Torque alteration after a training protocol of maximal-short duration contractions in handball athletes with goalie’s elbow syndrome

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ABSTRACT

Objectives. Handball goalie’s elbow is a specific elbow injury in handball goalkeepers. Although it seems that muscular strengthening programs are more effective from other therapeutic methods, there is little knowledge for the rehabilitation of the syndrome using this type of method. The aim of the study is: a) to present a strengthening training program with the method of maximal contraction of short duration and b) to record the subjective evaluation of the specific program from these athletes.

Materials and Methods. The sample consisted of sixteen (16) top level Greek male goalkeepers (8 experimental / 8 control) who had suffered from goalie’s elbow injury. The experimental group (n=8) underwent a strengthening protocol with constant resistance for three months. The intervention program was isotonic with resistance training utilizing free-weights and specifically 3 bouts of 3-4 repetitions of 85-90% intensity.

Results. 1 RM (repetition max) of strength at flexion and extension of elbow joint, at pronation and supination of forearm and at flexion and extension of the wrist has significant statistical differences between initial and final measurement in all movements of experimental group. The increase of 1 RM was 22.7% at extension of right wrist up to 45.5% at flexion of right elbow. In contrast to the control group, there was not any significant statistical difference.

Conclusions. The application of the muscle strengthening training program with this kind of method is recommended to handball goalkeepers suffering from handball goalie’s elbow injury.

Keywords: Strength protocol, handball, goalkeepers, elbow injury

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INTRODUCTION

The term handball goalie’s elbow is reported as a syndrome which goalkeepers present in team handball, and refers to the problems that these athletes have at and around the elbow area.\(^1\) The mechanism of this specific syndrome is due to forcible repetitive hyperextensions of the forearm caused by the intensive impact of the ball, which has considerable mass and speed.\(^1\)--\(^3\) This is the main cause for aggravation and relapse of the injury.\(^1\)--\(^4\) In a relevant study, it was reported that the particular mechanism that causes the syndrome differentiates it from the other handball players’ injuries in the elbow, which are caused from throwing the ball.\(^2\) Similarly, other researchers supported that a combination of forced hyperextension of the elbow and supination of the forearm is possible to lead to the appearance of the syndrome.\(^5\) The above study concluded this after a laboratory study on cadaveric elbows in which, with the assistance of a mechanism on stress to the elbow, researchers, applied various loads.

Although researchers in their study did not mention some lesions of ulnar nerve that were found from clinic and laboratory research, others reported that the syndrome causes nerve lesions and includes the specific syndrome in a table with other injuries that cause nerve lesions from other sports.\(^6\),\(^7\) Furthermore handball goalkeepers have a high incidence of synovitis and bursitis of the elbow with an incidence rate of as much as 66%.\(^8\) The most frequent mechanism that handball goalkeepers experience during ball blockade on their elbow is a combination of valgus and hyperextension loads. Valgus-extension overload syndrome forms the basic pathophysiologic model behind the most common elbow injuries in the overhead athlete. The combination of large valgus loads and elbow extension produce tensile stress along the medial compartment restraints (ulnar collateral ligament, flexor-pronator mass, medial epicondyleapophysis, and ulnar nerve) and shear stress in the posterior compartment (posteromedial tip of the olecranon and trochlea/olecranon fossa), and compression stress is produced laterally (radial head and capitellum).\(^9\)

As concerns the management of the syndrome, it seems that muscular strengthening exercises in male participants are more effective than other therapeutic methods like taping, use of special splint, bracing and physiotherapy.\(^1\) The above conclusion seems to be supported by the fact that healthy goalkeepers used special and specific strength training for the elbow more often than others who had this syndrome’s symptoms.\(^1\) Furthermore exercise can enhance muscle function and therefore joint stability. The activation and the strengthening of the muscles which are adjacent and cooperate with the medial collateral ligament of the elbow joint, may possibly enhance the elbow stability. This contributes to the prevention or healing, after an injury of the medial collateral ligament in athletes participating in throwing events.\(^10\)

For the above reasons, strength exercise drills were proposed as an extra preventive step for this specific syndrome.\(^11\) There is only one study regarding a rehabilitation program of the syndrome and their results showed that the specific strength training program can be effective for the rehabilitation of handball goalie’s elbow. There are no studies about treatment and prevention of elbow injuries in goalkeepers. That makes it important to implement randomized clinical trials to evaluate interventions for treating and preventing the syndrome handball goalie’s elbow.

The aim of the study was twofold: a) to present a strengthening training program with the method of maximal contraction of short duration and b) to record the subjective evaluation of the specific program from these athletes.

MATERIALS AND METHODS

Participants

Participants of the current study were 16 male handball goalkeepers. They were players of senior
categories (A1, A2 leagues) of the Greek National Championship. Individuals were selected by random sampling. In the last two years, the players had constantly and actively participated in their teams and taken part in championship matches as well. All 16 individuals had experienced, in the past, problems at/in the elbow joint but in the meanwhile had not undergone any previous surgery. Problems at/in the elbow area were defined by a feeling of pain at the joint during training and official matches.

**Equipment description.** During this study the instruments used were the following: Dumbbells. Dumbbells were used for the calculation of strength (1 RM) for elbow flexion and extension, wrist flexion and extension, and forearm pronation and supination. Moreover dumbbells were also used during the intervention program which was performed by the handball players. The weight of the dumbbells ranged from 0.5 to 10 kilograms by changing the knuck-heads.

**Subjective evaluation of the program.** The subjective evaluation of the program was recorded after an interview of each of the players according the fifth scale: a) “bad program”, b) “poor program” (without improvement or little improvement), c) “moderate” (clear improvement with less symptoms and/or less duration of symptoms), d) “good” (minimum symptoms) e) “excellent-perfect” (without symptoms).

**Description of trials**

The calculation of the intensity of the maximum effort of each athlete was executed with the strength test of 1 RM. Each athlete started with sub maximum efforts until he could achieve one maximum (100%) repetition (1 RM). In this way there was the calculation of 90% of maximum performance which was done according to the next half kilo which was added to or subtracted from the dumb bell. The subjective evaluation of the program was recorded after an interview. Each player who had participated in the program then evaluated the program.

**Measurement process**

Before the beginning of the game season, measurements of each goalkeeper were recorded regarding the calculation on strength (1 RM) for elbow flexion and extension, wrist flexion and extension and forearm pronation and supination of both arms. The experimental group followed the intervention protocol of maximal strength development through the method of maximal contraction of short duration. The muscular strengthening program lasted three months. The program started in the beginning of the sport season and included strength exercises for elbow and wrist in flexion and extension, and forearm in supination and pronation. The exercises were performed 3 times a week, in 3 bouts of 3-4 repeats each. The intensity was 90% of maximum repeat and every month the maximum effort of each athlete was determined so as to readjust the weight of each muscular group that participated in the program. The initial measurement was repeated after 3 months in the middle of the game season. Furthermore, all the athletes of the experimental group underwent the process of subjective evaluation of the program after an interview.

**Training intervention**

Before and after every training session there was a warm up using mostly upper limb exercises and muscle stretching. The exercises were divided into six parts. The first part included elbow extension of the right limb. Subjects used the top of an inclined board to perform standing preacher curls supporting right upper arm on the board. After, they gripped a dumb-bell with their palm facing upwards bending the elbow rapidly, drawing the dumb-bell to the shoulder. Then, the second repetition was performed. After four repetitions, elbow extension of the left
limb followed. The second part involved forearm pronation of the right limb. While kneeling over an exercise bench, holding a one-armed dumbbell with the weight at the top of the hand and the palm up and the forearm rotating outwards. The dumbbell was raised as quickly and as high as possible. Returning the dumbbell to the starting position with the help of the other hand the second repetition was attempted. After four repetitions, athletes performed forearm pronation of the left limb. The third part of the exercises was wrist extension of the right limb. Kneeling over an exercise bench holding the dumbbell in their hand with their palm down, subjects were asked to raise the dumbbell as quickly and as high as possible. The dumbbell was then returned to the starting point with the help of the other hand, and a second repetition was attempted. After four repetitions wrist extension of the left limb was performed. The fourth part of the program included elbow flexion exercise of the right limb using the same mode. After four repetitions elbow flexion exercise of the left limb was executed. The fifth part of the program included forearm supination of the right limb with the forearm rotating inwards. After four repetitions the left limb was done in the same mode. Finally in the last stage, there was wrist flexion of the right limb with palm up. After four repetitions the left limb followed the same course.

Study design

The subjects of the sample were randomly assigned into two groups: Group A (N=8, experimental) and group B (N=8, control). After the initial measurement which was before the starting of the game season, group A performed a muscle strengthening program that lasted exactly 3 months. The program aimed to develop the maximum power output through maximum contractions with short duration method. Group A (experimental) performed exclusively the specific program, while group B (control) did not take any part of particular program for strengthening the elbow during this period.

Statistical analysis

The statistical program used for the analysis of the results, was the SPSS 21.0. Descriptive statistics were implemented (mean ± SD). In order to indicate the analysis effect and to present more comprehensible results, the index Eta Squared (E.S.) was used. In cases that the conditions of parametric tests applications were not applicable, non-parametric tests were used. A paired T-test was also applied in order to compare the values between the two groups. The level of significance was set at .05.

RESULTS

The results showed that 1RM (repetition max) of strength at flexion and extension of elbow joint of both arms, at pronation and supination of forearm of both arms and at flexion and extension of the wrist of both arms have significant statistical differences between initial and final measurement in all movements of the experimental group. In contrast to the control group, there was not any significant statistical difference. The training group improved in all the examined values of all the selected parameters. In fact, elbow, forearm and wrist joints, bilateral, and in all examined motions, presented higher values compared to the pre-intervention protocol (p<0.001). The minimum value of this increase was at extension of right wrist while the maximum value was at flexion of right elbow. However, this was not the case for the control group. In fact, in the control group we observed a decrease in their values in almost all examined parameters. In their subjective evaluation of the program, 50% of the players in the experimental group (4 goalkeepers) assessed the program as “good” and after the intervention program presented minimum symptoms.
of the syndrome. The others (4 goalkeepers) reported that the program was “excellent–perfect” and after the intervention program they did not have any symptoms whatsoever.

All the results of descriptive, statistical significance and Eta Squared values are presented in Table 1.

**DISCUSSION**

The results showed in the control group that there was an increase of 1 RM which was 22.7% at extension of right wrist to 45.5% at flexion of right elbow. These findings agree with those of a similar study in which an increase of performance (1 RM) in duration of 12 weeks was reported.12

There were statistical significant differences in all movements of the examination of strength (1 RM) in our tests. This could have been biased by the athletes in the experimental group. As a consequence athletes in the experimental group presented better results. It was reported that when strength training and the strength test were performed with the same equipment, a significant strength improvement was achieved. During dynamic training with external resistance, the strength which is developed and increased in the muscles during execution with these exercises is not steady but varies according to the mechanical advantage of the joint which participates in the exercise and the length of the muscle in different places of movement.12

In our study 50% of the experimental group stated that the program was “good” and after the intervention program they had few symptoms. The other 50% of this group reported that the program was “excellent – perfect” and none of them after the intervention program had any symptoms of the syndrome. Since the symptoms of the syndrome are crucial factors and they are very important, it seems that our intervention program with this kind of method led goalkeepers to eliminate almost the majority of the symptoms of the syndrome. Therefore, in the future it is suggested that goalkeepers should use this kind of method during training, reducing their symptoms, helping in this way their athletic performance and enhancing their effort during training and games.

It seems that goalkeepers regard strength training as the most effective method of treatment in comparison to other methods. This ascertainment contradicts the results of a similar study in which it seems that although goalkeepers consider strength training as effective, they are using other methods like bandaging. In the future, athletes must realize the importance of programs and methods for the prevention and management of the syndrome. For this reason muscular strength programs must be a first priority treatment method, as long as their effectiveness is noticeable between handball players.1

Future studies should be conducted employing larger sample of participants. The research should refer to goalkeepers at a different performance level. Moreover the duration of the specific muscular strength intervention program should be longer. Furthermore it should be a complex of a muscular strength training program with technique exercises during training (for example technique exercises with self-contained dumbbells attached to the hand). Additionally, our specific method could be compared with another (for example our training program with steady external resistance to be compared with isokinetic program). Women participants having similar problems because of the specific syndrome should also be included in the research. To follow all the above suggestions should be the trigger for further research in clarifying methods for prevention and management in the field of handball goalie’s elbow syndrome.

**ACKNOWLEDGMENTS**

The authors would like to thank the study participants for their dedication throughout the course of this study.
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