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Instrumentation of the Loss-of-Resistance Technique for Epidural Needle Insertion

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Abstract:

Epidural anesthesia is the most common form of anesthesia in obstetrics. The loss-of-resistance to saline injection is used to confirm when the needle tip enters the epidural space. This procedure is highly dependent on skill and expertise, so it is useful to quantify the tissue resistance during insertion. Sensors are used to measure the force and displacement of the plunger of the syringe and the pressure at the needle tip. A model is also developed to estimate the pressure from the force and displacement. Tests are first performed on porcine tissue to compare the continuous-pressure and intermittent-pressure versions of the technique and to compare the paramedian and midline needle approaches. The accuracy of the pressure model is 12% of peak pressure for the continuous technique and 20% for the intermittent technique. Significant differences in injection flow rate were also found for the muscle, interspinous ligament, and ligamentum flavum encountered in the two approaches. A small clinical study on human subjects was performed and again significant differences were found in flow rate for different tissues. These quantitative results improve the understanding of small differences in feel that have been previously known qualitatively and may help in the development of simulators.

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I. Introduction

In obstetrics, a patient may require the use of anesthesia to ease the pain of labor or a cesarean section. Epidural anesthesia is the most common form of anesthesia used for these purposes. To administer the anesthesia, a needle is inserted into the lumbar epidural space located approximately 20–90 mm below the skin [1]. As anesthesia may be required to be injected at different times, a catheter is inserted through the epidural needle into the epidural space and remains there until anesthesia is no longer needed. Although epidural anesthesia has been practiced for decades, the failure rate remains 6%–25% [2], [3], and the procedure is considered more difficult than other regional anesthesia procedures [4]. A failed epidural needle insertion procedure, in which the needle punctures the dura mater just below the epidural space, may cause the patient to experience headaches, or in more severe cases, paralysis or death [5].

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