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Physical Therapy Management of Scoliosis Resulting in Bilateral Shoulder Pain in an Older Factory Worker: A Case Report

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Abstract

Background: Adolescent Idiopathic Scoliosis (AIS) affects as many as 4 in 100 adolescents. The efficacy of conservative treatments has been closely examined in younger age groups, but little research exists examining conservative management of AIS as adolescents age into adulthood and beyond. Considering the aging population, including those with conservatively managed AIS, is at risk for pain and dysfunction resulting from degenerative changes of spinal alignment, a need for this research exists in order to properly manage cases of peripheral joint dysfunction rooted in spinal deformity. **Case Description**: A 61 year old male presenting with bilateral shoulder pain also has a history of AIS. Through adolescence, his AIS was managed by observation only and he encountered few issues. His shoulders began hurting more frequently with age until he sought medical attention. This patient was working full time as a factory worker throughout this episode of care. **Intervention**: Physical therapy to treat shoulder impingement including manual therapy, neuromuscular re-education, therapeutic exercise, and therapeutic activity. Intervention evolved from targeting shoulder pain to increasing spinal mobility and postural control as symptoms improved. **Outcome**: Improvement of 29.5% as measured by QuickDASH. Patient expressed satisfaction with his recovery and opted to discontinue therapy. **Discussion**: AIS can continue to alter function and cause pain into adulthood. These symptoms can be treated with physical therapy by implementing interventions targeted at both the spine and the primary symptom location.

Keywords: Shoulder; musculoskeletal pain; scoliosis; orthopedics; physical therapy; rehabilitation

Introduction:

Adolescent Idiopathic Scoliosis (AIS) is defined as an abnormal curvature of the spine of at least 10 degrees as measured by the Cobb angle. Specifically, this refers to curvature in the frontal plane, however, changes here often affect curvature in other planes. AIS is generally diagnosed and treated, if deemed necessary, when patients are in their adolescence and the spine is still developing.[1]

There are many theories regarding the etiology of AIS, however the cause remains undetermined. Some of the theories put forth are based on research examining biomechanical, genetic, environmental, neurologic, and hormonal factors. It may be possible that each of these factors contributes to AIS.[2] Fadzan and Bettany-Saltikov suggest in their review of etiological research that grouping all individuals with scoliotic curvature into one AIS group may hinder our ability to determine causes. Moreover, very little effort is made at the time of the initial diagnosis to determine a cause. As the child continues to develop, the factors that may have contributed to this condition and its possible progression increasingly overlap, making it nearly impossible to determine a root cause.[2]

After being diagnosed with AIS, there are traditionally three treatment options. One of these is observation of curvature progression over time to determine if more dramatic treatment is indicated. A second option is bracing and/or physical therapy intervention and the third involves surgical intervention (Table 1).[1] The decision to pursue one of these options is based in part on the radiographic measurements taking into account three factors: the magnitude of the cobb angle, the change in cobb angle, and the rate of change of the cobb angle. Conservative measures, such as bracing and physical therapy or exercise, are generally selected on a case-by-case basis according to the needs of the child and the doctor's expertise.

Table 1. Common interventions for AIS and the generally accepted thresholds for each.

Common AIS Interventions	Threshold for treatment
Observation Only	Cobb angles <30 degrees while still growing or <45 when skeletally mature with no functional complaints
Conservative Treatment: Bracing and/or Physical Therapy	Moderate angle and/or moderate rate of progression; determined on a case-by-case basis.
Spinal Fusion	Cobb angles >45º while still growing or ≥45º when skeletally mature.

While the prevalence for AIS in the adolescent population hovers around 4%, the prevalence of all scoliotic curvatures in adults over 40 years old increases to 8.85%.[3] Another study found that value increased to 68% in a sample of adults with an average age of 70.5 years.[4] In this particular study, none of the subjects had previously been diagnosed with scoliosis, indicating that these changes were likely degenerative and age-related. This same degeneration occurs for those who have had scoliotic curvatures since childhood, perhaps even at an increased rate due to asymmetrical anatomy leading to uneven loading.[5]

Adult scoliosis is a significant source of health care costs in the US. According to the Healthcare Costs and Utilization Project, the average hospitalization cost for adults with scoliosis is twice the national average.[6] The average cost of non-operative management over a two year course ranges from $9,704 in low symptom patients up to $14,022 in patients with more severe symptoms.[7] Given the aging demographic profile in the United States, the economic burden of adult scoliosis is only going to increase in the coming years.

At this time, there is little existing evidence to support conservative care such as physical therapy. Studies examining the effectiveness of physical therapy have consistently found that current practices have minimal changes in health status while also contributing to the large financial burden previously alluded to.[7, 8, 9, 10] However, individuals experiencing either the effects of AIS or those of adult scoliosis can have a wide variety of symptoms including pain that is arthrogenic, musculogenic, neurogenic, and/or vascular in nature depending on their specific curvature. The location of pain can also vary greatly. Many patients will report back pain, or a history of back pain.[4] However, reports of pain away from the spine are common as well.[4] As such, even patients with known scoliosis who are experiencing musculoskeletal pain are often referred to physical therapy for treatment, despite the lack of evidence supporting this conservative measure. For shoulder patients specifically, a link between thoracic motion and shoulder impingement pain has been demonstrated in multiple studies using ultrasound imaging to examine thoracic motion. These studies consistently found decreased segmental thoracic motion in individuals with impingement symptoms.[11] While this correlation has been repeatedly shown, more research is needed to determine the true clinical relevance in general shoulder patients.[12,13] However, for shoulder patients with scoliosis and more severe thoracic impairments, the link between these two joint complexes is worth considering.

Given the increasing reliance on and use of physical therapy in the medical system, it is unlikely that these referrals will slow down. Therefore, it is imperative that physical therapists maximize the treatment efficiency for individuals experiencing pain related to scoliosis. This can be accomplished in two ways. First, therapists must respect that the current literature suggests treating the spine to reduce scoliotic curvature is not well supported. However, treating the pain associated with scoliosis shows more promise. Second, therapists and researchers should continue to investigate the causes, and possible treatment options, behind both AIS and adult degenerative scoliosis.

The purpose of this case report is to present an effective plan of care for an occupationally active 61 year old male suffering from bilateral shoulder pain associated with previously diagnosed AIS.

Case Description:

A 61 year-old male with a 6-month history of bilateral shoulder pain, was referred for outpatient physical therapy. He reported he often had referred pain into his neck, arms and hands as far distally as his left thumb. He had pain with most functional reaching tasks including those he was required to complete at work, although this was not a workman’s compensation case.

The patient had worked a physically demanding occupation since graduating from high school. Initially he worked in refrigeration services doing sales, delivery, and repair. Part of the reason he left this job approximately a decade ago was because of its physicality. Throughout the current episode of care, he was employed at a local tractor manufacturing factory. He initially described his job duties as fairly low intensity stating that he was responsible for downloading computer programs onto various machines and then running some preliminary tests on them. He would later clarify that he had to connect a wide variety of cables at eye-level prior to initiating these downloads. Once the download was complete, he had to operate the controls to put the machine through several patterns. Climbing into the vehicles and then using the controls was particularly painful.

His medical history was negative for all major medical conditions, with the exception that he had been diagnosed with scoliosis as a child. He does not know the magnitude nor location of his curvature. However, at age 19, he was referred to the Mayo Clinic for possible surgical correction. In the end he decided not to have the spinal fusion, but the fact that he was referred for surgery indicates that his curve was likely greater than 45º or progressing in curvature at that time.

The patient described his pain as a constant dull ache throughout his upper quadrants bilaterally, with his left side more intense than his right. This pain has been progressively becoming worse over the last 6 months. He brought with him to his initial evaluation a list of actions that caused his pain to increase. Most of these actions were very specific tasks that he had to do around his home such as raking leaves, putting dishes away, and working on his hobby race car. At the time of the evaluation, this patient rated his shoulder pain as 6/10. He reports that his lowest, or best, pain rating was 2/10 and the worst was 8/10. His pain was the lowest when he was resting. His pain was worse after doing any of the activities on his list or after work. When asked, he noted that he occasionally had vague symptoms of numbness in his left hand and achiness into his arms, although he had none at the time of the evaluation.

The patient stated that his goals were to be able to continue working at his current job without pain until retirement age (approximately 4 more years). Before and after retirement, he wanted to regain the ability to be able to complete all necessary odd jobs around his home without pain, such as tasks on the list he provided at the initial evaluation. He also wanted to be able to continue with his racing hobby, which required building, repairing, and occasionally racing cars.

Examination: Tests and Measures

When this patient was brought back to the treatment area, his kyphotic posture was immediately noted, however he had no obvious scoliotic curvature. As the exam progressed, the extensiveness of his kyphosis became more apparent. His kyphosis did not change when sitting compared to standing, and when supine he was unable to rest his shoulders on the treatment table. This kyphosis may even have altered his gait pattern. When walking, his stride was truncated and he presented with decreased thoracic rotation, which resulted in decreased arm swing bilaterally.

Due to presence of bilateral pain and history of numbness into his hand, both cervical and shoulder range of motion (ROM) measurements were assessed at the initial evaluation. The screen of the cervical spinal region was unable to reproduce the patient's pain symptoms or any sensations of numbness or tingling. Similarly, Spurling's test did not alter symptoms, thus the cervical spine was ruled out as an immediate source of pain. This numbness was not reproducible at this visit or at any other. After the patient's second visit, he reported that he no longer experienced these symptoms.

Examination of the patient's shoulder ROM yielded more positive findings than his cervical ROM exam. The ROM data from the full exam can be found in Table 2. He was only mildly limited in ROM, but he presented with large painful arcs. With flexion and abduction ROM, his pain started before 90 degrees and continued to his end range. Interestingly, his motion in each of these planes was equal bilaterally. However, his pain was consistently greater on his left side. Also of note, thoracic extension was observed to be decreased at end range flexion. To screen internal rotation (IR) and external rotation (ER) ROM, Apley's scratch test was performed. For both IR and ER, the patient had slightly more motion on his right relative to his left. Neither motion increased his pain. As a right-handed individual, this was considered to be within normal limits at the time. At subsequent visits, it was determined that the patient's posterior capsule was tight. This was observed through limited glenohumeral IR ROM and appropriate treatments were added to the HEP at that time.

Strength testing revealed that the patient had maintained nearly normal strength despite his chronic pain (Table 2). He demonstrated bilateral impairments in abduction (4/5 MMT) and flexion (4+/5 MMT). However, both of these actions increased his pain. He also reported increased pain bilaterally with ER testing, although his strength was normal. This patient had no complaints of weakness and felt he was almost exclusively limited by pain with daily, work, and recreational activities as well as while undergoing strength testing.

Additional special tests were positive for subacromial impingement (Table 3). Labrum testing was negative both for reproduction of pain and production of mechanical symptoms. Apprehension tests were also negative. Additionally, strength testing was sufficient to rule out any significant rotator cuff tears. Lastly, a shortened form of the Disabilities of the Arm, Shoulder, and Hand (DASH) form, known as the QuickDASH, was used to asses self-reported function. The patient scored 63.6%, indicating a moderately high level of disability at the start of his care.

Table 2. Summary of AROM and strength measured and initial evaluation. P! indicates presence of pain with test. P! indicates pain with testing.

	AROM		**MMT**	
	Right	Left	Right	Left
Flexion	160º, P! from 85º	160º, P! from 85º	4+/5	4+/5
Abduction	140º, P! from 70º	140º, P! from 70º	4/5	4/5
External Rotation	Apley's Scratch: T4	Apley's Scratch: T3	5/5 P!	5/5 P!
Internal Rotation	Apley's Scratch: T8	Apley's Scratch: T9	5/5	5/5

Table 3. Summary of Special Tests assessed at initial evaluation.

Test	**Result**
Hawkin's-Kennedy	Positive
Neer's	Positive
Obrien's Active Compression	Negative
Speed's Test	Negative
Clunk	Negative
Grind	Negative
Crank & Relocate	Negative

Clinical Impression:

This patient presents with bilateral shoulder pain resulting from impingement of structures within the subacromial space. This impingement may be due to chronically decreased scapulothoracic and thoracic mobility, both of which result from scoliotic curves present since childhood. Chronically poor posture, also a result of scoliosis, may have created an environment of microtrauma preventing the tissues affected by these active motions from fully recovering when they are not being impinged on.

Due to the negative trend in symptom intensity, irritability, chronicity, and the history of chronic scoliosis, the decision was made to see this patient two times per week, tapering appropriately for up to 12 weeks. It was anticipated that treatments including therapeutic exercise, neuromuscular re-education, therapeutic activity, and manual therapy would be appropriate treatments. Although still an active individual with a strong desire to continue to be, due to the above characteristics as well as research suggesting functional outcomes of scoliotic-related pain are not excellent with conservative treatment such as physical therapy, this patient's prognosis was documented as fair.

Intervention:

The rationale for the selected interventions can be organized into four phases: pain reduction, increasing ROM, neuromuscular re-education, and strength training. The home exercise program (HEP) followed a similar pattern but was restricted to exercises the patient was able to complete at home and in the workplace. Treatments corresponding to each phase were provided within each session as appropriate. As the patient progressed, treatment emphasis gradually transitioned from phases I and II toward phases III and IV. Of course, as the patient progressed, some treatments remained appropriate and valuable, but for different reasons.

The treatments and exercises from Phase 1 (Table 4) were selected to either decrease the patient's pain or allow him to create motion without increasing his pain. This category could also include all of the joint mobilizations, which the patient reported reduced his pain. However, while those exercises were successful in doing so, they were selected primarily for improving ROM based on concave/convex principles of the glenohumeral (GH) joint. The patient reported that his shoulder caused him pain fairly constantly. Thus, time was spent on finding active movements within his pain free ROM. This allowed him to continue to move his shoulder joint without increasing his pain. While it is highly unlikely that these motions increased his AROM, they did allow for therapeutic muscle activity and pain free motion at the shoulder. While this patient does not fit the high risk categories for adhesive capsulitis, his chronically decreased range did make this more of a concern. It was recommended that the patient try both heat and ice as he reported a hot shower in the morning helped his shoulders feel better and that his pain often increased throughout the day until he finished the workday. However, he denied these treatments in clinic and reported that he never used them independently.

As the cervical spine was cleared, referred musculogenic pain was the primary suspect for the vague numbness and aching pain he occasionally experienced into his arm and down to his thumb. The infraspinatus, supraspinatus and subscapularis were all evaluated for active trigger points at the initial evaluation and periodically reassessed throughout the first 4 visits. While there were trigger points present in each of these muscles, none of them recreated his arm symptoms when deep pressure was applied. After his second visit, he noted he had not had any symptoms distal to his shoulder for quite some time and did not have them throughout the remainder of his care. Thus these symptoms were not treated.

Table 4. Exercises and treatments chosen for the rationale of reducing or limiting pain.

Phase I: Pain Control			
Exercise	**Rationale**	**Sets/Reps**	**HEP**
Postural Training and Education	Reduce chronic impingement of subacromial space throughout the day	≥5x/day	Yes
Bent over reaches within pain free ROM in frontal and sagittal planes	Allow for active movement without increasing pain (gravity eliminated plane)	≥3x/day	Yes
Soft tissue trigger point release	Pectoralis major/minor, subscapularis, infraspinatus, supraspinatus all assessed for presence of trigger point pain referral.	No production of symptoms	No

The treatments from Phase II (Table 5.) were selected with the rationale of improving ROM. As noted above, the patient reported that several of these interventions also decreased his pain. ROM treatments targeted several loci throughout the upper extremity (UE) kinetic chain. It is important to keep in mind that the shoulder complex is comprised of three joints, glenohumeral, acromioclavicular, and sternoclavicular, as well as a pseudo joint, the scapulothoracic junction. Each of these is has an indirect connection to the thoracic spine.

The scapulothoracic (ST) junction is comprised of the scapula gliding over the posterior aspect of the ribcage. Changes in rib orientation and position, as would be expected in scoliosis and was noted in this patient, will alter the ability of the scapula to effectively glide on the ribs. Patients with thoracic curvature often demonstrate a rib hump on the convex side of their curvature. Additionally, the curvature of the spine has been well documented to alter the normal length-tension relationships of the attaching muscles.[14] This includes muscles that attach both to the thoracic and cervical spine (ie. rhomboids, tapezius, etc.) as well as those muscles that attach to the ribs (ie. serratus anterior). In general, the concave side tends to exhibit increased tone while the convex side is put on stretch.[14] For this patient, his concave side was his left. Thus, mobility of his left side was decreased by the shape of the rib cage, which causes a relative indentation decreasing scapular mobility, and by increased muscle tone of the scapular positioners. The convex side was similarly affected by the rib cage shape, causing a relative rounding, and by increased tension of the musculature on that side. It is important to keep in mind that altered length tension relationships will affect the patient's functional strength and neuromuscular control.[14] This holds true as he gains motion at the ST junction, necessitating significant neuromotor retraining.

Although not observed in this case, it is possible for scoliosis patients to have joint mobility impairments through the sternoclavicular (SC) and acromioclavicular (AC) joints. As rib positioning is altered due to spinal curvature, their positioning at the sternum is also altered. This could very well affect the SC joint. Depending the altered mobility of the SC joint, the AC joint will be affected similarly. In this case, at the patient's third session, both of these joints were found to be slightly hypomobile, similar to all other examined joints in this patient. Mobilizations at both sites bilaterally improved neither functional pain free ROM, nor his overall pain levels. Thus, it was determined that at this stage of recovery, neither of these joints was a significant limitation.

While the glenohumeral (GH) joint is several joints removed from the spine, this was still the location of pain for this patient. Thus, treating this joint for pain control and working to maximize the biomechanics was warranted. Additionally, as mentioned above, research has consistently shown that conservative treatments for scoliosis itself are not effective. While efforts were made to maximize thoracic and ST junction mobility, it is entirely possible that these would be fixed variables. In that case, the patient would require optimal biomechanical performance at the GH joint to minimize subacromial impingement.

As the patient was reporting symptoms primarily at the lateral aspect of the shoulder, the GH joint was targeted first using grade III/IV inferior and posterior mobilizations. The other primary joint mobilization that was utilized was a scapulothoracic distraction mobilization. This mobilization was initially difficult to perform due to heightened tone and tension throughout the periscapular musculature. However, as therapy progressed, his tone decreased and this treatment became easier to perform and a more effective mobilization was achieved.

The other mobility target was the spine. As noted research suggests that conservative treatment does not consistently alter scoliotic curvature. However, the thoracic spine was targeted not for the purpose of correcting his curve, but for increasing extension ROM to minimize stress on the shoulder when attempting to perform overhead reaching tasks. As described previously, this patient's posture was very kyphotic but not necessarily fixed as he was able to produce some active extension. Exercises working on thoracic extension and stretching anterior musculature were the staple of his HEP.

Table 5. Exercises and treatments selected for the rationale of increasing ROM.

Phase II: ROM			
Exercise	**Rationale**	**Sets/Reps**	**HEP**
Soft Tissue Mobilization	Pectoralis major and minor; subscapularis	Bilaterally, ~5 minutes	No
GH joint mobilizations	Increase joint play in the inferior and posterior directions to minimize impingement	3 sets of 10	No
Scapulothoracic mobilizations	Increase joint play to improve scapulothoracic rhythm and decrease subacromial impingement	3 sets of 10	No
Thoracic Extension over Foam Roll	Improve thoracic extension at end range GH motion	20 seconds/ spinal level	Yes
Open Book or Big Circle	AROM throughout full GH and thoracic ROM	1 set of 10 reps, bilaterally	Yes
Thoracic mobility with pelvic driver in frontal plane	Thoracic mobility, aiding in thoracic extension	2 sets of 10 bilaterally	Yes
Pectoral Stretch (doorway or foam roll)	Improve anterior soft tissue tightness allowing for improvement of kyphotic posture.	3 sets of 30 seconds	Yes
Sleeper Stretch	Posterior capsule stretch	3 sets of 30 seconds	Yes

The treatments and exercises from Phase 3 were all targeting neuromuscular re-education (Table 6.). These could be broken down further into postural retraining, scapular positioning retraining, and rotator cuff retraining. Postural training was to be performed throughout the day. It was fortunate for this patient that there were discrete points within his workday when he could take a minute and correct his posture. He also worked on his posture following thoracic mobility work. Again, these interventions were not selected for the purpose of decreasing a scoliotic curvature, but for increasing thoracic extension. Postural training was done following these mobility exercises in an effort to take advantage of recently gained ROM and start facilitating this into existing motor programs.

Scapular positioning muscles were also targeted, especially following ST junction mobilizations. Although middle/lower trapezius strength was not assessed, the neuromotor control of these muscles was very poor. In standing, with gravity assisting, he was able to position his shoulder blades down and back. However, he required constant verbal and tactile cueing in order to activate them without also using his upper trapezius when performing prone I's, T's, and Y's. Eventually, he improved enough for this to become more of a strengthening exercise and this was added to his HEP.

The last muscle group that was extensively targeted from a motor retraining standpoint was rotator cuff group. The primary purpose of this muscle group is to correctly position the humeral head over the glenoid fossa. While the primary cause of this patient's subacromial impingement was most likely decreased mobility, he also had poor motor control of this muscle group. One of the tools available to therapists at this clinic were Body Blades. These pieces of exercise equipment force users to activate muscles in a precisely timed alternating fashion in order to maintain a standing wave vibration of the tool. This exercise was deemed sufficiently challenging for the patient and it was determined he was getting the necessary stimulus at his biweekly visits. Thus, a similar neuromotor retraining exercise was not required in his HEP.

Table 6. Exercises selected for the primary purpose of facilitating neuromuscular re-education.

Phase III: Neuromuscular Re-Education			
Exercise	**Rationale**	**Sets/Reps**	**HEP**
Postural Training and Education	Reduce chronic impingement of subacromial space throughout the day	≥5x/day	Previously included
Scapular rolls	Increases awareness and control over scapular position; also prompts improved posture.	≥3x/day	Yes
Prone I's, T's, Y's	Eventually became a strengthening exercise, however pt required numerous verbal and tactile cues to create scapular motion	2 sets of 10 each direction, 1x/day, 5x/week	Yes
Body Blade	Starting with static vibrations, progressing to punches/reaches, and then to diagonal reaching patterns (D1/D2)	2 sets to fatigue	No

Exercises from the strengthening phase (Table 7.) targeted primarily scapular positioners. From his initial exam, he was limited in flexion and abduction, but primarily by pain. His primary impairments were in his middle and lower trapezius, which he had learned to compensate for with his upper trapezius. He demonstrated both strength and endurance weaknesses in these muscles. The push-up plus exercise for serratus anterior strength was performed during two early sessions. However, the patient had significant difficulty creating the appropriate motion and was limited by neuromuscular control and pain. Although he would have benefitted from strengthening here, the decision was made to forgo this exercise in favor of others the patient could perform more effectively. He also benefited from a significant rotator cuff strengthening stimulus using Body Blade exercises, even though the rationale for this set of exercises was neuromotor in nature.

Table 7. Exercises selected for the purpose of increasing muscular strength.

Phase IV: Strengthening			
Exercise	**Rationale**	**Sets/Reps**	**HEP**
Scapular rows	Strengthening of middle/lower trap	2 sets of 15-20	Yes
Standing Theraband shoulder extension	Strengthening of middle lower trap	2 sets of 15-20	Yes
Prone I's, T's, Y's	Strengthening of scapular positioners allowing good scapulo-humeral rhythm with loading and as the day progresses (with fatigue)	2 sets of 10 each direction, 1x/day, 5x/week	Yes
Push-up plus	Serratus strength in forward flexion	2 sets of 15	No

It is worth noting that business model of this clinic allowed for extensive training during a therapy session beyond what would be prescribed in the home exercise program (if such stimulus was appropriate for the patient). Patients were often seen 1-2 times per week with these therapy sessions essentially functioning as a primary workouts consisting of exercises the patient was either not able to complete at home or that required excellent technique. In this case, we focused on manual therapy, neuromuscular re-education and exercises he did not have the equipment for at home during his therapy sessions. This allowed the patient to achieve a reasonable level fatigue during physical therapy while simultaneously treating pain. The patient would then work on the strengthening portions of his HEP on most days of the week as time allowed, while the ROM and posture exercises were to be done several times/day.

Outcomes:

For this patient, the primary outcome measures were the QuickDASH and the numeric pain rating scale (NPRS). The QuickDASH improved from 63.6% at initial evaluation to 29.5% at his last therapy session (Table 8). This reflects greatly improved reported functional outcomes, however that he was still limited in several activities. Studies have indicated that the minimal detectable change (MDC) for the QuickDASH is 10.81 percentage points.[15] The minimal clinically important difference (MCID) for the QuickDASH ranges from 15.91-20 percentage points and was observed at the time of discharge.[15] Similarly, resting pain improved from 6/10 to 0/10 throughout this episode of care. The MDC and MCID for NPRS are 3 points and 2 points respectively.[16] Both were observed in this case. Pain free AROM also provided some insight to the treatment outcome. At the beginning of the episode of care, the patient had a painful arc in flexion and abduction starting below 90 degrees and through his full range. By the end, this arc was decreased to only active motions between 90-100 degrees. The final outcome measure was a list of painful activities that the patient presented at the time of his initial evaluation. By the end of the episode of care, only a few tasks remained on his list that consistently increased his pain. These were largely overhead reaching tasks, many of which had a loading component as well. Other tasks, including most housework and yard work were no longer painful.

Table 8. List of standardized outcome measures and their results utilized throughout this episode of care compared to their respective MCDs and MCIDs.

Outcome	At Initial Evaluation	At Discharge	Change	MDC	MCID
QuickDASH	63.6%	31.4%	29.5%	10.8%	15.9-20%
Verbal Pain Rating	6/10 (constant pain)	0/10 (intermittent pain)	6 points	3 points	2 points

Discussion:

Ultimately, this patient considered himself to be successful with his rehab. After 9 visits, the patient decided he had made significant improvement and chose not to schedule additional visits. As noted above, the most important metric for him was whether or not he could complete all of the tasks he needed to throughout his day. At the time of discharge, he was able to get through a day of work without having significant pain and he was able to complete most of the items on his list.

Had this patient decided to continue therapy, the focus would have shifted primarily to strengthening, especially targeting the muscles and movement patterns necessary for producing overhead motion. Such motions were the only ones that were reliably causing him pain at this point in his rehab process. As he was transitioning past the phase II ROM and Phase III neuro re-education emphasis into this phase IV strengthening, the plan of care would have shifted appropriately. Instead of seeing him twice each week, it would become more appropriate to see him less frequently, giving his body time to adapt to the strengthening stimulus. This change would likely have started by seeing him once a week while continuing some of the neuro re-education and ROM work gradually tapering off to once every 2-3 weeks.

As this individual worked in a factory throughout his episode of care, performing a workplace evaluation may also have been warranted. As noted previously, his job was less repetitive than many other factory jobs as he would regularly complete testing on 5-7 machines per day. However, the patient described a number of required motions taking place at or above chest height, high enough to cause shoulder impingement given the presence of anatomic risk factors for impingement. Based on factory reputation, there was a good chance any egonomic changes recommended by a therapist would have been seriously considered.

Two components which were not present in this case but could likely be involved in similar cases were neural tension and thoracic outlet symptoms. With any abnormal curvature of the spine, the spinal cord is going to be placed under greater tension. This in itself is not likely to cause neural tension issues, however it does mean that otherwise insignificant obstructions to appropriate neural gliding may now cause symptoms. In a way, there is much less room for error. Likewise, with the significant alterations in posture and anatomy that come with scoliosis, there is a possibility for thoracic outlet symptoms.

Hopefully, this successful case can serve as a guide for similar cases of shoulder pain in patients with scoliosis. Current research regarding conservative treatment of scoliosis itself consistently shows that treating the spine does not alter functional outcomes or quality of life. In this case, functional outcomes were improved by maximizing the biomechanics and neuromuscular control at the source of the pain, not targeting the anatomical impairments in the spine. Research on this topic should more formally compare the effectiveness of various shoulder impingement treatments for individuals with scoliosis to determine the most effective forms of treatment. The general pattern of treatment used in this case can might be applicable to physical therapy patients having scoliosis related pain in other joints such as the hip. However, caution should be taken when extrapolating the results of this case study to a case of scoliosis related hip pain given that the hip and shoulder are notably different in anatomy and weight bearing requirements.

At this point in time, the most important research on scoliosis is working on determining the root causes. Understanding the specific cause, or causes, of scoliosis will ultimately help all medical professionals to design specific and likely personalized treatments to help correct the unique curvature of each individual. As AIS is by far the most common form of scoliosis, it is logical to focus on this population. Being able to reliably correct AIS in younger individuals will help decrease its prevalence in the older population. However, given the aging demographic, there will continue to be a high occurrence of scoliosis in older individuals including those with AIS and those with degenerative curves. Better understanding how to work with these older individuals represents the possibility for significant improvement in function and quality of life as well as notable reductions in health care costs.

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