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Age-dependence of the auditory threshold-difference between albino and pigmented Guinea pigs *(Cavia porcellus)*[1]

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Receipt of Ms. 25. 10. 1982

Abstract

Determined were the auditory thresholds of albino and pigmented guinea pigs in five age-groups between birth and an age of 54 months. Both albino and pigmented animals exhibited an elevation of thresholds with age. No differences in sensitivity could be found between two groups within the first weeks of life. But with advancing age pigmented guinea pigs showed increasingly higher thresholds than albinos.

Introduction

Previous studies have shown contradictory results about auditory threshold differences between albino and pigmented guinea pigs. Whereas Nuttall (1974) found that both groups did not differ, a behavioral study yielded a smaller sensitivity of pigmented guinea

[1] With the support of the Deutsche Forschungsgemeinschaft (DFG).

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Z. Säugetierkunde 48 (1983) 95–99
© 1983 Verlag Paul Parey, Hamburg und Berlin
ISSN 0044-3468 / InterCode: ZSAEA 7

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pigs (Crifo 1973). Moreover, an investigation of young adult and old animals has given evidence that, besides higher thresholds in both age-groups, pigmented guinea pigs sustain a greater loss of auditory sensitivity correlated with age (Dum et al. 1980). To clarify, in how far the differences between the two groups could be dependent upon age, guinea pigs of three further age-classes were examined. The present report combines the data of this investigation and the above mentioned results of Dum et al. (1980).

Materials and methods

The thresholds were determined by recording auditory brainstem responses or the compound action potential of the auditory nerve at the round window. The investigation included guinea pigs of five age-groups between birth (recordings within 24 h after birth) and an age of 54 months. The Table summarizes the number of animals studied and the method used in the different age-classes.

Table

Number of animals studied in the different age-groups

BSR: Auditory brainstem responses; CAP: Compound action potential of the auditory nerve

	Age (months)				
	0[1]–1	3	6	42	54
Pigmented guinea pigs	7	10	9	11	10
Albino guinea pigs	3	5	3	5	6
Method	BSR	CAP	BSR	BSR	CAP

[1] Recordings within 24 h after birth.

The acoustic stimuli consisted of pure tones of trapezoidal envelope 10 ms in overall duration with rise and fall times of 2 ms each. The stimuli were presented at frequencies between 500 Hz and 24 kHz (compound action potential) and from 500 Hz to 15 kHz (brainstem responses). A detailed description of the recording methods, the apparatus for analysis and the stimulus presentation has been published elsewhere (Dum 1982; Dum et al. 1980, 1982).

The results of both ears of each animal were evaluated. The older animals were obtained from an experimental animal breeding (B. Buchner, D-8221 Kienberg; albinos: Purbright white; pigmented guinea pigs: short-haired, multicoloured animals). The newborn guinea pigs were litters of our own breeding stock, which descended from offsprings of the above mentioned breeding.

Results

The first striking demarcation between the two groups was the occurrence of deafness in old pigmented guinea pigs. (Deafness was defined as the absence of response at the maximal sound intensity of 100 dB SPL.) From 6 of 22 stimulated ears of the 42 months old pigmented animals no responses could be recorded. In the guinea pigs aged 54 months 5 of 20 ears showed no response. Furthermore, many of the old pigmented animals exhibited a restriction in the frequency extent of the response range. In the 54 months old group from 50 to 80 % of the stimulated ears no compound action potential could be recorded at frequencies below 4 kHz and above 16 kHz.

One of the old pigmented guinea pigs showed thresholds which were 30 dB below the mean values of the nine remaining animals aged 54 months. This animal was hardly pigmented and had red eyes like albino guinea pigs. The data of this animal were not included in the calculation of the threshold differences.

At birth the lowest absolute thresholds were measured. The greatest sensitivity was found at 8 kHz with a mean threshold of 5 dB SPL. Towards lower and higher frequencies

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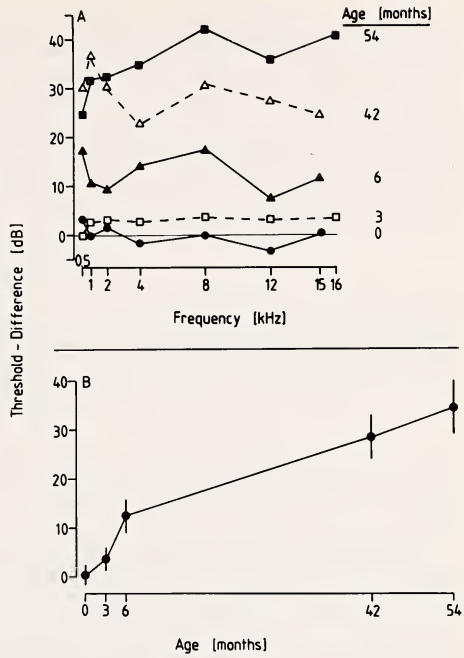

Fig. 1. Age-dependence of the auditory threshold difference between albino and pigmented guinea pigs. A: The thresholds of the pigmented guinea pigs of the different age-groups in relation to the thresholds of the albino guinea pigs of the corresponding age in the frequency range between 500 Hz and 15 kHz, respectively 16 kHz. B: The thresholds of the pigmented guinea pigs in relation to those of the albino guinea pigs plotted against age. Values are means ± s. d. of the threshold differences at the frequencies specified in part A. The data at an age of 6 and 42 months are based on results of DUM et al. (1980)

the sensitivity declined to an average excitation level of 23 dB SPL at 500 Hz and 21 dB SPL at 15 kHz. Because of the few data at frequencies above 16 kHz in old pigmented guinea pigs, the differences in sensitivity were only evaluated in the range up to 16 kHz. Fig. 1A shows the difference of the threshold values between albino and pigmented guinea pigs of the corresponding age. At birth no distinction between the two groups can be seen. This could also be found at an age of four weeks. But with advancing age, pigmented animals exhibited increasingly higher thresholds than albino guinea pigs. This is still more striking when the means of the threshold differences of the frequencies studied are plotted against age (Fig. 1B).

These threshold differences in older animals are an expression of a greater age-dependent loss of auditory sensitivity in pigmented guinea pigs. While albinos aged 42 months showed an average threshold elevation of 16.9 dB, and 21.4 dB at an age of 54 months, the corresponding values in pigmented guinea pigs amounted to 33.3 dB and 47.7 dB, respectively.

A further demarcation between the two groups could be found during the microscopic

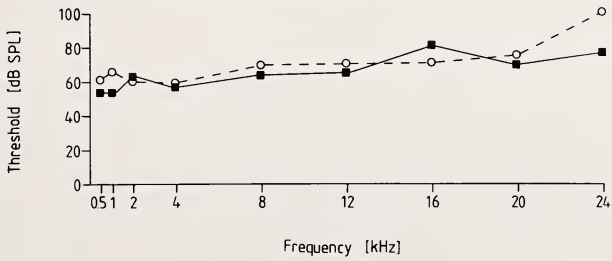

Fig. 2. Thresholds of the compound action potential in old pigmented guinea pigs with (○--○; n = 4) and without (■—■; n = 9) pathological changes of the middle ear

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examination of the middle ears before the recording of the compound action potential. Seven of 20 ears of the 54 months old pigmented animals showed osteitis of the bulla tympanica and/or middle ear effusions. No correlation between these damages and the deafness or the restriction in the frequency extent of the response range described above could be ascertained. Only three of the five deaf ears showed damages, and the absence of response at a particular frequency was observed in the same quantity in ears with and without pathologies. Moreover, the thresholds of ears with and without changes were approximately the same (Fig. 2).

Discussion

Until now there have been apparent contradictory results about a different hearing ability of albino and pigmented guinea pigs. Whereas behavioral experiments (Crifo 1973) and the recording of auditory brainstem responses (Dum et al. 1980) showed lower thresholds of albinos, Nuttall (1974) found no differences between the two groups with respect to microphonic potentials. Considering the age of the animals, these results agree on ground of the data obtained in the present study. Crifo (1973) examined guinea pigs with an age up to two years, the weight of the animals investigated by Nuttall (1974) points to an age of four to six weeks.

The present study showed no threshold differences between albino and pigmented guinea pigs in the first four weeks after birth. That is consistent with the results of Nuttall (1974). With advanced age, however, albino guinea pigs – in agreement with the data of Crifo (1973) – exhibited lower thresholds than pigmented animals. The increasing threshold difference express a greater loss of hearing in pigmented guinea pigs of advanced age.

These findings are supported by the occurrence of deafness and the restriction in the frequency extent of the response range in old pigmented guinea pigs. A similar loss of hearing ability could neither be found in any of the old albinos studied in the present investigation, nor in an examination of twenty further albino guinea pigs aged 3½ years, in which age-related changes of evoked potentials from the inferior colliculus and auditory cortex were analyzed (Dum 1982).

Besides the differences in sensitivity, old pigmented animals often showed pathological changes of the middle ear, whereas these damages did not occur in old albinos. Yet, the threshold differences of the two groups cannot be explained by a reduced sound conduction caused by these pathologies, since the thresholds of ears with and without damages did not differ in pigmented animals. Moreover, the absence of the compound action potential at a particular frequency could be observed in the same quantity in ears with and without pathological changes. The results rather point to a stronger effect of aging upon the sensory and neural level of the auditory pathway in pigmented guinea pigs.

The effect of albinism upon the auditory function has also been studied in the laboratory mouse (Henry and Haythorn 1975). But in this investigation only mice up to an age of 21 days were included. At that age no threshold differences between albino and pigmented mice could be found.

The difference between albino and pigmented guinea pigs could be caused by a pleiotropic gene action, by which the gene responsible for albinism also effects a different damage of the middle and inner ear with advancing age. In this context it is interesting to notice a distinct loss of sensitivity in pigmented guinea pigs within the first two years of life (Dum 1982). A comparable early threshold elevation has also been found in mice with a genetic hearing defect (Henry and Chole 1980). The low thresholds of one old pigmented guinea pig, that was hardly pigmented and had red eyes like an albino, indicate, that the difference between the two groups must not be directly combined with the albinism. Either one or several of the four allels of the gene responsible for albinism in guinea pigs (UFAW

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1976) could cause the difference of the hearing ability. Cross-breedings of albino and pigmented guinea pigs and their offsprings may make a valuable contribution to clarify this question.

Acknowledgement

I am grateful to Prof. Dr. U. Schmidt for his discussions during the preparation of the manuscript.

Zusammenfassung

Altersabhängigkeit der Hörschwellenunterschiede zwischen Albino- und pigmentierten Meerschweinchen

Die Schwellen akustisch evozierter Potentiale von Albino- und pigmentierten Meerschweinchen wurden in fünf Altersgruppen von der Geburt bis zu einem Alter von 54 Monaten ermittelt. Sowohl Albinos als auch pigmentierte Versuchstiere zeigten eine Schwellenerhöhung im Alter. Innerhalb der ersten Lebenswochen fanden sich keine Unterschiede zwischen den beiden Gruppen. Mit zunehmendem Alter jedoch wiesen pigmentierte Meerschweinchen verstärkt höhere Schwellen als Albinos auf.

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Zeitschrift/Journal: Mammalian Biology (früher Zeitschrift für Säugetierkunde)

Jahr/Year: 1982

Band/Volume: 48

Autor(en)/Author(s): Dum Norbert

Artikel/Article: Age-dependence of the auditory threshold-difference between albino and pigmented Guinea pigs (Cavia porcellus) 95-99