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## REVIEW ARTICLE

# Neuraxial labor analgesia: a literature review



Fábio Farias de Aragão <sup>a,b,c,\*</sup>, Pedro Wanderley de Aragão <sup>b</sup>,  
Carlos Alberto Martins <sup>a,b,d</sup>, Karlla Fernanda Custódia Silva Leal <sup>b</sup>,  
Alexandro Ferraz Tobias <sup>c</sup>

<sup>a</sup> Sociedade Brasileira de Anestesiologia, Rio de Janeiro, RJ, Brazil

<sup>b</sup> Universidade Federal do Maranhão (UFMA), Ciências da Saúde, São Luís, MA, Brazil

<sup>c</sup> Maternidade Natus Lumine, Serviço de Anestesiologia, São Luís, MA, Brazil

<sup>d</sup> Clínica São Marcos, São Luís, MA, Brazil

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### Abstract

The use of analgesia techniques for labor has become increasingly frequent, with neuraxial techniques being the most commonly used and most effective. Labor pain entails a number of physiological consequences that may be negative for the mother and fetus, and therefore must be treated. This literature review was performed through a search in the PubMed database, from July to November 2016, and included articles in English or Portuguese, published between 2011 and 2016 or anteriorly, if relevant to the topic. The techniques were divided into the following topics: induction (epidural, combined epidural-spinal, continuous spinal, and epidural with dural puncture) and maintenance of analgesia (continuous epidural infusion, patient-controlled epidural analgesia, and intermittent epidural *bolus*). Epidural analgesia does not alter the incidence of cesarean sections or fetal prognosis, and maternal request is a sufficient indication for its initiation. The combined technique has the advantage of a faster onset of analgesia; however, patients are subject to a higher incidence of pruritus resulting from the intrathecal administration of opioids. Patient-controlled analgesia seems to be an excellent technique, reducing the consumption of local anesthetics, the number of anesthesiologist interventions, and increasing maternal satisfaction.

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\* Corresponding author.

E-mail: [fabio.aragao30@gmail.com](mailto:fabio.aragao30@gmail.com) (F.F. Aragão).

**PALAVRAS-CHAVE**

Analgesia de parto;  
Analgesia neuroaxial;  
Resultados  
obstétricos

**Analgesia de parto no neuroeixo: uma revisão da literatura****Resumo**

O uso de técnicas de analgesia para o trabalho de parto tem se tornado cada vez mais frequente. As técnicas neuroaxiais são as mais comumente usadas e de maior eficácia. A dor do trabalho de parto traz uma série de consequências fisiológicas que podem ser negativas para a mãe e para o feto, e por isso deve ser tratada. Esta revisão de literatura foi feita na base de dados PubMed, de julho a novembro de 2016, e foram incluídos artigos em inglês ou português publicados entre 2011 e 2016, ou mais antigos que fossem relevantes ao tema. As técnicas foram divididas nos tópicos: indução (peridural, raquiperidural combinada, raquianestesia contínua e peridural com punção dural) e manutenção da analgesia (infusão peridural contínua, analgesia peridural controlada pela paciente e *bolus* peridural intermitente). A analgesia peridural não altera a incidência de cesarianas nem o prognóstico fetal, e o desejo materno é indicação suficiente para seu início. A técnica combinada apresenta como vantagem um início mais rápido da analgesia, entretanto as pacientes estão sujeitas a maior incidência de prurido decorrente da administração intratecal de opioides. A analgesia controlada pela paciente parece ser uma excelente técnica, diminui o consumo de anestésicos locais e o número de intervenções do anestesiológista e aumenta a satisfação materna.

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**Introduction**

Labor is considered one of the most emotional experiences, but it is also one of the most painful experiences a woman can experience during her lifetime. There is no other circumstance in which it is considered acceptable for a person to experience such intense pain while under medical care.<sup>1</sup>

Although labor pain does not threaten the life of a parturient, it has important consequences for the mother and fetus. Physiological responses to pain during vaginal delivery influence maternal and fetal well-being, as well as the evolution of labor. High levels of pain lead to hyperventilation and maternal respiratory alkalosis, with a consequent shift of the oxyhemoglobin dissociation curve to the left, which decreases oxygen transport to the fetus.<sup>2</sup>

Pain, stress, and anxiety increase the release of cortisol and catecholamines that affect uterine activity and uteroplacental blood flow.<sup>3</sup> Adrenaline, for example, has tocolytic action and may lead to uncoordinated uterine contractions, corrected after adequate labor analgesia.<sup>2</sup>

Moreover, postpartum depression may be more common when analgesic techniques are not used, and the severity of pain during childbirth may be related to the development of post-traumatic stress syndrome.<sup>3</sup>

Therefore, the use of analgesic techniques to relieve labor pain has become more and more frequent. Among them, neuraxial analgesia (epidural, spinal anesthesia, and combined spinal-epidural anesthesia) is considered the most effective.<sup>4</sup>

Its use has increased progressively, particularly in developed countries. In the Netherlands, between 2000 and 2009, the number of nulliparous and multiparous patients receiving neuraxial analgesia tripled (from 7.7% to 21.9% and from 2.4% to 6.8%, respectively).<sup>5</sup> In England, 33% of the women opted for neuraxial analgesia between 2010 and 2011.<sup>6</sup> In

the United States, 61% of the parturients receive neuraxial analgesia to relieve labor pain.<sup>7</sup>

The effects of neuraxial analgesia techniques on labor and its outcome are grounds for discussion. Analgesia does not seem to affect the incidence of Cesarean sections (C-sections), but may increase the chance of instrumental vaginal delivery, in addition to prolonging the second stage of labor; however, without changing the prognosis. The assessment of the risks and benefits of neuraxial delivery analgesia should be individualized and discussed with each parturient.<sup>8</sup>

Thus, even in large centers, where neuraxial analgesia is available and routinely used, effective and well-tolerated options should be available for patients presenting with contraindications to neuraxial blockade, who desire less invasive techniques, or in pregnant women with rapidly progressive deliveries and no other more effective methods are readily available.<sup>9</sup>

There are pharmacological and non-pharmacological techniques that may be offered to pregnant women to relieve labor pain. Non-pharmacological analgesic techniques such as hydrotherapy, acupuncture, and transcutaneous electrical nerve stimulation are available.<sup>10</sup>

Pharmacological techniques, besides neuraxial, include peripheral blockades (paracervical and pudendal), inhaled analgesia (nitrous oxide and halogenated), and intravenous analgesia (opioids and non-opioids).<sup>11,12</sup>

The aim of this review is to discuss the main pharmacological techniques of labor analgesia available, among them the neuraxial, inhaled and intravenous (remifentanyl) techniques, as well as to evaluate the advantages and disadvantages associated with each technique. We will also discuss induction techniques (epidural, combined spinal-epidural, continuous spinal, dural puncture epidural) and maintenance of analgesia (intermittent epidural bolus,

continuous epidural infusion, patient-controlled epidural analgesia, computer-integrated patient-controlled epidural analgesia).

## Methods

A bibliographic search was performed in the Medline/PubMed virtual library. The following descriptors were used for the search: labor analgesia, neuraxial analgesia, and obstetrics outcomes.

We included in this review articles in English or Portuguese, published between 2011 and 2016, available in full text, or abstracts in which the methodologies were randomized clinical trials, literature reviews, meta-analyses or systematic reviews.

The bibliographic search was conducted from July to October 2018.

## Neuraxial analgesia

### Induction of analgesia

#### Epidural

Epidural anesthesia is the most commonly used technique for treating labor pain. However, maternal-fetal repercussions are a matter of debate regarding the increased incidence of C-sections, a greater chance of instrumental vaginal delivery and prolonged labor, in addition to the time at which epidural analgesia is performed.

In a Cochrane review evaluating the effects of epidural analgesia on labor, a longer second stage of labor (13.66 min, 95% CI 6.67–20.66) and an increased incidence of instrumental vaginal delivery (RR = 1.42, 95% CI 1.28–1.57) were seen without altering the incidence of C-sections or fetal prognosis.<sup>13</sup> In another review comparing early or late epidural anesthesia in labor, there was no difference in the assessed outcomes (incidence of C-sections, vaginal delivery with instrumentation, labor second stage duration, Apgar score, umbilical cord blood pressure), indicating that the mother's desire alone is enough for analgesia.<sup>10,14</sup>

The local anesthetic traditionally used is bupivacaine in concentrations of 0.25%. This practice has undergone changes and the concentration of epidural local anesthetic has been reduced, as it is known that higher concentrations are associated with prolonged labor, need for oxytocin, increased instrumental delivery, and significant motor blockade, hampering the pull and limiting ambulation during labor.<sup>13</sup> Thus, low doses (0.1%) or ultra-low doses (0.0625%) of opioid-associated bupivacaine have been used with a low incidence of adverse effects and satisfactory analgesia.<sup>15</sup>

In a meta-analysis comparing the effects of labor analgesia with high and low concentrations of local anesthetic (concentrations less than or equal to 0.1% bupivacaine or less than or equal to 0.17% ropivacaine), the incidence of vaginal delivery was higher in parturients receiving high concentrations of local anesthetic (OR = 0.7, 95% CI 0.56–0.86,  $p < 0.000$ ). Additionally, low concentrations improved the other obstetric outcomes (shorter second stage of labor) and had a lower incidence of side effects (lower incidence of motor blockade and urinary retention, as well as better walking ability), without compromising analgesia.<sup>16</sup>

Shen et al., in a study with pregnant women under patient-controlled epidural analgesia with 0.08% ropivacaine + sufentanil ( $0.4 \text{ mcg} \cdot \text{mL}^{-1}$ ) during the first stage of labor, randomized pregnant women in the second stage of labor to receive infusion of the same solution or placebo and observed adequate control of pain with no effect on second stage duration, incidence of vaginal delivery, incidence of episiotomy, fetal position or measures of fetal well-being.<sup>17</sup>

Ropivacaine, a levorotatory propionic homologue of bupivacaine, produces effective analgesia comparable to that of bupivacaine, with no difference in the incidence of spontaneous vaginal delivery, duration of second stage of labor, instrumental vaginal delivery, and incidence of C-sections. On the other hand, ropivacaine is associated with a lower incidence of motor blockade than bupivacaine and lower cardiotoxicity.<sup>18</sup>

In a meta-analysis comparing bupivacaine ( $0.1023\% \pm 0.0375\%$ ) and ropivacaine ( $0.1095\% \pm 0.042\%$ ), associated with fentanyl ( $0.00021\% \pm 0.00089\%$ ), there was a greater incidence of motor blockade measured by the Bromage scale in parturients receiving bupivacaine than in those receiving ropivacaine (32.8% and 18.4%, respectively,  $p < 0.00001$ ), and the incidence of motor blockade was higher with higher concentrations of ropivacaine and bupivacaine, reaching statistical significance only in the latter. It was also observed that when raising the fentanyl concentration from 0.0001% to 0.00025%, there was a decrease in the incidence of instrumental delivery in the ropivacaine group, but not in the bupivacaine group.<sup>19</sup>

Le Gouez et al. determined the effective concentration of levobupivacaine and ropivacaine in 80% of the patients (EC80) who received epidural analgesia in the first stage of labor, with a dilation of less than or equal to 5 cm, using the continual reassessment method. In the study it was found that the EC80 of levobupivacaine and ropivacaine is about 0.17% and 0.2%, with 82% and 72% probability of success, respectively, which translate a levobupivacaine: ropivacaine potency ratio at the EC80 level of 1.7 for epidural labor analgesia.<sup>20</sup>

#### Combined spinal-epidural

Combined spinal-epidural involves the administration of analgesic drugs, local anesthetics or both via intrathecal and epidural routes. Although variations have been described, the procedure is usually performed with an epidural needle to identify the epidural space, followed by insertion of a long needle for subarachnoid puncture and administration of drugs (usually a local anesthetic, opioids or both) into the cerebrospinal fluid. This needle is then removed and an epidural catheter is inserted through the epidural needle. In this way, analgesia can be maintained throughout labor. This technique has gained popularity for having advantages over traditional epidural, such as quicker installation of effective analgesia, possibility of ambulation during labor, in addition to allow the introduction of an epidural catheter for subsequent analgesia or C-section.<sup>21</sup>

Moreover, traditional epidural analgesia with high doses of local anesthetic was associated with longer second stage of labor, increased need for oxytocin, and increased risk of instrumental vaginal delivery.<sup>13</sup>

However, these advantages are seen when combined spinal-epidural is compared with the so-called traditional epidural analgesia, in which local anesthetics are used at high concentrations (above 0.25%), associated or not with opioids. With the use of lower concentrations (0.125–0.0625% bupivacaine and 0.17% ropivacaine), there are no differences between the epidural or combined spinal-epidural techniques regarding the incidence of C-sections, use of forceps, need for oxytocin to increase labor, side effects in pregnant women (hypotension, urinary retention, nausea and vomiting, post-dural puncture headache), need for rescue analgesia, neonatal prognosis (umbilical pH, Apgar score, admission to the neonatal intensive care unit), and maternal satisfaction with the technique chosen.<sup>22</sup>

One of the most common side effects of neuraxial administration of opioids is pruritus. Although this unpleasant effect is present in both epidural and combined analgesia, it is much more common after the administration of opioids via intrathecal than via epidural.<sup>23</sup> Compared with epidural with low doses of local anesthetic, it is known that combined spinal-epidural analgesia has a higher incidence of pruritus (RR = 1.80, 95% CI 1.22–2.65).<sup>22</sup>

Therefore, there is great debate about which technique offers superior analgesia during labor, when epidural analgesia with low concentration of local anesthetic and spinal-epidural are compared. Issues such as the effective analgesia time, need for rescue doses, total dose of anesthetics, need for epidural catheter repositioning, and incidence of fetal bradycardia raise doubts about which technique would be superior for induction of labor analgesia.

The induction of labor analgesia with the combined spinal-epidural technique is faster compared to that of epidural. In a meta-analysis involving 461 parturients, in which the two neuraxial techniques were compared, an average reduction of 5.42 min (95% CI –7.26 to –3.59) was found for the onset of effective analgesia with the combined spinal-epidural anesthesia.<sup>22</sup>

The induction of analgesia with the combined spinal-epidural technique raises doubts about the time required to detect failures in the epidural catheter positioning, since analgesia begins with the intrathecal dose, it may mask the catheter incorrect positioning.<sup>23</sup> Pan et al. in an observational study involving 19,259 deliveries, of which 75% of the parturients received combined spinal-epidural or epidural analgesia, found that parturients who received epidural compared to combined spinal-epidural had a higher failure rate (14% vs. 10%;  $p < 0.001$ ), higher incidence of inadequate analgesia (8.4% vs. 4.2%;  $p < 0.001$ ), higher incidence of epidural catheter replacement due to inadequate analgesia (7.1% vs. 3.2%;  $p < 0.001$ ), and a higher incidence of multiple catheter replacement (1.9% vs. 0.7%;  $p < 0.001$ ).<sup>24</sup>

In a study involving 5487 labor analgesia administrations (combined spinal-epidural or epidural), the epidural catheter replacement index was low with both techniques, but higher in the epidural group (2.1% and 3.9%, respectively;  $p < 0.001$ ). The lower incidence of failure in epidural catheter placement requiring replacement in the spinal-epidural group can be explained by the presence of cerebrospinal fluid after the subarachnoid puncture, which helps to confirm the needle correct positioning. The authors found that catheter placement failure tends to be more frequent and detected earlier in the epidural group, but the

detection of late failures (over 3–4h) is similar between groups. It is known that late failures are related not to the initial incorrect positioning of the catheter, but to other factors, such as catheter migration.<sup>25</sup>

The experience of anesthesiologists also affects the quality of labor analgesia. In a study carried out in a private center with experienced anesthesiologists, Gambling et al. found that parturients receiving combined spinal-epidural anesthesia completed analgesia on average 11 min faster, had lower pain scores in the first stage of labor, and received fewer rescue doses than the group receiving epidural analgesia with low doses of local anesthetic. There was no difference between groups regarding the need for epidural catheter replacement.<sup>26</sup>

Combined analgesia has been associated with changes in fetal heart rate, mainly decelerations and fetal bradycardia. Among the hypotheses proposed to explain the association between combined analgesia and cardiocardiographic alterations, we can mention reduced uteroplacental blood flow, secondary to sympathetic block, and uterine hyperactivity, which would occur with the rapid relief of pain achieved with the intrathecal component of combined analgesia, mainly due to the use of opioids, which leads to a dramatic reduction in plasma levels of epinephrine and  $\beta$ -endorphins. This change causes the unopposed action of oxytocin and noradrenaline, resulting in uterine hypertonia. Hypertonia could lead to reduced uterine blood flow and/or cause rapid descent, vagal response in the fetus, and lead to changes in fetal heart rate.<sup>27–29</sup>

In a study with 77 parturients who requested labor analgesia and who randomly received combined or epidural analgesia, uterine contraction (through an intrauterine pressure catheter) and fetal heart rate were evaluated before and after analgesia. Parturients receiving combined analgesia compared to those receiving epidural anesthesia had a higher incidence of uterine hypertonia (17 vs. 6,  $p = 0.018$ ), higher incidence of fetal heart beating abnormalities (13 vs. 2,  $p < 0.01$ ) and coincidence between events (11 vs. 1;  $p < 0.01$ ). The type of analgesia was the only independent predictor factor of uterine hypertonia (OD = 3526; 95% CI 1.21–10.36;  $p = 0.022$ ). Regarding the occurrence fetal heart rate abnormalities, uterine hypertonia was an independent factor (OD = 18,624, 95% CI 4.46–77.72;  $p < 0.001$ ). It was also evidenced that the quicker the pain relief after analgesia, as in combined analgesia, the greater the probability of uterine hypertonia and fetal heart rate abnormalities.<sup>30</sup>

Patel et al. compared the fetal heart rate patterns of parturients receiving combined or epidural analgesia 30 min before and 60 min after analgesia and concluded that in both techniques there was a significant increase in abnormal heart rate patterns ( $p < 0.0001$ ), without altering the neonatal prognosis. It was further noted that the deterioration of the fetal heart rate pattern is multifactorial, but usually transient, and resolved spontaneously or as a result of intrauterine fetal resuscitation maneuvers, such as reduction or discontinuation of oxytocin prior to blockade, fluid administration, and reduced dose of intrathecal opioids.<sup>31</sup>

In a study involving 596 parturients undergoing combined analgesia, the ability of ephedrine to prevent early profound fetal bradycardia (primary outcome), defined as fetal heart

rate below 90 beats per minute for more than two minutes, was evaluated in the first 30 min after the blockage. Parturients were randomized into two groups to receive ephedrine (10 mg) or placebo (saline solution). Abnormal patterns of fetal heart rate, tachysystole, and uterine hypertonia (secondary outcomes) were also evaluated. No differences were seen between groups, and the authors concluded that ephedrine is ineffective for preventing early profound fetal bradycardia.<sup>32</sup>

### Continuous spinal anesthesia

Continuous spinal anesthesia consists of intentionally inserting a catheter through the dura mater into the subarachnoid space for intrathecal administration of local or opioid anesthetics. The Food and Drug Administration (FDA) banned the use of continuous spinal anesthesia catheters with diameters smaller than 24G after reports of cauda equina syndrome. However, it was not clear whether the occurrence of this complication was due to intrathecal micro-catheter placement or hyperbaric lidocaine administration at high concentrations (5%).<sup>33</sup>

The fear of cauda equina syndrome with the use of micro-catheters caused macro catheters (sometimes even epidural catheters) to be used for introduction into the subarachnoid space. However, even if care is taken in selecting larger caliber catheters and administering local anesthetics in smaller concentrations, the use of intrathecal catheters is much lower due to the fear of neurological lesions (transient neurological syndrome or cauda equina syndrome) and higher incidence of post-dural puncture headache, as the dura mater opening would be bigger.<sup>2</sup>

In a retrospective review, Cohn et al. evaluated 761 intrathecal catheters (19G and 20G), which were intentionally placed (108 parturients) or after inadvertent dural puncture (653 parturients) in obstetric patients. There were no serious complications such as meningitis, abscesses, hematomas, arachnoiditis or cauda equina syndrome. On the other hand, there was a high incidence of post-dural puncture headache (41%). Obesity (53.7%), puncture or epidural failure (26.9%), and cardiopulmonary diseases (13.9%) were among the most common causes for the option of continuous spinal anesthesia (deliberate dural puncture).<sup>34</sup>

In an observational study, Tao et al., Evaluated 113 parturients who received labor analgesia through intrathecal catheters (23G) and with an internal needle (27G), no neurological lesions were seen in the 30th day evaluation. Additionally, a low incidence of post-dural puncture headache was observed in 2.6% (95% CI 0.7–8.1%), which was related to the fact that the catheter was maintained in the subarachnoid space for at least 12 h.<sup>35</sup> Some investigators have suggested that the introduction of a catheter into the subarachnoid space after inadvertent dural puncture and its permanence for a certain period of time may reduce the incidence of post-dural puncture headache.<sup>35</sup>

On the other hand, it was evidenced that a good part of the parturients had an important motor block (Modified Bromage Scale median of 4<sup>3,4</sup>) with 10 min, 20 min, two hours and complete cervical dilatation.<sup>36</sup>

Thus, it is preferable to choose catheters with intermediate diameters to reduce the incidence of post-dural puncture headache, in addition to catheter maintenance for a certain period of time (between 12 and 24h). Micro-catheters should be avoided. Moreover, the use of continuous spinal anesthesia for labor analgesia may be considered in pregnant women who present physical characteristics related to difficult epidural puncture (morbid obesity and scoliosis or others), difficult catheter placement or after inadvertent dural puncture.

### Dural puncture epidural

The dural puncture epidural technique consists of dural puncture immediately before the beginning of epidural analgesia, without administration of anesthetics into the subarachnoid space. Thus, using the material for combined spinal-epidural, the epidural procedure is performed as usual, followed by dural puncture with a spinal anesthesia needle, without the injection of anesthetics into the subarachnoid space and epidural catheter passage. This technique would allow the passage of the anesthetics administered into the epidural space to the subarachnoid space through the puncture orifice of dura mater, improving the quality of analgesia. In a study involving 80 nulliparas with cervical dilation undergoing conventional or dural puncture epidural, Cappiello et al. found that parturients in the dural puncture epidural group had more frequent S1 dermatome block, visual pain scale scores below 10/100 at 20 min, and lower incidence of unilateral blockade.<sup>37</sup>

On the other hand, this technique has not gained popularity, as its efficacy is superior when the dural puncture is performed with 25G needles, which may increase the risk of post-dural puncture headache.<sup>15</sup>

### Maintenance of analgesia

#### Continuous epidural analgesia

This technique consists of continuous infusion of a solution with local anesthetics (usually associated with opioids) into the epidural space, at a rate to be defined according to the parturients response. A decrease in the number of doula interventions and a reduced risk of infection are among the advantages of this technique. On the other hand, there is an association between continuous infusion and increased consumption of local anesthetics and increased incidence of motor block.<sup>15</sup>

#### Intermittent epidural bolus

This technique involves the administration of local anesthetics, associated or not with opioids, as intermittent boluses into the epidural space at scheduled intervals. This would lead to greater dispersion of the local anesthetic into the epidural space.<sup>38</sup> Thus, the same dose of anesthetic that would be administered continuously, when administered in intermittent epidural boluses may result in higher quality analgesia. When compared to the continuous infusion technique, the intermittent epidural bolus is related to a lower duration of the second stage of labor (–12 min, 95% CI –23 to 0) and reduction of the total dose of local anesthetics (–1, 2 mg bupivacaine equivalent per hour; 95% CI –2.2 to

–0.3). However, there are no differences in the incidence of additional anesthetic interventions or type of delivery.<sup>39</sup>

Intermittent epidural bolus may be used as an option for continuous epidural analgesia, alone or in combination with patient-controlled epidural analgesia. There are studies comparing intermittent epidural bolus associated with patient-controlled epidural analgesia and continuous epidural analgesia associated with patient-controlled epidural analgesia, with varying results but suggestive of benefits regarding the use of the intermittent epidural bolus technique.<sup>40–42</sup>

In a study by Capogna et al., which compared the continuous and intermittent bolus infusion techniques associated with patient-controlled epidural analgesia and was designed to detect differences in instrumental delivery rates, it was seen that the technique with intermittent bolus shows significant reduction (7% vs. 20%;  $p=0.03$ ).<sup>40</sup>

In a retrospective review of vaginal delivery medical records with neuraxial analgesia, which compared the results before and after the introduction of intermittent bolus associated with patient-controlled epidural analgesia with a device designed for such purpose, a 7% reduction was found in the need for rescue boluses (19% vs. 12%;  $p=0.01$ ), reducing the need for team interventions. However, both techniques provided satisfactory analgesia without differences in pain scores.<sup>43</sup>

Most centers use manual intermittent epidural bolus or devices that are not designed for intermittent epidural bolus administration. Thus, more studies are needed before replacing infusion pumps with devices designed to deliver intermittent epidural bolus.

### Patient-controlled epidural analgesia

It is a mode of epidural drug administration that allows the patient to administer intermittent bolus of a maintenance solution. The schedule (bolus dose, lockout time, basal infusion rate, and maximum dose) is usually decided by the anesthesiologist. The use of patient-controlled epidural analgesia is related to a reduction in local anesthetic total volume without reducing the quality of analgesia, thus reducing the incidence of side effects.<sup>44</sup> In a review involving 19 studies comparing continuous infusion and patient-controlled epidural analgesia, the latter presented advantages, such as reduced consumption of local anesthetics, lower incidence of motor block, lower pain scores, lower number of anesthesiologist and doula interventions, and greater maternal satisfaction.<sup>45</sup>

The schedule of patient-controlled epidural analgesia with or without basal infusion is still a matter of debate. Some studies have shown that basal infusion reduces pain scores and incidence of severe pain requiring medical intervention, without increasing anesthetic consumption.<sup>46,47</sup> On the other hand, there are studies showing an increase in anesthetic consumption without improvement in analgesia.<sup>48</sup>

Loubert et al., in a review of the literature, found that most studies recommended moderate basal infusion (between 4 and 6 mL.h<sup>-1</sup>); it was possible to reduce pain scores without increasing the incidence of side effects.<sup>49</sup> Halpern and Carvalho evaluated six studies comparing various patient-controlled epidural analgesia schedules and

suggested that the use of larger bolus and greater lockout times would lead to greater distribution of anesthetics in the epidural space and would improve the quality of analgesia. However, there were no benefits regarding the number of rescue doses made by anesthesiologists and maternal satisfaction.<sup>50</sup>

In a recent meta-analysis involving 891 pregnant women and comparing patient-controlled epidural analgesia with or without continuous infusion, Heesen et al. concluded that the rate of instrumental vaginal delivery was higher in pregnant women who received continuous basal infusion (RR = 1.66, 95% CI 1.08–2.56,  $p=0.02$ ), as well as prolonged second stage of labor (12.3 min, 95% CI 5.1–19.5,  $p=0.0008$ ) and consumption of ropivacaine equivalents. However, due to the heterogeneity of the studies, the authors conclude that no conclusion could be drawn regarding the risks or benefits of adding continuous infusion to patient-controlled epidural analgesia.<sup>51</sup>

### Computer-integrated patient-controlled epidural analgesia

A promising area that has been developed is the computer-integrated patient-controlled epidural analgesia (CIPCEA), which automatically adjusts the basal infusion based on CIPCEA demands.<sup>10,43</sup>

Although patient-controlled epidural analgesia increases the mother's ability to control her pain relief, it does not allow any variation in basal infusion rate, whose role becomes more important in the later stages of labor. It has been shown that there is greater maternal satisfaction and reduced incidence of pain periods without increasing local anesthetic.<sup>10,43</sup>

### Conclusion

Childbirth is a unique and exciting time for pregnant women. However, the pain can be severe, with important consequences for both mother and fetus. Thus, the maternal request is sufficient for an indication of analgesia. Among the various techniques of labor analgesia available, the neuraxial route is considered to be the most effective; the epidural is the most commonly used technique. In order to avoid local anesthetic side effects and to achieve the least possible motor block, solutions in much smaller concentrations have been used successfully. The combined spinal-epidural technique has as its main advantage the rapid onset of analgesia, but it is associated with a higher incidence of pruritus when opioids are administered into the subarachnoid space. Both techniques are equally safe for induction of labor analgesia. For the maintenance of analgesia, the currently used techniques are continuous epidural, CIPCEA, and intermittent epidural bolus. Due to the great heterogeneity of the studies, it is not possible to determine the best technique, but all demonstrate similar neonatal and obstetrical outcomes and satisfactory relief of maternal pain.

### Conflicts of interest

The authors declare no conflicts of interest.

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