Hearing Loss after Spinal Anaesthesia: A Too Little Appreciated Complication?

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Abstract

Introduction: Spinal anaesthesia is one of the most frequently used regional anaesthesia techniques in surgical interventions, but unfortunately it may be associated with some degree of auditory dysfunction, notably low-frequency hearing loss. Several authors have investigated this phenomenon using pure tone audiometry for audiologic assessment, but only very few studies have been devoted as yet to the role of otoacoustic emissions in evaluation of hearing loss after spinal anaesthesia.

Aims of the study: The present study was designed to:
1- Evaluate the incidence and magnitude of auditory dysfunction associated with spinal anaesthesia.
2- investigate the sensitivity of transient evoked otoacoustic emissions (TEOAEs) to the changes in auditory function associated with spinal anaesthesia, and.
3- Determine the possible causes of the expected auditory dysfunction associated with spinal anaesthesia.

Material and Methods: Fifteen males, ASA physical status I or II patients, in the age between 20-40 years, who were scheduled for surgical repair of varicocele under spinal anaesthesia were enrolled into this study. All patients were subjected to otoscopy, tympanometry, pure tone audiometry and TEOAEs. Measurements were taken twice on the day of surgery: Preoperatively, prior to administration of spinal anaesthesia and postoperatively, in the recovery room.

Statistical analysis: Statistical analysis included the arithmetic mean, standard deviation (SD), standard error and hypothesis Student’s “t” test, and Pearson’s correlation tests.

The level of statistical significance was determined by a probability value of $p < 0.05$.

Results: Five patients were excluded from the study. In the remaining ten patients (20 ears), a bilateral, highly-significant reduction in TEOAEs response was recorded at all frequencies, but with the greatest reductions occurring at 2000 and 3000Hz.

No correlation could be found between TEOAEs amplitude and the haemodynamic changes associated with subarachnoid block.

Conclusions: Transient hearing loss after spinal anaesthesia may occur more often than it is generally assumed and the symptoms might not be recognized. Audiometry may be a more sensitive indication of cerebrospinal fluid leak than postspinal headache. OAEs can be used as an effective and objective way of evaluating the hearing loss in this particular group of patients.

Future recommendations: The use of small-gauge (≤26-gauge) spinal needles of the splitting type, together with proper volume replacement, is strongly advised to minimize any possible auditory dysfunction occurring after subarachnoid block.

For medico-legal reasons, all patients should be informed about any possible transient hearing loss that could be associated with spinal anaesthesia.

Key Words: Spinal anaesthesia – Hearing loss – Audiometry – Otoacoustic emissions.

Introduction

IN the last two decades, research has highlighted another not so frequently recognized complication of spinal anaesthesia, which is low-frequency hearing loss [1-12]. The incidence rates reported vary between 3% and 92% and it is frequently associated with the “postspinal headache syndrome” [1-4, 13-17]. It is suggested that the mechanism of transient hearing loss after spinal anaesthesia is related to a decrease in cerebrospinal fluid (CSF) pressure after dural puncture with concomitant decrease in perilymphatic pressure. This decrease in perilymphatic pressure leads to an increase in endolymphatic pressure, resulting in the formation of an endolymphatic hydrops, which displaces the hair cells on the basement membrane and results in low-frequency hearing loss [18,19].
Several comparative studies using different types and different sizes of spinal needles have been conducted so far [3,5,9,11,12]. The audiologic evaluation in most of these studies consisted mainly of pure tone audiometry PTA [3,7,12,19,20]. To test for the patency of the cochlear aqueduct, some studies also included tympanic membrane displacement (TMD) analysis in addition to PTA [17]. Other studies added electrocochleography for patients with a hearing impairment > 15 dB [12].

Yet another ideal, non-invasive tool to detect the cochlear status are otoacoustic emissions (OAEs). OAEs are low-level sounds generated either spontaneously or in response to a stimulus. They are transmitted from the cochlea through the middle ear cavity and can be measured in the external ear canal via a small, sensitive microphone built into the ear probe and they are supposed to specifically represent the electromotility of the outer hair cells (OHCs), the most fragile structure of the cochlea. However, although otoacoustic emissions (OAEs) are extensively used as a rapid objective screening test for cochlear dysfunction, being known for their susceptibility to ototoxic agents, as well as metabolic and haemodynamic changes induced by various anaesthetics [21], and although the reproducibility of transient-evoked otoacoustic emissions (TEOAEs) is well established, together with their amplitude stability under experimental manipulations, changes in cerebrospinal fluid pressure or body position and alertness level [22], we know only of very few studies who have been devoted as yet to their role in evaluation of hearing loss after spinal anaesthesia [23]. In a study conducted by Karatas et al., the emission amplitudes of the TEOAE and distortion product otoacoustic emissions (DPOAE) of right and left ears were found to be affected immediately after surgery under spinal anaesthesia and progressive improvement detected with full recovery within 15 days postoperatively. These changes were mainly at around 1,500-3,000 Hz. None of the patients had permanent OAE amplitude deterioration. Transient-evoked otoacoustic emissions (TEOAE) and distortion product otoacoustic emissions (DPOAE) were evaluated one day before the operation and on postoperative days 1, 2, and 15, but not intraoperatively [23].

Aims of the study:
The present study was designed to:
1 - Evaluate the incidence and magnitude of auditory dysfunction associated with spinal anaesthesia.
2- Investigate the sensitivity of TEOAEs to the changes in auditory function associated with spinal anaesthesia, and
3- Determine the possible causes of the expected auditory dysfunction associated with spinal anaesthesia.

Material and Methods

After approval by the Ethics Committee, written informed consent of all patients entering the trial was obtained.

Studied patients:
The study was conducted in the theatre for urologic surgery at Cairo University Hospitals in the time period extending from September to December 2012.

Fifteen male patients, ASA physical status I or II, in the age between 24-40 years, undergoing surgical intervention for repair of varicocoele were enrolled into the study. Exclusion criteria included an ASA physical status other than I or II, age outside the range (20-40 years), systemic disorders (e.g. hypertension, diabetes mellitus), patients with a history of acute otitis media, or documented hearing impairment (e.g. sensorineural hearing loss, sudden hearing loss), or those on ototoxic medications, patients with inspissated cerumen, patients with history of migraines, chronic headaches, tinnitus, or Meniere’s disease, patients who were unable to cooperate during audiometry, those with negative results in audiometry and those who had previously received radiotherapy to the head and neck, and patients with head trauma or intensive care treatment within the last 3 months. Patients with absolute or relative contraindications to spinal anaesthesia, chronic smokers, patients with recent or current upper respiratory tract infection and those requiring more than one dural puncture were also excluded from the study.

Anaesthesia protocol:
To standardize the protocol of anaesthesia, the following steps were taken:
1- On the morning of operation and prior to admission to the operating theatre, all patients were first evaluated by an audiologist to determine their eligibility and the preoperative audiologic tests were performed. Patients did not receive any premedication.

2- Systolic, diastolic, and mean arterial blood pressure were measured non-invasively using the oscillometric principle. Baseline values were determined prior to performing the subarachnoid block and then at 5min. interval till the end of surgery. The ECG was displayed continuously using
lead II. Arterial oxygen saturation (SpO₂) and pulse rate were continuously monitored non-invasively.

All measurements were taken using the GE Solar 8000M vital signs monitor.

3- After preloading with normal saline (average 1000 ml), spinal anaesthesia was administered by one and the same anaesthesiologist with a midline approach through the L 3-4 interspace using a 22 gauge Quincke needle (manufactured by Braun, Germany) with the patient in the sitting position. After establishing a free flow of CSF, 3.5 ml of 0.5% bupivacaine (Mylan S.A.S, France) and 0.5 ml (25µg) of fentanyl were injected intrathecally. Only one dural puncture was allowed for each patient; if an additional dural puncture deemed necessary, or if spinal anaesthesia had to be substituted by general anaesthesia, the patient was excluded from the study.

The bevel of the needle was inserted parallel to the longitudinal dural fibres.

The level of analgesia was estimated by the pin-prick method after 20 min.

Patients were treated with IV ephedrine to maintain systolic blood pressure > 100 mmHg when deemed necessary. All patients were asked to remain recumbent for the first twelve postoperative hours.

4- Postoperatively, all patients were examined by an anaesthesiologist to determine the presence or absence of postspinal headache or dysfunction of the third, fourth, sixth, seventh or eighth cranial nerves. Patients developing hypotension or headache after spinal anaesthesia that was severe enough to require treatment were excluded from the study.

Audiologic measurements:

All patients enrolled into the study were examined preoperatively by an audiologist, including:

a- Otoscopy:

The ear canals were examined with an otoscope to exclude any external ear abnormality, foreign body, impacted cerumen or perforated tympanic membrane (TM).

b- Tympanometry:

To ensure normal function of the middle ear, tympanometric evaluation was conducted using a portable hand-held tympanometer model Danplex.

c- Pure tone audiometry:

Audiometric testing was performed in the quietest section in the patient preparation room adjacent to the operating theatre using a calibrated pure-tone audiometer model AD226 with TDH-39 earphones. Tests were carried out only when the noise level meter reading was < 45 dBA.

The measurements were taken: Preoperatively before spinal anaesthesia, and postoperatively immediately after discharge from the operating room.

The audiometer used was previously calibrated by the manufacturing company. In addition, the following preliminary checks were performed on the audiometer according to the operating manual: All power connections were checked, including the connection from the headphones to the audiometer, to ensure adequate delivery of testing tones. The audiologist explained the testing procedure to the patient, and ensured that the headphones were fitting properly around both ears.

The patient was positioned in such a way, that he could not view the audiometer’s control panel and was therefore unaware of the frequency used or the ear being tested. The hearing was tested at the frequencies 125, 250, 500, 1000, 2000, 4000, and 8000 Hz. As a frequency was chosen, the audiologist adjusted the decibel (dB) level until the patient signaled that he heard the tone by lifting the index finger on the side he heard the tone. The results of the hearing tests were recorded in dB levels at corresponding frequencies in Hertz.

d- Transient evoked otoacoustic emissions:

TEOAEs were recorded using the portable Oto-port DP & TOAEs, by Autodynamics, UK. The test parameters included: Click stimuli with stimulus level at 84 dBSPL, 30 sweeps (min), with an input filter of 1189 Hz-475 Hz.

The maximum test time was 300 seconds.

Measurements were performed in both ears of each patient on the day of surgery prior to admission to the operating theatre (control value), and then at the end of surgery. To standardize the place for audiologic measurements, the patient was transferred postoperatively once again to the patient preparation room where the initial preoperative measurements were taken.

Statistical analysis:

An IBM compatible PC was used to store and analyze the data of important results. Calculations were done by means of “SPSS” statistical software program (13.0). For sample size calculation, the values used were based on the literature published during the time of conducting the study (3, 12, 17, 19, 20, 23). Data were tabulated and statistically
analyzed to evaluate changes in the various parameters under study.

Correlations were tried in between the essential studied parameters.

The statistical analysis included the arithmetic mean, standard deviation (SD), standard error and hypothesis Student’s ‘t’ test, and Pearson’s correlation tests.

The level of statistical significance was determined by a probability value of \( p < 0.05 \).

**Results**

There were no significant differences among the patients with respect to demographic data and clinical procedures (Table 1). The analgesic level was similar in all patients (T7±2 segments). The mean maximum decrease in MAP was 74.40±7.22 (Table 2).

<table>
<thead>
<tr>
<th>Table (1): Patients and procedures (Demographic data).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (male/female)</td>
</tr>
<tr>
<td>Total number of ears tested</td>
</tr>
<tr>
<td>Age (years)</td>
</tr>
<tr>
<td>Height (cm)</td>
</tr>
<tr>
<td>Weight (kg)</td>
</tr>
<tr>
<td>ASA physical status</td>
</tr>
<tr>
<td>Volume replacement (ml)</td>
</tr>
<tr>
<td>Type of surgery</td>
</tr>
<tr>
<td>Operation time (min)</td>
</tr>
<tr>
<td>Maximal height of SAB</td>
</tr>
</tbody>
</table>

SAB = Subarachnoid block.

**Table (2): Haemodynamic changes.**

<table>
<thead>
<tr>
<th></th>
<th>Systolic blood pressure (mmHg)</th>
<th>Diastolic blood pressure (mmHg)</th>
<th>Mean arterial blood pressure MAP (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative NIBP</td>
<td>122.0±18.96</td>
<td>65.4±7.35</td>
<td>80.80±3.85</td>
</tr>
<tr>
<td>Maximum decrease in NIBP</td>
<td>111.4±14.46</td>
<td>57.0±7.69</td>
<td>74.40±7.22</td>
</tr>
</tbody>
</table>

NIBP = Non-invasive blood pressure.

The clinical courses of all patients were uneventful and none of the patients complained of postspinal headache. Apart from the audiometric changes, no postoperative cranial nerve palsies were detected in any of the studied patients.

**Audiometric results:**

Fifteen patients were enrolled into the study. All of them were subjected to preoperative audiometric evaluation. After discharge from the operating theatre, five patients were too exhausted to participate in postoperative audiometric evaluation and thus were excluded from the study. The results of pure tone audiometry did not show any statistically significant difference between the right and the left ears before and after subarachnoid block in any of the patients under study. Hence, the results of the right and left ears were summed up together for further analysis with a total number of 20 ears tested.

Changes in hearing threshold at different frequencies before and after subarachnoid block are summarized in Table (3). The hearing threshold increased by more than 5 dB at frequencies of 125, 250, 500, 1000 Hz and by one dB only at the remaining frequencies (2000, 4000, and 8000 Hz). All changes in hearing threshold recorded at frequencies of 125, 500 & 1000 Hz were highly significant \( (p < 0.001) \). Changes recorded at 2000 & 4000 Hz were statistically significant \( (p < 0.05) \), while those recorded at a frequency of 8000 Hz turned out to be of no statistical significance \( (p = 0.186) \).

**Table (4) summarizes the number and percentage of ears with failed TEOAEs at different tested frequencies before and after subarachnoid block, reflecting the effect of CSF pressure changes on cochlear fluid pressure. These changes in cochlear fluid pressure are reflected on TOAEs responses which represent the backward and forward motion of the eardrum generated by the fluctuations in cochlear fluid pressure.**

**Table (5) summarizes the changes in TEOAEs response recorded at different tested frequencies before and after subarachnoid block.**

At a frequency of 1000 Hz, 70% of the tested ears failed to give any TEOAEs response before and after subarachnoid block, so the results obtained at this frequency could not be included in any further statistical analysis.

At a frequency of 1500 Hz, no TEOAEs response could be elicited in 35% of the tested ears prior to spinal anaesthesia, and this percentage increased to 55% after subarachnoid block. The TEOAEs response in the remaining ears decreased by 43% after subarachnoid block and this decrease was statistically highly significant \( (p = 0.001) \).

At a frequency of 2000 Hz, the percentage of ears with failed TEOAEs response decreased to 10%, whether before or after subarachnoid block, when compared to the previous frequency of 1500 Hz. The TEOAEs response in the remaining ears decreased by 87% after subarachnoid block and
again this decrease was statistically highly significant ($p = 0.001$).

At a frequency of 3000 Hz, the percentage of ears with failed TEOAEs response was again 10% before subarachnoid block, but this percentage increased to 20% after subarachnoid block. The TEOAEs response in the remaining ears decreased by 85% after subarachnoid block and once again this decrease was statistically highly significant ($p = 0.000$).

At a frequency of 4000 Hz, no TEOAEs response could be detected in 20% of the tested ears before subarachnoid block, and this percentage increased to 30% after subarachnoid block. The TEOAEs response in the remaining ears decreased by 65% after subarachnoid block and again this decrease was statistically highly significant ($p = 0.000$).

The total percentage of ears which failed to give any TEOAEs response at the various tested frequencies all together was similar before and after subarachnoid block (20%). The reduction in the overall response of TEOAEs after subarachnoid block was 92%, which was statistically significant ($p = 0.018$). The mean preoperative TEOAEs overall response was 7.76±4.23 and decreased to 7.11±4.00 after subarachnoid block.

Table (6) shows that the correlation between TOAEs amplitude and the change in MAP was of no statistical significance.

Table (3): Hearing threshold at different frequencies before and after subarachnoid block.

<table>
<thead>
<tr>
<th>Tested frequency (HZ)</th>
<th>Baseline hearing threshold (dB)</th>
<th>Hearing threshold after SAB</th>
<th>“t” test</th>
<th>p-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>26.5±4.6</td>
<td>38.5±6.5</td>
<td>-9.395*</td>
<td>0.000</td>
<td>HS</td>
</tr>
<tr>
<td>250</td>
<td>29.0±7.5</td>
<td>38.0±7.6</td>
<td>-13.077</td>
<td>0.000</td>
<td>HS</td>
</tr>
<tr>
<td>500</td>
<td>31.0±5.0</td>
<td>38.5±6.09</td>
<td>-6.381</td>
<td>0.000</td>
<td>HS</td>
</tr>
<tr>
<td>1000</td>
<td>24.5±7.4</td>
<td>30.0±10.2</td>
<td>-3.039</td>
<td>0.007</td>
<td>HS</td>
</tr>
<tr>
<td>2000</td>
<td>22.5±4.7</td>
<td>23.5±5.1</td>
<td>-2.179</td>
<td>0.042</td>
<td>S</td>
</tr>
<tr>
<td>4000</td>
<td>22.5±8.9</td>
<td>23.5±6.2</td>
<td>-2.179</td>
<td>0.042</td>
<td>S</td>
</tr>
<tr>
<td>8000</td>
<td>14.5±3.2</td>
<td>15.2±3.0</td>
<td>-1.371</td>
<td>0.186</td>
<td>NS</td>
</tr>
</tbody>
</table>

Values are presented as mean±SD.

Hz = Hertz, HS = Highly significant.

dB = Decibel, S = Significant.

SAB = Subarachnoid block, NS = Non-significant.

The level of statistical significance was determined by a probability value of $p < 0.05$.

Table (4): Number and percentage of ears with failed TEOAEs at different tested frequencies before and after subarachnoid block.

<table>
<thead>
<tr>
<th>Tested frequency (HZ)</th>
<th>Number &amp; percentage of ears with failed TEOAEs before SAB</th>
<th>Number &amp; percentage of ears with failed TEOAEs after SAB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>14 (70%)</td>
<td>14 (70%)</td>
</tr>
<tr>
<td>1500</td>
<td>7 (35%)</td>
<td>11 (55%)</td>
</tr>
<tr>
<td>2000</td>
<td>2 (10%)</td>
<td>2 (10%)</td>
</tr>
<tr>
<td>3000</td>
<td>2 (10%)</td>
<td>4 (20%)</td>
</tr>
<tr>
<td>4000</td>
<td>4 (20%)</td>
<td>6 (30%)</td>
</tr>
<tr>
<td>Total</td>
<td>4 (20%)</td>
<td>4 (20%)</td>
</tr>
</tbody>
</table>

Table (5): TEOAEs response at different frequencies before and after subarachnoid block.

<table>
<thead>
<tr>
<th>Tested frequency (HZ)</th>
<th>Mean±SD before SAB</th>
<th>Mean±SD after SAB</th>
<th>“t” test</th>
<th>p-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>1500</td>
<td>2.93±3.45</td>
<td>1.25±2.10</td>
<td>3.79</td>
<td>0.001</td>
<td>HS</td>
</tr>
<tr>
<td>2000</td>
<td>6.87±0.37</td>
<td>5.95±1.04</td>
<td>4.11</td>
<td>0.001</td>
<td>HS</td>
</tr>
<tr>
<td>3000</td>
<td>7.30±0.65</td>
<td>6.23±0.84</td>
<td>5.67</td>
<td>0.000</td>
<td>HS</td>
</tr>
<tr>
<td>4000</td>
<td>3.79±0.95</td>
<td>2.46±1.81</td>
<td>4.74</td>
<td>0.000</td>
<td>HS</td>
</tr>
<tr>
<td>Total</td>
<td>7.76±4.23</td>
<td>7.11±4.00</td>
<td>2.58</td>
<td>0.018</td>
<td>S</td>
</tr>
</tbody>
</table>

Values are presented as Mean±SD.

Hz = Hertz, HS = Highly significant.

SAB = Subarachnoid block, NS = Non-significant.

The level of statistical significance was determined by a probability value of $p < 0.05$. 
Hearing deficits after spinal anaesthesia are usually transient, although they may take several months to disappear [1-3]. Major hearing deficits have been reported in association with postspinal headache [1,3]; whereas minor auditory losses are usually not accompanied by postspinal headache [1].

The aetiology of vestibulocochlear disturbances after spinal anaesthesia is not clear.

Several factors may contribute to this phenomenon.

**Needle size:**

Fog et al., suggested that hearing loss after spinal anaesthesia is related to needle size [3]. In their study, 28 patients scheduled for transurethral resection of the prostate (TURP) under spinal anaesthesia were divided into two equal groups, each comprising 14 patients. In one group 22-gauge and in the other group 26-gauge spinal needles were used. Audiograms performed preoperatively and 2 days postoperatively showed that the hearing loss was significantly greater in the 22-gauge group than in the 26-gauge group at 125, 250, 2000, and 3000 Hz.

Similarly, Malhotra et al., found that the use of a 23-gauge Quincke needle is associated with a greater reduction in the mean hearing level compared to a 26-gauge needle of the same type [12].

**Needle type:**

The needle type might also be a contributing factor to hearing loss after spinal anaesthesia. Sundberg et al. reported a 24% hearing loss with the use of cutting needles (e.g. Quincke) compared to only a 9% hearing loss with pencil-point (e.g. Sprotte) or splitting needles (e.g. Withacre) [5].

**Age group:**

The patient’s age may also affect HL. Wang et al., and Gültekin and Ozcan investigated HL after spinal anaesthesia in both young and old patients and reported a higher incidence of HL in young patients [2,20]. They explained this by the fact that the spinal and epidural spaces become smaller and less compliant with advancing age thus minimizing CSF leakage after dural puncture in the elderly population, a finding that may also explain the infrequent incidence of postdural puncture headache in the elderly. However, other studies of young patients did not show the same significance [19,24]. A possible explanation for this contradictory finding could be the difference in total volume replacement leading to alterations in plasma osmolarity (hyper- or hypoosmolarity) which may influence hearing thresholds by affecting the motility of the hair cells of the organ of Corti [23,24].

### Table (6): Correlation between TEOAEs amplitude and haemodynamic pattern (MAP)

<table>
<thead>
<tr>
<th>Pearson’s correlation coefficient</th>
<th>p-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.60</td>
<td>&gt;0.05</td>
<td>NS</td>
</tr>
</tbody>
</table>

The level of statistical significance was determined by a probability value of $p<0.05$.

NS = Not significant.

**Discussion**

Transient hearing loss (HL) after spinal anaesthesia occurs more often than is generally assumed and the symptoms might not be recognized [23].

This study shows that OAEs can be used as an objective, accurate, frequency-specific, non-invasive, easily and quickly performed bedside audimetric test for evaluating hearing loss in this particular group of patients.

In our patients, we found a bilateral, highly-significant reduction in TEOAEs response at all frequencies, with the greatest reductions occurring at 2000 and 3000 Hz.

At 1000 Hz, 70% of the ears tested failed to give any TEOAEs response before and after subarachnoid block, so the results obtained at this frequency could not be included in any further statistical analysis. However, a statistically highly-significant ($p=0.001$) reduction in TEOAEs response by 43%, 87%, 85% and 65% was recorded at frequencies of 1500, 2000, 3000 and 4000 Hz, respectively. The reduction in the overall response of TEOAEs after subarachnoid block was 92%, which was statistically significant ($p=0.018$). The mean preoperative TEOAEs overall response was 7.76±4.23 and decreased to 7.11±4.00 after subarachnoid block. In our patients, no correlation could be found between TEOAEs amplitude and the haemodynamic changes associated with subarachnoid block.

Another important finding of this study are the results recorded by pure tone audiometry (PTA) which showed a highly-significant ($p<0.001$) increase in hearing threshold by more than 5 dB at the low frequencies of 125, 250, 500 and 1000 Hz. At the higher frequencies 2000, 4000 and 8000 Hz, the hearing threshold increased by 1 dB only, but only the increase recorded at 2000 and 4000 Hz was statistically significant ($p<0.05$).

Many authors have investigated the auditory dysfunction related to spinal anaesthesia which is defined as a transient low-frequency sensorineural hearing loss [1-20,23].

Most of these studies used pure tone audiometry for audiologic evaluation.
Sex:

It is interesting to note that loss of hearing for higher frequencies is more common in men [25]. Equally interesting are the clinical findings of Finegold et al., in their randomized, double-blind study conducted on 44 parturients receiving spinal anaesthesia for elective Caesarean section delivery, who could not find any demonstrable hearing loss in the obstetric population [19]. They explained this paradox by the fact that the obstetric population has not been studied systematically for hearing changes, in addition to the uniqueness of this particular group of patients.

Whether or not the patient’s sex is involved in hearing loss after spinal anaesthesia needs further investigation.

Type of anaesthesia:

Schaffartzik et al., failed to prove that the type of anaesthesia could be one of the contributing factors to HL [17]. In a comparative study conducted on a total number of 37 patients, they found that HL occurs after spinal as well as after general anaesthesia, and that although the average low-frequency hearing threshold was significantly worse after spinal rather than after general anaesthesia, the latter influenced the hearing acuity to a greater extent. They found a significant correlation between the magnitude of intraoperative intravascular volume replacement and low-frequency hearing loss. Patients belonging to the general anaesthesia group received more intravenous fluids intraoperatively, supporting the fact that changes in plasma osmolarity influence hearing levels [17].

Epidural anaesthesia may also cause a brief period of hearing loss (<10 minutes), as reported by Finegold et al., [19], because the transient increase in CSF pressure caused by the injection of fluid into the epidural space may affect the function of the cochlear hair cells [26].

Type of surgery:

One of the contributing factors to HL after spinal anaesthesia that should not to be ignored, however, is the type of operation. Wang et al., suggested that the irrigating solution used in transurethral resection of the prostate (TURP) is also a factor involved in HL [3,6]. Not only does the irrigating solution affect the plasma osmolarity [23], but glycin is known to be an inhibitory neurotransmitter [12]. In addition, TURP produces profound alterations in fluid and electrolyte balance [12].

The finding of the present study that the hearing loss was located in the low-frequency range is in accordance with previous reports [1-20,23].

Because the needle type and size, the age, sex, weight, height, dose of bupivacaine used, level of sensory blockade, type of surgery, as well as the degree of hypotension were all similar, the most likely explanation for the hearing loss recorded in our patients is the decrease in cerebrospinal fluid (CSF) pressure associated with CSF leakage after dural puncture which is transmitted to the perilymph via the cochlear aqueduct connecting the CSF and the cochlear fluid (Fig. 1), thus resulting in a concomitant decrease in perilymphatic pressure. The decrease in perilymphatic pressure associated with CSF leakage after dural puncture leads to a relative increase in endolymphatic pressure, resulting in the formation of an endolymphatic hydrops, which displaces the hair cells on the basilar membrane leading to low-frequency hearing loss [18,19]. This is most pronounced in the apical region of the cochlea where the basilar membrane is least stiff and the intracranial pressure changes during spinal anaesthesia are transmitted to the cochlear fluids via the cochlear aqueduct [12,23].

Fig. (1): Inner Ear Fluids (quoted from: Alec N. Salt, Ph. D.; Department of Otolaryngology; Washington University School of Medicine; St. Louis, Missouri, 63110, US).

No other factors accounting for the aetiology of hearing loss after spinal anaesthesia have been demonstrated so far and it is worth mentioning that this type of hearing loss is seen not only after spinal anaesthesia, but also with any procedure that involves opening of the dura, such as lumbar puncture, myelography, ventriculo-peritoneal shunts, surgery for acoustic neuroma and other neurosurgical procedures [12,20].

Limitations of the study:

One of the disadvantages of the present study is the limited number of patients, which does not allow us to make categorical statements.

Another possible drawback to the current study design is that the follow-up of patients was limited.
to the immediate postoperative period on the same day of surgery because of the early discharge of patients. However, the majority of cases of postspinal headache develop within 2 days of spinal anaesthesia [1,2,3,12]; therefore, it is possible that some potential cases of postspinal headache were missed.

The use of 22-gauge spinal needles of the Quincke variety appears to be a further disadvantage of the present study. Previous studies reported that the incidence of hearing loss with the use of a 22-gauge spinal needle was more common than with the 25- or 26-gauge needles [3,9,11,12,23]. Moreover, the use of a cutting type of needle was found to be associated with a greater decrease in the mean hearing level compared to the non-cutting type [5,9,12,23].

Still another shortcoming of this study is that the hearing tests were performed in the patient preparation room that lies in close proximity to the operating theatre. For pure tone audiometry, measurements could be done in a quiet room after assessment of the background noise using the sound level meter to ensure that tests meet the minimum noise restrictions within a test environment, but for more accurate or near to optimum results OAE testing in particular should be performed in a noise-free, non-echogenic sound proof room [27].

Implications and future recommendations:

It was proposed that isotonic saline solution should be injected into the subarachnoid space at the same amount as the CSF loss to prevent hearing loss [20,28], but this needs further investigation. Lambreg et al., suggested that spinal catheters may mechanically plug the hole in the dura causing an inflammatory swelling which may prevent CSF leakage and the resulting hearing loss [29].

Conclusion:

Transient hearing loss after spinal anaesthesia may occur more often than it is generally assumed and the symptoms might not be recognized, although it is frequently associated with the postspinal headache syndrome. No cases of postspinal headache occurred in the present study, suggesting that audiometry may be a more sensitive indication of cerebrospinal fluid leak than postspinal headache. OAEs can be used as an effective and objective way of evaluating the hearing loss in this particular group of patients. Since the individual risk for hearing loss after a spinal puncture is not predictable, we suggest that for medico-legal reasons, all patients should be informed about any possible transient hearing loss that could be associated with spinal anaesthesia.

References