HEARING DEFICIT: IS IT A COMPLICATION OF SPINAL ANESTHESIA?

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Abstract

The present study was designed to determine the degree of hearing deficit in patients assigned to receive spinal anesthesia, and to determine if the incidence is related to the size of spinal needle. The study comprised 26 male patients assigned to receive spinal anesthesia using either a 22-gauge (Group I) or a 26-gauge (Group II) spinal needle. Audiometric studies were performed preoperatively and 24 hr after operation, and the decrease of hearing level was determined. For patients with decreased hearing level by ≥10 dB, a third audiometry was performed 7 days postoperatively. There was a decrease of hearing levels of varied intensity in all patients included in both groups; however, the mean change in hearing level was significant in group I on both sides. In group I, there was a significant (P<0.05) bilateral decrease of hearing level at 125, 250, 500 and 1000 Hz, while a non-significant decrease at 2000, 3000, 4000 and 6000 Hz compared to the preoperative levels, and a decrease of 10 dB or more at any frequency occurred in 9 of 13 patients (92.3%) in group I and in 4 of 13 patients (30.7%) in group II. Seven days after operation, the 13 patients with decreased hearing level by ≥10 dB were reevaluated, and persistent decrease in hearing level by 10dB was reported in only one patient in group I. We can conclude that the temporary hearing loss is one of postspinal complications that occurs by an incidence of 50%; however, this incidence can be reduced by the use of more fine spinal needles.

Introduction

Regional anesthesia sharply reduced surgical complications such as blood clots, pneumonia and respiratory problems. The benefits were seen both in patients who re-
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ceived only regional anesthesia and those who had regional and general anesthesia. Regional anesthesia may cut deaths and complications for a number of reasons. It may, for instance, cut the body's "stress response" to major surgery, or help patients breathe free of pain, (Hensel, 2000).

Although the spinal route for administering anesthetics and analgesics has many advantages, it's not without serious risks. Most postspinal complications, especially headache are related to the degree of cerebrospinal fluid leakage, (Auroy et al., 1997).

The physical phenomenon which causes spinal complications is very simple: In spinal anesthesia, when the needle pierces the dura the spinal fluid can leak out so the pressure of the fluid inside the dura drops. There is a membrane at the base of the skull which separates the spinal fluid from the fluid in which the brain floats. Normally, the fluid pressures are balanced, but, if spinal fluid leaks out through a needle hole, the pressures become imbalanced, and the cushioning effect of the fluid disappears and tension is applied directly to the nerves. The degree of pressure imbalance determines the degree of complications, e.g., headache, (Freedman et al., 1998).

Vestibulocochlear dysfunction as a postoperative complication was previously reported with an incidence of 0.2-8% in operations performed under spinal anesthesia, (Wang, 1986). However, this previously reported incidence of vestibulocochlear dysfunction was based on the incidence with which patients complained of deafness, i.e., major hearing deficit (Wang et al., 1987).

The aim of the present study was to clarify the association of vestibulocochlear dysfunction and spinal anesthesia, and to determine if the incidence of the vestibulocochlear dysfunction is related to the size of spinal needle used.

**Patients and Methods**

The study was conducted at Benha University Hospital, and
comprised 26 male patients assigned to undergo various surgical procedures using spinal anesthesia. There were 12 patients suffering from unilateral incomplete inguinal hernia, 7 patients with unilateral varicocele, 3 patients with hydrocele, and 4 patients with perianal fistulae. Patients suffering of systemic diseases, or with history of deafness, inspisated cerumen and inability to cooperate during audiometry were excluded.

The audiologic evaluation consisted of pure tone audiometry using the ascending technique performed by experienced audiometrist. Amplaid 151 audiometer (Amplaid, Italy) was used and the system calibrated for hearing level in dB re: ANSI S 3.6, ISO 389, 1969. Audiometry was performed in silent chambers.

The patients were randomized to receive spinal anesthesia using either a 22-gauge (Group I, n=13) or a 26-gauge (Group II, n=13) spinal needle. On the morning of operation an audiogram was performed for each patient. Premedication followed with 50 mg of meperidine given intramuscularly. After intravenous infusion of at least 500 mL of Ringer's lactate solution, spinal anesthesia was administered in the L3-4 interspace using 3.5 mL of 0.5% bupivacaine in 8% glucose. One dural puncture was allowed in each patient; if an additional dural puncture was necessary the patient was excluded of the study. The bevel of the needle was inserted parallel to the longitudinal dural fibers. Systolic arterial blood pressure was measured by sphygmomanometer at 5-min intervals during the operation, and any untoward event was recorded. The level of analgesia was estimated by the pin-prick method after 20 min. All patients remained recumbent for the first 12 postoperative hours. Twenty-four hours after surgery, a second audiogram was performed for each patient under the same conditions as the preoperative examination. The audiometrist and the patient were unaware of the needle size used. The extent of the decrease in the hearing level was estimated by subtracting the preoperative minus the postoperative hearing level in dB, and patients with decreased hearing level...
by $\geq 10\text{dB}$, at any frequency, were instructed to revisit one week later for reevaluation of changes occurring in the hearing level. On the second postoperative day each patient was also examined by an anesthesiologist to determine the presence or absence of postspinal nausea and vomiting, headache, postural hypotension or dysfunction of the third, fourth, sixth, seventh, or eighth cranial nerves.

All results are presented as mean±SEM. In each pair of audiograms from each patient the change in hearing level was calculated at each frequency. The mean change in hearing level for right and left ears respectively for all patients in each of the two groups was calculated at each frequency. The results were analyzed for statistical significance using a t-test. Student's t-test for independent samples was used to establish the possible statistical significance of demographic and audiometric differences between groups. P values of $<0.05$ were accepted as indicative of statistical significance.

**Results**

Patients characteristics, namely age, weight and height showed a non-significant difference ($P>0.05$) between both groups. The mean level of analgesia (thoracic segments 'T seg.') was at $T7.7\pm1.6$, range 6-11 in group I, and was $8.4\pm1.4$, range 6-11 in group II with a non-significant ($P>0.05$) difference between both groups. (Table 1).

The mean preoperative SBP was $143.5\pm11.8$, range 125-165 mmHg, the mean postoperative SBP was $104.6\pm5.7$, range 95-115 mmHg, with a mean decrease of SBP throughout the duration of analgesia, in group I, of $38.8\pm7.6$, range 30-50 mmHg. Comparison of pre- and post-operative SBP showed a significant ($P<0.05$) decrease of SBP through the period of analgesia in group I. Similarly, in group II the mean preoperative SBP was $149\pm8.8$, range 130-165 mmHg and the mean postoperative SBP was $108\pm6$, range 95-115 mmHg, with a mean decrease of SBP of $40.8\pm8.7$, range 30-60 mmHg. Also, there was a significant ($P<0.05$) decrease of SBP on comparison the pre- versus the post-operative SBP. On the other hand, there was a non-significant
(P>0.05) difference between both groups as regards the pre-, post-operative and the mean decrease of the SBP between both groups (Table 2, Fig. 1).

The audiometric results showed a decrease of hearing levels of varied intensity in all patients included in both groups, however, the mean change in the hearing level was significant in group I (-4.36±0.76 on Rt & -2.55±0.39, on Lt) compared to group II (-1.3±0.22 on Rt & -1.09±0.2, on Lt), on both sides (P=0.004 & 0.022, respectively) (Table 3, Fig. 2). In group I (22 gauge group) there was a significant (P<0.05) bilateral decrease in the hearing level at 125, 250, 500 and 1000 Hz, while there was a non-significant (P>0.05) decrease in the hearing level at 2000, 3000, 4000 and 6000 Hz compared to the preoperative hearing levels. A decrease in hearing level of 10 dB or more at any frequency occurred in 9 of 13 patients (92.3%). On the other hand, in group II (26 gauge group) there was a non-significant (P>0.05) decrease in hearing level in both sides at all frequencies used and a decrease in hearing level of 10 dB or more at any frequency occurred in 4 of 13 patients (30.7%). Moreover, inter-group comparison showed a significant (P<0.05) decrease in hearing level on right side in group I as compared versus its ipsilateral side in group II at 250 and 500 Hz, but non-significant (P>0.05) difference was noted at all the other frequencies, (Table 3, Fig. 3). However, there was a non-significant (P>0.05) decrease between both groups on the left side at all frequencies used, (Table 3, Fig. 4).

Seven days after the operation, the 13 patients with decreased hearing level by ≥10 dB (9 in group I & 4 in group II) at any frequency were reevaluated for the degree of decreased hearing level. Audiometric evaluation revealed a non-significant difference compared to the preoperative hearing level in 12 of the 13 patients. Only one patient in group I, who showed a decreased hearing level by 25 dB on the second postoperative day, remained having a decreased hearing level by 15 dB on the seventh postoperative day. (Fig.5).
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Postspinal complications were minimal in both groups with a non-significant (P>0.05) inter-group difference, within the first 48 postoperative hours 4 patients (30.7%) in group I had postspinal complications, namely two patients (15.4%) had postspinal nausea and vomiting, one patient (7.7%) had postspinal headache and another patient (7.7%) had postspinal postural hypotension, whereas only one patient (7.7%) had postspinal postural hypotension in group II within the first 48 hours, (Table 4). No postspinal dysfunction of the third, fourth, sixth, seventh, or eighth cranial nerves was detected.

Table (1): Patients' characteristics in both groups

<table>
<thead>
<tr>
<th>Character</th>
<th>Group I</th>
<th>Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>39.5±7.8 (27-51)</td>
<td>41.7±7.5 (28-52)</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>82±7.3 (69-92)</td>
<td>83.2±4.8 (72-90)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>169.2±2.7 (165-174)</td>
<td>169.5±2.2 (166-174)</td>
</tr>
<tr>
<td>Level of analgesia (T seg.)</td>
<td>7.7±1.6 (6-11)</td>
<td>8.4±1.4 (6-11)</td>
</tr>
</tbody>
</table>

Ranges are presented in parenthesis

Table (2): SBP changes in both groups throughout the duration of spinal analgesia

<table>
<thead>
<tr>
<th>SBP (mmHg)</th>
<th>Group I</th>
<th>Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative</td>
<td>143.5±11.8 (125-165)</td>
<td>149±9 (130-165)</td>
</tr>
<tr>
<td>Postoperative</td>
<td>105±6 (95-115)</td>
<td>108±6 (95-115)</td>
</tr>
<tr>
<td>Decrease</td>
<td>38.8±7.6 (30-50)</td>
<td>40.8±8.7 (30-60)</td>
</tr>
</tbody>
</table>

* Probability versus preoperative SBP
Ranges are presented in parenthesis

Table (3): Changes in hearing level (dB) in both groups (preoperative minus postoperative) at various audiometery frequencies

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Group Side</th>
<th>Group I</th>
<th>Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Rt.</td>
<td>Lt.</td>
</tr>
<tr>
<td>125</td>
<td></td>
<td>-1.4±5.5*</td>
<td>-4.2±6.07*</td>
</tr>
<tr>
<td>250</td>
<td></td>
<td>-4.2±3.4*</td>
<td>-3.1±3.3*</td>
</tr>
<tr>
<td>500</td>
<td></td>
<td>-4.6±4.5†</td>
<td>-1.5±2.2*</td>
</tr>
<tr>
<td>1000</td>
<td></td>
<td>-2.7±4.1*</td>
<td>-3.1±3.3*</td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td>-1.9±4.8</td>
<td>-1.2±9.2</td>
</tr>
<tr>
<td>3000</td>
<td></td>
<td>-2.7±6.3</td>
<td>-2.3±6.6</td>
</tr>
<tr>
<td>4000</td>
<td></td>
<td>-7.1±12.2</td>
<td>-3.5±7.5</td>
</tr>
<tr>
<td>6000</td>
<td></td>
<td>-8.1±13.2</td>
<td>-1.5±3.2</td>
</tr>
<tr>
<td>Mean±SEM</td>
<td></td>
<td>-4.36±0.76†</td>
<td>-2.55±0.39†</td>
</tr>
</tbody>
</table>

* Probability versus the preoperative hearing level
†Significant decrease of hearing level versus the ipsilateral side of the other group

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Table (4): Postspinal complications in both groups

<table>
<thead>
<tr>
<th>Complications</th>
<th>Group I</th>
<th>Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nausea &amp; Vomiting</td>
<td>2 (15.4%)</td>
<td>0</td>
</tr>
<tr>
<td>Headache</td>
<td>1 (7.7%)</td>
<td>0</td>
</tr>
<tr>
<td>Postural hypotension</td>
<td>1 (7.7%)</td>
<td>1 (7.7%)</td>
</tr>
</tbody>
</table>

Fig. (1): SBP changes in both groups throughout the duration of spinal analgesia

Fig. (2): The mean decrease of the hearing level in both groups on both sides at various audiometric
Fig. (3): The mean decrease (Δ) of hearing level on the right side in patients enrolled in both groups on the right side at various estimation frequencies.

Fig. (4): The mean decrease (Δ) of hearing level on the left side in patients enrolled in both groups on the right side at various estimation frequencies.

Fig. (5): The changes of the hearing level 24 hrs and 7 days after surgery in patients with decreased hearing level of >10 dB in first audiometry.
**Discussion**

The audiometric results showed a decrease of hearing levels of varied intensity in all patients included in both groups. However, a decrease in hearing level of 10 dB or more at any frequency occurred in 9 of 13 patients (92.3%) in group I and in 4 of 13 patients (30.7%) in group II, with a total incidence of 50%. These results confirmed the previous studies performed by Panning et al., (1983), Wang, (1986) and Wang, et al., (1987) who reported the occurrence of hearing deficit after spinal anesthesia. Moreover, our reported incidence coincided with that reported by Wang, et al. (1987), who reported an incidence of hearing deficit in 42% of his patients, but is contradictory to the incidence reported by Panning, et al., (1983), but the difference might by attributed to the fact that in this study they depended on the patients’ complaint that only accompanies major hearing deficits thus missed minor hearing deficits, but we had depended on the audiometric estimation of the hearing levels.

The occurrence of vestibulo-cochlear disturbances after spinal anesthesia can be attributed to the fact that the decrease in the cerebrospinal fluid pressure that follows the dural puncture may be transmitted through the cochlear aqueduct to the inner ear, thus resulting in an endolymphatic hydrops. The resulting distortion of the membranous labyrinth may be accompanied by displacement of Reissner’s membrane into the scala vestibuli (Carlborg & Farmer, 1983). It is generally accepted that the endolymphatic hydrops is involved in the pathogenesis of M eniere’s disease, (Dohlman, 1983).

The mean change in the hearing level in both groups was minor decrease, despite being significant in group I (-4.36±0.76 on Rt & -2.55±0.39, on Lt.) compared to group II (-1.3±0.22 on Rt & -1.09±0.2, on Lt), on both sides (P=0.004 & 0.022, respectively). These results agreed with Wang et al., (1987) who reported only minor hearing deficits after spinal anesthesia on the second postoperative day in their series. The significant decrease in hearing level detected in group I (22-gauge
Mohamed Salem et al. indicated that the occurrence of hearing deficit is closely related to the extent of the dural puncture and thus to the size of the needle used. These results agreed with Wang et al., (1987), Hampl et al., (1995) and (Horlocker, 2000) who found no statistically significant difference in hearing levels in patients anesthetized via epidural or spinal anesthesia using 26-gauge spinal needle and concluded that hearing levels seems to be unaffected by epidural anesthesia and by spinal anesthesia using a 26-gauge needle.

In group I, there was a significant (P<0.05) bilateral decrease in the hearing level at 125, 250, 500 and 1000 Hz, while there was a non-significant (P>0.05) decrease in the hearing level at 2000, 3000, 4000 and 6000 Hz, compared to the preoperative hearing levels. The finding of this study that the hearing loss was located in the low-frequency range is in accordance with the previous reports of Panning et al., (1983), Wang, (1986) and Wang et al., (1987) and is consistent with audiometric studies carried out by Carlborg & Farmer, (1983) and Dohlman, (1983) on patients suffering from Mni re's disease that indicated the fact that the early changes in hearing level occur in the low-frequency range.

Reevaluation of the 13 patients with decreased hearing level by ≥10 dB, seven days postoperatively revealed improvement of the audiometric measurements in 12 of these patients and only one patient in group I still having a decreased hearing level by ≥10 dB, seven days after the operation. These results indicated that the postspinal hearing deficit is not only minor deficit but also is transient and are in agreement with Hampl et al., (1995), Freedman et al., (1998) and Horlocker, (2000) who reported that hearing deficits after spinal anesthesia were small and transient.

There was a non-significant (P>0.05) difference between both groups as regards the pre-, postoperative and the mean decrease of the SBP between both groups. Moreover, patients' characteristics, namely age, weight and height, and the level of anesthesia showed a non-significant differ-
ence between both groups. This signifies that the most likely explanation for the observed hearing changes is that differences in needle sizes caused differences in the size of the dural tears allowing cerebrospinal fluid leakage to alter the cerebrospinal pressure. Studies of fresh cadaver dura punctured by different sizes of spinal needles support this explanation (Dittman et al., 1988 & Ready et al., 1989).

This study suggests that the vestibulocochlear disturbances in the form of temporary hearing loss is one of complications of spinal anesthesia with an incidence of 50% and that the size of the needle used for lumber puncture is of importance to the change in hearing level that can be reduced by the use of finer spinal needles.

References


