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Wpływ lecznictwa uzdrowiskowego na funkcję ręki u kobiet z reumatoidalnym zapaleniem stawów

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Ocena funkcjonalna kompleksu barkowego u zawodników uprawiających siatkówkę w różnych kategoriach wiekowych

Functional assessment of the shoulder joint in volleyball players from different age groups

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Streszczenie

Cel pracy. Celem pracy była ocena funkcjonalna oraz ocena zakresów ruchu stawów obręczy barkowej w kończynie dominującej i niedominującej u siatkarzy

Materiał i metodyka badań. Materiał badawczy stanowiło 40 zawodników podzielnych na 2 grupy, uprawiających wyczynowo siatkówkę. Ocena zakresu ruchomości stawu ramiennego polegała na czynnym wykonaniu określonych ruchów przez badanych w pozycji leżącej. Narzędziem użytym do tych pomiarów był standardowy goniometr, a ruchy w poszczególnych płaszczyznach były wykonywane w określony i usystematyzowany sposób zgodny z metodą SFTR. Drugi etap badań polegał na wykonaniu 3 zaproponowanych testów funkcjonalnych, pozwalających ocenić złożoną ruchomość obręczy barkowej. Narzędziami wykorzystanymi do oceny wykonywanych testów był standardowy goniometr oraz elastyczna miarka krawiecka.

Wyniki badań. Uzyskane wyniki badań zostały poddane analizie statystycznej za pomocą programu Statistica 10. W obliczeniach przyjęto poziom istotności $p<0,05$. Dodatkowo porównano średnie zakresy ruchu i wyniki w testów funkcjonalnych.

Wnioski

1. Zarówno w grupie młodzików, jak i seniorów wystąpił istotny spadek zakresu rotacji wewnętrznej kończyny dominującej w porównaniu do niedominującej. Dodatkowo w grupie młodzików wykazano deficyt zgięcia horyzontalnego kończyny dominującej
2. Wyniki testów funkcjonalnych wykazują gorsze rezultaty testu agrafki dla kończyny dominującej w obu grupach. U młodzików różnica wyniosła 7,4cm, a u seniorów 10,1cm w porównaniu do kończyny niedominującej
3. Seniorzy osiągali większe zakresy zgięcia w płaszczyźnie strzałkowej, a młodzicy w wyproście i wyproście horyzontalnym
4. Zawodnicy cechujący się większym zakresem rotacji wewnętrznej stawu ramiennego w kończynie dominującej osiągali większe wartości w teście „agrafki".

Słowa kluczowe:
Siatkarze, staw barkowy, ocena funkcjonalna

Abstract

Objective. The aim of the paper was to perform functional analysis and assessment of the range of movement of the joints of the pectoral girdle in the dominant and non-dominant limb in volleyball players.

Materials and methods. The study involved 40 competitive volleyball players divided into 2 groups. The shoulder joint movement range assessment involved active performance of specific movements by the participants while lying down. The tool used to take the measurements was a standard goniometer, while the movements were performed in different planes in a specified and systematic way in accordance with the SFTR method. The second stage involved the performance of 3 proposed functional tests to assess the complex range of movements of the shoulder girdle. The tools used to assess the tests performed were a standard goniometer and a flexible tape measure.

Results. The results of the tests were subjected to statistical analysis with the use of the Statistica 10 software. Statistical significance was set at $p < 0.05$. In addition, the average motion ranges and functional test results were compared.

Conclusions

1. Both the Youth group and the Senior group showed a significant decrease in the range of internal rotation of the dominant limb as compared to the non-dominant limb. In addition, a deficit was found in the Youth group in horizontal flexion of the dominant limb.
2. The results of the functional tests show worse results of the "safety pin" test for the dominant limb in both groups. In the Youth group, the difference amounted to 7.4 cm and in the Senior group - 10.1 cm as compared to the non-dominant limb.
3. The Seniors achieved higher ranges of flexion in the sagittal plane and the Youth in extension and horizontal extension.
4. Athletes with a higher internal rotation range of the shoulder joint of the dominant limb achieved higher results in the "safety pin" test.

Key words:
Volleyball players, shoulder joint, functional assessment

Introduction

Sport disciplines which require activation of the upper limbs and performance of asymmetric movements over the head, such as volleyball, pose a threat of significant strain of the shoulders. While the lower limbs and the spine handle more symmetric loads in such disciplines, the dominant upper limb is much more engaged. While analysing the biomechanics of volleyball throws it is easy to conclude that this is a highly dynamic activity which requires both eccentric and concentric muscle movements. It has been proven that serves, throws and hits requiring eccentric movements of rotator cuff muscles predispose those muscles to injuries [1, 2].

The majority of the force used by the player during an attack performed with the upper limb is generated by the torso. A great amount of force is transferred through the shoulder blade to the shoulder joint, allowing for dynamic movements of the upper limb over the head. The bone structure in the shoulder makes it unstable, which is why the basic role in its optimal functioning is played by dynamic shoulder blade and shoulder joint stabilisers [3].

Dysfunctions and pain in the shoulder area in athletes are often referred to as "tennis shoulder" or "pitcher's shoulder" and are related to pathological changes in the shoulder area connected to GIRD. Acquired glenohumeral internal rotation deficit is caused by contracture of the posterior-inferior part of the joint capsule, which secondarily leads to an increased external rotation of the joint [4]. During the final phase of a throw, the posterior-inferior surface of the joint capsule is subjected to excessive stretching to prevent frontal translocation of caput humeri.

Repeated micro-injuries cause hypertrophy of the joint capsule, loss or flexibility and multiple scarring. Similar mechanisms take place in the muscles, mainly external rotors, which, in response to sudden and chronic tensions and abrupt eccentric movements, sustain micro-damage to in the belly area. The imbalance created between strong internal rotators and weakened and tense external rotators, together with the contracture of the joint capsule seem to be the main cause of GIRD [4, 5, 6].

Objective

The aim of the paper was to perform functional analysis and assessment of the range of movement of the joints of the pectoral girdle in the dominant and non-dominant limb in volleyball players.

Materials and methods

The study involved 40 competitive volleyball players divided into 2 groups [tab.1.].

Study participation criteria

Youth division group

- Membership in a sports club competing in youth tournaments
- Participation in matches and training sessions at least 4 times a week
- Less than 5 years of playing volleyball

▪ No past surgeries of the shoulder area
▪ No pain currently experienced in the shoulder area

Senior division group
▪ Membership in a sports club competing in senior tournaments
▪ Participation in matches and training sessions at least 4 times a week
▪ More than 5 years of playing volleyball
▪ No past surgeries of the shoulder area
▪ No pain currently experienced in the shoulder area

Table 1. Characteristics

Group	Height [cm]	Weight [kg]	Age [years]	Volleyball career [years]
Youth	183.7 ± 7.4	70.4 ± 9.8	15.4 ± 0.6	3.4 ± 1.3
Seniors	189.6 ± 6.8	84.4 ± 7.4	21.6 ± 1.6	8.8 ± 2.1
All subjects	186.6 ± 7.6	77.4±11	18.5± 3.3	6.1 ± 3.3

In both groups tests were performed in a standardised manner on a non-training day or before training to eliminate any additional overheating and stretching of tissues. The study comprised of two stages. During stage one, the active range of movement of the shoulder girdle was measured in four planes, and during stage two the results of functional tests proposed by the author were assessed. Before the tests, each participant received the following instructions:
▪ Information about the method of performing each movement and test;
▪ The first completed attempt was taken into account;
▪ No additional force or compression should be applied in order to improve the result.

Shoulder joint active movement range test
The shoulder joint movement range assessment involved active performance of specific movements by the participants while lying down. The tool used to take the measurements was a standard goniometer, while the movements were performed in different planes in a specified and systematic way in accordance with the SFTR method.
1. Shoulder joint flexion in the sagittal plane
2. Shoulder joint extension in the sagittal plane
3. Shoulder joint abduction in the frontal plane
4. Internal and external rotation in the shoulder joint
5. Shoulder joint flexion and extension in the transverse plane

Table 2. Average range of motion in youth division group

	Dominant shoulder	Non-dominant shoulder
Flexion (°)	163.5 ± 9.2	165.5 ± 9.0
Extension (°)	43.6 ± 8.6	43.3 ± 7.4
Abduction (°)	173.6 ± 10.7	176.5 ± 4.9
Horizontal flexion (°)	123.6 ± 7.2	129 ± 7.9
Horizontal extension (°)	40.5 ± 9.9	38.5 ± 8.8
External rotation (°)	87.3 ± 8.0	82.3 ± 12
Internal rotation (°)	65 ± 8.3	75.5 ± 9.6
Total rotation (°)	152.3 ± 13.5	158.3 ± 17.6

Table 3. Average range of motion in senior division group

	Dominant shoulder	Non-dominant shoulder
Flexion (°)	170.5 ± 7.6	169 ± 8.0
Extension (°)	35 ± 7.8	36.3 ± 8.9
Abduction (°)	176.3 ± 10.4	177.6 ± 9.7
Horizontal flexion (°)	119.5 ± 7.4	124.3 ± 7.7
Horizontal extension (°)	31.6 ± 6.3	34 ± 6.4
External rotation (°)	88.3 ± 9.1	83 ± 10.7
Internal rotation (°)	62 ± 15.0	76 ± 11.5
Total rotation (°)	150.3 ± 18.3	159.8 ± 18.3

Functional tests

The second stage involved the performance of 3 proposed functional tests to assess the complex range of movements of the shoulder girdle. The tools used to assess the tests performed were a standard goniometer and a flexible tape measure.

Subacromial space irritation test

A subacromial space irritation test performed using the functional movement screen method is used to exclude any conflict or irritation in the subacromial space. During the test the participant places the hand on the opposite shoulder in the area of the quadratus femoris prominence and without removing the hand raises the elbow towards the forehead (Fig. 1). Once the elbow is raised, the distance is measured between the olecranon and the xiphoid process of the sternum, which is an additional test component introduced by the author. The test should be performed within the limit of pain free motion range. In case of pain, subacromial impingement syndrome may be suspected, but such a diagnosis requires additional diagnostic testing [7, 8]. For simplification, the test is called "raising horizontally flexed elbow" in the study report.

Fig.1 Subacromial space irritation test

Shoulder mobility assessment

The second test was shoulder girdle mobility assessment known commonly as the "safety pin" test. The participant, while standing up, is asked to perform an extension, adduction and internal rotation of the shoulder joint of one limb and a flexion, abduction and external rotation of the other limb. Adduction with internal rotation of the right limb is called the right pin (Fig. 2A) while abduction and external rotation of the left limb is called the left pin (Fig. 2B). During the test the participant attempts to join their hands in the interscapular area, i.e. to close the "safety pin". The researcher measures the distance between the furthest (most extreme) points of both hands. A negative result means that there was a distance between the hands, which did not come into contact, while a positive result indicates that the participant was able to join hands and to what degree.

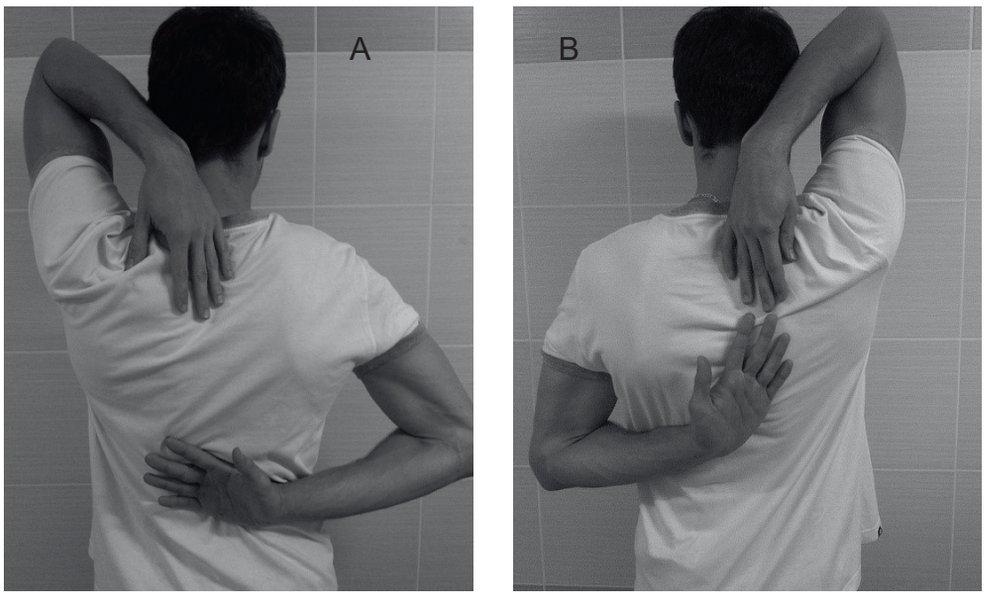


Fig. 2. Shoulder mobility assessment. Right pin (Fig. 2A), left pin (Fig. 2B)

Active abduction with stabilised shoulder blade

The active abduction test of the shoulder joint with passively stabilised shoulder blade facilitates assessment of the range of abduction without involvement of the shoulder blade. The participant is standing up with upper limbs in a neutral position, sideways to the researcher. After finding the lateral edge of the shoulder blade on the tested side, the researcher stabilises with both hands. Next, the researcher asks the participant to perform an active abduction in the frontal plane until experiencing resistance from the stabilised shoulder blade. In this position a measurement is taken with a goniometer of the angle between the longitudinal axis of the humerus and the side of the torso (Fig. 3).

Fig. 3. Active abduction with stabilised shoulder blade

Results

The results of the tests were subjected to statistical analysis with the use of the Statistica 10 software. Statistical significance was set at $p<0.05$. In addition, the average motion ranges and functional test results were compared.

Analysis of selected results from the Youth group

Results of independent motion range test attempts showed statistically significant differences between the dominant and non-dominant limb at the level of $p<0.05$ for horizontal flexion and internal rotation movements (Tab. 4; Fig. 4).

Tab. 4. A comparison of the motion ranges horizontal flexion and internal rotation movements in in youth division

	Dominant shoulder [°]	Non-dominant shoulder [°]	p value	Differences between arm side
Rotacja Wewnętrzna	123.6 ± 7.2	129 ± 7.9	0.034340	5.4
Internal Rotation	65 ± 8.3	75.5 ± 9.6	0.000335	10.5

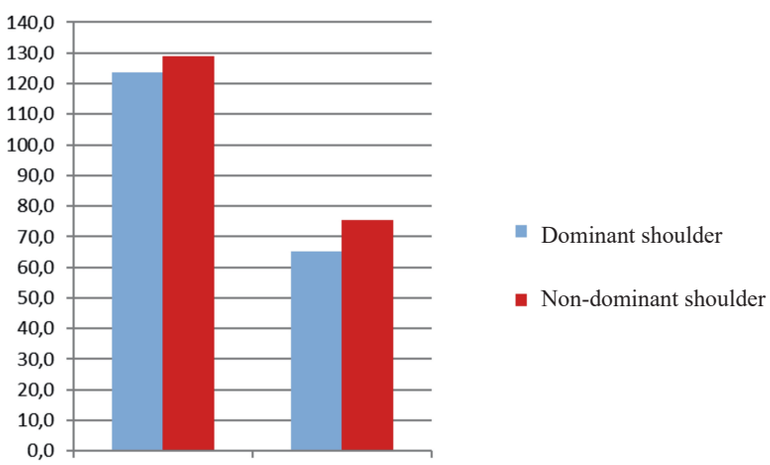


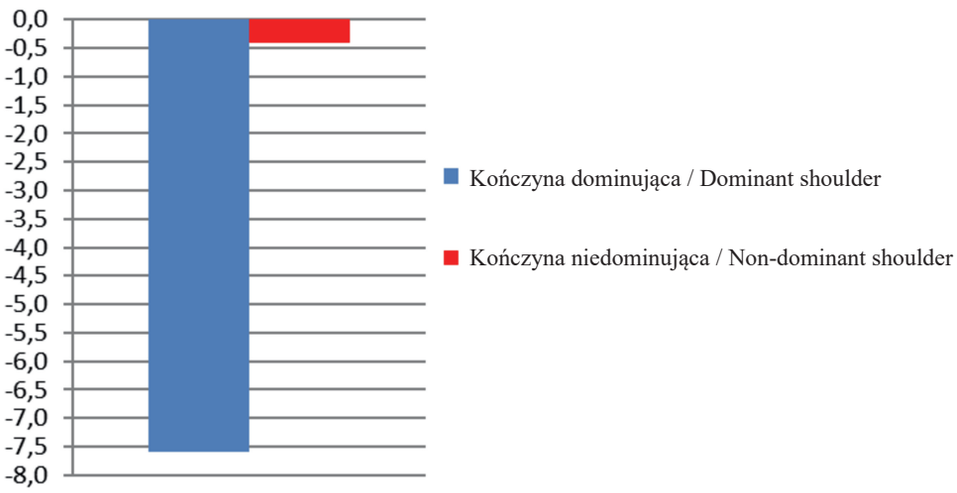
Fig. 4. A comparison of the motion ranges horizontal flexion and internal rotation movements in in youth division group

A comparison of the motion ranges of the dominant and non-dominant limb showed a significant drop in the horizontal flexion range and internal rotation in the dominant limb. Moreover, an increase in the average external rotation range was observed for the dominant limb, however, the increase was not statistically significant.

A comparison of functional test results for the dominant and non-dominant limb in the Youth group shows statistically significant differences at the level of $p <0,05$ in the "safety pin" test (Tab. 5; Fig. 5).

Table 5. A comparison of functional test results in youth division group

	Dominant shoulder [cm]	Non-dominant shoulder [cm]	p value	Differences between arm side
Test „Agrafki” Functional test “safety pin”	-7.8 ± 8.1	-0.4 ± 8.0	0.006190	7.4



Ryc. 5. Porównanie wyników testu agrafki w grupie młodzików
Tab. 5. A comparison of functional test results in youth division group

Wstęp

Dyscypliny sportowe wymagające aktywacji kończyn górnych oraz wykonywania asymetrycznego ruchu ponad głową, do których zaliczmy siatkówkę narażają bark na znaczne przeciążenia. O ile kończyny dolne i kręgosłup w tych dyscyplinach obciążane

Analysis of selected results from the Senior group

Results of independent motion range test attempts showed statistically significant differences between the dominant and non-dominant limb in the Senior group at the level of $p<0.05$ for internal rotation movements (Tab. 6; Fig. 6).

Tabela 6. Porównanie średnich wartości dla rotacji wewnętrznej w grupie seniorów
Table 6. A comparison of internal rotation in senior group

	Dominant shoulder [cm]	Non-dominant shoulder [cm]	p value	Differences between arm side
Functional test “safety pin”	-7.8 ± 8.1	-0.4 ± 8.0	0.006190	7.4

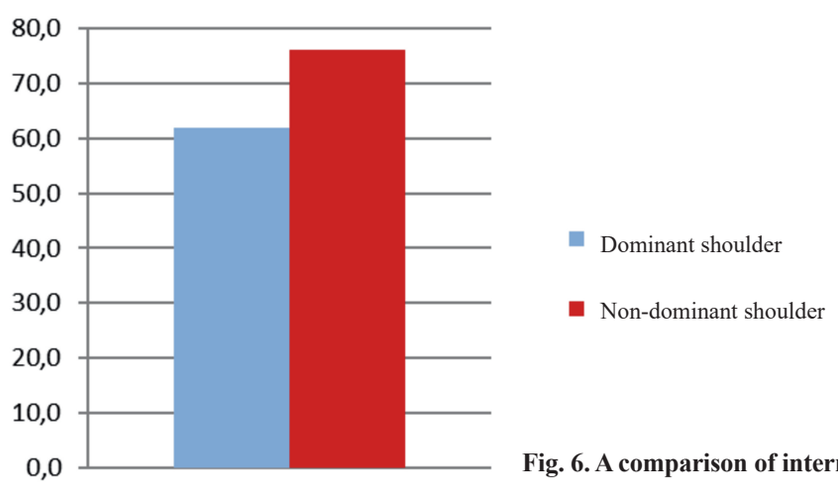
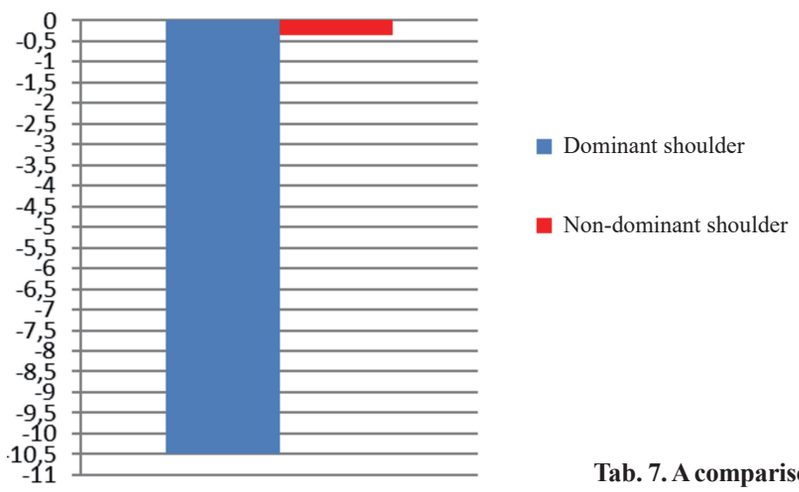


Fig. 6. A comparison of internal rotation in senior group

Analysis of functional test results for the dominant and non-dominant limb in the Senior group shows statistically significant differences at the level of p <0,05 in the "safety pin" test (Tab. 7; Fig. 7).

Tab. 7. A comparison of functional test results in senior group

	Dominant shoulder [cm]	Non-dominant shoulder [cm]	p value	Differences between arm side
Functional test "safety pin"	-10.5 ± 11	-0.4 ± 7.3	0.001540	10.1



Tab. 7. A comparison of functional test results in senior group

Comparison of the results between both groups

A comparison of the results of functional tests between the Youth group and the Senior group shows that the Youth achieve better results in the "safety pin" test and in abduction with shoulder blade stabilisation for both limbs. The comparison of the "safety pin" test results is shown in Fig. 8, and of the abduction test with shoulder blade stabilisation in Fig. 9.

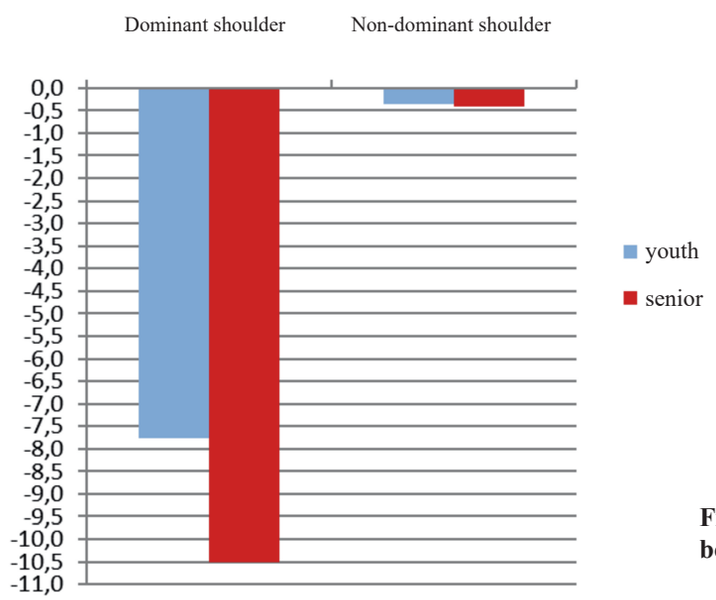


Fig. 8. Comparison of the results functional test between both groups

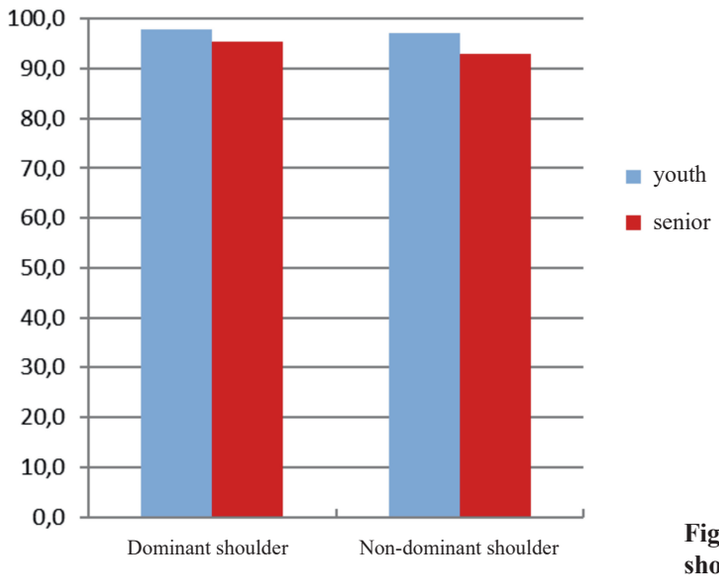


Fig. 9. Comparison of the results abduction with stabilised shoulder blade between both groups

Discussion

Sport injury needs to be considered a major issue in competitive circumstances; it often limits athletes' ability or totally prevents them from performing their professional activities [9, 10]. By analysing the range of movement of the shoulder blade in both groups a deficit was found in internal rotation of the dominant limb as compared to the non-dominant limb. In both groups the deficit value reached 10.5°. A similar correlation was found by Baltaci and Tunay while examining volleyball players and Kibler, who examined baseball and tennis players [5, 11].

In both groups increased external rotation was observed in the dominant limb as compared to the non-dominant limb. The reason for the increased range of external rotation may be considered repetitive maximal stretching of the anterior structures of the shoulder joint. This mechanism is created by maximal abduction combined with external rotation while swinging the dominant limb during an attack or a serve.

By analysing the remaining motion ranges a deficit was found in horizontal flexion of the dominant limb in the Youth group. A similar correlation was observed in the Senior group. Due to the lack of available research analysing different motion ranges of the shoulder blade in athletes it is difficult to explain the reason for the deficit. One hypothesis may be increased muscle mass of the dominant limb, which prevents movements in a wider range, or contracture of the posterior part of the joint capsule.

The results of the functional tests show worse results of the "safety pin" test for the dominant limb in both groups. In the Youth group, the difference amounted to 7.4 cm and in the Senior group - 10.1 cm as compared to the non-dominant limb. The visible difference between the groups corresponds to the lesser range of internal rotation of the dominant limb in Seniors as compared to the Youth. Therefore, it seems that the "safety pin" test is a useful functional test to assess the mobility of the shoulder girdle, especially in terms of internal rotation. On the basis of the results presented it can be stated that volleyball players suffer from disorders typical for athletes practising disciplines which require move-

ment of the arms over the head. The main issues include internal rotation deficit in the dominant limb as compared to the non-dominant limb. In order to prevent such changes it is recommended to introduce a prevention programme. Targeted tensioning of the posterior-inferior joint capsule combined with stretching may improve the range of internal rotation by 10° by following a two-week exercise plan [4, 12].
The effects of the therapy may be monitored with the "safety pin" test, while introducing stretching of the posterior-inferior joint capsule as the basis of training could decrease the risk of shoulder injuries in athletes.

Conclusions

1. Both the Youth group and the Senior group showed a significant decrease in the range of internal rotation of the dominant limb as compared to the non-dominant limb. In addition, a deficit was found in the Youth group in horizontal flexion of the dominant limb.
2. The results of the functional tests show worse results of the "safety pin" test for the dominant limb in both groups. In the Youth group, the difference amounted to 7.4 cm and in the Senior group - 10.1 cm as compared to the non-dominant limb.
3. The Seniors achieved higher ranges of flexion in the sagittal plane and the Youth in extension and horizontal extension.
4. Athletes with a higher internal rotation range of the shoulder joint of the dominant limb achieved higher results in the "safety pin" test.

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