WEIGHT WALKING IN TOP PERFORMANCE SPORTS - ADDITIONAL TRUNK VS. ANKLE WEIGHTS

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INTRODUCTION

Generation of resistance with moved loads is a well known principle of strength training (VERCHOSHANSKIJ/1971; ZATSIORSKY/1991 and others). The specificity of endurance strength training is the combination of long working periods (or many repetitions) and increased resistance. The structural conformity of training and competition exercise is one essential criterion for the success of strength training. In endurance competitions the rate of movement plays an important role. Especially in spurt situations (and during fatigue) the variability of frequency determined the success. High movement rates requires high energy for the swinging movements and the development of special qualities of muscles. The purpose of the study was to determine the effect of higher shank swinging masses in endurance training on the structure of walking movement (including the working conditions of muscles). For comparison normal walking without additional mass and traditional overload walking with additional trunk mass (waistcoat) was tested.

METHOD

The subject a national top walker performed three tests during one week. Each of the tests included 15 km walking on a treadmill with a velocity of 3 m/s. Such a training intends increasing of the aerobic performance. The test was subdivided into five distances of 3 km with a rest of one minute. This rest was necessary for the analysis of blood lactate concentration. The first test was performed without additional weights, the second with additional trunk weight (4 kg - waistcoat) and the third with additional ankle weights (200 g each). On each distance the myoelectric activities of glutaeus maximus (GM), tensor fasciae latae (TFL), biceps femoris (BF), rectus femoris (RF), vastus latcralis (VAL), tibialis anterior (TA) and gastrocnemius medialis (GAM) muscles were recorded twice (on 500 and 2500 m) (NORAXON, MYO 2000). The beginning and the end as well as the integral of activity of all muscles were obtained from the rectified EMG-signal.
The average oxygen uptake was tested in each case on 2000 m. The angles of hip, knee and ankle were measured with the help of video analyses. These parameters were used for a mathematical-geometrical model of the lower extremities, which calculated the alterations of muscle length (RÜSTENBERG, WITT/1990).

RESULTS

The physiological parameters such as oxygen uptake, lactate concentration and heart rate did not show any difference throughout all tree tests. All parameters are typical for endurance training with low velocity. The basic effect of overload training on the structure of walking can be explained in terms of rising frequencies (Fig.1). The used range of joint angles is highly consistent.

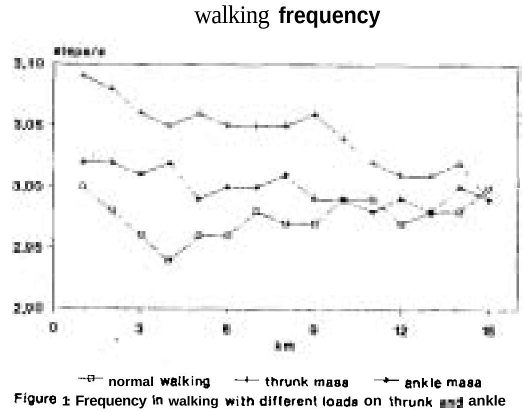

Fig. 1. Frequency in walking with different loads on trunk and ankle mass.

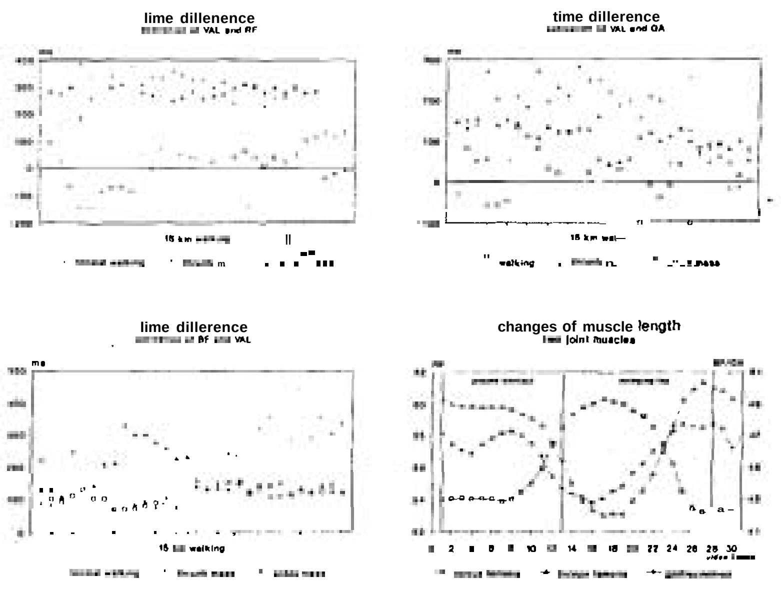

Fig. 2. Changes of temporal activity and length of the tested muscles.

The analysis of electromyograms were carried out under qualitative and quantitative aspects. The integral of activity as a quantitative parameter shows only minor alterations. These changes concern especially all hip muscles (GM, TFL, BF). For these muscles were found an increased activity during fatigue as well as under application of overload. The only dramatic effect of load increasing is the alteration of temporal activity of all tested muscles (Figure 2). The time lapse between activation of VAL and RF muscle increases during overload training, that means the activity of RF muscle has shifted into the swinging phase. The VAL muscle starts its activity in any case simultaneously to the touch down. For the BF vs. VAL activation there are different relationships of the walking distance for additional trunk and ankle weights. In overload training with

waistcoat it is only in the second part of distance (i.e. during fatigue) that BF activation begins earlier. The same effect is found in overload training with packing rings on ankle however, here it occurs only in the first part of the distance. The time lapse between activation of VAL and GA muscle increases only in overload training with waistcoat. This is an undesirable effect because of the lifting of centre of gravity at the end of the ground contact phase. With the help of the determined joint angles the alterations of muscle length during walking were calculated (Figure 2). These alterations in connection with electromyographic activities allow to explain the working conditions of several muscles. Especially the definition of concentric, isometric and eccentric working phases and various possibilities of their combination gives several information e.g. about the utilisation of elastic energy. For the knee extensor and flexor muscles (RF, VAL, BF) large alterations of muscle length were calculated particularly in the phase without ground contact. That means the BF were extremely extended before ground contact while the VAL and RF were shortened. During a long period of ground contact all these muscles are working under isometric conditions. This is due to the straight knee as required by the competition rules.
Contrary to these muscles we find a stretch shortening cycle for the GA muscle during ground contact. The utilisation of elastic energy is dependent on the velocity of stretching and shortening. If the muscle shortening occurs too late or too early elastic energy can not be used (like in early knee flexion). The SOL has good working conditions during ground contact. Especially at the end of ground contact the SOL is not influenced by the knee angle. This is why its contribution to the ankle extension can be considerable.

DISCUSSION

Overload training with waistcoat has a substantial impact on muscle work during the ground contact phase. The TFL muscle was been recruited for stabilisation of the higher trunk mass. The work on, touch down was increased for the hip joint muscles. The extension of activity of GA muscle up to the end of ground contact increases the risk of an undesirable lifting of the centre of gravity. The flight phase may be prolonged when practising without waistcoat. Overload training with packing ring on ankle essentially influences the muscle work during eccentric phases. The advantage of this training form is the reduction of spine load. Furthermore, the desirable effects can be achieved under non-fatiguing conditions. We suggest the combination of both forms for the training process and also with uphill training . The use of packing rings should be stopped at the onset of fatigue. The most beneficial weight of the packing rings may vary from athlete to athlete.

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