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Low-Frequency Vibrations Enhance Thrombolytic Therapy and Improve Stroke Outcomes

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Abstract

Background and Purpose- We aim to determine the potential impact on stroke thrombolysis of drip-and-ship helicopter flights and specifically of their low-frequency vibrations (LFVs). **Methods-** Mice with a middle cerebral artery autologous thromboembolic occlusion were randomized to receive rtPA (recombinant tissue-type plasminogen activator; or saline) 90 minutes later in 3 different settings: (1) a motion platform simulator that reproduced the LFV signature of the helicopter, (2) a standardized actual helicopter flight, and (3) a ground control. **Results-** Mice assigned to the LFV simulation while receiving tPA had smaller infarctions (31.6 versus 54.9 mm³; $P=0.007$) and increased favorable neurological outcomes (86% versus 28%; $P=0.0001$) when compared with ground controls.

Surprisingly, mice receiving tPA in the helicopter did not exhibit smaller infarctions (47.8 versus 54.9 mm³; $P=0.58$) nor improved neurological outcomes (37% versus 28%; $P=0.71$). This could be due to a causative effect of the 20- to 30-Hz band, which was inadvertently attenuated during actual flights.

Mice using saline showed no differences between the LFV simulator and controls with respect to infarct size (80.9 versus 95.3; $P=0.81$) or neurological outcomes (25% versus 11%; $P=0.24$), ruling out an effect of LFV alone. There were no differences in blood-brain barrier permeability between LFV simulator or helicopter, compared with controls (2.45-3.02 versus 4.82 mm³; $P=0.14$).

Conclusions- Vibration in the low-frequency range (0.5-120 Hz) is synergistic with rtPA, significantly improving the effectiveness of thrombolysis without impairing blood-brain barrier permeability. Our findings reveal LFV as a novel, safe, and simple-to-deliver intervention that could improve the outcomes of patients.

Visual Overview- An online visual overview is available for this article.

Keywords: air ambulance; murine models; stroke; thrombolytic therapy; vibration.

Figures



Fig. 1. Consort-style diagram of the study

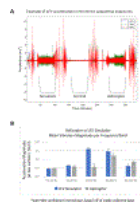


Fig 2. A: Time based LFV profile...

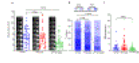


Fig 3. Raw data results of the...

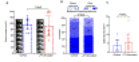


Fig 4. Raw Data results of the...

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