

VJEŽBE ZA JAČANJE I STABILIZACIJU U PREVENCIJI POVREDE RAMENA

STRENGTHENING AND STABILIZATION EXERCISES IN PREVENTION
OF SHOULDER INJURIES

Bernarda Letnar¹

¹Danila Kumar Primary School, Slovenija

**IZLAGANJE SA NAUČNOG SKUPA
STRUČNI RAD**

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Korespondencija: Bernarda Letnar, prof.
Teacher at Danila Kumar Primary School
Email: bernarda.letnar@gmail.com

SAŽETAK

Rameni zglob je najfleksibilniji zglob u ljudskom tijelu koji trpi velika opterećenja tokom određenih sportskih aktivnosti koje uključuju pokrete rukama iznad glave. Izvodeći pokret iznad glave sportisti brzo podižu ramena, vrše odvođenje i vanjsku rotaciju i nakon čega dolazi do brzog usporavanja nakon pokreta, što čini rame osjetljivia na ozljede. Zbog ekstremnih raspona pokreta, sportisti imaju tendenciju da u pokretima iznad glave razvijaju povećanu vanjsku rotaciju, u kombinaciji sa smanjenim obimom unutarnje rotacije, tako da je neophodno provoditi uravnoteženim program njege ramena u trenažnom procesu kako bi se spriječile takve pojave. Cilj istraživačkog rada bio je osmisliti režim treninga za prevenciju povreda i održavanje ramena koji se može uključiti u svakodnevne treninge sportista kako bi se smanjila pojava povreda. Trodijelni program treninga sastavljen je od specifičnih vježbi zagrijavanja, jačanja i stabilizacije te vježbi istezanja. Cilj specifičnog zagrijavanja bio je pripremiti rame za opterećenja u treningu, oponašajući pokrete iznad glave i stimulirajući stabilizaciju u zglobu. Vježbe jačanja i stabilizacije usmjerene su na jačanje vanjskih rotatora u ramenu i poboljšanje stabilizacije ramenog zgloba ciljanjem specifičnih mišića poput serratusa anterior. Fokus vježbi istezanja bio je istezanje mišića s unutarnjom rotacijom, koji doživljavaju velika opterećenja na treningu sportista kada vrše pokrete iznad glave. Učinkovit program treninga koji se može izvoditi s minimalnom opremom i u kratkom vremenskom okviru osmišljen je kako bi omogućio njegovu jednostavnu ugradnju u svakodnevni trening sportista kada vrše pokrete iznad glave.

Ključne riječi: *rame, sportista iznad glave, povrede ramena, prevencija povreda.*

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INTRODUCTION

The shoulder joint is the most flexible joint in the human body which experiences high loads during certain sport activities involving overhead motion. Overhead athletes experience rapid shoulder elevation, abduction and external rotation, making them susceptible to shoulder injuries. Apart from the throwing motion itself, deceleration of the arm segment after the movement significantly contributes to injuries as well. Since overhead athlete requires a delicate balance between shoulder mobility and stability, regular stretching, strengthening and stabilization exercises must be balanced in a year-round training.

Due to special loads on the athlete's shoulder, researchers have observed that anatomical changes of overhead athlete's arm are sometimes inevitable in order to increase the maximum external rotation. Baseball pitchers demonstrated up to 21° more external rotation at 90° abduction than other players on the team (Johnson, 1992). To achieve this extreme external rotations, some range of motion loss in internal rotation is to be expected.

Manske, Wilk, Davies, Ellenbecker and Reinold (2013) defined a loss of up to 18 - 20° of internal rotation with no total range of motion loss, as normal anatomical

changes consistent with repetitive overhead motion.

Therefore, regular assessment of athlete's shoulder and maintenance of the joint's flexibility and strength is required to prevent injuries.

Reinold, Gill, Wilk and Andrews (2010) list six principles of injury prevention and treatment programs: maintaining range of motion, maintaining strength of the glenohumeral and scapulothoracic musculature, emphasizing dynamic stabilization and neuromuscular control, core and lower body training, off-season preparation and in-season maintenance. Development of the injury prevention program followed the before mentioned principles, previous research in the field and personal experiences with effectiveness of exercises as part of the training program.

Specific muscles, known to contribute to shoulder problems were targeted by the training program to minimize the occurrence of injuries. Three part training program was designed consisting of specific warm up, strengthening and stabilization exercises and stretching exercises. The aim of the specific warm up was to prepare the shoulder for the training

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loads, mimicking the overhead movements and stimulating the stabilization in the joint.

The focus of stretching exercises was to stretch internal rotation muscles, which experience high loads in the overhead athlete's training. Effective training program that can be performed with minimal equipment and in a short time frame was designed to enable its simple incorporation into the daily training of overhead athletes. Strengthening and stabilization exercises for overhead athlete have been thoroughly researched by Wilk, Meister and Andrews (2002).

Among various exercises, push up plus in external rotation position has been proved as highly effective shoulder stabilization exercise by Cho et. al. (2014) and Lee, Lee and Park (2013). It has been confirmed to be most effective when performed on the

floor in a standard position by Ludewig, Hoff, Osowski, Meschke and Rundquist (2004).

Our training program included the recommended exercises by these researchers. The importance of the stretching regimen was emphasized in research of Lintner, Mayol, Uzodinma, Jones and Labossiere (2007). Recommended stretching techniques for overhead athletes include sleeper stretch and cross-body stretch (Manske et al., 2013 and Laudner, Sipes and Wilson, 2008). Manske, Meschke, Porter, Smith and Reiman (2010) included posterior joint mobilization techniques with cross-body stretch, which proved even more effective.

The stretching regimen of our tree part program followed the recommended guidelines by previous researchers.

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MATERIALS AND METHODS

Existing research in the field of injury prevention and shoulder care in overhead athletes has been obtained from PubMed Central and Google Scholar. Meta-analysis of the material was performed and shoulder exercises that demonstrated positive correlation with improved shoulder health were used as a building blocks for the training program. Reviewed research papers included male and female

subjects of different quality levels (rating from high-school athletes to professionals). The subjects were young adults, participating in regular sports activity. A preventive training program for overhead athletes was consequently designed based on the findings of the previous researchers and personal experiences with injury prevention exercises for shoulder joint.

RESULTS

Based on the previous research and personal experiences a three phase preventive training program has been designed. It includes specific warm-up for the shoulder, stabilization and strength exercises for antagonists of the athlete's throwing motion and stretching exercises for agonist muscles used in the motion.

An established set of exercises should be used as an addition to daily training plan, requiring minimum equipment and allowing individual intensity adjustment.

The training program is condensed in a short unit that can be performed in 30-40 minutes and is therefore viable as a regular addition to daily routine in the overhead athlete's training.

Repetitive training loads and similar movement lead to constant overloading of the same muscle groups. The proposed set of exercises should therefore be performed regularly in order to ensure preventive function of the exercises and flexibility-strength ratio in the shoulder muscles.

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The complete training program is represented in the Table 1 below:

Table 1. *Training program for shoulder injury prevention in overhead athlete*

WARM UP		
15 min		Full body aerobic activity such as running
2-3 sets	10 repetitions	<ul style="list-style-type: none"> • Forward crawl • Backward crawl • Bunny hops • Shoulder rotations with free weights in sagittal plane (Figure 1) • Shoulder rotations with free weights with both hands circling in the same direction in a sagittal plane
STRENGTH AND STABILIZATION EXERCISES		
3-4 sets	10 repetitions	<ul style="list-style-type: none"> • External rotation (Figure 2), • Standing external rotation with elastic bands (Figure 3), • Throwing motion imitations in reverse (Figure 4), • Push up plus (Figure 5) • Horizontal abduction in prone position (Figure 6).
STRETCHING EXERCISES (performed as a separate unit after a training session)		
1-3 sets	30 seconds (three increases in position every 10 seconds)	<ul style="list-style-type: none"> • Sleeper stretch (Figure 7) • Cross-body stretch (Figure 8)

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Detailed explanation of the training program for shoulder injury prevention in overhead athlete by section:

WARM-UP

The warm up routine consists of dynamic exercises including full range of motion in the shoulder. Thorough general warm-up should be performed before specific shoulder exercises in this program (running, etc.). Exercises include forward crawl, backward crawl, bunny hops and shoulder rotations with free weights in sagittal plane (Figure 1), which can be followed by shoulder rotations with free weights with both hands circling in the same direction in a sagittal plane (advanced athletes). The exercises should be performed in 2-3 sets of 10 repetitions. Forward crawl, backward crawl and bunny hops should be performed on a flat, clean non-slippery surface, while shoulder rotations with free weights require the athlete to stand upright on a flat surface.

Description of the exercises:

Forward crawl: Athlete crawls on all fours in forward direction, keeping contact with the floor with their hands and feet.

Backward crawl: Athlete crawls on all fours with legs in the front, keeping contact with the floor with their hands and feet.

Bunny hops: Athlete performs bunny hops from both legs, switching the floor contact phase from hands to legs and back while moving forward.

Shoulder rotations with free weights in sagittal plane: Athlete stands upright and rotates with a free weight of appropriate weight in sagittal plane. Circling is performed with one hand. Athlete's aim is to perform the rotation in shoulder joint and avoid excessive bending in the elbow joint.

Shoulder rotations with free weights with both hands circling in the same direction in a sagittal plane (advanced athletes): This exercise is an advanced version of previous exercise, aimed at better prepared athletes. Athlete stands upright and rotates with free weights in both hands in a sagittal plane. Both hands simultaneously move forward or backward. Athlete's aim is to perform the rotation in shoulder joint and avoid excessive bending in the elbow joint.

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STRENGTH AND STABILIZATION EXERCISES

Strength and stabilization exercises should be performed during training (ideally as a part of the routine preparation for the training session including overhead motion) or as a separate training session. The preventive training for overhead athletes includes strengthening of the upper back and shoulder muscles to increase scapular stabilization (serratus anterior) and shoulder's external rotator's strength (infraspinatus and teres minor) to contradict the strong internal rotators. The aim of the strengthening exercises is to achieve balance in strength of agonists and antagonists and therefore prevent possible injuries due to muscular imbalance. Stabilization exercises, such as push up plus add important element of proper muscle activation and protection of the joint.

Strength and stabilization exercises in this training program include:

External rotation (Figure 2), standing external rotation with elastic bands (Figure 3), throwing motion imitations in reverse (Figure 4), push up plus (Figure 5), and horizontal abduction in prone position (Figure 6).

The order of the exercises performed can vary and should be done in fluid motion in 3-4 sets of 10 repetitions, with 1 minute rest. Different strength elastic bands or free weights should be used to adapt the training according to the athlete's needs.

Description of the exercises:

External rotation: Athlete stands upright with elbow by his body. The rubber band of appropriate thickness is attached to stable surface parallel to the athlete. The athlete performs external rotation with bent elbow joint while keeping elbow close to his body. A rolled towel can be placed between the athlete's body and his elbow to maintain stable and static position of the elbow during the exercise. The rubber band is then slowly returned to the starting position.

Standing external rotation with elastic bands: Athlete stands upright, holding the ends of a rubber band of appropriate thickness in his hands. His arms are by his body with bent elbows. Athlete slowly proceeds to stretch the rubber band in the opposite directions, performing external rotation with both arms simultaneously. The rubber band is then slowly returned to the starting position.

Throwing motion imitations in reverse: A rubber band of appropriate thickness is

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attached to the stable object in front of the athlete. Athlete holds the rubber band in front of him and by pulling it backwards stimulates the throwing motion in reverse. The rubber band is then slowly returned to the starting position.

Push up plus: Athlete starts in the push up position. He performs the downward movement with his chest while maintaining straight arms, using serratus

anterior muscle to cause an outward rotation of the scapula. Athlete then returns to the starting position.

Horizontal abduction in prone position: While lying on his stomach, the athlete performs horizontal abduction with straight arm. Appropriate heavy weights should be used as a resistance. Athlete returns to the starting position and repeats the motion without touching the floor during the set.

STRETCHING EXERCISES

Research articles in the field of stretching have found acute decreases in strength following stretching and it is therefore recommended that stretching exercises should be performed at the end of a workout or as a separate workout.

Recommended stretching techniques for overhead athletes concentrate on increasing internal rotation of the shoulder and maintaining functional length of the subscapularis.

Stretching exercises included in the training program are sleeper stretch (Figure 7) and cross-body stretch (Figure 8).

Sleeper stretch: Athlete performs the stretch while lying on his hip. Elbow joint should be bent at 90 degrees with the palm

of the hand facing towards the floor and elbow resting on the floor. Slow movement of the palm of the hand towards the floor is stimulated by the free arm. The aim of the exercise is to improve the internal rotation of the shoulder by targeting infraspinatus and the teres minor muscles. The stretch should last 30 seconds with the free arm pushing the wrist and the palm of the hand a bit further towards the floor every 10 seconds.

Cross-body stretch: Cross-body stretch accompanies the sleeper stretch as exercise that improves internal rotation and horizontal adduction's range of motion in the overhead athlete. Cross-body stretch is performed with the athlete lying on the floor with the arm bent at 90 degrees towards the body. Free hand slowly moves

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the arm from one side of the body towards another. The stretching position should be held for 30 seconds, which is considered

an optimal time frame. A static technique with three increases of the position every 10 seconds is recommended.

DISCUSSION AND CONCLUSIONS

Overhead athletes experience rapid shoulder elevation, abduction and external rotation, making them susceptible to shoulder injuries. Muscle balance and appropriate flexibility of the joint is therefore necessary to prevent them. After a thorough review of the available research, a set of preventive exercises has been developed. The training program is designed to maintain the length of internal rotators and strengthen external rotators of the shoulder, preventing possible injuries due to muscular imbalance. The established set of exercises should be used as an addition to daily training, requiring minimum equipment and allowing individual intensity adjustment. It has been concluded that in order to ensure the preventive function of the exercises, the developed set of exercises must be

performed regularly. The proposed exercises can be improved by different variations, specific to the athlete's discipline (javelin throw, baseball, rugby, etc.), further developing the individuality of the proposed program. Better athletes can advance to more dynamic execution of the exercises (throwing balls instead of pulling the elastic band). Researchers have observed two potential possibilities to further expand the research: Viability of the static stretching exercises such as sleeper stretch and cross-body stretch could be further analyzed in comparison to the dynamic alternatives due to dynamic nature of the overhead sports and high training loads. Additionally, various combinations and variations of different exercises could result in different outcomes and could be further analyzed.

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FIGURES AND ILLUSTRATIONS

Figure 1. Shoulder rotations with weights in sagittal plane free



Figure 2. External rotation



Figure 3. Standing external rotation withn elastic bands



Figure 4. Throwing motion imitations in reverse position



Figure 5. Push up plus



Figure 6. Horizontal abduction in prone



Figure 7. Sleeper stretch



Figure 8. Cross-body stretch



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ABSTRACT

The shoulder joint is the most flexible joint in the human body which experiences high loads during certain sport activities involving overhead motion. Overhead athletes experience rapid shoulder elevation, abduction and external rotation during the movement and rapid deceleration after the movement, making them susceptible to shoulder injuries. Due to the extreme ranges of motion, overhead athletes tend to develop increased external rotation, combined with decreased range of internal rotation, emphasizing the need for balanced shoulder care program in the training process to prevent such occurrences. The aim of the research paper was to develop training regimen for injury prevention and shoulder maintenance that can be incorporated in daily training activities of the athletes in order to decrease the occurrence of injuries. Three part training program was designed consisting of specific warm up, strengthening and stabilization exercises and stretching exercises. The aim of the specific warm up was to prepare the shoulder for the training loads, mimicking the overhead movements and stimulating the stabilization in the joint. Strengthening and stabilization exercises aimed to strengthen external rotators in the shoulder and improve the stabilization of the shoulder joint by targeting specific muscles such as serratus anterior. The focus of stretching exercises was to stretch internal rotation muscles, which experience high loads in the overhead athlete's training. An effective training program that can be performed with minimal equipment and in a short time frame was designed to enable its simple incorporation into the daily training of overhead athletes.

Keywords: *shoulder, overhead athlete, shoulder injuries, injury prevention.*

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Korespodencija:

Bernarda Letnar, prof.

Teacher at Danila Kumar Primary School

E-mail: bernarda.letnar@gmail.com