Reports of Investigation

Risk factors of inadequate pain relief during epidural analgesia for labour and delivery

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Purpose: To determine the causes of failure of epidural analgesia during labour and delivery.

Methods: During six months, pregnant patients receiving epidural analgesia and delivering vaginally were studied prospectively. Bupivacaine 0.125% was used for the initial bolus dose and subsequent continuous infusion. Top-ups of the same solution were used for inadequate pain relief assessed using a visual analogue pain score (VAPS) and/or by clinical examination. Inadequate pain relief was defined as the need for $\geq$ 2 top-ups in addition to epidural infusion and failure during delivery as VAPS $\geq$ 30 mm during the expulsion phase.

Results: 1009 patients delivered during this period, 596 had epidural analgesia for vaginal delivery of a live infant and data were complete in 456. Inadequate pain relief during labour and during delivery were found in 5.3% and 19.7% of patients. Risk factors of inadequate pain relief included: inadequate analgesic efficacy of the first dose (Odds ratio: 3.5, P = 0.001) and posterior presentation (Odds ratio: 5.6, P = 0.001). Radicular pain during epidural placement was associated with failure during labour (Odds ratio: 3.9, P = 0.05). Duration of epidural analgesia > six hours (Odds ratio: 9.1, P = 0.001) was a risk factor for insufficient pain relief during labour whereas duration of epidural analgesia < one hour was associated with pain during delivery (Odds ratio: 18.3, P = 0.001).

Conclusion: Several obstetrical and epidural-related factors increase the risk of inadequate epidural analgesia. For some, simple changes of practice pattern may lead to improved pain relief.

Objectif : Déterminer les causes d'insuffisance de l'analgésie péridurale obstétricale.

Méthodes : Pendant 6 mois, toutes les patientes en travail ayant reçu une analgésie péridurale ont été évaluées prospectivement. La bupivacaïne 0,125 % a été utilisée pour l'injection péridurale initiale et pour la perfusion continue de même que pour les réinjections qui ont suivi l'évaluation de la douleur par l'échelle visuelle analogique (EVA) et la vérification du bloc. Une insuffisance d'analgésie pendant le travail a été définie par le besoin d'au moins deux réinjections (en plus de la perfusion péridurale continue) et lors de l'accouchement par une EVA 30 mm.

Résultats : Parmi les 1009 patientes étudiées, 596 ont reçu une analgésie péridurale pour donner naissance à un enfant vivant par voie vaginale et les données étaient complètes pour 456 d'entre elles (76,5 %). Une insuffisance d'analgésie a été constatée pendant le travail chez 5,3 % des patientes et, lors de l'accouchement, chez 19,7 %. Plusieurs facteurs de risque d'insuffisance d'analgésie ont été communs aux phases de dilatation et d'expulsion : insuffisance analgésique du premier bolus (coefficient de risque CR : 3,5; P = 0,001) et présentation postérieure (CR : 5,6; P = 0,001). La survenue d'une radiculalgie pendant la ponction était associée à un risque d'analgésie insuffisante pendant le travail (CR : 3,9; P = 0,05). Une durée d'analgésie péridurale > 6 h (CR : 9,1; P = 0,001) était un facteur de risque d'insuffisance pendant le travail alors qu'une durée < 1 h était associée à un risque accru d'échec lors de l'expulsion (CR : 18,3; P = 0,001).

Conclusion : Plusieurs facteurs obstétricaux ou liés à la technique péridurale sont asssociés à un risque accru d'analgésie inadéquate. Pour certains facteurs techniques, des modifications simples des pratiques pourraient conduire à une amélioration notable de l'analgésie.

EPIDURAL analgesia is widely viewed as the most effective form of pain relief during labour and provides better satisfaction than other methods.[1,2] However, even in experienced hands, epidural analgesia may fail to relieve pain adequately. Although no direct comparisons are available, the literature suggests that the rate of inadequate analgesia is greater in obstetrical analgesia than in the non-pregnant patient and ranges from 3.5 - 13.5%[3,4] to 24 - 32%[5-6] whereas the incidence of failure in the surgical patient is 2 - 4%.[7,8]

A variety of patient-technique-catheter or drug-related factors have been identified.[9-16] Although these factors are well known by anaesthetists, the rate of failure or of inadequate pain relief has not decreased in recent years. This suggests that several important factors have still to be identified. Thus, we performed this prospective analysis to determine risk factors for failed block.

Material and methods

During a six month period (January 1st - June 30, 1994), epidural analgesia performed for labour pain relief in parturients at term who delivered vaginally was studied prospectively and data were recorded using a pre-printed form. Every patient had been seen in a pre-anaesthetic visit at 36 ± 2 wk gestation and epidural analgesia discussed and oral informed consent obtained. Only those women with intrauterine death or abortion were excluded from evaluation. Ethical approval was not deemed necessary as no attempt was made to modify the routine practice during this period. Since this study was performed in a University teaching hospital, most epidural insertions were performed by residents according to our protocols. Catheter placement was performed with the patient in a sitting position and the L_{2-3} or L_{3-4} intespace was entered depending on the ease of locating the spinous processes. After local anaesthesia with 40 mg lidocaine 2%, a 18 G Tuohy needle was inserted with the bevel cephalad and the epidural space was located using loss of resistance to saline. A terminal-hole catheter was inserted 3 cm in the epidural space and secured with Tegaderm®. The initial bolus dose was injected through the catheter, in 3 - 5 ml increments and consisted of 12 - 18 ml bupivacaine 0.125% according to the patient's height. Thirty minutes after the first bolus dose, a continuous epidural infusion of bupivacaine 0.125% was begun at 10 - 14 mL·hr⁻¹. The infusion was continued until delivery at the same rate if analgesia was adequate. Pain was evaluated using a 0-100 mm visual analogue pain scale (VAPS) before and 30 min after the first bolus dose and at delivery. When analgesia was inadequate, VAPS was measured again and the nurse anaesthetist evaluated motor block, sensory

spread on each side and the warmth of the feet. When asymmetry was confirmed, the depth of the epidural catheter was verified and additional analgesia was given as a bolus of 5 - 10 mL bupivacaine 0.125%. Failure during labour was defined as the need for two top-ups and failure during delivery was defined as a VAPS > 30 mm during the expulsion period. For the two groups (success and failure), we examined physical characteristics, obstetrical factors, analgesic and technical data.

Potential univariate correlates of epidural analgesia failure were identified using χ^2 analysis and analysis of variance. All variables significant at a nominal P value < 0.05 were entered into a logistic regression analysis. P values and 95% confidence intervals (CI) are reported.

Results

During this period, of the 1009 patients who delivered in our maternity unit 596 fulfilled the criteria of this study. However, all data were available in only 456 (76.5%). Table I shows a comparison of the main physical and obstetrical data in the study group compared with the total population who received epidural analgesia. Weight before pregnancy and at delivery, height, gestational age and parity did not differ. The mean age of the total population was higher than for the patients studied ($P < 0.05$) but the small difference was not clinically relevant. Analgesia failure rates of 5.3% and 19.7% were found during labour and delivery respectively. Compared with patients in whom analgesia was successful, patients' with failed analgesia, weight before pregnancy and at term were greater, the duration of the first stage (5-10 cm cervical dilatation) was longer and the duration of epidural analgesia was longer (Table II). Consequently, the rate of cervical dilatation per hour was lower in the failure group while the hourly dose bupivacaine was larger. The analgesic efficacy of the initial bolus dose (VAPS after epidural < 30 mm) was less frequent in the analgesia failure group.

TABLE I Comparison between the patients who had epidural analgesia and for whom analgesia details at delivery are available and total population.

	Complete medical records $n = 456$		Whole population $n = 596$	P
Age (yr)	29.7 ± 4.8		30.6 ± 4.7	0.03
Weight before pregnancy (kg)	58.1 ± 8.7		59.1 ± 9.7	0.08
Weight at term (kg)	71.3 ± 10.3		71.8 ± 9.9	0.40
Height (cm)	164.5 ± 5.9		164.2 ± 5.8	0.43
Gestational age (wk)	39.5 ± 1.5		39.3 ± 1.1	0.03
Parity: I	149	157		
II	148	194		0.10
III	81	124		
≥ IV	78	121		

TABLE II Analgesic and delivery data in patients with adequate or inadequate pain relief with epidural analgesia (EA) during labour. Univariate analysis

	Adequate pain relief $n = 432$	Failure $n = 24$	P
Age (yr)	29.6 ± 4.8	30.3 ± 4.1	NS
Height (cm)	164 ± 6	166 ± 8	NS
Weight before pregnancy (kg)	57.8 ± 8.6	62.5 ± 9.3	0.01
Weight at delivery (kg)	71 ± 10.1	76.7 ± 10.2	0.007
Gestational age (wk)	39.5 ± 1.4	39.6 ± 1.4	NS
Abnormal presentation (posterior, breech)(%)	33.4	66.6	0.001
Twin pregnancy (%)	2.9	14.3	0.009
Cervical dilatation before EA (cm)	3.5 ± 1.6	3.4 ± 1.7	NS
VAPS before EA (mm)	61.2 ± 42.4	62.5 ± 25.3	NS
Radicular pain (%)	4.9	20.8	0.01
VAPS after EA (mm)	18.9 ± 21	30.2 ± 28.6	0.001
Interval (5-10 cm) of cervical dilatation (min)	139 ± 82	197 ± 115	0.0043
Duration of labour (min)	390 ± 145	489 ± 166	0.0013
Cervical dilatation rate (cm·hr^{-1})	2.3 ± 2.1	1.2 ± 0.5	0.014
Epidural analgesia (min)	227 ± 119	355 ± 138	< 0.0001
Total bupivacaine use (mg)	99.5 ± 42.39	175 ± 52.4	< 0.0001
Bupivacaine use (mg·min^{-1})	0.5 ± 0.2	0.5 ± 0.1	NS

TABLE III Analgesic and delivery data in patients with adequate or inadequate pain relief with epidural analgesia (EA) during delivery. Univariate analysis

	Adequate pain relief $n = 366$	Failure $n = 90$	P
Age (yr)	29.7 ± 4.8	29.7 ± 4.8	NS
Height (cm)	164.5 ± 6.0	164.2 ± 6.0	NS
Weight before pregnancy (kg)	58.0 ± 8.7	58.5 ± 8.8	NS
Weight at delivery (kg)	70.9 ± 10.2	72.7 ± 10	NS
Gestational age (wk)	39.5 ± 1.3	39.2 ± 1.7	NS
Abnormal presentation (breech, posterior)(%)	26.0	38.9	0.001
VAPS before EA (mm)	60 ± 45	66 ± 23	NS
VAPS after EA (mm)	16 ± 18	34 ± 29	0.0001
Interval (5-10 cm) of cervical dilatation (min)	144 ± 84	132 ± 87	NS
Duration of labour (min)	403 ± 148	365 ± 142	0.03
Epidural analgesia (min)	246 ± 119	184 ± 132	0.0001
Total bupivacaine (mg)	107.5 ± 44.3	87.1 ± 51.8	0.002
Bupivacaine use (mg·min^{-1})	0.40 ± 0.16	0.60 ± 0.30	0.0001
Neonatal weight (g)	3338 ± 485	3359 ± 489	NS

TABLE IV Variables associated with an increased risk of epidural failure during labour and delivery. CI: confidence interval

	P	Odds Ratio	95% CI
Failure during labour VAPS > 30 mm 30 min after first dose	0.001	3.5	1.3 - 9.1
Duration of epidural analgesia 6 h	0.001	9.1	3.5 - 23.4
Radicular pain	0.05	3.9	1.1 - 13.7
Abnormal presentation	0.001	5.6	2.2 - 14.4
Failure during delivery VAPS > 30 mm 30 min after first dose	0.001	4.1	2.4 - 7.1
Duration of epidural analgesia < 1 h	0.001	18.3	4.8 - 70.3
Abnormal presentation	0.001	3.0	1.7 - 5.3

Failure was seen more frequently in unusual presentations (posterior, breech) and twin pregancies. Univariate analysis for analgesic failure during delivery displayed similar conclusions (Table III).

By multivariate analysis (Table IV), radicular pain during epidural placement was associated with failure during labour (Odds ratio: 3.9, $P = 0.05$). Duration of epidural analgesia > six hours (Odds ratio: 9.1, $P = 0.001$) was a risk factor for inadequate analgesia during labour whereas a duration of epidural analgesia < one hour was associated with failure during delivery (Odds ratio: 18.3, $P = 0.001$). Several risk factors of inadequate pain relief were the same for both labour and delivery: inadequate analgesic efficacy of the first dose (Odds ratio: 3.5, $P = 0.001$) and posterior presentation (Odds ratio: 5.6, $P = 0.001$).

Discussion

Using a multivariate analysis, we were able to determine several factors which may lead to an increased risk of analgesia failure. Some of these factors (i.e. inadequate analgesic efficacy of the first dose and posterior presentation) were common for both labour and delivery. Radicular pain during epidural placement and a long duration of labour increased the risk of analgesia failure during labour whereas a duration of labour < one hour predicted an increased risk of failure at delivery. The overall failure rate found in this study, ranging between 5% during labour and 20% at delivery, is similar to that of previous studies of obstetrical analgesia.[3-6] The greater pain and incidence of analgesia failure during the late phase of labour is consistent with previous observations.[17,18] Since the analgesic protocol used during this period was local anaesthetic without opioid, it could be argued that the failure rate is not representative of current practice of most obstetric units.

However, several studies comparing the efficacy of analgesia with either bupivacaine alone or combinations with opioids during labour have failed to show any difference in the quality of analgesia.[18-20] This suggests that, in the range of doses presently used, non pharmacological factors are essential.

Obstetric factors-posterior presentation and slow labour

Abnormal presentations were found to be associated more likely with pain. This had been suggested a long time ago by Bonica[16] and reference to more painful labours has been reiterated recently[21] although no data were available to support this. Wuitchik *et al.* noted that posterior presentations were associated with distress-related thoughts which in turn were predictive of long and painful labours.[22] We also found that long labours were more painful. Although it is possible that a long labour may lead to exhaustion and subsequent reduced tolerance to pain, it is more likely that pain and anxiety produce incoordinate uterine contractions by stimulating hormonal release.[22]

Body weight

Although an increase in body weight was associated with inadequate analgesia in univariate analysis, this factor was not found to be independently associated with failure and this seems contradictory with the results of several[20,23,24] but not all authors.[25] These apparent differences may be reconciled for at least two reasons. First, body weight differences were unimportant and body mass index was < 30 in both groups. Second, more technical problems are encountered during placement of the block in obese persons[25] and we found that radicular pain was independently associated with failure. Since distance from skin to the epidural space is increased with greater body mass index and since the risk of placing laterally the catheter is increased with greater skin-epidural space distance,[10] it is likely that epidural catheters were more often misplaced in this group. However, this was probably minimised because only 3 cm were inserted into the epidural space.

Analgesic efficacy of the first dose

Insufficient pain relief after the first dose was found to be a major cause of subsequent failure. This was true both for failure of pain relief during labour where it was associated with long duration of epidural analgesia and for failure during delivery where it was seen more frequently in cases of late placement of the epidural catheter. Several mechanisms could be proposed to explain this phenomenon seen during labour. Psychological factors may be important since immediate and complete pain relief after the first dose may

decrease patient's anxiety for the rest of labour whereas an initially unsatisfactory block may lead to deception and loss of confidence. Alternatively, an initial poor block might not be improved by a fixed rate and fixed dose continuous epidural infusion.[26] In practical terms, this suggests that every effort should be made to obtain excellent initial pain relief. This may be obtained either by an initial bolus dose of bupivacaine 0.25%[27] or by a combination of a lower dose of bupivacaine with a lipophilic opioid.[19,28] Dubost *et al.*[29] have also found that the effectiveness of the first epidural injection is a major factor of maternal satisfaction. Although this is only speculative, it might be that the increased satisfaction seen with combined spinal epidural analgesia - compared with conventional epidural analgesia - is related to the profound and almost immediate analgesia produced by this technique.[30] Moreover, since failure during delivery is seen more frequently when the epidural catheter is placed late in labour, the use of combined spinal epidural analgesia in advanced labour might be a useful tool to prevent failure. This was suggested in the study by Abouleish *et al.* who used a combination of 2.5 mg bupivacaine and 10 μg sufentanil in patients with a mean cervical dilatation of 6.2 cm. They obtained deep analgesia in less than five minutes while their patients expressed extreme satisfaction and willingness to utilize this technique in future deliveries.[31]

This study has several limitations. An arbitrary definition of analgesia failure was used and no attempt was made to separate the causes of failure because a general working definition was necessary to enter data for multivariate analysis. However, the incidence of failure fell well in the range of previous studies[3-6] supporting our choice. Although data from 23.5% of patients were missing, analysis remained valid and no biases were introduced since missing data occurred at random and the number of records evaluated was large.

In conclusion, several obstetrical (duration of labour, posterior fetal presentation) and epidural-related factors (radicular pain during epidural placement) increase the risk of inadequate epidural analgesia. The most interesting finding of this study was that great efficacy of the first bolus dose used for epidural induction is a major factor of success. Knowledge of these factors may lead to simple changes of practice pattern and to improved pain relief.

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