

# Effects and Efficacy of Invasive and Non-Invasive Neuromodulation in Patients with Lewy Body Dementia: A Systematic Review

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Neuromodulation demonstrates variable efficacy in DLB, with alpha-tACS showing the most consistent cognitive benefits and ECT improving motor and disease-related outcomes.

| INTRODUCTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | METHODS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | RESULTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | CONCLUSIONS | REFERENCES |              |                                                 |                        |                                                                                |                                         |                |                                                                                                    |                                         |                 |                                                      |                                        |                 |                                                                                       |                                               |                       |                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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| <p>Dementia with Lewy bodies (DLB) is the second most common neurodegenerative dementia and is characterized by cognitive decline, visual hallucinations, cognitive fluctuations, and parkinsonism. Current treatments provide limited benefit, making neuromodulation a promising therapeutic alternative. This systematic review evaluated the efficacy and safety of invasive and non-invasive neuromodulation techniques in patients with DLB.</p>                                                                                                                                                                                                                                                                                                                                      | <p>A PRISMA-based systematic review was conducted using PubMed, Embase, and Cochrane Library. Searches included terms related to Lewy bodies and neuromodulation techniques. Two independent reviewers performed blinded screening using Rayyan. Cohort studies and randomized trials were included, while studies with neurological or psychiatric comorbidities and abstracts without full texts were excluded. Of 493 records identified, 7 studies met the eligibility criteria.</p> | <div><div>Comparative Efficacy of Neuromodulation Techniques</div><table><tr><th>TECHNIQUE</th><th>EVIDENCE</th><th>KEY FINDINGS</th></tr><tr><td><div>DBS</div><div>Invasive (NBM target)</div></td><td>No significant benefit</td><td>Gratwicke 2020 — total recall p = 0.416<br/>Maltête 2021 — free recall p = 0.80</td></tr><tr><td><div>tDCS</div><div>Non-invasive</div></td><td>Mixed evidence</td><td>Elder 2016 — improved reaction time p = 0.01<br/>Elder 2019 — no change in hallucinations p = 0.808</td></tr><tr><td><div>tACS</div><div>Non-invasive</div></td><td>Positive effect</td><td>Benussi 2024 — visuospatial/executive gains p &lt; 0.05</td></tr><tr><td><div>ECT</div><div>Non-invasive</div></td><td>Positive effect</td><td>Morikawa 2024 - - reduced parkinsonism p &lt; 0.001 and disease severity (CDR) p = 0.037</td></tr><tr><td><div>Ultrasonic</div><div>Non-invasive</div></td><td>Transient improvement</td><td>Manabe 2025 — MMSE gains at week 8 p = 0.0254<br/>Cognitive fluctuations (CFI) week 12 p = 0.0039</td></tr></table><p><small>This figure compares the direction of effect reported for each neuromodulation strategy in DLB: color reflects the reported outcome, not a quantitative effect size, and findings are based on single studies per technique.</small></p><p>Seven studies involving 154 patients were included. NBM-DBS showed no significant benefit, tDCS produced mixed results, while alpha-tACS and ECT demonstrated positive outcomes. Ultrasonic stimulation was associated with transient cognitive improvements.</p></div> | TECHNIQUE   | EVIDENCE   | KEY FINDINGS | <div>DBS</div> <div>Invasive (NBM target)</div> | No significant benefit | Gratwicke 2020 — total recall p = 0.416<br>Maltête 2021 — free recall p = 0.80 | <div>tDCS</div> <div>Non-invasive</div> | Mixed evidence | Elder 2016 — improved reaction time p = 0.01<br>Elder 2019 — no change in hallucinations p = 0.808 | <div>tACS</div> <div>Non-invasive</div> | Positive effect | Benussi 2024 — visuospatial/executive gains p < 0.05 | <div>ECT</div> <div>Non-invasive</div> | Positive effect | Morikawa 2024 - - reduced parkinsonism p < 0.001 and disease severity (CDR) p = 0.037 | <div>Ultrasonic</div> <div>Non-invasive</div> | Transient improvement | Manabe 2025 — MMSE gains at week 8 p = 0.0254<br>Cognitive fluctuations (CFI) week 12 p = 0.0039 | <p>Neuromodulation demonstrated variable efficacy in DLB. While NBM-DBS and tDCS showed inconsistent results, alpha-tACS was associated with positive cognitive effects and ECT improved motor and clinical outcomes. Ultrasonic stimulation produced transient cognitive benefits, suggesting that some neuromodulation approaches may offer therapeutic value in selected patients. Larger randomized clinical trials are needed to confirm the long-term efficacy and safety of these techniques.</p> | <p>Gratwicke J, et al. Bilateral DBS of the nucleus basalis of Meynert in DLB. Brain Stimul. 2020.<br/>Maltête D, et al. Nucleus basalis stimulation in DLB. Neurology. 2021.<br/>Elder GJ, et al. tDCS and visuoperceptual function in DLB. Int Psychogeriatr. 2016.<br/>Elder GJ, et al. tDCS for visual hallucinations in DLB. Alzheimers Res Ther. 2019.<br/>Benussi A, et al. Alpha-tACS improves cognition in DLB. Mov Disord. 2024.<br/>Morikawa M, et al. Electroconvulsive therapy in DLB. Mov Disord. 2024.<br/>Manabe Y. Ultrasonic stimulation in DLB. Alzheimers Dement. 2025.</p> |
| TECHNIQUE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | EVIDENCE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | KEY FINDINGS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |             |            |              |                                                 |                        |                                                                                |                                         |                |                                                                                                    |                                         |                 |                                                      |                                        |                 |                                                                                       |                                               |                       |                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <div>DBS</div> <div>Invasive (NBM target)</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | No significant benefit                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Gratwicke 2020 — total recall p = 0.416<br>Maltête 2021 — free recall p = 0.80                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |             |            |              |                                                 |                        |                                                                                |                                         |                |                                                                                                    |                                         |                 |                                                      |                                        |                 |                                                                                       |                                               |                       |                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <div>tDCS</div> <div>Non-invasive</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Mixed evidence                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Elder 2016 — improved reaction time p = 0.01<br>Elder 2019 — no change in hallucinations p = 0.808                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |            |              |                                                 |                        |                                                                                |                                         |                |                                                                                                    |                                         |                 |                                                      |                                        |                 |                                                                                       |                                               |                       |                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <div>tACS</div> <div>Non-invasive</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Positive effect                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Benussi 2024 — visuospatial/executive gains p < 0.05                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |             |            |              |                                                 |                        |                                                                                |                                         |                |                                                                                                    |                                         |                 |                                                      |                                        |                 |                                                                                       |                                               |                       |                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <div>ECT</div> <div>Non-invasive</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Positive effect                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Morikawa 2024 - - reduced parkinsonism p < 0.001 and disease severity (CDR) p = 0.037                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |             |            |              |                                                 |                        |                                                                                |                                         |                |                                                                                                    |                                         |                 |                                                      |                                        |                 |                                                                                       |                                               |                       |                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <div>Ultrasonic</div> <div>Non-invasive</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Transient improvement                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Manabe 2025 — MMSE gains at week 8 p = 0.0254<br>Cognitive fluctuations (CFI) week 12 p = 0.0039                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |            |              |                                                 |                        |                                                                                |                                         |                |                                                                                                    |                                         |                 |                                                      |                                        |                 |                                                                                       |                                               |                       |                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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