Optimal dose of an anesthetic in epidural anesthesia and its effect on labor duration and administration of vacuum extractor and forceps

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Summary

This study examined the factors that influence the optimal dose of epidural anesthesia (EA), its effect on labor duration, and the frequency of vacuum and forceps administration at the end of delivery. The study group included 100 women who underwent vaginal delivery with EA with administration of 0.125% bupivacaine. A control group included 100 vaginally delivered women, without EA administration. In both groups delivery was stimulated by syntocinon. The level of labor pain influenced the optimal bolus dose of EA more than the body mass. However, the maintenance dose was influenced by both of these factors equally. Labor in the study group was somewhat shorter. In the group with EA the percentage of forceps and vacuum extractor application was twice that in the control group. There was no difference in average value of 5-minute Apgar scor in newborns.

Key words: Labor; Delivery; Epidural anesthesia; Syntocinon; Bupivacain.

Introduction

Epidural anesthesia (EA) is the most efficient method for neutralizing labor pain in modern obstetrics. Experiments demonstrated that the labor pain was a result of sensitization at three levels: peripherally – at the level of the uterus, centrally – at the level of the spinal nerves and at the psychological level [1]. Local anesthetics are weak bases, highly disolvable in lipids, but with a relatively low grade of ionifortion. Non-ionized forms pass through the tissue barriers, while ionized forms are pharmacologically active and block nerve conductibility. Research on animals demonstrated that maternal plasma-proteins bind for the drugs, thus reducing the accumulation rate, which is particularly characteristic of bupivacaine hydrohloride [2]. Repeated and prolonged administration of bupivacaine may result in accumulation of the drug in the maternal blood, and consequently in the blood of the fetus [3]. This should be accounted for when deciding on the optimal dose of the drug.

The aim of this study was to establish the extent of influence of body mass and the severity of pain on the optimal bolus and maintenance dose; the effect of EA on duration of labor; incidence of administration of vacuum extractor (VE) and forceps (F) in labor with EA, and the condition of the newborns.

Material and Methods

The study group included 100 women who underwent vaginal delivery with EA, while the control group also included 100 vaginally delivered women, but with no EA administered. All subjects were chosen randomly, and had to fulfill the following inclusion criteria: first labor, normal term pregnancy, one fetus, spontaneous beginning of labor, occipital presentation of the fetus, and the delivery was stimulated by syntocinon (Sy) 10 IU (international units) in 500 ml of saline solution. Exclusion criteria: cesarian section delivery and all forms of high-risk pregnancies, whether or not they had been prepared for EA.

Variables recorded for each delivered woman were: age, education, adminstered dose of Sy, duration of labor, administration of vacuum extractor or forceps, and the condition of the newborns measured by 5-min Apgar score. In the study group we analyzed average bolus dose of anesthetic and maintenance dose in ml (mg) in regard to body mass (BM) and level of pain. In defining the optimal bolus dose of anesthetic we applied the formula: 0.25 mg/kg of BM. Allowed bolus dose was 11 ml (13.75 mg) of 0.125% bupivacaine for the group whose BM was 55-59 kg, and for the group with BM 95-99 kg the dose was 19 ml (23.75 mg) of 0.125% bupivacaine. An 18 gauge (G) catheter, manufactured by Braun or Vigon were used to administeri EA. Anesthetic solution of 0.125% bupivacaine was used for both bolus doses with a continuous technique, administered by infusion pump «Agilia» manufactured by Fresenius Kabi.

The Students t-test and Fisher ANOVA were applied to compare the duration of labor with previously defined normal distribution using the Kolmogorov-Smirnov test. Frequencies were compaired with the chi-square test; significance level was set at 0.05.

Results

Education structure and age of patients in both groups are presented in Table 1. Women in labor who decided to use EA were far better educated, with a university (UD) or college degree, compared with the women in labor

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Table 1. — *Education (F = 12.839; df = 3; p < 0.01) and age (T = 1.292; df = 198; ns) in the study and control group.*

Education	Study group Number (%)	Control group Number (%)
University degree	60	7
College	19	3
High school	11	32
Lower level of education	10	58
Total	100	100
Age		
≤ 20	2	8
21-25	10	18
26-30	35	47
31-35	44	21
36-40	9	3
> 40	/	3
Total	100	100

Table 2. — *Number of drops of syntocinon per minute administered during labor in both groups (t = 4.997; df = 1; p < 0.05).*

Syntocinon (drops/min)	Number of patients	
	Study group	Control group
10-15	16	79
16-20	76	15
21-25	6	5
> 25	2	1
Total	100	100

Table 3. — *Amount of 0.125% of bupivacaine administered in bolus (F = 11.048; df = 3; p < 0.01), and maintenance (F = 1.28; df = 3; ns) dose for analgesia in regard to body mass and the intensity of pain.*

Body mass (kg)	Intensity of labor pain: Mild		Moderate		Intensive		Very intensive	
	Bolus dose (ml)	Maintenance dose (ml/h)	Bolus dose (ml)	Maintenance dose (ml/h)	Bolus dose (ml)	Maintenance dose (ml/h)	Bolus dose (ml)	Maintenance dose (ml/h)
60-64	/	/ /	/	/ /	/	/ /	12	6 4
65-69	4	4 1	6	4 3	8	4 3	/	/ /
70-74	5	5 2	8	4 13	10	5 7	15	6 2
75-79	5	5 1	8	4 9	10	5 8	15	6 3
80-84	6	6 1	8	4 12	10	5 5	16	6 1
85-89	6	6 1	8	4 2	10	5 3	16	6 2
90-94	7	7 1	10	5 1	12	6 5	16	7 4
95-99	7	7 1	10	5 2	12	6 2	16	7 1
N		8		42		33		17

Table 4. — *Duration of labor in the study and control group (t = 2.013; df = 198; ns).*

Group	Duration of labor					Total
	≤ 4h	4-6 h	6-8 h	8-10 h	10-12 h	
Study group %	10	20	58	12	/	100
Control group %	/	30	48	17	5	100

Table 5. — *Frequency of administration of vacuum extractor and forceps (x-2 = 0.117; df = 1; ns).*

Analyzed parameters	Study group %	Control group %
Spontaneous delivery	96	98
Delivery with vacuum extractor and forceps	4	2
Total number of deliveries	100	100
Average value of 5-minute Apgar score	9.53	9.52
Total number of newborns	100	100

who chose not to use EA, with a high school or lower level of education. The difference was statistically significant (F = 12.839; df = 3; $p < 0.01$). Average age in the study group was 30.4 years and in the control group 28.7 years, which was not statistically significant (T = 1.292; df = 198; ns).

Average number of drops of Sy per minute administered during labor in the study group was 17.7 and in the control group 14.4 (Table 2). This difference was statistically significant (t = 4.997; df = 1; $p < 0.05$).

Table 3 represents the amount of 0.125% Bupivacaine (ml/h) administered to women in labor in the form of bolus and maintenance dose for analgesia and BM and level of pain. The women in labor were divided in eight groups depending on their BM spanning from 60-90 kg, and in four groups depending on the level of pain - mild, moderate, severe and extremely severe.

Average bolus dose for mild pain was 5.6 ml; for moderate pain 8.0; for severe pain 11.4 and for extremely severe pain 14.8 ml. The difference of administered bolus dose (ml) in those four groups of women was statistically significant (F = 11.048; df = 3; $p < 0.01$). Average maintenance dose for mild pain was 5.6 ml, for moderate pain 4.1, for severe pain 5.1, and for extremely severe pain 6.3 ml. The difference of administered maintenance dose (ml) in those four groups of women was not statistically significant (F = 1.28; df = 3; $p > 0.05$). Bolus dose was increased in the groups depending on the BM as 0.25 mg/kg. Bolus dose equaled the maintenance dose for mild pain, for moderate and severe pain the maintenance dose was twice the bolus dose, while for extremely severe pain maintenance dose was more than twice the bolus dose.

In the study group the average duration of labor in hours was 6.5 h while it was 6.9 h in the control group (Table 4). This difference was not statistically significant (t = 2.013; df = 198; ns).

Administration of forceps and VE was 4% and 2% in the study and control group, respectfully, without statistical significance (x-2 = 0.117; df = 1; ns). Average values of 5-minute Apgar score were almost identical in both groups (Table 5).

Discussion

Women in labor who decided on administration of EA were far better educated than women in labor who chose not to use EA (60% with UD) and older (53% above 30) compared with 7% and 27% of those without EA. Better educated women started families and gave birth at a later age. In addition, they were better informed and more likely to decide to use EA during labor. Moreover, their economic situation also influenced the decision to use EA, which was not completely covered by the insurance plan. We corrected a partial decrease of uterus activity

due to reduction of serum oxytocine [4] after the bolus dose in subjects with EA by direct increase in number of drops/min of Sy infusion. Therefore the average number of drops of Sy infusion was higher in the study group. Alexander *et al*. [5] reported a higher amount of Sy with 1 cm of cervical dilatation (22 mU/cm) in the group with EA compared with 16 mU/cm in the group without EA. Our first experiences with administration of EA during labor indicated prolongation of labor as a result of excessive doses of bupivacaine with motor blockade and thus weakened uterus contractions. The optimal dose of anesthetic that neutralises labor pain but preserves sensation of contraction was finally the result of increasing the anesthesiologist's experience and improved cooperation with women in labor. We administered a far lower dose in bolus than the recommended one, which, depending on the level of pain, was between 5-15 ml/h for the group with BM between 70-74 kg, and 7-16 ml/h for the group with BM between 95-99 kg. Yancey *et al*. [6] in their work reported a bolus dose of 8 ml of 0.125% of bupivacaine and a maintenance dose 10 ml/h, but did not mention the connection with the severity of pain. Srivastava *et al*., in 2009 [7] reported the identical dose of 10 ml of 0.125% bupivacaine solution, for both bolus dose and maintenance dose. We did not find any study regarding connection of the bolus dose and the severity of pain, which was 2-3 fold greater within the same BM group in our study, and was statistically significant ($p < 0.01$). Only Hess *et al*. [8] reported that the severity of labor pains was a confusing factor in research of delivery with EA. The maintenance dose in our study depended to some extent on the severity of pain, but not as much as with the bolus dose, and the difference between the groups relative to the severity of pain, was not statistically significant. By reaching the perfect balance between the bolus and maintenance dose, we managed to reduce average duration of labor in the study group to 6.5 h, compared with 6.9 h in the control group. It is necessary to underline that complete dilatation excluded the use of anesthetic. This difference was not statistically significant, however within the system of large numbers it can represent a significant savings of time and expenditures. Our experience was confirmed by other authors [9, 10] who reported that EA did not prolong the early labor phase. We did not analyze duration of the first and the second phase separately, because in our opinion it is difficult to establish a precise time of complete dilatation. It sometimes happened that a woman started straining some 30-40 minutes after the last examination, when she was only 6-7 cm dilated. The majority of authors consider that the first and the second phase of labor [5, 11] last from 42 minutes up to > 100 minutes.

In the study group, vacuum extractor and forceps were administered at the end of delivery twice as often as in the control group, which correlates with other authors' reports [11, 12]. Increased incidence of application of vacuum extractor and forceps is the result of weaker contractions and head malrotation due to EA [13], or unprepared women for the second labor phase. There was no case of placental abruption, rupture of the uterus, nor loss of the fetus in either the EA group or control group [14].

Average value of 5-minute Apgar score of the newborns in the EA group was almost identical to that in the control group (9.53 : 9.52) and the difference was insignificant. The individual variability of metabolism rate of each woman should be accounted for, with respect to reaction to the administered drug. Neonatology studies demonstrated statistically less frequent hypoxic encephalopathy in newborns delivered following epidural anesthesia, compared with newborns delivered without EA. This may be explained by loss of fear, and thus no hyperventilation nor acidosis [15].

In conclusion, our results demonstrated that an optimal bolus dose of EA in women in labor depends markedly more on severity of pain than on BM. However, maintenance dose depends equally on both. Optimal dose, intensive guidance of labor and an experienced obstetric team may reduce duration of labor. Deliveries with EA are more often ended by application of vacuum extraction and forceps. An insignificantly higher average value of 5-minute Apgar score in newborns from the EA group is the evidence that epidural anesthesia is not harmful for a baby.

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