EVALUATION OF PARTIAL STATIC WEIGHT LOAD TRAINING

MARTA CRISTINA DA SILVA GAMA[1], LUCIANE FERNANDA RODRIGUES MARTINHO FERNANDES[2], EDUARDO GOMES BENITES[1], SABRINA RODRIGUES[3], ROSANA MACHER TEODORI[4],

SUMMARY

Gait training with partial load is common in a physical therapist practice; however, in the hospital environment, the time for this training is limited, lasting only for the time of hospitalization. Therefore, this study was aimed to check on the effects of previous partial weight load training in volunteers without orthopaedic injuries seeking to indicate it to patients submitted to orthopaedic surgeries on lower limbs. 32 volunteers showing no postural changes or history of trauma on lower limbs were included in this study. The partial load training was carried out by distributing 20% of the total body mass on the right lower limb in an anthropometric digital scale. The volunteers were divided into two groups, with group I repeating the drill 6 times, and group II 12 times. Data about the static load distribution were collected by a pressure platform Matscan-Tekscan® and compared on the pre- and post-training periods. A significant difference was found for 12-repetitions drills ($p<0.015$). Pre-training with partial weight load was shown to be effective to be applied on patients during hospitalization period, because with only a single drill repeated 12 times, partial load learning was noticed.

Keywords: *Weight-Bearing; Lower extremity; Evaluation.*

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INTRODUCTION

One of the roles of a physical therapist is to restore normal gait, by seeking, whenever possible, to achieve the same functional level as previously to injury. In order to accomplish this objective, it is required to identify the deficiencies that will need attention and prepare the patient for gait. Preparing a patient consists of strengthening lower limbs' muscles, performing weight load exercises, and strengthening upper limbs when the use of special devices is required.

Partial load support is a common approach in postoperative treatment of fractures or surgical reconstructions of the lower limbs when modern concepts of stable fracture fixation are applied[1]. The amount of load to be supported by a patient should be determined by the surgeon and will depend on the surgical approach selected[2].

Weight bearing may be defined in five different ways: a) without weight bearing, b) weight bearing only with the toes touching the ground, c) partial weight bearing , d) weight bearing as much as tolerated, and, e) full weight bearing[3].

When weight bearing is provided only with the toes touching the ground, a cookie may be placed under the plantar portion of the affected foot asking the patient to apply foot weight without breaking the cookie [2], or, also, using a domestic scale[4] in order to visualize the amount of load required to support the affected limb.

However, during gait training with partial load, a physical therapist does not have a quantitative response of the load applied. Besides, it is difficult for the patient to distribute load on the operated limb, especially when partial load or as much as tolerated weight bearing is demanded. Many times, this difficulty emerges from lack of confidence, pain or difficulties to know exactly the amount of load that can be applied to the affected lower limb.

For achieving a quantitative response of the load applied by the patient during gait training with partial load, a baropodometry system assessing the distribution of plantar forces applied by an individual on a pressure platform or inner sole may be used.

This baropodometry system (pressure platform) provides a reliable quantitative analysis, allows for a better comprehension of proprioceptive responses and assessed plantar pressure distribution on different supports, different loads, and during gait. This equipment provides information about foot contact pressure peak, the contact area of plantar surface, the site of force core (mass center projection) and applied force (weight).

Plantar pressure is calculated by force (weight)/ sensor area[5] and may be used for detecting, treating, and clinically following up lower limb conditions caused by musculoskeletal, neurologic and other dysfunctions[6]. For the analysis and distribution of foot pressure, platforms or inner soles may be used as pressure sensors.

Plantar pressure distribution has been used for evaluating surgical techniques such as in hallux valgus deformities[7] and after ankle's peripheral nerves decompression[8], for correlating pressure and the different kinds of feet [9], for evaluating plantar sensitivity after cold immersions[10], and for checking a physical therapeutic intervention's outcome after ankle sprains[11].

The possibility of quantifying plantar pressure is of great importance, since the distribution of static and dynamic pressure resulting from the contact with the ground reflects a foot's structural and functional status[12], the place where weight load is distributed. Therefore, this study intended to check the effects of previous static training with partial weight load, in female volunteers with no orthopaedic injuries in view of indicating this therapy to patients submitted to orthopaedic surgeries on the lower limbs.

Study conducted at Multidisciplinary Research Laboratory, Physical Therapy Post Graduation Program, FACIS-UNIMEP.

Correspondences to: Universidade Federal do Triângulo Mineiro – Campus Urbano Salomão – Av. Guilherme Ferreira, 650 CEP 38022-200 . Uberaba – MG – Brasil. e-mail: lfrm@terra.com.br

1. Physical therapist, graduated by Health Sciences College – UNIMEP - Piracicaba-SP
2. Associate Professor, Physical Therapy Course, Federal University of Triângulo Mineiro – UFTM – Uberaba – MG
3. Physical Therapist, Master in Physical Therapy by Health Sciences College – UNIMEP - Piracicaba-SP
4. Professor of the Physical Therapy course, Health Sciences College and Physical Therapy Post-Graduation Program – UNIMEP - Piracicaba-SP

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MATERIALS AND METHODS

Volunteer's overall characteristics

At first, 63 female university students of the physical therapy course were assessed. The assessments collected personal data (name, age, dominant foot, telephone number, address, shoe size), anthropometric data (mass, height), and a specific physical examination focusing stance evaluation at a symmetographer, as well as an assessment of plantar arcs on the podoscope. Foot dominance was recorded by asking the volunteers to climb a step; the limb first used to move was regarded as the dominant one.

Of these 63 volunteers, 32 women were selected. The exclusion criteria were the following: presence of scoliosis, hyper-lordosis and kyphosis, cavus foot, flat foot, asymmetries and differences on lower limbs' length. These criteria were used because those changes might influence plantar pressure distribution.

This project was approved by the Committee on Ethics in Research by Universidade Metodista de Piracicaba – UNIMEP, under the protocol nr. 12/95, and the volunteers were included in the study after signing a free and informed consent term.

Materials employed

In the stance evaluation, a symmetographer and a podoscope were used. For partial load training, a Technos chronometer, a WELMY digital scale (model RIW200 with maximum load of 200kg) and a wooden support (10x20x40cm), specially built for supporting left lower limbs at the same level to the scale during training.

For data collection, a Pentium-IV micro computer and a pressure platform MatScan 5.1 Tekscan®, with 2288 sensors, 1.4 sensor/cm² resolution and 436mm x 369mm in size was used. a Windows-based software with real-time monitoring application was employed for data readings on the platform.

Data collection

Previously to data collection, a pilot test was conducted in order to check for the potential of errors occurrence, as well as to promote investigators' familiarization with the system and treatment protocol. The volunteer of the pilot test did not make part of the collections. After anthropometric measurements were made (mass and height) on each volunteer on the scale, a value corresponding to 20% of the total body mass was calculated. The volunteers were informed about this value, which was also used for partial load training of the right lower limb. The value for total body mass of each volunteer was also used for calibrating the baropodometry system, according to manufacturer's recommendations.

The orthostatic position with bipodal support was selected for each volunteer for data acquisition on the platform. Four collections were provided on every volunteer in both groups. Pre-training collections (1 and 2) served as control, while collections 3 and 4 were made after training.

The volunteers were divided into two groups for training purposes. Training was similar to both groups, except for the number of repetitions. Group I (n=16) repeated the drills 6 times, while Group II (n=16) repeated it 12 times.

Pre-training data acquisition: On collection 1, volunteers were asked to uniformly distribute load between both lower limbs on the pressure platform (CHpre). On collection 2, they were asked to distribute 20% of total body weight "according to their perception" on the right lower limb (C20pre).

Training: For training purposes, the volunteers had to remain with the right foot on the scale and the left foot on the wooden support next to the scale and at the same level to the right lower limb (Figure 1). During training, the volunteers were asked to maintain load application corresponding to 20% of their total body mass on the right lower limb, controlling this load by checking the value shown on the scale for 30 seconds, with 30-second intervals between each repetition. The training and rest time were controlled by the investigator using a chronometer. For group I, training was repeated 6 times, with a mean duration time of 7 minutes. For Group II, training was repeated 12 times, with a mean duration time of 13 minutes.

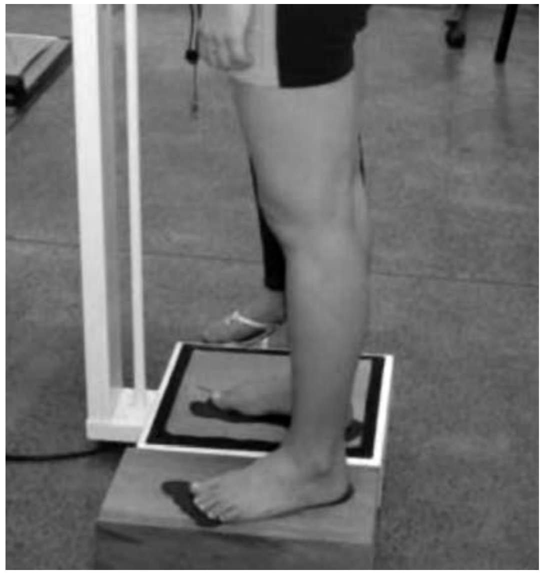

Figure 1 - *Volunteers' feet position during training. Right foot on the scale, and left foot on the wooden support.*

Post-training data acquisition: on collections 3 and 4, the same positions as in collections 1 and 2 were repeated. On collection 3, the volunteers were asked to remain at bipodal stance with load evenly distributed between both lower limbs (CHpost) and, on collection 4, they had to distribute 20% of total body weight on the right lower limb and the rest of the load on the left lower limb, according to the previous training on the scale (C20post).

Each collection was repeated 3 times, and the time for each acquisition was 5 seconds, at a 40-Hz frequency.

The system provides the peak values for foot contact pressure, plantar surface contact area, force core site (mass center projection) and applied load (weight load). For this study, only the applied load was assessed in a relative form, as a result of the objective described above.

Statistical analysis: For data analysis purposes, pre- and post-training values (C20pre and C20post, respectively) were compared. Values for relative load were submitted to statistical analysis with 5% significance level. In the descriptive analysis, mean and standard deviation values were studied. In the inferential analysis, data normality was assessed by using the Kolmogorov-Smirnov's tests, followed by Student's t parametric test for paired samples.

RESULTS

Concerning volunteers' overall characteristics, mean values for age were 20.7 (±1.8), mass 58.5 kg (±8.1), and height 1.63 (±0.05). The mean and standard deviation values for age, mass, height, BMI, and shoes size of the volunteers, separated by groups, are presented on Table 1. For foot dominance, 65.6% of the volunteers had a dominant right foot.

For volunteers' selection, the major exclusion criterion was cavus foot, a condition found in 20 volunteers, bilaterally in most of the cases. Only one volunteers presented with bilateral flat foot.

Table 1- Volunteers' overall characteristics

	n	Age (years)	Mass (kg)	Height (m)	BMI	shoe size
G I	16	20.69 ±1.45	59.20 ±9.03	1.63 ±0.04	22.13 ±2.86	36.5 ±1.55
G II	16	20.69 ±2.18	57.74 ±7.16	1.62 ±0.06	22.07 ±2.38	35.94 ±1.44
Total	32	20.69 ±1.82	58.47 ±8.05	1.63 ±0.05	22.10 ±2.59	36.22 ±1.50

The mean and standard deviation values for relative load on the 4 collections (pre- and post-training) of volunteers from Group I and II are presented on Table 2.

***Table 2 –** Groups I and II mean and standard deviation values for relative load on the right lower limb, pre- and post-training.*

	CH pre (%)	CH post (%)	20D pre (%)	20D post (%)
G I (n=16)	53.44 (±3.09)	52.93 (±3.71)	33.31 (±21.54)	23.68 (±8.91)
G II (n=16)	52.53 (±2.40)	52.47 (±3.76)	34.26* (±21.72)	22.99* (±11.77)

CH pre: uniformly distributed load, pre-training; 200pre: load of 20% of the total body mass on right lower limb, pre-training; CH post: uniformly distributed load, post-training; 20D post: load of 20% of the total body mass on right lower limb, post-training; * significant for $p<0.05$.

For inferential statistical analysis, partial load data were assessed on pre- and post-training collections. No significant difference was found between collections 1 and 2 in which the even distribution of the load was assessed (CHpre and CHpost). a significant difference was found between relative load values pre- and post-training (C20pre and C20post) only for Group II ($p< 0.015$).

DISCUSSION

The present study intended to assess two partial load training programs in asymptomatic women, using a computer-based baropodometry system, with the objective of checking for the effect of previous static partial load training in volunteers with no orthopaedic injuries in an attempt to identify if previous training would be effective enough to be used postoperatively in patients submitted to orthopaedic surgeries of the lower limbs.

A stance evaluation was initially made, and only those volunteers showing no changes have participated of the collections. Since there is a great variation on plantar pressure distribution forms among the individuals[8], in this study, only those volunteers with no history of trauma, lower limbs' surgeries, postural changes, and foot arc alterations have participated of the study in order to minimize the number of cases with potential changes on plantar distribution and achieve more accurate results.

Another data collected during baseline evaluation was concerned to the dominant foot. According to Peters, 1998 *apud* Gobbi et al.[13] foot dominance can be defined as the foot of choice to manipulate an object or start a movement, while the non-dominant foot is the one used as a stance stabilizer. In this study, dominant foot prevalence was for the right one (65.6%), and, on bipodal support with uniform distribution of load (CH), the heaviest load was applied on the right lower limb in both groups, both in pre-training collections (53.44% and 52.53%), and in post-training ones (52.93% and 52.47%). We believe that, as we have asked the volunteers to uniformly distribute load on the platform, we couldn't evidence dominance for starting a movement and not the dominance of the limb responsible for stance stabilization.

Concerning the methodology employed on the assessment of plantar and load distribution, Villardi et al.[14] used a pressure evaluation device from a modified sphygmomanometer in patients with unilateral knee conditions, while Vasarhelyi et al.[1] used a baropodometry system (inner soles) in patients submitted to surgical treatment of fractures of the lower limbs. In the present investigation, we used a scale for load training applied on the right lower limb and a baropodometry system (pressure platform) to see if trained partial load was learnt because both equipment provide a response of the applied load, which does not happen in most partial gait training in hospitalized patients. In these cases, the patient is not aware of how much load he/ she has to apply and how much a demanded load represents. In addition, the professional in charge of training gait doesn't have any response of the load being applied.

Comparing pre- and post-training data in both groups, post-training force values were close to 20% (group I, 23.68%; group II, 22.96%). These data show that training was effective for load awareness; however, for group I, this difference was not significant.

Concerning the training programs applied, during group II training, where 12 repetitions were done with partial load distribution on the scale, the volunteers complained of discomfort on the left lower limb (which supported 80% of the load). The most common complaints were calcaneus pain and a feeling of "fatigue" on the support limb. When gait with partial load is performed, patients use devices (walkers, crutches, canes) that enable the distribution of load on the upper limbs, not causing overload to the support or injured limb. In the training done by volunteers, none of these devices was used; thus, we believe that the discomfort complaint was due to an excessive load applied on the support lower limb for a extensive time (13 minutes), since no complaint was reported by volunteers of group I.

However, the results of this study indicated that training with 12 repetitions promotes a significant learning experience when compared to training repeated 6 times. Nevertheless, the high rate of discomfort reports on support lower limb during training on Group II emphasizes the importance of using devices for partial load training.

CONCLUSION

In this study, a significant learning experience was observed regarding partial distribution of the proposed load when drills were repeated 12 times. Thus, we can infer that using a previous training protocol with partial load on a regular domestic scale is reliable and can be used in the postoperative care of orthopaedic surgeries of the lower limbs.

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