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Research Article

Risk Factors for Epidural Analgesia Failure and Its Consequences in the Natural Birth Process: An Anesthesia Intervention in Reducing Patients' Pain

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ABSTRACT

Background: Epidural is a type of regional anesthesia performed by injecting a local anesthetic agent. In this type of anesthesia, by using a catheter in the epidural space, the anesthetic drug can be re-injected if necessary. For this reason, this study was conducted with the aim of determining and investigating the risk factors for epidural analgesia failure (FEA) and its outcomes in the normal labor process of pregnant women referring to Arash Hospital.

Methods: This prospective cohort study evaluated 160 mothers requesting epidural to identify the risk factors for failed epidural analgesia (FEA), where FEA was defined based on the VAS score half an hour after the initial dose. Following thorough pre-anesthesia tests, standard doses were injected using the Loss of Resistance technique, and labor progression and pain (VAS) were monitored periodically. Analyses focused on comparing demographic, technical (physician skill), and obstetric outcome variables between the successful and unsuccessful groups at a significance level of $P < 0.05$.

Results: A statistically significant difference was observed in the variables of effacement, the length of the first and second stages of labor, and the one-minute Apgar score ($P < 0.05$) between the successful and unsuccessful groups, indicating that in the unsuccessful group, effacement was less, and the labor stages were longer. Moreover, the unsuccessful group exhibited a greater prevalence of Apgar scores below 7 at the first minute, and a higher incidence of fetal heart rate deceleration was also noted in this group ($P = 0.01$). However, the mean dilation, mode of delivery, satisfaction scores, and five-minute Apgar scores showed no statistically significant difference. These results emphasize the importance of accurate assessment of variables related to labor progression and fetal status in determining the success of the procedure.

Conclusion: Overall, the results showed significant differences between the successful and unsuccessful groups in the mean effacement, the length of the labor stages, and the one-minute Apgar score, while other variables, such as dilation, mode of delivery, satisfaction, and the five-minute Apgar score, did not show a statistically significant difference. These results show how the success of labor affects the stages of labor and the baby's health in the first few minutes after birth.

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Introduction

During surgical procedures, general anesthesia is the method of choice in most centers. However, the complications associated with this anesthesia, such as respiratory issues and prolonged recovery times, have led to a tendency towards regional anesthesia methods [1-3]. Some studies have shown that using the spinal anesthesia method is more suitable for performing surgery. But it is recommended for all patients, especially at-risk patients or those undergoing prolonged surgery, and the possibility of needing further anesthesia during the operation must be considered [4-6].

The intensity of pain, on average, during labor has been reported to vary among different women, depending on variables such as previous history of labor, ethnicity, body mass index (BMI), pain tolerance, history of previous illnesses, etc. [5,7-8]. Labor pain is highly variable, but many women perceive this pain as severe. Several factors influence the perception of labor pain, including the duration of labor, the mother's pelvic anatomy and fetal size, the use of oxytocin, previous pregnancy, participation in labor preparation classes, fear and anxiety about childbirth, coping behaviors and experiences, and adaptive mechanisms [9-11].

The prevalence and effective factors on pain have been investigated in various studies and in different types of patients, and its prevalence has been reported as high [12-17]. Injectable narcotics can exacerbate maternal respiratory distress, whereas regional analgesia can reduce the effects of labor pain on respiration and the sympathetic nervous system [18-19]. Among regional anesthesia types, epidural anesthesia can be mentioned, whose most important advantages are the absence of headaches and the lack of severe hemodynamic changes. On the other hand, back pain is a relatively common complication after epidural analgesia [19-20]. An epidural is a type of regional anesthesia performed by injecting a local anesthetic agent. In this type of anesthesia, using a catheter in the epidural site allows for repeated injection of the anesthetic drug if needed [21]. In this method, an analgesic agent, such as bupivacaine, with or without a narcotic, is injected into the epidural space via the catheter and prevents the transmission of pain signals to the spinal cord by blocking nerve fibers [22]. Women who choose epidural analgesia are at risk of increased fever during labor. The reason for the phenomenon is not well understood but is likely due to non-infectious inflammation. Fever can lead to adverse outcomes for the newborn. Therefore, its diagnosis and prevention seem necessary [23-25]. Epidural anesthesia can affect maternal and neonatal complications such as increased labor duration, the rate of instrumental delivery, fever, the use of oxytocin, as well as the improper rotation of the fetal head in the birth canal [26-27]. Epidural analgesia is one of the most popular methods for achieving labor analgesia, and its administration early in labor, based on the mother's first request for analgesia, will not lead to an increased risk of instrumental delivery and cesarean section [28]. Epidural narcotics cause analgesia without causing motor block, but if used alone, they will not provide satisfactory analgesia during labor [29-30].

Aim

Given the importance of women's health, this study was conducted with the aim of determining the risk factors for epidural analgesia failure (FEA) and its outcomes in the normal labor process of pregnant women.

Methods

This study was conducted as a prospective cohort study from April until the completion of the sample size on pregnant women referred to Arash Hospital for normal labor.

Inclusion and Exclusion Criteria

After obtaining informed consent, before the start of the epidural for all mothers, the degree of dilation, effacement, and station were recorded, and the fetal heart rate and maternal vital signs were monitored. All pregnant women in 4 to 6 cm of dilation who requested epidural analgesia were placed under infusion of one liter of Ringer's lactate solution. Exclusion criteria included non-cephalic presentation; stillbirth; presence of epidural contraindications, including thrombocytopenia less than 100,000, recent use of anticoagulant drugs, maternal underlying medical diseases, abruptio placentae, sepsis, and chorioamnionitis; and receiving other methods of labor analgesia.

Intervention Procedure

An epidural was performed in the sitting position using a G17 needle and the loss-of-resistance technique. Subsequently, a test dose including 3 cc of 2% lidocaine with 15 micrograms of epinephrine was administered under hemodynamic and heart rate monitoring, and after confirming correct placement in the epidural space, the initial dose, including 15 cc of 0.125% bupivacaine with 50 micrograms of fentanyl, was injected. Then, the epidural catheter was advanced 6 to 7 centimeters into the epidural space and fixed to the patient's back. The patient was placed in the supine position, and close monitoring continued for one hour after the injection. Then, the patient was freed from monitoring to walk or perform labor-related movements. Dilation, effacement, and station were recorded every hour. Subsequent epidural doses were administered by the anesthesia specialist in an intermittent bolus manner, commensurate with the progress of labor, using the same initial solution.

Pain Assessment and Variables Studied

Pain severity was measured using the Visual Analog Scale (VAS) before the intervention and at minutes 15 and 30 after each bolus dose. Variables studied during labor and recorded for comparison between the successful and unsuccessful epidural groups included: the number of times analgesia was administered, the number of attempts to place the catheter, the number of physicians performing the analgesia, the physician's academic level, dilation time at each stage, the need for adjunctive therapeutic methods, mode of delivery, labor induction, perineal laceration, infant weight, and primary and secondary outcomes.

Definition of Failed Epidural Analgesia (FEA)

A failed epidural was defined based on the VAS score half an hour after the loading dose. VAS assessment was performed by a physician other than the anesthesiologist. If labor did not progress for two hours and contractions were present with intervals greater than 3 minutes and duration less than 30 seconds, oxytocin was prescribed for augmentation, and the amount used until delivery was recorded. Postpartum hemorrhage and maternal satisfaction were also recorded on a scale of 1 to 5 (1: Very Dissatisfied, 5: Very Satisfied).

Study Outcomes

The study outcomes were divided into two categories: primary outcomes and secondary outcomes.

Primary Outcome Included

Identification of independent risk factors affecting the occurrence of FEA, including demographic, obstetric, and technical factors (e.g., number of times analgesia was administered and skill of the anesthesiologist). The work history of the anesthesiologist was recorded as senior (more than 10 years of experience) and non-senior (less than 10 years of experience). Working shifts (morning, evening, and night) were also considered.

Secondary Outcome Included

Peripartum outcomes affected by the epidural, the need for intrapartum interventions, the need for a laser, the rate of cesarean section, the length of the first and second stages of labor, fetal heart rate deceleration half an hour after the epidural, and side effects (including nausea, vomiting, etc.).

Sample Size

Considering the use of logistic regression in the final analysis, 10 people were considered for each variable. Accordingly, the number of variables was set at 16, the number of subjects per variable was set at 10, and the total sample size was determined to be 160 people.

Statistical Analysis Method

For quantitative variables, mean and standard deviation were used, and for qualitative variables, frequency and percentage were used. In comparing quantitative data, the independent sample t-test was used if the data were normal, and otherwise, the Mann–Whitney U test was used. The Chi-square test was used to compare qualitative data. The statistical significance level was set at $P < 0.05$.

Results

There is a slight difference between the two unsuccessful and successful groups in terms of mean dilation, but this difference is not statistically significant. The results of the independent t-test showed that there was a statistically significant difference in the mean effacement between the successful and unsuccessful groups. That is, the mean effacement in the successful group was greater than in the unsuccessful group.

The results of the chi-square test showed that there is no statistically significant correlation between the two successful or unsuccessful groups and the type of delivery (natural or cesarean) ($P = 0.33$). In the subsequent follow-up, we had 11 cases of back pain and no cases of hypotension or other complications. A summary of this information with details is provided in the table below. Also, there is a statistically significant correlation between the two successful or unsuccessful groups and the incidence of fetal heart rate deceleration ($P = 0.01$), in such a way that the incidence of fetal heart rate deceleration was higher in the unsuccessful group than in the successful group, which is statistically significant.

The results of the chi-square test showed that there is not much difference between the successful and unsuccessful groups in terms of the rate of satisfaction (good and very good), and this difference is not statistically significant (Table 1).

Table 1- Baseline characteristics of participants between the two groups with unsuccessful and successful epidurals

Variable	Total sample	Unsuccessful group	Successful group	T-test P value	Chi^2 P value
Age, M(SD)	26.3(5.1)	26.8(5.7)	26.5(4.8)	0.66	-
BMU, M(SD)	24.3(3.9)	23.5(3.8)	24.7(3.9)	0.05	-
Pregnancy, N (%)	2.36	2.6	2.3	-	0.01
Childbirth, N (%)	1.36	1.6	1.3	-	0.01
Pain before intervention	9.1(0.47)	9.8(0.5)	9.1(0.45)	0.66	-

Table 2- Examination of dilation, effacement, and fetal head station between the two groups with unsuccessful and successful epidurals

Variable	Total sample	Unsuccessful group	Successful group	T-test P value	Chi^2 P value
Dilation	4.8(0.85)	4.7(0.79)	4.9(0.87)	0.06	-
Effusion	48.4(9.1)	46.5(8.8)	49.4(9.1)	0.05	-
1st minute Apgar (less than 7)	16(10%)	11(20%)	5(4.8%)	-	0.002
5th minute Apgar (less than 7)	5(3.1%)	3(5.5%)	2(1.9%)	-	0.22
Cesarean section, N (%)	42(26.3%)	17(30.9%)	25(23.8%)	-	0.33
Heart rate drop	10(6.3%)	7(12.7%)	3(2.9%)	-	0.01
Postpartum hemorrhage	10(6.3%)	7(12.7%)	3(2.9%)		0.03

An independent T-test showed that there is a difference between the mean length of the first stage of labor in the two groups, such that the mean first stage of labor (in minutes) in the unsuccessful group was higher than in the successful group, and this difference was statistically significant ($P = 0.02$). The independent T-test results showed that there is a difference between the mean length of the second stage of labor in the two groups, such that the mean second stage of labor (in minutes) in the unsuccessful group was higher than in the successful group, and this difference was statistically significant ($P = 0.01$). The test results showed that there was a statistically significant difference between the Apgar score less than 7 and the score greater than 7 between the successful and unsuccessful groups ($P = 0.002$), such that the frequency of Apgar score less than 7 was higher in the unsuccessful group than in the successful group. The Chi-square test results showed that there was no statistically significant difference between the Apgar score at the fifth minute (less than 7 and greater than 7) between the successful and unsuccessful groups ($P = 0.22$) (Table2).

Discussion

Paying attention to women's health is one of the priorities of healthcare, and it is necessary that attention be paid to this group as soon as possible [31-32]. Given the importance of women's health, this study was conducted with the aim of determining the risk factors for the failure of epidural analgesia and its outcomes in the normal labor process of pregnant women. In the retrospective study by Chao and colleagues, out of 534 pregnant women who underwent cesarean section with EA and catheterization methods, 94 people experienced EA failure. Consistent with the findings, a history of previous epidural injection, as the most important variable, is directly related to an increased risk of epidural anesthesia (EA) failure in cesarean section. Statistical analyses confirmed that low age, history of EA, and short waiting time are independently strong predictors for EA procedure failure. Comparison of the groups showed that patients with unsuccessful EA were often younger, and a high percentage of them reported a history of normal labor or previous EA reception [33].

In the meta-analysis study by Li and colleagues, based on 19 studies, the overall rate of conversion of epidural anesthesia (EA) to general anesthesia in cesarean section was estimated at 6%. Patients with unsuccessful EA were significantly younger and taller than the successful group; also, the rate of incomplete block, extra administered dose, and emergency cesarean section rate was higher in this group. Demographic risk factors associated with failure included lower age, taller height, BMI, and higher weight, with lower age confirmed as an independent risk factor. Contrary to expectations, factors such as BMI, gestational age, or parity status did not show a statistically significant difference in the EA failure rate [34]. Also, in the meta-analysis study by Bauer and colleagues, the overall rate of conversion of EA to general anesthesia in cesarean section was reported as 5.0% (95% CI: 3.5 to 6.5%), and the need for any supplement was reported as 10.7%. The three main risk factors for unsuccessful EA conversion were an increase in the number of extra boluses by the physician during labor, high urgency of cesarean section, and provision of care by a non-obstetric anesthesiologist. On the other hand, contrary to assumptions, there was insufficient evidence to support spinal-epidural combination techniques, the duration of EA, cervical dilation, or BMI as provable risk factors [35]. In summary, both studies emphasize the low conversion rate (about 5-6%) and the vital role of intrapartum management (extra injections) and the experience of the anesthesia service provider in the success or failure of the epidural.

Conclusion

Overall, the results showed that there are significant differences in the mean effacement, the length of labor stages, and the Apgar score at the first minute between the successful and unsuccessful groups, while other

variables, such as dilation, type of delivery, satisfaction, and Apgar at the fifth minute, did not show a statistically significant difference. These findings indicate the effect of delivery success on the progression of labor stages and the newborn's condition in the initial minutes after birth.

Ethical Approval

The current study was conducted after obtaining approval from the Ethics Committee of Tehran University of Medical Sciences (IR.TUMS.MEDICINE.REC.1398.811).

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