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Gait rehabilitation in patients with lower-limb amputations: a systematic literature review

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1. Introduction

The higher the level of amputation, the greater the functional consequences (pain, lameness, psycho-social consequences, etc.) and the higher the energy cost of gait. Compared to able bodied individuals, the energy costs 35% more for all amputee on average, 12 to 36% more for transtibial amputee (TTA), 41 to 102% more for a transfemoral amputee (TFA), 120% more for a hemipelvic or disarticulated hip and 100% more for a bilateral below knee amputee. Kinematic gait parameters showed increased pelvic anterior tilt, length of the stance phase on the amputated side and muscular stump contraction. Also, it showed decreased hamstring length-strength relationship and decreased paravertebral, lumbar and stump muscles strength. The objective of this systematic literature review was to determine the most effective rehabilitation protocols on gait parameters in people with lower-limb amputations. Our major hypothesis was that protocols based on standardized exercises significantly improved gait parameters in people with lower-limb amputations compared to non-standardized rehabilitation (usual care).

2. Methods

We only included randomized controlled trials (RCTs) assessing adults, with unilateral or bilateral lower limb amputations (regardless the levels of amputation and the aetiologies) and able to walk with their prosthesis. The intervention was program including standardized rehabilitation methods. The comparator was non-standardized rehabilitation. The outcomes were gait spatio-temporal parameters: speed (m/s), step length (m), step width (m), cadence (step/min) and distance (m). We searched for RCTs from the following electronic databases: MEDLINE, Cochrane Library, PEDro, Science Direct and Google Scholar, in English or French, from June 2022 to March 2023. The RoB2 tool, the PEDRO scale and the AMSTAR 2 tool were used to assess the risk of bias, the overall quality of the RCTs and of the systematic review, respectively.

3. Results and discussion

3.1 Results

The search retrieved 6338 studies. 12 RCT (a total sample of 507 participants), published between 2002 and 2021 were included. The number of patients included in the RCTs varied from 15 and 154. In the intervention group, the standardized rehabilitation program included hip abductor muscle strengthening, proprioceptive neuromuscular facilitation, dual-task training and electrical stimulation therapy. In the comparator group, the participants had usual non-standardized rehabilitation. Only 3 RCTs reported a higher effectiveness of standardized rehabilitation exercises on gait speed, stride length, cadence, stance and distance compared to non-sdandardized rehabilitation. [1, 2, 3]. They were all designed in 1-hour sessions twice a week combining muscular work on the lower limbs and trunk, cardiorespiratory work, balance, weight-bearing, and walking trails appear to be effective on spatio-temporal gait parameters.

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A RCT including 26 participants, (16 TFA and TTA participants from 18 to 60 years, and 10 able-bodied people) assessed a 4 weeks program with 2 sessions of 60min/week intervention using low-cost basic rehabilitation material: TheraBand, balls… (Almeida et al. 2021) [1]. This RCT showed a clinically meaningful improvement in gait speed, stride length, cadence and stance [Table 1].
A RCT including 15 TFA and TTA 60(+/-12) years assessed a 12 weeks program including a supervised, circuit-style group exercise session twice weekly at the University and personalized exercises at home once a week, progressing to twice-weekly from the mid-point of the intervention (Schafer et al. 2018) [2]. This RCT showed a clinically meaningful improvement in gait speed, length, cadence and stance [Table 1].
A RCT including 16 unilateral TTA 63.25 (+/-11.5) years assessed a 8 weeks, 60min/week program including table of exercises based on AMPPRO tool results (Gailey et al. 2020) [3]. This RCT showed clinically meaningful improvement in distance [Table 1].
The RoB 2 tool varied from moderate [1,3] to high [2] risk of bias. The Pedro score was 4/10 [3], and 7/10 [1,2]. The Amstar-2 tool estimated that this systematic review was of average quality.

Table 1. Improvements in gait, temporal-spatial parameters

Study	Almeida et al. (2021) n=16	Schafer et al. (2018) n=15	Gailey et al. (2020) n=16
Speed	+0.35m/s > MDC= 0.11m/s **	+0.25m/s > MDC=0.10m/s**	
Length amputated + sound side	+0.06** and +0.07m**	+0.07m*	
Cadence amputated + sound side	+43 step/min **	+10 step/min* and +12 step/min*	
Stance amputated+ Sound side	57.5% (-7.6)*	56.4% (-3,3)* and 68,6%(-2,7) and 27%(-4,45)*	
Distance			+74m** >MDC=58,2m & MCID=50 m

* means statistically significant
** means clinically relevant
Credit: Baltus Lisa

3.2 Discussion

The present systematic literature review showed that 3 standardized exercise programs were more effective on improving gait-speed, stride-length, cadence, stance and gait distance in people with lower limb amputation than non-standardized programs. Nevertheless, in 9/12 RCTs the standardized rehabilitation was not more effective on improvement in gait parameters than non-standardized rehabilitation in people. This result cannot allow us to validate our major hypothesis.
This systematic review has several limits: A single rater performed studies inclusion and data extraction. The content of the rehabilitation programs and timelines for collection of gait parameters varied between studies which makes it difficult to perform a meta-analysis. The samples of participants in most RCTs remained small.

4. Conclusion

Future studies should explore the long-term effects of multidimensional standardized rehabilitation programs on gait parameters and core outcomes (activity limitation and quality of life). The use of in-prosthesis IMUs and pressure sensors may allow to have real-life data. Providing more detailed rehabilitation protocols and including more homogenous populations may bring valuable information to optimize rehabilitation strategies in people with lower limb amputation.

Conflict of Interest Statement

The author declares no potential conflicts of interest.

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