ROBOTIC-ASSISTED LOCOMOTOR TRAINING FOR WALKING IN SPINAL CORD INJURY PATIENTS :SYSTEMATIC REVIEW

by

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ABSTRACT

Objectives: To provide an overview and evaluate the current evidence on robotic-assisted locomotor training approach for gait rehabilitation in patients with spinal cord injury. **. Methods**: By using electronic database: Pubmed, Cochrane library, google scholar, reference lists, and Physiotherapy Evidence Database (PEDro). Randomized Control Trials (RCTs) were only included in this review and the others were excluded according to eligibility criteria. **Results:** Nine RCTs were only included in this review, six studies were analyzed by meta-analysis statistics, and the three other studieswere analyzed by descriptive or qualitative analyses. Significant effect in walking function (speed, distance, duration), minimal significant effect in balance and spasticity**. Conclusion:** robotic-assisted has a minimal significant effect in spinal cord injury patients butmore studies must be included in this area to cover the needs of this study.

Key Words: robotic-assisted, spinal cord injury, locomotor training, gait, rehabilitation, RCTs, PEDro.

Introduction

A spinal cord injury (SCI) is damage to the spinal cord that causes changes in its function, either temporary or permanent. These changes translate into loss of muscle function, sensation, or autonomic function in parts of the body served by the spinal cord below the level of the lesion.Injuries can occur at any level of the spinal cord and can be classified as complete injury, a total loss of sensation and muscle function, or incomplete, it means some of nervous signals are able to travel past the injured area of the cord. Depending on the location and severity of damage along the spinal cord[1].

The incidence (number of new cases) since 1995 of SCI ranges from 10.4 to 83 people per million per year and the estimated prevalence (number of people living with SCI) in the world ranges from 236 to 4187 per million[2]**.**

A Body-weight support (BWS) systems can be used prior to the patient gaining adequate motor control or having sufficient strength to fully bear weight[3],[4].The patient will wear a specialized trunk harness with adjustable strapswhich attach to an overhead suspension system. The harness and its attachments support a certain amount of the patient's body weight[5]**.**A Body-weight support (BWS) system can be used on a treadmill or over ground for gait training. Body-weight-supported treadmill training (BWSTT) enables individuals with motor deficits that have rendered them incapable of completely supporting their own body weight to practice and experience locomotion at physiological speeds[6]**.**

Subject, materials and methods

Comprehensive databases were used to find studies comparingRAGT with any other exercise or physiotherapy.This study was performed according to the Cochrane Review Methods and

reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.[7,10]

Data source & literature source:

Randomized trials were identified by searching in the Cochrane Central Register of Controlled Trials (CENTRAL), Physiotherapy Evidence Database (PEDro), Pubmed , Google scholar.Search strategies were developed for each database using both free-text terms and the controlled vocabulary (MeSH and Emtree). We also searched the reference lists of included studies and other reviews to identify additional trials. Duplicate records

were identified by title, authors and journal citations andremoved.

Study selection:

Study inclusion was decided independently by two reviewersbased on the selection criteria.

Studies were selected in two stages, as follows: First, searchers screened the titles and abstracts of identified studies.Second, we screened the full text. searchers included randomizedcontrolled trials (RCTs) of parallel-group or crossoverdesign involving patients with SCI. Studies wereincluded in our meta-analysis if they compared RAGTto a control comprising any other exercise or no treatment;or involved participants with an incomplete, traumatic or nontraumatic, nonprogressive SCI, as definedby AIS grades B, C, or D; participants were a minimumof 16 years of age because most neurologic developmentis complete once adolescence is reached;training parameters were specified in detail; and locomotoror locomotor-related outcomes were evaluated.

Data extraction:

The two reviewers independently extracted data fromeach study using a predefined data extraction form.Disagreements were resolved through discussion or, ifrequired, adjudication by a third reviewer.The following variables were extracted from

studies:(1) mean and SD of walking speed, walking capacity,walking independence and safety and incidence of adverseevents during the trial in the intervention and controlgroups; (2) demographic, clinical, and treatmentcharacteristics (e.g., number of patients in the interventionand control groups); (3) intervention and controlprotocol type; and (4) method of assessment. If theabove variables were not mentioned in the studies, thedata were requested from the authors via email**.**

outcome(s) pre review:

Primary outcome(s):Gait speed, cadence,step length, stride length.

Secondary outcome(s): Gait distance, functional level of gait, spasticity, balance

Risk of bias (quality) assessment:

Two authors separately evaluated the methodological qualities of each study assessing the risk of bias of RCTs by Cochrane collaboration's tool or the Physiotherapy Evidence Database (www.pedro.org.au)(PEDro) scale scores The PEDro Scale has 11 items and is

designed to rate the methodological quality (internal validity and statistical information) of randomized trials[8].

Each item contributes one point to the total PEDro score (range, 0 to 10 points). The PEDro score is a valid measure of the internal validity and completeness of reporting. Any disagreement was decided upon by other authors. Searchers will conduct sensitivity analyses to assess the robustness of the results. Searchers plan to assess possible publication bias and other biases using symmetry/asymmetry of funnel plots. Searchers estimated patient outcome measures after excluding studies with lower methodological quality to check whether the results have changed**[9].**

Results

Description of the study selection:

The initial literature searches of electronic databases Cochrane, Google Scholar, PubMed and Pedro resulted in 588 potentially relevant records after removal of duplicates within and between the individual databases and reviews for further examination. Manual screening of the reference lists of these potentially eligible trials did not generate any additional results. Therefore, a total of 588 full-text studies were retrieved and analyzed according to the inclusion and exclusion criteria.

Included articles:

Of the 588 retrieved articles, 572 were eliminated because they did not fulfill the established inclusion and exclusion criteria. Of the articles, 7 presented with inadequate study design (1case study, 1 case report, 2 prospective observational cohort study ,2 not related to my out comes measurements and 1 nonrandomized) and were therefore not included. The remaining 9 articles were evaluated in more details **fig(1)**

The main reasons for exclusion of other studies were:

•Review articles, case reports, case series or non randomized studies including retrospective studies;

•Studies measured outcomes which not related to gait , walking ,balance, spsticity, distance and speed

•Target population was less than 18 years old.

• Abstracts only published and no full text article available

Quality assessement of studies:

The scoring of each study with the Physiotherapy Evidence Database (PEDro) scale is listed in **Table (1)**. The scores of the studies in (PEDro) scale is ranged from 0 to10 , the more the number of scores of the aspects evaluating the quality of the study, the more quality of the study. From 5 to 10 is a high quality, and less than 5 is a low quality. 6 of included studies scored more than 5 in (PEDro) scale and 3 of others scored less than 5 in this scale.

The number of "Yes" achieved the quality of included studies in the following table. (Mónica et al) and (Tania Lam et al) scored 8 in (PEDro) scale, (Gabrielle et al), (Markus Wirz et al) and (Rob Labruyère et al) scored 6 in (PEDro) scale,(JiCheol et al) scored 5 in (PEDro) scale,(Ming Wu et al) and (Lynsey D et al) scored 4 in (PEDro) scale and the last study (Evan B et al) in selected articles scored 2 in (PEDro) scale.

Table (1): Methodology assessment of studies according to the Physiotherapy Evidence Database (PEDro) scale.

(PEDro) criteria	Mónica et al., (2012)	Ming et al., (2014)	Jil et al .,(2014)	Rob et al., (2014)	Lynsey et al., (2014)	Tania et al., (2015)	Evan et al., (2016)	Markus et al., (2017)	Gabrielle et al., (2017)
1-Random allocation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2-Concealed allocation	Yes	No	No	No	No	No	No	Yes	No
3-Baseline characteristics Comparable	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes
4-Subjects blinded	No	No	No	No	No	Yes	No	No	No
5-Therapists blinded	No	No	No	No	No	No	No	No	No
6-Assessors blinded	Yes	No	No	Yes	No	Yes	No	No	Yes
7-Outcomes for 85% of initial participants	Yes	No	Yes	Yes	No	Yes	No	Yes	Yes
8-Intention-to-treat analysis	Yes	No	No	Yes	No	Yes	No	No	No
9-Between-group statistical Comparison	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
10-Point and variability measures	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Total score	8	4	5	6	4	8	2	6	6

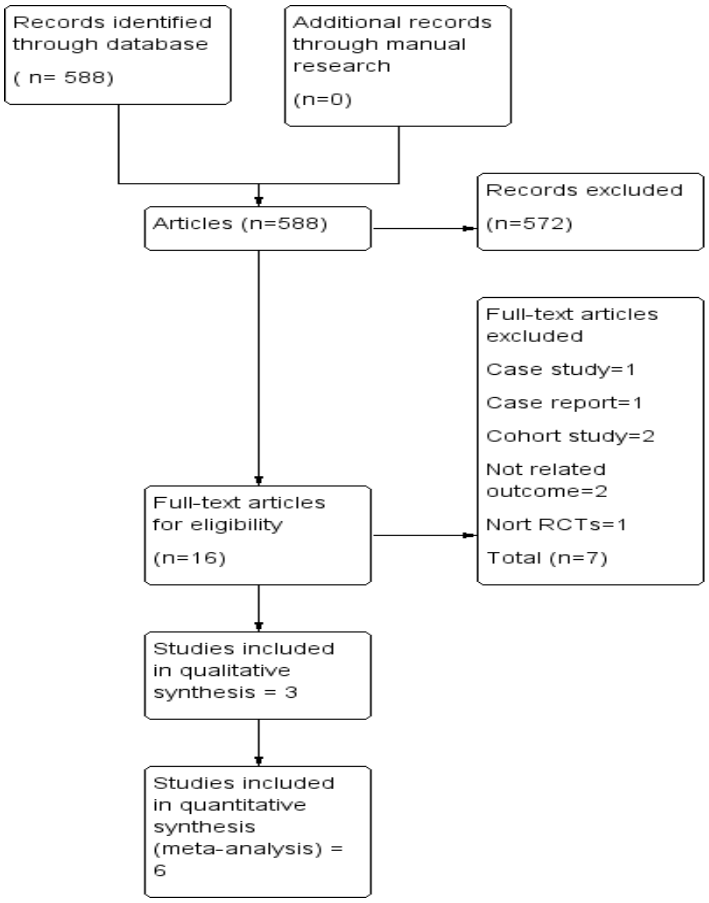


Fig (1): Preferred Reporting Items for Systematic Reviews and Meta-Analyses diagram of study refinement and selection procedure (PRISMA) [7,10]

Data Extraction: Data Extraction Sheet includes general information about the studies and

participant characteristics andextraction Sheet includes intervention, procedures, outcome measures characteristics, key results and author's conclusions.as in **table (2),(3)**

Table 2- Data Extraction Sheet includes general information about the studies and participant characteristics.

Author (Year)	Study Design	Sample size	Patient Characteris-tics	Inclusion Criteria	Exclusion Criteria
1-Mónica et al.,(2012)	RCTs singleblind, parallel-group design.	**25**	**Diagnosis:**SCI **Age:**16 to 70 years **Male :**62% of total number. **Female:**38% of total number.	-C2 to T12 of SCI - classified as AIS grades C and D -Onset less than 6 months.	-Orthopedic injuries that are unstable.-Osteoporosis with high risk of pathological fracture. -Cutaneous lesions and/or pressure ulcers in areas where the Lokomat harness or thigh straps are fitted. -Joint rigidity. -Asymmetry of lower-extremity length more than 2 cm.
2-Tania et al.,(2015)	double-blind, stratified, RCTs	**15**	**Diagnosis:**SCI **Age:** 19 to 65 yrold	-m-iSCI at least 1 yr ago. -19 to 65 yr old.	-Lesion below thoracic 11 or lower motoneuron injury. -inability to step even with the help of a treadmill and partial BWS -weight > 300 lb or height > 6 ft 1 in. -presence of cardiac, musculoskeletal, orother condition for which exercise is contra-indicated.
3-Rob et al .,(2014)	RCTs cross over design	**9**	**Diagnosis:** SCI Age: 18to 70 yr old	-chronic iSCI (time after injury >1 y). -sensorimotor incomplete (grade C or D -The motor level C4 and T11	-If they presented contraindications for training in the Lokomat system. -Injuries limiting training, as well as orthopedic, psychiatric or neurological diseases, except for the iSCI ..

4-Markus et al.,(2017)	RCTs	**21**	**Diagnosis:** spinal cord injury **Age:** 18 to 60 years	- acute traumatic etiology of SCI (i.e., early post-injury); - initial SCI categorization AIS-B or AIS-C level between C4 and T12; post-trauma; and - able to followthe study intervention and assessment procedures.	-anthropometrics exceeding the possible range of the Lokomat (i.e., body weight >130 kg, body height >200 cm, or difference in leg length >2 cm); osteoporosis, unstable fracture of lower extremity, restricted range of motion, decubitus ulcer of lower extremity, lower extremity fractures, unstable spine fractures, joint instability preventing
5-Gabrielle et al.,(2017)	A Randomized Crossover Study	**17**	**Diagnosis: incomplete spinal** **cord injury (iSCI)** **Age: 18to 60 years**	-a motor iSCI (classified as C or D using the American Spinal Injury Association Impairment Scale) at neurological injury level of T10 or above for >1 year duration.	-osteoporosis; cardiovascular or metabolic instability; unhealed decubiti or existing infection; active heterotrophic ossification; previous history of other central nervous system injury; and inability to adhere to study requirements.
6-Ji et al.,(2014)	RCTs	**60**	**Diagnosis:** incomplete spinal cord injury (SCI)**.** **Age:**20 to 65 years old	1)non-progressive spinal cord lesion as a result of traumatic or non-traumatic causes, 2) onset less than 6 months, 3) classified by the ASIA impairment scale (AIS) as grade D at entry, and 4) 20 to 65 years old.	patients with pressure ulcers, severe limitation of range of motion of the hips and knee joints, severe cognitive impairment, or patients with pulmonary or heart disease requiring monitoring during exercise. Patients were also excluded if they had lower motor neuron lesion, such as caudaequina injury.

7-Lynsey et al.,(2014)	RCTs	**83**	**Diagnosis:** incomplete spinal cord injury (SCI)**.** **Age:** 18to 50 years old. **Male**: 57 **Female**: 26	-age 18 to 50 years, motor incomplete SCI (ASIA C or D) with level of injury above T10 and >12 months postinjury, -medical clearance to participate, evidence of clinical spasticity in the ankle joint [MAS] ≥1), - lower-limb passive ROM within functional Limits for ambulation.	Existing infection, severe cardiovascular or pulmonary disease,concomitant neurological injury, history of fractures post-SCI, and known orthopedic or peripheral nerve injury in the lower extremities
8-Ming et al.,(2014)	RCTs crossover design.A Pilot Study	**10**	**Diagnosis:**chro nic incomplete SCI. **Age:** 16 and 65 years;	-medically stable with medical clearance to participate. -level between T10. - passive ROM of the legs within functional limits of ambulation, -ability to walk on a treadmill.	existing infection, severe cardiovascular and pulmonary disease, concomitant central or peripheral neurologic injury (eg, traumatic head injury or peripheral nerve damage in lower limbs), history of recurrent fractures, and known orthopedic injury to theL.L
9-Evan et al.,(2016)	a single-blind, RCTs	**64**	**Diagnosis: chronic incomplete SCI.** **Age:__**	(ASIA) ,(AIS) C or D, injury level at or above T1,.Ability to take at least 1 step with 1 leg,	-Orthopedic problems of cardiac condition, or radiographic evidence of hip pathology.

RCTS, randomized control trials.ASIA, American spinal cord injury association.SCI, spinal cord injury.ROM, range of motion. MAS, modified ashworth score, L.L. Lower Limb

Table3-Data Extraction Sheet includes intervention, procedures, outcome measures characteristics, key results and author's conclusions.

Author (Year)	Intervention vs Control Condition	Procedures	Outcome	Main Results	Author's Conclusion
1-Mónica et al., (2012)	a walking reeducation **program using Lokomat**vs **conventional overground training** among individuals with incomplete SCI	Patients received 40 sessions of equal time using aLokomat program with overground practice or overground mobility therapy alone.	**Primary measurements** of outcome were walking speed and the (WISCI II). **Secondary outcomes** were - the 6-mwt, -(LEMS), MAS and VAS	**No significant** differences -**The WISCI II** for the Lokomat group was **better than** for overground therapy **The 6-MWT t and LEMS** displayed **significant differences** in favor of Lokomat therapy	
2-Tania et al.,(2015	(BWSTT) with Lokomat-applied resistance (Loko-R) vs Conventional Lokomat-assisted BWSTT (Control).	Training parameters for both groups consisted of 45 min Lokomat-based training sessions (not including rest breaks), 3times/week for 3 months.	-The primary outcome measure to assess the potential efficacy of Loko-R was skilled walking capacity, as assessed (SCI-FAP). - Assessed (10MWT), (6MWT).	There were no significant between-group differences in any of the demographic or outcome measures.	Given the promising results of this pilot study, a larger randomized controlled trial with more subjects is warranted to confirm the effects of locomotor training with Loko-resistance.
3-Rob et al., (2014)	robot-assisted gait training (RAGT) vs strength training in patients with chronic SCI.	Group 1 received 16 sessions of RAGT (45 min each) within 4 weeks followed by 16 sessions of strength training (45 min each) within 4 weeks. Group 2 received the same interventions in reversed order.	-walking speed under different conditions, balance, strength, and 2 questionnaires that evaluate risk of falling and pain. Data were collected at baseline, between interventions after 4 weeks, directly after the interventions and at follow-up 6 months after the interventions. Pain was assessed repeatedly throughout the study.	There were **no significant**, except for maximal walking speed (10MWT), which improved significantly more after strength training than after RAGT. Pain reduced after both interventions.	RAGT was not more effective in improving walking-related outcome compared to lower extremity strength training. However, the low sample size limits generalizability and precision of data interpretation.

4-Markus et al., (2017)	IG: The walking time per training 50 min by using a robotic device CG: The walking time per training 25 min by using a robotic device	-Patients of both groups performed 3–5 days of training per week of robotic assisted locomotor training, which were observed for a 34 trainings period of 8 week. -IG: The walking time per training was set at a minimum of 50 min. -CG: The walking time per training was kept at a maximum of 25 min.	-(SCIM). - IIWISCIII (MAS) -Duration, speed and distance.	There were larger improvements observed in the intervention group. However, both groups improved to a statistically significant level.	
5-Gabrielle et al., (2017)	High-Intensity vs Low Intensity Then cross over.	-Both high- and low-intensity LT consisted of up to 20 one hour sessions at a frequency of 3 to 5 days/week over ≤6 weeks. - sessions were to achieve 40 minutes of stepping Practice.	-Primary measures treadmill speeds and distance Secondary measures of metabolic function. Balance,LEMS	Significantly greater increases in peak treadmill speeds and secondary measures of metabolic function and overground speed were observed following high- versus low-intensity training, with no effects of intervention order. No significant main	Such training is feasible in larger patient populations and contributes to improved locomotor outcomes deserves further consideration.
6-Ji et al., (2014)	robotic-assisted gait training (RAGT) compared to conventional overground training.	**The RAGT group** received RAGT 3sessions per week at duration of 40 minutes with regular physiotherapy in 4 weeks then physiotherapy twice a day in a 30-minute session. T**he conventional group** underwent regular physiotherapy twice a day, 5 times a week.	- (LEMS), - (AMI), - (SCIM3-M), and - (WISCI-II) scale.	both groups showed significant improvement in LEMS, AMI, SCIM3-M, and WISCI-II. Based on WISCI-II, statistically significant improvement in the RAGT group. .	RAGT combined with conventional physiotherapy could yield more improvement in ambulatory function than conventional therapy alone. RAGT should be considered as one additional tool to provide neuromuscular reeducation in patient with incomplete SCI.

7-Lynsey et al., (2014)	3 groups: no intervention, Lokomat, or tizanidine	Interventions for 4 weeks in the Lok and Tiz groups. **Control participants** received no intervention. Training by lokomat was provided 3 times per week; each session lasted ≤1 hour, with 30 to 45 minutes of training. Treadmill speed. For **the Tiz group**, 0.03 mg/kg of tizanidine was administered 4 times a day for 4 weeks.	(10MWT). -6 mwt - (TUG).	walking speed and endurance improved, with no difference between interventions.	Improvements in function were achieved in a limited number of people with SCI. Using the MID and GMM techniques, therefore, have potential to be used for characterizing therapeutic effects resulting from different interventions.
8-Ming et al., (2014)	One group received 4 w of assistance training followed by 4 w of resistance training, while the other group received 4 w of resistance training followed by 4 w assistance training.	an 8-week training trial was conducted by using a randomized crossover schedule. Training was performed 3 times a week for 8 weeks, with the training time for each visit set to 45 minutes as tolerated, excluding setup time. For each training session	-Primary measures were self-selected and fast overground walking velocity and 6-minute walking distance. -Secondary measures included clinical assessments of balance, muscle tone, and strength.	A significant improvement in walking speed and balance in humans with SCI was observed after robotic treadmill There was no significant	Cable-driven robotic resistance training may be used as an adjunct to BWSTT for improving overground walking function in humans with incomplete SCI, particularly for those patients with relatively high function.
9-Evan etal., (2016)	(TM), (TS), (OG), (LR).	Subjects trained 5 days/week for 12 weeks, with the goal of 60 training sessions.	- distance (traversed in 2 minutes). - speed (over 10 meters) were acquired prior to and following training.	-greater distance achieved (OG)training is associated with better walking outcomes(distance,speed) in the studied population.	a greater walking distance during overground training yields better walking function in the studied population.

BWSTT,Body weight support treadmill training. SCI, spinal cord injury.WISCI II**,** walking index spinal cord injury.MAS, modified ashworth score.6MWT, 6 minute walk test. 10MWT, 10 minute walk test.TM, treadmill with manual assistance. TS, treadmill with stimulation. OG, overground training with stimulationLR treadmill-locomotor robotic device assistance. TUG**,** Timed Up and Go .W, week

Study characteristics and patient populations

Participants:

The demographic characteristics of all 304 participants in the 9 studies are shown in **Table 4.** The number of participants in each study ranged from 9 to 83 and the age of the participants ranged from 16 to 80 years; more males than females participated. All included studies provided information on the level of spinal cord injury (C2 to L3) and baseline severity (AIS grades B to D); i.e., incomplete SCI. All studies involved upper motor neuron lesions only.

Most studies were AIS grade C/D or D, motor incomplete SCI only,but one studies included AIS grade B/C, motor or sensory incomplete SCI. Of the participants,146 in 3 studies were assessed at <6months post-injury and 139 in 6 studies were assessed at > 12 months post-injury,and19 were dropped in 5studies.

Study characteristics and patient populations

Table(4)

Study	N	Age	Male\Female	Time of Injury(mo)	Level of Injury	ASIA Grade	No of Patient\ Patient Drop	Causes of Patient Drop
1-Mónica et al.,(2012)	25	16 to 70	12\13	Less than 6 months	C2 to T12	C,D	80\5 75 in study	4 withdrawals; and, 1 for reasons unconnected with the study)
2-Tania et al.,(2015)	15	19 to 65	9\6	More than 1 year	C2 to T 10	C, D	15\2 13 in study	Illness, family Difficulties
3-Rob et al.,(2014)	9	18 to70	5\4	More than 1 year	C4 to T11	C,D	No Patient Drop	
4-Markus et al.,(2017)	21	18 to 60	2\16	Within 60 days post trauma	C4 to T12	B,C	21\3 18 in study	1 patient had knee pain , 2others did spine injury
5-Gabrielle et al.,(2017)	17	18 to 75	11\4	More than 1 year	T10 or above	C,D	17\2 15 in study	2 lost post testing
6-Ji et al.,(2014)	60	20\65	34\19	Less than 6 Months	C,T,L	D	60\7 53 in study	Not mentioned
7-Lynsey et al .,2014	83	18 to 50	57\26	More than 1 year	Above T1o	C,D	N0 DROP	
8-Ming Wu et al 2012	10	16 to 65	8\2	(range,1-14)	C2 to T10	D	NO DROP	
9-Evan et al.,(2016)	64	NO mentioned	NO mentioned	More than 1 year	T4 or above	C,D	NO DROP	
Total	304							

ASIA, American Spinal Injury Association

Outcomes: see analyses(1**)**

1.1Primary outcomes :.

walking function: It was represented in speed, distance, 10 minute walk test(10 MWT), 6 minute walk test(6MWT), and walking index spinal cord injury (WISCI).

1.1.1 speed: 3studies with 32 participants in experimental group and 29 participants in control group said that there were on significant difference between both groups on speed

(SDM 0.14 ,[-0.36 to 0.64] CI 95%).P= 0.58

1.1.2 Distance:2studies with 23 participants in experimental group and 20 participants in control group with no significant difference between both groups on distance.(SDM

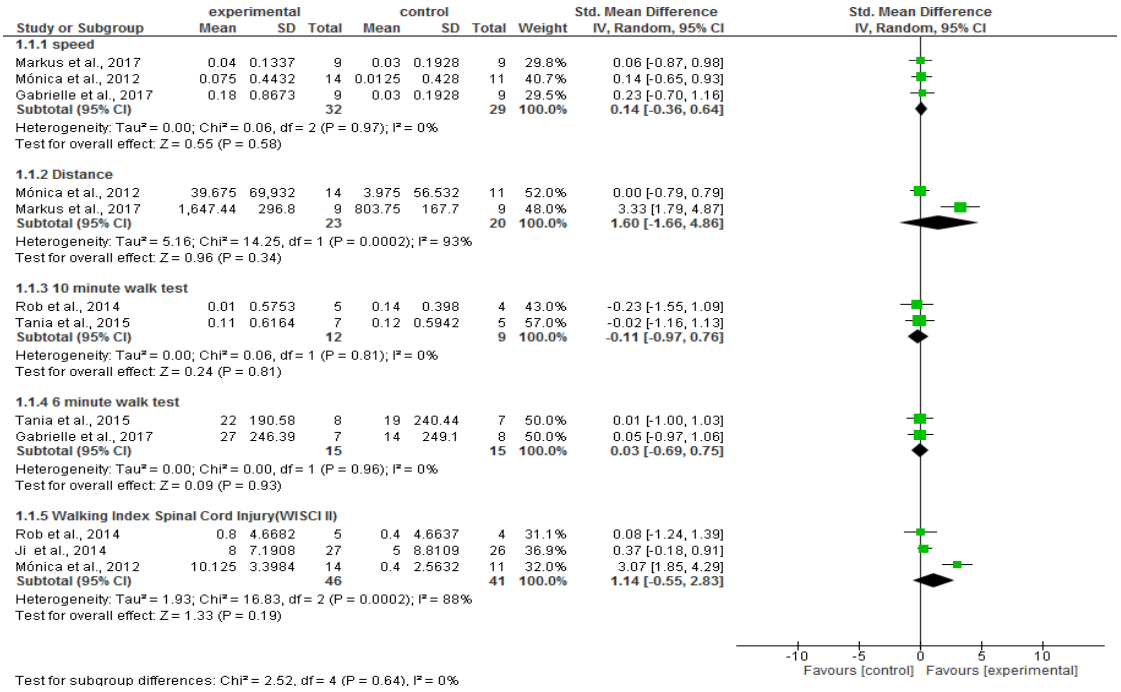
1.60 [-1.66, 4.86].

1.1.3 10 minute walk test:2studies with 12 participants in experimental group and 9 participants in control group with no significant difference between both groups.(SDM -0.11 [-0.97, 0.76].P=0.81

1.1.4 6 minute walk test:2studies with 15 participants in experimental group and

15 participants in control group with no significant difference between both groups.(SDM0.03 [-0.69, 0.75] P=0.93 .

1.1.5 Walking Index Spinal Cord Injury(WISCI II): :3studies with 46 participants in experimental group and 41 participants in control group with no significant difference between both groups.(SDM1.14 [-0.55, 2.83] P=0.19.



analyses(1): walking function

Secondary outcomes :.

1.2 Spasticity:

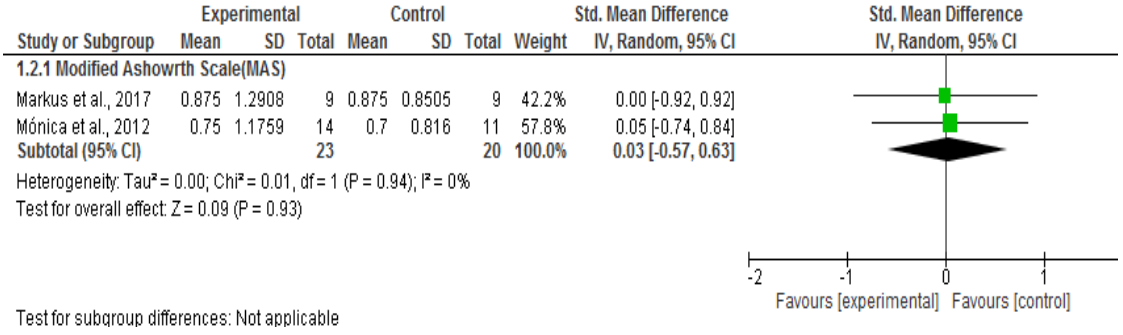
1.2.1 Modified AshowrthScale(MAS): 2studies with 23 participants in experimental group and 20 participants in control group with no significant difference between both groups . (SDM 0.03 [-0.57, 0.63].P=0.93 See analyses (2)

1.3 motor fuction See analyses (3)

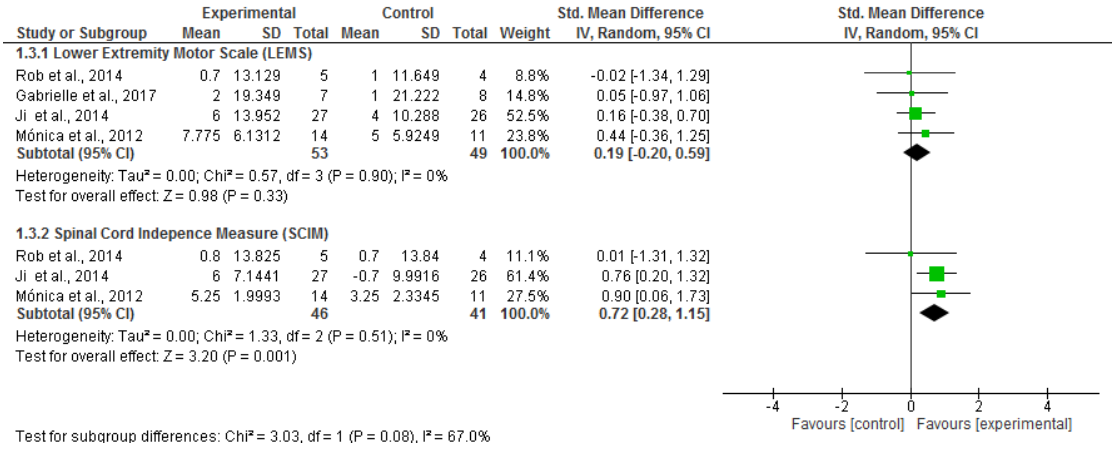
1.3.1 Lower Extremity Motor Scale (LEMS): 4studies with 53 participants in experimental group and 49 participants in control group with no significant difference between both groups . (SDM0.19 [-0.20, 0.59]. P=0.33

1.3.2 Spinal Cord Indepence Measure (SCIM): 3 studies with 46 participants in experimental group and 41 participants in control group with high significant difference between both groups . (SDM0.72 [0.28, 1.15] P=0.001.

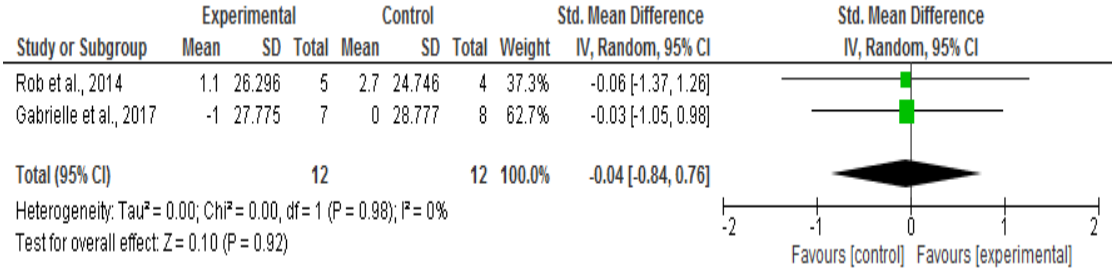
1.4 Balance: 2studies with 12 participants in experimental group and 12 participants in control group with no significant difference between both groups . (SDM-0.04 [-0.84, 0.76] P=0.92 see analyses (4)



analyses(2) Modified Ashoworth Scale(MAS



analyses (3) motor fuction



analyses(4)Balance

Descriptive analysis :

The three studies***(Lynsey et al 2014,Ming Wu et al 2012,Evan et al 2016)***were analytic by descriptive way because of its low quality assessement.

Discussion

Primary outcomes:

1.1walking function:

1.1.1 speed*: In **Ming Wu et al 2012***, The average training speed ± SD increased from 0.71±0.24m/s at the first training session to 0.92±0.25m/s at the last training session. In addition, body weight support ± SD decreased from 23.8%±4.3% at the first training session to 14.3%±9.9% at the last

training session. In ***Evan et al 2016*** , Mean walking speeds for the over ground(OG), treadmill training with stimulation(TS), treadmill training with manual resistance(TM), and locomotor robotic assistance (LR) groups were 0.19 m/s, 0.18 m/s, 0.17 m/s, and 0.17 m/s, respectively. Distance walked in 2 minutes averaged 24.0 m, 20.6 m, 22.1 m, and 16.8 m for the OG, TS, TM, and LR groups.

1.1.2 Distance: *In* ***Ming Wu et al 2012,*** The average training distance ± SD increased from 1.68±0.64km at the first training session to 2.27±0.65km at the last training session. . In ***Evan et al 2016***, Mean values of distance-dose in meters were OG = 2989, TS = 1141, TM = 1700, LR =14793. Mean values of time-dose in minutes were OG = 176.71, TS = 60.58, TM = 70.93, LR = 358.26.Correlations between distance-dose and change in walking distance ranged from r= -0.23 - 0.61. The OG group was the only group for which the relationship between distance-dose and change in walking distance was significant (r = 0.61, p = 0.02). Correlations between distance-dose and change in walking speed ranged from r = -0.18-0.62. The OG group was the only group for which the relationship between distance-dose and change in walking speed was significant (r = 0.62, p = 0.01). Only low, non-significant correlations were found in the relationships among time-dose and change in walking distance (r = -0.12 *f*{ 0.25), and among time-dose and walking speed (r = -0.25-0.09)

1.1.3 10 minute walk testand6 minute walk test: In***Lynsey et al 2014***had significantly higher baseline walking speedsin both Tiz (P < .001) and control (P = 0.04) groups, and those who achieved the MID for the 6MWT had significantly higher baseline walking distance in the Tiz group (P < .001). Finally, those who achieved the MID for the TUG had significantly longer times in the control (P = .04) and Lok (P = .04) groups.

Secondary outcomes :.

1.2 Spasticity:

1.2.1 Modified Ashowrth Scale(MAS): I*n**Lynsey et al 2014***, There were no significant difference in MAS between participants who did and did not attain the MID, for all interventions and outcome measures also ***Ming Wu*** said that There were no significant changes in muscle strength afterrobotic training. Specifically, the peak torque and rate of torque development at the hip, knee, and ankle joints had no significant changes and The Modified Ashworth Scale scores had no significant changes following training (*P*0.82 and *P*0.55 for flexor and extensor, respectively.

1.3 motor fuction:

1.3.1 Lower Extremity Motor Scale (LEMS): ***Ming Wu*** said that mean lower-extremity motor scores ±SD slightly increased from 45±4 to 46±3 after robotic training, although this change was not significant (P 0.37).

1.3.2 Spinal Cord Indepence Measure (SCIM):*In* ***Ming Wu*** study, no change

in their mean Walking Index for Spinal Cord Injury–II scores_±SD before and after robotic treadmill training (17±4), but in ***Lynsey*** study, Participants in lokomat group had significantly higher WISCI II scores and significantly improved baseline scores compared with class 1 for all outcome measures and intervention groups.

Conclusion: robotic-assisted has a minimal significant effect in spinal cord injury butmore studies must be included in this area to cover the gap of this study

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