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Shoulder joint function evaluation after reverse total shoulder arthroplasty – preliminary reports

Ocena funkcji stawu ramiennego po alloplastyce odwróconej – doniesienia wstępne

Ewelina Żyżniewska-Banaszak[1(A,D,E,F)], Magdalena Gębska[1(A,D,E)], Sebastian Sokołowski[2(D,E)], Anna Sobczak[1(B,E)], Łukasz Kołodziej[1(D,E)]

[1]Zakład Rehabilitacji Narządu Ruchu, Pomorski Uniwersytet Medyczny w Szczecinie /
Department of Musculoskeletal Rehabilitation, Pomeranian Medical University in Szczecin, Poland
[2]Klinika Ortopedii, Traumatologii i Onkologii Narządu Ruchu, Samodzielny Publiczny Szpital Kliniczny nr 1 w Szczecinie /
Department of Orthopaedics, Traumatology and Oncology of the Musculoskeletal System, Independent Public Clinical Hospital No. 1 in Szczecin, Poland

Abstract

Introduction. Physiotherapy is an important part of the comprehensive treatment of patients after reverse total shoulder arthroplasty (RTSA). Patients qualified for RTSA struggle with shoulder joint dysfunctions of various aetiologies - most often with irreparable damage to the rotator cuff tendons. The aim of physiotherapy after RTSA is to restore the lost functions of the shoulder joint based on a targeted rehabilitation protocol taking into account the changed biomechanical conditions of the shoulder.

Materials and methods. The study material consisted of 6 patients after RTSA. Patients were examined before the procedure and after rehabilitation with the use of the Constant-Murley Score. The rehabilitation model was implemented on the day before surgery and continued for 12 weeks.

Results. Each patient experienced an improvement in shoulder mobility and a reduction in pain intensity.

Conclusions. Rehabilitation after RTSA improves the functions of the shoulder joint expressed by an increased range of joint mobility, elimination of pain and improved quality of life.

Key words:

shoulder joint, total shoulder arthroplasty, orthopaedics, rehabilitation

Streszczenie

Wstęp. Fizjoterapia stanowi ważną część kompleksowego postępowania leczniczego u pacjentów po zabiegu odwróconej alloplastyki stawu ramiennego (ang. *reverse total shoulder arthroplasty* – RTSA). Pacjenci, kwalifikowani do zabiegu RTSA, zmagają się z dysfunkcjami stawu ramiennego o różnej etiologii – najczęściej z nienaprawialnym uszkodzeniem ścięgien stożka rotatorów. Celem fizjoterapii po RTSA jest przywrócenie utraconych funkcji stawu ramiennego w oparciu o celowany protokół usprawniania z uwzględnieniem zmienionych warunków biomechanicznych barku.

Materiały i metody. Materiał badany stanowiło 6 pacjentów po RTSA. U pacjentów przed zabiegiem i po odbytej rehabilitacji wykonano badanie, wykorzystując kwestionariusz Constanta. Model usprawniania wdrażano w dniu poprzedzającym zabieg operacyjny i kontynuowano przez 12 tygodni.

Wyniki. U każdego z pacjentów odnotowano poprawę ruchomości stawu ramiennego i zmniejszenie poziomu natężenia bólu.

Wnioski. Rehabilitacja po zabiegu RTSA poprawia funkcje stawu ramiennego wyrażoną zwiększeniem zakresu ruchomości stawu, eliminacją bólu i polepszeniem komfortu życia.

Słowa kluczowe:

staw ramienny, alloplastyka, ortopedia, rehabilitacja

Introduction

Reverse total shoulder arthroplasty (RTSA) is a surgery involving replacement of the joint – most often in patients who experience irreparable damage to the rotator cuff tendons with concomitant osteoarthritis. The procedure uses a prosthesis in the form of a reverse shoulder joint, where the anatomical structures (socket and ball) are reserved (Fig. 1).

Fig. 1. Reverse shoulder prosthesis. ***Source: DePuy Synthes, Johnson & Johnson***

The loss of the rotator cuff function causes reorganization of the fibres of the deltoid muscle, as a result of which it becomes the initiator of every movement. Thanks to the created unique biomechanics of the joint, this procedure is widely used in the treatment of shoulder pathologies, and also allows to achieve greater ranges of motion compared to other methods of treating similar diseases [1, 2].

The goal of physiotherapy after RTSA is to restore the lost functions of the shoulder joint based on a targeted rehabilitation protocol taking into account the altered biomechanical conditions of the shoulder. Rehabilitation is long-term and requires a lot of commitment from the patient. The rehabilitation process should be adequate to the patient's needs and capabilities. Rehabilitation begins on the day preceding surgery and lasts about 4 months. In the early stages of treatment, to protect the joint it is important to prevent dislocation and loosening of the endoprosthesis. For this purpose, an abduction orthosis with a hip pad (Fig. 2a, 2b) is used for a period of 4 to 6 weeks [5]. The purpose of using the orthosis is to keep the joint in a neutral position and to prevent movements that are initially contraindicated, such as bending the shoulder joint in the horizontal plane. According to Kirsch et al. [2], in patients using a simple, straight orthosis, the endoprosthesis was dislocated more often.

Fig. 2a, 2b. Shoulder abduction orthosis with a hip pad. ***Source: own elaboration***

Materials and methods

Patients undergoing the surgery at the Department of Orthopaedics, Traumatology and Oncology of the Musculoskeletal System of the Pomeranian Medical University in Szczecin, with diagnosed degenerative changes of the shoulder joint or after the proximal humerus fracture were qualified for the study.

In the period from June 2019 to January 2020, eleven RTSA procedures were performed. The study group consisted of 6 people who gave consent to participate in the study. Among them, there were 5 women aged 70 (2), 73 (2), 85 (1) and 1 man aged 72. In 4 patients degeneration of the joint with arthropathy of the rotator cuff tendons was diagnosed, while in two – a fracture.

Inclusion criteria:

1. Patients after RTSA in the course of degenerative changes with damage to the rotator cuff tendons or with the proximal humerus fracture.
2. General good health and range of motion of both shoulder joints allowing for the assessment of range of motion (ROM) and muscle strength.
3. Written consent to participate in the study and undergo follow-up examinations.

Exclusion criteria:

1. Coexisting injuries within the operated and/or the other shoulder joint (e.g. infection, nerve damage), making it impossible to perform the examination.
2. Contraindications to physiotherapy (e.g. serious condition of the patient, sudden weight loss for no apparent reason).

The study design was approved by the Bioethics Committee (KB – 0012/142/19) of the Pomeranian Medical University.

The study was planned and conducted in two stages – pre- and postoperative.

The preoperative stage included an interview with the patient, during which detailed information on the proprietary rehabilitation program was provided.
RTSA was performed from the deltopectoral groove approach. In cases of omarthrosis, the subscapular muscle tendon was subjected to tenotomy and reconstructed at the end of the procedure. On the other hand, in cases of the proximal humerus fracture, the greater and lesser tubercles together with the tendons of the subscapular, infraspinatus and teres minor muscles attached to them were reconstructed. The same type of reserve shoulder prosthesis was used in each patient. The functional assessment of patients after RTSA was performed using the Constant-Murley Score [6, 7]. It is a research tool recommended by the Polish Shoulder and Elbow Society.
The last examined element involved the assessment of the muscle strength of the upper limbs, measured with a SAEHAN dynamometer. The patient's task during the examination was to obtain the maximum isometric contraction of the examined muscles and maintain it for 3 seconds. The range of joint mobility was tested with a SAEHAN manual goniometer [8].

All measurements were made before surgery and after the rehabilitation process was completed.

Tab. 1. Rehabilitation protocol after RTSA

Implemented procedure	Duration / number of repetitions	Remarks
HOSPITALIZATION PERIOD		
1 day after surgery		
Shoulder abduction orthosis with hip pad	From 4 to 6 weeks	Learning to put on and take off the orthosis
Passive stabilization of the scapula by kinesiotaping (rigid and flexible tapes) – Fig. 3	Tapes kept for 5 days	
Passive exercises for the scapula and passive flexion of the arm up to 90°	5 repetitions – 3 series 3 times a day	The operated side – passive exercises, the non-operated side – active exercises
Active exercises of extension of the shoulder joint and hand	5 repetitions – 3 series twice a day	The operated and non-operated side
Isometric exercises in the plane of the scapula and periscapular muscles	Every 3-4 hours during the day	
Learning the correct way to change body position when standing up, sitting down and lying down	To achieve natural and safe transfer	
Overview and implementation of the home self-therapy program		Education in the safe handling of the limb

Implemented procedure	Duration / number of repetitions	Remarks
POST-HOSPITALIZATION PERIOD **from the 3rd to the 6th week (obtaining a painless passive range of motion and the ability to perform an isolated movement of the scapula qualified the patient for further exercises)**		
Deltoid isometric exercises	10 times 1 series	
Increasing the passive range of motion	Individually selected time and pace of exercises	Observation of the occurrence of pain, especially on the side of the initial deltoid attachment
Delicate support on the elbow, wrist and hand in the supine position on the back	Time for muscle tension 5-10 seconds 10 times during a session	The operated and non-operated side
Gradual increase in resistance exercises as above	Muscle contraction time 10 seconds times 5 repetitions	Observation of the occurrence of pain, especially on the side of the initial deltoid attachment
Postoperative scar mobilization	Once a day	After the wound has healed
Active movements of flexion and elevation of the limb	10 times in each plane	
POST-HOSPITALIZATION PERIOD from approx. 6th week		
Active movements of external and internal rotation of the limbs	10 times in a series twice a day	
Active shoulder exercises	10 times in a series twice a day	
Activation of the pericapular muscles (scapula retraction)	10 times in a series twice a day	
Using the limb in daily activities (no lifting)		An explanation of what movements should not be made
Activation of individual acts of the deltoid muscle	10 times in a series twice a day	
Introducing the habit of posture control while exercising in front of the mirror	Every day	

Wdrożone postępowania Implemented procedure	Czas trwania / liczba powtórzeń Duration / number of repetitions	Uwagi Remarks
Resistance exercises with a maximum load of 1.5 kg for flexion and elevation movements in the plane of the scapula as well as external and internal rotation while lying on the side	10 times in a series	
Exercises increasing the range of motion of the shoulder joint with the use of a rehabilitation ball with a diameter of 65 cm	10 times in a series	

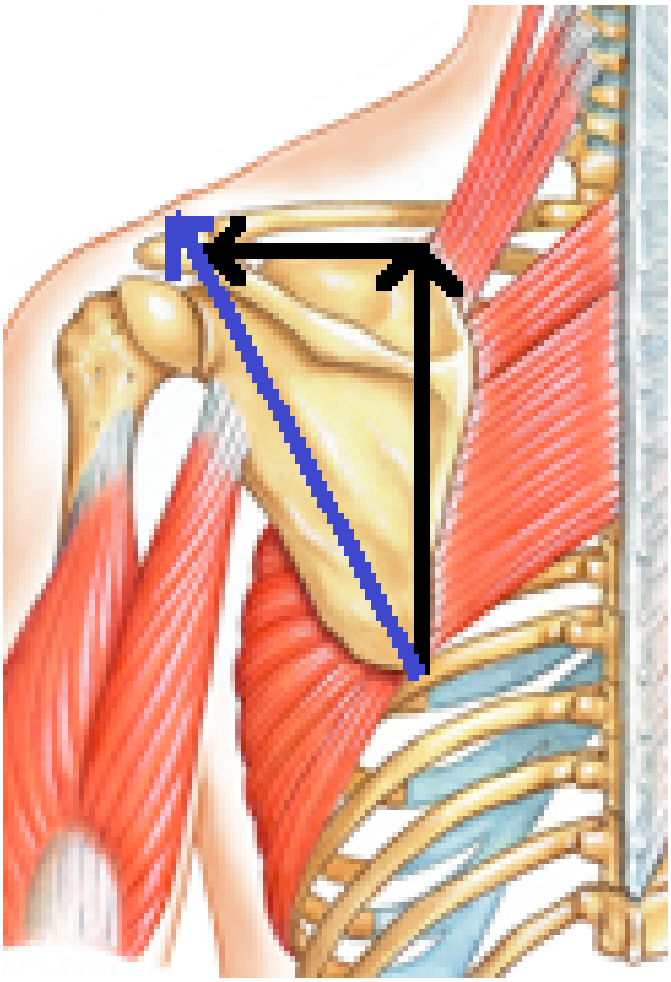

Fig. 3. Application of kinesiotaping with its directions, overview drawing (black arrow – elastic tape, blue arrow – rigid tape). ***Source: own elaboration***

The rehabilitation process was completed after achieving a painless maintenance of the operated limb in flexion, abduction, external and internal rotation with the optimal range of motion. After being educated on the prevention of injuries, the patients remain under the care of the Orthopedic Clinic.

The obtained results were analyzed in the Excel spreadsheet program.

Results

Analysis of the obtained results

Tab. 2. Characteristics of the mobility of the shoulder joint in the preliminary and follow-up examination

Examined movement in the shoulder joint [°]	Before surgery		Follow-up examination	
	min-max	mean	min-max	mean
Flexion	20–90	70	55–165	131
Extension	15–25	15	25–50	35
Abduction	75–96	86	85–130	109
External rotation	10–35	23	25–75	47
Internal rotation	15–30	20	15–45	29

Table 2 shows the range of motion of the shoulder during the preliminary and follow-up examinations in 6 patients. In all patients an increase in the range of flexion, extension, abduction, adduction, external and internal rotation was observed. The greatest improvement was observed in flexion and abduction, and the smallest in internal rotation.

Tab. 3. Constant scores before treatment and at the final follow-up

Data characteristics	Constant-Murley Score	
	Before [points]	After [points]
min-max	4–53	42.5–96
średnia/mean	36	76

The mean value obtained during the preliminary examination was 36 points. The lowest value was 4 and the highest was 53. During the follow-up examination, the mean value increased to 76 points. The lowest value obtained was 42.5 points, and the highest 96 points.

Tab. 4. Constant-Murley Score – assessment of pain intensity in the preliminary and follow-up examination

Constant-Murley Score – Assessment of pain intensity	Patient						Mean value
	I	II	III	IV	V	VI	
Preliminary examination	1.5	3.5	8	5	2.5	0	4.1
Follow-up examination	10.5	15	15	15	11	6.5	12.1

Table 4 shows the number of points scored by each patient in the Constant-Murley Score in the section assessing pain. On the scale, the maximum number of points obtained is 15, where "0" is maximum pain and "15" is no pain. The mean value of pain intensity in patients before surgery was 4.1 points, and 12.1 points after surgery in the follow-up examination.

Tab. 5. Constant-Murley Score – activities of daily living (ADL) in the preliminary and follow-up examination

Constant-Murley Score – ADL	Patient						Mean value
	I	II	III	IV	V	VI	
Preliminary examination	4	4	12	6	6	4	6
Follow-up examination	20	20	18	18	14	12	17

Table 5 shows the number of points obtained by each patient in the Constant-Murley Score in the section assessing activities of daily living (ADL). On the scale, the maximum number of points obtained is 20, where "0" is the inability to perform activities, and "20" is the full ability to perform activities. The mean ADL value in patients before surgery was 6 points, and after surgery it was 17 in the follow-up examination.

Tab. 6. Constant-Murley Score – range of motion (ROM) in the shoulder joint in the preliminary and follow-up examination

Constant-Murley Score – ROM	Patient						Mean value
	I	II	III	IV	V	VI	
Preliminary examination	8	18	8	12	4	0	8.3
Follow-up examination	34	36	32	24	18	12	26

Table 6 shows the number of points scored by each patient in the Constant-Murley Score in the section assessing the range of motion (ROM) in the shoulder joint. On the scale, the maximum number of points obtained is 40, where "0" is no range of motion and "40" is the full range of motion. The mean preoperative ROM value in patients was 8.3 points, and after rehabilitation it was 26 in the follow-up examination.

Tab. 7. Constant-Murley Score – assessment of the strength of the hand grip using a dynamometer in the preliminary and follow-up examination

Constant-Murley Score – strength [kg]	Patient						Mean value
	I	II	III	IV	V	VI	
Preliminary examination	12	20	12.5	25	25	0	18.9
Follow-up examination	25	25	25	25	25	12	22.8

Table 7 shows the number of points obtained by each patient in the Constant-Murley Score in the section assessing the strength of the hand grip. On the scale, the maximum number of points obtained is 25, where "0" is the lack of strength and "25" is the strength comparable to the healthy limb. The mean value of strength in patients before surgery was 18.9 kg, and after rehabilitation it was 22.8 kg in the follow-up examination.

Results

Significant increases in shoulder mobility were noted in all patients. The greatest improvement was achieved in shoulder

joint flexion, where the mean increase in value was 60°. Internal rotation increased by an average of 9°. Improvement of both rotations was the hardest to achieve, possibly due to the absence of the rotator cuff tendons responsible for this function. The analysis of the data obtained with the use of the Constant-Murley Score allows for the conclusion that the proposed rehabilitation system used after RTSA brings satisfactory results. In addition to improving the function of the upper limb, pain reduction was also observed.

Discussion

The study presents the course of rehabilitation of patients after shoulder surgery. The functional parameters of the upper limb before RTSA and after the rehabilitation program were compared. There was a noticeable improvement in the Constant-Murley Score. At the first measurement before surgery, the mean value on the scale was 36 points. After RTSA and the rehabilitation process, the result was improved and an average value of 76 points was obtained (Table 2). Collin et al. [9] presented similar results in their research. In their research, the total Constant-Murley Score was initially 28 points, and at the final stage it was 64 points. Their results also showed an improvement in mobility in the shoulder joint. The individual data and differences in the Constant-Murley Score are presented in Table 8.

Tab. 8. Constant-Murley Score before surgery and during the last follow-up

Assessed feature	Own study		Collin et al.	
	Before surgery	At the end of the study	Before surgery	At the end of the study
Total score	36	76	28	64
Pain	3.4	12.1	6.3	13.2
ADL	6	17	7.6	17.7
ROM	8.3	26	13.1	28
Strength [kg]	17.8	20.7	0.50	2.31

Improvement of the shoulder joint function was also demonstrated in the studies conducted by Simovitch et al. [10]. Before surgery, the mean score was 31.1, and after the procedure it was 71.2. In the study conducted by Kim et al. [11] an increase in the Constant-Murley Score was also observed (44.3 vs 67.1 points); it is also noted that the desired values of flexion and external rotation were restored within 6 months after surgery. The publication by Li et al. [12] presents the results where slightly lower values of the range of motion were achieved. The range of flexion was 116°, abduction 93°, and external rotation 39°. In internal rotation, patients were able to reach the third lumbar vertebrae. In the cited study, an improvement was achieved in the Constant-Murley Score. Initial mean values were 33 and final values were 55 points. The results of the studies presented here indicate improvement in the mobility of the shoulder joint. In all participants improvement in shoulder flexion and abduction was observed. In all patients, the com-

fort of life expressed in the ADL scale improved, and a decrease in pain intensity and an increase in the muscle strength of the operated limb was observed. The small size of the group does not allow for statistical analysis (quantitative and qualitative). Nevertheless, the obtained results of rehabilitation of patients after RTSA prove the effective choice of methods in the reverse biomechanical structure of the shoulder joint. Taking into account the specificity and complexity of RTSA, separate methods of rehabilitation of operated patients should be implemented, which differ from the rehabilitation model after TSA (total reverse arthroplasty). There is no consistent data available in the available algorithms for physiotherapy treatment regarding the postoperative exercise program in the case of RTSA. Literature describes rehabilitation models practiced in orthopaedic centres, e.g. Brigham and Women's Hospital Harvard Medical School [13]. The current epidemic situation (COVID-19) resulting in limited access to rehabilitation prompted the authors to create a model of rehabilitation to be used after RTSA that could be implemented in conditions of difficult access to health services and at the same time would constitute the basis for rehabilitation at home. Considering the limitations (small group size and short follow-up time), it is necessary to point out the need to undertake activities enabling patients to participate in rehabilitation after RTSA. The authors of the program managed to obtain satisfactory results for both patients and researchers. Bearing in mind the patients' well-being and needs, the above research is continued in cooperation with a physiotherapist, an orthopaedist and patients.

Conclusions

Rehabilitation after RTSA improves the function of the shoulder joint, expressed by an increased range of joint mobility, elimination of pain and improved comfort of life of patients undergoing surgery.

Adres do korespondencji / Corresponding author

Magdalena Gębska

e-mail: mgebska@pum.edu.pl

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