A New Technique of Identifying the Epidural Space "Dripping Infusion Method"

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We developed a new visual technique of identifying the epidural space, using the hydrostatic pressure produced by a suspended micro-drip intravenous apparatus. When the needle pierces the ligamentum flavum, the resistance to positive pressure disappears and the saline in the apparatus flows freely into the epidural space. Thus, the entry of the needle point into the epidural space is visually confirmed by the appearance of dripping flow in the drip bulb (dripping infusion sign). This procedure was clinically evaluated at the thoraco-cervical area in 114 patients; the thoracic area in 116; and the lumbar area in 272, respectively. In 491 (97.8%) of the patients, the epidural space was identified with facility. In the remaining 11 patients (2.2%), a false dripping infusion sign appeared at the more superficial site than expected. If the pressure waveform in the epidural space is analyzed, the correct positioning of the needle can be easily confirmed. We believe that this method is one of the most accurate visual methods of identifying the epidural space and useful for teaching the epidural blockade to students and residents. (Key words: epidural analgesia, dripping infusion method)

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The success of epidural analgesia is dependent upon identifying the epidural space correctly. The identification of the epidural space is usually performed by the "loss of resistance" as tactile method, the "hanging drop" as visual method, or other methods with some mechanical devices[1]. The loss of resistance method which is perhaps most commonly used has the advantage of great simplicity as no special apparatus is required[2,3]. The disadvantage of this method is that the technique involves holding the needle in one hand only while the other hand applies pressure to the piston. On the other hand, the two-handed grip of the hanging drop method ensures controllable advancement of the needle[2,3]. Many anesthesiologists, however, feel that the hanging drop method is less reliable than the loss of resistance method because low or no negative pressure is occasionally demonstrated. The requirements of the ideal method of identifying the epidural space are: no need to use special apparatus; controllable advancement of the needle; keen sense of the resistance when the needle pierces the ligamentum flavum; objective and accurate sign of the entry of the needle into the epidural space. Cosidering these requirements, we designed a new visual technique of identifying the epidural space and evaluated this technique clinically.

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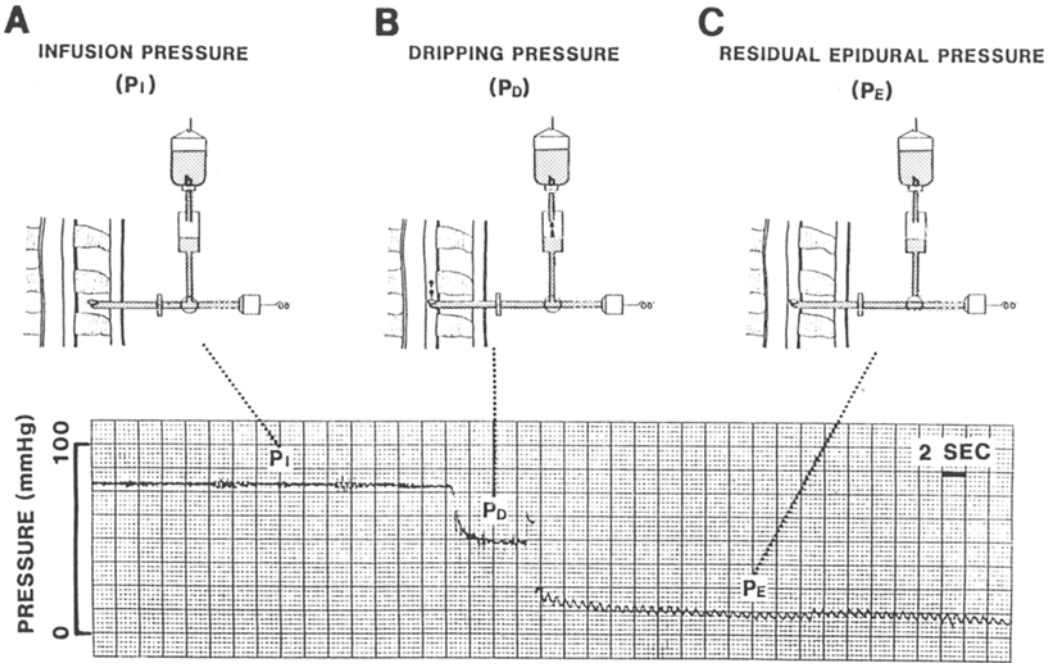

Fig. 1. The change of pressure within the needle during epidural puncture is directly recorded by means of a pressure manometer. When the needle is remaining in the interspinous ligament, the infusion pressure is equal to the hydrostatic pressure that is produced by a suspended intravenous apparatus (A–P_I). As soon as the needle pierces the ligamentum flavum and enters the epidural space, the infusion pressure immediately decreases to the dripping pressure (B–P_D). After disconnecting the intravenous apparatus, the residual epidural pressure is recorded (C–P_E).

Five hundred and two surgical patients aged from 12 to 91 years old without neurological disease, bleeding diathesis, or extreme deformity of the vertebral column were included in this study. The injection site of the spine was chosen depending upon the locus of each surgical incision: the thoraco-cervical area was selected in 114 patients; the thoracic area, in 116; and the lumbar area, in 273, respectively. The mid-line approach was used in the thoraco-cervical, lower-thoracic, and lumbar area, and the para-median approach, in the middle thoracic area. After positioning the patient in the flexed right-lateral decubitus position on a horizontal operating table, a 17-gauge Tuohy needle with the bevel pointing cephalad was inserted into the interspinous ligament and the stylet was withdrawn. A three-way tap, connected to a micro-drip intravenous apparatus and to a pressure transducer (Yokokawa Hewlett Packard 78742A), was attached to the hub of the Tuohy needle (fig. 1A). The hydrostatic pressure which was produced by the suspended intravenous apparatus was given to the needle via a three-way tap. The Tuohy needle was advanced slowly, until the dripping flow of saline could be found in the drip bulb; when the needle pierced the ligamentum flavum, the resistance to the positive pressure disappeared and the saline in the apparatus flowed freely into the epidural space. Thus, the entry of the needle point into the epidural space was visually confirmed by the appearance of dripping flow in the drip bulb (dripping infusion sign. fig. 1B). The change of pressure within the needle was continuously recorded throughout the procedure and the three components of the pressure curve were defined as the infusion pressure (P_I), the dripping pressure (P_D), and the residual epidural pressure

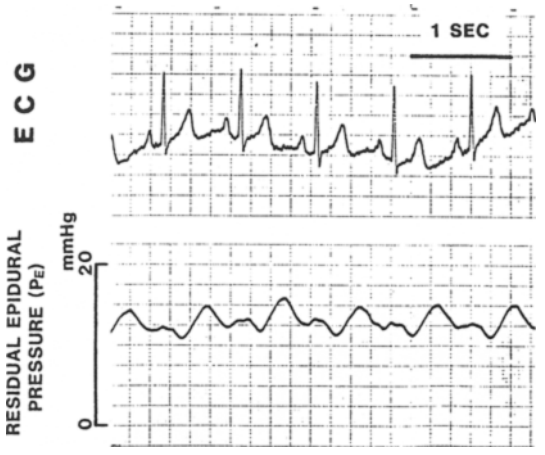

Fig. 2. When the tip of the needle is correctly positioned within the epidural space, the waveform of residual epidural pressure (P_E) shows the pulsation synchronized with heart beats.

(P_E), as shown in figure 1.

Four hundred and ninety one (97.8%) of the patients, had uniformly consistent interspinous ligament with continued resistance to the positive pressure, until the ligamentum flavum was pierced. The dripping infusion sign was detected only when the ligamentum flavum was penetrated. The typical trace of the change in pressure during a successful epidural puncture was showed in figure 1. The loss of resistance associated with piercing the ligamentum flavum was evidently recorded as the decrease in pressure from P_I to P_D. The waveform of P_E showed the pulsation synchronized with heart beats, as shown in figure 2.

In the remaining 11 patients (2.2%), appreciable dripping infusion sign was observed at the more superficial site than expected. However, the pulsation of P_E observed in successful epidural puncture was not found at such a site. As the Tuohy needle was advanced further, the resistance to the positive pressure returned. The subsequent dripping infusion sign and the typical pulsation in the waveform of P_E were observed. Therefore, the false dripping infusion sign was clearly differentiated from the successful epidural puncture by observing the waveform of P_E.

No accidental dural puncture was experienced and every surgical procedure was uneventfully performed under the sufficient epidural analgesia without or with supplementary nitrous oxide.

There are several advantages in this dripping infusion method. First, the wings of the Tuohy needle can be held by both hands and the dorsa of the fourth and fifth fingers of the hands can be firmly braced aganist the patient's back. Therefore, the operator can control the direction and the depth of the needle directly and steadly, and besides can feel the keen sense of the resistance when the needle pierces the tough ligamentum flavum. Second, the tactile sense in the coventional method of loss of resistance is replaced by the drip of the saline in the apparatus. The objective sign, that is, the appearance of dripping flow in the drip bulb is observed as soon as the needle pierces the ligamentum flavum and enters the epidural space. Not only one operator who holds the needle but also many observers such as students and residents can observe the dripping infusion sign that indicates the entry of the needle point into the epidural space. Third, the change of pressure within the needle can be directly recorded by means of a pressure manometer and the correct positioning of the needle within the epidural space is confirmed by analyzing the change of the pressure waveform following the advancement of the Tuohy needle. Lastly, no special device is required except for a commertially available intravenous infusion apparatus, if one acquires a few experiences in this method. We believe that this method is one of the most accurate visual methods and useful for teaching epidural blockade to students and residents.

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