SHORT COMMUNICATIONS

Auditory disturbance associated with interscalene brachial plexus block

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Summary
We performed an audiometric study in 20 patients who underwent surgery of the shoulder region under an interscalene brachial plexus block (IBPB). Bupivacaine 0.75% with adrenaline was given followed by a 24-hr continuous infusion of 0.25% bupivacaine. Three audiometric threshold measurements (0.25-18 kHz) were made: the first before IBPB, the second 2-6 h after surgery and the third on the first day after operation. In four patients hearing impairment on the side of the block was demonstrated after operation, in three measurements on the day of surgery and in one on the following day. The frequencies at which the impairment occurred varied between patients; in one only low frequencies (0.25-0.5 kHz) were involved. The maximum change in threshold was 35 dB at 6 kHz measured at the end of the continuous infusion of bupivacaine. This patient had hearing threshold changes (15-20dB) at 6-10 kHz on the opposite side also. IBPB may cause transient auditory dysfunction in the ipsilateral ear, possibly via an effect on sympathetic innervation. (Br. J. Anaesth. 1995; 74: 89-91)

Key words
Anaesthetic techniques, regional, brachial plexus. Complications, hearing loss.

Recently, we encountered a previously unreported side effect of interscalene brachial plexus block (IBPB) (0.75% bupivacaine with adrenaline) in a 24-yr-old man who underwent arthroscopy of the shoulder joint. Six hours after surgery, during continuous interscalene infusion (0.25% bupivacaine 6 ml h⁻¹), the patient complained that he was unable to hear high-pitched sounds on the side of the interscalene block. The infusion was discontinued and his hearing acuity returned within 2 h. An audiometric study in 20 patients scheduled for IBPB and a continuous interscalene local anaesthetic infusion was therefore performed.

Methods and results
This study was approved by the Ethics Committee of the hospital and informed consent was obtained from 20 patients. Patients with a history of hearing impairment, Ménière's disease, inspissated cerumen and inability to co-operate during audiometry were excluded from the study.

The patients (aged 25–71 yr, ASA I–III) were undergoing surgical operation of the shoulder joint region and were premedicated with diazepam 5–15 mg orally and oxycodone 0.1–0.15 mg kg⁻¹ i.m. approximately 1 h before IBPB. One patient did not receive oxycodone.

IBPB was performed using a nerve stimulation technique [1] (Dualstim, Life-Tech Inc., Houston, TX, USA). A cannula (Contiplex, B.Braun-Melsungen AG, Germany) was introduced into the interscalene space. For the surgical block, 0.75% bupivacaine with adrenaline 20-28 ml, according to the patient's weight, was injected. An interscalene catheter (Contiplex) was inserted through the cannula and an infusion of 0.25% bupivacaine 5–9 ml h⁻¹ was started before surgery [2]. The infusion was continued for approximately 24 h, that is until the audiometry had been completed.

Diazepam, midazolam or propofol were administered i.v., as required for sedation. Pain caused by surgery was treated with fentanyl 50 µg i.v. Three patients were scheduled to receive general anaesthesia in addition to IBPB, and in another general anaesthesia was given as IBPB was inadequate. In the postoperative period, if the infusion of bupivacaine did not provide sufficient analgesia, oxycodone i.m. or an oral anti-inflammatory drug was administered on request.

Otoscopy was performed before audiometry, and cerumen was removed when necessary. Conventional air conduction audiometry at frequencies of 0.25–8 kHz (Madsen DSA 84, Madsen Electronics, Copenhagen, Denmark) and high-frequency air conduction audiometry at 10–18 kHz (Interacoustics A510HF, Interacoustics, Assens Denmark) with Koss HV/1A earphones were performed before operation in a quiet room. The measurements were

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repeated 2–6 h after IBPB, and approximately 24 h after the start of the continuous infusion of bupivacaine. All of the audiometric measurements were performed by one of the investigators (T.S.L.) in an environment equivalent to that of the control test. The stimuli were given as hearing levels and a change in threshold of 15 dB or more was considered clinically significant [3]. Conventional pure tone audiometry was calibrated according to the ISO-389 (1985) standards, and the high-frequency audiometer according to the calibration suggested by Fausti and colleagues [4].

In two patients there was marked hearing impairment on the side of IBPB at 8 kHz or higher, in the first postoperative test (table 1). In one patient significant hearing impairment at 2, 6 and 12 kHz, and loss of sensitivity at 16 and 18 kHz was evident on the day after surgery at the end of the continuous bupivacaine infusion in the ipsilateral ear. This patient had hearing threshold loss on the contralateral side also (at 6–10 kHz, 15–20 dB). Full recovery occurred within 24 h. In another patient there was a reduction of 15 dB at low frequencies (0.25–0.5 kHz) in the ipsilateral ear during the surgical block. All three patients with hearing impairment on the day of surgery had normal hearing on the first postoperative day. None of the patients had a subjective impression of hearing difficulties during the study.

An elderly patient (71 yr) with a history of diabetes mellitus and coronary bypass surgery exhibited hearing threshold loss (15 dB) at 10 kHz on the side of the block and at 8 kHz on the opposite side on the day after surgery. He had received a total dose of oxycodone 30 mg i.m. before the auditory test. In all other patients the audiometric recordings remained unchanged.

In 11 patients the primary IBPB included innervation area of the greater auricular nerve. Two of them (L.V.-T, M.B.) had hearing loss on the side of the block (table 1).

Horner’s syndrome was observed in five of the 20 patients during the block; none had hearing impairment.

Comment

The results of this audiometric study showed that hearing may sometimes be affected by an interscalene brachial plexus block. The changes were clear and occurred at varying frequencies. In the patient with the greatest threshold change (35 dB) there were also milder changes in the contralateral ear, and bilateral changes at single frequencies were observed in our oldest (71 yr) patient. This could have been caused by a combined central nervous system effect of the analgesic drugs and the local anaesthetic. The changes in CSF pressure and perilymphatic pressure in the inner ear that may occur after spinal anaesthesia [5] are unlikely to be implicated in the hearing loss associated with IBPB.

Although audiometry was not performed in the patient whose complaint initiated this study, it can be assumed that a wide range of frequencies were involved. His subjective observation that high-pitched sounds were lost in comparison with other regular sounds of the hospital ward environment was not substantiated in the present study. None of the study patients was aware of the block-induced hearing threshold loss.

The effect of IBPB on hearing is probably not caused by an effect on the vestibulocochlear nerve because of its central location. The innervation area of the greater auricular nerve, a derivative of the cervical plexus, is often involved in an IBPB. However, this nerve is not known to affect hearing. The nerves supplying the outer ear canal and the tympanic membrane (branches of the mandibular, facial and vagal nerves) are located far enough from the IBPB injection site to make their involvement unlikely. However, sound conduction through the middle ear to the inner ear, and functioning of the spiral organ of the cochlea may be indirectly affected by regional sympathetic block [6]. Sympathetic block may cause vasodilatation and swelling of the mucosal membranes of the middle ear and the eustachian tube with deterioration of hearing. We observed Horner’s syndrome in five of 20 of our patients, but others have noted it more frequently. The lack of

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (yr)</th>
<th>Anaesthesia</th>
<th>Frequency (kHz)</th>
<th>Findings (dB)</th>
<th>Time</th>
<th>Postop. analgesia (24 h)</th>
<th>Additional factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.T.</td>
<td>57</td>
<td>IBPB + sedation</td>
<td>14</td>
<td>&gt; 20</td>
<td>Op. day</td>
<td>Oxycodone 10 mg</td>
<td>—</td>
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<tr>
<td>L.V.-T.</td>
<td>37</td>
<td>IBPB + analgesics</td>
<td>8</td>
<td>20</td>
<td>Op. day</td>
<td>Oxycodone 8 mg i.m.</td>
<td>Diabetes mellitus</td>
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<td></td>
<td></td>
<td></td>
<td>4 mg i.v.</td>
<td></td>
<td></td>
<td>Ketorolac 30 mg i.v.</td>
<td>Arterial hypertension</td>
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<td></td>
<td></td>
<td></td>
<td>Ibuprofen 600 mg orally</td>
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<td></td>
<td>Nausea in the immediate postop. period (metoclopramide)</td>
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<tr>
<td>M.B.</td>
<td>52</td>
<td>IBPB + GA*</td>
<td>0.25</td>
<td>15</td>
<td>Op. day</td>
<td>Tolphenamic acid 200 mg orally</td>
<td>—</td>
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<tr>
<td>I.K.</td>
<td>44</td>
<td>IBPB + GA*</td>
<td>2</td>
<td>15</td>
<td>1 postop. day</td>
<td>Oxycodone 3 x 7 mg i.m.</td>
<td>Nausea in the immediate postop. period (droperidol)</td>
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<td>6</td>
<td>35</td>
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<td>12</td>
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</table>

* GA = general anaesthesia

**Table 1** Characteristics of patients with auditory disturbance in the ipsilateral ear during interscalene brachial plexus block (IBPB).
correlation between hearing impairment and Horner's syndrome in our study does not exclude sympathetic block. Horner's syndrome usually results from block of the thoracocervical sympathetic ganglion while the eye and ear receive their main sympathetic innervation separately from the superior cervical ganglion.

In three of the patients with hearing impairment during surgical IBPB, hearing was normal on the following day despite a successful continuous bupivacaine infusion. The occurrence of hearing threshold loss in these patients may have been caused by the effect of the large initial bupivacaine dose (> 150 mg) which probably allowed sufficient local anaesthetic to reach the sympathetic trunk and cervical ganglia.

References