

Effect of Healthy Pregnancy on Auditory Evoked Potentials: Two Cases

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Abstract

While there are various known hormone-related effects on different auditory-evoked potential (AEP) classes, there is a paucity of research on the effect of pregnancy on the ABR, MLR, and LLR. We collected audiological data as well as AEPs throughout the healthy pregnancies of two mothers, one with normal hearing and one with stable mild-to-moderately severe sensorineural hearing loss. Our findings and both research and clinical implications will be discussed.

Background and Significance

During periods of menstruation there are altered levels of estrogen and progesterone similar to pregnancy; however, there are contradictory findings concerning the impact of menstruation on hearing sensitivity. For example, Resende et al (2000) reported no change in auditory brainstem responses (ABRs) during the menstrual cycle, while another study by Elkind-Hirsch et al (1992) reported a significant increase in the peak latencies of waves III and V during active menstruation. Furthermore, Elkind-Hirsch et al. indicated that wave V latency is increased by estrogen while decreased by progesterone. Given that hormones may have some effect on hearing sensitivity, there has been some interest in the literature of the possibility that hormones associated with pregnancy may affect auditory evoked potentials. During pregnancy, both estrogen and progesterone rise, but in significantly different amounts. One of the major estrogens (estradiol) rises from less than 2 ng/ml in the first few weeks of pregnancy to as high as 18 ng/ml. On the other hand, progesterone rises from less than 25 ng/ml to 150 ng/ml in the same time frame. This is quite different scenario from the menstrual cycle in which estrogen (estradiol) rises at the beginning of the menses to a peak of 0.7 ng/ml just before ovulation and gradually falls back down to pre-menstrual levels.

Progesterone during the menstrual cycle rises immediately during and after ovulation coming to a peak at about 9 ng/ml before gradually falling back to pre-menstrual levels. Thus, pregnancy and menstrual cycles reflect two different hormonal patterns between estrogen and progesterone.

Tandon et al (1990) were one of the first to study ABRs in pregnant and they women concluded that absolute peak latencies I-V were similar between pregnant and non-pregnant control groups. However, interpeak latencies I-III, III-V, and I-V were higher in pregnant women when compared with the control group. Later, Egeli and Gürel (1999) conducted a similar study and found that wave I was statistically different between groups, yet no other absolute nor interwave latencies reached significance. In a more recent publication, Sennaroglu and Belgin (2001) studied the impact of pregnancy on hearing thresholds as well as ABRs with 20 pregnant mothers and 18 non-pregnant controls. In the pregnant mothers, low-frequency hearing (125 to 500 Hz) worsened throughout the pregnancy but returned to normal levels post-partum. The ABRs did not reveal any significant differences between groups for absolute or interwave latencies, a finding contrary to the previous two studies. Because ABRs only assess neural integrity through the upper brainstem, it seems reasonable to determine if later auditory evoked potentials might be affected irrespective of the function of the inner ear.

Looking at middle latency responses (MLRs) and slow vertex responses (SVRs; cortical potentials) during pregnancy, Yadav et al (2003) revealed no differences in MLR latency and amplitude compared to non-pregnant controls. However, the SVR waves were significantly delayed in pregnant women when compared with non-pregnant women. For the auditory P3, Tandon et al (1996) reported a significant increase in latency and amplitude in pregnant women compared to non-pregnant controls. These two studies suggest that pregnancy hormones may have more of an effect on auditory evoked potentials than for earlier potentials, including ABR and MLR.

One of the significant problems with many of the studies described above is that the participants were not all followed in a longitudinal fashion. Therefore, any changes that occur at the subject level might have been lost during the statistical analyses.

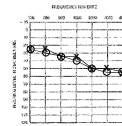
Methods

Participants

- No known neurological problems reported
- Tympanograms with static admittances between 0.3 and 1.8 mmhos and tympanometric peak pressure between -100 and +50 daPa
- Healthy pregnancies with no reported obstetrics nor medical concerns
- Completed informed consent form (Study approved by the UALR Institutional Review Board, Protocol #08093M1)

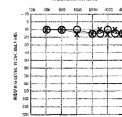
Case 1 - (Sensorineural Hearing Loss)

- Age: 29 years
- Stable sensorineural hearing loss since childhood due to ototoxicity (see Figure 1a)
- Pregnant with first child
- Began study at 15 weeks (9 sessions including 1 session 1-month post-partum)



Case 2 - (Normal Hearing)

- Age: 24 years
- Hearing within normal limits (see Figure 1b)
- Pregnant with second child
- Began study at 15 weeks (5 sessions including 1 session 1-month post-partum)



Evoked Potential Equipment and Procedures

Participant Instructions

- Napped during ABR recordings
- Read a book or magazine of their choice during MLR and LLR recordings
- Any session could be rescheduled depending on how participant felt that day
- Breaks were allowed if requested

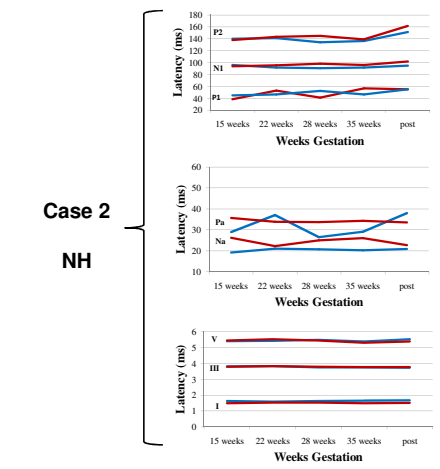
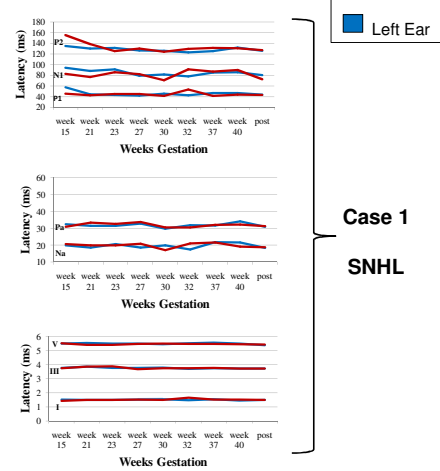
Equipment

- 1-Channel Bio-Logic NavPro Auditory Evoked Potential System
- Electrode montage: Fz referred to stimulus earlobe and ground on the contralateral earlobe (impedances kept < 4 kΩ; inter-electrode < 2 kΩ)
- ER-3A insert earphones used

Recording Parameters

	ABR	MLR	LLR
# Points	256	512	512
Epoch	10.66 ms	106.6 ms	533 ms
Gain	100,000x	75,000x	50,000x
Filter Settings	100-3000 Hz	3-300 Hz	0.1 to 30 Hz
Artifact Rejection	23.8 μV	31.7 μV	47.5 μV
Stimulus Type	100 μs click	1 kHz toneburst	1 kHz toneburst
Stimulus Level	80 dB nHL	60 dB nHL	70 dB nHL
Stimulus Polarity	rarefaction	rarefaction	rarefaction
Stimulus Rate	17.7/s	7.1/s	1.7/s
Repetitions	2000	500	200

Results



Discussion

In the present study, a longitudinal study of ABR, MLR, and LLR latencies was conducted on two individuals: one with stable sensorineural hearing loss and one with normal hearing. Although not reported here, audiometry and tympanometry remained stable during and following pregnancy.

The absolute latency values plotted across the weeks of pregnancy and 1-month post-partum show the following patterns:

- ABR latencies for waves I, III, and V between ears are similar and stable over time for both participants.
- MLR latencies for Na and Pa are similar between ears and quite stable over time for the participant with sensorineural hearing loss. For the participant with normal hearing, however, Na and Pa latencies grossly appear stable but had highly variability from session to session.
- LLR latencies for P1, N1, and P2 were largely similar between ears and stable over time for both participants.

The results presented here support the conclusions of Sennaroglu and Belgin (2001) that there are no changes in ABR latencies over time, but are in contrast to results reported by Tandon et al (1990) and Egeli and Gürel (1999). One study (i.e., Yadav et al [2003]) indicated no changes in MLR during pregnancy, but our participant with normal hearing showed the most instability of MLR latencies between ears and over time. We are unable to attribute this variability to any single reason. For both participants, LLRs remained showed little differences between ears and were largely stable over time, which is in contrast to Yadav et al (2003) indicating that SVRs/LLRs are prolonged in pregnant women. We see no such result here in our two participants when viewed in a longitudinal fashion.

Conclusions

Except for the MLR Na and Pa variability seen in the participant with normal hearing, waves I, III, V of the ABR and P1, N1, and P2 components of the LLR appear to be relatively stable are probably more influenced by technical and physiological signal-to-noise ratio issues and the signal averaging process. The relative lack of variability seen in the participant with sensorineural hearing loss may reflect the existing pathology of the cochlea that might otherwise be sensitive to hormonal changes.

Additionally, although conservative artifact rejection levels were employed, future studies could consider using an ocular electrode for MLR and LLR.

Lastly, future studies could consider adding endocrinologic measures, incorporating a rigorous timeline, conducting regular audiologic examinations (including otoacoustic measures with and without contralateral suppression), incorporating the study of the P300 component, and exploring other acoustic stimuli to come to some more solid conclusions about the effect of pregnancy on auditory evoked potentials.

References

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