



Revista Colombiana de Anestesiología

Colombian Journal of Anesthesiology

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Review

Test dose in regional anesthesia[☆]



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ARTICLE INFO

Article history:

Received 12 June 2013

Accepted 26 October 2013

Available online 2 January 2014

Keywords:

Anesthesia
Conduction
Anesthesia
Local
Toxicity
Anesthesia
Epidural
Lidocaine

ABSTRACT

Introduction: The use of the test dose in regional anesthesia is not standardized, and there is no consensus regarding what dose it should be or about the anesthetic or type of drug to be used. Moreover, many anesthesiologists do not use it routinely in their practice.

Objective: To review the test dose for regional anesthesia, its indications and utility, the drugs used, and positive signs.

Methods: A non-systematic search was conducted in medical database publications including MedLine, SciELO and Embase.

Results: The application of the test dose before giving the full injection of the local anesthetic helps in detecting the inadvertent placement of the needle or catheter in the intravascular or the subarachnoid spaces.

Conclusions: The test dose must be used every time critical doses of a local anesthetic are utilized or when normal doses are given to patients with risk factors. The test dose is not necessary in labor analgesia.

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Dosis de prueba para anestesia regional

RESUMEN

Introducción: El uso de la dosis de prueba en anestesia regional no está estandarizado: no existe consenso sobre su dosis, el anestésico o el tipo de fármaco que se debe utilizar, y muchos anestesiólogos no la utilizan rutinariamente en su práctica.

Objetivo: Hacer una revisión de la dosis de prueba para anestesia regional, sus indicaciones, su utilidad, los fármacos utilizados para ella y los signos considerados como positivos.

Métodos: Se realizó una búsqueda no sistemática de publicaciones en bases de datos médicas que incluyeron MedLine, SciELO y Embase.

Resultados: La aplicación de la dosis de prueba previa a la inyección total de anestésico local ayuda a detectar la colocación inadvertida de una aguja o catéter en el espacio intravascular o subaracnoideo.

Palabras clave:

Anestesia de conducción
Anestesia local
Toxicidad
Anestesia epidural
Lidocaína

[☆] Please cite this article as: Galindo Gualdrón LA. La dosis de prueba para anestesia regional. Rev Colomb Anestesiolog. 2014;42:47-52.

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Conclusiones: La dosis de prueba debe utilizarse siempre que se utilicen dosis críticas de anestésico local o incluso dosis normales en pacientes con factores de riesgo. En analgesia para trabajo de parto la dosis de prueba no es necesaria.

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Introduction

In all procedures where substantial doses of local anesthetic are used there is a possibility of the inadvertent injection into the intravascular or subarachnoid space, or of massive systemic absorption and subsequent toxicity.

Even at therapeutic doses, the inadvertent administration of the local anesthetic into the intravascular space may have fatal consequences, and resuscitation following local anesthetic-induced circulatory collapse is very difficult.¹ Consequently, early identification, a high degree of suspicion, and constant application of various preventive measures are required.²

The consensus of the American Society of Regional Anesthesia underscores the importance of prevention in reducing the frequency and severity of toxicity due to local anesthetics. Although imperfect, the test dose is the most reliable method for the early detection of intravascular^{3,4} or intra-spinal placement of a needle or catheter.

The goal of the test dose in regional blocks is to rule out inadvertent intravascular injection, while in epidural blocks the goal is to rule out the presence of the needle or the catheter either in the subarachnoid or the intravascular space.

The use of the test dose is not standardized, as there are multiple controversies regarding its safety, and there is no consensus about the dose, the anesthetic or the type of drug to be used. In obstetrics, for example, despite the fact that not giving a test dose before an emergency cesarean section is associated with severe consequences for the mother and the fetus, most obstetric anesthesiologists in Britain do not use a test dose⁵ in patients, previously managed with peridural analgesia, taken to emergency cesarean section. In our setting, although there are no statistics, this practice is also very common.

Hence the importance of reviewing the indications, utility, positive results, and the way of using the test dose.

Methods

A non-systematic search was conducted in medical database publications including MedLine, SciELO and Embase. The following MESH terms were used: regional anesthesia and test dose, local Anesthetic and Toxicity.

The test dose

Ideally, a test dose must detect the wrong placement or migration of the needle or catheter into the intravascular or the subarachnoid space, and never yield a false positive response. It must be safe, effective and reliable, allowing practical interpretation within a reasonable period of time.^{6,7}

In order to detect subarachnoid placement, the test dose must prevent a high block leading to respiratory problems or cardiovascular instability.^{8,9} In order to detect intravascular placement, it must be able to elicit clear clinical signs and symptoms of toxicity of rapid onset, either cardiovascular or of the central nervous system; these should resolve rapidly and have little probability of causing harm.¹⁰

Multiple studies have tried to determine the components of an effective test dose.⁹⁻¹² Moore and Batra conclude that the test dose for peridural block must contain 0.015 mg of epinephrine in order to detect the intravascular component, and local anesthetic to induce prompt spinal anesthesia.¹³

The use of lidocaine as a single component of the test dose has been described, with reports of presentation of atypical symptoms.¹⁴ When direct intravascular injection occurs, prodromic signs may be missed or not appear, and the patient may move rapidly to develop seizure activity or symptoms of agitation or cardiac depression.¹⁵ Particularly with the more potent local anesthetics, cardiotoxicity may occur simultaneously with seizures, or even precede them.¹⁴

Studies with ropivacaine and levobupivacaine have shown several limitations regarding the use of these two drugs as a test dose.^{16,17}

The use of hyperbaric solutions has been recommended in test doses in order to limit the extent of the block, should the injection go to the subarachnoid space.¹⁸⁻²² However, due to the commercial unavailability of preparations containing hyperbaric lidocaine and epinephrine, many authors continue to recommend the dextrose-free solution.^{21,22}

Hemodynamic changes brought about with the test dose with epinephrine are usually not observed or are hidden or diminished in the elderly, in patients with sedation, beta-blockers or under general anesthesia, in women in labor^{3-5,13} and in patients with low output.² This has created the need for alternative methods for determining whether the catheter or needle for regional block has been placed in the intravascular space. Some proposed methods include: an injection of 1-2 cm³ of air during chest auscultation, using Doppler evidence for the presence of air.²³ In children under general anesthesia, changes in T-wave amplitudes have been described after administering epinephrine, as a reliable indicator of accidental intravenous injection.^{6,24-26} In labor, it has been found that fentanyl can be used reliably and safely as an intravenous test dose.^{27,28}

Among the various options, only fentanyl and epinephrine meet the suggested applicability and reliability standards for the detection of intravascular injection, according to the American Society of Regional Anesthesia. It has been shown that 100 mcg of intravenous fentanyl produces reliable symptoms of drowsiness and sedation in patients in labor.^{4,27} As for epinephrine, a dose of 10-15 mcg/ml has a positive predictive value and 80% sensitivity for the detection of intravascular injection in adults if heart rate increases by 10 or more beats

per minute, or if the systolic blood pressure rises by 15 mmHg or more.^{3,4,7}

Finally, it is important to bear in mind that a negative test dose does not mean that there is no risk of incorrect placement or migration of the needle or catheter. A test dose is of diagnostic value only when it is positive; a slow injection with frequent aspirations and continuous electrocardiographic monitoring while administering the drug continues to be mandatory.^{1,6}

Review

Test dose in epidural analgesia for labor

The indication of the test dose in peridural analgesia for labor is controversial.

The addition of epinephrine to the intra-thecal component of the test dose in women in labor is sensitive but not specific; this means that a certain percentage of positive responses do not represent a true intravascular placement of the peridural catheter, leading to unnecessary removal.²⁹

The test dose with lidocaine before initiating peridural analgesia may cause motor blockade and interfere with proper ambulation during the first 30–60 min.^{12,30}

It is believed that the accidental injection of low-dose, low-concentration solutions of local anesthetics, used frequently in labor analgesia, does not cause systemic toxicity,³¹ and that the test dose is unnecessary considering that ultra-diluted solutions commonly used, together with aspiration, are usually diagnostic in themselves.^{29,32,33}

Considering that not only local anesthetics but also opioids are used in obstetric analgesia, there are reports of changes in fetal heart rate and uterine hypertonia with intra-thecal or intravascular injections. Consequently, in cases where an epidural mix containing opioids is used for analgesia, careful monitoring and correct interpretation of fetal heart rate are required.^{34–36}

It is also important to consider that when therapeutic analgesic doses are used as a test dose, the total dose may be equivalent to the one used for subarachnoid anesthesia. Therefore, if the catheter is placed intra-theccally, the mother will present sensory motor block and hemodynamic compromise, which may affect fetal wellbeing.³¹

Birnbach and Browne conclude that, regardless of the technique used, the safe practice for the administration of epidural analgesia in labor requires initial catheter aspiration, gradual dose increases and continuous monitoring during and after catheter placement in order to detect any sign of anesthetic toxicity, bearing in mind that an epidural analgesia infusion that has been working well and stops having the desired effect may be an indication of catheter migration.^{33,37}

Test dose in cesarean section

Peridural anesthesia, with or without a catheter, may give rise to complications due to inadvertent intravascular or subarachnoid puncture. In such circumstance, the injection of critical amounts of local anesthetic may be life threatening.³⁸

The incidence of inadvertent intravascular injection in obstetric patients is estimated to range from 4.9% to 7%,

higher than the 2.8% rate in non-pregnant patients,^{10,29} and drops from 0.6% to 2.3% with aspiration before the injection.^{31,39,40} Subarachnoid catheterization occurs approximately in 0.6–2.7% of cases, and is usually detected because of the exit of cerebrospinal fluid through the needle or catheter.^{12,31,41}

There are multiple reports of inadvertent intravenous injections for cesarean section in catheters that had been working normally and had been tested for peridural analgesia⁴²; this may happen due to catheter migration⁴³ or, as shown by

Hogan,⁴⁴ in multiport catheters: with slow, low-pressure injection, the fluid exits through the proximal orifice; when the fluid is injected more rapidly or under greater pressure, the flow occurs mainly through the distal orifice. Consequently, if the catheter is placed only partially in the subarachnoid space, the continuous peridural analgesia infusion may be delivered through the proximal orifice into the peridural space, but when the total anesthetic dose for cesarean section is delivered at a faster rate, it may flow through the distal orifice into the subarachnoid space. It may be inferred that the same thing may happen if the catheter is partially placed into the intravascular space.

Routine aspiration of the catheter will usually identify incorrect placement, but aspiration may yield false positive results.¹²

In cases of elective cesarean section, the use of a test dose is mandatory.³¹

It is not clear whether epinephrine should be used in obstetric patients, whose unique conditions may affect the sensitivity and applicability of the test. These conditions include uterine contractions, pre-eclampsia, lower thresholds for heart rate increases, and risk of reduced uterine blood flow; regarding the latter, there are no clinical data of fetuses that have sustained harm or been at risk as a result of the test dose.^{45,46}

In view of all of the above, many authors have studied fentanyl as a test dose and have found that, if delivered intravascularly, it produces predictable and easily detectable symptoms, with a 92.4% sensitivity and a 92% specificity. Therefore, they suggest the use of 100 mcg as an intravascular test dose in obstetric patients.^{4,7,27,28}

For Colona et al., the controversy on the use of epinephrine in the test dose is non-existent in elective cesarean section. In this case, a sudden increase in maternal heart rate by more than 10 beats per minute, lasting 30–60 s, within the first 30 s after the administration, is considered a safe sign of intravascular placement.⁴⁷

In patients taken to emergency cesarean section, the time delay in establishing the block for the surgery because of the test dose is insignificant compared to the risk to which the patient may be exposed. Despite maternal heart rate variability, it is easy to detect the rapid development of a peak maternal heart rate following the intravascular injection of 12.5 mcg of epinephrine.⁴⁸ Nonetheless, Rueda et al., recommend, in patients scheduled for urgent cesarean section, NICE categories 2 and 3 who come with peridural analgesia, the use of 2% lidocaine plus epinephrine as anesthetic, considering its low neurological and cardiovascular toxicity profile and reduced latency time.⁴⁹

Due to large volumes of local anesthetics delivered to the epidural space for cesarean section, several authors recommend various measures to reduce the risk of toxicity from local anesthetics. First, before using it, catheter aspiration is required and the appropriate test dose must be administered. Second, the anesthetic must be delivered in fractionated doses. Finally, the drugs of choice must preferably be safe drugs like chlorprocaine and lidocaine, or the new amine-type local anesthetics like ropivacaine and levobupivacaine.^{3,31,37}

Test dose using the combined spinal-epidural technique

When this technique is used, the onset of analgesia is fast and it is not possible to test the peridural catheter until the effects of the initial spinal dose fade away. The greatest disadvantage is that the real location of the peridural catheter is uncertain during this period. In any case, the test dose is recommended every time the peridural catheter is used initially either for a rescue dose or for post-operative pain management.^{31,50,51}

Considering that an intentional arachnoidal perforation is made, there is concern of a greater possibility of migration of the peridural catheter tip.⁵¹ However, such an event would occur only after multiple dural perforations, considering the impossibility of introducing an epidural catheter through a dural orifice previously made with a 25-gauge needle.⁵²

Test dose for procedures under peridural anesthesia

Although the test dose given before the induction of epidural anesthesia may take 5–10 min longer, knowing whether the catheter is placed correctly is better quality care and offers enhanced safety for perioperative care.⁵³

Test dose in pediatrics

Regional caudal and epidural analgesia are accepted as safe and reliable methods for delivering perioperative analgesia in children.^{54,55} An incidence of up to 5.6% of accidental intravascular puncture has been reported, and aspiration before the injection fails to detect up to 86% of intravascular placements.²⁵

The recommended epidural test dose is 0.1 ml/kg of 1% lidocaine plus 0.5 mcg/kg of epinephrine. In children, most blocks are performed under general anesthesia, which may alter hemodynamic responses to the test dose during intravascular injection.⁶ Consequently, besides careful observation of any increase of more than 10 beats per minute in heart rate or of more than 15 mmHg in blood pressure with epinephrine,²⁴ several authors have found that a more reliable parameter to detect intravascular injection are changes of 25% in T wave amplitude in lead DII of the electrocardiogram, both visually in the anesthesia monitor and in the printed EKG result, in children receiving general anesthesia with sevoflurane.^{6,24,25,56}

Test dose in peripheral nerve blocks

The use of peripheral blocks has been associated with adverse events secondary to toxicity from local anesthetics.⁵⁷

The site of the block, the intrinsic vasoactivity of the local anesthetic, the use of epinephrine, and patient-related factors

such as heart, liver or kidney disease are the most important predictors of the plasma levels of local anesthetics that may be reached.³

Although real-time ultrasound-guided blocks may be particularly useful for ensuring the correct delivery of the local anesthetic around the nerve, avoiding other structures,⁵⁸ there are no retrospective controlled studies that confirm or refute reduced toxicity due to local anesthetics, in particular when considering frequent needle movements inherent to the technique.^{59,60}

For the consensus of the American Society of Regional Anesthesia, prevention of intravascular injection must be based on a combination of ultrasound-guided block and a test dose with epinephrine, especially in procedures where large amounts of local anesthetics are used.³

Regarding the risk of nerve injury from the use of epinephrine, it is not clear if the additive injury in humans is clinically relevant over and above the primary cause of the local anesthetic itself.⁶¹

Conclusions

Systemic toxicity due to inadvertent intravascular injection of the local anesthetic may occur during any regional anesthesia technique. Consequently, an appropriate test dose with fractionated injection, adequate monitoring and immediate availability of the airway management and resuscitation equipment and, in particular, vigilant attitude, continue to be essential for ensuring patient safety.

A test dose must be used every time critical doses of local anesthetic are employed, or even normal doses in patients with risk factors, for all types of regional blocks.

The recommended drugs for the test dose are 1% lidocaine with epinephrine and fentanyl in obstetric patients. The variables that need to be monitored are heart rate, blood pressure, the T wave in the electrocardiogram, and consciousness changes.

The time delay and the risk from placing the test dose are insignificant when compared to the serious complications that may occur if the inadvertent puncture goes undetected.

In labor analgesia there is no need for a test dose, considering that the doses delivered for analgesia may play that role.

The test dose should be mandatory in patients receiving peridural anesthesia for cesarean section, because not using it means placing the patient at risk of toxicity from local anesthetics.

Funding

None.

Conflict of interest

The author has no conflicts of interest to declare.

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