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Effect of Epidural Analgesia on Labor and Neonatal Outcomes

Abstract

Introduction: Labor pain is one of the most intense forms of pain experienced by women. Epidural analgesia offers several benefits that support pregnancy and facilitate the labor process.

Objective: This study aimed to evaluate the impact of epidural analgesia (EA) on labor progression and neonatal outcomes.

Methods: A prospective interventional study was conducted in Maternity Hospital in Duhok City, Kurdistan Region, Iraq over a nine-month period (April 1 to December 31, 2018). This study included 200 pregnant women in labor, divided into two groups: 100 received EA during labor, while the remaining 100 women did not receive EA. Maternal and intrapartum outcomes were systematically evaluated by the research team, whereas neonatal assessments were conducted independently by a hospital pediatrician.

Results: A significant association was observed between epidural analgesia (EA) and assisted vaginal delivery ($p = 0.01$). The first stage of labor was significantly longer among women without EA, whereas the second stage was prolonged in those who received EA ($p < 0.001$). No significant differences in neonatal outcomes were identified between the two groups ($p > 0.05$).

Conclusion: Epidural analgesia demonstrated a measurable impact on maternal labor characteristics, without compromising neonatal safety, reinforcing its role in obstetric care.

1. INTRODUCTION

Labor pain is one of the most intense forms of pain experienced by women during their reproductive years. Managing this pain effectively remains a key challenge for physicians, as successful pain relief enhances maternal satisfaction during labor [1]. Various methods are utilized to alleviate labor pain, including electrical stimulation, massage, nursing support, acupuncture, and pharmacological interventions [2]. Over time, anesthesia for labor pain has evolved from basic anesthetic agents to modern epidural anesthesia, which has demonstrated high efficacy in pain management [3]. Currently, epidural anesthesia (EA) is the most commonly chosen method for labor analgesia [4].

Lumbar epidural analgesia (LEA) is widely regarded as the most effective pain relief method during labor, with support from the World Health Organization. In developed nations, it is commonly employed in 10–64% of vaginal deliveries [5]. A range of analgesic agents, including local anesthetics, opioids, and other medications, are introduced into the epidural space via catheter insertion, altering afferent fibers to produce analgesia. Labor pain arises from uterine contractions and cervical dilation, activating nociceptive fibers, which are further stimulated by fetal descent and the expansion of the perineum and vaginal tissues [6].

Despite the effectiveness of EA in alleviating labor pain, various adverse effects have been documented, including prolonged labor, increased rates of cesarean section and assisted delivery, as well as potential neonatal complications. Minor side effects associated with EA include back pain, headache, itching, lower limb numbness, dysuria, hypotension, and, in rare cases, nerve damage [1]. These adverse effects pose challenges to the widespread implementation of EA for painless labor. Nonetheless, epidural anesthesia remains a commonly used method for labor pain relief in developed countries [7]. According to the American College of Obstetricians and Gynecologists, a woman's request for EA should be considered a primary indication, provided no contraindications exist [8]. The primary obstetric indication for EA is pain relief during labor, while contraindications include patient refusal, local infection, elevated intracranial pressure, hemodynamic instability, cardiomyopathy, coagulopathy and spinal cord anomalies [9,10]. EA does not impair consciousness or alter blood stress hormone levels, thereby reducing the risk of hypertension [11]. Despite its established safety, various maternal and neonatal complications have been reported [12]. In addition to labor pain management, EA is also routinely used for cesarean section anesthesia [13].

EA during labor has been associated with a prolonged second stage and an increased likelihood of instrumental delivery. A longer second stage, oxytocin use, and instrumental delivery contribute to higher neonatal co-morbidities [14]. Additionally, EA is linked to elevated rates of intrapartum fever in women, which may lead to neonatal morbidities such as neonatal sepsis [15,16]. However, some studies have reported no significant impact of EA on neonatal morbidity, while others have noted that previous research has primarily focused on maternal outcomes, often overlooking neonatal effects [17].

The aim of the study is to evaluate the impact of epidural analgesia (EA) on labor progression and delivery outcomes, specifically assessing its association with assisted vaginal delivery, the duration of the first and second stages of labor, as well as neonatal outcomes.

2. PATIENTS AND METHODS

A prospective interventional study was conducted at the Maternity Hospital in Duhok, Kurdistan Region, Iraq, over a nine-month time period from April 1 to December 31, 2018. A total of 200 pregnant women were enrolled and categorized into two groups: 100 received EA during labor while the remaining 100 patients were not administered EA. The study population included all pregnant women presenting with labor symptoms and signs. Patients with a singleton viable pregnancy with cervical dilation and cephalic presentation were included in the study while those with multiple pregnancies, intrauterine fetal demise, a history of two or more cesarean sections, bleeding disorders, coagulopathies, pelvic anomalies, allergies to anesthesia or analgesics, and refusal to participate were excluded. The study was conducted in accordance with Declaration of Helsinki. The study was initiated after obtaining informed consent from selected participants and ensuring continuous monitoring and management.

Patient information was obtained through direct interviews and recorded in a structured questionnaire designed by the researcher. The questionnaire included key demographic details (age, body mass index, gestational age, gravidity, parity, and miscarriage history), clinical history (hypertension, diabetes mellitus, heart disease, neurological disease, and psychiatric disorders), labor characteristics (oxytocin augmentation, mode of delivery, duration of the first and second stages of labor, perineal injury, and minor adverse effects), and neonatal outcomes (birth weight, Apgar scores at one and five minutes, neonatal gender, NICU admission, and early neonatal death). Labor was identified by the presence of symptoms and cervical dilation exceeding 4 cm in cephalic presentation. EA was administered to 100 pregnant women via epidural catheter at the L2-L3 or L3-L4 intervertebral space, delivering 10 ml of ropivacaine 0.2% and 50 µg fentanyl. A test dose of 3 ml lidocaine (2%) was given after five minutes. Maternal and labor outcomes were documented by researchers, while neonatal assessments were conducted by a hospital pediatrician. Statistical analysis

Statistical analysis was performed using SPSS, version 24. Chi-square or Fisher's exact tests were employed for categorical variables and independent sample t-tests were conducted for continuous variables. A p-value of 0.05 or less was considered statistically significant.

3. RESULTS

This study included 200 pregnant women divided into two study groups (100 pregnant women administered EA at labor and 100 pregnant women were without EA. The mean age of enrolled women in the EA group was

significantly lower than that of the non-EA group ($p < 0.001$). No significant differences were observed between groups in terms of body mass index, gestational age, parity, or history of miscarriage ($p > 0.05$). Notably, primigravida status was significantly associated with the use of EA during labor ($p=0.04$). (Table 1)

Table 1: Demographic details of enrolled patients

Variable	Study groups		P-value
	EA	Without EA	
Age			<0.001
Mean±SD (years)	25.6±3.4	29.8±4.7	
Body mass index			0.3
Mean±SD (Kg/m2)	28.7±2.2	29±2.1	
Gestational age			0.06
Mean±SD (weeks)	37.8±1.1	37.5±1.2	
Gravidity			0.04
Primigravida	36	22	
Multi-gravidity	64	78	
Parity			0.06
Nulliparous	30	18	
Multi-parity	70	82	
Miscarriage			0.7
Yes	6	4	
No	94	96	

Table 2: Description of clinical history in enrolled patients

Variable	Study groups		P-value
	EA	Without EA	
Hypertension			0.78
Yes	8	6	
No	92	94	

Diabetes mellitus			0.67
Yes	2	4	
No	98	96	
Heart disease			0.2
Yes	1	5	
No	99	95	
Neurological disease			1.0
Yes	1	1	
No	99	99	
Psychiatric disease			1.0
Yes	2	2	
No	98	98	

A statistically significant association was found between EA and the need for oxytocin augmentation during labor ($p = 0.002$). EA was also significantly associated with an increased rate of assisted vaginal delivery ($p = 0.01$). While the first stage of labor was significantly longer in women without EA, the second stage was notably prolonged in those who received EA ($p < 0.001$). No significant differences were observed between the groups regarding perineal injury ($p = 0.2$). However, minor adverse effects, particularly nausea and vomiting, were significantly more frequent among women who received EA ($p = 0.01$) (Table 3).

Table 3: Labor characteristics across the study groups

Variable	Study groups		P-value
	EA	Without EA	
Oxytocin augmentation			0.002
Yes	63	41	
No	37	59	
Mode of delivery			0.01
Assisted vaginal delivery	72	55	
Cesarean section	28	45	

1st stage of labour			<0.001
Mean±SD (hour)	3.2±0.8	3.9±1.3	
2nd stage of labour			<0.001
Mean±SD (minute)	33.4±12	25.5±9.3	
Perineal injury			0.2
No	24	34	
Grade 1-2	58	46	
Grade 3-4	18	20	
Minor adverse effects during labor			0.01
No	57	79	
Itching	7	7	
Nausea	13	3	
Vomiting	10	4	
Dizziness	9	5	
Urinary retention	4	2	

No significant differences were observed between study groups in regard to neonatal outcomes of women (p>0.05). (Table 4)

Table 4: Assessment of neonatal outcomes across study groups

Variable	**Study groups**		**P-value**
	EA	**Without EA**	
Neonatal birth weight			0.06
Mean±SD (Kg)	3.1±0.7	3.3±0.8	
Apgar score after 1 minute			0.6
Mean±SD (Kg/m2)	7.9±1.5	8±1.4	
Apgar score after 5 minutes			0.08
Mean±SD (weeks)	8.5±0.5	8.6±0.3	
Neonatal gender			0.68
Primigravida	44	48	
Multi-gravidity	56	52	
NICU admission			0.36
Yes	22	16	
No	78	84	
Early neonatal death			0.9
Yes	3	2	
No	97	98	

4. DISCUSSION

EA is widely regarded as the gold standard for pain management during labor [18]. However, increasing concerns have emerged regarding its routine use. Research has primarily focused on influence of EA on labor progression, delivery mode, maternal health, and neonatal outcomes [19]. In such a pursuit, the present study evaluated the effect of EA on labor and neonatal outcomes.

The mean age of pregnant women who received EA was significantly lower than those without EA, at the time of labor ($p<0.001$). A similar trend was observed in a study conducted in Qatar; however, the difference in their analysis did not reach statistical significance [20]. In contrast, findings reported elsewhere indicated that English women receiving EA were significantly older [21]. The observed difference in both studies may be attributed to ethnic differences. No significant differences were noted between study groups with respect to body mass index, gestational age, parity, or miscarriage history ($p > 0.05$). A significant association was observed between EA and primigravida status at labor ($p = 0.04$; Table 1). Literature also indicates that EA is more frequently administered to primigravidas (57.5%) and primiparas (67.1%), particularly in later stages of pregnancy [22]. This trend aligns with a reported finding which indicated an increased prevalence of primigravidas among individuals receiving EA [23].

Oxytocin is frequently administered to women experiencing slow labor progression to enhance delivery outcomes and potentially reduce the need for cesarean section. Although early initiation of oxytocin may not significantly decrease cesarean or instrumental delivery rates, evidence suggests it is unlikely to cause harm and may shorten the time to delivery [24]. In the present study, oxytocin augmentation was significantly more common among women receiving EA compared to those without EA (63% vs 41%, $p=0.002$). Although the relationship remains debated, previous studies have highlighted this association, potentially reflecting the impact of EA on uterine contractility or pre-existing risk factors for labor dystocia, such as fetal macrosomia, malpresentation, or inefficient uterine activity [25,26].

Assisted vaginal delivery was significantly more frequent in the EA group compared to the non-EA group (72% vs 55%; $p = 0.01$), suggesting a potential association between EA and increased rates of assisted delivery, along with reduced cesarean section rates. A plausible mechanistic explanation lies in the action of local anesthetic agents used in labor epidural analgesia (LEA), which block sodium channels. This leads to effective inhibition of afferent pain signal transmission, but concurrently, due to limited selectivity, can also impair efferent motor function, resulting in maternal motor weakness. [27]. The findings were consistent with previous publications indicating that EA is associated with increased rates of operative vaginal delivery and prolonged durations of both the first and second stages of labor, in both nulliparous and multiparous women [28,29]. However, the association between EA and caesarean delivery appeared more nuanced: a reduced incidence of caesarean section was observed among nulliparous women, whereas no significant association was noted in multiparous women. These observations contrast with earlier reports that suggested an increased risk of caesarean delivery with EA [30,31].

The second stage of labor was significantly prolonged in the EA group compared to the non-EA group (33.4 ± 12 min vs 25.5 ± 9.3 min; $p < 0.001$). This prolongation may be attributed to stage-specific physiological factors, as the second stage relies more heavily on effective expulsive efforts. Theoretically, local anesthetics used in EA may contribute to motor blockade, which can impair both voluntary and involuntary muscle activity, potentially extending the duration of this stage [32]. This effect may be attenuated with the use of low-concentration epidural maintenance solutions. A double-blind randomized controlled trial conducted in 2017 involving 400 parturients—randomized to either continue low-concentration epidural analgesia through delivery or discontinue it at full cervical dilation—found no significant differences in the duration of the second stage of labor or the mode of delivery between the two groups [33].

The present study indicated no significant difference in perineal injury rates between groups ($p=0.2$). The findings are consistent with the ones reported elsewhere [34,21]. Adverse effects were less commonly reported in the non-EA group, with 79% of participants experiencing no symptoms, compared to 57% in the EA group. Nausea, vomiting, dizziness, and urinary retention occurred more frequently among women who received EA. Notably, analysis from a separate study also demonstrated a significantly higher incidence of postpartum urinary retention in the EA group compared to the non-EA group (30% vs. 11%, $p = 0.02$), supporting the observed trend [35]. Univariate analysis revealed that, within the epidural analgesia group, primiparity and prolonged second stage of labor were significantly associated with postpartum urinary retention.

Timely evaluation of fetal wellbeing during labor is vital, as exposure to distressing neonatal conditions—including hypoxia, low Apgar scores, and NICU admission—may affect the infant's immediate physical health and long-term emotional development [36]. In the present study, no significant differences were observed between study groups in regard to neonatal outcomes ($p>0.05$) (Table 4). Consistent with the 2018 Cochrane review, the present findings suggest that EA does not significantly influence immediate neonatal outcomes such as Apgar scores or the need for neonatal intensive care [27]. These review findings are in contrast to those of the Cochrane review of 2011 [37]. A study conducted by a group of researchers concluded that APGAR scores were comparable between the epidural and non-epidural groups, indicating no significant impact of epidural analgesia on neonatal status. Moreover, the study reported that NICU admission rates did not significantly differ between groups and were not influenced by the

mode of delivery [38]. The findings are in agreement with two other published reports, where no significant association between EA and the incidence of birth asphyxia or NICU admissions was noted [39, 40].

5. CONCLUSION

This study highlights the clinical relevance of epidural analgesia in labor, demonstrating its association with maternal outcomes and labor dynamics. EA use correlated with a longer second stage of labor, greater oxytocin augmentation, and increased assisted vaginal delivery, suggesting its influence on labor progression and need for intervention. While minor side effects such as nausea and vomiting were observed, neonatal outcomes and perineal injury rates remained comparable between groups, underscoring EA's safety for both mother and child. Nevertheless, further investigation is warranted to elucidate the underlying mechanisms and long-term implications of EA. These findings advocate for individualized pain management strategies that consider patient-specific factors, and call for future studies to address confounders influencing EA administration in order to refine labor analgesia protocols.

6. CONFLICT OF INTEREST

None

7. ACKNOWLEDGMENT

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