Table 16. Repetitive Transcranial Magnetic Stimulation (rTMS) and Other Approaches for Standing Balance

Author Year Country Research Design Score Total Sample Size	Methods	Outcome
Krogh et al. (2021); Denmark RCT PEDro=7 Level 1 N=20	**Population:** 20 participants with motor-incomplete SCI and capable of participating in lower limb resistance training; 15 males and 4 females; mean age 54.45 years; injury level C2 (n=2), C4 (n=4), C5 (n=4), C8 (n=1), T3 (n=1), T9 (n=1), T10 (n=1), T11 (n=1), T12 (n=1), L1 (n=1), and L2 (n=2); AIS A (n=1), AIS C (n=5), and AIS D (n=13); and mean time since injury 89.3 days. **Treatment:** All participants received lower limb resistance training (twice weekly) and lower limb physical therapy (thrice weekly) for 4 weeks; and were randomly assigned to receive active stimulation (REAL group) (n=11) or sham stimulation (SHAM group) (n=9) rTMS with a double-cone coil over bilateral leg motor cortex, daily (Monday–Friday) immediately before training sessions. • Lower limb resistance sessions lasted 60 min and strength exercises, for each major functioning muscle group, were performed (3 x 10 at moderate to vigorous [50–80% one repetition maximum] loading intensity). • Lower limb physical training included stair climbing, balance and mobility exercises, OL, BWSTT, FES, and stretching/mobilization. Participants were engaged in additional clinical activities as part of their usual care, such as hydrotherapy, occupational therapy, activities of daily living training, and upper extremity resistance training classes. **Outcome Measures:** Maximal voluntary contraction, LEMS, and gait function* (10MWT, 6MWT, and TUG) were assessed the day before the first rTMS session and the day after the last session; except for LEMS assessment, which was performed at admission and within 1 week of discharge. *Gait function was assessed in a sub-group of ambulators (REAL group, n=8; SHAM group, n=8).	1. A seizure during stimulation (n=1 in REAL group) and mild and transitory headaches following their first treatment session (n=2 in SHAM group) were reported as AEs. Apart from that, only harmless side effects such as drowsiness, twitching facial muscles, and tingling/poking sensations in the scalp were occasionally reported. 2. Both groups improved in the 6MWT and TUG at POST with no clear main effects (treatment: $p<0.76$, treatment x time: $p<0.90$, time: $p<0.76$).

Benito et al. (2012); Spain RCT PEDro=6 Level 1 N=17	**Population**: 17 participants - 13 males and 4 females; incomplete SCI; all AIS D; level of injury: C4 – T12; age range= 18 – 60y; mean time since injury: 6.9 months **Treatment**: Patients were randomized to active rTMS or sham stimulation. Three patients from the initial group of 10 randomized to sham stimulation entered the active rTMS group after a 3-week washout period. Therefore, a total of 10 patients completed each study condition. Both groups were homogeneous for age, gender, time since injury, etiology, and ASIA scale. Active rTMS consisted of 15 days of daily sessions of 20 trains of 40 pulses at 20 Hz and an intensity of 90% of resting motor threshold. rTMS was applied with a double cone coil to the leg motor area. **Outcome Measures:** LEMS, Modified Ashworth Scale, WISCI II, 10MWT, Step length and cadence (assessed during 10MWT), TUG.	1. There was a significant improvement in LEMS in the active group but not in the sham group. 2. Both the active and sham groups showed significant improvements in TUG scores.
Naro et al. (2022); Italy Case control Level 3 N=40	**Population:** • 15 participants with incomplete and thoracic SCI (> 6 months since injury) and with spasticity; 6 males and 9 females; mean (± SD) age 38 (± 9); level of injury T3 (n=3), T4 (n=1), T5 (n=3), T6 (n=1), T7 (n=1), T8 (n=2), and T9 (n=4); AIS C (n=6) and AIS D (n=9); and mean (± SD) time since injury 10 (± 4) months. • 25 matched-SCI persons with spasticity; 11 males and 14 females; mean (± SD) age 44 (± 14); level of injury T3 (n=4), T4 (n=2), T5 (n=3), T6 (n=6), T7 (n=2), T8 (n=4), T9 (n=2), T10 (n=2); AIS C (n=12) and AIS D (n=13); and mean (± SD) time since injury 12 (± 3) months. **Treatment:** Participants were divided into: • Robot-assisted rehabilitation (RAR) + non-invasive brain stimulation (NIBS) group (n=15) (RAR + NIBS). • RAR – NIBS group (n=25): Matched-SCI persons who previously underwent the same amount or RAR without NIBS. Patients were provided with a daily (six sessions weekly) NIBS session followed by a RAR session, for eight consecutive weeks. • NIBS consisted of a rTMS carried out simultaneously with a transvertebral direct current stimulation (tvDCS).	1. There were no side effects during or after the training. 2. The 6MWT and TUG test improved in both groups, but without significant differences between groups. 3. There was no significant effect of patients' stratification depending on ASIA on clinical outcome measure changes (all $p>0.1$). 4. The significant predictors of recovery were the LEMS, age, and time since injury (all $p<0.0001$).

	• Patients performed a 40-min session per day of RAR with LokomatPro. The amount of BWS was initially set at 70% of the patient's weight, then progressively decreased, and the gait speed was individually adjusted. Patients underwent conventional physical therapy twice a day and five-times a week using the Bobath principles, occupational therapy, and FES. **Outcome Measures:** 6MWT, 10MWT, TUG, WISCI II, FIM-L, and LEMS were assessed at baseline (T0), after (T1), and three months after (T2) the training.	