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ORIGINAL RESEARCH

Effects of a mechanical passive exercise device on pain and functioning during motor rehabilitation

Efeitos de um dispositivo mecânico de exercícios passivos na dor e funcionalidade durante a reabilitação motora

Efectos de un dispositivo mecánico de ejercicios pasivos sobre el dolor y la funcionalidad durante la rehabilitación motora

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ABSTRACT | The RA Godoy® device reproduces the physiological movements of the calf and foot muscles, functioning as a venous and lymphatic "pseudo-heart." In this study, the effects of a passive mechanical exercise device in patients with pain, edema, and reduced ankle range of motion were evaluated. We studied 27 patients who underwent one hour of RA Godoy® treatment, as well as a control group of 27 patients who underwent one hour of conventional physical therapy for five consecutive days. Participants were evaluated using goniometry, the Berg balance scale, the Tinetti test, the timed up and go test, an analog pain scale, and the SF-36. There was a significant alleviation in pain intensity in the RA Godoy® group. A significant increase in the dorsiflexion range of motion, plantar flexion and bilateral ankle inversion was observed in the RA Godoy® group, while in the control group there was a significant increase in the range of motion of right ankle dorsiflexion. There was considerable improvement in the gait of individuals in the RA Godoy® group. The mechanical passive exercise device is effective in pain treatment, edema and decreased ankle joint mobility—which consequently leads to improved gait and body balance—and a new treatment option for patients during motor rehabilitation.

Keywords | Conical Pain; Arthralgia; Edema; Joint Range of Motion; Physical Therapy Specialty.

RESUMO | O aparelho RA Godoy® reproduz os movimentos fisiológicos dos músculos da panturrilha e do pé, que funcionam como um "pseudocoração" venoso e linfático. Neste estudo foram avaliados os efeitos de um dispositivo de exercício mecânico passivo em pacientes com dor, edema e redução da amplitude de movimento articular do tornozelo. Foram estudados 27 pacientes submetidos ao aparelho RA Godoy® por uma hora, bem como um grupo controle de 27 pacientes submetidos a uma hora de fisioterapia convencional, durante cinco dias consecutivos. Foram avaliados por goniometria, Escala de Equilíbrio de Berg, Teste de Tinetti, Teste *Timed Up and Go*, escala analógica de dor e SF-36. Houve melhora significativa na intensidade da dor no grupo RA. Foi observado aumento expressivo na amplitude de movimento de dorsiflexão, flexão plantar e inversão do tornozelo bilateralmente no grupo RA, enquanto no grupo-controle aumentou significativamente a amplitude de movimento de dorsiflexão do tornozelo direito. Houve melhora considerável na marcha no grupo RA Godoy®. O aparelho mecânico de exercício passivo é eficaz no tratamento de dores, edema e diminuição da mobilidade articular do tornozelo – o que leva, consequentemente, à melhora da marcha e do equilíbrio corporal –, sendo uma nova opção de tratamento para pacientes durante a reabilitação motora.

Descritores | Dor Cônica; Artralgia; Edema; Amplitude de Movimento Articular; Especialidade Fisioterapia.

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RESUMEN | El dispositivo RA Godoy® reproduce los movimientos fisiológicos de los músculos de la pantorrilla y del pie, que funcionan como un "seudocorazón" venoso y linfático. En este estudio se evaluaron los efectos de un dispositivo mecánico de ejercicio pasivo en pacientes con dolor, edema y rango de movimiento reducido de la articulación del tobillo. Participaron 27 pacientes que se sometieron al dispositivo RA Godoy® durante una hora y un grupo control de 27 pacientes que se sometieron a una hora de fisioterapia convencional durante cinco días consecutivos. Se evaluaron a los participantes mediante la goniometría, la escala de equilibrio de Berg, la prueba de Tinetti, la prueba *Timed Up and Go*, la escala analógica de dolor y el SF-36. Hubo una mejora significativa en la intensidad del dolor en el grupo RA. Un aumento significativo en el rango de movimiento de la flexión dorsal, de la flexión plantar y de la inversión del tobillo se observó bilateralmente en el grupo RA, mientras que en el grupo de control aumentó significativamente el rango de movimiento de la flexión dorsal del tobillo derecho. Hubo una mejora considerable en la marcha en el grupo RA Godoy®. El aparato mecánico de ejercicio pasivo es eficaz en el tratamiento del dolor, del edema y en la disminución de la movilidad de la articulación del tobillo, lo que en consecuencia conduce a una mejor marcha y equilibrio corporal, convirtiéndose en una nueva opción de tratamiento para los pacientes durante la rehabilitación motora.

Palabras clave | Dolor Cónico; Artralgia; Edema; Rango del Movimiento Articular; Especialidad de Fisioterapia.

INTRODUCTION

Mobility is a component of functioning that is closely related to the performance of basic and instrumental activities of daily living. It is essential for both simple tasks and complex tasks, such as locomotion and walking, which directly correlates with balance and gait[1].

Partial or complete immobilization leads to different adjustment processes, like loss of muscle strength, decreased overall performance, and edema. Degeneration of immobilized muscle groups and early joint stiffness are critical factors that prolong the healing process[2]. In the advanced stages of wasting syndrome, weakness occurs due to amyotrophy caused by disuse or malnutrition, in which the muscles are overworked or hypertonic due to pain and sensitization[3-5].

In this context, physical activity programs aim to restore muscle function, strength, and trophism, in addition to developing proprioception, and working on coordinated, efficient, and uniform movements, restoring joint flexibility, and preventing disuse syndrome. Active, passive, self-passive, and active-assisted exercises preserve or increase joint range of motion[3].

The RA Godoy® mechanical drainage device reproduces the physiological movements of the calf and foot muscles, which function as a venous and lymphatic "pseudo-heart," because external forces help the contraction mechanism of the lymphatic vessels and stimulate the contractions of the lymphangions. Muscle activity is critical in natural lymphatic drainage. This approach not only significantly reduces edema, but also controls muscle trophism and joint mobility when considering the dorsiflexion motion provided by the mechanical device[6,7].

The exercise can be performed continuously or at intervals, depending on the patient. Proper guidance is important for patients, as they should not try to control the movements, which need to be performed passively by the device. It is important that the contraction mechanism drains more than the capillary filtration capacity. Thus, passive exercises are better in treating lymphedema because they require less blood supply to the muscles and therefore less capillary filtration[8-11].

Notably, the current literature holds few studies evaluating the benefits of mechanical drainage by the RA Godoy® device in the outpatient physical rehabilitation of patients with neuromusculoskeletal disorders.

OBJECTIVE

To evaluate the effects of a mechanical passive exercise device on the motor rehabilitation of patients with pain, edema and decreased ankle joint range of motion.

Casuistry

We studied 54 patients of both sexes, over 18 years of age, being treated at a physical therapy outpatient clinic of a teaching hospital, with neuromusculoskeletal disorders, regardless of etiology, who had edema, pain and decreased range of motion in the lower limbs. Exclusion criteria were active infection and any clinical disease with contraindication for physical exercise,

such as heart failure and advanced neoplasia, as well as patients who did could not stand still and actively gait. Six patients who missed any treatment session were also excluded.

Participants were chosen at random in order of arrival and agreement to participate in the study. Research subjects were divided into two groups:

- RA Group: 27 participants underwent physical therapy using the RA Godoy® device for five consecutive days in one-hour sessions.
- Control group: 27 participants underwent conventional physical therapy for five consecutive days in one-hour sessions.

METHODOLOGY

Participants answered a clinical and demographic data collection form, the analogue pain scale and the SF-36 quality of life questionnaire on the first day and after the five days of treatment.

They were also subjected to goniometry exams (to evaluate dorsal flexion, plantar flexion, ankle inversion and eversion), perimetry, Berg balance scale, Tinetti test, timed up and go test, on the first day and after the five days of treatment.

Physical therapy intervention

RA Godoy®

The RA Godoy® mechanical drainage device is a device that allows the reproduction of the physiological movements of the calf and foot muscles, significantly reduces edema, controls muscle trophism and improves joint mobility.

Conventional physical therapy

In the groups subjected to conventional physical therapy, the routine treatment of the physical therapy outpatient clinic was adopted, including kinesiotherapeutic techniques to increase the range of motion and reduce pain and edema.

RESULTS

We evaluated 27 patients in the RA group, with a mean age of 52 years (SD=10.89), 85.19% female (n=23) and 14.81% male (n=4), and 27 patients in the control group, with a mean age of 61.62 years (SD=15.35), 77.77% female (n=21) and 22.22% male (n=6).

In the RA group, 66.66% were married (n=18), 25.93% were single (n=7), 3.70% were widowed (n=1) and 3.70% were divorced (n=1). In the control group, 51.85% were married (n=14), 22.22% were single (n=6), 22.22% were widowed (n=6) and 3.70% were divorced (n=1).

Regarding education, in the RA group, 59.26% (n=16) had completed secondary education, 33.33% (n=9), incomplete secondary, and 7.40% (n= 2), tertiary education. In the control group, 59.26% (n=16) had completed secondary education, 40.74% (n= 11) had incomplete secondary education, and none of the patients had tertiary education.

Most patients in the RA group (74.08%) and the control group (66.66%) had a medical diagnosis of low back pain when referred to the physical therapy outpatient clinic.

Pain assessment and quality of life

All patients in the RA group and the control group suffered from chronic pain (lasting more than 12 weeks) and answered a questionnaire to assess pain characteristics, as pain intensity, which was classified by the patient as mild, moderate, severe, or absent.

The McNemar-Bowker test was used to compare the change in pain intensity profile before and after treatment. In the RA group, as the p-value was not significant (0.001211), the null hypothesis can be rejected and, thus, attest that there was variation between before and after treatment in the distribution of pain complaints. In the control group, a less varied pain perception spectrum was perceived, with a lower transition between classes (p-value=0.4795). Thus, a significant relief of pain intensity limited to the RA group was observed.

Patients were also asked to rate their pain using an analogue scale ranging from 0 (no pain) to 10 (maximum pain). There was a significant decrease in pain in the RA group (p-value=0.00000000001) and the control group (p-value=0.007679) according to the analogue scale. However, it can be attested with 95% confidence that there was a reduction of 4 to 5.99 points in the pain scale in the RA group and a decrease of 0.2 to 1.2 points in the control group.

Thus, it was identified that the RA group showed a large pain reduction, while the control group showed a less expressive decrease.

Regarding the SF-36 quality of life assessment, a significant improvement restricted to the RA group "pain" domain was observed when comparing assessments before and after intervention (Table 1). In the control group, there was no significant difference in all SF-36 domains.

Table 1. RA and control group patient distribution in relation to the SF-36 quality of life assessment before and after treatment

RA Group			
Domain	Mean before intervention (SD)	Mean after intervention (SD)	p-value
Physical functioning	40.74 (SD=27.96)	56.56 (SD=44.50)	0.6879
Role functioning/physical	32.77 (SD=46.18)	32.40 (SD=43.19)	0.938
Pain	37.38 (SD=21.00)	48.88 (SD=19.31)	0.0002
General health	46.42 (SD=25.01)	61.44 (SD=21.05)	0.1292
Energy/fatigue	51.33 (SD=19.61)	54.59 (SD=18.91)	0.3197
Social functioning	62.59 (SD=31.51)	66.57 (SD=26.42)	0.1523
Role functioning/emotional	37.64 (SD=45.19)	43.66 (SD=48.22)	0.1767
Emotional well-being	61.18 (SD=21.18)	64.44 (SD=20.61)	0.2892
Control group			
Domains	Mean before intervention (SD)	Mean after intervention (SD)	p-value
Physical functioning	38.51 (SD=20.46)	38.33 (SD=20.75)	0.713
Role functioning/physical	13.88 (SD=29.68)	14.81 (SD=31.96)	0.573
Pain	24.74 (SD=13.78)	23.96 (SD=14.00)	0.365
General health	46.33 (SD=22.86)	44.85(SD=20.78)	0.4387
Energy/fatigue	42.96 (SD=18.14)	43.33 (SD=18.23)	0.678
Social functioning	39.20 (SD=24.52)	41.70(SD=27.69)	0.1697
Role functioning/emotional	22.06 (SD=36.13)	19.59 (SD=32.79)	0.2119
Emotional well-being	50.65 (SD=18.06)	49.40 (SD=14.90)	0.3396

Goniometric evaluation

Regarding the goniometric evaluation, in the RA group, there was a highly significant increase in the dorsiflexion range of motion, plantar flexion and bilateral ankle inversion, while in the control group only the right ankle dorsiflexion range of motion increased considerably (Table 2)

Table 2. RA and control group patient distribution in relation to goniometry before and after treatment

RA Group			
Movement	Mean before intervention (SD)	Mean after intervention (SD)	p-value
R dorsiflexion	10.25 (SD=4.58)	15.66 (SD=5.10)	0.00000058
L dorsiflexion	9.00 (SD=4.89)	14.70 (SD=4.79)	0.0000069
R plantarflexion	23.70 (SD=8.39)	35.40 (SD=7.42)	0.0000000388
L plantar flexion	25.22 (SD=7.99)	36.03 (SD=7.88)	0.0000000282
R inversion	16.03 (SD=6.33)	22.29 (SD=7.67)	0.00000159
L inversion	16.33 (SD=6.87)	22.40 (SD=7.29)	0.000002951
R eversion	12.00 (SD=4.52)	15.03 (SD=4.64)	0.00581
L eversion	11.66 (SD=4.26)	15.14 (SD=4.52)	0.00046
Control group			
Movement	Mean before intervention (SD)	Mean after intervention (SD)	p-value
R dorsiflexion R	14.18 (SD=3.95)	15.14 (SD=4.32)	0.034
L dorsiflexion L	14.59 (SD=4.60)	15.22 (SD=4.33)	0.1824
R plantar flexion R	22.11 (SD=6.68)	22.18 (SD=6.48)	0.8427
L plantar flexion L	26.11 (SD=6.16)	25.11 (SD=6.75)	0.3319
R inversion R	19.29 (SD=8.18)	19.70 (SD=8.20)	0.3807
L inversion L	20.11 (SD=8.24)	22.37 (SD=8.46)	0.2439
R eversion R	12.74 (SD=4.40)	12.14 (SD=3.99)	0.223
L eversion L	14.66 (SD=4.10)	14.96 (SD=4.14)	0.147

Note: R = right; L = left.

Gait assessment and body balance

In the evaluation of balance and gait using the Berg scale and the Tinetti test, there was a significant improvement in these variables when comparing treatments before and after using RA Godoy®. There was no considerable improvement in gait and balance after five days of conventional physical therapy.

Mobility and body balance assessment via the timed up and go test showed significant improvement in the RA group (p-value=0.000153) and the control group (p-value=0.0081). However, a large reduction in the test execution time was observed in the RA group, between 2.04 and 5.58 seconds, and a lesser reduction was observed in the control group, between 0.24 and 1.51 seconds.

Table 3 shows patient distribution in relation to body balance and gait assessment.

Table 3. RA and control group patient distribution in relation to body balance and gait

RA Group			
Domains	Mean before intervention (SD)	Mean after intervention (SD)	p-value
Berg scale	40.00 (SD=10.69)	50.92 (SD=8.84)	0.00000000005
Tinetti balance test	10.22 (SD=3.68)	13.96 (SD=3.49)	0.000000008
Tinetti gait test	6.70 (SD=2.98)	10.33 (SD=2.28)	0.00000000007
Tinetti total score	17.00 (SD=6.36)	24.14 (SD=5.50)	0.0000000009
Control group			
Domains	Mean before intervention (SD)	Mean after intervention (SD)	p-value
Berg scale	43.70 (SD=9.72)	44.07 (SD=9.60)	0.057
Tinetti balance test	11.44 (SD=2.85)	11.62 (SD=3.05)	0.096
Tinetti gait test	8.96 (SD=3.78)	8.62 (SD=2.64)	0.468
Tinetti total score	19.11 (SD=5.26)	20.22 (SD=5.39)	0.062

Edema evaluation (perimetry)

During perimetry evaluation, a significant decrease in edema was observed in the RA group; the same did not occur in the control group (Table 4).

It was also identified that the analyses of the Berg scale results and the goniometric evaluation of the left ankle plantar flexion showed the greatest statistical differences before and after treatment with the RA Godoy® device (Graph 1).

Table 4. RA group patient distribution in relation to perimetry before and after treatment

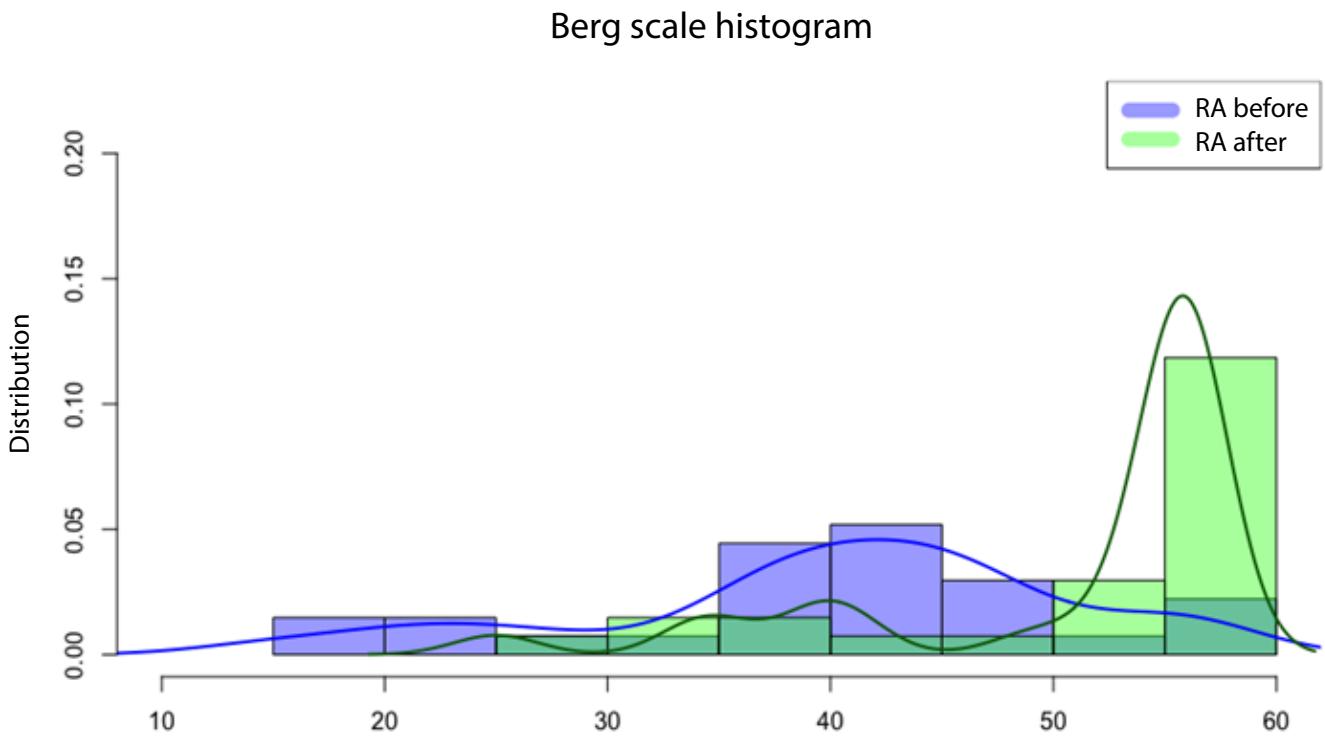
RA Group			
Measure	Mean before intervention (SD)	Mean after intervention (SD)	p-value
10 cm R	25.92 (SD=2.14)	25.37 (SD=1.96)	0.029
10 cm L	26.48 (SD=3.23)	25.51 (SD=1.97)	0.069
20 cm R	24.81 (SD=3.22)	24.18 (SD=3.40)	0.0164
20 cm L	24.59 (SD=3.51)	24.29 (SD=3.83)	0.245
30 cm R	33.40 (SD=5.00)	32.77 (SD=5.31)	0.232
30 cm L	33.18 (SD=5.44)	32.03 (SD=4.81)	0.057
40 cm R	38.81 (SD=4.28)	37.70 (SD=4.53)	0.00012
40 cm L	38.77 (SD=4.24)	38.07 (SD=4.248	0.0015
50 cm R	40.85 (SD=4.76)	40.33 (SD=5.00)	0.094
50 cm L	40.92 (SD=5.34)	40.37 (SD=4.69)	0.096
60 cm R	47.37 (SD=7.43)	46.92 (SD=7.49)	0.426
60 cm L	47.18 (SD=8.11)	46.55 (SD=7.38)	0.342
Control group			
Measure	Mean before intervention (SD)	Mean after intervention (SD)	p-value
10 cm R	26.18 (SD=2.00)	26.22 (SD=2.10)	0.663
10 cm L	25.96 (SD=2.02)	26.03 (SD=2.06)	0.573
20 cm R	24.22 (SD=3.20)	24.92 (SD=3.72)	0.215
20 cm L	24.14 (SD=2.55)	24.22 (SD=2.50)	0.489
30 cm R	32.07 (SD=4.76)	32.03 (SD=4.77)	0.801

(continues)

Tabela 4. Continuation

Measure	Control group Mean before intervention (SD)	Mean after intervention (SD)	p-value
30 cm L	32.33 (SD=4.25)	31.96 (SD=4.22)	0.115
40 cm R	38.18 (SD=5.12)	38.11 (SD=5.11)	0.194
40 cm L	37.92 (SD=5.02)	37.81 (SD=5.02)	0.448
50 cm R	40.00 (SD=4.78)	39.88 (SD=4.80)	0.477
50 cm L	38.96 (SD=6.36)	39.74 (SD=4.65)	0.483
60 cm R	45.44 (SD=6.71)	45.18 (SD=6.78)	0.147
60 cm L	45.74 (SD=6.75)	45.59 (SD=6.85)	0.475

Note: R = right; L = left.



Graph 1. Berg scale histogram

DISCUSSION

In this study, a new therapeutic strategy was presented for patients with pain, edema and decreased joint mobility who had already been in a conventional motor rehabilitation program for at least 30 days. The RA Godoy mechanical device was used in the treatment of these patients for five consecutive days, which, when compared to conventional physical therapy for the same length, proved to better reduce pain, gaining joint mobility, and improving gait and body balance.

The equipment performs a significant number of passive ankle movements in one hour, which makes it possible to enhance the expected results to be achieved in the motor rehabilitation of these individuals[12], making it an excellent tool for physical therapists in their daily practice.

The standardization of patients was done regardless of their neuromusculoskeletal disorders. It was identified that most patients had a diagnosis of chronic low back pain in both groups, which potentially qualifies them for therapy with RA Godoy®. However, the sample size did not enable assessing the effectiveness of the method by type of disease.

The RA Godoy® device has been used in the treatment of lymphedema and its performance evaluated over the years. The RA Godoy® device represents a new method of lymphatic drainage, as it reproduces physiological movements that facilitate and stimulate drainage systems[12].

Therapy with RA Godoy has been shown to be effective in improving joint mobility and, in association with manual and cervical lymphatic therapies and compression mechanisms, enables the reversal of lymphedema in all clinical states[13,14]. Edema reduction increases joint mobility, which results in gait pattern improvement. The edema suggests that the functional reserve of the lymphatic system has been exceeded and more intense active exercise may result in more edema and hinder rehabilitation[7].

Studies have demonstrated the use of conservative approaches to treat chronic venous insufficiency, including physical therapy, which treats and prevents complications via compression therapy, lymphatic drainage, hydrotherapy, and therapeutic exercises. The exercise protocols used often combine flexibility, strength, and endurance training, aiming to strengthen peripheral muscle pumps and improve venous return[15].

A recent systematic review of the effectiveness of therapeutic exercises in improving the quality of life of patients with chronic venous insufficiency identified only one of four randomized controlled trials that reported positive and significant results attributed to the effects of therapeutic exercises on the quality of life of evaluated participants. However, the quality of the evidence in existing studies on therapeutic exercise for chronic venous insufficiency is weak or uncertain[16]. Therefore, there is insufficient evidence to indicate or contraindicate therapeutic exercises to improve the quality of life, pain, and functioning of patients with chronic venous insufficiency. This finding reinforces the need for additional research that adopts greater methodological rigor to limit bias[16].

In this study, there was a significant improvement in the quality of life of patients limited to the "pain" domain and the RA group, which can be attributed to the assessment of quality of life before and after five days, considering that the SF-36 verifies the quality of life in the last four weeks. The relevance of new medium- and long-term studies is emphasized.

However, there are no studies evaluating the effectiveness of a mechanical passive exercise device on pain and functionality during motor rehabilitation. A pilot study looked at the improvement of pain and gait in individuals who used a locomotion aid, like a cane or a walker[7]. The results corroborate the findings presented here in relation to improvement in gait, pain, and edema. However, the need for future research comparing the efficacy of RA Godoy in patients of different ages, genders, and conditions is emphasized.

CONCLUSION

The mechanical passive exercise device is effective in treating pain, edema and decreased ankle joint mobility during motor rehabilitation – which consequently leads to improved gait and body balance – and can be an ally during the rehabilitation process.

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