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# Therapeutic procedures in shoulder impingement syndrome (SIS) for professionally active people: randomized research

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**ABSTRACT**

**Objectives.** Pain and limitation of motions in the glenohumeral joint are frequently the consequence of the shoulder impingement syndrome (SIS). Misdiagnosis or improper treatment of the illness may effect in a serious functional impairment of the upper limb. The treatment, dependent on the medical condition, involves: rest, NSAID therapy, physiotherapy as well as kinesitherapeutic procedures. The aim of the research was to conduct a detailed diagnosis of the shoulder impingement syndrome and the efficacy assessment of the matched rehabilitating procedures considering the symptoms.

**Material and methods.** The research was conducted in 39 people aged 30 to 81 treated for SIS. 85% of the respondents were professionally active. In order to assess the efficacy of the therapy the following were carried out: the pain assessment test, functional tests (Neer's, Ludington's, Hawkins', Apley's, Job's and the active painful arc test) as well as measurements of the active range of motion of the joint. The patients were subjected to two kinds of physiotherapy – ultrasound therapy (US) procedures and the short wave diathermy (SWD), both connected with procedures aiming at mobilization of the shoulder complex and off-load exercises. The outcome was submitted to statistical analysis.

**Results.** The results obtained in both groups of patients were compared via the Mann-Whitney U test. No significant differences between the SWD and the US groups in the efficacy of the conducted procedures were observed. The data analysis within therapeutic groups revealed the existence of significant differences ($p<0,01$) before and after the therapy, in the VAS and Laitinen scales as well as in the measurements of the range of motions.

**Conclusions.** The outcome of both conducted therapies in both research groups included: decrease in pain, increase in the range of motions of the glenohumeral joint and improved function of the upper limb. Both procedures may be successfully employed in the treatment of SIS in professionally active people.

**Key words:** Shoulder Impingement Syndrome (SIS), Ultrasound (US), Manual Therapy, Short Wave Diathermy (SWD), VAS

**Introduction**

Diseases revealing themselves in pain and dysfunction of the glenohumeral joint are most frequently described as PHS (lat. *perihumeroscapularis syndrome)* or shoulder impingement syndrome. It is also known as a frozen shoulder. Unfortunately, very rarely may one come across a very precise diagnosis which would explain the real cause of the shoulder ailments. In case of the shoulder impingement syndrome (SIS), it is the pain of the front-lateral area of the shoulder which increases at night and difficulties in abduction of the upper limb which are the first symptoms. Pain at rest, radiating down to the elbow, usually appears in the subsequent stadium of the disease together with a weakness of the entire limb. The physical examination usually reveals palpable pain in the acromioclavicular view, decrease of the muscle strength, positive tests: Neer's, Hawkins', Ludington's, Apley's, Job's and the active painful arc in the range of 60°-120° [1,2,3]. The inability of performing this movement always indicates the tear of rotators or the deltoid muscle paralysis [4].

Following Neer, the causes of the primary SIS are tracked in: a shortening of the distance between the processus coracoideus and the tuberculum maius as well as the increased pressure in the subacromial space [5,6,7]. Most frequently this disease involves anatomic and biomechanical transformations at the level of the acromioclavicular joint, processus acromialis, bursa subacromialis and the long head tendon of the biceps muscle [8,9]. They are accompanied by pain and inflammation which is conducive to the adhesions of the synovial membrane resulting in a linger immobilization of the joint. It is reflected at the muscle layer. The earliest observed is weakening of the supraspinatus muscle, the deltoid muscle and the teres minor muscle as well as an increase in the tension of the remaining joint structures. What is usually overloaded are such muscles as: biceps, pectoralis major and the descendant part of the trapezius muscle. Such a distribution of forces effects in the general weakening and dysfunction of the upper extremity.

The shoulder impingement syndrome appears in three stages [5,7,9,10]:

- stadium I – revealing through the swelling or haematoma in the rotator cuff – concerns patients under 25 years old and is reversible;
- stadium II – more advanced degenerative transformations within tendons, fibroses often resistant to treatment – concerns patients between 25 and 40 years old;
- stadium III – prolonged, advanced inflammatory and degenerative transformations of the periarthric structures, often resulting from mechanical injuries – usually among people over 50 years old, transforms into a chronic form.

SIS is the form of the shoulder complex injury resulting from overload and is present among about 40-60% of people aged over 40 afflicted with shoulder pain [3,4]. It is usually the

result of repeated, tedious actions or movements with arm raised above the head e.g. swimming, throwing, installing devices, playing golf, shovelling snow etc. [4,11]. In elderly people, the pain-provoking factor is the contracture of the anterior structures of the shoulder complex resulting from: a bad body posture – rounded back and protracted arms, injury or degenerative transformations in the joint area. One of the main factors causing SIS in this group is previous overload of the shoulder complex induced by lugging – e.g. in nurses, office workers or people working with machines, such like dressmakers [3].

The system of three cooperating joints: shoulder, sternoclavicular and acromioclavicular, is responsible for the proper mobility of the shoulder complex [12,13]. The proper activity of this complex, in turn, depends on the condition of the cartilage, the quality of the capsular ligamentous apparatus as well as the strength and efficiency of the muscles. Long-preserved overload transformations within the shoulder joint lead to further rotator cuff pressure and the subacromial bursitis [6]. Most frequent is also the instability of the shoulder joint which is characteristic of professional sportsmen – badminton players, swimmers, weightlifters or shot putters [11,14,15,16]. It is the effect of the unbalanced muscle tensions within the shoulder complex and the superior and anterior migration of the humerus as well as the subacromial space narrowing.

The treatment of the SIS usually comes down to rest and immobilization in the phase of pain. Further recommended are the ice compression and the NSAID therapy conjoined with physical therapy – in order to decrease the state and enable further kinesitherapeutic and manual procedures. It is advised in subsequent stages of the disease, to continue the physical therapy with special emphasis on the aided and free exercises.

**Aim of the study**

The presumption of the research was to carry out a detailed diagnosis of the shoulder impingement syndrome and the efficacy assessment of the matched therapeutic methods in patients with SIS. The research also aimed at assessing the extent of the transformations in the active mobility of the shoulder joint after applying physical therapy procedures.

**Material and method**

39 people (19 women and 20 men) aged between 30 and 82 (the average age of 54,4 years old) were enrolled in the research. 85% of the respondents were professionally active with 40% working in office in front of a computer, 30% - physical workers, 20% - working in a hospital or school. All of them were treated between 2011 and 2012 in the Department of Laser Therapy and Physiotherapy of the CM UMK in Bydgoszcz for the II and III degree SIS. The

lesions mainly concerned (80%) the upper dominant extremity and the average time of the ailments was 30 months. A number of physical measurements were conducted in order to confirm the diagnosis and to estimate the degree of the changes in the mobility of the shoulder complex and the muscle tension. The assessed elements [following 1,2,5] were:

- the level of the perceived pain – the palpable pain around the joint, the results of the VAS scale and the Laitinen questionnaire;
- the presence of the Trigger Points in the deltoid, trapezoid and infraspinatus muscles;
- the presence of positive symptoms in the tests of: Neer, Hawkins, Ludington, Apley as weel as the active painful arc test;
- the deltoid muscles strength through the Job's test (subjective measurement);
- the hand grip strength of the afflicted arm (the hydraulic dynamometer).

The patients were randomly categorized into two surgical groups. The first group underwent the short wave diathermy (SWD), with the electromagnetic field of 27,12 MHz and the II and III degree doses – between 60 and 100W. The procedures used the capacitive method and lasted 5-12 minutes. The second group underwent the ultrasound therapy (US) with a constant wave of 1 MHz in doses growing from 0,8W/cm$^2$ to 1,6 W/cm$^2$. The procedures were conducted using the dynamic technique for 3-4 minutes for every painful area. The kinesitherapy was based on the off-load exercises in the coronal and sagittal planes. The exercises were preceded by shoulder complex mobilization procedures aiming at the centralization of the humeral head in the joint and increase in the scapular glide [1].

The measurement of the ranges of active and passive motions – mainly abduction, flexion, external and internal rotation in the shoulder joint, was carried out with the use of the SFTR method. This method was published and recommended by the International Society for Measurement Standardisation in Orthopaedics [17].

The obtained outcome was statistically processed and presented in the form of tables and figures. The statistical analysis was conducted with the Statistica 8.0. software. In order to compare the significance of the differences between the means obtained in the tests both before and after the therapy, the Wilcoxon signed-rank test was applied in both groups. The level of statistical significance was established to be $\alpha$=0,01. The differences between the groups were established through the Mann Witney's U test. The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation in Bydgoszcz.

**Results**

On the basis of a palpative examination and the Job's test, conducted before and after the therapy, a significant decrease in the area of pain was observed together with an increase in the strength in abduction among 91% of the patients. The analysis of the data in both therapeutic groups revealed statistically significant differences *(p*<0,01) in the measurements of pain before and after the applied physiotherapeutic procedures (Tab. 1, Tab. 2). In the group of people *(N*=19) who were subjected to SWD therapy, the average level of pain the joint before the procedures reached the value of Mean (*M*)=5,67, (*SD*=1,56), with the particular values falling between 3 and 9 points. After the therapy the pains decreased (*p*=0,0001) to the *M*=3,57, (*SD*=2,31) with the extreme values of 1 and 6 points. In the second group (*N*=20), with the US therapy, comparably satisfactory analgesic effect was obtained *(p*=0,00001), which was confirmed by the decrease in the average values of pain from the Median (*Md*)=5,5 – ranging between 3 and 8 points, to *Md*=3 – ranging between 0 and 6 points. The pains that influenced the functional limitations and were connected with an increased need for NSAiDS, estimated by patients through the Laitinen questionnaire, dropped by 4 point on average in the first group and by 2 points on average – in the second (Fig. 1, 2).

**Figure 1.** The Laitinen questionnaire results before and after SWD procedures.

**Figure 2.** The Laitinen questionnaire results before and after US procedures.

**Table 1.** The z-test statistic values and the p level for particular tests, obtained among the patients treated with SWD.

**Table 2.** The z-test statistic values and the p level for particular tests, obtained among the patients treated with US.

Below is also presented the change in the range of active motions in particular sequences – before and after the therapy in both therapeutic groups. The obtained results confirm the statistically significant (*p*<0,01) improvement in the active mobility both in the group of patient subject to ultrasound therapy and those, who underwent short wave diathermy, in combination with manual therapy and off-load exercises. Equally statistically significant improvement (*p*<0,01) was observed with respect to the range of the passive mobility. The active abduction movement in the first (SWD) group improved by 5° on average, extending the range of movement from 30-40° to 30-45°. In the second (US) group, the average value of the range did not change, however in the range of higher values (40-45°), a confidence interval appeared between $25^{th}$ and $75^{th}$ percentile in contrast to the results obtained before the US therapy – from the range of 30-40°. The flexion also improved by 5° in the group with SWD

whereas among patients with US its average value did not change. In both groups the minimum value of this movement came up to 140° from the earlier measured value of 120°. A considerable improvement in the abduction in the shoulder joint by 20° on average was observed in the first group, which allowed to achieve the maximum range of 155° (Fig. 4). The improvement of all those ranges was definitely related to the internal rotation, which also improved in both groups by 5° on average, towards the maximum of 65° (SWD group) and 60° (US group) – Fig. 5, 6.

**Figure 3.** The active range of movement – abduction before and after the SWD therapy.

**Figure 4.** The active range of movement – abduction before and after the US therapy.

**Figure 5.** The active range of movement – external rotation in the SWD group.

**Figure 6.** The active range of movement – external rotation in the US group.

Only the results concerning the hand grip strength display a statistically significant improvement at the level of $p<0,05$. These values only slightly increased by 1,24 kg (SWD group) and 2,5 kg (US group) on average.

The Mann-Whitney U test was applied to compare the measurements taken among patients after the short wave diathermy procedures combined with kinesitherapy and those, of patients subject to ultrasound therapy combined with kinesitherapy. Nevertheless, the statistical analysis did not reveal a significant difference between the groups ($p>0,5$).

**Discussion**

The presented outcome of the research carried out in a group of 39 patients confirm the findings of other authors [8,13,18] that the majority of the ill people were professionally active and their average age was 54. The comparative studies of the mobility ranges of the healthy shoulders and those afflicted with SIS confirm that the transformations in the shoulder complex considerably impair its functions. The greatest impairment is noticed among patients in such moves as abduction and external rotation of the shoulder and the scapulohumeral glide, similarly to other research groups [13,19,20]. Due to the dependence of other flexion and abduction movements on the external rotation, the movement becomes a significant monitor of the shoulder joint dysfunction and the effects of its treatment [13,21].

The majority of studies concerning the treatment of the shoulder impingement syndrome are oriented towards the assessment of the effectiveness of the targeted kinesitherapy and the manual methods of therapy [9,18]. No significant differences are observed in the ranges of mobility in groups which differ in the kind of the applied manual therapy [22]. An increase

in the pain in the joint was observed among a good number of patients with acute symptoms of SIS subject to conservative treatment with special emphasis on the untimely facilitation. Eventually, it manifests itself in an impairment of the functions of the entire extremity [3,23]. In our research, kinesitherapy was repeatedly preceded by manual procedures which were the attempts to align the humeral head in the joint which decreased the pressure and pain during subsequent off-load exercises. What was also privileged during the mobilization of the shoulder joint were the scapula glide movement and the external rotation of the shoulder joint which is of key importance in the full restoration of the upper extremity functions according to the Codman paradox [1,13,21,24,25].

There are no reports in the literature concerning the use of ultrasound therapy in the treatment of the shoulder impingement syndrome. Some therapists [11,26,27] achieved satisfactory analgesic effects in comparison to placebo after the application of the ultrasonic wave in case of the calcification of the tendons occurring in the shoulder area. By contrast, Johansson et al. [28], comparing the effects of the ultrasound and acupuncture procedures combined with exercises performed by patients at home, obtained better results in the group of people who underwent acupuncture. It is possible that the worse results among the people in whom the ultrasound therapy was applied were conditioned by the infrequent use of it – only twice a week. Yang et al. [21] have given evidence for the increase in the therapeutic effect of the 3-month passive mobilization combined with stretching in the shoulder joint and exercises performed twice a week – with physical methods of US, SWD and electrotherapy. The treatment effectiveness monitor of the frozen shoulder was an improvement in the range of external rotation – the movement of the arm behind the head, and the glide of the scapula.

Calis et al. [29], however, presented comparative research concerning the effectiveness of SIS treatment with ultrasounds and laser therapy combined with thermotherapy and exercises. No statistically significant differences between the groups were observed. In both groups a considerable improvement in the mobility and functionality of the upper limb as well as a decrease in pain were noticed.

Akyol et al. [30] applied microwave diathermy and its apparent form – sham diathermy – “placebo” combined with a facilitation exercises programme, in patients with SIS. In both groups satisfactory and statistically significant improvement has been obtained in the range of the measured parameters: joint mobility, pains, muscle strength, quality of life and depression. No considerable differences between the effectiveness of both therapies were observed also with regards to a period of one month after the therapy.

Other kinds of physical procedures are also widely applied in the treatment of the shoulder impingement syndrome. In the research by Santamato and associates [31] statistically

significant decrease in the level of pain was obtained as well as an increase in the muscle strength and the range of movements with a general improvement of the functions of shoulder, due to the 10-day use of a high intensity laser therapy (HILT). With regards to patients with SIS subject to two-week ultrasound therapy, a greater improvement was observed after applying the HILT.

What brings the therapist towards the success is an early recognition of the shoulder impingement syndrome at the beginning of the process of shoulder joint therapy. At the first stage of treatment, it is the quick and proper diagnosis and an introduction of a proper conservative treatment, what is of the utmost importance [3,32,33]. During the first 1-3 weeks, in the period of the acute pain, it is advisable to immobilize the limb and apply NSAIDs with physical treatment (cold, laser radiation, magnetic field). In the following weeks, targeted manual procedures are added as well as phonophoresis, electrotherapy and other physical procedures. In some cases there are reason for the use of NSAID or steroid injections [12,34,35]. Some authors also suggest applying the crosswise massage of the muscles surrounding the joint [12].

In case of introducing exercise during the acute phase it ought to be remembered that they may bring negative effects in the shape of an increase in pain, which is reported by some authors. The crucial problem is the instant irritation of the bursa subacromialis and the rotator cuff during abduction. In the subsequent stages of the rehabilitation, active and passive isometric exercises in closed chains and resistance exercises should be introduced in order to strengthen the entire muscle apparatus. The joint capsule stretching and weight exercises are advisable as soon as the acute pain stops [3,36].

In people taking up sport activity the technique of performing movements should additionally be observed (e.g. swimming of throwing). The history of injuries and methods of their treatment are also an important aspect as well as the protective measures applied to minimize the risk of SIS in the future [14,15,16]. In case of unsatisfactory effects of the conservative treatment, a surgery is suggested with special emphasis on the closed, arthroscopic method [4,37,38].

The shoulder impingement syndrome is the most frequent cause of pain in the shoulder complex area. Contemporary methods of therapy used in the treatment of this illness are most often based on combined physiotherapeutic methods using physical stimuli, which are a form of preparation for kinesitherapeutic and manual procedures. The choice of a proper therapeutic dose and the kind of the stimulus preceded by an accurate diagnosis of the discussed area seem to be the key to success with regards to the improvement in the comfort and quality of life among patients suffering from SIS.

**Conclusions**

As a result of the applied combination if therapeutic methods, in the both groups the following have been obtained:

1. A significant decrease of pain in the entire shoulder complex – the joint, the nearby muscles and the adjacent structures.
2. An improvement in the active and passive mobility in the shoulder joint.
3. An increase in the grip strength and an improvement in the general functionality of the upper extremity.
4. Both procedures may be successfully employed in the treatment of SIS in professionally active people.

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**Table 1.** The z-test statistic values and the p level for particular tests among the patients treated with SWD.

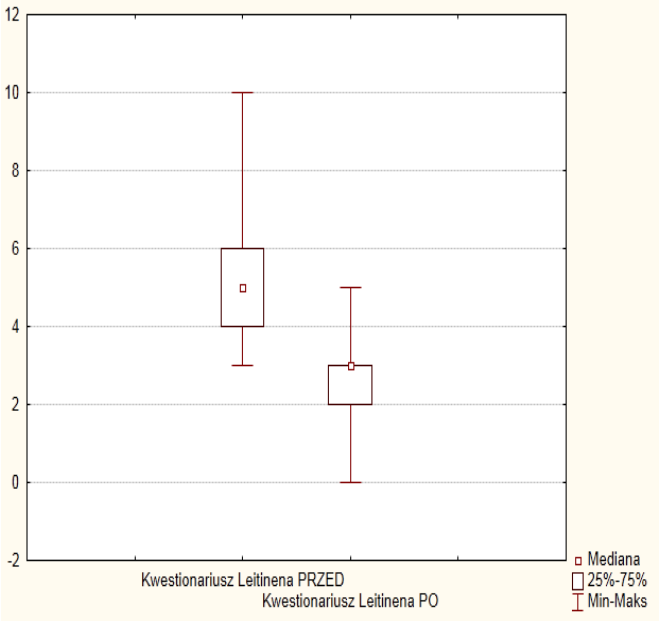
| **Variable** | **Z-test statistics** |
|---|---|
| VAS | 4,02*** |
| Laitinen Scale | 3,52*** |
| Hydraulic dynamometer | 2,24* |
| SFTR active extension | 3,30** |
| SFTR active flexion | 3,62*** |
| SFTR active abduction | 3,72*** |
| SFTR active external rotation | 3,52*** |
| SFTR active internal rotation | 3,18** |
| SFTR passive extension | 2,80** |
| SFTR passive flexsion | 2,93** |
| SFTR passive abduction | 3,72*** |
| SFTR passive external rotation | 3,41*** |
| SFTR passive internal rotation | 3,06** |

* p<0,05; ** p<0,01; *** p<0,001

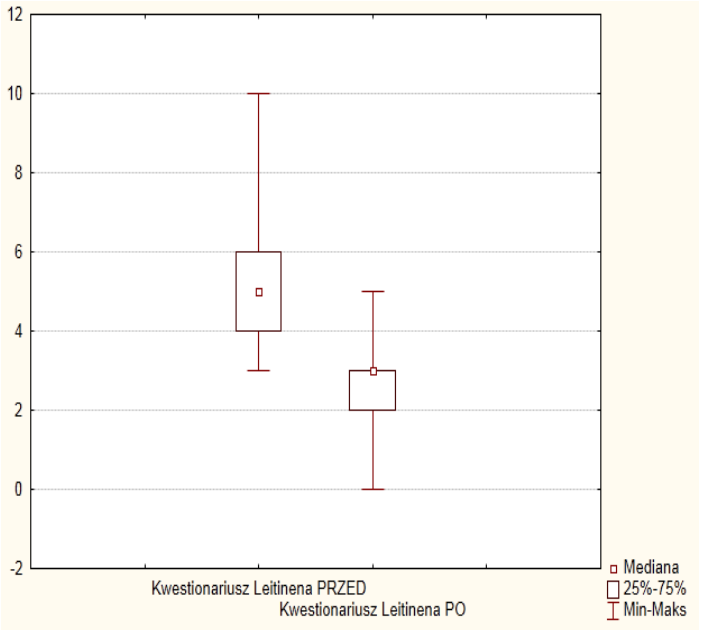
**Table 2.** The z-test statistic values and the p levels for particular tests among the patients treated with US.

| **Variable** | **Z-test statistics** |
|---|---|
| VAS | 4,37** |
| Laitinen Scale | 4,37** |
| Hydraulic dynamometer | 3,11* |
| SFTR active extension | 3,62** |
| SFTR active flexion | 3,72*** |
| SFTR active abduction | 4,20** |
| SFTR active external rotation | 3,41** |
| SFTR active internal rotation | 3,62** |
| SFTR passive extension | 3,30* |
| SFTR passive flexsion | 3,72** |
| SFTR passive abduction | 3,82** |
| SFTR passive external rotation | 3,41** |
| SFTR passive internal rotation | 3,52** |

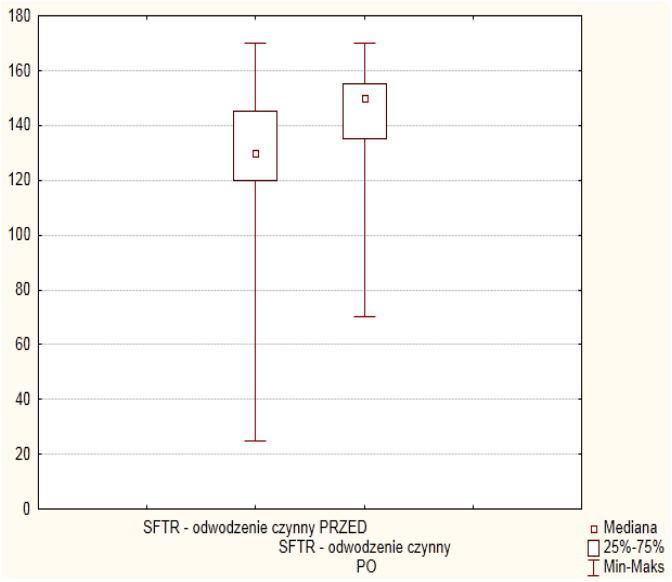
* p<0,01; ** p<0,001



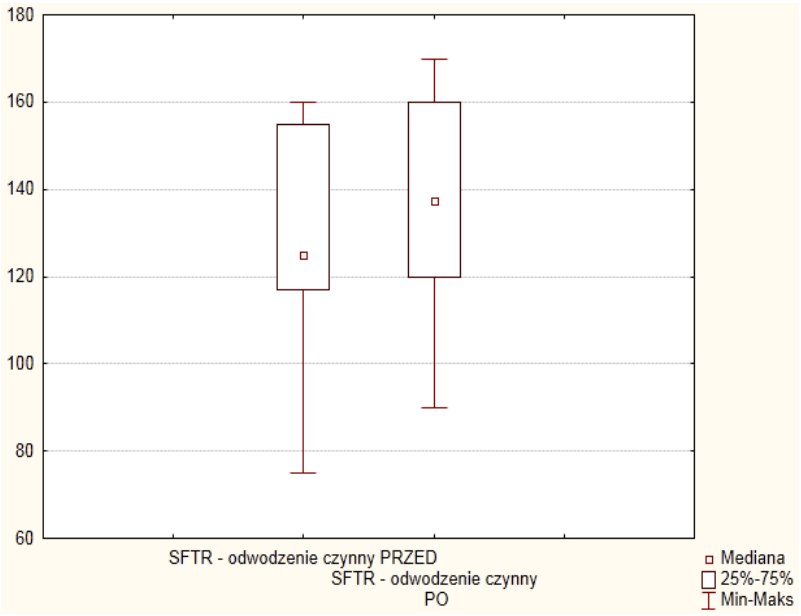

***Ryc.1.*** *The Laitinen questionnaire results before and after SWD procedures.*



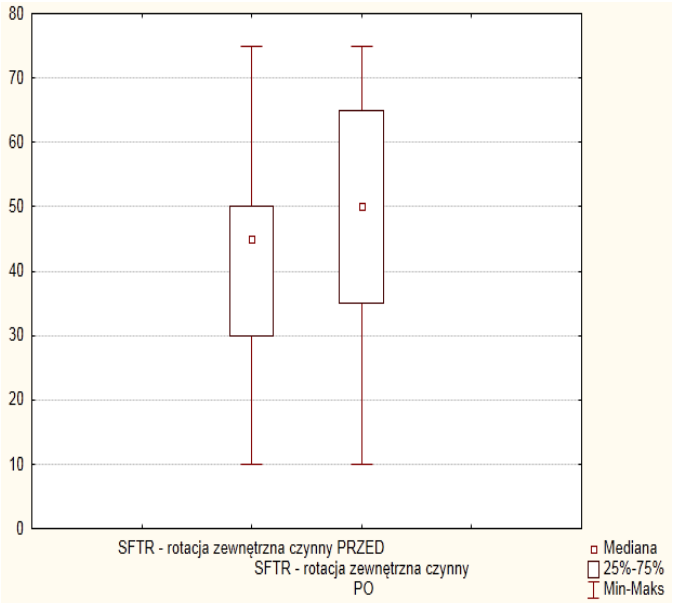

***Ryc.2.*** *The Laitinen questionnaire results before and after US procedures.*



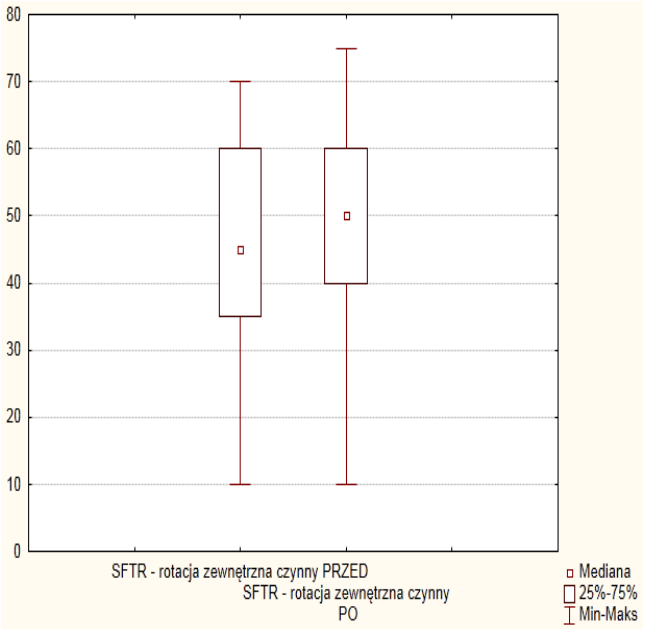

**Ryc.3.** *The range of movements according to SFTR – the active abduction before and after SWD*




**Ryc.4.** *The range of movements according to SFTR – the active abduction before and after US*




**Ryc.5.** *The range of movements according to SFTR – the active external rotation before and after SWD.*




**Ryc.6.** *The range of movements according to SFTR – the active external rotation before and after US*