<table>
<tr><th>Author Year
Country
Research Design
Score
Total Sample Size</th><th>Methods</th><th>Outcome</th></tr>
<tr><td colspan="3">Virtual Reality Biofeedback</td></tr>
<tr><td>An & Park 2022
Republic of Korea
RCT
PEDro = 7
Level 1
N = 40</td><td>Population: 40 tetraplegic participants with incomplete SCI; 23 males and 17 females; mean age 42.6 years; level of injury C5-7 (n = 40); AIS C (n = 17) and AIS D (n = 23); and time since injury > 1 year.
Treatment: Participants were randomly divided into two groups and received 12 sessions of a 30 min therapy three days/week for four weeks in their homes:
• Participants in the experimental group (n = 20) participated in ‘virtual soccer games.’ While seated in their wheelchair, they performed kicking motions with their legs.
• Participants in the control group (n = 20) underwent a similar rehabilitation intervention but without the VR content.
Outcome Measures: Stability during a pattern of five sit-to-stand movements (by the chair stand test); and walking speed (by 10MWT) were assessed before and after the intervention protocol.</td><td>1. There were significant differences between groups at the end of the intervention, favoring the experimental group for chair stand test time (p = 0.03), and for 10MWT (p = 0.03).
2. Within-group improvements were significant in both groups (p < 0.02) for all the outcome measures, but greater decreases were seen in the experimental group for all of them (p< 0.04):
a. Chair stand test times had a large effect size (Cohen’s d = 0.71).
b. 10MWT had a medium effect size (Cohen’s d = 0.61).</td></tr>
<tr><td>Zwijgers et al. 2024
The Netherlands
RCT
PEDro = 5
Level 2
N = 35</td><td>Population: 35 participants with incomplete SCI with the ability to walk at least 10m with or without a walking aid (but without physical assistance) and the ability to walk at comfortable speed between 0.3 and 1.0m/s.
• Walking adaptability training group (n = 17):
Median (IQR) age: 62 (56-71) years.</td><td>1. Participant’s adherence and experience:
a. The number of steps per training session was significantly higher for the walking adaptability training group (median [IQR] = 2670 [2261-3352]) compared to the conventional locomotor and strength training group</td></tr>
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	10M, 7F Level of injury: Cervical (n = 8), thoracic (n = 3), and lumbar (n = 6). AIS C (n = 2) and AIS D (n = 15). Cause of injury: Traumatic (n = 6) and non-traumatic (n = 11). Median (IQR) time post injury: 47 (20-120) months. • Conventional locomotor and strength training group (n = 18): Median (IQR) age: 67 (60-72) years. 9M, 9F Level of injury: Cervical (n = 10), thoracic (n = 5), and lumbar (n = 3). AIS C (n = 1) and AIS D (n = 17). Cause of injury: Traumatic (n = 9) and non-traumatic (n = 9). Median (IQR) time post injury: 66 (20-135) months. **Treatment:** Participants were randomly assigned to receive either walking adaptability (n = 17) or conventional locomotor and strength training (n = 18). Both interventions consisted of 11 training sessions of 60 minutes over a period of 6 weeks (on average 2 training sessions per week). The training interventions were designed to contain approximately 20 minutes of active walking to ensure a similar number of steps per session for both interventions. • Walking Adaptability Training: It was conducted using the Gait Real-time Analysis Interactive Lab (GRAIL). The GRAIL incorporates an instrumented split-belt treadmill with adjustable pitch and sway, an 10-camera motion capture system, and a 180° semi-cylindrical screen for the projection of synchronized VR environments. For safety reasons, participants wore a safety harness attached to a rail on the ceiling without BWS.	(median [IQR] = 2400 [1490-2555]; P = 0.03). b. The perceived intensity (defined as the difference between the ratings of physical tiredness before and after) was significantly higher for the walking adaptability training group (mean ± SD = 5.3 ± 1.9) compared to the conventional locomotor and strength training group (mean ± SD = 3.8 ± 2.0; P = .03). 2. Walking capacity: a. Independent of intervention, maximal walking speed increased by 0.07m/s (95% CI=0.03-0.11) at post-intervention (P < 0.01) and by 0.10 m/s (95% CI = 0.06-0.14) at follow-up (P < 0.01) relative to baseline. b. No significant difference (P = 0.23) in maximal walking speed between both training groups was found 6 weeks after training at follow-up (−0.05 m/s; 95% CI = −0.12-0.03). 3. Functional ambulation: a. Independent of intervention, significant improvements across time between baseline and follow-up (median difference = −3.3 points, IQR = −6.0 to −0.3, P < .01) were found. b. No significant difference (P = 0.79) in SCI-FAP between groups was found 6 weeks after training at follow-up.

	During a training session, multiple walking adaptability tasks were performed, including precision stepping, obstacle avoidance, and/or reacting to perturbations for 20 minutes. In the remaining time available (0-10 minutes), standing balance tasks were included. • Conventional Locomotor and Strength Training: It consisted of treadmill training (20 minutes) and lower-body strength exercises (10-20 minutes). **Outcome Measures:** Maximal walking speed (2MWT) was measured at baseline, immediately post-intervention, and at follow-up (at 6weeks post-intervention). The SCI-FAP, the ABC scale, and the USER-P were measured at baseline and during the follow-up assessment.	
Duffell et al. 2019 UK Pre – post Level 4 N = 11	**Population:** 11 participants with incomplete SCI who were using a wheelchair for at least 2 hours per day; 10 males and one female; mean age 56.5 years; injury level C1 (n = 2), C3 (n = 1), C4 (n = 1), T2 (n = 3), T3 (n = 1), T5 (n = 1), T7 (n = 1), and T12 (n = 1); AIS C (n = 7) and AIS D (n = 3); and median time since injury 1 year and 1 month. **Treatment:** Participants trained three 1-h sessions per week over 4 weeks on the iCycle (which is a FES ergometer) with biofeedback through a VR game (in which the speed of the avatar depends on the actual crankshaft torque while motion is maintained by a motor) to encourage voluntary drive during pedalling. **Outcome Measures:** Voluntary motor function (assessed using ISNCSCI motor scores); Oxford scale motor power grading (carried out	1. Participants did not report serious AEs. Only two participants noticed skin redness at the end of a session. 2. There was an improvement in ISNCSCI motor scores by 10% in participants with chronic injuries (n = 6) and by 16% in participants with subacute SCI (n = 5). 3. Changes in ISNCSCI motor score did not correlate with age, time since injury, baseline ISNCSCI motor score, baseline power output during cycling, time spent training, or stimulation amplitude. 4. Median (range) improvement in Oxford scale motor power grading from baseline to follow-up for knee flexion was 0.5 (- 1.0 to + 2.0), for knee extension was 1.0 (- 1.0 to + 2.0), for ankle dorsiflexion was 0.5 (- 1.0 to +

	for knee extension/flexion and ankle plantarflexion/dorsiflexion); WISCI II; and 10MWT were assessed pre- and post- training, and 4 weeks after completing training.	2.0), and for ankle plantarflexion was 0.5 (- 1.0 to + 3.0). 5. Only two of the participants included were ambulatory; and only one of them demonstrated an improvement in WISCI II score of 5 points at end of training compared with baseline, and 10MWT time improved from 82 s at baseline to 41 s at end of training.
van Dijsseldonk et al. 2018 The Netherlands Pre-post Level N = 15	**Population:** 15 participants with incomplete and chronic SCI who could walk independently for 2 min without assistance; 11 males and 4 females; mean (± SD) age 59 (± 12) years; AIS level C (n = 2) and D (n = 13); and mean (± SD) time since injury 42 (± 48) months. **Treatment:** Individualized VR gait training on the GRAIL for 12 1-h training sessions spread over a 6-week period. The GRAIL consisted of an instrumented dual belt treadmill with two embedded force plates and an eight-camera motion capture system. The platform was able to move in several directions to generate mechanical perturbations. In front of the treadmill, VR environments were projected on a 180° semi-cylindrical screen. Reflective markers were adhered to the patients to interact with the virtual environment and to capture kinematic data. The GRAIL system was controlled, and the visual information was matched to the treadmill speed. During the GRAIL training multiple applications (categorized in three themes; "gait adaptability" and "walking" were performed in an individualized pattern. **Outcome Measures:** 2MWT on the GRAIL; spatiotemporal parameters (walking speed, stride length, step width, and stride frequency); and	1. Spatiotemporal parameters: a. The mean walking speed was significantly higher at post measurement (1.04 ± 0.38 m/s) compared to baseline 1 (0.85 ± 0.41 m/s, p < 0.001) and baseline 2 (0.93 ± 0.37 m/s, p = 0.003). b. Stride length was significantly larger at the post measurement (112 ± 31cm) compared to baseline 1 (94 ± 39 cm, p < 0.001) and baseline 2 (101 ± 33 cm, p = 0.002). c. Stride frequency and step width were not significantly affected. 2. The follow-up data was performed in 10 of the 15 patients: a. There was no significant difference in patient's walking speed, stride length, step width, or stride frequency between post and follow-up measurement.

	gait stability measures; were assessed at the last training session (post measurement) and at 6 months after the last training session (follow-up measurement).	
An & Park 2018 Republic of Korea Pre-post Level 4 N = 10	**Population:** 10 participants with chronic SCI; 6 males and 4 females; mean (± SD) age 44.20 (± 8.66) years; level of injury C2 (n = 1), C4 (n = 3), C6 (n = 2), C7 (n = 2), and T1 (n = 1); AIS level C (n = 4) and D (n = 6); and mean (± SD) time since injury 19.20 (± 3.93) months. **Treatment:** Participants underwent semi-immersive VR therapy (using an Interactive Rehabilitation Exercise 30 min per day, 3 times a week for 6 weeks. Six programs were included: "soccer", "conveyor", "volleyball", "formula racer", "airborne", and "snowboard". Each program was performed for 4 min with a 1-min break between programs. **Outcome Measures:** Upright mobility function (ABC scale and WISCI II) was assessed before and after the intervention.	1. There were no AEs during the semi-immersive VR therapy. 2. The WISCI II score after intervention showed significant improvement from 16.30 to 17.90 ($P < 0.05$).
Villiger et al. 2017 Switzerland Pre-post Level 4 N = 11	**Population:** 11 participants with motor-incomplete SCI and able to sit in a chair without assistive and supporting systems; mean (± SD) age 60 (± 10.2) years; level of injury C4 (n = 1), C5 (n = 3), C7 (n = 2), T4 (n = 1), T9 (n = 1), T12 (n = 2), and L3 (n = 1); AIS C (n = 1) and AIS D (n = 10); and mean time since injury 7.6 years. **Treatment:** All participants were trained at home on the VR tasks over a period of 4 weeks, with 16–20 sessions of 30–45 min each, and with the mobile prototype of the YouKicker system. Around 500 repetitions of ankle movements and 100 knee movements with each leg were performed through different blocks by a typical patient during a training session.	1. None of the participants had any pain while playing the games or after the sessions. 2. One participant was unable to perform the walking assessments. 3. At post-assessment, significant increases in comparison with the averaged pre-baseline and baseline were found in LEMS ($P = 0.008$) 4. There were no significant effects on 10MWT ($P = 0.169$), 6MWT ($P = 0.037$); SCIM-III mobility ($P = 0.18$), and WISCI II ($P = 0.180$). 5. At follow-up assessment, no significant changes were found in muscle strength (LEMS, $P = 0.065$), or walking speed/distance and mobility

	Outcome Measures: LEMS, 10MWT, 6MWT, SCIM-III, and WISCI II were tested 4 weeks before treatment (pre-baseline), directly before treatment (baseline), after finishing the training program (post-assessment), and 2-3 months after the treatment program (follow-up).	(10MWT [P = 0.169], 6MWT [P = 0.32], SCIM-III mobility [P = 0.026], and WISCI II [P = 0.317]).
Villiger et al. 2015 Switzerland Pre-post Level 4 N = 23	**Population**: 9 participants with SCI - 5 males and 4 females; incomplete SCI; all AIS D; Lesion level between C4 to T12; mean age= 55.1 ± 15.8y; years post injury= 1-5y; 14 healthy persons were in the control group - 8 males and 7 females; mean age= 47.1 ± 14.4y. **Treatment**: Patients underwent 4 weeks of intensive VR-augmented lower limb training. The patients with incomplete SCI were trained with the VR movement tasks 16–20 times during the 4 weeks (4–5 × 45 min. per week). The training used a VR-augmented therapy system for lower limbs combining action observation, imagination and execution. Before and after the training period a structural volumetric 3D MRI data set was acquired in patients. Retention of the performance improvements was assessed in a 3–4 month follow-up session **Outcome Measures:** 10MWT, BBS, LEMS, and SCIM mobility.	1. The intense VR-augmented training of limb control improved significantly walking speed, ambulation, and muscle strength in patients. 2. Retention of clinical improvements was confirmed by the 3–4 months follow-up.
Villiger et al. 2013 Switzerland Pre-post Level 4 N = 14	**Population:** 14 participants - 9 males and 5 females; chronic SCI; 2 AIS C and 12 AIS D; level of injury: C4-T12. mean age= 53y; median years post-injury= 4y. **Treatment:** Participants received 4-5 45-min sessions of intensive VR augmented training sessions per week for a total of 16-20 sessions. **Outcome Measures:** BBS, 10MWT and WISCI II.	1. Significant improvements in 10MWT, BBS and WISCI II were shown after intervention.

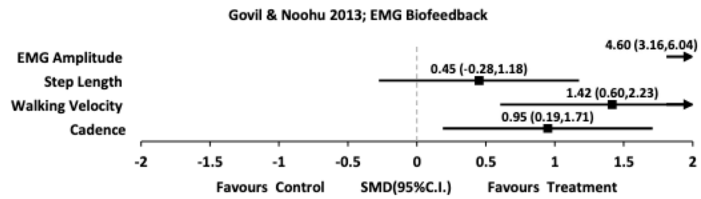
Other Biofeedback Approaches		
Mollà-Casanova et al. 2024 Spain RCT PEDro = 7 Level 1 N = 12	**Population:** 12 volunteers with chronic incomplete SCI and the ability to walk with or without aids. Mean age: 52 years Level of injury: C2-S1 AIS C (n = 3) and AIS D (n = 9) Mean time since injury: 5.25 years **Treatment:** Participants were divided into two intervention arms (experimental intervention and control intervention). Both interventions lasted 6 weeks (3 days a week), and the session were carried out in groups of three people. • Experimental intervention (n = 6) consisted in a visual illusion therapy intervention based on virtual walking for 10 minutes. The patient was facing a mirror (from the waist up), and a standing frame set-up provided support for the lower body. For the lower body, a screen (from the waist down) where a video of legs walking on a treadmill was projected. • Control intervention (n = 6) included placebo virtual walking. The set-up and duration were the same as in the experimental virtual walking, but videos of landscapes without featuring any type of human or animal movement were projected. Both groups performed a therapeutic exercise program which was divided into two parts: i) gait technique training (i.e., coordination exercises), and ii) multicomponent training (i.e., strength, balance and stretching exercises); with a total duration of 35 min.	1. All participants completed at least 80% of the intervention sessions and none of the participants dropped out before the end of the intervention. 2. With regard to unwanted effects, all participants reported fatigue at the end of each session. Moreover, one participant in the control intervention group suffered dizziness while viewing placebo virtual walking video on the second session of the intervention. 3. Significant ($p < 0.05$) improvements in the experimental intervention were found for tibialis anterior mean and maximum strength (Cohen's d = -0.51 [medium effect size] and -0.18, respectively), 10MWT (Cohen's d = 0.52 [medium effect size]) and WISCI (Cohen's d = 0.13), while no significant ($p > 0.05$) differences were found between assessments in the control group.

	Outcome Measures: 10MWT, WISCI, and isometric strength (using a load cell) of the least affected leg tibialis anterior and quadriceps were measured at baseline and at the end of the 6-week treatment.	
Amatachaya et al. 2023 Thailand RCT PEDro = 6 Level 1 N = 44	**Population:** 44 ambulatory individuals with chronic SCI and with the ability of independent walking with or without a walking device over a distance of at least 15m: • Control group (n=22): Mean (SD) age: 53.3 (12.1) years; 15M, 7F; ASIA: ASIA C (n=8) and ASIA D (n=14); level of injury: Tetraplegia (n=5) and paraplegia (n=17); and mean (SD) time since injury: 57.6 (34.7) months • Experimental group (n=22): Mean (SD) age: 51.2 (14.9) years; 18M, 4F; ASIA: ASIA C (n=10) and ASIA D (n=12); Level of injury: Tetraplegia (n=8) and paraplegia (n=14); and mean (SD) time since injury: 51.7 (31.4) months **Treatment:** Participants were assigned to the control intervention group (i.e., bodyweight shifting and lower limb loading training [LLLT] without augmented loading feedback) or the experimental intervention group (i.e., bodyweight shifting and lower limb loading training with augmented loading feedback) for 30min/day, 5days/week, over 4weeks. • Control intervention program (n=22): The participants in this group engaged in stepping training while in a step-standing position, for each leg continuously, as long as they could without fatigue, for 10min/leg. They were then trained to walk on a smooth,	1. Mobility outcomes: a. After the training programs, participants demonstrated significant improvement in all mobility outcomes at week two and week four (within-group analysis) ($p<0.05$). The mobility outcomes of participants in the experimental intervention group also showed significant improvement at six-month follow-up. b. When adjusted for the baseline data, the mobility improvement of participants in the experimental intervention group at week two and week four was significantly greater than that of the participants in the control intervention group ($p<0.05$). However, this difference was not found at six months after the training programs. 2. Fall data: During the six months after the training, there were nine participants who fell in the control intervention group and four participants who fell in the experimental intervention group. The number of faller participants was significantly different between the groups ($p=0.044$).

	flat, and firm surface for 10min. • Experimental intervention group (n=22): The participants were trained using the same protocols as those used in the control intervention group; however, in this group, external augmented loading feedback was also obtained using a visual weight-taking machine. **Outcome Measures:** Incidence of falls was measured 6 months before the start of the intervention and 6 months after finishing the intervention. Mobility outcomes (TUG test, 10MWT, FTSTS test, and 6MWT) were assessed at baseline, at week two and week four, and after 6 months follow-up.	
Nithiatthawanon et al. 2020 Thailand RCT cross-over PEDro = 6 Level 1 N = 30	**Population:** 30 community-dwelling participants with SCI who had the ability to walk independently, with or without a walking device, over at least 17 m (FIM-L Score of 5–7); 22 males and 8 females; mean age (± SD) 53.2 (± 11.8) years; level of injury paraplegia (n = 20) and tetraplegia (n = 10); AIS C (n = 12) and AIS D (n = 18); and mean (± SD) time since injury 71.9 (± 74.5) months. **Treatment:** All participants involved in a single control and a single experimental session with a 2-week washout period between them: • Control intervention session, consisting of: o Bodyweight shifting and lower limb loading training during stepping (forward and backward) without external feedback for 10 min for each leg. o OWT with an emphasis on lower limb loading, with or without a walking device,	1. Both training programs significantly improved all the outcome measures, excepting lower limb loading of the less-affected leg following the control intervention training program. 2. The improvement after the experimental intervention program was significantly greater than that following the control intervention program for all the outcome measures ($p < 0.05$).

	according to their ability for 10 min. • Experimental intervention session: The participants were trained using the same protocols as those of the control intervention program but with visual feedback relating to the amount of lower limb loading of the stance leg from a visual weight-taking machine to alert the participants and the therapist of the adequate amount of lower limb loading on the stance limb (at least 80% of the participant's bodyweight). **Outcome Measures:** 10MWT, FTSTS test and maximal lower limb loading ability were assessed prior and immediately following each training session (four times).	
Cheung et al. 2019 China RCT PEDro = 8 Level 1 N = 16	**Population:** 16 participants with incomplete SCI and able to perform BWSTT; 11 males and 5 females; mean age 54.3 ± 9.6 years; level of injury C1-L2; AIS C (n = 11) and AIS D (n = 5); and mean time since injury 13.7 ± 7.4 months. **Treatment:** All participants received, twice a week, one hour of standard physiotherapy program, including limbs mobilization and strengthening, trunk stabilization, wheelchair maneuver training and OWT. Additionally, 3 times per week, for 8 weeks, participants were randomly allocated to: • 30 min of BWSTT with Lokomat system, at comfortable walking speed, with assist-as-needed guidance force, and 40% of BWS. Additionally, EMG-biofeedback system was applied to the bilateral vastus lateralis and audio feedback was generated if the muscle activation was less than 30% of maximal recruitment to	1. No AE or discomfort was reported by participants. 2. Significant ($p < 0.025$) improvements in BWSTT group in the mobility sub-score of SCIM-III and bilateral symmetry were shown, but none of these outcome measures were improved in the control group. 3. No significant time X group interaction was found in other outcomes with no significant between group difference.

	- encourage active participation during the stance phase of the gait cycle. - Control group: Participants received passive lower limb mobilization training by using lower limb active-passive exerciser. **Outcome Measures:** WISCI II, SCIM-III, LEMS, Lower limb-force (L-force) function in Lokomat system, and quality of gait pattern (by gait analysis system) (walking speed, heel-heel base support, bilateral stance duration and bilateral symmetry [ratio of stride length of two legs]) were collected within 1 week before the start of intervention and within 1 week after the completion of the 8 weeks program.	
Govil & Noohu 2013 India PEDro = 5 RCT Level 2 N = 30	**Population:** 30 participants with incomplete SCI; randomized to 2 groups. For Group 1: mean (SD) age = 38.73 (10.75); DOI= 17.87 (8.37). For Group 2: mean (SD) age=38.03 (7.45); DOI = 16.93 (7.10). **Treatment:** Group 1 received EMG biofeedback to the gluteus maximus muscle, as well as traditional rehabilitation and gait training for 5 days/wk for 4 wks. Group 2 received traditional rehabilitation and gait training for 5 days/wk for 4 wks. **Outcome Measures:** Walking speed, step length, cadence, EMG.	1. Significant differences were found between the two groups in: - Walking velocity (m/s): Group 1 pre=0.12(0.11), post=0.27 (0.25); Group 2 pre=0.11(0.08), post=0.12(0.10); (p=0.043) - Cadence: Group 1 pre=22.15(16.18), post=40.40(28.27); Group 2 pre=21.67 (20.71), post=22.04(21.71); (p=0.05). 2. Group 1 showed significant changes for EMG amplitude, step length, walking velocity and cadence pre and post. 3. Group 2 showed significant changes for EMG amplitude, walking velocity and step length, but not cadence pre and post.
	Effect Sizes: Forest plot of standardized mean differences (SMD ± 95%C.I.) as calculated from pre- and post-intervention data.	

		
Petrofsky 2001 USA Prospective Controlled Trial Level 2 N = 10	**Population:** 10 males; age 22-30 yrs; incomplete, T3-T12 lesion level. **Treatment:** The control group (n=5) had 2-hour daily conventional physical therapy, including 30 min biofeedback of more affected gluteus medius for 2 months. Experimental treatment (n=5) had same program and used a portable home biofeedback device. **Outcome Measures:** Muscle strength (isometric strain gauge transducer) and gait analysis.	1. Gains in strength (in quadriceps, gluteus medius and hamstring) were seen for both groups but were greater for the experimental group than controls. 2. After two months of therapy the reduction in Trendelenburg gait was greater for the experimental group than for the control group and the experimental group showed almost normal gait.
Tamburella et al. 2013 Italy Case Control Level 3 N = 12	**Population:** 12 participants with SCI; 6 in the visual biofeedback task-specific balance training (vBFB) group and 6 in control group. vBFB group: mean (SD) age: 52 (11.74); 3M 3F. Control group: mean (SD) age: 53.5 (13.21); 3M 3F. **Treatment:** 2 groups: vBFB and Rehab group (control). vFBF and control groups underwent 8 wks of rehab 5 times/wk (control: 60 min devoted to Rehab; vBFB: 40 min of rehab plus 20 of vBFB). **Outcome Measures:** BBS; WISCI; 6MWT; 10MWT; and kinematic spatiotemporal gait parameters.	1. Only the vBFB group experienced a significant improvement in gait: a. BBS: 26 (10.69) at baseline to 41 (7.8) at end of intervention. b. WISCI: 14.17 (1.83) at baseline to 17.15 (1.64) at end of intervention. c. 6MWT: 193.18 (68.08) at baseline to 259.64 (82.84) at end of intervention. 2. The improvement in gait for the vBFB group was maintained at follow-up examinations. 3. vBFB participants experienced greater improvements than control participants for all measures 4. vBFB treatment demonstrated a significantly higher level of effectiveness than conventional rehabilitation.
Sayenko et al. 2010 Canada, Japan Pre-post	**Population:** 6 participants- 5 males and 1 female; chronic SCI; 4 AIS C and 2 AIS D; level of injury: C4-T12;	1. All participants showed substantial improvements in the scores, which varied between

Level 4 N = 6	mean age= 41y; median years post-injury= 7y **Treatment:** Patients participated in 3 60-min visual feedback training sessions, totaling 12 sessions. During training, participants stood on a force platform and were asked to shift their center of pressure (COP) in the indicated directions as represented by a cursor on the monitor. **Outcome Measures:** Static standing eyes open and closed as measured by COP displacement; Dynamic standing as measured by voluntary COP displacement.	236±94 and 130±14% of the initial values for different exercises. 2. Improvements were all statistically significant for both eyes open and closed except mean velocity in the medial/lateral direction.