ORIGINAL ARTICLE

Evaluation of Very Low Birth Weight (≤1500 g) as a Risk Indicator for Sensorineural Hearing Loss☆

Silvia A. Borkoski-Barreiro, a,∗ Juan C. Falcón-González, a José M. Limiñana-Cañal, b Ángel Ramos-Macías a

a Unidad de Hipoacusia, Servicio de ORL y PCF, Complejo Hospitalario Universitario Insular-Materno Infantil, Las Palmas de Gran Canaria, Spain
b Unidad de Investigación, Complejo Hospitalario Universitario Insular-Materno Infantil, Las Palmas de Gran Canaria, Spain

Received 23 March 2013; accepted 23 May 2013

KEYWORDS
Neonatal hearing loss; Early detection; Very low birth weight; Prematurity

Abstract
Introduction and objective: Hearing plays an essential role in the acquisition, development and maintenance of the properties of the speech and language. Birth weight is an indicator of biological maturation of the newborn. Premature newborns with very low birth weight (VLBW<1500 g) constitute a group with the highest risk of sensorineural hearing loss. Our objective was to ascertain the degree of hearing loss, sensorineural hearing loss and presence of the association to other risk factors for hearing loss in VLBW infants included in the Universal Hearing Loss Screening Programme at the University Mother-Child Hospital of Gran Canaria (Spain) in the 2007–2010 period.
Material and methods: This was a retrospective study of 364 infants with VLBW, measured by transient evoked otoacoustic emissions and auditory brainstem response.
Results: There were 112 newborns (30.8%) referred for auditory brainstem response. A diagnosis of hearing loss was given to 22 newborns (2.2%), 14 had conductive hearing loss and 8, sensorineural hearing loss (SNHL), of which 2 had bilateral profound hearing loss. The VLBW newborns presented the association to another risk factor in more than a quarter of the sample studied. All those diagnosed with SNHL were premature.
Conclusions: The percentage of VLBW newborns diagnosed with hearing loss is higher than expected in the general population. All those diagnosed with SNHL were premature and presented one or 2 hearing risk factors associated with VLBW.
© 2013 Elsevier España, S.L. All rights reserved.

☆ Please cite this article as: Borkoski-Barreiro SA, Falcón-González JC, Limiñana-Cañal JM, Ramos-Macías Á. Evaluación del muy bajo peso (≤1.500 g) al nacer como indicador de riesgo para la hipoacusia neurosensorial. Acta Otorrinolaringol Esp. 2013;64:403–408.
∗ Corresponding author.
E-mail address: silviaborkoski@hotmail.com (S.A. Borkoski-Barreiro).

2173-5735/$ - see front matter © 2013 Elsevier España, S.L. All rights reserved.
### PALABRAS CLAVE
- Hipoacusia neonatal;
- Detección precoz;
- Muy bajo peso al nacer;
- Prematuridad

### Evaluación del muy bajo peso (≤1.500 g) al nacer como indicador de riesgo para la hipoacusia neurosensorial

### Resumen

**Introducción**

La audición cumple un rol fundamental en la adquisición, desarrollo y mantenimiento de las propiedades del habla y del lenguaje. El peso al nacer es un indicador de maduración biológica del recién nacido (RN). El RN con muy bajo peso al nacer (MBPN ≤ 1500 g) y el gran prematuro es un grupo de población de mayor riesgo para hipoacusia neurosensorial. El objetivo del estudio es conocer el grado de hipoacusia, presencia de hipoacusia neurosensorial y la asociación a otro factor de riesgo para hipoacusia en el RN de MBPN, incluidos en el Programa de Cribaje Universal de la Hipoacusia del Complejo Hospitalario Universitario Insular Materno Infantil de Gran Canaria, durante el periodo 2007-2010.

**Material y método:** Estudio retrospectivo de 364 RN con MBPN, mediante otoemisiones acústicas provocadas transitorias y potenciales evocados auditivos de tronco cerebral.

**Resultados:** Ciento doce RN (30.8%) fueron derivados a potenciales evocados auditivos de tronco cerebral. Veintidós RN (2.2%) presentaron diagnóstico de hipoacusia, 14 hipoacusias de transmisión, 8 hipoacusias neurosensoriales (HNS), y de estos, 2 con hipoacusia bilateral. La asociación a otro factor de riesgo de los RN con MBPN se presenta en más de la cuarta parte de la muestra estudiada. Todos los diagnosticados de HNS fueron grandes prematuros.

**Conclusiones:** El porcentaje de niños con diagnóstico de hipoacusia entre los RN con MBPN es superior al esperado en la población general. Todos los diagnosticados de HNS fueron grandes prematuros y presentaban uno o 2 factores de riesgo auditivo más, asociados al MBPN.

© 2013 Elsevier España, S.L. Todos los derechos reservados.

### Introduction

Throughout life, hearing fulfills a fundamental role first in the acquisition and later in the development and maintenance of speech and language abilities, thus establishing our communicative competency.

According to international reviews and data collated in screening studies of large population groups in Spain, USA, Australia and Great Britain, hearing loss is the sensorineural alteration with the greatest prevalence in developed countries: 5/1000 live newborn children (NB), and if we consider only profound sensorineural hearing loss, it is 1/1000 NB.¹²³

The Joint Committee on Infant Hearing has set out certain risk criteria for suffering hearing loss. Between 10% and 30% of children will present one of these factors at birth.³

Birth weight is an indicator of biological maturity affecting the NB’s health and subsequent progression. Two out of three children with low birth weight are premature. Any NB weighing less than 1500 g, regardless of gestational age, is considered to be an NB with very low birth weight (VLBW).

Extremely premature babies (<32 weeks of gestation) or NB with VLBW form a specific group of greater vulnerability and, thanks to technological advances, it has been possible to increase their survival but not to improve their medical morbidity with the consequential possibility of auditory sequelae.⁴⁵ The frequency of hearing loss in these children is between 5% and 6%, although it is not clear whether, in and of itself, being born with <1500 g or having a gestational age <32 weeks are really risk factors (RF) or there may be other additional circumstances that make them vulnerable to hearing deficit.⁶

The goal of this article is to identify the degree of hearing loss, the presence of sensorineural hearing loss and its association with other RF for hearing loss in NB with VLBW included in the Universal Hearing Loss Screening Programme at the Gran Canaria Island Mother and Child University Hospital Complex (CHUIMI) over the period between 2007 and 2010.

### Material and Method

A total of 364 NB born with <1500 g and included in the CHUIMI’s Universal Childhood Hearing Loss Screening Programme were studied. In the Canary Island Region, this programme is based on a two-stage screening system for the universal population (Fig. 1).

The first examination is performed during pregnancy through the detection of otoacoustic emissions with portable automated devices (Echo-ScreenTA Plus⁶). All of these were referred for the second phase for the detection of transient evoked otoacoustic emissions (TEOAE) through the use of Intelligent Hearing Systems (TE audio test).

If the TEOAE are absent in both ears, they are referred to the Hearing Loss Unit at the Otorhinolaryngology Department for diagnosis by means of brainstem auditory evoked potentials (BAEP).

For the statistical processing of the data, version 20.0 for Windows of the SPSS statistical package was used. In order to study the possible associations between categorical variables, Fisher’s exact test was used. A hypothesis contrast was considered statistically significant when the corresponding P value was less than .05.

The performance of this study was approved by the CHUIMI Clinical Trials Committee.

### Results

During the period running from January 1st, 2007 to December 31st, 2010, a total of 364 NB presenting <1500 g at birth were studied, 205 males (56.3%) and 159 females (43.7%).
Evaluation of very low birth weight (≤1500 g) as a risk indicator for sensorineural hearing loss

The distribution of the RFs by gender is shown in Table 1.

In the first phase, the TEOAE were negative in 40.8% of the NB, whereas they were absent in 15.5% of the sample in the second phase. A total of 112 NB were referred for BSAEP, 64 boys (17.6%) and 48 girls (13.2%).

Of the NB who attended the BSAEP test, according to the records obtained, 22 presented a diagnosis of hearing loss, a statistically significant result in comparison with the hearing loss expected in the general population (P<.001).

A diagnosis of transmission hearing loss (THL) was made in 14 children (63.6%) whereas sensorineural hearing loss (SNHL) was diagnosed in 8 (36.4%). Two children presented a diagnosis of profound bilateral SNHL. Although there was a difference between the number of NB with a diagnosis of profound hearing loss among children with VLBW in our sample and that expected in the general population, this difference turned out not to be significant (P>.05).

Of the NB diagnosed as having hearing loss, 12 presented only VLBW; 6 presented VLBW in association with the use of ototoxic medication and hyperbilirubinaemia; 3 NB presented VLBW, the use of ototoxic medication plus perinatal asphyxia; and only one NB presented the association of

<table>
<thead>
<tr>
<th>Table 1 Distribution of Risk Factors by Gender.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Very low weight (VLW)</td>
</tr>
<tr>
<td>VLW, ototoxic medication and hyperbilirubinaemia</td>
</tr>
<tr>
<td>VLW, ototoxic and other medication</td>
</tr>
<tr>
<td>VLW, no ototoxic medication</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Figure 1 Flowchart used in the Universal Hearing Loss Screening Programme at the Gran Canaria Island Mother and Child University Hospital Complex.
VLBW, ototoxic medication and the presence of congenital cardiopathy (Table 2).

The distribution of the type of hearing loss between NB with a diagnosis of hearing loss by RF marked by BSAEP is shown in Table 3.

With regard to the distribution of the type of hearing loss between right and left ears as marked by BSAEP, we observed that a total of 7 NB presented bilateral SNHL, and one NB unilateral SNHL (right ear), while unilateral THL was observed in 10 patients (6 in the left ear and 4 in the right ear), and 4 NB had bilateral THL (Table 4).

The study of the association between RFs and the presence of hearing loss marked by BSAEP for right/left ears is shown in Table 5, where it is seen that there is no association between the RFs and the pathology (normal/hearing loss) in either ear.

Of all the NB subjected to BSAEP testing, the 22 who were diagnosed as having hearing loss were very premature, that is to say NB with less than 32 weeks of gestation at birth ($P=.011$) (Table 6).

### Discussion

Hearing loss produces not only permanent effects on the development of oral language but may also have an impact on a child’s progress and educational, emotional and social development.7

It has been shown that an early intervention on childhood hearing loss results in good language acquisition by taking advantage of the period of cerebral plasticity in the early years of life, so its early and universal detection is the only reasonable strategy for the early identification of hearing loss in childhood.8–11

Studies such as those by Erenberg et al. and Ptok report that the rate of SNHL among children presenting an associated RF is 1%–2%,12,13 values similar to those observed in our sample, where a total of 8 children were diagnosed as having SNHL (2.2%).

Several studies have concluded that the combination of RFs and the general status of the NB has a greater influence on the development of SNHL than low birth weight.7

Ohl et al. found that associations of 2 or more RFs significantly increase bilateral hearing loss.15 In our sample, more than a quarter presented an association with another RF for hearing loss in addition to VLBW, the most frequent of which were the use of ototoxic medication in 72.7% and the presence of hyperbilirubinaemia in 31.8%. A diagnosis of profound bilateral SNHL was made in 2 children who presented an association of 2 or 3 RFs most associated with VLBW.

Although VLBW has ceased to be considered as an indicator of the risk of hearing loss, several authors agree that

### Table 4 Distribution of the Type of Hearing Loss by Right/Left Ear as Marked by BSAEP

<table>
<thead>
<tr>
<th>BSAEP right ear</th>
<th>BSAEP left ear</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Conductive hearing loss</td>
<td>Sensorineural hearing loss</td>
</tr>
<tr>
<td>Normal</td>
<td>54</td>
<td>6</td>
</tr>
<tr>
<td>Conductive hearing loss</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Sensorineural hearing loss</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Not present</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>59</td>
<td>10</td>
</tr>
</tbody>
</table>

### Table 5 Distribution of the Type of Hearing Loss by Right/Left Ear as Marked by BSAEP

<table>
<thead>
<tr>
<th>Only weight less than 1500 g</th>
<th>Conductive hearing loss</th>
<th>Sensorineural hearing loss</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLBW, ototoxic medication and hyperbilirubinaemia</td>
<td>9</td>
<td>8.0</td>
<td>4</td>
</tr>
<tr>
<td>VLBW, ototoxic medication plus perinatal asphyxia</td>
<td>2</td>
<td>1.8</td>
<td>3</td>
</tr>
<tr>
<td>VLBW, ototoxic medication and congenital cardiopathy</td>
<td>1</td>
<td>0.9</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td>12.5</td>
<td>8</td>
</tr>
</tbody>
</table>

### Table 2 Distribution of Risk Factors Due to Hearing Loss Marked by BSAEP

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>With hearing loss</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only weight less than 1500 g</td>
<td>34</td>
<td>12</td>
</tr>
<tr>
<td>VLBW, ototoxic medication and hyperbilirubinaemia</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>VLBW, ototoxic medication plus perinatal asphyxia</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>VLBW, ototoxic medication and congenital cardiopathy</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>VLBW, ototoxic medication and other medication</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>54</td>
<td>22</td>
</tr>
</tbody>
</table>
being born with <1500 g is one of the factors present among those most frequently identified in an NB diagnosed as having hearing loss.\textsuperscript{17-20}

VLBW and prematurity are often concomitant findings and it is difficult to separate them completely. In addition, a higher incidence of hearing loss has been observed in those premature children in comparison with children born at full term.\textsuperscript{17,18,21,22}

Very premature NB (≤32 weeks) and/or weighing less than 1500 g at birth constitute a population at higher risk for SNHL. Some studies report an incidence of SNHL that fluctuates between 2 and 4 out of every 100 NB.\textsuperscript{12,23}

Authors such as Torres Valdivieso et al., Bielecki et al., Pereira et al. and Marlow et al. refer to the co-existence of prematurity and very low birth weight in children diagnosed as having SNHL.\textsuperscript{6,17,24,25}

The results in our sample reveal that all the children diagnosed as having SNHL were born with a gestational age ≤32 weeks, and all of them presented co-existence of 2 or more RFs for hearing loss, representing 2.2% of the total NB studied.

Conclusions

The percentage of children with a diagnosis of hearing loss among NB with VLBW is 2.2%, higher than the percentage expected in the general population. All children diagnosed with SNHL were very premature and presented an association of one or two auditory RFs in addition to VLBW.

Although there are differences between the number of NB with a diagnosis of profound SNHL among the children with VLBW and the value expected in the general population, this turned out not to be significant.

Conflict of Interest

The authors declare no conflict of interest.

References