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TITLE

Radial Shock Wave Therapy: effect on pain and motor performance in a Paralympic athlete. A case report.

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NOTES:

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Declaration of interest:

The authors declare that there is no conflict of interests regarding the publication of this paper.

ABSTRACT

BACKGROUND:

Recent studies demonstrated the usefulness of Radial Shock Waves Therapy (RSWT) in treating hypertonia in patients affected by cerebral palsy (CP), stroke, and dystonia. RSWT have never been used to treat spasticity in disabled athletes.

CASE REPORT:

An athlete affected by tetraparesis due to CP underwent three RSWT sessions in a week. We assessed muscular tone using the Modified Ashworth scale (MAS), pain and fatigue experienced during athletic performance with Visual Analogic Scale (VAS) and Borg scale Category-Ratio anchored at number 10 (Borg CR10). We also performed an electrophysiological study recording the stretch reflex on the quadriceps femori muscle and assessing the soleus H-reflex to calculate post-activation depression (PAD). After 3 RSWT sessions, we found a reduction in all clinical parameters. Although MAS was unchanged, stretch reflex was significantly reduced and PAD increased, suggesting a role in contrasting non-reflex components of hypertonia.

CLINICAL REHABILITATION IMPACT:

The use of RSWT may improve the disabled athletes' performance.

KEYWORDS:

Shockwaves - Cerebral palsy - Pain - Fatigue - Athletes – Muscle spasticity.

TEXT

INTRODUCTION

The Shock Waves Therapy is a physical therapy treatment which has long been used in clinical practice to treat bone and tendon diseases, but recent studies have demonstrated its usefulness in treating hypertonia in patients affected by cerebral palsy (CP), stroke, dystonia and multiple sclerosis [1,2,3].

External Shock Waves Therapy (ESWT) devices use pressure waves which have the point of higher pressure at the center of their focus - within the treated tissue - and they are hence defined as focused shock waves [4]. Conversely, Radial Shock Wave therapy (RSWT) consists in unfocused shock waves which have the point of highest pressure at the tip of the applicator, outside the treated tissue [4].

RSWT has been extensively used in rehabilitative medicine to treat painful musculoskeletal disorders such as medial tibial stress syndrome, lateral epicondylitis and plantar fasciitis. In the Upper Motor Neuron (UMN) syndrome, spasticity may be defined as a form of hypertonia due to a velocity-dependent increase in tonic stretch reflexes resulting from abnormal spinal processing of proprioceptive inputs [5]. Patients with UMN syndrome are also suffering from a non-reflex hypertonia, due to connective tissue changes [6]. Recent works suggest that RSWT can reduce hypertonia in patients with UMN syndrome due to cerebral palsy, stroke and multiple sclerosis [1,2,3]. This clinical improvement has been related to a direct effect of RSWT on muscle fibrosis and other components of non-reflex hypertonia [1].

A paralympic swimmer outpatient was brought to our attention because of increased stiffness and pain during athletic performance. RSWT have never been used to treat spasticity in disabled athletes. Since RSWT is a safe treatment which has no side effects on strength [2,3] and is not considered doping by the International Paralympic Committee (IPC) statement [7], we decided to treat the athlete with this physical therapy.

The first aim of our study was to assess the clinical effect of RSWT on pain, fatigue and hypertonia during athletic performance. The second aim was to investigate whether the treatment affects spinal excitability and therefore support the effect on reflex or non-reflex components of hypertonia. The study was approved by the local Ethics Committee.

CASE REPORT

A nineteen years old paralympic swimming athlete affected by tetraparesis due to cerebral palsy (CP), was visited in our center since he complained worsening hypertonia and rapid onset of fatigue and pain during sports performances. The subject presents quadriplegia with higher spasticity in the lower limbs; he can walk unaided for very shorts distances, but with altered gait pattern. In childhood he underwent surgery to lengthen the Achilles tendon, the hamstring, adductor and rectus femori bilaterally. He competes in races of 100 and 400 meters front crawl.

Spastic hypertonia has been quantified with the Modified Ashworth scale (MAS), strength with the Medical Research Council scale (MRC), pain and fatigue experienced during athletic performance with respectively Visual Analogic Scale (VAS) and Borg scale Category-Ratio anchored at number 10 (Borg CR10).

Moreover, we performed an electrophysiological study recording the stretch reflex on the quadriceps femori muscle and stimulating the posterior tibial nerve to assess the M-wave and H-reflex peak-to-peak amplitudes and a soleus H–M recruitment curve. To assess stretch reflex, whose increased excitability is a primary effector of spasticity and rigidity [8], the subject was tested in supine position. The EMG was recorded through bipolar surface pre-amplified electrodes (TSD150B; Biopac Systems Inc, USA) positioned over the rectus femori muscle, while the knee joint angle was registered with an electronic goniometer. The examiner performed lengthening and shortening of the muscle following a steady pace imposed by a metronome connected to a headset, as previously described [8]. We collected six measures for each of the three tasks done. The EMG recordings were sampled at 2 kHz, filtered (Band Pass 80-300 Hz) and rectified offline (Biopac Systems Inc, USA). We then studied the mean amplitude of the stretch reflex on the quadriceps femori muscle for the dynamic phase of the movement and we normalized the mean with that found in the rest phase of the EMG.

To assess H-M amplitudes, subject was tested while lying in a prone position at complete rest. A surface bipolar electrode placed in the popliteal fossa stimulated the posterior tibial nerve. Rectangular pulses of 1ms duration were administered by means of a constant-current stimulator (model DS7A; Digitimer, UK). EMG was recorded through bipolar surface pre-amplified electrodes (TSD150B; Biopac Systems Inc, USA) positioned over the soleus muscle, 3cm below the insertion of the gastrocnemii. The EMG recordings were sampled at 5 kHz, filtered (80-300 Hz) and then M-wave and H-reflex peak-to-peak amplitudes were evaluated by means of the Acqknowledge software (Biopac Systems Inc, USA).

The soleus H–M recruitment curve was built up using 0.1 Hz stimulation frequency. The electrical stimulation intensities producing H-max (the H-reflex with the maximal amplitude) and M-max (the M-wave elicited by a supra-maximal stimulus) was defined and the H-max/M-max ratio was calculated. Stimulus strength was set to produce H-reflexes having amplitude near to H-max/2 using 0.1 Hz frequency. Using this stimulation intensity, 20 H-reflexes were collected at 0.1Hz and then 20 H-reflexes were recorded at 1 Hz frequency to calculate post-activation depression (PAD) [9,10] as the ratio between H-reflex amplitude at 1Hz and H-reflex amplitude at 0.1 Hz: a higher ratio corresponds to a smaller PAD. PAD is a pre-synaptic inhibitory phenomenon regulating stretch reflex excitability and is decreased in spastic subjects [11,12].

The athlete underwent three treatment sessions in a week. We used a RSWT instrument (BTL-6000 SWT Topline Unit, Italy). Each treatment lasted about an hour, administering a total amount of 12000 shots equally distributed on both legs. The frequency used was 4 Hz, with a pressure of 1.5 Bars. The treatment was not painful and the subject did not present side effects.

All assessments were performed 8 times for clinical parameters and 20 times for each electrophysiological evaluation before the first treatment (T0) and after the last treatment (T1).

To quantify pain and fatigue experienced during athletic performance, the subject was asked to express the Borg CR10 and VAS score every 50 meters (two laps in the pool, forward and back) and we collected all values. Total time spent to perform 400 meters front crawl was taken during a race performed the day before and the day after treatment. We also registered the time spent to swim every 50 m. We measured the MAS and MRC in different lower limb muscle groups bilaterally just before and after the race.

The time course of the clinical measures (MAS, VAS, Borg CR10, MRC) are reported at T0 and T1 in Figure 1. Changes in the repeated measures of H-reflex parameters (H-max/M-max ratios and 1Hz/0.1Hz ratios), stretch reflex, total race time and PAD were compared between T0 and T1 using unpaired T-test.

After the 3 RSWT sessions, we found a reduction in VAS scale for pain, in the Borg CR10 scale and a reduction of the swimming time in the 400 meters (9 seconds of reduction between T0 and T1). MRC and MAS remained stable before and after RSWT, consistently with previous findings [13].

Means, standard deviations and statistic significance of electrophysiological parameters are shown in Table I. In the normalized dynamic phase of the stretch reflex we found a reduction at T1 ($p = 0.0005$). PAD increased at T1 (smaller ratio) compared to baseline ($p = 0.02$).

DISCUSSION

The most important finding of our study is the decrease in the VAS and Borg CR10 score obtained after treatment and consequently the reduction of time spent to perform 400 meters front crawl.

As previously demonstrated [2,3], differently from conventional treatment such as botulinum toxin or baclofen, RSWT does not induce strength reduction. Strength is necessary to perform a correct athletic gesture, especially in a sport that contemplates continuous movement against water resistance.

Moreover, in line with studies demonstrating the usefulness of the shock waves, both focused and radial, in patients with spastic hypertonia [2,3], an important and significant pain reduction was observed also in this subject.

Our subject came to our observation because of the increase of pain related to hypertonia during athletic performance, causing rapid fatigue with a reduced quality of athletic performance. Clinically detectable hypertonia is unmodified after treatment, as reflected by MAS score. As reported in the literature [14], a possible explanation for this finding could be related to the insufficient sensitivity of MAS in recording changes in extreme levels of the explored functioning (in segments affected by retractions or fibrosis score is 4, regardless of the effect obtained in the available range of movement). Furthermore, the fact that the stretch reflex is reduced after the treatment, without a consensual reduction in the MAS score, can be explained because the stretch reflex is a very sensitive neurophysiological measure for spasticity and because the muscle tone evaluation depends on the joint range of motion and, in the CP, the persistent hypertonia involves soft tissues and joints modifications with a consequent articular ROM reduction; in particular, this athlete in the childhood underwent tendon elongation surgery in various segments of lower limbs, with soft tissues repercussions.

As reported in the literature [6,15], muscle hypertonia can be divided into two components: hypertonia mediated by the stretch reflex (reflex muscle hypertonia), which corresponds to spasticity, and hypertonia due to muscle contracture, joint retraction, or non-reflex muscle overactivity (intrinsic or non-reflex muscle hypertonia).

Concerning the electrophysiological evaluation, it is not surprising to observe an increase of PAD following treatment, because PAD increases in healthy subjects after exercise and decreases after immobilization as previously reported [16]. An athlete trains for several hours per day, so a PAD value similar to healthy subjects at baseline is easily explained; in T1 this value is even more reduced suggesting that RSWT determined an increased joint mobility.

All the parameters considered so far, can explain the reduction obtained in the Borg CR10 score. Our athlete burdened with less pain and feeling minor stiffness during athletic performance, perceived a lower degree of fatigue. The fatigue score still reached the maximum level, but only at the end of the performance.

Even concerning the total amount of time of the athletic performance, or rather the reduction of time to cover 400 meters front crawl, this result could arise from lower exertion perceived during athletic performance and lower degree of stiffness and pain following treatment.

CONCLUSIONS

In conclusion, the use of the RSWT in patients with UMN syndrome due to cerebral palsy, as previously demonstrated in the literature, may aid in contrasting hypertonia and pain and may be an option to improve the disable athletes' performance.

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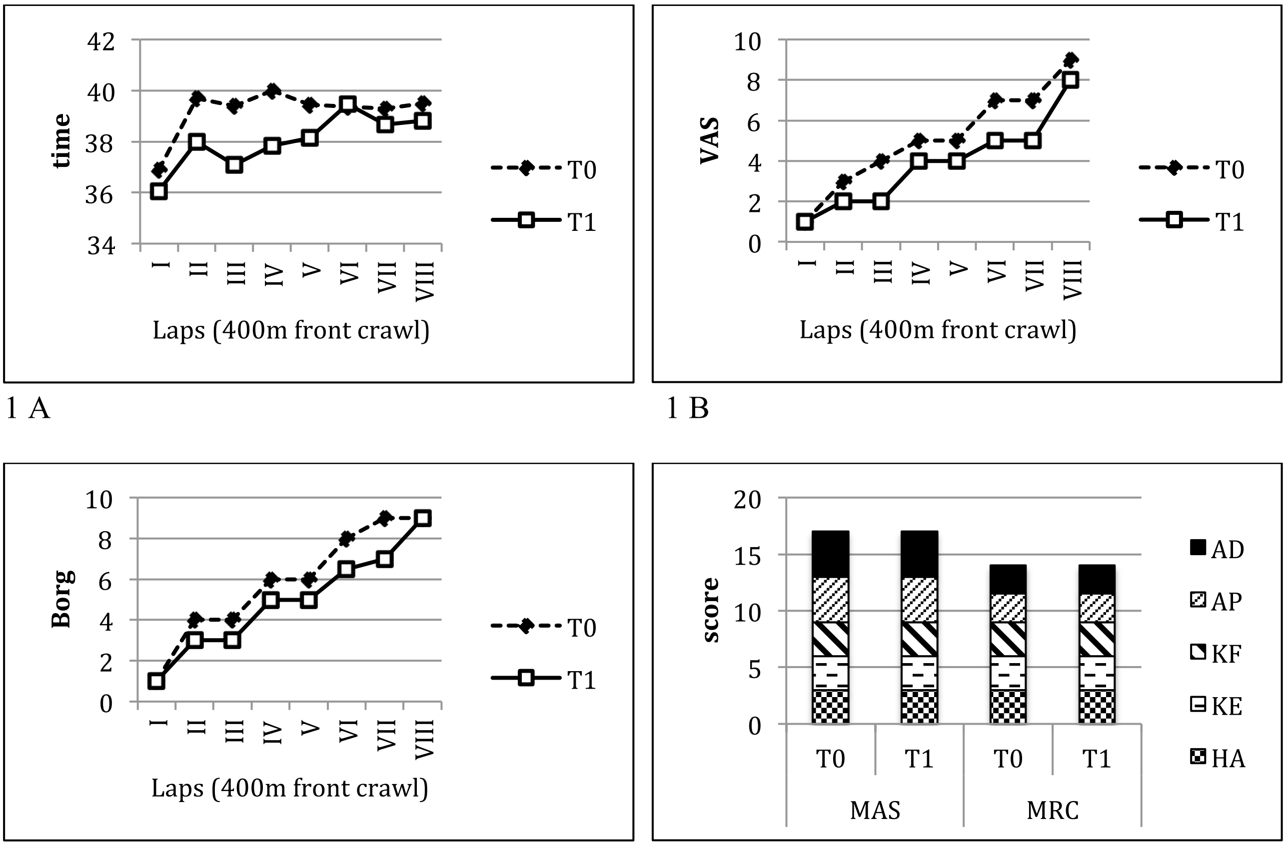
TABLES AND FIGURES

Figure 1: Mean values of clinical parameters: 1 A – Time spent to perform 400 meters front crawl; 1 B – VAS score collected during the athletic performance; 1 C – Borg score collected during the athletic performance; 1 D – MAS and MRC score collected before and after a race.

Table I: Means, standard deviations (SD) and statistic significance of electrophysiological parameters.

Electrophysiological parameters	Stretch reflex (mV) (mean±SD)	PAD
T0	1.32±0.58	0.34
T1	0.75±0.35 (p=0.0005)	0.23 (p=0.02)

Table I. Means, standard deviations (SD) and statistic significance of electrophysiological parameters



1 A

1 B

1 C

1 D

Figure 1: Mean values of clinical parameters. 1 A – Time spent to perform 400 meters front crawl; 1 B – VAS score collected during the athletic performance; 1 C – Borg score collected during the athletic performance; 1 D – MAS and MRC score collected before and after a race.

(AD: ankle dorsiflexors; AP: ankle plantiflexors; KF: knee flexors; KE: knee extensors; HA: hip adductors.)