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Bupivacaine as a Local Anesthetic for Hernia Repair

Joseph L. Ponka, MD* and James A. Sapala, MD**

Bupivacaine hydrochloride is a safe, useful local anesthetic agent for repair of groin hernias.

Prolonged anesthesia, lasting six hours or longer, was observed in 94 of 100 patients.

No toxic effects involving the central nervous system were observed using a 0.25% solution with epinephrine. Hypotension and cardiac arrhythmia occurred in one patient.

Wound complications, such as hematomas and ecchymosis, were more common with Bupivacaine than when Chlorprocaine was used.

However, painstaking hemostasis, which required ligation of even the tiniest blood vessels, reduced the wound complications. As experience is gained in the use of Bupivacaine, complications will be reduced to a minimum.

The search continues for an ideal local anesthetic agent for repair of hernias. Low incidence of toxicity, rapid onset of anesthesia and prolonged anesthetic effects are the essential qualities desired.

Most of the agents currently available for local anesthesia, including Chlorprocaine hydrochloride (Nesacaine), Mepivacaine hydrochloride (Carbocaine hydrochloride), Lidocaine hydrochloride (Xylocaaine) and Bupivacaine hydrochloride (Marcaine hydrochloride) have been found effective and remarkably safe. Although the rapidity of effectiveness following injection varies, all produce acceptable anesthesia in a reasonable time.

We continue to be interested in the total duration of local anesthesia after the operative procedure is completed. We feel that prolonged post-surgical anesthesia tends to minimize the patient's appreciation of pain and, as a result, less narcotic medication is needed. Since the patient is more easily mobilized, postoperative complications are fewer. Postoperative pulmonary complications are uncommon, and those that do occur can be more easily treated. The incidence of urinary retention can be reduced, since patients can void postoperatively if they are relatively comfortable. The avoidance of catheterization is a highly desirable objective in every postoperative patient.

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Through extensive experience, we were thoroughly familiar with the rapid onset of anesthesia following injection of Chlorprocaaine. It was safe and produced few complications. We decided to study the effects of Bupivacaine in 100 hernia repairs because it produces long duration of anesthesia.

Chemistry and pharmacology of Bupivacaine

Bupivacaine (Marcaine) is a local anesthetic agent synthesized relatively recently. In 1957 af Ekenstam et al. reported on general methods for preparation of aromatic amides of N-alkyl pyrrolidine and N-alkyl piperidine carboxylic acid amides. These agents, including Bupivacaine, were to be tested as local anesthetics. Bupivacaine is 1-butyl-2',6'-pipercoloxylidide hydrochloride and the structural formula is as follows:

Other designations for Bupivacaine include WIN 11,318, LAC-43, Carbostesin and Svedocaine.

As with other local anesthetic agents, the central nervous system and cardiovascular system are especially vulnerable to the effects of Bupivacaine. The toxic effects of this substance, related to dose of the agent, can be compared to Mepivacaine (Carbocaine).

Bupivacaine has an amide linkage between the aromatic nucleus and the piperidine group. Such drugs are metabolized in the liver where they are conjugated to glucuronides and subsequently eliminated in the bile and urine. It is to be recalled that the procaine group of anesthetics is detoxified by the plasma esterases.

Toxicity

It has been shown that drugs like Bupivacaine, containing the amide linkage, produce reactions of both the nervous system and the cardiovascular system. The following groups of reactions have been observed:

1) Central nervous system. Excitation and nervousness, also vertigo, visual disturbances and shakiness. Respiratory arrest is rare.

2) Cardiovascular system. The blood pressure effects are variable, but hypotension may lead to cardiac arrest.

3) Allergies. Edema is seen occasionally. Urticaria may be generalized.

Reactions are measurably dose related. Whenever epinephrine is used, its possible toxic effects must be considered.

Clinical study

Bupivacaine had been amply studied previously in experimental animals and had enjoyed extensive clinical application in a number of nerve block anesthetic techniques. We became interested in the agent primarily because of its prolonged local anesthetic effect. Our plan was to study and compare 100 patients who had Bupivacaine during groin hernia repair with a group who had their operations under Chlorprocaaine local anesthesia. These studies were carried out during the years 1974 and 1975. The two groups of patients were selected at random.

Sex and age

The well-known fact that groin hernias occur with much greater frequency in males is supported in this study.

There were only eight groin hernias in females among the 200 patients studied (Figure 1).

The increasing incidence of groin hernias with advancing years is well illustrated in
Sex incidence of patients with groin hernias.

Types of hernias repaired

In general both groups of patients in this study had similar problems (Table I).

As is well known, indirect inguinal hernias are more common than other varieties.

Three patients underwent hydrocelectomy and one patient had an appendectomy under Bupivacaine anesthesia. Twenty-four patients who had this form of anesthesia had recurrent inguinal hernias. Two patients underwent hydrocelectomy and 13 had repairs of recurrent hernias under Chlorprocaine anesthesia.
Ponka and Sapala

Table I
TYPES OF HERNIAS REPAIRED

<table>
<thead>
<tr>
<th>Type</th>
<th>Chlorprocaine</th>
<th>Bupivacaine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of Hernias</td>
<td>No. of Hernias</td>
</tr>
<tr>
<td>INDIRECT</td>
<td>38</td>
<td>45</td>
</tr>
<tr>
<td>DIRECT</td>
<td>47</td>
<td>34</td>
</tr>
<tr>
<td>DIRECT-INDIRECT</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>FEMORAL</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>INCISIONAL</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Table II
AMOUNT OF ANESTHETIC SOLUTION USED

<table>
<thead>
<tr>
<th>Type</th>
<th>Chlorprocaine 1% Solution</th>
<th>Bupivacaine 0.25% Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>LARGEST AMOUNT</td>
<td>200 cc</td>
<td>265 cc</td>
</tr>
<tr>
<td>LEAST AMOUNT</td>
<td>65 cc</td>
<td>90 cc</td>
</tr>
<tr>
<td>AVERAGE AMOUNT</td>
<td>150 cc</td>
<td>150 cc</td>
</tr>
</tbody>
</table>

Table III
TYPE OF REPAIR

<table>
<thead>
<tr>
<th>Type</th>
<th>Chlorprocaine</th>
<th>Bupivacaine</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC VAY</td>
<td>62</td>
<td>54</td>
</tr>
<tr>
<td>BASSINI</td>
<td>34</td>
<td>40</td>
</tr>
<tr>
<td>BASSINI-KIRSCHNER</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>HALSTED</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>WITH MESH</td>
<td>1</td>
<td>9</td>
</tr>
</tbody>
</table>
Bupivacaine for Hernia Repair

**Figure 2**

Age incidence of patients included in this study shows that the two groups were generally comparable.

### Amount and strength of anesthetic agent used

It is always essential to use a sufficient amount of local anesthetic. This will vary from patient to patient, so during administration the patient's mental status and vital signs should be carefully and continuously monitored.

The technic of administration was essentially that described by Ponka.²

The average volume of local anesthetic solution used was 150 cubic centimeters for both groups. It should be noted that we used a 1% solution of Chlorprocaine and a 0.25% solution of Bupivacaine. Epinephrine hydrochloride in the amount of 1:200,000 was added to both of the anesthetic solutions. The largest amount of Chlorprocaine used was 200 cubic centimeters while the smallest quantity was 65 cc (Table II). The largest amount of Bupivacaine used was 265 cubic centimeters; 90 cubic centimeters was the smallest volume required to achieve satisfactory anesthesia.

### Type of repair

The increasing popularity of the Loeheissen-McVay repair is noteworthy (Table III). This procedure is well indicated in patients with direct and femoral hernias.

The Bassini repair continues to give satisfactory results in patients with indirect inguinal hernias. Transplantation of the spermatic cord is being done infrequently. It is of fundamental importance that the hernia be repaired before the external oblique is reached in the reconstruction. Synthetic mesh is used only when the tissue remaining is so poor after numerous previous repairs as to preclude satisfactory repair.
Duration of anesthesia

We used a simple but practical method of determining the length of anesthesia following the injection of anesthetic solution. We designated the onset of anesthesia at the time the incision was made. The total duration of anesthesia included the time from skin incision to the moment of the first injection of a narcotic for relief of postoperative pain. This method of estimation may be crude but it provides us with extremely useful information (Figure 3).

The objective was to compare the duration of two local anesthetic agents in a situation where the patient population and clinical situation would be comparable. The onset of anesthesia with Chlorprocaine is very rapid, occurring within six minutes in most patients. The duration of anesthesia without epinephrine added is between 30 to 60 minutes. When epinephrine had been added the anesthetic effect was regularly prolonged four to six hours.

We achieved anesthesia in the second group of 100 patients by injecting a 0.25% solution of Bupivacaine to which epinephrine was added as noted. Onset of anesthesia was so rapid that the incision could be made as soon as the area was methodically injected as Ponka has described. The duration of anesthesia lasted from 6 to 12 hours in most patients (Figure 3).

It can be seen from Figure 3 that Chlorprocaine with epinephrine provides an ade-
Bupivacaine for Hernia Repair

### Table IV

**WOUND COMPLICATIONS**

<table>
<thead>
<tr>
<th></th>
<th>CHLORPROCAINE</th>
<th>BUPIVACAINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEMATOMA (bleeding)</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>ECCHYMOSIS</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>SEROMA</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>WOUND INFECTION</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>WOUND EDEMA</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>7</strong></td>
<td><strong>14</strong></td>
</tr>
</tbody>
</table>

Wound complications were somewhat more frequent in patients given Bupivacaine (Table IV).

No problems of postoperative urinary retention occurred in either group.

Wound complications were more common with Bupivacaine. Several hematomas and ecchymoses occurred early in the study. We had to learn to modify our standards of hemostasis. Bupivacaine with epinephrine causes intense and prolonged vasoconstriction. This is a partial explanation for the prolonged effect. Hence, even the smallest oozing vessels must be clamped. It is well-known that with vasoconstrictors, such as epinephrine, the constriction is later followed by a compensatory vasodilation. This action, in our opinion, results in wound hematomas in some patients. Once we learned the importance of ligating vessels with minute bleeding, we encountered fewer instances of hematomas, bleeding and ecchymosis. Bupivacaine, for some reason, causes considerable wound edema and induration in the occasional patient; this is not due to bleeding, but appears to be due to fluid loss into the area of injection. Such induration subsides within one week without other wound complications. We believe that, as we gain experience in the use of Bupivacaine, fewer wound complications will be seen.

Drug reactions

The infrequent occurrence of drug reactions with a 1% solution of Chlorprocaïne has been noteworthy. In this group of 100 patients only one patient developed hypotension and tachycardia. There were no reactions involving the central nervous system; no convulsions; no instances of allergic reactions.

With 0.25% Bupivicaine anesthesia one patient developed postoperative cardiac arrhythmia and hypotension. The injections were discontinued and oxygen and fluids given, with improvement following.
Discussion

The search for safe, long acting local anesthetic drugs will continue. With Bupivacaine hydrochloride the duration of anesthesia following injection has been extended considerably. It is well-known that local anesthetic drugs produce longer duration of anesthesia when epinephrine is added. This addition has not prolonged the duration of anesthesia sufficiently when added to such agents as Chlorprocaine hydrochloride.

A number of observers have recognized that Bupivacaine hydrochloride produces more prolonged postoperative analgesia than other local anesthetics in various types of nerve blocks.6,7,8 Others have observed that postoperative narcotic injections are reduced and even eliminated in some patients.9

It has been established that Bupivacaine produces anesthesia approximately one and one-half to two times longer than Lidocaine or Mepivacaine9 and longer than Tetracaine as well. We found that, following local infiltration and nerve block technics, anesthesia may last for over 12 hours.

Even though our method of evaluation has its limitations, Bupivacaine has proven to provide prolonged analgesia. The duration of anesthesia produced was significantly greater than that produced by injections of Chlorprocaine.

We agree with Abadir et al.,10 who concluded that long-acting local anesthetics such as Bupivacaine result in a decreased need for narcotics. Ease of ambulation decreased to a minimum the need for pulmonary therapy and catheterization.

Bibliography