Impact of blast-induced hearing loss on short-term locomotive behavior

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Introduction

- Blast injury often results in hearing loss and damage to vestibular organs, leading to neurological sequelae in service members (Akin & Murnane, 2011; Lien & Dickman, 2018).
- However, postural control and motor assessments are not routinely performed in blast-induced traumatic brain injury (bTBI) patients.
- This study investigates the association between blast-induced hearing loss and short-term locomotive behavior in rats using auditory brainstem response (ABR) thresholds, distortion product otoacoustic emissions (DPOAE), and general locomotive behavior assessments.

Objective

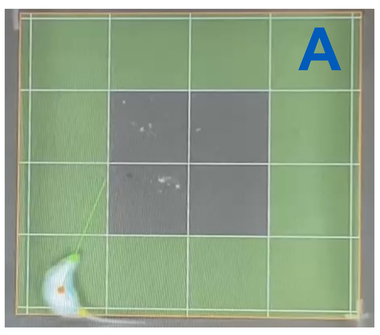
- Blast injury, being an acoustic insult, results in hearing loss, accompanied by damage to vestibular organs and the associated higher cortical centers.
- However, postural control and motor assessments are not routine assessments in blast-induced TBI patients. Here, we studied the association of blast-induced hearing loss with the performance in short-term locomotive behavior of rats.

Methods

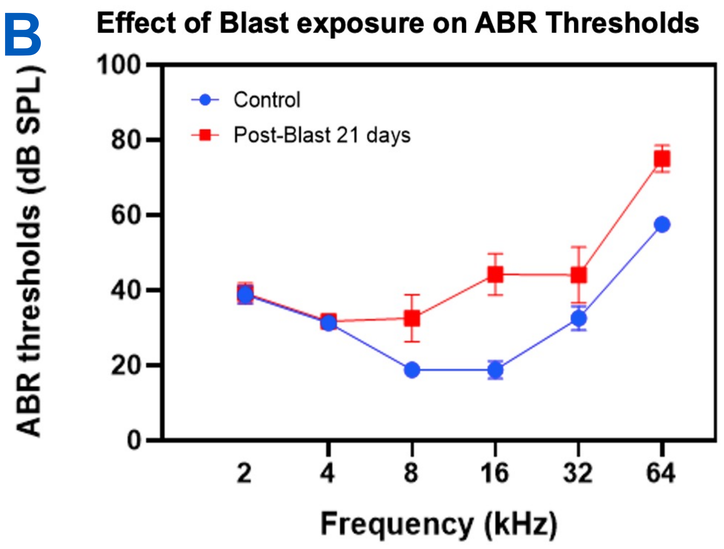
- In this study, rats (n=6) were exposed to single blast exposure (180 dB SPL).
- The functional integrity of the auditory systems was assessed by ABR thresholds and oto-acoustic emissions (DPOAE). The general locomotive behavior was assessed using open-field (ANY-maze, IL, USA) activity, and grid walking tests.
- The open field activity was measured at pre-blast and post-blast 1, 3-, 7-, 14-, and 21-day post-blast exposure. Parameters such as distance traveled, maximum and average speed, path efficiency, and time in zones were assessed.

Results

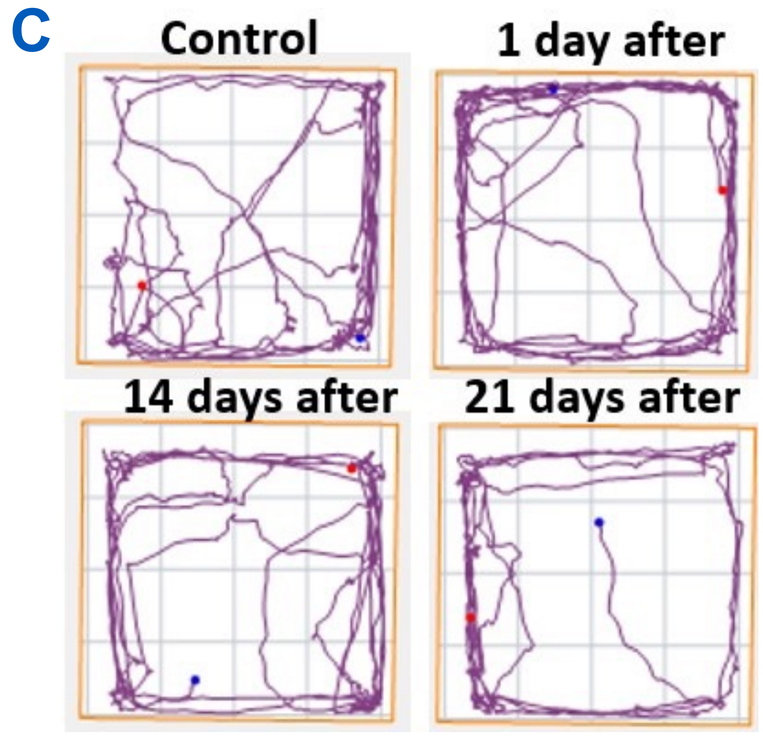
- The ABR thresholds were significantly reduced at 16 and 64 kHz at the alpha level of 0.05 (using multiple t-tests with the two two-stage step-up methods of Benajmini, Krieger, and Yekutieli).
- The distance traveled and the average speed was significantly reduced in 3d compared to the pre-blast performance.



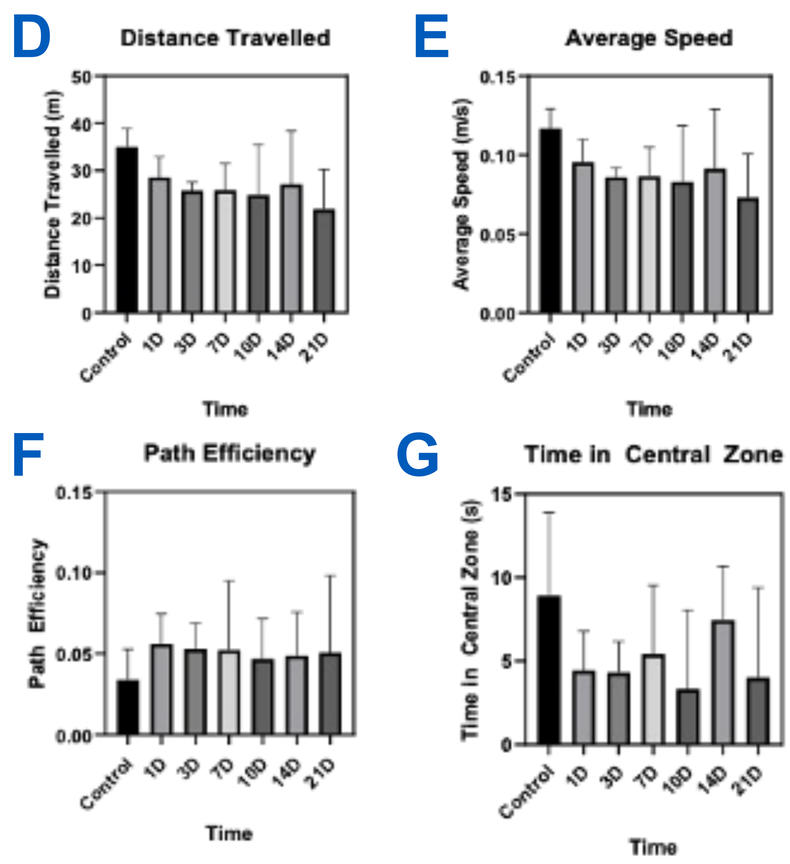
FigA.Point of view during OFT. The green zone represents the peripheral zone, and the gray area represents the central zone.



FigB. ABR thresholds at different frequencies for control and blast-exposed groups. The blast-exposed group shows significantly elevated thresholds at 16 and 64 kHz



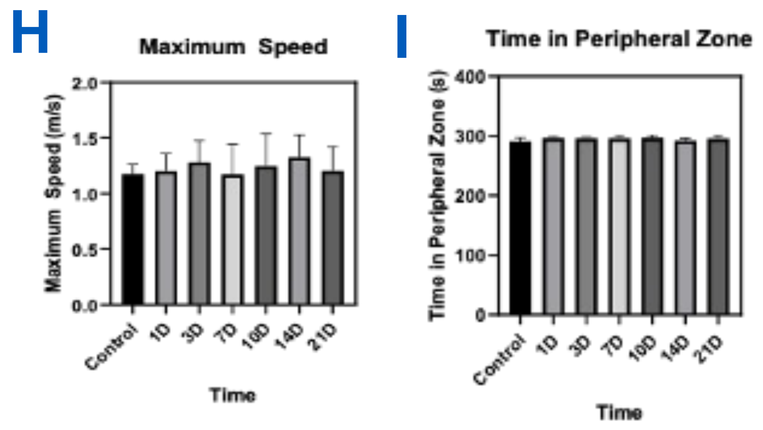
FigC. Representative image of the open field test setup and tracking of rat movement at different time points.



FigD: Total distance traveled in the open field test at different time points.
FigE: Average speed in the open field test at different time points. The blast-exposed group shows a significant decrease in average speed at 3 days post-blast compared to pre-blast levels.
FigF: Path efficiency in the open field test at different time points. The blast-exposed group slightly decreases path efficiency post-blast, indicating less directed movement.
FigG. Time spent in the central zone of the open field at different time points.

Inference

- A single blast exposure can result in a significant threshold shift on the audiogram, associated with reduced performance in general locomotive behavior, as assessed by the open field test.
- The reduced distance traveled and average speed observed three days after blast exposure suggest that blast-induced hearing loss, evident from the ABR threshold shifts, may directly impact motor function and exploratory behavior.
- These results align with the challenges highlighted by Tucker and McCabe, emphasizing the importance of standardizing experimental procedures and employing multiple behavioral tests to assess anxiety-like behaviors following TBI.
- Further investigation into the morphological and molecular changes in the vestibular nuclei is warranted to elucidate the mechanisms underlying motor and postural instability associated with blast-induced hearing loss and TBI.



FigH. Maximum speed achieved in the open field test at different time points. The blast-exposed group demonstrates a trend towards reduced maximum speed post-blast, although not statistically significant.
FigI. Time spent in the peripheral zone of the open field at different time points.

Conclusion

- The single blast exposure results in a threshold shift on the Audiogram.
- This threshold shift is associated with reduced performance in the general locomotive behavior, warranting further morphological and molecular analysis of vestibular nuclei to shed insights on motor and postural instability related to the blast injury and blast-induced hearing loss.

References

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