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Rehabilitation Treatment following Total Shoulder Arthroplasty

Debbie Aarhus
University of North Dakota

REHABILITATION TREATMENT FOLLOWING TOTAL SHOULDER ARTHROPLASTY

by

Debbie Aarhus
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This Independent Study, submitted by Debbie Aarhus in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

Michelle LaBrecque
(Faculty Preceptor)

Thomas Moak
(Graduate School Advisor)

Thomas Moak
(Chairperson, Physical Therapy)

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Department Physical Therapy

Degree Master of Physical Therapy

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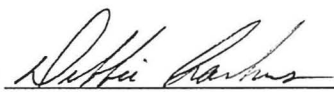
Signature 

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I would like to thank my parents for without their support and pushing, I would not have ever made it.

ABSTRACT

The shoulder is a very complex joint in the human body and, therefore, is easily injured and/or damaged. When conservative methods (pain reducing modalities, exercise, or medication) to treat the injury fail, an alternative method of treatment could be a total shoulder arthroplasty. Corrective surgery alone, however, is not enough. A rehabilitation program involving range of motion and strengthening exercises is fundamental in the successful return of function at the shoulder.

The purpose of this literature review is to provide an overview of shoulder anatomy, surgical procedures of total shoulder arthroplasty, rehabilitation protocols, and outcomes. The information gained from this literature review will be useful for physical therapists who work with individuals following a total shoulder arthroplasty by enhancing their knowledge of surgical procedures, outcomes, and the importance of rehabilitation.

CHAPTER I

INTRODUCTION

The shoulder has more available range of motion than any other joint in the body and has the capability to move through a space greater than its hemisphere.[1] This freedom of movement is gained from the absence of bony constraints.[2] Due to the lack of bony support, the shoulder must depend on muscles and tendons to support the integrity of the joint. Due to this dependency, the shoulder has a high potential for injury and dysfunctional pathology.

The shoulder girdle is frequently injured following violent contact or excessive overuse exercises.[3] Particular lesions may be divided into three fairly definable groups: 1) contusions or strains of soft tissue structure, 2) injuries of the clavicle and its articulation which may include fractures of the clavicle, sprains, subluxation and dislocations of the acromioclavicular and sternoclavicular joints, and 3) injuries of the glenohumeral joint including subluxations and dislocations, fractures of the proximal humerus, scapular fractures related to the glenohumeral joint, and various traumatic lesions.[3]

Performing a total shoulder arthroplasty is one option available to patients with shoulder pathology. Often physicians prefer a more conservative approach

to address problems at the shoulder. This may include medications, modalities for pain relief, and exercise. When conservative methods fail, a total shoulder arthroplasty, an open surgical technique which consists of replacing the surfaces of the glenoid cavity and humeral head with a prosthesis, may be performed.

An articular replacement for the humeral head was first described in the 1955 *Journal of Bone and Joint Surgery* by Dr. Neer.[4,5] These surgeries were performed on patients with humeral fractures or with dislocations.

When it comes to shoulder pathology, finding the diagnosis of the problem and corrective surgery are not enough.[6-9] A proper rehabilitation program is an essential component for the success of shoulder pathology recovery.[10-12] The rehabilitation is as important as the surgical technique itself and should be started on post-operative day one.[13]

Following total shoulder arthroplasty, the patient must follow a sensible rehabilitation program permitting healing of the tissues, joint mobilization, range of motion, and muscle strengthening. Normal shoulder function is achieved through gaining maximum available range of motion (passive and active) and good to normal strength. Even though every patient is different and has special requirements, it is important to keep these factors in mind for the choice of shoulder protocols and progression of their rehabilitation.

One of the most commonly used shoulder protocols is the three phase system suggested by Hughes and Neer.[14] The phase system describes the progression of exercise programs with phase one being passive, phase two

active, and phase three resistive. There are three primary goals for rehabilitation of the shoulder post-arthroplasty. They are mobilizing the shoulder joint, achieving maximal range of motion (ROM), and strengthening the rotator cuff muscles. Hughes and Neer also believe that the optimal results are achieved through three primary motions: flexion or forward elevation, internal rotation, and external rotation. They also concluded that emphasis on abduction causes the patient to be discouraged by a poor rate of return in both strength and motion.

The world's best surgery and rehabilitation can be ineffective if the patient is not motivated to perform exercises.[15] Early movement is necessary to prevent maturation of adhesions.[14] The patient should be actively involved with their rehabilitation prior to surgery, by attending total shoulder arthroplasty workshops (if they are offered), and researching the procedures and precautions of the operation.

The purpose of this study is to review the type of shoulder rehabilitation protocol that is presently being used following total shoulder arthroplasty. This literature review will include general anatomy, surgical procedure, exercise protocols, and outcomes to provide a comprehensive review of these areas as related to total shoulder arthroplasty.

CHAPTER II

ANATOMY AND BIOMECHANICS OF THE SHOULDER

The shoulder is one of the most complex structures in the body as it has the greatest amount of mobility. The shoulder consists of four primary joints: glenohumeral (GH), acromioclavicular (AC), sternoclavicular (SC), and scapulothoracic articulation (ST). The three bones at the shoulder are the humerus, scapula, and clavicle. There are 15 different muscles in the shoulder and many ligaments and tendons.

Shoulder Joints

The acromioclavicular (AC) joint is a planar synovial joint with three degrees of freedom, located between the lateral/acromial end of the clavicle and the acromion of the scapula.[16-19] It is located two to three centimeters medial to the acromion, which projects anteriorly from the lateral end of the spine of the scapula.[16] The AC joint has a capsule and two major ligaments; a joint disc may or may not be present.[18] The acromion forms a palpable and sometimes visible prominence known as the "point of the shoulder."[16]

The sternoclavicular (SC) joint might be considered the "base of operation" for the scapula since, via connection to the clavicle, it is the only structural point where the scapula is attached to the rest of the body.[16,18,19] The

SC joint is a plane synovial joint with three degrees of freedom of motion, a joint capsule, three major ligaments, and a joint disc.[18] The SC joint is made up of two saddle type joints; one at the sternal end of the clavicle and one at the notch formed by the manubrium of the sternum and first costal cartilage.[16,18] The articular cartilage of the SC joint surfaces are separated by a strong, thick, densely fibrous or fibrocartilaginous articular disc.[16] The anterior and posterior sternoclavicular ligaments thicken the fibrous capsule of the SC joint, preventing medial displacement of the clavicle and absorbing shock.

The scapulothoracic (ST) joint is formed by the articulation of the scapula with the thorax beneath it.[16-18] It is not considered a true anatomic joint since it has none of the usual joint characteristics of union by fibrous, cartilaginous, or synovial tissue.[18]

The acromioclavicular joint, sternoclavicular joint, and scapulothoracic joint aid in enabling the humerus to travel through 180° of abduction. This available range of motion allows a person to perform common activities of daily living, such as reaching up in a cupboard, reaching behind one's back to unfasten a brassiere, or extending one's hand for a handshake.[2]

The glenohumeral (GH) joint is a ball-and-socket synovial joint which has three degrees of freedom: flexion/extension, abduction/adduction, and internal/external rotation.[16] Located around the edge of the glenoid is a fibrocartilage ring which is called the labrum.[16,18] The labrum adds depth to the glenoid cavity and it lends extra stability to the joint. The ball is the head of the

humerus which only has a small amount of contact with the glenoid. The glenohumeral joint, along with the labrum, is not deep enough to give stable bone support. This results in a loose joint capsule that must rely on the strength of tendons and muscles, particularly the rotator cuff, to hold it together.[20] On the lateral-superior portion of the scapula, the socket part of the joint is directed anteriorly, laterally, and superiorly.

In the physiologic motion of the glenohumeral joint, the humerus goes in the opposite direction of the head of the humerus. During shoulder flexion, the humeral head slides posteriorly and during extension, the humeral head slides anteriorly.[21]

The open pack position of the shoulder is 20° in the scapular plane. The closed pack position is achieved when the shoulder is taken to the end of abduction and then placed into external rotation.[22]

Shoulder Muscles

The rotator cuff consists of four muscles: the subscapularis, infraspinatus, teres minor, and supraspinatus (SITS). These muscles make up the musculotendinous cuff which aids in stabilizing the head of the humerus while it moves on the glenoid labrum and creates a fulcrum.[2,19,23] This fulcrum enables the deltoid to abduct the arm without causing an impingement of the muscles between the head of the humerus and against the acromion arch.

The supraspinatus lies in the supraspinatus fossa located superior to the spine of the scapula and attaches to the greater tubercle of the humerus.[16,19] The main function of the supraspinatus is abduction.

The subscapularis is located on the costal surface of the scapula forming part of the posterior wall of the axilla. The muscle then crosses the anterior aspect of the shoulder joint and is attached to the lesser tubercle of the humerus.[16,19] The main actions are medial rotation and adduction.

The teres minor muscle originates on the superior portion of the lateral border of the scapula, part of the posterior wall of the axilla, and attaches to the greater tubercle of the humerus.[16,19] The main actions are lateral rotation and adduction.

The infraspinatus muscle occupies most of the infraspinatus fossa and attaches to the greater tubercle of the humerus.[16,19] The main action is lateral rotation.

Other primary muscles that are involved in the total shoulder arthroplasty are the deltoid and the pectoralis major. The deltoid muscle is divided into three portions. It originates on the lateral third of the clavicle, acromion, and spine of scapula and attaches to the deltoid tuberosity of the humerus.[16,19] This muscle is used for abduction/adduction and flexion/extension. It is this combined ability of the deltoid that aids in the action of shrugging. The deltoid can provide some of the stability normally provided by the rotator cuff in cases where the rotator cuff is severely deficient.[2]

The pectoralis major muscle covers the superior part of the thorax, while its lateral border forms the anterior axillary fold and the majority of the anterior wall of the axilla.[16] The pectoralis major originates at the medial portion of the clavicle and the surface of the sternum, with attachment on the intertubercular groove of the humerus. Its main actions are adduction and medial rotation.

CHAPTER III

INDICATIONS AND CONTRAINDICATIONS OF TOTAL SHOULDER ARTHROPLASTY

Indications for humeral head replacement can be divided into two major categories. The first category is acute trauma in which the tuberosities of the humerus are usually fractured.[14] Three specific acute injuries are: 1) four-part displacement fractures and fracture-dislocations where the head segment is detached from the body, 2) articular surface "impression fracture" (of greater than 50%), and 3) "head-splitting fracture."[5,14] The second major category consists of painful glenohumeral incongruities, other than acute trauma, in which the tuberosities are intact. This could include osteoarthritis, rheumatoid arthritis, traumatic arthritis, osteonecrosis, avascular necrosis of the humeral head, chronic fracture, dislocation arthropathy, cuff tear arthroplasty, sickle cell infraction, tumor (neoplasms), hemochromatosis arthroplasty, and chronic pain which requires potentially harmful medication to control the pain.[2,14,24,25]

Before physicians will even consider a surgical procedure on a perspective patient, they must make sure that the patient has no contraindications. Patient contraindications for a total shoulder may include recent or active shoulder sepsis, substantial loss of glenoid bone, deficient

deltoid and rotator cuff strength, extensive paralysis with complete loss of deltoid and rotator cuff function, suprascapular nerve paralysis, neuropathic arthroplasty, uncontrolled alcoholism, or a psychiatric disorder (inability to comply with rehabilitation regiment).[2]

CHAPTER IV

THE PHYSICAL THERAPIST'S ROLE PRE-OPERATIVELY

Physical therapy includes a wide variety of modalities, such as hands-on techniques (muscle stretching and strengthening), heat, ice, ultrasound, phonophoresis, and electrical stimulation. Physical therapy, however, is not just a mechanical exercise program performed on an individual.[26] For rehabilitation to be a success, the therapist needs to be experienced in exercise mechanics in addition to being empathetic, sympathetic, and interactive. Patients often see the therapist as a professional, a supporter, and a friend who understands their pain and apprehension.

The physical therapist should visit the patient prior to total shoulder arthroplasty surgery to discuss and demonstrate the post-operative rehabilitation program.[26] This initial interaction between the patient and physical therapist is an ideal time to begin the development of an interpersonal relationship. During the pre-surgical evaluation, the therapist should meet with the patient and any family member who will be participating in and supporting the post-surgical home care.[14,26] At this time, the therapist needs to discuss the course of the rehabilitation program, including the intent, purposes, and expectations.[14,26] During this period, a thorough evaluation should be completed. The therapist

should examine the involved shoulder, assessing range of motion and muscle strength, and discuss these findings with the patient and surgeon.[26] The therapist should then demonstrate the range of motion program that will follow the joint replacement and reassure the patient that pain and stiffness will be normal and conquerable.[14,26] The physical therapist should also be open to discussion to help answer questions and misunderstandings that arise after surgery.[26] The physical therapists' role in rehabilitation following total shoulder arthroplasty is outlined in Chapter VI.

CHAPTER V

SURGICAL PROCEDURE

In *Taber's Cyclopedic Medical Dictionary*,[17] arthroplasty is described as "the operative procedure of reshaping or reconstructing a diseased joint." This procedure is done to alleviate pain, permit normal function, and/or to correct a developmental or hereditary joint defect.

Total joint replacement is one of the major advances in orthopedic surgery in the last 20 years.[9] The pioneering techniques for replacement arthroplasty and shoulder surgery led to modern shoulder arthroplasty.

Patients often present to a physician only after they have attempted home remedies on their shoulder pain and it has not resolved.[7] These patients complain of loss of function due to pain, stiffness, and/or weakness.

Before the physician decides to use surgical intervention, he/she must evaluate the shoulder for the extent of comminution, degree of osteoporosis, and effect of interruption of the proximal humeral blood supply.[5] The blood supply to the proximal humerus is primarily from the ascending branch of the anterior humeral circumflex artery. This branch enters the bicipital groove between the tuberosities and is often interrupted in three- and four-part displacements, leading to a variable incidence of non-union and osteonecrosis.[5,6]

Besides the anatomic considerations, the surgeon must take care to select which patients are appropriate for the surgical procedure.[5] The patient must be of satisfactory health to undergo such a major surgery and also have the ability to take part in the intensive rehabilitation program which is required for a successful outcome. Patients who are unable to participate in such rigorous therapy for medical or psychological reasons should not be considered for arthroplasty.

Shoulder arthroplasty is the primary surgery for rheumatoid arthritis of the shoulder in use today.[10] The form of arthritis that is present before the operation can determine the amount of improvement in the post-operative shoulder. As a rule, patients with degenerative joint disease fare better with shoulder arthroplasty than do those with inflammatory arthritis.[10] A typical candidate for shoulder arthroplasty is 55 years of age, with his/her dominant arm affected.[9,11] The majority of female patients have rheumatoid arthritis while the male patients have osteoarthritis.[9]

The History of Total Shoulder Arthroplasty

In earlier studies, the results of 20 unimpacted fracture-dislocations treated by reduction, excision of the head, or arthrodesis were found unsatisfactory.[27] Reduction was followed by avascular necrosis because the head was without soft-tissue attachments.[4] Arthrodesis failed because of the associated displacement of the tuberosity. Excision of the head with or without tendon transportation resulted in a flail joint which lacked a fulcrum for abduction

and rotation.[28] After excision of the humeral head, the shoulder remained painful for many months until ankylosis through fibrous tissues and bone finally occurred.[4] Replacement with a prosthesis presented a logical solution in these cases. The initial prosthesis had been designed for the treatment of these injuries.[3,27]

A French surgeon, Dr. Pean, attempted the first documented total shoulder arthroplasty in 1893.[2,29] Shoulder arthroplasty in the modern era was pioneered by Dr. Lawrence Jones, who performed a resection arthroplasty of the humerus in the early 1900s.[2] In 1951, Charles Neer pioneered the hemi-arthroplasty and, in 1955, he formally reported his initial success with this technique.[2,4] In 1970, Dr. Neer began performing total shoulder arthroplasties by adding a component to replace the glenoid socket.[2] By 1973, Dr. Neer began exclusively implanting the Neer II prosthesis, which was the first prosthesis with two separate surfaces for the glenoid and humeral head (this is called an unconstrained model). The Neer II prosthesis was released for general use in 1982 with a redesigned humeral head (to fit the glenoid component) and an ultra-high molecular weight polyethylene (UHMWPE) cemented glenoid component that is still in use today.

This was the beginning of the huge influence that Dr. Charles Neer would have on general shoulder arthroplasty. His surgical and rehabilitation protocol is followed by nearly all of the literature compiled for this study. The most widely used shoulder replacement is the one designed by Neer.[5,30]

Pre-operative Management

After the patient has been cleared of any contraindications, it is then necessary to conduct a pre-operative evaluation. The pre-operative evaluation must be done as soon as possible since surgery should be performed within ten days of injury.[14]

Prior to admission into the hospital, the patient should be given information regarding the upcoming surgery and what to expect. This information should include a list of the medical evaluations required, information about the anesthesia, use of antibiotics, and the general pre-operative and post-operative nursing and physical therapy management.[9,14] Pre-operatively, the surgeon will often discuss the surgical procedure with the patient including possible outcomes.

The surgeon routinely orders either an arthritis or trauma series of x-rays before the patient is admitted into the hospital. The series of x-rays performed depends on the reason for shoulder surgery. The arthritis series includes a standard anteroposterior view (AP), an axillary lateral view, and a Grashey, which is an AP x-ray with the patient placed at a 15° angle to the x-ray beam.[9] The Grashey view radiographically opens the glenohumeral articulation and allows the surgeon to see the thickness and integrity of the articular surfaces. The trauma series are radiographic views that are taken at right angles to one another.[5] This series includes a true anteroposterior (AP), a transcapular, and an axillary view of the fracture. The axillary view may be difficult to obtain but is

helpful in some cases where there has been severe articular damage, a head-splitting fracture, or severely displaced tuberosity. Posterior fracture dislocations are often unrecognized if this view is not taken. The surgeon will also order laboratory tests including urinalysis, a complete blood count, surgical profile, sedimentation rate, blood type and screen, electrocardiogram, and chest x-ray.[9] Four hundred ccs of autologous blood is also collected event though a blood transfusion is rarely necessary.

The patient will also be interviewed by an anesthesiologist who will assess the patient's recent and long-term medication history, medical and surgical history (especially that relating to respiratory and neurological systems), communicable disease history, smoking history, height, weight, allergies, and if the patient has dentures, bridges, capped, or loose teeth.[9]

After the patient is admitted, the pre-operative nurse will assess his/her health history including any injuries, allergies, illnesses, and/or surgeries. Family history, social history, personal hygiene, activity patterns (e.g., drug/tobacco use, recreation/exercise), and sleep patterns are also noted.[9] Then the nurse will note any pain, tenderness, swelling, weakness, deformity, atrophy, paresthesia, and/or abnormality present in any of the systems.[9]

Design of the Prosthesis

The integrity of the shoulder depends on the strength of the muscles supporting tendons and ligaments. In the total shoulder arthroplasty procedure, the anterior half of the capsule will be divided or excised at the time of the

replacement, thereby weakening these muscles and tendons.[4,31] During total shoulder arthroplasty, care is taken to minimize disturbing the muscles, tendons, and their bony attachments in an attempt to provide stabilization to an otherwise unstable joint.[3,4,31]

The prosthesis is designed to replace the articulating surfaces only. There are two primary styles of prostheses: constrained and unconstrained. In the constrained prosthesis, the glenoid and humerus components are fixed together. Unfortunately, this style has an unacceptably high rate of component breakage due to forces across the glenoid anchorage.[2] The unconstrained prosthesis uses separate glenoid and humeral components to provide free physiologic articulation.[2,4,31]

New prostheses have been developed incorporating designs such as two-piece modular humeral stems, porous-coating, and press-fit technologies.[2] The materials used for the construction of these prostheses is often either titanium or vitallium.[2,4,31]

Surgical Procedure

The size of the stem needs to be determined prior to the operation. This is done by taping the prosthesis to the lateral surface of the arm in the position that it is to occupy and taking an anteroposterior roentgenogram.[4,31] The small, medium, and large prosthesis may in turn be measured against the medullary canal in this manner.[4,31] Once that is completed, the patient is then prepared for

surgery by being seated in the "barber chair" position, which involves raising the patient's head and knees 30°.[4,31]

The patient's skin is often prepared with providoneiodine from the wrist of the involved extremity to the midsternum and midback, and from the bottom of the rib cage up to the mandible.[9]

Since general anesthesia is rarely used in total joint replacements, shoulder replacements are usually performed under peripheral nerve blocks.[10] One benefit of using a regional anesthesia (interscalene block) is that at the completion of the surgery, while the patient is still in the operating room and before the dressing is placed, the involved shoulder can be placed through range of motion.[26,32] When the patient is able to view his/her arm and the extent of motion allowed by the anesthesia, he/she appears to regain motion more quickly.[26] The patient is more easily convinced that the pain spasm reflex limits the motion rather than a true mechanical block.

The initial incision is made lateral to the coracoid over the deltopectoral interval, beginning at the clavicle and passing downward 12.5 centimeters.[5,31] Charles Neer prefers this deltopectoral route instead of the transacromial approach because the latter results in the problem of a weakened deltoid after the operation.[31] Through the 13 centimeter incision, the anterior eight centimeters of the origin of the deltoid is detached from the clavicle and anterior acromion and the subscapularis is divided transversely.[5,14] The approach should be accomplished with minimal disturbance of the muscles and their

attachments.[31] The surgeon then identifies the injured anatomy using the biceps tendon and bicipital groove for anatomic landmarks.[5,14]

The head of the humerus is relocated into the incision through external rotation and prying with a blunt elevator, bringing the entire articular surface into view.[5,14,31] The articulating dome is excised with a broad osteotome.[14,31] Next, the medullary canal is prepared and fitted with the proper sized prosthesis.[5,14,31] Following the fitting of the prosthesis and checking the shoulder movement, the subscapular tendon and deltoid are repaired with the shoulder placed in neutral rotation. Special care should be taken to place the prosthesis in 35° of retroversion to decrease the possibility of dislocation of the prosthesis.

Immediately after the operation, the shoulder should be placed in a sling.[14,31] The arm should be resting at the patient's side with the elbow flexed at a 90° angle, and the forearm strapped across the abdomen.[9] A sling is not prescribed when repair of the rotator cuff or tuberosity is excessively difficult; instead, casting is performed.[14,31]

Immediate Post-operative Nursing Protocol

The patient is transported to the recovery room in his/her own bed to decrease the number of transfers and reduce the risk of dislocation.[9] The nurse closely observes the patient for effective airway clearance.[9] The nurse may have a problem maintaining the patient's airway if temporomandibular joint pathology or cervical spine stiffness and/or instability exist.[9]

In the immediate post-operative period, the critical nursing measures include neurovascular assessment of the affected extremity at least every four hours or per institutional protocol..[2,9] Compromise of the brachial plexus may be assessed by checking each involved nerve as follows: a) Median: assess grasp, especially of the first and second fingers, b) Radial: assess thumb movement, c) Ulnar: assess finger spread, d) Cutaneous: assess for flexion of biceps, e) Axillary: assess deltoid contractions. Vital signs should be taken every two hours or per institutional protocol.[2]

Movement should be limited in the affected extremity and avoided in any plane not cleared by the surgeon. The immobilizer/sling should be worn as per surgeon's orders and often is worn at all times.[2,9]

The pre-operative nurse should also be assessing the wound drainage. Saturation through dressing is not expected unless no wound drain is used.[2,9] If saturation occurs, the nurse will assess patency/function of the wound drain. The wound drains should be emptied and measured every eight hours or per institutional protocol. Establish parameters pre-operatively with the surgeon for drainage amounts of which he/she wishes to be notified. Initial dressing change will normally coincide with discontinuation of the wound drain (24-48 hours post-op).[2,9] Saturation will necessitate an earlier dressing change, again per the surgeon's order.[2]

Continuous Passive Motion (CPM) may be initiated on the day of surgery or on the first post-operative day, according to individual surgeon's preference. If initiated on the day of surgery, expect heavier wound drainage.[2,9]

Pain medication for the shoulder arthroplasty patient is vital because, when under sedated, the patient will feel his/her shoulder with each breath and may become apprehensive and restless.[9] Patient controlled anesthetic (PCA) is an effective modality for pain control post-total shoulder arthroplasty, especially is CPM is initiated soon after surgery. The PCA pump should be used until patient is ready for oral pain medication, usually 24 to 48 hours.[9] If CPM is initiated the first post-op day rather than on the day of surgery, pain may be controlled with morphine or meperidine every three to four hours and supplemented with Ketrolac (Toradol) every six hours.[2]

CHAPTER VI

SHOULDER REHABILITATION FOR POST-TOTAL SHOULDER ARTHROPLASTY

A proper rehabilitation program is essential for the successful treatment of shoulder pathology.[12] There are many published rehabilitation protocols in physical therapy and orthopaedic texts with the goal of improving function and mobility.[14,21,26,33] The fact that these published protocols are all different suggest that the rehabilitation process is flexible with no preferred program of treatment.[26] The physical therapist should develop a program that satisfies the patient's goals and produces a successful result.[2,12,21,26,31,34] A successful rehabilitation program should include the following principles: (1) initiate the rehabilitation program as early as possible, (2) allow early active motion, (3) eliminate or limit the use of supportive devices such as slings and immobilizers, and (4) maximize passive joint motion (elevation, internal rotation, and external rotation) before initiation of a strengthening program.[26]

Until several years ago, post-arthroplasty rehabilitation did not begin until several days after surgery.[26] This delay was to allow sufficient healing of the deltoid following the transacromial procedure which had included release of the deltoid muscle origin.[4,22,26] Concern for dislocation of the joint also led to a

several-day delay in initiation of the rehabilitation program.[25,26] The newer surgical technique using the deltopectoral route allows for early rehabilitation of the shoulder. Using this route preserves deltoid strength, allows proper component orientation, and modification in component design provide intrinsic joint stability.[4,11,22,30]

In spite of techniques and beliefs to promote early mobility, a shoulder sling is still prescribed to maintain immobilization for the first few days after surgery.[26,34] With use of a sling, care must be taken to avoid adhesive capsulitis which causes chronic shoulder pain and stiffness.[34] Early movement is currently deemed necessary to prevent maturation of adhesions and to promote return of optimal function.[14]

The current direction being taken by experienced shoulder surgeons has been to begin the therapy program very early.[26,31] Some doctors begin a rehabilitation program the day of surgery. Dr. Charles Rockwood, for example, initiates passive movement exercises of the extremity a few hours after joint replacement.[26] Dr. John Brems prefers to initiate the rehabilitation program on the second post-operative day. Both doctors recommended that physical therapy sessions are preceded by the application of moist heat and analgesic medication for the first several weeks to reduce the amount of pain during exercises.[26]

The following rehabilitation phases are supported by many authors in the literature.[5,9,12,14,21,22,26,31,33,35] The initiation of the exercises and stretches fit within

the time frame in the subheadings. Phase one is started two days post-surgery. The physical therapist will progress the patient as appropriate through the other phases as an outpatient.

Phase One (Weeks 0-3)

Phase one exercises support the early goals desired by the surgeon of obtaining motion, preventing formation of adhesions, and protecting the surgical repair.[12] The initial phase of rehabilitation is aimed at achieving full passive range of motion.[5] Passive range of motion is allowed within the ranges determined at the time of surgery. The physical therapy goals for phase one usually consist of a) increasing passive range of motion, b) decreasing shoulder pain, and c) preventing rotator cuff shutdown.[33] These goals are achieved through a series of passive stretches and exercises.

Passive Range of Motion Exercises

The following exercises in this phase include passive range of motion stretches for the patient. Stretching is always done with low intensity continuous pressure; a pulsating force should not be used.[21,26]

1) Assisted Supine Elevation: The supine position will give the patient a greater sense of security during these early exercises.[14] The position is also ideal for shoulder flexion since, after 90° is reached, gravity assists the activity. Do not place a pillow under the patient's head; a pillow raises the head, shoulder, and scapula off the table which may adversely affect joint mobility.[26] For comfort, it helps to place the patient on a soft mat. The therapist will first

stabilize the axillary border of the scapula. A slight traction should be applied to the humerus of the affected arm, gradually elevating it in the scapular plane (30° in flexion from the coronal plane).[21,26] When the patient begins to experience pain, a gentle firm pressure is applied for three to five seconds.[26] Once the arm is gently assisted back down to the side, the stretch may be repeated two to three more times.

2) Assisted External Rotation: The supine position is ideal for external rotation because the shoulder musculature is relaxed when the patient is supine.[14] The external rotation motion can be initiated with the shoulder at 0° of abduction or 30° of abduction to be in the scapular plane.[14,26,33] The patient can be instructed to assist him/herself by using a cane or stick to rotate the humerus by pushing the forearm away from the side.[14,21,26,31] Care must be taken to have proper orientation of the stick so that it rotates the humerus and does not merely extend the elbow.[26]

3) Assisted Internal Rotation: Since this is a more aggressive stretch, it will not be initiated until 8 to 14 days post-operatively.[14,26] As in assisted external rotation, this stretch is also done in supine at either 0° or 30° of abduction.[26,33] The patient is instructed to assist with the unaffected arm by grasping the wrist of the operated extremity behind the low back and trying to slide it upwards.[14,26]

4) Assisted Abduction: Only one article included assisted abduction along with the other stretches.[26] Other sources did not include it[9,13,31,33] and a

few recommended not performing this movement.[4,14,22] Due to the lack of support for assisted abduction, it will not be further discussed.

The Pendulum Exercise

The patient performs this exercise while standing up, bending forward at the waist, and supporting his/her weight on the uninvolved arm on a chair or table to allow the involved arm to hang freely. Ideally, the thoracic spine should be parallel to the floor.[26] The patient's elbow should be kept straight throughout the exercise. The involved arm should circle one way and then the other, performing each direction for 30 to 60 seconds, gradually increasing the size of the circles. The motion is to be obtained by weight shift or trunk swing. The patient should be discouraged from using shoulder muscles to obtain motion.

Rope and Pulley

Approximately eight to ten days post-operatively, pulley exercises are added to assist the patient in passive elevation of the arm.[26,31,35] The pulley set-up is critically important.[26] Two pulleys distanced shoulder width apart should be attached either to the ceiling or a foot above the patient's pre-operative extended reach on an overhead bar.[21,33] A rope is passed through the pulleys and a handle is attached to each end of the rope. The patient may be sitting, standing, or supine with shoulders aligned under the pulleys.[21,33] The pulley should be slightly above the patient's head or slightly behind the patient to ensure that the affected arm is hoisted by the good arm and maximal elevation force will occur.[14] The primary planes of movement for the pulley system are

shoulder flexion and abduction; however, therapists are currently starting to replace the two movements with elevation in the scapular plane only.[21,33]

The patient must be carefully instructed in the use of the pulley; it is easily misused by the patient, resulting in compression of the humerus against the acromion process.[14,21,26,33,37] If a patient cannot learn to use the pulley with proper shoulder mechanics, it should not be done.[21,33]

Isometric Strengthening Program

Isometrics should be initiated by the physical therapist between day 10 and 17 depending on the surgeon's preference.[14,31,35] These exercises are submaximal, pain-free isometrics for the shoulder external rotators, internal rotators, and abductors.[14,26,31,35] Early strengthening is encouraged because it is critical for the patient to restore rotator cuff control and function as quickly as possible to prevent excessive and uncontrolled humeral head migration.[31] The primary function of the rotator cuff is to dynamically stabilize and guide the humeral head during shoulder movements. Increasing shoulder strength is essential to successful rehabilitation. Isometric strengthening exercises will allow the patient to use his/her arm later in the more active phases of the rehabilitation program.

Other Exercises

It is crucial to remember that even though the shoulder is the main structure involved, other muscles and joints distal to the shoulder require treatment too. A patient who is favoring a painful shoulder will tend to neglect

the elbow, wrist, and fingers on that same arm. Exercises should also include elbow and wrist range of motion and strengthening exercises for the hand.[33] These exercises should be encouraged through all the phases of shoulder rehabilitation.

Phase Two (Week 4-6)

Phase two objectives are to further assist in achieving maximal motion, eliminate all pain in movements, and strengthen the shoulder girdle musculature. An exercise program of isotonic strengthening would be included in phase two with focus on rotator cuff strengthening.

Stretching

Assisted External Rotation: The patient stands in a doorway with the affected shoulder's elbow held against his/her side bent to 90°.[21,26] While keeping the elbow close to the trunk, the patient turns his/her body away from the affected side. This exercise is useful in increasing external rotation from 40° to 60°.[21,26]

Isotonic Strengthening Program

Muscle strengthening can be a long, difficult process and the patient must be made aware of this as it is easy to become discouraged.[26] Often, the underlying condition that led to weak muscles is aggravated by the protection that must be imposed to allow satisfactory healing.

There are a wide variety of devices available to provide resistance for strengthening exercises: cuff weights, theraband, sportscord, and

dumbbells.[21,26] The muscles that are targeted for strengthening are the shoulder musculature (rotator cuff muscles, deltoid, etc.), scapulothoracic musculature, biceps, and triceps.[33]

It is recommended that all exercises in a strengthening program be completed in repetitions of ten and performed twice daily.[14,21,26,33] These exercises will be initiated in the supine position to minimize the effect of gravity.[33] Weights are to be added as required for resistance in half pound increments.[14,21,26,33] When five-pound weights are being used in this exercise, the patient is to be advanced to phase three.[26]

As the patient progresses, the supine positioning will be appropriately adjusted to either sitting or standing. The patient will use this increase of gravity in an eccentric muscle strengthening fashion by passively elevating his/her involved arm with the other and then actively controlling the arm as it is lowered.[26]

Phase Three (Weeks 7-12)

The main goals for this phase include pain free full range of motion, improving strength, power, and endurance.[14,26,33] The goals are described more specifically below.

Aggressive Stretching

1) Assisted External Rotation: As the patient achieves increased range of motion, he/she can do this stretch with the elbows at 90°, forearms placed flat against the door jam, and both humeri parallel to the floor.[21,26] The patient will

then lean forward into the open doorway to stretch the anterior capsule and assist range into external rotation.

2) Assisted Elevation: The patient stands approximately 12 to 14 inches away from a corner of the room.[21,26] The patient should be instructed to keep the elbow straight and apply minimal pressure with the hand of the affected extremity after it is lined up with the corner groove. The patient slowly leans inward, forcing the axilla up and into the corner, for several seconds as stretching occurs.

3) Assisted Adduction: Have the patient stand with his/her back to a table or ledge approximately at waist level.[26] The arm is to be held behind the back with the thumb along the spine and resting on the table. As the patient bends his/her knees, the arm is forced into internal rotation and extension.

Strengthening Exercise Program

The phase three strengthening program can be initiated sooner if the patient had good muscle strength prior to the shoulder replacement.[14,26,33] This strengthening phase involves constant loading resistance exercises with the combination of concentric and eccentric contraction.[21,31] Surgical tubing is primarily used for strengthening the deltoid and individual rotator cuff muscles in this phase. The patients can use other types of weights or resistance, however, if they feel more at ease using them.

Return to Activity

This phase is not included in Neer's three phase plan. It involves functional activities as the desired result, such as throwing a baseball, golfing, or tennis for the sports oriented patient.[14] Once the patient returns to unrestricted activities, he/she should be encouraged to continue with the exercise program for one year from the date of surgery.

Frequency of Physical Therapy

Patients are to be seen twice daily while in the hospital. Once they are discharged from the hospital, they are seen three times a week for three weeks in an outpatient physical therapy setting.[14] The frequency is then decreased to once every three to four weeks for the next six months, depending on the patients' motivation level (if they are not motivated, they will be seen more often).[14,26,33] During the second year, stretching and strengthening exercises in the areas of deficiency are to be continued daily. The outpatient visits will be decreased to once every three months and, after that time, at longer intervals for periodic re-evaluation of strength and revision of program as needed.[14]

The frequency of physical therapy should be determined for each individual's needs. Frequency of treatment or re-evaluation of status may be dependent on the pain level, the patient's progress with range of motion, strength, and patient's compliance.

CHAPTER VII

OUTCOMES

The results of total shoulder arthroplasty have been reported by several authors. One benefit of a total shoulder arthroplasty is that is offers the patient drastic relief of pain. The functional gains can be even more dramatic with mean improvement of two-thirds of normal active movement.[8] At least 85% to 95% of patients who undergo shoulder replacement may have significant or complete pain relief for up to ten years after the implantation.[9]

Weiss, Adams, Moore, and Weiland[36] reported 43 out of 46 patients having satisfactory to excellent results. Compito, Self, and Bigliani[13] reviewed their results after humeral head replacement for acute proximal humeral fractures (47 cases) or head splitting fractures (23 cases). Satisfactory to excellent results were noted with 53 of these patients. Comparison of the patients with the Neer and English-McNab total shoulder arthroplasty design show similar improvement in functional motion (36 of 40 patients).[36] Hughs and Neer[14] reported that 48 shoulders of 47 patients with glenohumeral osteoarthritis were treated by replacement arthroplasty. The primary aim of treatment was pain relief and the secondary objective was to improve range of motion.[14] Both objectives were met in 28 of the patients who had only osteoarthritis and in all

but four of the 19 who had osteoarthritis resulting from trauma to the shoulder. One deficiency in the results was the slow recovery of adequate strength and the continuing fatigability noted by some patients.[14]

Patients must be able to cooperate in the intense and prolonged rehabilitation program required after such surgery if good functional results are to be obtained.[35] If they cannot, such patients do poorly from a functional point of view. The only significant factor associated with an unsatisfactory result was the lack of patient compliance with post-operative therapy protocols and activity restrictions.[13,14]

CHAPTER VIII

CONCLUSION

Total shoulder arthroplasty is a routinely effective procedure for pain relief in those persons suffering chronic, refractory shoulder pain.[2,33] Functional improvement to some degree is noted in nearly all cases.

The shoulder is perhaps the most challenging joint in the body to rehabilitate post-operatively.[14] The shoulder is designed for mobility rather than stability, and the muscles that stabilize the shoulder also move it.[14] Proper rehabilitation after total shoulder replacement is not only necessary but critical to a successful outcome.[26] The previously outlined rehabilitation program proceeds in a logical and orderly fashion beginning with passive joint mobilization, progressing to strengthening, and return to activity. When the principles of surgical techniques are combined with the principles of rehabilitation, successful total shoulder replacement can often be obtained.[2]

There is a need for more research in the areas of new surgical techniques and approaches, new glenohumeral prosthesis components, methods and tools for re-evaluation. A more rapid rehabilitation progression, including functional return to activities and patient compliance, is an important area requiring further research as well.

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