Physical therapist management of a 42 year old female following a reverse total shoulder replacement: a case report.

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Physical therapist management of a 42 year old female following a reverse total shoulder replacement: a case report.

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Title: Physical therapist management of a 42 year old female following a reverse total shoulder replacement: a case report. **Purpose:** The purpose of this study is to discuss the physical therapist management for a patient following a reverse total shoulder replacement (rTSR). **Case Description:** The patient is a 42 y/o F with a 6 year history of left shoulder pain, weakness, and loss of function of non-traumatic nature. Her past medical history included two previous surgeries and numerous conservative attempts for rehab including physical therapy, chiropractic management, and acupuncture. She was referred to physical therapy initially for left frozen shoulder and 4 months later at 6 weeks post rTSR. **Outcomes:** The physical therapy interventions resulted in improved outcomes as measured by ROM, MMT and DASH scores. The patient reported increased functional use of the shoulder and improved quality of life. The patient's outcomes were typical results as reported in the literature as she still had difficulty with forward elevation above shoulder height and external rotation. **Discussion:** Treatment of the patient was done following the rTSR protocol as outlined in The Journal of Orthopaedic and Sports Physical Therapy. Several factors including delayed start of physical therapy, limited overall visits, history of brachial plexus injury and diabetes, may have been factors in her rehabilitation. **Conclusion:** While this procedure might be beneficial for similar patients, further research with randomized controlled trials is needed and long term follow-up to determine outcomes and possible complications.

Keywords: reverse total shoulder replacement, total shoulder replacement, arthroplasty, rotator cuff arthropathy, osteoarthritis, physical therapy protocol, shoulder rehabilitation

Introduction

Shoulder pain is a debilitating problem as we rely on our arms to perform many activities of daily living. Common diagnoses including osteoarthritis, fractures of the shoulder complex, rheumatoid arthritis, avascular necrosis, rotator cuff arthropathy, and failed previous shoulder surgeries or replacements are causes of a patient's pain and functional loss. In the United States about 23,000 people each year have shoulder joint replacements to alleviate these problems.[1] The total shoulder replacement (TSR) is typically done as a last effort to decrease pain and restore function in patients with painful shoulder conditions.

The TSR has been a very effective method of restoring function and decreasing pain for patients with the above mentioned diagnoses of the shoulder. Many of the patients achieve good relief of pain but continue to have significant limitations in range of motion and strength, resulting in loss of function.[1] Multiple studies noticed that this was particularly true in patients with a history of rotator cuff tear and/or deficient rotator cuff muscles who were not getting the functional results that they wanted.[2,3]

In March of 2004, the Food and Drug Administration approved the reverse total shoulder replacement (rTSR) as another option for patients who were considering a conventional TSR.[1,4,5,] To better understand the differences between both the conventional method of shoulder replacements and its limitations thus far which ultimately led to the development of the rTSR will be discussed.

The first TSR is credited to French surgeon Péan in 1893.[2,3,6] Péan implanted the device into a 37 year old man who had tuberculosis arthritis of the shoulder which involved the glenohumeral joint. He used platinum and rubber to replace the proximal part of the

humerus. Over the next 50 years multiple attempts were made to reproduce the motion of the glenohumeral joint to compensate for the loss of the proximal humerus. These attempts produced substandard results until Neer became known in the 1950's.

Neer is credited with starting the modern age of the shoulder replacement by being the first to report on the use of a hemiarthroplasty in 1955.[3,6] He first used a metal device for the replacement of the humeral head in patients with fracture-dislocations of the humeral head. Neer was getting positive results with this type of surgery and shortly after started to use the hemiarthroplasty in patients with osteoarthritis of the glenohumeral joint. In the 1970's Neer added a polyethylene glenoid component. According to Hansen et al[3] the first successful reporting of TSR was by Neer in 1982, describing a large study using polyethylene glenoid components.

Since the 1970's many attempts have been made to perfect the TSR. A constrained total shoulder prosthesis refers to implants that are based on a fixed-fulcrum or semi-fulcrum ball and socket design.[2] Several constrained total shoulder prostheses were developed, however, according to Wirth et al[2] the incomplete understanding of the kinematics of the shoulder led to a variety of non-anatomical shoulder prostheses, which were designed both to replace the arthritic joint and to restore the stability that was presumably lost as a result of an abnormality of the rotator cuff. The constrained shoulder implants were based on a fixed-fulcrum resulting in a limited range of motion in a joint that usually has a large normal range. This loss of motion is what is thought to be the most likely cause of complications related to the TSR. The three main complications of TSR are mechanical loosening, instability, and failure of the implant either due to plastic deformation, fracture or dissociation of the components.[2,3,7]

The high rate of problems associated with the constrained total shoulder arthroplasty lead to the development of the unconstrained TSR. In this procedure the damaged joint surfaces are replaced with prosthetic components that approximate the normal joint surfaces and are stabilized by mechanisms similar to those stabilizing a native glenohumeral joint.[7] While these replacements were getting better results than their constrained counterparts, they were not with out complications. The most common complications were noted to be loosening of the component, glenohumeral instability, rotator cuff tear or limited intrinsic stability, and weakness or deltoid dysfunction.[2,3,7,8]

According to Wirth et al[2] glenoid loosening accounts for one-third of all complications associated with conventional TSR. These cases typically involved a failure of the fixation of the glenoid component and were attributed to poor cementing technique. In a study by Barrett et al[6] of 58 patients who underwent Neer-II total shoulder arthroplasties, there was a 16 percent incidence of perioperative complications and a 10 percent incidence of loosening of the glenoid component. From their study they determined that only the patients who had significant rotator cuff deficiencies had definite loosening of the glenoid component.

In the normal shoulder the glenohumeral joint is stabilized by a combination of passive constraints and joint forces that compress the humeral head into the glenoid fossa.[2,7,9] The collective actions of the deltoid, rotator cuff, and capsulolabral structures allow the shoulder to function normally. According to Dines et al[8] if this balance is disrupted, as can occur with a shoulder arthroplasty, instability can occur in any direction on the basis of the condition of the soft tissues and the positions of the components.

Anterior instability is due to malrotation of the humeral component, dysfunction of the anterior part of the deltoid, defects in the glenoid labrum, or most commonly defects in the subscapularis.[2,7,9] A second operation is required to repair the subscapularis tendon and restore stability. Superior instability is associated with defects in the supraspinatous muscle. Rupture of the supraspinatous or failed repair of the rotator cuff causes progressive superior migration of the humeral head. This superior migration can lead to the potential for loosening of the glenoid component but does not typically cause increased pain or result in failure of the operation. Posterior instability results from posterior glenoid erosion, soft-tissue imbalance, or excessive retroversion of the glenoid or humeral components. These shoulders are revised to restore the normal retroversion of the humeral component. Upward displacement of the humerus is caused by fractures or deficiency of the coracoacromial arch. This upward displacement slackens the deltoid muscle, weakening it and resulting in decreased elevation of the humerus. In these cases the anatomical humeral length needs to be instituted to restore the tension and maximize deltoid function.[2,7,9]

According to Wirth et al[2] postoperative rotator cuff tears are the third most frequent complication of TSR. As noted above the muscles of the rotator cuff play a large role in the stability of the shoulder. The rotator cuff is an active stabilizer helping to balance the humeral head in the glenoid against the upward pull of the deltoid muscle.[10,11] Therefore, with an intact rotator cuff, excursion of the humeral head on the glenoid surface is limited.[10,11] With massive defects of the rotator cuff, however, according to Barrett et al[6] the kinematics of the shoulder are altered. This in turn leads to the unopposed upward force of the deltoid muscle, causing superior migration of the humeral component. These off-center stresses can explain the glenoid loosening observed with many TSR's.[8,11,12]

Lastly, deltoid dysfunction may result in a significant loss of shoulder function following a TSR. According to Matsen et al[7] a conventional shoulder arthroplasty can only minimally modify the tension and moment arm of the deltoid. The deltoid tension can be adjusted by raising and lowering the humeral component but maintenance of the origin of the deltoid muscle is critical to the success of the surgery. [2,7] Matsen[7] also states that with a TSR the center of rotation of the humeral head cannot be medialized to increase the deltoid moment arm, resulting in compromised shoulder function.

As with any surgery there is the potential for complications and failure of the surgery.[2,6,7,13] The most commonly seen with any type of shoulder reconstructions are fractures, infection, neural injuries, and failure of the implant. Fractures of the glenoid or humerus, whether intraoperatively or postoperatively, usually require a TSR revision. Infection, though not as common, can be a potentially damaging complication. Infections are usually treated with antibiotics, irrigation and debridement, or removal of the prosthesis and reimplantation. Neural injuries can also occur involving the peripheral nerve or the brachial plexus. Most of these injuries are treated non-operatively and resolve completely. Failure of the implant is occasionally the cause of a failed shoulder replacement. Fractures of the metal parts or fixation screws, subluxation of spacers, and dissociation of the glenoid insert have been reported as complications requiring revisions.[2,6,7,13]

Despite its many complications, numerous studies have been done that support the use of TSR or hemiarthroplasty for the treatment of osteoarthritis. The common finding with a majority of these studies, however, was the failure or lack of success when rotator cuff arthropathy was present.[4,6,12,13,14] This lead to the development of the rTSR by Paul Grammont in 1985.[3,15]

The rTSR was specifically designed for patients with glenohumeral arthritis when also associated with rotator cuff deficiencies. For these people treatment has been challenging as nonconstrained prostheses have produced limited functional results and constrained prostheses have failed leading to early loosening of the replacement.[15] According to Matsen[4] the goal of the rTSR is to restore function to the damaged joint by providing stability and a fulcrum against which the deltoid muscle can help elevate the shoulder to a functional level.

The rTSR addresses some of the limitations of conventional TSR by altering the actual mechanics of the shoulder.[4] Grammont developed a prosthesis in which a convex articular surface is fixed to the glenoid and a concave articular surface is fixed to the proximal part of the humerus.[16] The first models developed had only 2 components.[3,15,16,17] The glenoid component was a metallic or ceramic ball and was fixed with cement. The humeral component was a polyethylene socket. This initial Grammont reverse prosthesis was cemented on both the humeral and glenoid sides. Several failures of the cemented glenoid design led Grammont to change the glenoid to an uncemented system. The second model, the Delta III, has been available since 1991 and is still in use today. It consists of 5 parts: the glenoid base, the glenosphere, the polyethylene humeral cup, the humeral neck, and the humeral system. According to Grammont there are 4 main biomechanical advantages: the large ball offers a greater potential arc of motion and more stability; the small lateral off set places the center of rotation directly in contact with the glenoid surface and reduces the torque at the point of fixation of the glenoid component; medializing the center of rotation recruits more of the deltoid fibers for elevation and abduction; lowering the humerus increases tension on the deltoid.[3,15,16,17] With this system the rotator cuff is minimally

involved, instead relying almost entirely on the deltoid to compensate for the deficient rotator cuff and resulting in an improvement of shoulder elevation and shoulder function.[18]

The rTSR is indicated for people who have complete rotator cuff tears, irreparable rotator cuff tears associated with glenohumeral arthritis or instability, severe arthritis, complicated fractures, or who had a previous failed hemiarthroplasty or TSR.[1,10,19] While the rTSR is promising, it is recommended for people who have exhausted all other means of repair and the patient should be first treated with medications and formal therapy before surgery is considered.

Contraindications for rTSR include patients with deltoid deficiency, rheumatoid arthritis, infection, poor bone quality, metal allergy, and neurological, vascular, or lymphatic deficiencies.[7,11,19] Patients who also have general medial, emotional, motivational, or social health issues are not good candidates for any shoulder arthroplasty.

The rTSR is a new surgery and while it theoretically improves the mechanics of the shoulder it is not without its own complications. These include recurrent instability, glenoid/humeral socket dislocation, fracture, infection, and neurological injuries.[7,15,17,19,20]

Instability following an rTSR may be related to insufficient tension of the deltoid and medial impingement, but can also be brought about by medialization of the humerus.[15] Medialization of the humerus refers to keeping the center of rotation within the glenoid bone. According to ElMaraghy et al[20] medial wear on the polyethylene component after rTSR has been attributed to impingement of the humeral cup on the lateral border of the scapula. They reported that polyethylene wear was observed in up to 50% of patients who undergo rTSR. This impingement can also result in what is known as scapular or medial notching of the

scapula. Scapular notching increases the risk for glenoid loosening thus effecting outcomes of the rTSR.[17,20]

Loosening of the glenoid component remains another problem with rTSR and results when it is not anchored securely either because of positioning or due to trauma on the joint.[7] Loosening of the humeral component is not as common but is associated with a fracture or infection. Postoperative hematomas are common and can be another cause of prosthetic instability or loosening.[15] Hematomas can be prevented by careful hemostasis, use of drains, and delaying early range of motion (ROM).[1]

Dislocation also occurs as a result of previous arthroplasty, soft-tissue trauma, or malpositioned components. It is more common in revision surgery because of the atrophy of the anterior deltoid muscle. Early postoperative dislocation can be managed with immobilization of the arm in a sling. If the instability is due to malpositioning of the component or improper soft-tissue tension, then revision surgery may be required.[7]

Humeral or tuberosity fractures may occur during rTSR and are typically treated at the time of the surgery.[7,15,17] Glenoid fractures are common due to the age of the bone and are also stabilized in surgery. Fracture of the acromion is often seen because of high tensioning of the deltoid muscle or preexisting lesions or patients with severe osteoporosis. These fractures typically only require treatment of symptoms and appear not to have a significant effect on function.[7,15,17]

Another frequent complication of an rTSR is infection. If unable to be treated with medications it can lead to the removal of the prosthesis. Neurological injures include axillary nerve damage or traction injuries from lengthening of the arm. These injuries typically resolve by themselves or cause insignificant effects on the overall outcome of the surgery.

To date there are few studies that assess the outcomes following rTSR. The studies that are in the literature are predominately of patients in their sixties and seventies. For this reason patients who undergo this surgery need to be aware that their shoulder mechanics and function will have some limitations when compared to their non-involved shoulder. The patients' age, expectations of return to function, and standard of living need to be taken into consideration when developing their postoperative rehabilitation plan.

According to Boileau et al[15] the reverse prosthesis restores active elevation but not active rotation. In their study of 45 patients treated with the Delta reverse prosthesis, the mean active elevation improved from 55° preoperatively to 121° postoperatively. There was no significant improvement in mean active ER, which was 7° preoperatively and only 11° postoperatively. Internal rotation also showed no improvement with patients only being able to reach the first sacral vertebra both pre and postoperatively.

In another study by Werner et al[19], 58 patients, with a mean age of 68 years, with severe shoulder pain and active elevation of <90° due to an irreparable rotator cuff tear were treated with a Delta III rTSR. The average active anterior elevation increased from 42° to 100° and active abduction increased from 43° to 90.° The average ER, however, decreased from 17° to 12.° According to Werner[18] these findings reflect the inability of the deltoid to perform ER.

The rTSR can be distinguished from the conventional TSR based on the biomechanics, design, and absent or minimally involved rotator cuff. The surgeon, physical therapist, and patient need to take these factors into consideration when developing a postoperative treatment plan. The purpose of this study is to discuss the physical therapist management of a 42 year old female following an rTSR.

Case Description

A 42 year old female patient presented to the clinic with a 6 year history of left shoulder pain, weakness, and loss of function of non-traumatic nature. The patient was a homemaker who cared for 2 children ages 3 and 7. The patient's hobbies included playing with her children, gardening and yoga. The patient's past medical history included diabetes, anemia, headaches and arthritis. She was taking the following meds: Vicodin (as needed for pain control), insulin, Topamax, Effexor, Wellbutrin, vitamin C and E, iron supplements, glucosamine, and Tizaridine. Specific dosages of medications were not reported. The patient had 2 previous shoulder surgeries including a left shoulder arthroscopy 5 years prior and rotator cuff repair 2 years prior. During the second surgery she sustained a brachial plexus injury. Due to continued loss of motion the patient underwent a manipulation which resulted in a fracture of the left humerus and little improvement in ROM. The patient had a radiograph, magnetic resonance imaging, and computed tomography scan done. She had also tried multiple conservative treatments consisting of physical therapy, chiropractic treatment, and acupuncture, all with minimal relief of pain and no significant restoration of function.

Examination

Initially the patient was referred to physical therapy with the diagnosis of left frozen shoulder. A screen of systems review was negative for cardiovascular, integumentary, and neuromuscular impairments, with positive musculoskeletal gross strength, ROM, and muscle symmetry differences noted in affected versus non-affected upper extremity. She reported pain on a visual analog scale (VAS) to be a constant 8/10, with 0 meaning no pain and 10 the worst pain imaginable.[28] The patient reported difficulty with all activities of daily living

(ADL) and was unable to use her left arm for bathing, grooming, cooking, and childcare. She was unable to reach overhead, to the side, or behind her back. The patient also stated that she woke 3 times per night due to her shoulder pain. She also reported a feeling of her shoulder "giving way" as if it might dislocate. The patient identified goals for therapy included being able to wash her hair, perform ADL's and to move her arm as much as possible.

Objective findings included postural abnormalities of left rounded and protracted shoulder. Joint integrity was positive for crepitus, when grade 1-2 posterior and inferior glenohumeral joint mobilizations were performed, in the left glenohumeral joint. There was observed muscle atrophy of the left scapular area including rhomboids and latissimus dorsi muscles. The patient had tenderness to palpation of the teres minor, supraspinatous muscle belly, and infraspinatous tendon. Special tests included a positive empty can and horizontal adduction tests on the left shoulder. Both active range of motion (AROM) and passive range of motion (PROM) were severely limited as noted in Table 1. Strength of her left shoulder was grossly 3+/5 with manual muscle testing (MMT) as specified in Table 2. All objective measurements were taken by the same physical therapist to ensure a greater reliability of the outcomes. The ROM measurements were done with a goniometer following the test positions outlined by Norkin and White.[25] The MMT was done following the guidelines according Kendall[26] with a score of 0, being equal to no muscle contraction, and 5, being able to hold test position against strong resistance.

Evaluation

After completing her clinical examination the referring doctor's medical diagnosis of left frozen shoulder and left rotator cuff tear was confirmed. The patient's physical therapy

diagnosis falls into the Guide to Physical Therapist Practice[27] pattern 4D; impaired joint mobility, motor function, muscle performance and ROM associated with connective tissue dysfunction. Her diagnosis of rotator cuff tear and poor glenohumeral mobility contributed to her impairments including decreased ROM, muscle weakness, and pain resulting in the patient's inability to lift her arm greater than 38 degrees of forward flexion and 43 degrees of abduction, making ADL's very difficult to perform.

Based on the initial evaluation findings, the evaluating physical therapist thought the patient's prognosis was only fair. According to the Guide to Physical Therapist Practice[27] the patient's prognosis states that the patient will demonstrate optimal joint mobility, muscle performance, and ROM and the highest level of functioning in home, work community, and leisure environments.

The goals of the physical therapy interventions were for the patient to have AROM and PROM to 75% of the non-affected side in order to self-groom with the affected upper extremity; to have 4/5 MMT in order to reach into the upper shelves in kitchen; and to have less than 3/10 on the VAS scale in order to restore prior function with ADL's.

Intervention

The patient was treated for her left frozen shoulder with initial physical therapy intervention consisting of a combination of manual, stretching, AROM and PROM exercises, and strengthening exercises. Manual techniques included glenohumeral and scapular mobilizations in an effort to increase ROM. The patient was placed in supine on the table and while stabilizing the scapula, left shoulder posterior and inferior grade 2-3 glenohumeral glides were performed to increase flexion (FF) and abduction (ABD) respectively. Scapular mobilizations were done on the left shoulder with the patient in right sidelying focusing on

upward and downward rotation to increase mobility. This was followed by PROM into flexion, abduction, internal rotation (IR), and external rotation (ER) to increase muscle and soft tissue flexibility.

The patient was then instructed in therapeutic exercise consisting of left shoulder active assisted range of motion (AAROM) and AROM exercises. These included the rope and pulley system for FF and ABD for 3-5 minutes each and the wall walk for the same directions 10 times each. No additional weight was added for these exercises. The patient stretched into IR using a strap behind her back and having the patient pull her left arm towards her shoulder blades with her right arm. The patient stretched into ER at O° ABD using her right arm to passively push her left arm using a cane into ER. These stretches were held for 30 seconds for 3 repetitions. Pendulums were performed in clockwise and counterclockwise rotations, 30 times in each direction, to provide some glenohumeral distraction and decrease pain between stretches.

Isometric strengthening, with the glenohumeral joint at neutral, was done to increase scapular and rotator cuff strength. This was done with the patient pushing into a pillow into 6 directions FF, ABD, adduction (ADD), extension (EXT), ER, and IR. The isometrics were held for 10 seconds with 10 repetitions of each direction. Cryotherapy in the form of an ice pack at 10 degrees Celsius was used at the end of each session on the patient's left shoulder and scapula area to decrease pain. This was done for a duration of 10 minutes. The patient was also given a home exercise program (HEP) to perform independently. This consisted of FF, ABD, IR and ER AAROM exercises to be performed 2-3 times per day.

Outcomes

After approximately 1 month, with a total of 4 visits 1x/wk, the patient was re-examined and noted to have little, if any, improvements in subjective and objective findings. She continued to have an extreme amount of pain and loss of motion and strength, resulting in very limited functional use of her left shoulder.

The patient's goal to regain functional use of her shoulder was not obtained. The patient's physical therapy goals were also not met. She was then referred back to her doctor for follow-up to pursue further medical intervention since conservative options failed. Despite her young age, the patient, along with her doctor, decided that an rTSR was the best option for the treatment of her osteoarthritis with associated rotator cuff tear. The patient met many of the criteria for the surgery including irreparable rotator cuff tear with associated glenohumeral arthritis and instability, severe arthritis, history of fracture and a previous failed rotator cuff repair and arthroscopy. The patient underwent a rTSR 4 months after her discharge from physical therapy. The patient again presented to physical therapy 6 weeks post-op rTSR.

Examination Post-Operative rTSR

On examination the patient's findings included pain 7/10 on the VAS. Her initial score on the Disabilities of the Arm, Shoulder and Hand Outcome Measure (DASH) was 67 (Figure 1).[29] The scores range from 0-100; a higher DASH score indicates greater disability. A sample of the DASH disability/symptom questionnaire can be found in Appendix A. The patient reported difficulty with reaching overhead, to the side, and behind her back to get dressed. She was unable to drive, wash her hair, or carry her child. The patient also had trouble performing ADL's and was unable to sleep due to pain.

Objective findings included left shoulder girdle atrophy, forward head, rounded shoulders, and a protracted and depressed shoulder. She had a hypomobile scar but with good healing. She also had limitations in ROM and strength (refer to Tables 1-2). Cervical range of motion was within normal limits and cervical strength was 4+/5 throughout all planes.

Evaluation Post-Operative rTSR

Following her surgery the patient then presented to the clinic with a physical therapy diagnosis of impaired joint mobility, motor function, muscle performance and ROM findings associated with joint arthroplasty. These impairments and functional limitations put her into the 4H classification according to the Guide to Physical Therapist Practice.[27]

Intervention Post-Operative rTSR: Protocol Description

Treatment of the patient was done following the rTSR protocol as outlined in The Journal of Orthopaedic and Sports Physical Therapy.[23] Refer to Appendix B for the rTSR protocol agreed upon by the Physical Therapist and Doctor for this patient. Surgical procedures, techniques, approaches, and the patients' history all vary greatly; therefore, before initiating any protocol, the therapist should first consult with the referring surgeon. Delays within the protocol or specific ROM restrictions may be made by the surgeon to protect the integrity of the surgery.

The rTSR protocol consisted of 4 phases: phase 1 (day 1 to week 6), immediate post surgical/joint protection phase; phase 2 (weeks 6-12), AROM/early strengthening phase; phase 3 (week 12-26), moderate strengthening phase; and phase 4 (typically 4+ months), progressive home exercise program (HEP).[5,21,22,23,24]

During phase 1 the sling was worn for a total of 6 weeks, except for bathing and exercise, due to the patient's history of failed previous rotator cuff repair and fracture. The

patient was not allowed to lift objects greater than 1 pound, support her body weight with her operated extremity, or perform AROM. No IR AROM or PROM was performed for 6 weeks. Stretching into PROM was initiated for FF and elevation to 90° and ER in the scapular plane to 20-30°. Active elbow, wrist and hand ROM in all planes was encouraged as long as the shoulder joint stayed immobile. Submaximal pain free deltoid and periscapular isometrics were also initiated during this phase, with the glenohumeral joint in neutral position. This is done to restore deltoid function and provide stability for the joint. Continuous cryotherapy with the use of a cryocuff was used at home to control pain, decrease swelling, muscle spasm, and inflammation. The pain medication percocet was also taken by the patient on an as needed basis. The patient was given a HEP consisting of the elbow, wrist, and hand ROM exercises to increase circulation, prevent dependant edema, and prevent elbow contracture.

Progression from PROM to AAROM and AROM is Phase 2 of the rTSR protocol. At week 6 of physical therapy, PROM of IR was initiated in the scapular plane. This phase also included the addition of gentle strengthening exercises such as ER and IR submaximal pain free isometrics. Deltoid and periscapular isotonic strengthening exercises were started using a low-weight, high-repetition program. These exercises included the use of theraband for rows and shoulder extension with patient performing 2 sets of 10 repetitions. Scapular protraction was performed with the patient in a supine position, first with no weight then increasing gradually from 1-3 pounds as tolerated for 2 sets of 10 repetitions. Scapular depression was done with the patient in standing, elbow extended and pressing closed fist down onto a table at waist height for 2 sets of 10 repetitions. During this phase it is important to monitor the patient's quality of movement, motor control, and exercise

performance to limit unwanted stresses on the shoulder joint.[5] During this phase the patient initiated use of her left upper extremity for light ADL's including feeding, dressing, and washing. The patient continued to use ice on an as needed basis.

The patient was progressed to phase 3 when goals of the previous phases were met. This phase focused on advanced strengthening and increasing functional independence. The patient was allowed to increase functional use of her left arm for ADL's but was advised to continue to avoid lifting objects greater than 6 pounds, sudden lifting or pushing activities. The patient continued with her rehabilitation for approximately 6 months, being seen for physical therapy 31 times post-operatively, before moving onto phase 4 and her independent home exercise program.

Outcomes Post-Operative rTSR

From week 6-8 post-op rTSR, the patient reported pain to be intermittent 0-7 on the VAS scale. She reported continued difficulty with overhead ADL such as washing her hair and getting dishes out of the cabinet. She was unable to perform household chores and was still limited with lifting per the protocol. She also reported pain at night to be 5/10 with her elbow supported.

During phase 2, which the patient was in from 10 -14 weeks post-op rTSR, she reported her pain to be intermittent 0-5/10 on the VAS. Her biggest complaint was continued weakness. The patient had difficulty with reaching high shelves but was able to reach enough to independently wash her hair with her left hand. She was able to drive now and perform light household chores for about 20 minutes but could not yet carry a bag of groceries. The patient reported that she was now able sleep on her left shoulder for a few hours at night.

In the final 2 months of her therapy the patient continued to have a decrease in pain reporting it to be intermittent 0-3/10, mostly with use. The patient's complaint continued to be her inability to lift objects above shoulder height. She was able to dress and bathe independently with minimal pain.

Formal re-evaluations were done at 6 weeks, 14 weeks, 22 weeks and 26 weeks post-op, with ROM and MMT measurements found in Tables 1 and 2. DASH scores were taken at 6 weeks, 12 weeks, 16 weeks and 26 weeks post-op (Figure). At discharge her final DASH score was 10, indicating minimal disability related to shoulder function. At discharge she was able to perform limited overhead ADL but not able to actively perform ER. She was able to carry her child, put a cup away in a cupboard, and sleep without pain. The patient was treated for a total of 31 sessions over a 6 month period with good progress in ROM, strength, pain, and overall ADL function.

Discussion

Several factors including the patient's activity level and physical therapy intervention contributed greatly to the outcome variables for the patient. The patient's history of osteoarthritis and rotator cuff deficiency were the main factors leading to the decision for the procedure of an rTSR. Research related to function, quality of life, and ROM improvements in patients with osteoarthritis and/or defects in the rotator cuff, determined that a standard TSR should not be considered.[12,13,14] The patient in this case had significant osteoarthritis and rotator cuff degeneration with previously failed surgical repairs and conservative treatments. This led her to believe that a TSR would not provide the most optimal outcomes, thus assisting in her, and her surgeon's, decision to perform the rTSR.

Although this case was performed on a much younger patient than reported by most studies, the results were typical. The results of previous studies are consistent with my case study in that the patient had an increase in active elevation from 38° to 111.° The patient's ER increased from -8° preoperatively to 35° postoperatively, however, the patient was only able to obtain this motion when her shoulder was extended to only 10 degrees past neutral, thus recruiting more of her posterior deltoid.

According to Katz et al[17] this limited ER can be due to a number of factors. These include: medialization of the humeral component which limits ER by increasing the medial impingement of the humeral cup against the lateral border of the scapula, it is also referred to as medial notching; medialization of the center of rotation which reduces the strength of the posterior deltoid fibers; the status of the teres minor which is important for lateral rotation and if intact, lateral rotation is significantly better; and injury to the suprascapular nerve intraoperatively may also be a cause of lack of external rotation.[17]

The loss of ER following rTSR is an area that needs further research and attention. Some studies suggested that additional tendon transfers may be able to improve function and is a good subject for future studies. The need for functional ER is important and necessary for the patient to be able to perform ADL's with greater ease.

Katz et al[17] also describe the possible causes of limited internal rotation which include prosthesis design, medialization reducing the strength of the anterior deltoid fibers, and the state of the subscapularis. They determined that active medial rotation will be better if part of the subscapularis remains intact. Different surgical techniques allow for different results. The superior approach allows for preservation of the inferior part of the subscapularis. With a deltopectoral approach, it is not usually possible to preserve that part of the muscle.

Due to the rTSR procedure performed in this case study the doctor outlined a protocol with specific guidelines. These focused on 3 main concepts: joint protection, deltoid function, and determining realistic functional and ROM expectations.[5, 19, 21, 22, 23] Following rTSR there is a higher risk of shoulder dislocation compared to a conventional TSR. Patients will typically dislocate with the arm in internal rotation (IR) and adduction, especially when in combination with extension of greater than 20 degrees past neutral. The patient was not allowed to perform AROM or PROM of IR for 6 weeks and was not able to perform these combined motions for 12 weeks post-operatively. The patient was reminded these motions occur with activities such as tucking in a shirt, reaching behind your back to hook a bra or for personal bathing, and should be avoided. The fact that IR was held for a while may have contributed to her lack of gaining full motion back. The patient, however, did not find this to be a problem functionally and did gain as much back as she had prior to the surgery.

Deltoid function is crucial in regaining postoperative strength of the shoulder joint. Due to the fact that the shoulder is no longer relying on the rotator cuff muscles for movement, the stability and mobility of the shoulder is now dependent upon the deltoid and periscapular muscles. Exercises, therefore, focused on increasing the recruitment of the deltoid and periscapular musculature. Towards the end of her rehabilitation, she was able to ER more when her shoulder was brought into 10 degrees of extension. Had this been realized earlier, strengthening in this position could have been done and may have improved the outcome for her active ER and strength. The patient's history of previous brachial plexus injury may also have contributed to her lack of ER due to the damage to her nerves. The extent of this injury was not known.

Other factors that may have limited this patient's shoulder rehabilitation include the fact that she started physical therapy 6 weeks post-operatively while many other patients with similar procedures usually start within a week of surgery. The doctor did this due to the patient's complicated history of previous procedures, brachial plexus injury, and actual intraoperative procedure. This meant, however, that she was staying fairly immobile in her sling and was not starting the early ROM that most patients perform. Being able to start earlier may have assisted in a quicker return of functional use of her arm.

Some limitations to the study include incomplete evaluation of the shoulder complex and inconsistent and unknown specifics for manual techniques. During the evaluation the scapula was not closely evaluated for position, nor were any special tests or MMT done. While strengthening exercises for the scapula were performed during the intervention according to the protocol, the results could not be commented on because of the lack of data. Another limitation was the unknown manual techniques. Joint mobilizations were performed preoperatively consisting of posterior and inferior glides, as noted in the intervention, but the specific technique for each visit is unknown because the patient was seen by a total of 3 therapists over the course of her 31 sessions. These differences could have affected her outcomes.

Another factor that may have inhibited her rehabilitation was her diabetes. Patients with diabetes typically have a slower healing time to begin with and this patient often had complications due to her diabetes. Because of poorly controlled blood sugar, even with a pump, the patient often missed visits due to illness. She ended up only attending a total of 31 physical therapy sessions over a 6 month period. Protocol for attendance in the physical therapy clinic where the patient was seen is 3 times per week at the beginning, then wean

down to 2 once they become more independent with their programs. This means she should have been seen closer to 60 visits. While the patient was instructed in a HEP it is difficult to monitor and really know what is being done and to what extent at home. For this reason she also was behind on the expected progression of phases in the outlined protocol.

Lastly, realistic expectations should be considered largely on an individual basis. Underlying pathology, past medical history, and the status of the external rotators will all affect the outcome of the rTSR. The patient needs to understand that full ROM is not expected following rTSR but that functional ROM at or slightly above 90° of active elevation is likely.[5,19,21,22,23] In this case, while the actual AROM, PROM, and strength measurements did not demonstrate a great increase in numbers, the patient's functional improvement and overall satisfaction is noted by the decrease in the DASH scores. She was aware of the limitations of the surgery before hand and per subjective report was very pleased with her progress and improved quality of life.

Research studies on rTSR are limited by the fact that it is a newer procedure and long-term studies are not available. Werner et al[18] discuss rTSR being a viable option for degenerated shoulders with successful outcomes. Frankle et al[19] also mentions the short-term achievements following rTSR. Numerous studies found report, after short-term follow-ups of patients receiving rTSR, that a majority of the patients self-reported functional outcome improvements.[7,10,11,18] However, the functional results were noted to decrease progressively after 6 years. This could be due to the fact that the procedure is typically performed on aging patients. Further studies are needed to determine the long term complications and longevity of rTSR.

Conclusion

The physical therapy interventions in this case resulted in improved outcomes for the patient as measured by ROM, MMT and DASH scores. The patient reported increased functional use of the shoulder and improved quality of life. The rTSR was beneficial for this patient, and may be for similar patients with rotator cuff tears with associated glenohumeral arthritis who have exhausted their means of conservative treatments. However, there is a great need for further research with randomized controlled trials and long term follow-up studies to determine outcomes and possible complications following rTSR surgery and rehabilitation.

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Table 1

Active range of motion (AROM) and Passive range of motion (PROM) for left (L) shoulder

AROM/PROM	Pre-op treatment for L frozen shoulder	Initial examination 6 wks post-op rTSR	Re-examination 14 wks post-op rTSR	Re-examination 22 wks post-op rTSR	Re-examination discharge 26 wks post-op rTSR
Flexion	38°/95°	55°/90°	88°/142°	104°/145°	111°/148°
Abduction	43°/85°	67°/65°	90°/130°	101°/135°	102°/142°
External Rotation	-8°/35°	-10°/32°	-5°/45°	0°/45°	35°/53°
Internal Rotation*	T10/60°	Gluteal insertion**/44°	T10/60°	T10/60°	T10/64°

*AROM of internal rotation as measured by patient's functional reach behind her back:

T10=level of 10^{th} thoracic vertebra

**gluteal insertion: distal insertion at greater trochanter

Table 2

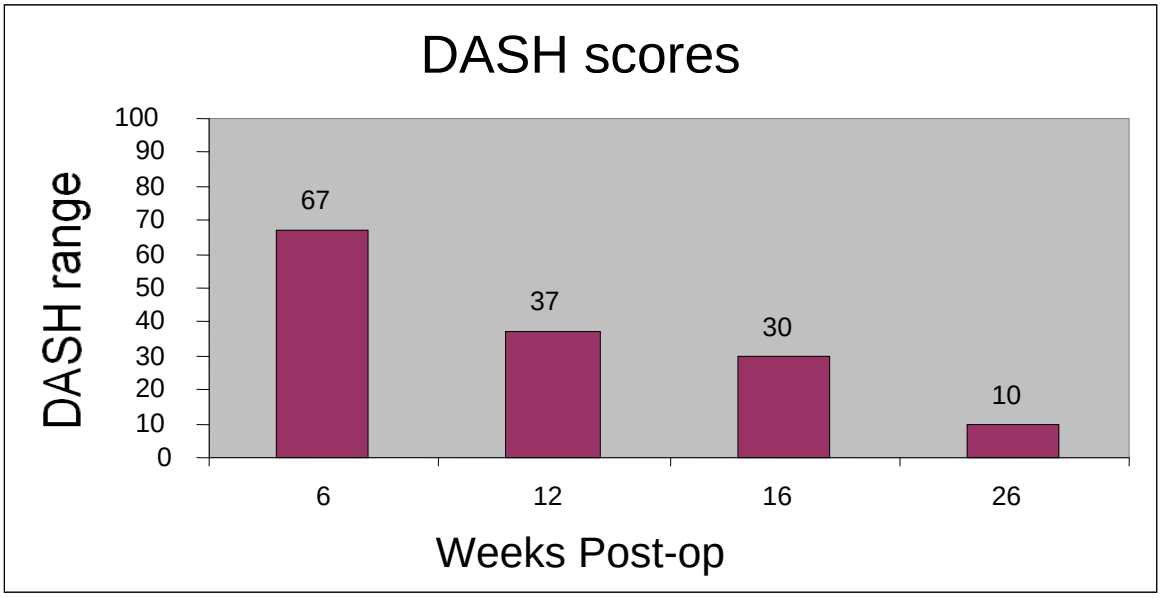
Manual muscle test (MMT) for left (L) shoulder

Based on a 0-5 scale with 0 no muscle contraction and 5 able to hold position against resistance

	Pre-op treatment for L frozen shoulder	Initial examination 6 wks post-op rTSR	Re-examination 14 wks post-op rTSR	Re-examination 22 wks post-op rTSR	Re-examination discharge 26 wks post-op rTSR
Flexion	3+	3	4-	4	4
Abduction	3+	3	4-	4	4
External Rotation	3+	3-	3	3+	4-
Internal Rotation	4+	3-	3+	4	4

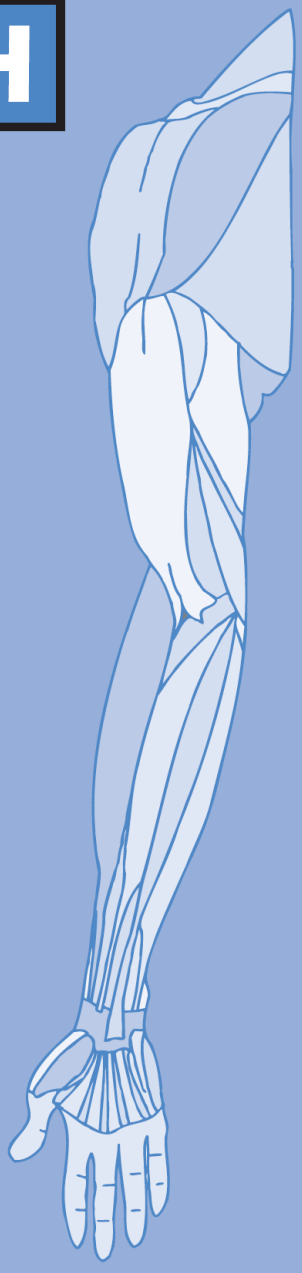
Figure 1

Disabilities of the Arm, Shoulder and Hand (DASH) scores



DISABILITIES OF THE ARM, SHOULDER AND HAND

THE DASH



INSTRUCTIONS

This questionnaire asks about your symptoms as well as your ability to perform certain activities.

Please answer *every question*, based on your condition in the last week, by circling the appropriate number.

If you did not have the opportunity to perform an activity in the past week, please make your *best estimate* on which response would be the most accurate.

It doesn't matter which hand or arm you use to perform the activity; please answer based on your ability regardless of how you perform the task.

Disabilities of the Arm, Shoulder and Hand

Please rate your ability to do the following activities in the last week by circling the number below the appropriate response.

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE
1. Open a tight or new jar.	1	2	3	4	5
2. Write.	1	2	3	4	5
3. Turn a key.	1	2	3	4	5
4. Prepare a meal.	1	2	3	4	5
5. Push open a heavy door.	1	2	3	4	5
6. Place an object on a shelf above your head.	1	2	3	4	5
7. Do heavy household chores (e.g., wash walls, wash floors).	1	2	3	4	5
8. Garden or do yard work.	1	2	3	4	5
9. Make a bed.	1	2	3	4	5
10. Carry a shopping bag or briefcase.	1	2	3	4	5
11. Carry a heavy object (over 10 lbs).	1	2	3	4	5
12. Change a lightbulb overhead.	1	2	3	4	5
13. Wash or blow dry your hair.	1	2	3	4	5
14. Wash your back.	1	2	3	4	5
15. Put on a pullover sweater.	1	2	3	4	5
16. Use a knife to cut food.	1	2	3	4	5
17. Recreational activities which require little effort (e.g., cardplaying, knitting, etc.).	1	2	3	4	5
18. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.).	1	2	3	4	5
19. Recreational activities in which you move your arm freely (e.g., playing frisbee, badminton, etc.).	1	2	3	4	5
20. Manage transportation needs (getting from one place to another).	1	2	3	4	5
21. Sexual activities.	1	2	3	4	5

Disabilities of the Arm, Shoulder and Hand

	NOT AT ALL	SLIGHTLY	MODERATELY	QUITE A BIT	EXTREMELY
22. During the past week, *to what extent* has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups? *(circle number)*	1	2	3	4	5

	NOT LIMITED AT ALL	SLIGHTLY LIMITED	MODERATELY LIMITED	VERY LIMITED	UNABLE
23. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem? *(circle number)*	1	2	3	4	5

Please rate the severity of the following symptoms in the last week. *(circle number)*

	NONE	MILD	MODERATE	SEVERE	EXTREME
24. Arm, shoulder or hand pain.	1	2	3	4	5
25. Arm, shoulder or hand pain when you performed any specific activity.	1	2	3	4	5
26. Tingling (pins and needles) in your arm, shoulder or hand.	1	2	3	4	5
27. Weakness in your arm, shoulder or hand.	1	2	3	4	5
28. Stiffness in your arm, shoulder or hand.	1	2	3	4	5

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	SO MUCH DIFFICULTY THAT I CAN'T SLEEP
29. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand? *(circle number)*	1	2	3	4	5

	STRONGLY DISAGREE	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	STRONGLY AGREE
30. I feel less capable, less confident or less useful because of my arm, shoulder or hand problem. *(circle number)*	1	2	3	4	5

DASH DISABILITY/SYMPTOM SCORE = $\left[\left(\frac{\text{sum of n responses}}{n}\right) - 1\right] \times 25$, where n is equal to the number of completed responses.

A DASH score may <u>not</u> be calculated if there are greater than 3 missing items.

DISABILITIES OF THE ARM, SHOULDER AND HAND

WORK MODULE (OPTIONAL)

The following questions ask about the impact of your arm, shoulder or hand problem on your ability to work (including homemaking if that is your main work role).

Please indicate what your job/work is:_____

p I do not work. (You may skip this section.)

Please circle the number that best describes your physical ability in the past week. Did you have any difficulty:

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE
1. using your usual technique for your work?	1	2	3	4	5
2. doing your usual work because of arm, shoulder or hand pain?	1	2	3	4	5
3. doing your work as well as you would like?	1	2	3	4	5
4. spending your usual amount of time doing your work?	1	2	3	4	5

SPORTS/PERFORMING ARTS MODULE (OPTIONAL)

The following questions relate to the impact of your arm, shoulder or hand problem on playing *your musical instrument or sport or both*.
If you play more than one sport or instrument (or play both), please answer with respect to that activity which is most important to you.

Please indicate the sport or instrument which is most important to you:_

o I do not play a sport or an instrument. (You may skip this section.)

Please circle the number that best describes your physical ability in the past week. Did you have any difficulty:

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE
1. using your usual technique for playing your instrument or sport?	1	2	3	4	5
2. playing your musical instrument or sport because of arm, shoulder or hand pain?	1	2	3	4	5
3. playing your musical instrument or sport as well as you would like?	1	2	3	4	5
4. spending your usual amount of time practising or playing your instrument or sport?	1	2	3	4	5

SCORING THE OPTIONAL MODULES: Add up assigned values for each response; divide by 4 (number of items); subtract 1; multiply by 25.
An optional module score may <u>not</u> be calculated if there are any missing items.

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Appendix B: rTSR protocol

APPENDIX

REVERSE TOTAL SHOULDER ARTHROPLASTY PROTOCOL

Shoulder Dislocation Precautions

Precautions should be implemented for the first 12 wk postoperatively unless surgeon specifically advises patient or therapist differently:

- No shoulder motion behind lower back and hip (no combined shoulder adduction, internal rotation [IR], and extension)
- No glenohumeral (GH) joint extension beyond neutral

Progression to the next phase based on clinical criteria and time frames as appropriate.

Phase I: Immediate Postsurgical Phase, Joint Protection (Day 1 to Week 6)

Goals

- Patient and family independent with
  - Joint protection
  - Passive range of motion (PROM)
  - Assisting with putting on/taking off sling and clothing
  - Assisting with home exercise program (HEP)
  - Cryotherapy
- Promote healing of soft tissue/maintain the integrity of the replaced joint
- Enhance PROM
- Restore active range of motion (AROM) of elbow/wrist/hand
- Independent with activities of daily living (ADLs) with modifications

Precautions

- Sling is worn for 3-4 wk postoperatively. The use of a sling may be extended for a total of 6 wk, often, if it is a revision surgery
- While lying supine, the distal humerus/elbow should be supported by a pillow or towel roll to avoid shoulder extension. Patients should be advised to "always be able to visualize their elbow while lying supine"
- No shoulder AROM
- No lifting of objects with operative extremity
- No supporting of body weight with involved extremity
- Keep incision clean and dry (no soaking/wetting for 2 wk); no whirlpool, jacuzzi, ocean/lake wading for 4 wk

Days 1 to 4 (acute care therapy)

- Begin PROM in supine after complete resolution of interscalene block
  - Forward flexion and elevation in the scapular plane in supine to 90°
  - External rotation (ER) in scapular plane to available ROM as indicated by operative findings, typically around 20°-30°
  - No IR range of motion (ROM)
- AROM/active assisted ROM of cervical spine, elbow, wrist, and hand
- Begin periscapular submaximal pain-free isometrics in the scapular plane
- Continuous cryotherapy for first 72 h postoperatively, then frequent application (4-5 times a day for about 20 min)

Days 5 to 21

- Continue all exercises as above
- Begin submaximal pain-free deltoid isometrics in scapular plane (avoid shoulder extension when isolating posterior deltoid)
- Frequent (4-5 times a day for about 20 min) cryotherapy

Weeks 3 to 6

- Progress exercises listed above
- Progress PROM
  - Forward flexion and elevation in the scapular plane in supine to 120°
  - ER in scapular plane to tolerance, respecting soft tissue constraints
- At 6 wk postoperatively start PROM IR to tolerance (not to exceed 50°) in the scapular plane
- Gentle resisted exercise of elbow, wrist, and hand
- Continue frequent cryotherapy

Criteria for progression to the next phase (phase II)

- Patient tolerates shoulder PROM and AROM program for elbow, wrist, and hand
- Patient demonstrates the ability to isometrically activate all components of the deltoid and periscapular musculature in the scapular plane

Phase II: AROM, Early Strengthening Phase (Weeks 6 to 12)

Goals

- Continue progression of PROM (full PROM is not expected)
- Gradually restore AROM
- Control pain and inflammation
- Allow continued healing of soft tissue/do not overstress healing tissue
- Re-establish dynamic shoulder stability

Precautions

- Continue to avoid shoulder hyperextension
- In the presence of poor shoulder mechanics avoid repetitive

Sage Graduate School

Office of the Dean

March 16, 2009

Jocelyn Rubino
Orthopedic Specialty Group
2 Enterprise Drive, Suite 204
Shelton, CT 06484

IRB PROPOSAL # 08-09-065
Reviewer: Samuel W. Hill, Chair

Dear Ms. Rubino:

The Institutional Review Board has reviewed your application and has approved your project entitled "Physical therapist management of a 42 year old female following a reverse total shoulder replacement (rTSR): a case report." Good luck with your research.

Please refer to your IRB Proposal number whenever corresponding with us whether by mail or in person.

Please let me know if you have any questions.

Sincerely,

Samuel Hill

Samuel W. Hill, PhD
Chair, IRB

SWH/nan

Cc: Esther Haskvitz

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