**Evaluation of a compressed program for shoulder external rotation strength in handball**

**Introduction**

A considerable amount of handball players has shoulder pain while playing handball.1-6 Handball places large demands on the shoulder due to repetitive throwing and tackles. This makes the shoulder region vulnerable for both acute- and overuse injuries.7,8 Recent studies have demonstrated that overuse shoulder problems are dominating,2,9 and is the most common overuse injury in handball.10

Strength deficits; external rotation (ER) weakness and low ratios of ER to IR strength (ER/IR ratio) on the dominant side, have been reported as risk factors for shoulder problems among overhead athletes in general11,12 and in handball players.1,13-16

A recent study found a 28% reduction in the prevalence of shoulder problems after implementing a shoulder injury prevention program in an elite handball population.9 Despite this considerable reduction in shoulder problems, only 24 and 28% of the athletes and coaches respectively would continue using the whole program the subsequent season17. The reason was that the program was "too time consuming".

To be able to reduce the number of exercises and make the program more efficient we need to know the underlying mechanisms of the effect. A recently conducted randomized controlled study found no effect of the OSTRC prevention program for shoulder injuries in handball on the risk factors, dominant shoulder ER strength, ER/IR strength ratio, IR ROM, TROM or GIRD. (Fredriksen et al, unpublished study, writing in progress) A compressed program to address the risk factor ER strength was therefore developed thorough a Delphi consensus study. (Fredriksen et al, unpublished study, writing in progress)

The aim of this study is to examine the effect of the new, compressed shoulder ER strength program in handball.

Methods

A RCT over a 8-week period will be conducted to evaluate the effect of the new, targeted strength program designed to address the risk factor, ER strength for shoulder problems in handball.

Six female and male youth 16-18 handball teams will be invited to participate in this study.

The primary outcome measures are changes in shoulder ER strength, measured isometric with a handheld dynamometer (HHD) after 8 weeks of intervention. Secondary outcome measures are changes in IR ROM.

The isometric strength and ROM measurements will be conducted in accordance with previously described methods. The main investigator, a physiotherapist (PT) with several years of clinical experience, will conduct all the manual muscle strength and ROM testing, assisted by another PT. Good to excellent intrarater reliability has previously been demonstrated in a pilot study by the involved therapists.

Baseline questionnaires

At baseline, demographic data, hand dominance and years as a handball player will be registered. We will also register shoulder problems previous year and whether the players are playing with or without shoulder pain at baseline.

Intervention

The ER strength program will be implemented during regular handball training three times a week for twelve weeks in the intervention group. The program consists of two exercises with variations and progressions, aimed to increase ER strength. One dedicated PT will deliver and supervise the program in the teams once or twice a week. The program will take about ten minutes to complete.

Questionnaires

A questionnaire, including questions about adherence to the intervention, training and match exposure and prevalence of shoulder problems, other injuries and illnesses will be sent electronically to the participants each Sunday before and during the intervention period, thirteen times in total, using online survey software (Briteback AB, Norrköping, Sweden).

Adherence

Every week the players will provide information on how many times they have completed the exercise program the previous week. The total number of times completed will be divided by the number of respondents, to calculate the weekly adherence with the exercise program.

Exposure

Players will report their exposure to handball training and matches, as well as eventual additional shoulder training every week. The total number of minutes completed will be divided by the number of respondents, to calculate the weekly exposure in each group.

Prevalence of shoulder problems

Prevalence of shoulder problems, other injuries and illness will be recorded using the Oslo Sports Trauma Research Center (OSTRC) injury and illness questionnaire

Sample size

The sample size calculation is based on a previous study examining shoulder ER strength effects of a rubber band shoulder training program and values from our reliability testing of ER using a HHD. For a 15% increase in ER strength from baseline to the end of the study, the expected between group difference was set at 0.30N/kg with a SD of 0,34N/kg. With a power of 90%, a significance level (α) of .05, and a drop-out rate of 15% we needed 36 players per group.

Statistics

Analyses will be based on the intention-to-treat principle, where all randomized participants are included in the analyzes.

Repeated measures linear mixed-effect models with random intercept will be used to assess the between-group differences on each outcome variable. Time is defined as a categorical variable with two levels (baseline and post intervention). Group (two levels: intervention and control), time and group\*time interaction are fixed variables. Team and shoulder pain at baseline are defined as covariates.

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