Functional Electrical Stimulation – upper extremity

Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
Alon et al., 2008 PEDro score: 4	4	FES in combination with task-specific exercise vs. Task-specific exercise only Task-specific exercises were conducted 2x/ day x 30 min, 5 days/week x 12 weeks. Patients receiving FES also completed an additional 90 minutes of FES without task-specific exercises 2x/day.	**At post-treatment (12 weeks)** (+) Modified Fugl-Meyer Assessment (Upper extremity section) (-) Box and Blocks Test Jebsen-Taylor light object lift test
Bolton et al., 2004 PEDro score: N/A; Meta-analysis	N/A, meta-analysis	EMG-triggered neuromuscular stimulation vs. conventional stroke therapy	**At post-treatment:** (+) Fugl-Meyer Assessment (+) Box and Blocks Test (+) Rivermead Motor Assessment Mean effect size: Significant at 0.82 (SD = 0.59) with 95% confidence (C.I. 0.10-1.55)
Bowman et al., 1979 PEDro score: 4	4	Positional feedback stimulation therapy + conventional treatment vs. conventional treatment only. Sessions were given 30 min/day, 5 days a week for 4 weeks.	**At Post-treatment (4 weeks):** (+) Selective range of motion
Cauraugh & Kim, 2002 PEDro score: 4 or 5	5	EMG-triggered stimulation and bilateral movements vs. EMG-triggered stimulation and unilateral movement vs. wrist and finger exercises (control) Both EMG groups performed 3 sets of 30 active neuromuscular stimulation trials along with bilateral/unilateral training during 8, 90-minute sessions for 2 weeks. The control group executed 90 voluntary wrist/finger extensions for the same duration.	**At post treatment (2 weeks, FES and bilateral training compared to other groups):** (+) Box and Blocks Test (+) Reaction time (compared to control group only) (-) Sustained contraction of wrist extension **At post treatment (2 weeks, FES and unilateral training compared to control group):**

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			(+) Box and Blocks Test (+) Reaction time (-) Sustained contraction of wrist extension
Cauraugh & Kim, 2003a PEDro score: 6	6	Active Neuromuscular Stimulation (3 sets of 30 trials): 10 sec stimulation vs . 5 sec stimulation vs. 0 sec stimulation (control group) All patients received bilateral movement training 90 min/ per session for 2 weeks.	**At post-treatment (2 weeks) for 10 sec group compared to other groups:** (+) Box and Blocks Test (-) Reaction time (-) Sustained contraction of wrist extension **At post-treatment (2 weeks) for 5 sec group compared to control group:** (-) Box and Blocks Test (-) Reaction time (-) Sustained contraction of wrist extension
Cauraugh & Kim, 2003b PEDro score: 6	6	Active neuromuscular stimulation with blocked practice vs. active neuromuscular stimulation with random practice vs. no active stimulation (control). Treatments were given in 2, 90-minute sessions a week for 2 weeks.	**At post-treatment (2 weeks) for FES with blocked and FES with random practice groups compared to control group:** (+) Box and Block Test (+) Reaction time (+) Sustained contraction of wrist extension (No significant differences between Blocked and Random practice group for all outcome measures)
Cauraugh et al. 2005 PEDro score: 4	4 or 5	EMG-stimulation + bilateral movement vs.	**At post-treatment for bilateral training group:** **Note: (as compared to other groups)** (+) Intra-limb Transfer during task

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		EMG-stimulation + unilateral movement vs. no treatment (control) Patients in both treatment groups received 2, 90-minute sessions a week for a period of 2 weeks.	(-) Movement time analysis (-) Peak velocity
Cauraugh et al., 2000 PEDro score: 5	5	Electrical stimulation + voluntary extension of wrist/fingers vs. voluntary extension of wrist/fingers. Both groups received passive range of motion (ROM) and stretching exercises. Both groups performed 3 sets of 30 trials for the task during 12, 30-minute sessions for 2 weeks.	**At post-treatment (2 weeks):** (+) Box and Blocks Test (-) Fugl-Meyer Assessment (-) Reaction time (+) Sustained contraction of wrist extension (-) Motor Assessment Scale
Chae et al., 1998 PEDro score: 7	7	Surface neuromuscular stimulation (FES) to produce wrist and finger extension exercises vs. Sham neuromuscular stimulation (control) Sessions were given 1 hour a day for 15 sessions	**At post-treatment (4 weeks):** (+) Fugl-Meyer Assessment (-) FIM (self-care items) At follow-up (12 weeks): (-) Fugl-Meyer Assessment (-) FIM (self-care items)
Chan et al., 2009 PEDro score: 7	7	FES with bilateral upper limb training with conventional therapy vs. bilateral upper limb training with conventional therapy only for 15 sessions.	**At post-treatment (after 15 sessions):** (+) Functional Test for the Hemiplegic Upper Extremity (FTHUE) (+) Fugl-Meyer Assessment (-) Grip power (-) Forward reaching distance (+) Active range of motion of the wrist (-) Functional Independence Measure (FIM) (-) Modified Ashworth Scale

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Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
De Kroon et al., 2005 PEDro score:	PEDro:rN/A, review article	All RCTs from the deKroon article have been reviewed in detail. Non-RCT studies have not been systematically reviewed in the deKroon article and were not included	
Francisco et al. 1998 PEDro score: 6 or 7	6	EMG-triggered electrical stimulation + standard therapy vs. standard therapy only. Patients received treatment for 30 min/day, 5 days a week for duration of hospital stay.	**At post-treatment (end of each patients' hospital stay):** (+) Fugl-Meyer Assessment (upper extremity) (+) FIM (self-care items)
Glanz et al., 1996 PEDro score: N/A; Meta-analysis	N/A, meta-analysis	4 randomized controlled trials using FES for recovery of muscle strength after stroke	**Pooled results:** (+) Muscle strength Mean effect size (method of Glass): SD=0.63 (95% CI: 0.29-0.98) Statistically significant at p. smaller or =05
Gritsenko & Prochazka, 2004 PEDro score: No score	N/A, pre-post study	FES-assisted exercise therapy (reaching, grasping and moving) for 12, 1-hour sessions	**At post-treatment (2 weeks) and 2 month follow-up:** (+) Kinematic analysis of upper extremity movement (-) Fugl-Meyer Assessment (-) Motor Activity Log (+) Wolf Motor Function Test
Hara et al., 2008 PEDro score: 5	5	Power assisted FES and standard therapy vs. Standard therapy alone Sessions were conducted at home for 1-hour/day for 5	**At post-treatment (5 months):** (+) Electromyographic measures (+) 10 Cup Moving Test (+) Nine-Hole-Peg Test (+) Active ROM (measured by goniometry) (+) Modified Ashworth Scale

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Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
		months. Standard therapy was received for 1, 40-minute session per week for 5 months.	(-) Subacromial Impingement Syndrome Test
Hemmen & Seelen, 2007 PEDro score: 5	5	EMG-triggered feedback therapy with motor imagery in addition to conventional therapy vs. Electrostimulation in addition to usual therapy conventional therapy Both treatment sessions were received for 30 minutes / day, 5 days /week for 12 weeks.	**At Post-Treatment (3 months) and at follow-up (12 months):** (-) Action Research Arm test (Arm-hand function) (-) Brunnstrom Fugl-Meyer (Motor control)
Mangold et al., 2009 PEDro score: 7	7	FES and conventional occupational therapy vs. conventional occupational therapy only. Both groups received 45 minutes of occupational therapy, 3 to 5 times per week for 4 weeks, the intervention group replaced 3 of their sessions with FES.	**At post-treatment (4 weeks):** (-) Chedoke McMaster Stroke Assessment (+) Extended Barthel Index (-) Modified Ashworth Scale
Powell et al., 1999 PEDro score: 6	6	FES in combination with standard therapy (Bobath) vs. standard therapy only (Bobath) Sessions were given 30min/day, 3x per week for 8 weeks.	**At post-treatment (8 weeks):** (-) Barthel Index (-) Rankin scores (-) Nine Hole Peg Test (-) Passive and active range of motion (+) Reaction time (-) Modified Ashworth Scale

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Author, Year PEDro Score, Country	Sample size	Intervention	Outcome and significance: (+) significant (-) not significant
			(-) Grip strength (+) Action Research Arm test: grasp and grip **At follow-up (32 weeks**) (-) Barthel Index (-) Rankin scores (-) Nine Hole Peg Test (-) Passive and active range of motion (+) Reaction time (-) Modified Ashworth Scale (-) Grip strength (-) Action Research Arm test: grasp and grip