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Outpatient Physical Therapy Management for a Full Thickness Sutraspinatus Tendon Tear: A Case Study

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OUTPATIENT PHYSICAL THERAPY MANAGEMENT FOR A FULL THICKNESS SUPRASPINATUS TENDON TEAR: A CASE STUDY

by

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This Scholarly Project, submitted by Samantha Miller, SPT in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

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Signature Samantha Miller

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ABSTRACT

Background and Purpose. This article describes the 14-week physical therapy treatment of a pre- and postoperational full thickness supraspinatus tendon tear of a 45-year-old female. The four muscles of the rotator cuff provide stabilization to the glenohumeral joint of the shoulder. These muscles are the supraspinatus, infraspinatus, teres minor, and the subscapularis.[1] In the United States, roughly 460 000 rotator cuff repair surgeries occur each year and they are the second most common orthopedic procedure.[2] Past research studies have shown that a full recovery from this surgery takes 3 to 6 months, with factors such as integrity of tendons, extent of injury, and commitment to rehabilitation playing a role in the length of recovery.[3] The purpose of this case report is to describe the interventions implemented with a patient with a supraspinatus tear and the responses to them.

Case Description. This patient is a 45-year-old female that fell from a hammock onto an outstretched arm, which resulted in a full thickness supraspinatus tendon tear. The patient underwent a repair with a autogenous bicep's tendon, which resulted in a 14 week physical therapy treatment. She was extremely motivated and had an excellent support system. The patient had a full recovery and was back to her prior level of function by the end of therapy.

Intervention. The treatment for this patient included passive range of motion, active assistive range of motion, active range of motion, stretching, blood flow restriction training, and strengthening.

Outcomes. Following PT intervention, the patient achieved full active range of motion for all shoulder motions, symmetrical strength bilaterally, decreased pain, and improved symmetrical shoulder alignment with movement. The patient was able to return to work full time with limited pain, sleep throughout the night, and complete overhead tasks for short periods of time.

Discussion. Rationale for treatment followed Michelotti's *Arthroscopic Partial Articular Surface Rotator Cuff Repair Physical Therapy Protocol* for rotator cuff injuries.[1] The patient responded very well to our passive stretching in the beginning and blood flow restriction training towards the end of her therapy. I believe this was the case because of how tense her shoulder was after immobilization, that the passive stretching was the only way to increase her range of motion at that time. BFR was utilized to aid in the strengthening process.

Keywords: Supraspinatus tendon tear, stretching, strengthening, dry cupping, physical therapy

CHAPTER I

INTRODUCTION/LITERATURE REVIEW

The rotator cuff is an anatomical structure that is located on the glenohumeral joint and is made up of four muscles: supraspinatus, infraspinatus, teres minor, and the subscapularis. These muscles all provide stabilization for the shoulder and allow for rotation of the joint in both the external and internal planes of motion. In addition, the rotator cuff plays a critical role in depressing the humeral head when the humerus is elevated. This occurs every time the arm is raised, which happens extremely frequently throughout the day to day life of most people. According to iData Research, over 460 000 rotator cuff repair surgeries are performed each year in the United States, making it the second most orthopedic soft tissue repair procedure performed.[2] As the average age of the US population continues to increase, rotator cuff surgeries will become a more frequent occurrence, as age is a predecessor to a tear. Approximately 50% of adults over the age of 50 have some sort of rotator cuff pathology that may need to be operated on in the future.[3]

Etiology of rotator cuff repairs can be linked to many different factors in a person's life. Degenerative changes that come with age, repetitive microtrauma, and severe traumatic injuries are just a few of the possibilities that could elicit a tear in the rotator cuff. Degenerative changes that occur with age can be from thinning and disorganization of collagen fibers, calcification, fatty infiltration, and necrosis of the tendon due to cell apoptosis.[4] These can all be present or

just a few to make marked changes within the rotator cuff tendons. Repetitive microtrauma tears are common in overhead athletes such as baseball pitchers and swimmers. The repetitive stress that the overhead motion places on the tendons creates microtears within these tendons that eventually lead to a full tear.[5] Severe traumatic injuries such as falling on an outstretched hand that was both externally rotated and abducted from the body is the most common position. This is also the position our body naturally goes into from our body's protective extension, sideward, and backwards reflexes that are never integrated through the lifespan.

Treatment for rotator cuff tears can come in both nonoperative and operative forms. Non-operative treatment includes physical therapy, steroid injections, and anti-inflammatory medicine. Operative treatment is a surgical repair of the torn tendon that can be done by arthroscopic repair, open repair, or a mini-open repair. A few studies have found that recovery time for the arthroscopic repair is the shortest in duration compared to the open and the mini-open repair[8]. The best option varies greatly from patient to patient due to the degree of the patient's tear, the viability of remaining tissue, and the patient's current and prior level of function. Most surgeons will recommend nonsurgical treatment prior to surgery for partial tears of the rotator cuff. If nonsurgical options fail and patient satisfaction in their recovery is not reached, surgery would be the next step. Currently, there lacks evidence for which treatment option is better given the heterogeneity of the participants.

Treatment options that physical therapy can include, but are not limited to, stretching, strengthening, manual therapy, blood flow restriction therapy, and dry cupping. Throughout this case report, the patient's response to these treatments will be documented and discussed. Blood flow restriction (BFR) therapy is the act of partially restricting arterial blood flow while completely restricting venous blood flow throughout the extremity.[5] A pneumatic tourniquet

system is placed at the most proximal region of the extremity and inflated, causing a mechanical compression of vasculature. The compression causes a hypoxic environment for the muscle tissues within the extremity the cuff is placed on. When exercise is performed conjointly with the BFR cuffs, it increases intramuscular pressure beneath the cuff, which further disrupts blood flow.[2] Within the extremity that has the hypoxic environment occurring, it is thought that there is an increase of metabolites, which is thought to increase muscle cell swelling, intramuscular anabolic/anti-catabolic signaling, and muscle fiber recruitment, which are all thought to be beneficial for muscular adaptation.[3] Laurentino et al[3] determined the pressure required for complete vascular restriction at the upper thigh during rest is 80% arterial occlusive pressure and 50% for the upper extremity. Low-load exercise, 20% of one rep max, combined with the BFR cuffs has been shown to create a metabolic stimulus similar to multiple sets of high-load resistance exercise, without skeletal muscle damage, prolonged decrements in muscle function, or exaggerated muscle soreness ratings.

Dry cupping has been used as a treatment for pain dating back to ancient Greece and is common practice with traditional Chinese medicine. It uses negative pressure to create a suctioning with no skin perforation.[6] The negative pressure creates a decompression agent for underlying tissue and dilates the capillaries of the blood vessels. This increases the blood flow to the area, which stimulates the production of heme-oxygenase, which leads to the production of carbon monoxide, bilirubin, and iron which have been shown to have an antioxidant, anti-inflammatory, and anti-proliferative effect in both animal and human studies.[7] Indications for cupping can include tight muscles, trigger points, scar mobilization, and myofascial release. There are two main theories that can explain how dry cupping reduces the effects of the previously mentioned symptoms, Immune System Theory and Nitric Oxide Theory. The immune

system theory suggests stimulation by the cups because they irritate the area by creating artificial inflammation in a specific location. This activates the complementary system, which activates the antibodies, which increase the level of the immune products in the blood within the site of inflammation. Cupping incorporates the Nitric Oxide Theory by causing the release of nitric oxide (NO) from endothelial cells, which induces vasodilation, a decrease of vascular resistance, and lower systemic blood pressure.[8]

Prognosis for patients after an arthroscopic rotator cuff repair surgery is very good. Novoa-Boldo et al[7] found that 90% of patients are happy 6 months after surgery and maintain stability during the 5 years following. Factors that can deter patients from reaching their desired outcome include age, gender, smoking, tendon of quality, comorbidities, and size of the tear.[7] Physical therapy is prescribed after all rotator cuff repairs to aid in the recovery with most surgeons giving a specific protocol for the physical therapist to follow. The purpose of this case report is to describe the progression of treatment and outcome of outpatient physical therapy management of a full thickness supraspinatus tear with a bicep tendon graft with traditional interventions such as stretching, strengthening, and manual therapy and with less traditional dry cupping and blood flow restriction.

CHAPTER II

CASE DESCRIPTION

History. The patient is a 45-year-old right-handed Caucasian female that fell out of a hammock, landing on an outstretched right arm. She felt immediate pain in her right shoulder and was unable to move it after the incident. Radiographs were completed and were negative for a fracture, and an MRI was ordered. The MRI showed a full thickness tear of the supraspinatus tendon with a bone spur off of the acromion process. The patient elected to have surgery approximately one month after the incident, to both reattach the tendon and remove the bone spur. Physical therapy was utilized prior to the operation to strengthen and stretch the glenohumeral joint to prepare for surgery. One week postoperatively the patient presented to physical therapy in a sling with a protocol that allowed only passive range of motion for the first 6 weeks. During the first 6 weeks, the patient reported having severe pain and the inability to get comfortable at night and having a hard time completing her job tasks as a hospital administrator. Heat and getting out of the brace helped the patient's pain and discomfort, while any movement at the glenohumeral joint increased the patient's pain.

The patient lives with her husband in a three-story home that has railings on all staircases. She reports there being high cabinets in both her kitchen and bathroom and that she depends on her husband to reach, though she stated she moved most necessary items down to a lower height. Her hobbies include running, yoga, hiking, Pilates, hanging out with friends, and being active in her son's life by cooking and baking for both him and her husband. Patient has no previous history of shoulder or cervical injuries, though she reported suffering from knee tendonitis from excessive running approximately 5 years ago. She takes no medications and has no comorbidities that would affect her healing process.

Continued physical therapy would be warranted after the initial 6 weeks due to her increased levels of pain, decreased range of motion, inability to participate in her hobbies, and no hindering elements that would affect her progress. To address these concerns, manual therapy, stretching, and strengthening were prescribed via the orthopedic surgeon's protocol for the first 8 weeks postoperation. Blood flow restriction therapy and dry cupping were utilized postprotocol based on the patient's response to previous treatments and willingness to try new things. Based on systems review and subjective history, the patient was a good candidate for physical therapy in order to restore her prior level of function and improve her quality of life.

Examination

Evaluation was based upon the textbook of Donatelli's *Physical Therapy of the Shoulder.*[9] Upon observation of the patient prior to surgery, she presented with the right arm tucked protectively into her side. She stated that she was uncomfortable with most active range of motion because she was "scared of the pain." The initial examination focused heavily on pain and home exercise program education. The information obtained from the initial examination prior to surgery is described below in Tables 1, 2, and 3. All strength testing of the right upper extremity was weak and painful in nature.

Table 1. Initial Shoulder Active Range of Motion		
	Right	**Left**
Flexion	90	WNL
Scaption	90	WNL
Abduction	70	WNL
External Rotation in Neutral	20	WNL
Extension	20	WNL
Internal Rotation in Neutral	belly	WNL

Table 2. Initial Shoulder Passive Range of Motion			
	Right	**Endfeel**	**Left**
Flexion	110	Painful	Not Tested
Scaption	110	Painful	Not Tested
Abduction	90	Painful	Not Tested
External Rotation in Neutral	30	Painful	Not Tested
Internal Rotation in Neutral	30	Painful	Not Tested

Table 3. Initial Shoulder Special Tests			
	Right	**Sensitivity and Specificity** [5]	**Left**
Empty Can	Positive	Sen: 53-89% Spec: 65-82%	Negative
Subscapularis Lift Off	Positive	Sen: 17-100% Spec: 60-98%	Negative
Drop Arm	Positive	Sen: 10-73% Spec:77-98%	Negative
Painful Arc Sign[10]	Positive	Sen: 33% Spec: 81%	Negative
Infraspinatus Muscle Test	Positive		Negative

According to Park et al[11] the combination of the drop-arm sign, painful arc sign, and the infraspinatus test has a 91% probability of detecting a rotator cuff tear if all 3 tests are positive. The infraspinatus muscle test is never used as a stand-alone measure to diagnose rotator cuff tears and therefore has no sensitivity or specificity attached to it. After positive special test results that are summarized in Table 4 above, the lead physical therapist referred out for surgery as she thought the patient would see the best results with the operation and physical therapy compared to conservative treatment alone. The patient's functional disability was measured with the Disabilities of the Arm, Shoulder, and Hand (DASH) outcome measure questionnaire. The patient's initial score was an 82.5/100 which indicates a high level of disability and severity of her injury. The DASH has a reliability of 96%,

validity of greater than 70%, and a minimal detectable change of 10 points is needed for an important change to be documented.[12]

Postoperatively, the patient presented to physical therapy with her right arm in a sling and incision sites covered. All incision sites were negative for infection and bruising was present within anticipated limits. Formal strength, range of motion, and special testing were not completed at the initial post-operative examination due to protocol limitations.

Evaluation

After a thorough subjective and objective review, the patient's main impairments were limited range of motion compared to her nonsurgical arm, overall decreased strength in affected limb, and increased pain and stiffness with any active range of motion. The combination of the previously listed impairments have impacted her ability to independently wash her hair, do her hair, cook, and workout like she used to. She had problems with pain, though inconsistent, while sitting in her chair at work. Getting up to do her exercises or going for walks relieved this pain in her shoulder. The surgical repair of the supraspinatus tendon and the biceps graft would account for all the patient's previously stated symptoms.

Diagnosis

Clinical impression and initial evaluation data support the suspected range of motion restrictions, strength deficits, and increased levels of pain following an arthroscopic repair of the supraspinatus tendon with a biceps graft. These components were felt in aspects of the patient's daily life and made doing some ADL's independently, impossible. As such, the patient was an excellent candidate for continued skilled physical therapy in order to restore the previous level of function for the patient. Goals for therapy were focused on regaining the range of motion and strength on the operative limb and reducing the pain and stiffness felt by the patient. Short term goals were focused on returning active shoulder flexion without pain to give the patient the ability to independently wash/do her hair. Long term goals were focused on returning equal strength in arms bilaterally to allow the patient to have proper body mechanics while participating in her hobbies, Pilates, yoga, hiking, and cooking.

Prognosis

Based on the patient's age, prior level of function, and motivation to get better, the patient had a very good prognosis to advance through physical therapy. She demonstrated excellent intentions to be competent with her home exercise program and was compliant in postoperative care from her surgeon. Given that the first 6 weeks were limited to passive range of motion and included continuous brace wear, not much progress was made regarding the patient's goals. However, allowing the tendon to heal during that time allowed fast progression through the protocol during the next 9 weeks of treatments. Re-examination of range of motion was done each treatment session and the patient followed up with her doctor at the 6 weeks postoperative date and returned with clear instructions from the surgeon regarding active range of motion goals.

CHAPTER III

INTERVENTION

The first two weeks of physical therapy focused, per Michelotti's Protocol, heavily on passive range of motion with no active or resistive exercises. The patient was educated about doing a home program of scapular "clocks" (elevation, depression, protraction, retraction), limited by her pain within the degree of allowed motion. The patient's only complaint during this time was that the sling was uncomfortable to sleep in, but was able to arrange herself with pillows. By the end of two weeks, passive range of motion for shoulder flexion was 130 degrees and external rotation in supine was 25 degrees.

The next four weeks of sessions, following the protocol, focused on passive range of motion and active assistive range of motion exercises. Education was provided for the patient to complete external rotation with a cane lying in sidelying, pendulum exercises in prone with right arm hanging off the edge of a bed, and continuing with the scapular clocks. By 6 weeks, the patient had improved passive range of motion with flexion at 135 degrees and external rotation at 40 degrees. The patient had more frequent complaints of stiffness and pain throughout the right arm, shoulder, and neck. At the patient's follow up appointment, her surgeon recommended a manipulation to facilitate her range of motion, if it hadn't improved greatly by the 3-month mark.[13] This triggered a wave of anxiety for the patient while completing PROM during the sessions, but increased the patient's ambition in the coming weeks.

After the 6-week mark, the patient was able to participate in active range of motion, stretching, and isometric exercise. All precautions and restrictions were lifted, including the brace wear. At this time, sessions focused highly on manual therapy with emphasis on distraction, posterior glide, and inferior glide to facilitate flexion and external rotation. The patient was instructed in a home program that used a pulley system and cane to provide a way to complete active assistive range of motion.

At week 7, the patient was agitated at the idea of possibly having a manipulation done to the shoulder and wanted to try everything possible to get the extra range of motion. The patient's passive range of motion was at 136 degrees and external rotation was at 40. Passive and active range of motion measurements were taken at the beginning of each treatment session with a goniometer with the patient lying supine. The two treatment sessions during week 7 focused primarily on manual therapy and scapular re-education, as patient was showing a severe shoulder hike with shoulder flexion and abduction. During week 7, dry cupping was introduced to the patient and she saw significant improvements. Hard plastic cups were placed on her right latissimus dorsi, bicep tendon, rhomboids, and upper trapezius. Cups were positioned both statically (patient and cup remain still), and dynamically on static (patient remains still, cups move) for approximately 3 to 5 minutes on each muscle. Significant redness and bruising was seen on patient's skin; however, those effects are completely normal and the patient was educated on that beforehand.

Weeks 8 to 15 focused on strengthening all the muscles of the rotator cuff along with the glenohumeral joint using blood flow restriction (BFR) therapy, using the protocol from Khalil et al.[14] Dry cupping was continuously utilized throughout this time, often completed at the end of treatment sessions to loosen the patient's muscles. The same muscles were always done for the

same amount of time previously discussed above. The patient was educated on possible benefits and risks of BFR such as increased hormone production, greater strength gains over time with lesser load, and feelings of heaviness throughout the arms.[14] The patient was set up with BStrong (Park City, UT) cuffs and using a EDAN Vascular Doppler, the patients cuffs were elevated until no heart rate was detected on the Doppler. From that number, the patient was backed off approximately 50%, with heart rate returning to normal via the Doppler. The patient then completed a wide variety of upper extremity strengthening with 3 sets of 10 repetitions on each; rows with 10 lb, triceps pull downs with 20 lb, lateral pull downs with straight arms with 30 lb, bicep curls with 10 lb, and chest presses with 10 lb. The patient was visibly fatigued following exercises, but had no increase in pain posttreatment. The patient was instructed to continue to do her stretches and home exercise program as prescribed earlier in her sessions.

The patient's final session was composed of taking range of motion measurements and strength testing. All strength measurements were 5/5 bilaterally, with only a "slight pain" reported during abduction. All measurements were taken with the patient in sitting with her feet on the ground. The measurements can be seen in the tables below.

Table 4. Active Range of Motion after 15 weeks of Physical Therapy		
	Right	**Left**
Flexion	175	180
Abduction	180	180
External Rotation in Neutral	50	55
Internal Rotation in Neutral	Belly	Belly
External Rotation at 90°	47	52
Internal Rotation at 90°	41	45

CHAPTER IV

OUTCOMES

Following 15 weeks of physical therapy intervention, the patient saw significant gains in range of motion and strength in her operative limb. Table 5 details the right arm active range of motion pre- and posttreatment, with all motions having no pain reported during the motion.

Table 5. Active Range of Motion of Right Shoulder Pre and Post Treatment

	Pre-Treatment	**Post-Treatment**
Flexion	90	175
Abduction	70	180
External Rotation in Neutral	20	50
Internal Rotation in Neutral	Hand to stomach	Hand to stomach
External Rotation at 90	N/A due to pain	47
Internal Rotation at 90	N/A due to pain	41

At the last treatment session, the patient completed the DASH Functional Outcome Measure once again and scored a 31/100, which indicates a low level of disability. At discharge, the patient could complete all ADLs independently, participate in her desired hobbies, and complete all Pilates and yoga moves without pain (that she had tried). The patient enjoyed using the BFR technology for strengthening and often chose to use those over traditional options. Dry cupping was preferred for the patient over traditional passive or active stretching; however, those were

still completed to give the patient best possible outcomes. She still reported stiffness in her shoulder joint if inactive for too long, worst in the mornings and after sitting for too long. Patient was seen by the lead physical therapist at one month postdischarge. She expressed a major amount of gratitude at her progress through physical therapy that allows her to live at her current quality of life.

CHAPTER V

DISCUSSION

During the patient's 15 weeks of physical therapy, all short and long terms goals that were set at the beginning of her treatment, were met and exceeded. While more research needs to be completed on the benefits and uses of both dry cupping and blood flow restriction therapy, these treatment techniques proved to be useful in gaining the patient's range of motion that was lacking. In a randomized clinical study being completed by the Henry Ford Health System, it was found that BFR increases the strength of the rotator cuff post-operative of a repair.[14] While this study focused primarily on the usefulness of BFR post-operatively, it was still a significant gain in strength in the patients that utilized BFR compared to the control group. In another study conducted by Yasuda et al,[15] it was concluded that BFR increased muscle activation and blood lactate concentration compared to the control group with no BFR treatment. In future case studies, it would be appropriate to do an EMG analysis that provides accurate feedback of muscle activation for both the patient and the physical therapist to increase the knowledge of the benefits of BFR.

While there have been many studies completed on the use of dry cupping increasing the hormone and blood production in the target area, further research needs to be completed on the exact benefits for the muscles underneath the cup. For future reference, it would have been interesting to analyze the difference of using a static on static approach (when both patient and cup stay stationary) versus a static on dynamic approach (patient stays still while the cup is

moved). This would give a more detailed look at the effects the suction has when run throughout the length of the muscle or if there are greater benefits seen when the cup is left in place. Given that my patient reacted positively to both BFR and dry cupping, I hypothesize that these two interventions were beneficial in the strengthening and stretching of her muscles, respectively. Considerable gains in the patient's strength and range of motion after introducing her to the interventions in week 7 and 8. While further studies are needed to analyze the exact reason behind the benefits of these two interventions, positive benefits were seen during their use when treating this patient. However, it should be noted that the patient enjoyed both of these interventions and that should be taken into account when comparing her to people who are not fond of these types of treatment.

Reflective Practice

Given my ability at the time of the collection of data for this case study, there are many things I would do differently now that I have more knowledge under my belt. While the patient had a clear protocol lined up for her postoperatively, I believe an open dialogue with the surgeon could have prevented the patient's stiffness caused from the immobility of the brace for the first 6 weeks. With the patient progressing so rapidly and the care she received from her husband at home, I think it would have benefited her to be able to start to complete passive range of motion earlier than what was stated in the protocol.

As mentioned previously, I believe it would have been interesting to utilize an EMG analysis to compare the patients muscle activation pre- and post BFR cuff placement. Not only would this information benefit me as her health care provider, it would increase the patient's "buy in" with the interventions. While more research needs to be done on the true amount of

control the mental aspect of things plays a role in treatment, I believe there is enough evidence to know that this could have been a beneficial practice.

Given the extent of the patient's injury and the necessary allotted time needed for the protocol to be progressed, I believe that there were very few things that could have made this patient's recovery time shorter. As I mentioned above, if the passive range of motion could have been introduced at an earlier time, we might not have spent as much time trying to loosen the musculature of the rotator cuff. However, following an assigned protocol from the orthopedic surgeon and advancing without a consult is highly unprofessional and not recommended. The patient had excellent insurance coverage and the ability to pay for care not covered throughout her treatment. If the patient would have not been as able to pay the bill, I think that the patient's care would have suffered given how much hands-on treatment was completed during her time in therapy.

REFERENCES

1. Michelotti JD, Borquist ER, Malerie L, Schlepp CL, Weinert AM, Hanson PD. PDF.

2. Over 460,000 Rotator Cuff Surgeries per Year Reported in the United States by iData Research. iData Research. https://idataresearch.com/over-460000-rotator-cuff-surgeries-per-year-reported-in-the-united-states-by-idata-research/. Published June 19, 2019. Accessed April 23, 2020.

3. Via AG, De Cupis M, Spoliti M, Oliva F. Clinical and biological aspects of rotator cuff tears. Muscles Ligaments Tendons J. 2013;3(2):70-79. www.ncbi.nlm.nih.gov/pmc/articles/PMC3711705/.

4. John M. Eisenberg Center for Clinical Decisions and Communications Science. "Treatment Options for Rotator Cuff Tears." *Comparative Effectiveness Review Summary Guides for Consumers [Internet].*, U.S. National Library of Medicine, 29 Oct. 2010, www.ncbi.nlm.nih.gov/books/NBK51223/.

5. Novoa-Boldo A, Gulotta LV. Expectations Following Rotator Cuff Surgery. *Curr Rev Musculoskel Med.* 2018;11(1):162-166. www.ncbi.nlm.nih.gov/pmc/articles/PMC5825351/.

6. J. Megan Sions, PT. "Neck Pain." *APTA*, APTA, 4 June 2020, www.apta.org/Blogs/PTTransforms/2016/8/15/SeeingSpots/.

7. Lowe DT. Cupping therapy: An analysis of the effects of suction on skin and the possible influence on human health. Complementary therapies in clinical practice. https://www.ncbi.nlm.nih.gov/pubmed/29122256. Published November 2017. Accessed December 9, 2019.

8. Al-Bedah AMN, Elsubai IS, Qureshi NA, et al. The medical perspective of cupping therapy: effects and mechanisms of action. Journal of Traditional and Complementary Medicine.

9. "Full-Thickness Rotator Cuff Tear." *Physiopedia*, www.physio-pedia.com/index.php?title=Test_Item_Cluster_-_Full-Thickness_Rotator_Cuff_Tear.

10. "Painful Arc." *Physiopedia*, www.physio-pedia.com/Painful_Arc.

11. Park HB, Yokota A, Gill HS, Rassi GE, MacFarland EG. Diagnostic accuracy of clinical tests for the different degrees of subacromial impingement syndrome. J Bone Joint Surg Am. 2005;87(7):1446-1455.

12. "DASH Outcome Measure." *Physiopedia*, www.physio-pedia.com/DASH_Outcome_Measure.

13. Cluett J. What to Expect in Rehab After Rotator Cuff Surgery. Verywell Health. https://www.verywellhealth.com/rehab-after-rotator-cuff-surgery-2549905. Published September 26, 2019. Accessed April 23, 2020.

14. Khalil L. BFR Therapy in Patients With Rotator Cuff Tears - Full Text View. Full Text View - ClinicalTrials.gov. https://clinicaltrials.gov/ct2/show/NCT04384120. Accessed July 31, 2020.

15. Yasuda T, Fukumura K, Fukuda T, et al. Effects of low-intensity, elastic band resistance exercise combined with blood flow restriction on muscle activation. Scand J Med Sci Sports. 2014;24(1):55-61.