labor Analgesia at Different Periods and Its Effects on Maternal and Infant Outcomes and MiRNA-146b Level. J Healthc Eng. 2021;2021:2879678.<https://doi.org/10.1155/2021/2879678>

65. Wang X, Li J, Liu D. Effects of epidural analgesia exposure during parturition on autism spectrum disorder in newborns: A systematic review and meta-analysis based on cohort study. Front Psychiatry. 2022;13:974596.<https://doi.org/10.3389/fpsyt.2022.974596>

66. Herrera-Gomez A, Garcia-Martinez O, Ramos-Torrecillas J, De Luna-Bertos E, Ruiz C, Ocana-Peinado FM. Retrospective study of the association between epidural analgesia during labour and complications for the newborn. Midwifery. 2015;31(6):613-616.<https://doi.org/10.1016/j.midw.2015.02.013>

67. Mousa O, Abdelhafez AA, Abdelraheim AR, Yousef AM, Ghaney AA, El Gelany S. Perceptions and Practice of Labor Pain-Relief Methods among Health Professionals Conducting Delivery in Minia Maternity Units in Egypt. Obstet Gynecol Int. 2018;2018:3060953.<https://doi.org/10.1155/2018/3060953>

68. Gómez A, García-Martínez O, Ramos Torrecillas J, De Luna-Bertos E, Ruiz C, Ocaña-Peinado F. Retrospective study of the association between epidural analgesia during labor and complications for the newborn. Midwifery. 2015;31.<https://doi.org/10.1016/j.midw.2015.02.013>

69. Khan KS, Khan BF, Rasul S, Chohan U. The safety of epidural analgesia in labour and its effect on delivery--a case control study in Pakistani women. J Pak Med Assoc. 1993;43(6):115-117

70. Catalano PM, Shankar K. Obesity and pregnancy: mechanisms of short term and long term adverse consequences for mother and child. BMJ. 2017;356:j1.<https://doi.org/10.1136/bmj.j1>

71. Grivell RM, Reilly AJ, Oakey H, Chan A, Dodd JM. Maternal and neonatal outcomes following induction of labor: a cohort study. Acta Obstet Gynecol Scand. 2012;91(2):198-203.<https://doi.org/10.1111/j.1600-0412.2011.01298.x>

72. A. M. Antepartum and Postpartum Hemorrhage. Gabbe's Obstetrics Study Guide: A Companion to the 8th Edition. 1012020.

73. Sultan AH, Thakar R. Management of Acute Obstetric Anal Sphincter Injuries (OASIs). Pelvic Floor, Perineal, and Anal Sphincter Trauma During Childbirth: Springer International Publishing; 2024. p. 61-88.

74. Brown A, Jordan S. Active management of the third stage of labor may reduce breastfeeding duration due to pain and physical complications. Breastfeed Med. 2014;9(10):494-502

75. Williams M, Turner S, Butler E, Gardosi J. Fetal growth surveillance - Current guidelines, practices and challenges. Ultrasound. 2018;26(2):69-79.<https://doi.org/10.1177/1742271X18760657>

76. Tarimo CS, Bhuyan SS, Zhao Y, Ren W, Mohammed A, Li Q, et al. Prediction of low Apgar score at five minutes following labor induction intervention in vaginal deliveries: machine learning approach for imbalanced data at a tertiary hospital in North Tanzania. BMC Pregnancy Childbirth. 2022;22(1):275.<https://doi.org/10.1186/s12884-022-04534-0>

77. Jiang Q, Jin Z, Wang W, Ji Q, Qi C. Retrospective study to assess the effect of epidural analgesia on labor progress and women's pelvic floor muscle from the perspective of electromyography. J Matern Fetal Neonatal Med. 2023;36(1):2211198.<https://doi.org/10.1080/14767058.2023.2211198>