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Postoperative Rehabilitation of Patients with Shoulder Arthroplasty – A Review on the Standard of Care

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Abstract

Shoulder replacement is the third most common joint replacement worldwide following hip and knee replacements. Compared with hip and knee the rehabilitation for shoulder prosthesis is discussed controversially and depends strongly on the precepts of the surgeon. The objective of this paper is to determine the current standard of care of rehabilitation following shoulder arthroplasty based on a systematic review.

The PubMed database was searched with the terms, [rehabilitation] and [shoulder prosthesis]', '[rehabilitation] and [glenohumeral joint replacement]', '[shoulder prosthesis] and [physiotherapy]' and '[total shoulder replacement] and [rehabilitation]'. In total 1,026 papers were found in the primary search, crosschecking all relevant results another 1,332 papers were detected. All papers were scanned manually for relevance on the topic. Finally, ten papers were included which were in accordance with the inclusion criteria. All indications leading to shoulder replacement as well as all types of replacement procedures were included.

In summary there are many parallels between different rehabilitation protocols which can be used as a general guideline. Based on the consensus regarding intensity of physiotherapy, post-operation immobilization and total rehabilitation time a three-phase-protocol, which starts passive and increases to active-assisted and to active, was extracted. Up to now no publication shows the influence of rehabilitation following shoulder prostheses. Therefore, prospective studies are needed.

Keywords: Shoulder replacement; Rehabilitation

Introduction

Following hip and knee, the shoulder is the third most often replaced joint worldwide [1]. The number of implants is constantly growing and results are improving [2]. While there are comparable postoperative treatment protocols for hip and knee joints, evidence-based guidelines are missing for shoulder replacements [3]. However, the rehabilitation depends on the prescription of the surgeons and these precepts show a lot of variation, e.g. optimal start of rehabilitation, duration and method of immobilization. There are no uniform standards regarding the maximum allowed range of motion (ROM) and the intensity of physiotherapy. However, there are some similarities in the postoperative treatment protocols regarding intensity, starting point and type of physiotherapy [4]. These parameters lack any evidence regarding the outcome of the replacement procedure towards ROM, pain and function. Complicating, rehabilitation does not only depend on the prescription of the surgeons, it also relies on the preoperative condition of the patient, possible complications during surgery, surgical technique and prosthesis type [3,5].

This methodical review aims to give a general overview on current trends in postoperative care for patients receiving shoulder arthroplasty. Possible advantages and disadvantages of different rehabilitation protocols are examined based on the current literature. Furthermore, we intend to develop a guideline for the rehabilitation of patients receiving shoulder arthroplasty.

Methods

A literature search was performed in the PubMed database. Search terms were, '[rehabilitation] and [shoulder prosthesis]', '[rehabilitation] and [shoulder arthroplasty]', '[rehabilitation] and [glenohumeral joint replacement]', '[shoulder prosthesis] and [physiotherapy]' and '[total shoulder replacement] and [rehabilitation]'. All abstracts were scanned manually for relevance to the topic. Inclusion criteria were English or German language, publication date 1994 or later as well as an description of the rehabilitation protocol and the follow up. We included original papers and review articles on the topic. Exclusion criteria were works published before 1994, other languages than English and German, missing information on rehabilitation protocol, case reports and television based programs. Based on these selective criteria nine papers were eligible for inclusion. The nine selected papers were again entered in the PubMed database and crosschecked for all related articles. Based on the crosscheck one more paper fulfilled the criteria. Using the above mentioned search parameters and inclusion and exclusion criteria, ten studies were eligible for inclusion.

Results

A total of 1,026 papers were identified in the PubMed database published between October 1994 and October 2011 (Table 1). Crosschecking the relevant articles another 1,332 articles were identified and manually reviewed. With this method, one additional article was included, contributing to the objective of this study (Table 2). In total, there were ten relevant papers, nine were identified in the primary search; one more was identified by crosschecking the initially found papers (Table 3).

Search terms	Total results		Relevant articles	
	All	Review	All	Review
[Rehabilitation]and [Shoulder prosthesis]	567	71	9	1
[Rehabilitation] and[Glenohumeral joint replacement]	193	37	6	1
[Rehabilitation] and [Total shoulder replacement]	101	17	4	1
[Rehabilitation] and [Shoulder Arthroplasty]	301	68	6	1
[Physiotherapy] and [Shoulder prosthesis]	165	24	5	1
Total	1,026	149	24	4

Table 1: Search terms and respective results

Author	Journal	Date	Related articles		Relevant articles	
			All	Review	All	Review
Babhulkar et al. [9]	J OrthopSurg	08/2011	106	5	2	0
Mulieri et al. [10]	J Shoulder Elbow Surg	06/2010	97	1	1	0
Boudreau et al. [3]	J Orthop Sport PhysTher.	12/2007	88	30	2	1
Agorastides et al. [6]	J Shoulder Elbow Surg	05/2007	143	16	1	0
Amirfeyz, Sarangi [7]	J Orthop Sport PhysTher.	12/2007	189	16	3	1
Boardman et al. [4]	J Arthroplasty	06/2001	66	8	3	1
Brown, Friedman [11]	Ortho Clin North Am	07/1998	88	30	6	2
Brems [5]	ClinOrthopRelat Res	10/1994	100	27	5	2
Total			1.230	158	25	8

Table 2: Related articles identified by entering the search terms of Table 1 were crosschecked for each further relevant article containing information on the topic

Author	Level of Evidence	Number of patients	Follow-up	Rehabilitation protocol*	Conclusion
Babhulkar et al. [9] (India)	Case series – level III	27 patients	2 and 6 weeks & 3 and 6 month	4 phases	neither the injury-to-surgery interval, the age, the gender of the patients nor the fracture type had a significant impact on the outcome therefore it is shown that a hemiarthroplasty is the best treatment for a proximal humeral fracture
Mulieri et al. [10] (USA)	Case-Controls-Study – level III	81 patients – 2 groups (A: 43 pat., B: 38 pat.)	3,6 & 12 month	4 phases	2 groups: A: formal physical therapy, B: home-based program There are no significant differences between the two groups in the ASES and simple shoulder test in the final follow up. But Mulieri et al. mention in functional approach after 4 weeks

					– they train active-assisted in diagonal patters.
Bourdreau et al. [3] (USA)	Narrative review – level IV	n/s	n/s	4 phases	Rehabilitation of rTSA is different to a non-reversed TSA. 3 major aims: a) joint protection, b) deltoid function and c) ROM
Agorastides et al. [6] (England)	RCT – level I b	59 patients – 2 groups (early: 31 pat., late: 28 pat.)	12 month	Early: 3 phases Late: 2 phases (or 3 phases, if phase 1 is the immobilization)	No significant difference in the constant Shoulder Assessment & Oxford score between the 2 groups. The late group had less pain and was better in ADLs. They also show a trend to less tuberosity migration.
Amirfeyz, Sarangi [7] (England)	Case series – level III	40 patients	3,6 and 12 month	2 phases	Postoperative immobilization (4 weeks sling) does not lead to shoulder stiffness.
Boardman et al. [4] (USA)	Case series – level III	80 patients	2 years	Home based program – 3 phases	Reasonably safe, effective and user-friendly program
Brown, Friedman [11] (USA)	Survey article/ narrative review – level IV	n/s	n/s	4 phases	The rehabilitation program should include a preoperative visit and must be individual. The time the different phases start is not that important than the order of the exercises – maximizing motion to aggressive strengthening.
Brems [5] (USA)	Survey article/ narrative review – level IV	n/s	n/s	3 phases	Main aims: maximum ROM and high strength level. 4 key-points: 1. early therapy beginning, 2. allow active movement as soon as possible, 3. any aids should be reduced, also the sling and 4. maximum passive ROM in the first phase before starting with the strengthening
Wilcox et al. [8] (USA)	Narrative Review/ clinical commentary – level IV	n/s	n/s	4 phases	Achieving the next step does not follow a time-line, as in most other reports in the literature, but considers the healing progress, measured as ROM and strength, as significant parameters to continue in a personalized training program
Wicker et al. [13] (Austria)	Survey article/ narrative review – level IV	n/s	n/s	3 phases	sensomotoric function of the shoulder has to be focused on and the program has to be individual and early functional
				*: see Table 4 for further details rTSA: reversed total shoulder arthroplasty ASES: American shoulder and elbow surgeons score for pain ROM: range of motion ADL: activity of daily living	

Table 3: All included papers with the main key points, country, evidence level and type of study

Discussion

With this study we intended to identify relevant articles on the rehabilitation of shoulder arthroplasty. The focus of our interest was to analyze the influence of the postoperative rehabilitation protocols on the outcome and to show current trends in the application of physical therapy for these patients. Among a huge amount of articles, dealing with the topic in general, only few were identified fulfilling our highly selective inclusion criteria. Major limitation of most papers was the insufficient reporting on the protocols of how the patients actually were rehabilitated. Primarily, most papers focus on the influence of the surgical technique or the prosthesis type on the final outcome. Due to these criteria only 11 papers were contributing to answer our initial question.

The included works showed a great variety in the different postoperative treatment protocols following shoulder arthroplasty, although we were able to identify common patterns (Table 4). In

general, the different rehabilitation protocols can be differentiated in three- and four-phase-protocols. Independent of the prosthesis type, there is no standardized timing for the optimal starting point of the rehabilitation. Some protocols favor an early start, beginning immediately the day after surgery, while others start a few weeks postoperatively, in the meanwhile immobilizing the shoulder in a sling or a similar device [6].

Author	Procedure type	Phase			Comments
		1	2	3	
Agorastides et al. [6]	Hemiarthroplasty for 3/4-part humerus fracture	A: sling for 2 weeks, pendulum, elbow exercises B: sling for 6 weeks in neutral rotation, elbow exercises	A: week 3-6 – progress AAROM exercises B: week 7-12 – pendulum to AAROM	A: from week 7 on – active exercises B: from week 13 on – active exercises	Early (group A) vs. late (group B) start
Amirfeyz, Sarangi [7]	Hemiarthroplasty 3/4-part prox. Humerus fracture	Sling – shoulder in IR & 90° elbow FLEX Finger and wrist movement allowed	Week 5-10 – pendulum to active-assisted exercises	Form week 11 on – active exercises & strengthening rotator cuff	4 weeks sling before physiotherapy commences
Boardman et al. [11]	Primary TSA Cofield components	1.day post-surgery: AROM hand, wrist, forearm & elbow; PROM shoulder (depending on stability)	At week 3 – assisted pulley exercises for evel. Week 5 – AAROM & stretching with a wand for FLEX-EXT, ELEV – ADD; IR-ER at 90° ABD	From 8-10 weeks on: elastic strap strengthening	Shoulder immobilizer: 1 week during the day and 4 weeks during night, then: 4 weeks sling
Brems [5]	TSA	1.day post-surgery - pendulum, assisted spine ELEV, assisted ER, assisted ELEV with pulley and assisted ABD	Ca. 2 weeks after surgery - assisted IR, assisted ELEV, assisted ER	assisted ELEV, assisted ER with elbow 90° ABD, assisted IR and assisted ADD	After phase III strengthening program starts, full PROM should be reached by then
Babhulker et al. [9]	Hemiarthroplasty for 3/4-part prox. humerus fracture	1.day post-surgery – pendulum, PROM exercises	Week 3 to 6 – AAROM elev., ER, full elbow ROM exercises	Week 6 to 8 – stretching and strengthening with theraband	Sling pouch for 4 weeks
Wicker et al. [13]	Prosthesis upper extremity	Aim: freedom of pain, sling, pendulum, PROM	Aim: increasing ROM, no sling; AAROM to AROM, strengthening the trunk, cardiovascular training	Aim: stabilization, all ADLs, torso- and shoulder-stabilization, plyometric exercises	sensomotoric function of the shoulder has to be focused on
			ROM: range of motion AROM: active range of motion AAROM: active assisted range of motion PROM: passive range of motion ELEV: elevation IR: internal rotation ER: external rotation ADL: activity of daily living FLEX: flexion EXT: extension ADD: adduction ABD: abduction TSA: total shoulder arthroplasty		

Table 4: Three-phase protocols

Most of these protocols are based on recommendation made by Hughes and Neer (Hughes and Neer, 1975), who were among the first to report requirements for the post-surgery treatment following shoulder arthroplasty. Since then, only little evidence regarding postoperative treatment protocols can be found in the current literature.

Boudreau et al. [3] outline in a clinical commentary the main rehabilitation points for patients with a reverse total shoulder arthroplasty (rTSA) due to glenohumeral joint arthritis and complex fractures of the humeral head. They recommend the following four phases: phase 1 (1st day up to 6 weeks after surgery): immediate postsurgical joint protection; phase 2 (week 6-12): active ROM/early

strengthening; phase 3 (week 12+): moderate strengthening; phase 4 (four month post-op): independent/progressive home program. The authors recommend that the therapist should consult the surgeon and, optimally, meet the patient before the surgical intervention, giving him or her better understanding of the preoperational situation.

In accordance with Boudreau et al., Brems [5] recommended to develop an individual therapy program. Therefore the therapist has to get to know the patient personally before the surgery. The therapist should get the details of the surgical procedure. This includes a consultation with the surgeon, who performed the procedure. Based on these details, the program is tailored to the individual needs of the patient. The authors of this review emphasized that the main objective of the rehabilitation after a TSA is to maximize ROM and strength level.

Agorastides et al. [6] examined in a randomized controlled trial 59 patients with a three and four part fractures of the humeral head undergoing arthroplasty and indicate that these procedures request a slower rehabilitation process in comparison to other forms of shoulder arthroplasty. Therefore the patients were divided into two groups: one with an early, one with a late therapy start. The authors recommend starting passive mobilization early following the surgical procedure. In contradiction to other indications, fracture related replacement procedures demand a later start in active motion.

Although most of the rehabilitation protocols prefer an early mobilization start, Agorastides et al. did not detect a significant difference in the outcome between the early and the late group after 6 and 12 month. Even so, the tuberosity displacement was less in the late mobilization group.

Amirfeyz and Sarangi [7] analyzed in a prospective study including 40 patients without an control group the results of rehabilitation after shoulder hemiarthroplasty for fractures of the humeral head and hypothesize that a late rehabilitation start gives better results but has a higher risk of shoulder stiffness. The authors had to reject the initial hypothesis. Due to the lack of evidence on relevance of the start time of rehabilitation, the authors decided to immobilize their patients for four weeks. They concluded that postoperative immobilization did not result in stiffness or impaired functional results regarding the range of motion.

Wilcox et al. [8] included all indications of a total shoulder arthroplasty apart from fractures in their clinical commentary. In contradiction to most other reports in the literature, the authors' don´t recommend a timeline to proceed to the next phase, but clinical parameters such as ROM and strength. The authors emphasize that this will lead to a huge variety, since the patients´ progress based on these parameters shows a great variation. This implies the risk to overburden one patient, while another patient may have to potential to proceed faster. Even if an early rehabilitation start can be recommended, the therapist and the patient have to be aware that the tissue needs time to heal (Table 5).

Author	Procedure type	Phase				Comments
		1	2	3	4	
Boudreau et al. [3]	rTSA	1.day post-surgery to week 6 – PROM FLEX & ELEV to 90°-120°, ER 20°-30°, AROM/ AAROM elbow, wrist, hand	Week 6 to 12 – continue PROM and start AAROM, isometric IR/ER exercises, shoulder stabilization, end of phase II: AROM FLEX and ELEV with low weights	From week 12 on – AROM, strengthening, full PROM	4 month post-surgery – home program: return to functional and recreational activities	Sling for 4 weeks, cryotherapy for ca. 10 weeks
Brown, Friedman [11]	TSA	passive ELEV & ER, after a few days active-assisted training, pendulum, active hand, elbow and finger exercises From day 10 on - IR active-assisted	Week 3 to 6 - isotonic FLEX, EXT, ABD & IR exercises, scapular strengthening, assisted ER at 90° ABD	Week 6 to 10 – additionally active FLEX and ABD in a sitting position and resisted IR and ER	Week 12 to 6 month - resisted FLEX, EXT & ABD, strengthening bilateral push-up against the wall, a concentering strengthening with isokinetic equipment	
Mulieri et al. [10]	TSA for primary osteoarthritis	A: 1.day post-surgery to 3 weeks – immobilizer/ sling, AROM elbow, wrist, hand; shoulder PROM max. 20° ER & 120° ELEV in scapular plane B: for 8 weeks – immobilizer and pendulum	A: week 4 to 6 - sling; resisted elbow, wrist, hand exercises, AAROM 35° ER, 135° scaption; shoulder exercises with a wand, isometric shoulder exercises, kinetic exercises (closed chain) B: ADLs	A: week 7 to 9 – continue AAROM shoulder and start AROM shoulder in supine; isometric exercises all motion at various angles B: week 8 to 14 - ROM exercises, supine forward elevation	A: week 9 to 12 – shoulder AROM in standing position, strengthening exercises with theraband, ADLs B: week 14+ any ADLs and activities the patient chooses	2 groups – A: formal physical therapy – diagonal patterns, B: home-based program
Wilcox et al. [13]	TSA or HHR	1.day post-surgery – sling for 3-4 weeks,	Week 4 to 6 – continue PROM, AAROM pulleys flex &abd if PROM	Week 6 to 12 – AROM, PROM to maintain ROM, resisted IR & ER	From week 12 on – strengthening, weight-bearing exercises	

		PROM forward flexion in supine, ER 30°, IR to chest, pendulum, AROM elbow, hand, wrist, cryotherapy	>90°, AROM flex, IR, ER & ABD pain-free ROM, scapular strengthening, distal isometric exercises with resistance, cryotherapy	in scapular plane, light functional activities		
				ROM: range of motion AROM: active range of motion AAROM: active assisted range of motion PROM: passive range of motion ELEV: elevation IR: internal rotation ER: external rotation ADL: activity of daily living FLEX: flexion EXT: extension ADD: adduction ABD: abduction TSA: total shoulder arthroplasty		

Table 5: Four-phase protocols

In a prospective analysis including 27 patients and a 6 month follow up period, Babhulkar et al. [8] conclude that neither the patient's age, nor gender, nor injury-to-surgery interval, nor the fracture type had a significant impact on the outcome. In most cases there are complications, secondary diagnosis or a personal factor why the rehabilitation time lengthens.

Brems [5] showed in a retrospective analysis with 80 patients and a follow-up time of two years the clinical outcome after total shoulder arthroplasty. All indications for TSA were included. However, no fractures were included. The description by Boardman et al. gives samples for a home-based therapy program which is again based on Hughes and Neer's basic program. Patients are instructed at the hospital by a physiotherapist how to train hand, wrist and elbow actively and the shoulder passively from the first day post-surgery with the help of a relative. After three weeks, pulley exercises are added to the program. After five weeks, the patients get new instructions for active-assisted motion and stretching exercises. The results after two years show that this home-based program is safe and effective to maintain the obtained intraoperative motion.

Mulieri et al. [9] are the only ones to report on a different program. In their retrospective analysis, including 81 patients, who are divided in 2 groups, they compared a standard physiotherapy program with a home-based program. After the final follow-up time, there were no significant differences between the two groups. But in the physiotherapy group, Mulieri et al. emphasize on active-assisted training in diagonal patterns within 35° ER and 135° scaption (scapular plane elevation). They recommend this kind of training from the second phase on. This shows a functional approach within the rehabilitation after four weeks. Using three-dimensional movement patterns is an effective way to improve strength and stamina within a functional treatment concept. The aim of this kind of exercises is to regularize the movements and every pattern includes a rotation component. To train in diagonals is an effective way to restore the normal combination of movements which are necessary for any ADLs. The two basic principles for the rehabilitation of a shoulder arthroplasty should be: 1. immobilization as short as possible and 2. Function as early as possible.

In summary, most authors recommend a three phase protocol. Also, most authors agree to start with the rehabilitation immediately following the surgical procedure. We did not identify a study, employing a four phase protocol in patients receiving arthroplasty due to fractures of the humeral head. In early starts, the authors agree to start with passive motion. The time to start with active exercises with the replaced shoulder varies, starting from four to eleven weeks.

There is also agreement to start later with active exercises in case of a replacement of the shoulder joint in patients with fractures [6].

Considering all different studies, a general guideline for the rehabilitation of patients with shoulder arthroplasty for degenerative or rheumatoid diseases' (all indications, but no fractures) could consist of the following therapeutic treatments:

The first phase, lasting from week 1-4, the shoulder is immobilized in a cushion device or an abducting sling. Passive exercises are allowed up to 30° external rotation and 130° forward flexion [5]. Wrist, hand and elbow can be trained actively from the first day postoperatively on [10].

Most authors suggesting four-phase protocols define the last phase as the treatment following the rehabilitation to gain strength and ROM. Therefore, most authors agree to mobilize the patient depending on pain without limiting ROM and weight.

Beside the therapeutic issues this article deals with there are many other physical modalities that may contribute to the successful rehabilitation of patients following shoulder arthroplasty such as water based training, electrotherapy, massage, acupuncture and many more. Some of these methods already have shown statistically significant influence on the outcome while others are still being discussed in the literature. A comprehensive review regarding physical therapy for

patients following shoulder replacement is needed to discuss this interesting aspect further.

The initial aim of our work was to create a general guideline for the rehabilitation following shoulder arthroplasty. In the works we were able to identify, the duration of the rehabilitation protocols is very similar, but the duration and recommendations for the different phases in rehabilitation varies. Figure 1 is a synthesis of the recommendations of the works included in this review.

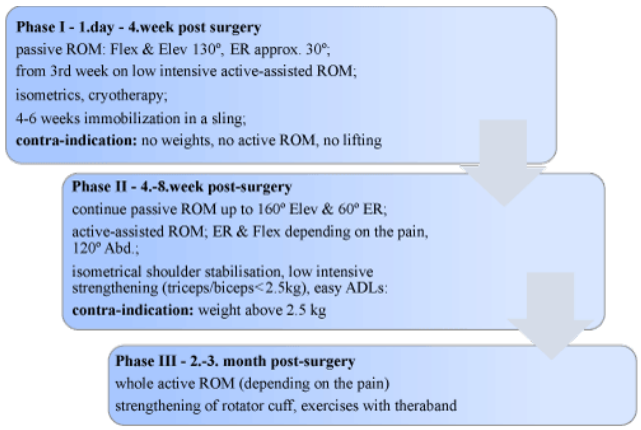

Figure 1: Synthesis of recommendations of all papers included in this review

Conclusion

As a first general program for physical therapy after shoulder replacement we recommend: the patient should wear a sling for immobilization for about four weeks to reduce the risk of a shoulder dislocation. The rehabilitation should start early as there is no evidence in the reviewed papers indicating a disadvantage to an early start [5,6]. An early rehabilitation start also reduces the chance of a therapy gap. The therapy protocol should be divided in three phases. Important is an immediately active hand, wrist and forearm training to avoid stiffness in the elbow and wrist [7-10]. Furthermore, increasing movement training from passive to active-assisted to active should be followed. Some of the authors advise to contact the surgeon for creating an individual rehabilitation program because he knows about any potential problems during surgery and the important information pertaining to the implanted type of prosthesis [3,5]. For a planned surgery, e.g. for arthritis patients, a preoperational report should be prepared to define appropriate therapy goals for each patient. The protocol should provide a target ROM for the end of each phase as a reference point for both the patient and the therapist.

In general it must be noticed that as of now there are is no evidence-based rehabilitation protocol for shoulder replacements. There is a lack of research data on advantages and disadvantages of existing protocols, thus no standard protocol could be deduced. Furthermore the consultation with the surgeon, if possible a pre-surgeon examination of the patient by the therapist, and the status of the tissue healing are the most important factors in creating an individual therapy protocol for each patient [11-13].

More prospective randomized studies are required to establish out best care following shoulder arthroplasty. There were no studies found comparing two different rehabilitation protocols or the outcome of one protocol for different surgical indications or different prosthesis types.

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