Is Lidocaine Hydrocarbonate More Effective Than Lidocaine Hydrochloride in Epidural Anaesthesia for Caesarean Section?

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Caesarean section is commonly performed under regional anaesthesia because it enables the mother to be conscious of the birth of her baby and it avoids the risks of failed tracheal intubation and inhalation of gastric contents. The onset, duration, and quality of sensory blockade are determined by the intrinsic properties and dose of the local anaesthetic and the addition of procaine or lidocaine.

To achieve solubility, local anaesthetics are prepared as salts in an acidic solution, in which most of the drug is ionized. After injection, tissue buffering increases the pH and a percentage of the drug associates into a nonionized form, which penetrates the axon membrane to reach the interior of the axon. Once inside, the cellular acidity causes the drug to reionize. It is this form which blocks the sodium channels, preventing the entry of sodium into the cell and the propagation of the action potential.

Alkalinization increases the proportion of nonionized drug and enhances its diffusion across the axon membrane. Carbonation increases the proportion of the ionized form in the axon by lowering the intracellular pH. In vitro studies on isolated nerve preparations have shown that potency is increased by either alkalinization or addition of carbon dioxide to a lidocaine solution. However, clinical trials designed to define and compare the characteristics of local anaesthetics have given inconclusive and sometimes conflicting results.

Lidocaine hydrocarbonate (CO2) has been used extensively because of superior effectiveness over the hydrochloride (HCl) salt, as demonstrated in nonrandomized, nonblinded studies conducted by Bromage. Subsequent randomized and blinded trials in patients undergoing various surgeries, have not shown significant differences in the onset of maximum analgesia between lidocaine HCl and lidocaine CO2. One study did report improved motor blockade with lidocaine CO2 and improved quality of sensory blockade was reported in another. Moreover, Bromage was able to confirm his results in a later randomized, blinded trial. Comparative trials of lidocaine HCl, lidocaine CO2 and alkalinized lidocaine solutions in caesarean section are equally contradictory. A critical analysis of this literature was undertaken to determine the role of lidocaine CO2 in caesarean section.

**Lidocaine CO2 versus Lidocaine HCl in Caesarean Section**

Two randomized-controlled, double-blind studies have compared lidocaine CO2 with lidocaine HCl in elective caesarean section. In a study by Hemmings et al., forty patients received an initial bolus dose of 12 mL lidocaine CO2 or lidocaine HCl with epinephrine, followed by an 8 mL dose five minutes later. Sensory loss to pin prick was determined every three minutes until sensory block to the sixth thoracic segment of the spinal cord was obtained. Spread of block was significantly faster with lidocaine CO2. Sensory block from the fifth lumbar to the first sacral dermatome took an average of 8.8 minutes for lidocaine CO2 versus 12 minutes for lidocaine HCl. Spread from the second to the fourth sacral dermatome averaged 10 minutes for lidocaine CO2 versus 12.5 minutes for lidocaine HCl. There was no difference in latency of block to the second sacral dermatome.

These results were not confirmed in a study by Cole where 20 patients received either lidocaine CO2 or HCl without epinephrine, as a 2 mL test dose, followed by 6 mL every three minutes to a maximum of 20 mL. Both groups were reported to be similar for maternal age, weight, and parity. The onset and spread of sensory block was evaluated by analgesia to pin prick and ice every two minutes until anaesthesia was extended to the second, third and fourth sacral, and fourth thoracic segments, and the furthest dermatome. Motor block was assessed using the Bromage scale. No statistically

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thick concentration. In conclusion, it is important to note
and lidocaine CO2 or pH-adjusted lidocaine (sodium bicarbonate added for pH >7) in 3 mL incremental
duced on the skill and experience of the individual anaesthetist. Therefore, many confounding biases existed in
injection (bolus versus incremental), other factors included: the lumbar interspace selected, variations in the
and the use of nonstandard scales for the assessment of quality of analgesia.
Our review of the literature suggests that lidocaine CO2 is no more effective than lidocaine HCl. A more important
question, however, is the clinical relevance of a statistically significant faster onset of sensory block of one to
three minutes in elective caesarean section. It is therefore concluded, that the use of the CO2 formulation in
elective caesarean section is no: warranted and, as its cost is four-fold higher than lidocaine HCl, is wasteful.
In emergency situations, where time of onset is critical, lidocaine CO2 may be appropriate. The addition of bicarbonate
to lidocaine HCl solutions may be a useful therapeutic alternative.

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A significant difference in any index was
reported between the groups. However, the use of incremental doses, as opposed
to the single bolus doses used by
Hemnings et al.,7 may have masked
differences in onset of block between
the two lidocaine solutions.

Lidocaine HCl versus Alkalinized
Lidocaine in Caesarean Section
Comparisons between alkalinized and
plain lidocaine solutions have
consistently shown a faster onset with
alkalinized lidocaine. In one study,9
148 patients undergoing epidural
anaesthesia for various surgeries,
including caesarean section, were
randomly assigned to five groups.
Sodium bicarbonate or saline (which
served as a control) was added to
lidocaine solutions with epinephrine
and the anaesthetic given in 5 mL
increments every 20-30 seconds. The
time of onset of sensory blockade to
the second lumbar dermatome and the
level of analgesia were assessed at 5, 10, 15
and 30 minutes by loss of scratch
sensation. The time of onset of sensory
analgesia decreased as the pH of the
lidocaine solution increased. Greater
spread of analgesia at 5, 10 and 15
minutes was documented with the pH-
adjusted solution, but at 30 minutes the
sensory level was not significantly
different among the groups.

A recent study conducted by
Capogna et al10 randomized 116
women undergoing elective caesarean
section to receive lidocaine buffered
with sodium bicarbonate or with saline
as a control. The addition of bicarbonate
resulted in an increase of pH from 6.6
to 7.1. After a 3 mL test dose, patients
received fentanyl, then incremental
doses of 5 mL of lidocaine every two to
three minutes. Patient age, weight,
height, and gestational age did not differ
among the groups. Onset of sensory
analgesia to the first sacral segment
was significantly shorter in the bicarbonate group (15 minutes) than in
the plain lidocaine group (19 minutes).
No differences in motor block as
assessed by the Bromage scale were
noted. Fewer patients experienced pain
in the alkalinized group, but serum
fentanyl levels were higher in this group.

All Three LidoCaine Solutions
Compared in Caesarean Section
A comparison of all three types of
lidocaine was conducted by Liepert et
al.11 In his study, 60 patients presenting
for elective caesarean section received
lidocaine HCl or lidocaine CO2 or pH-
adjusted lidocaine (sodium bicarbonate added for pH >7) in 3 mL incremental
doses injected every one to two minutes.
Sensory loss to temperature and pin
prick was assessed every 30 seconds.
The time to onset of sensory block to
the first lumbar and the second sacral
segments from the time of injection
was determined. Motor block was not
assessed. The groups were similar in
height, weight, parity, volume of
lidocaine, and supplemental fentanyl. There was no statistical difference in
onset of sensory block or maximum
spread and in duration of block among
any of the groups. However, as no
normal saline control was added to the
non-alkalinized lidocaine solutions, it
is possible that the lack of a faster onset
time with alkalinized lidocaine may
have been due to its lower concentration.

In conclusion, it is important to note
that the practice of epidural anaesthesia
depends on the skill and experience of
the individual anaesthetist. Therefore,
many confounding biases existed in
the administration and assessment of
anaesthesia. In addition to the method
of injection (bolus versus incremental),
other factors included: the lumbar
interspace selected, variations in the
frequency and extent of evaluation of
block, and the use of nonstandard scales
for the assessment of quality of
analgesia.