

# PLYOMETRIC TRAINING COMBINED WITH SPECIFIC TECHNICAL HANDBALL EXERCISES



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## INTRODUCTION

Plyometric training is a method designed to improve the functioning of foot muscle-tendon complexes during eccentric-concentric contractions. It is primarily used by athletes to improve the functioning of the ankle (a joint under excessive load particularly when there is a small movement amplitude of the centre of body gravity during foot contact), as well as other joints participating in landing and immediate take-off (eccentric-concentric muscle exertion).

Eccentric-concentric contraction is a method of muscular activity in which an eccentric contraction is immediately followed by a concentric contraction. This form of muscular activity is present in almost all natural forms of movement (runs, jumps, shots, ...). The results of studies have shown that a certain amount of elastic energy is stored in the muscle-tendon apparatus during eccentric contraction, and may be beneficially used during concentric contraction. In the ideal case, the entire work performed during stretching of the muscle-tendon apparatus would be returned during its contraction. In practice this is, of course, not possible. With adequate training, however, it is possible to increase the efficiency of this quality. The efficiency of an eccentric-concentric muscle contraction is influenced by the size and speed of the change in the length of the muscle and the time required to switch from an eccentric to a concentric contraction. Of considerable significance for eccentric-concentric muscle contraction is, in addition to these factors, the activation of the muscle, which from the aspect of the EMG signal is divided into the following phases: preactivation, reflex-controlled activation, and consciously controlled activation (Gollhofer et al, 1992). The preactivation phase includes the activity prior to foot contact, the reflex-controlled activation phase comprises the activity during the functioning of the reflexes, and the consciously controlled activation phase encompasses the activity in the period when the reflexes cease to

function, and movement is controlled by the central nervous system.

Since the preactivation phase and the reflex-controlled activation phase cannot be consciously influenced after the beginning of movement, these must be determined beforehand by means of a motor programme (open loop control) (van Soest and van Ingen Schenau, 1998). Because it is previously possible only to foresee how the movement will actually progress, previous experience is of utmost importance in the preparation of a motor programme. Previous experience can be shaped with training, which is why it is essential that the movements used in training sessions closely resemble those used under competitive performance conditions (Dolenec, 1998).

The elastic energy produced in the muscle-tendon complex during eccentric contraction is not only stored in the muscle (cross-bridges), but also in other serial elastic elements. The most important among these are the tendons. The tendons preserve elastic energy better than the muscles. The energy or work performed by the tendons depends on the force acting on them. Tendons will do more work if a greater force causes greater stretching of the tendons. The quantity of elastic energy in the muscle-tendon complex depends on the force causing the stretching, and on the extent of stretching of the muscle-tendon complex. The latter depends mostly on the rigidity of the muscle and tendon. A well-trained muscle may develop greater rigidity than the tendon. The result is that most of the stretching of the muscle-tendon complex encompasses the tendons, while the stretching of the muscle itself is minimal (Dolenec, 1998). Such functioning of the muscle-tendon complex is favourable from the aspect of speed, chemical energy consumption and created force.

As already mentioned above, in-depth jumps may help to improve the functioning of feet muscles (particularly the ankle) in eccentric-concentric conditions. However, improvements can only be achieved with proper loads on the foot muscle-tendon complex. In the case of in-depth jumps, load is determined by the height from which in-depth jumps are performed, the athlete's weight, the contact time, and the height of a jump. From the aspect of technique, the performance of in-depth jumps may be divided into two groups (Bobbert et al, 1987). The first includes in-depth jumps in which there are small amplitudes of decrease of the centre of body gravity during foot contact (HOP type), and the second includes in-depth jumps characterised by large amplitudes of decrease of the centre of body gravity during foot contact (CMJ type). For greater ankle and knee strength, HOP-type in-depth jumps are recommended for the long-term development of the abducent muscles of the knees and the plantar flexors. Based on ankle functioning, in-depth jumps may be performed, in the same way as vertical hops, in the plantar or dorsal techniques (Dolenec and Strojnik, 1998). The plantar technique is recommended (Dolenec, 1998) because, during the flight phase, the jumper's foot is in plantar position, and the triceps surae muscle performs isometric contraction.

In-depth jumps may be divided into the following phases: departure from the bench, flight, preparation for landing, braking, acceleration, flight, preparation for new jump and landing. Bobbert et al (1987b) found that the load exerted on the joints using the same in-depth jump technique from heights of 20 to 60 cm does not depend on the height from which the jumps are performed. The load is influenced to a much greater extent by the technique used to perform in-depth jumps (Bobbert et al, 1987a). This means that it is particularly significant for ankle muscle strength training that jumps are performed with the smallest possible contact time and the smallest possible amplitude of knee and hip movement. The optimal performance and linkage of all phases of an in-depth jump would result in the best in-depth jump that an individual could possibly perform. Despite extensive research in this area, there are no conclusive findings as to the optimal performance of an in-depth jump. When determining the optimal performance of an in-depth jump, the first problem arises in setting the criteria for the evaluation of optimal performance. The most frequently used criterion for evaluating the optimal performance of an in-depth jump is the height of a jump. The criterion for the optimal performance of an in-depth jump may be

based on the movement requirements of the sport in which an athlete is engaged. In sprint, an athlete has limited time for foot contact. For this reason it is extremely important that sprinters develop the greatest possible force in the smallest possible time, which means that, in their case, the criterion for an optimal jump is linked to foot contact time.

On the basis of the above-mentioned theoretical bases, two significant facts may be established (in connection with the issue discussed):

- In-depth jumps are an appropriate method for improving the functioning of the muscle-tendon complex of the feet in sports characterized by rapid, explosive movements - jumps, sprints (when properly performed, ankle strength increases notably). Handball is undoubtedly one of those sports in which such movements are frequent. The successful performance of a handball player therefore depends to a great extent on the level of development of the muscle-tendon complex of the feet in eccentric-concentric conditions.
- The kinematic structure of movement in an eccentric-concentric contraction must be as similar as possible to the specific kinematic structure of movement in a specific branch of sport.

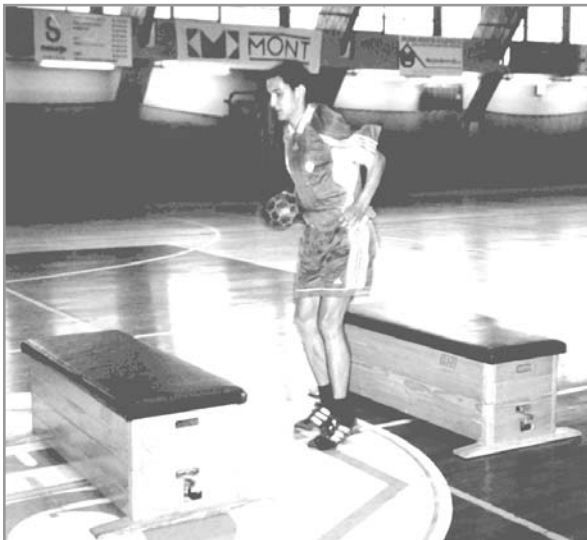
For the above reasons, it would be useful to include in-depth jumps in specific technical handball training. Naturally, this type of exercise is suitable for adult athletes in good physical condition, who have undergone a good deal of exercise including other methods for developing the abilities discussed. Such an approach would upgrade and connect classical training with easy and difficult athletic exercises and classical handball training. In this respect, the following two facts are of considerable importance:

- The motivation of trainees is greater, as the exercise embodies handball movements, which most handball players are much more willing to accept than tedious jumping without technical or even technical-tactical sense;
- In many cases the exercises designed to develop and preserve the above-mentioned abilities in handball are performed only during preparatory periods in the winter or summer cycle. The presented and other similar exercises may be performed in all periods - in accordance with the general sport training doctrine on the adequacy

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of specific types of exercises in a weekly microcycle (adequate time distance from competitions).

**Figure 1. The eccentric-concentric method of developing muscle strength is of great significance in handball**



Before presenting specific exercises, I would like to add some relevant instructions linked to in-depth jump training (adapted acc. to: William B. Allerheiligen: Speed Development and Plyometric Training. Essentials of Strength Training and Conditioning. Editor: Thomas R. Baechle. Human Kinetics, USA, 1994).

- When performing in-depth jumps, footwear with good ankle and arch support, good lateral stability, and a wide, nonslip sole are required. To prevent injuries, the landing surface must possess good shock-absorbing properties. Boxes used for jumps must be sturdy and should have a nonslip top.
- As in every training programme, begin an exercise session containing in-depth jumps with a warm-up period comprised of a general warm-up, stretching, and a specific warm-up.
- The three basic features determining the overall overload of a training programme are frequency, volume and intensity.
  - **Frequency** is simply the number of training sessions with in-depth jumps per certain period (usually per week). One to three sessions per week are recommended in the preparatory period, and one session per week during the season is appropriate for

handball players. It is not recommended to perform drills for the same body area two days in succession.

- **Volume** is normally expressed as the number of foot contacts (each time a foot, or feet together, contact the surface) per training session. The volume should be 80 to 100 foot contacts per session for beginners, 100 to 120 contacts per session for intermediate-level athletes, and 120 to 140 contacts per session for advanced athletes. These figures apply for all plyometric exercises performed during a training session. If the intensity is high, the volume should be low or medium.
- **Intensity** refers to the amount of stress placed upon the muscles, connective tissue and joints. In-depth jumps place high stress on the muscles and joints, which should be considered when volume and frequency are being determined.
- Recovery for in-depth jumps may consist of 5 to 10 seconds of rest between repetitions and 2 to 3 minutes between sets.
- Playing handball requires speed and power not only in the vertical plane, but also in the horizontal (straight ahead), lateral, and diagonal directions as well. Handball players use lateral movements or changes of direction, and include various degrees of horizontal and vertical components. Based on this fact, the exercises have been created to ensure the improved functioning of the muscle-tendon complexes of the feet in eccentric-concentric contractions in all the previously mentioned directions.

## EXERCISES

### **Exercise 1:**

The player stands in front of the wall bars (Swedish ladder) and holds onto the bars above his head. From this position he takes off with both feet and makes a two-foot jump onto the bar which he is still able to reach with outstretched knees. The same exercise can be performed with a single-foot take off and a single-foot jump.

### **Exercise 2:**

A bench is placed in front of the wall bars. The player stands with his feet apart in front of the bars in the

same manner as in the previous exercise. The bench is between his feet. From this position he jumps sideways onto the bench with one foot, holding onto the bars with his hands above his head.

### Exercise 3:

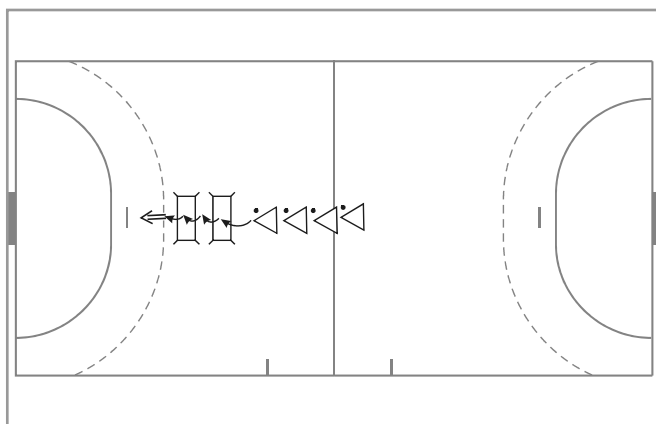
The box is placed at a small distance in front of the basketball board. The player jumps with both feet onto the box, jumps down and immediately takes off, attempting to touch the basketball board or even the ring.

The above exercises are primarily designed as a preparation for further loads.

### Exercise 4:

Two boxes or benches (height approx. 40 cm) are placed in the centre of the court at an appropriate distance from the goal. With ball in hand, the players jump with both feet onto the box, jump down and then jump onto the next box. After the second jump down, they take-off and make a jump shot. They may also shoot after various feints (they jump down with both feet into attack position, then immediately take-off and make feints or pass the players - e.g. with steps: left-right-left foot and a jump shot).

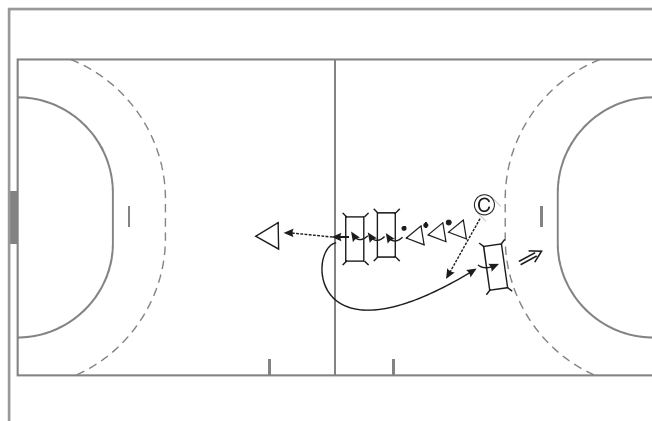
Illustration 1: Execution of exercise no. 4.



### Exercise 5:

The players make two jumps onto and off the box with a heavy ball in their hands (800 g). After making the second jump down and taking-off, they pass the ball in flight with both hands to another player, turn around and run back. They receive a ball from the coach, jump onto the bench and, as in the previous exercise, shoot at the goal.

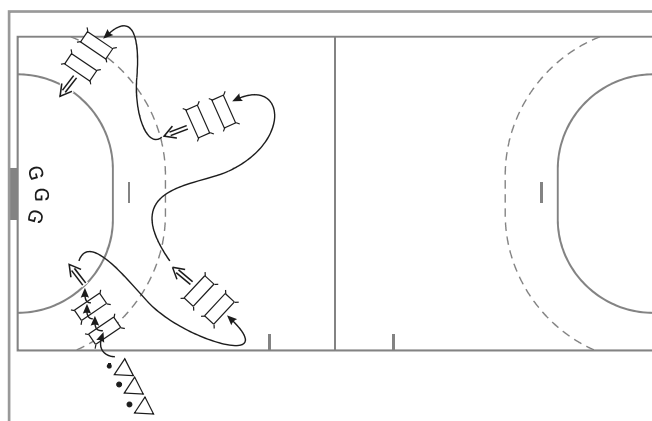
Illustration 2: Execution of exercise no. 5.



### Exercise 6:

The players make two jumps up and down on each marked spot and shoot at the goal. The shots may be made after various feints. There are two or three goalkeepers in each goal, and additional balls at each stop.

Illustration 3: Execution of exercise no. 6.



### Exercise 7:

The exercise is performed by players in LB position (also RB). With ball in hand, they first make a run towards the goal and centre and pass the ball to CB. Then they spread out, receive the ball and pass it to LW and immediately continue moving towards the center. They repeatedly catch the ball, take-off with one foot, make a two-foot jump onto the box with both feet, jump off, and make a jump shot after a two-foot take-off. They then sprint into a counter-attack, receive the ball from the other goalkeeper, pass it to the coach, who returns it to them. They jump onto and off the box, take-off and they shoot at the goal. Different take-off techniques may be used.

Illustration 4: Execution of exercise no. 7.

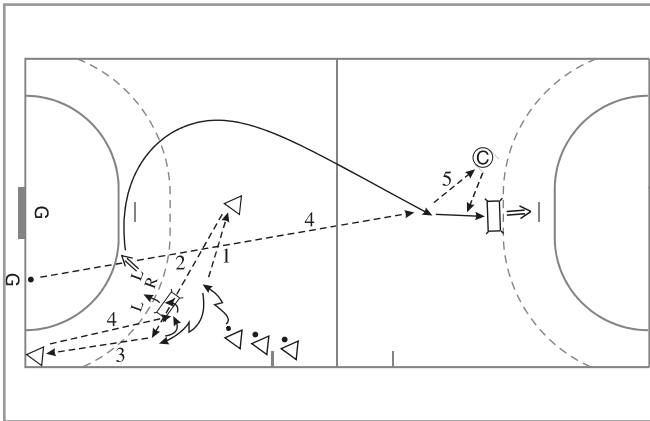
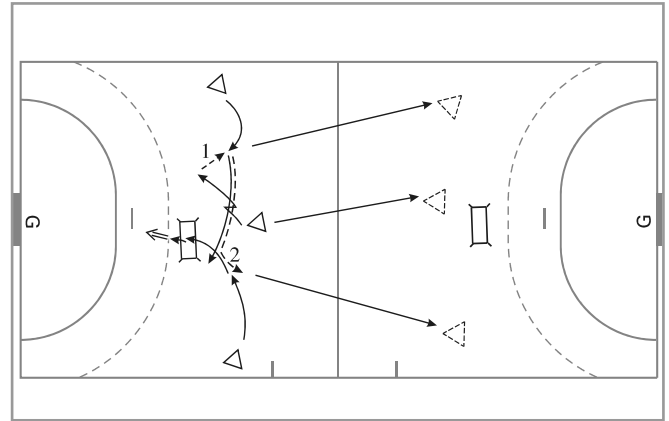


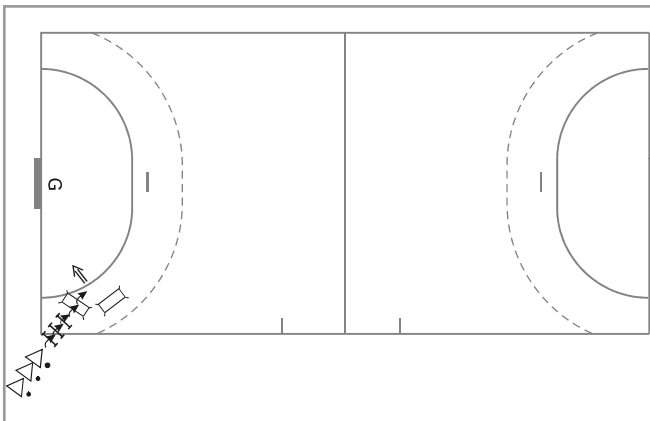
Illustration 6: Execution of exercise no. 9.



## Exercise 8:

Three obstacles are placed in the wing positions, and a box stands at the end. The players jump the obstacles, jump onto and off the box, immediately take-off and make a jump shot with inclination. They may use different shooting techniques after making various feints using various approach directions.

Illustration 5: Execution of exercise no. 8.



## Exercise 9:

Three players are assigned to the positions of three attackers. They perform a double crossing CB + RB + LB, who jumps onto the box, jumps off and shoots after a two-foot take-off. The players then rush into a counter-attack and perform the same exercise on the other side of the court.

## Exercise 10:

Three players are in defence position as 1st, 2nd and 3rd defenders. P is between defenders 2 and 3. Also participating in the attack are LW, CB and LB, who plays the leading role. With ball in hand, LB jumps three obstacles, jumps onto the box, jumps off with both feet into attack position, and makes some feints, e.g. L - R - L. He may make a jump shot, or continue with another tactic, depending on the reactions of the defenders.

Illustration 7: Execution of exercise no. 10.

