cantly greater in preeclampsia,[12] this is an important factor to consider, although it is pure conjecture at this point.

In conclusion, we have presented four cases in which preeclamptic patients were given LEA with local anesthetic solutions containing epinephrine. In no case was the hypertension enhanced. Previously, preeclamptic patients were felt to be at risk of a worsening of an already elevated blood pressure when given epinephrine in the epidural space.[1-3,‡] However, the amount of epinephrine absorbed from the peridural space seems to have primarily a beta-adrenergic agonistic effect and does not worsen preexisting hypertension in preeclamptic patients.

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Maternal Heart Rate Changes with a Plain Epidural Test Dose

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The argument as to what constitutes an effective test dose for epidural anesthesia has continued for many years. Following initial recommendations,[1,2] the use of test doses fell out of favor because the test doses used did not fulfill their function or were too time consuming.[3] Some reports highlighted the value and limitations of the technique, and that the overall complication rate was not different in centers where test doses were or were not employed.[4,5,‡]

The purpose of an epidural test dose is to reveal accidental intrathecal and iv injection using a small dose of drug. Renewed enthusiasm for the use of test doses followed a statement by Moore and Batra[6] that "for a single test dose of a local anesthetic solution to be of value . . . it must contain 0.015 mg epinephrine and a milligram dose of the local anesthetic drug which rapidly results in evidence of spinal anesthesia." The use of epinephrine as part of the test dose has subsequently been advocated extensively.[7-10]

A test dose containing 15 μg epinephrine will detect intravascular injection by causing a mean rise in heart

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‡ Soni V, Peeters C, Covino B: Value and limitations of a test dose prior to epidural anesthesia. Regional Anesthesia 6:23–25, 1981.

rate of 32 beats/min starting 23 s after injection and lasting for 31 s.[6] These data refer to sedated patients for elective surgery, and the validity of the same test for laboring obstetric patients is unproven. The purpose of this study was to determine the maternal heart rate changes that occur during the 60 s following a test dose of local anesthetic without epinephrine.

Methods

After institutional approval, 100 women requesting epidural analgesia for pain relief during labor were studied. None was receiving any β-adrenergic antagonist medication. An epidural catheter was inserted at L2–3 and advanced to 4 cm in the epidural space.

The heart rate was monitored using an ECG with a digital display of heart rate. The heart rate was noted during a period of uterine quiescence while the woman was lying comfortably on her left side. This was taken as the baseline heart rate. After confirming the absence of blood and cerebrospinal fluid in the catheter, 3 ml of plain 0.5% bupivacaine was injected through the catheter at the rate of 1.0 ml/s. This test dose is the same volume as that containing 15 μg of 1:200,000 epinephrine and the 15 mg bupivacaine will indicate an accidental intrathecal injection. The maximum change in heart rate from the baseline was noted over the following 60 s. This is the same time period that would reveal an iv epinephrine response.[6] If a uterine contraction occurred during this period, this was also recorded.

If there was no evidence of intrathecal or iv placement of the catheter, the epidural procedure was then managed in the usual way to achieve satisfactory analgesia.

Results

All 100 epidural blocks were effective. There was no evidence of accidental intrathecal injection or signs of systemic toxicity in the study. In one patient an epidural vein was entered on insertion of the catheter but after withdrawing 1 cm, no further blood could be aspirated.

The results of the maximum change in heart rate from the baseline heart rate are given in figure 1. The rate increased by more than 20 beats/min in 24 women and by more than 30 beats/min in 12 women. Figure 2 shows the heart rate changes for the 14 women who had a uterine contraction during the period of monitoring. Three of these women had heart rate increases of greater than 30 beats/min.

There was poor correlation between the values of maximum change in heart rate and baseline heart rate ($r = -0.37$).

Discussion

A diagnostic test should have its specificity and sensitivity defined. The incidence of the condition tested and its severity will modify what magnitude of sensitivity and specificity one is willing to accept. In the example of the epidural test dose for accidental iv injection, if the incidence of the complication is low, then the test should have a high specificity (or low rate of false positives) to be clinically useful.

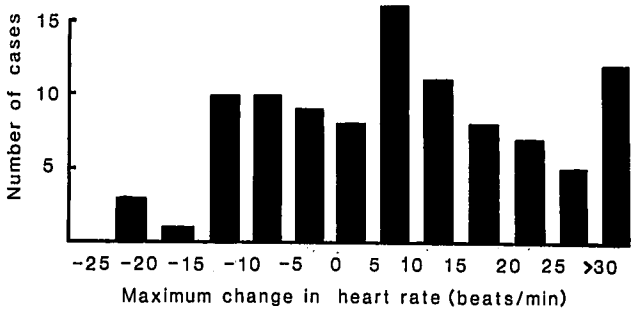

FIG. 1. The maximum change in heart rate from the baseline heart rate for the 100 women.

In sedated surgical patients, a mean increase in heart rate of approximately 30 beats/min occurs after 15 μg epinephrine is given iv.[6] Assuming a normal distribution for heart rate changes, an increase of at least 30 beats/min will occur in 50% of patients, *i.e.*, the test has a sensitivity of 50%. The sensitivity of the epinephrine test dose in obstetrics is unknown, but may be different than that for general surgical cases. This study demonstrated an increase in heart rate greater than 30 beats/min following a test dose of local anesthetic without epinephrine in 12% of cases. If this were interpreted as an iv placement of the catheter, it would mean a β-error or false positive rate of 12%, *i.e.*, a specificity for the test of 88%.

The incidence of accidental iv injection during epidural anesthesia is quoted at between 0.01% and 0.2%.[4,11–13] Taking the highest incidence of 0.2% and a false positive rate of 12%, a rise of 30 beats/min or more in heart rate is likely to be associated with intravascular placement of the catheter only once in 120 cases (table 1), and still miss 50% of intravascular injections. Thus, the acceptance of the epinephrine test dose for obstetric practice would result in much unnecessary reinsertion of epidural catheters.

TABLE 1. Results of a Positive Test of 30 beats/min. Rise in Heart Rate in 1,000 Patients*

	Intravenous Injection	No Intravenous Injection
Test positive	1	120
Test negative	1	878
No. of patients	2	998

* Using an incidence of intravenous injection of 0.2%, sensitivity of 50%, and specificity of 88% (current study).

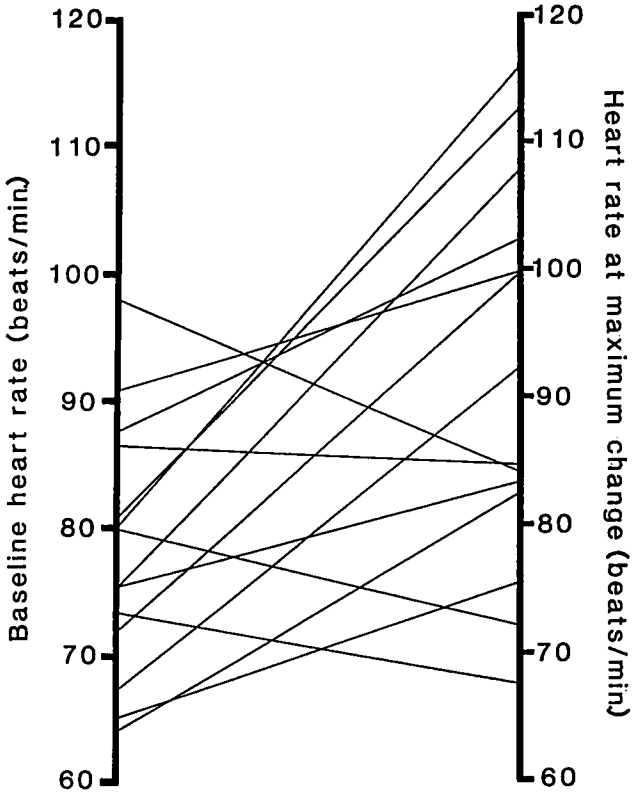

FIG. 2. The heart rate changes for the 14 women having a uterine contraction.

To reduce the criteria for a positive test to a 20 beats/min rise would increase the sensitivity of the test but in obstetric cases would lead to a β-error of 24%.

Of the 14 women having contractions during the measurement period, an increase in heart rate of more than 30 beats/min occurred in three cases. The tachycardia resulting from painful uterine contraction can be seen in figure 2, although this was not consistent. Nine patients had increases in heart rate of more than 30 beats/min in the absence of uterine contractions. Thus the absence of contractions does not rule out a false positive test.

In conclusion, this study indicates the β-type errors that can occur in using an epidural test dose where the change in heart rate is used as the test. The study was designed using a plain local anesthetic test dose to show that maternal heart rate changes not associated with epinephrine administration do occur. Thus, the interpretation of the epinephrine test dose for obstetric anesthesia is difficult because of the poor specificity of the test.

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