Training Methods for Improved Jumping Performance in Taekwon-Do

An Exert from A Human Exercise and Performance Project (Snelling, 1997)

Introduction

Taekwon-Do is world renowned as being the martial art with the most technical, graceful, powerful and aerial kicking (and hand) techniques. It is this last aspect, 'aerial' that is the focus of this thesis. By 'aerial' I am referring to jumping (or flying in correct Taekwon-do terminology). Being able to jump both high and quickly is an important aspect of all 'flying' techniques in Taekwon-do, therefore I have taken an exert from a study I conducted whilst in my final year of a Bachelor of Science (majoring in physiology) at Massey University. This study was a comparison of training methods in their effectiveness to increase the standing jump with and without a counter movement (dipping knees and swinging arms) after a set training program. The research information gathered prior to the study is outlined and referenced throughout this thesis and summarised in a bibliography at the end.

Anatomy and Physiology

Muscles have the ability to induce dynamic activity on the body as compared to other support structures such as bone, ligaments and tendons. Muscles have been studied extensively for years in the areas of science and sport complimenting each other in striving for determining maximum output and endurance of different muscles, and the training modalities to achieve these.

Muscles are made up of two types of fibres, intrafusal and extrafusal fibres. Extrafusal fibres consist of actual muscle cells which are made up of numerous myofibrils (see fig. 1), myofibrils inturn are made up of many ‘bands’ called sarcomeres, they are the basic unit of a muscle. Sarcomeres contain many actin and myosin filaments (actin and myosin are structural proteins) which overlap by cross-bridges. Signals from the nervous system cause a chemical reaction resulting in the collapse of the binding of cross-bridges thus allowing the filaments to slide past each other, either increasing the overlap (requiring energy input) or decreasing the overlap depending on the nervous stimulus (contraction or relaxation of muscle). Muscular contractions can 1 of 3 types: concentric (contraction), eccentric (negative contraction or relaxation), or isometric (continual muscle contraction with no net change in length).

Intrafusal filaments make up muscle spindles (3-10 intrafusal fibres comprise a spindle), muscle spindles are interspersed amongst muscle fibres and lie in parallel to them, they are the main stretch receptors in muscles.

“Either sudden or prolonged stretch on the central areas of the intrafusal muscle fibres stimulates the type Ia and type II dendrites”, Tortora & Grabowski (1996). Information is transmitted by the muscle spindles to the cerebrum about the muscle’s length and rate of contraction, the information allows for conscious perception and coordination of the associated limb.

The ‘stretch reflex’ refers to the rapid contraction of a muscle after it is stretched. In response to a stretch a muscle spindle sends a signal to the spinal cord where it is integrated and sent back to the appropriate muscles (-ve to antagonistic, +ve to effector) resulting in the rapid contraction of the effector muscle. It is the stretch reflex that is the principle behind plyometric training where the acceleration and deceleration of the body weight serve as the training overload.

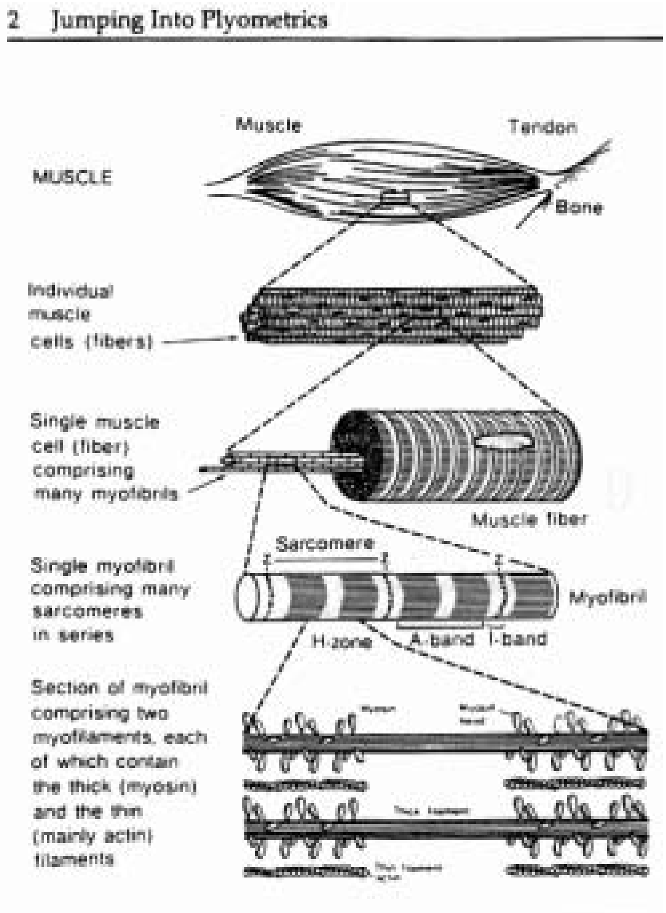

Figure 1.1 The architecture of the muscle. *Note*. From *Lore of Running* (3rd ed.) by T. Noakes, 1991, Champaign, IL: Leisure Press. Reprinted by permission.

Fig 1 from Chu (1992): Jumping into plyometrics

Plyometric Training

In many sports and activities that require an explosive power from particular muscles the "eccentric (lengthening) muscle contractions are rapidly followed by concentric (shortening) contractions", Chu (1992), the pre-load (dip down) forces muscles to stretch (eccentric contraction) which results in a rapid concentric contraction, this occurs with no conscious effort. The eccentric phase stores energy (potential energy) which is released during the concentric phase, however the concentric phase has to follow immediately after otherwise the potential energy stored is lost as heat. The muscle ability to store energy while rapidly stretched is analogous to that of a rubber band where there is potential energy to restore the rubber band/muscle back to it's original length, thus creating a more forceful concentric contraction. The purpose of plyometric training is to reduce the delay in the stretch reflex so that the muscle undergoes a contraction faster during a stretch shortening cycle. Power = force / time taken, through plyometrics force generated is increased and time for contraction is decreased, thus more power is produced. Plyometrics comes under the heading of 'Power training methods', along with standard strength training, and maximal power training. Maximal Power Training

"Maximal explosive power training involves the performance of dynamic weight training at the load which maximises mechanical power output", Bloomfield *et al* (1994), this training usually incorporates lifting a weight of 30% of maximum rapidly (see fig. 2). Experiments conducted by Berger (1963), Kaneko *et al* (1983), and later followed up by Moritani *et al* (1987) showed that this training results in the production of the highest mechanical power output of the associated muscles, and is reported to result in the greatest improvements in power. Training was tested using 0, 30, 60, and 100% of maximum, the experiment showed that 30% of maximum weight lifted resulted in the largest increase in maximal mechanical power output. The conclusion of any training for the increase of power should be done using weight at 30% of maximum by Moritani *et al* (1987), was supported by the research of Berger (1963), where it was stated that "the performance of squat jumps at a load of approximately 30% of maximum resulted in greater increases in vertical jump height than those achieved in traditional weight training, isometric training, or unweighted vertical jumps".

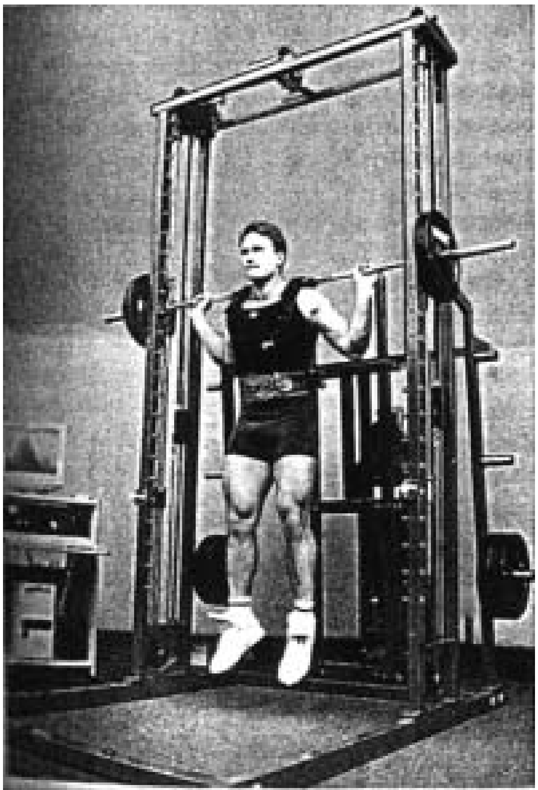

Fig. 8.29 Maximal power exercise: plyometric squats performed at the load which maximizes power output.

Figure 2 from Bloomfield *et al* (1994) in: Applied anatomy and biomechanics in sport

The effect of maximal power training is due to the fact that they are carried out so that the load (weight) is not at zero velocity at the end of the dynamic movement range (end of concentric contraction) as with normal weight/strength training, it is at zero while the subject in the air at zero velocity (as depicted in fig. 2), after concentric contraction. During normal weight training the high forces achieved are only through a small range-of-movement (see fig. 3), as compared to the full range of movement (see fig. 4). The squat jump eliminates the deceleration phase by, as stated by Bloomfield *et al* (1994) , allowing the subject to leave the ground with the load at the completion of the lift.

In essence maximal power training is a form of plyometric training that is performed at a specific load that maximises the power output of the exercise.

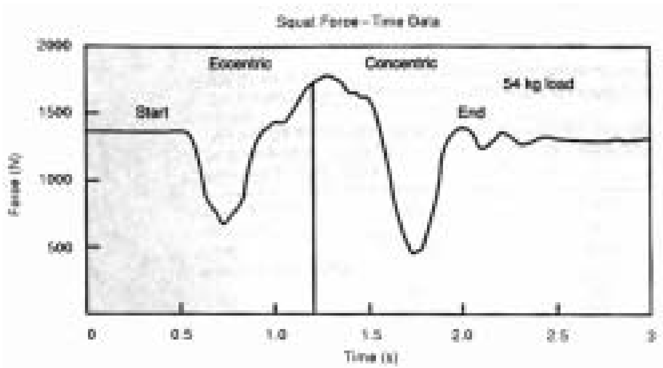

Fig 3 Force-time profile for a traditional squat exercise performed at 30% of maximum (courtesy of Wilson *et al*. 1983).

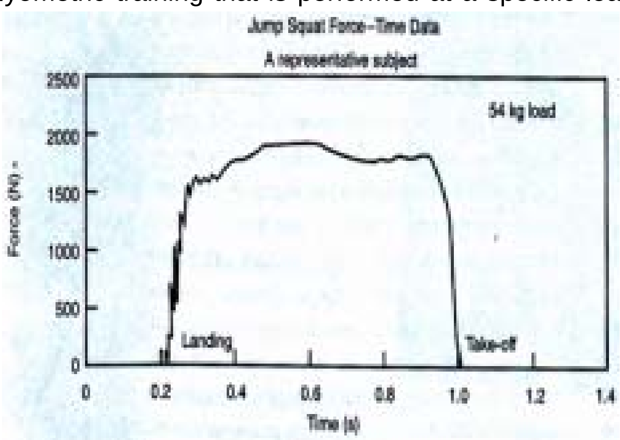

Fig 4 Force-time profile for a squat jump exercise performed at 30% of maximum (courtesy of Wilson *et al,* 1983).

Traditional plyometrics vs maximal power training

There was no direct scientific comparison between traditional plyometric training and maximal power training until a study was conducted by Wilson *et al* in 1993. In the study sixty four subjects of relatively equal strength ability were allocated randomly into one of four training regime groups: 1) Traditional weight training; 2) Plyometrics training; 3) Maximal mechanical power output training (at 30% of maximum, as outlined by previous research); and 4) Control group. The subjects were trained over a ten week period and tested prior to, after, and in the middle of training. The testing consisted of 5 different individual tests: 1) a timed 30m sprint; 2) a maximum vertical jump test with or without a counter-movement; 3) peak power output on a 6 s cycle test; 4) peak torque on an isokinetic leg extension set at 5.2 rads/s; and finally 5) a maximum isometric squat performed at a knee angle of 2.36 rads. It was found that the explosive weight training resulted in the best overall results in enhancing dynamic athletic performance, especially in the areas of jumping and isokinetic tests.

Conclusion

After conducting my study into this comparison of training methods I found to that maximal mechanical power output training to give much better results in the standing jump test than just standard plyometric jump training. However due to the short training time and small number of testing subjects the results were not 'statistically' significant. This does raise exciting applications with regards to training of Taekwon do students in jumping for black belt gradings, and especially the National team competing in the World Champs in the destruction's division. With maximum mechanical power output training to enhance out students jumping legs we could all be really 'flying'. Taekwon.

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