Comparison of Sprotte and Quincke needles with respect to spinal fluid leakage using artificial spinal cord

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Abstract

Purpose. This research investigated whether the Sprotte needle causes less leakage of CSF than the Quincke needle in the artificial spinal cord.

Methods. The changes in intradural pressure, extradural pressure, and leaked volume of CSF were evaluated following puncture with Sprotte and Quincke needles in the artificial spinal cord.

Results. The decrease in intradural pressure was $9.7 \pm 1.8$ mm H$_2$O with the Sprotte needle and $20.5 \pm 2.7$ mm H$_2$O with the Quincke needle ($P < 0.05$). The volume of leakage of artificial CSF was $2.0 \pm 0.3$ ml with the Sprotte needle and $3.3 \pm 0.3$ ml with the Quincke needle ($P < 0.01$). The extradural pressure increase was $166.1 \pm 8.2$ mm H$_2$O with the Sprotte needle and $186.8 \pm 13.2$ mm H$_2$O with the Quincke needle ($P < 0.05$).

Conclusion. The Sprotte needle produces less CSF leakage than the Quincke needle.

Key words: Spinal anesthesia, Spinal fluid, Spinal cord

Introduction

One of the complications of spinal anesthesia is postdural puncture headache (PDPH) [1]. PDPH is caused by several factors. Cerebrospinal leakage from the hole caused by dural puncture is believed to be the main mechanism [2]. The Sprotte needle was developed in an attempt to decrease the leakage of CSF from the dura hole by changing the shape of the spinal needle tip [3,4]. However, nobody has demonstrated a clear relationship between the volume of CSF leakage and the shape of the needle or between the pressure in the epidural space and CSF leakage. In this paper we would like to clarify the relationship between the shape of the needle tip and the volume of CSF leakage following dural puncture, as well as experimentally determine the effect of the pressure in the epidural space on the leakage of CSF.

Materials and methods

The two types of needles examined in this experiment were the Sprotte and Quincke needles (both 24 G). A spinal column model consisting of two plastic tubes was used (Fig. 1). The diameter of the outer tube was 56 mm and that of the inner tube was 30 mm. Artificial CSF, similar to real CSF in biochemical composition (NaCl 125, NaHCO$_3$ 25, KCl 3.5, CaCl$_2$ 1.3, MgCl$_2$ 1.1, Na$_2$HPO$_4$ 0.5, urea 130, and glucose 610 mmol·l$^{-1}$) and in viscosity to real CSF, was poured into the inner tube corresponding to the intradural space and adjusted to produce a CSF pressure of 15 cm H$_2$O. Artificial CSF has the same composition as mock CSF [5].

A small window ($2 \times 3$ cm) and a hole were made on the surface of the inner and outer tube, respectively. The small window was covered with human postmortem spinal dura mater (provided by the Department of Pathology of the Jikei University School of Medicine), using glue and with the longitudinal axis of the specimen running vertically. Nine samples of dura mater were examined with each needle. The small hole on the outer tube was plugged with rubber, through which the Sprotte and Quincke needles penetrated the inner space. The space between the inner and the outer tubes, corresponding to the epidural space, was filled with air maintained at a negative pressure of $-7$ cm H$_2$O. Pressure transducers (DP8A-50, DPA-200, NIPPON DENKI SANEI Engineering Co., Tokyo, Japan) were connected to the inner tube and the outer space to ensure that the appropriate pressure was maintained.

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Received for publication on August 22, 1996; accepted on May 29, 1997
Each needle penetrated the rubber plug and the dura to enter the inner tube.

Following withdrawal of the needle, the pressure change in the inner and outer tubes was monitored (CP640G, Nippon Denki Sanel, Tokyo, Japan), and the volume of CSF leaked in 2 min was measured.

Statistical analysis was performed by Student's t-test, and the data are expressed as mean ± SE. Differences were considered statistically significant at $P < 0.05$.

**Results**

The pressure change in the inner tube following withdrawal of either the Sprotte or the Quincke needle was very slight, but the decrease in pressure was less with the Sprotte needle than with the Quincke needle, whereas the pressure in the outer tube increased rapidly following withdrawal of both types of needle. The rate of this increase was steeper when the Quincke needle was used (Fig. 2).