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Application Of A Short-Term Aquatic Physical Therapy Program For A Patient With Chronic Low Back Pain And Radiculopathy: A Case Report

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The patient signed an informed consent allowing the use of medical information and video footage for this report and received information on the institution's policies regarding the Health Insurance Portability and Accountability Act.

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Abstract

Background and Purpose: Within the confines of approved Physical Therapy (PT) visits from independent and national insurance companies, PTs are often challenged to improve a patient's impairments and Quality Of Life (QOL) in a limited number of approved visits. The purpose of this case report is to document if six PT visits with aquatic intervention for a patient with chronic low back pain (CLBP) and radiculopathy improves a patient's subjective and objective impairments in relation to his QOL.

Case Description: The patient was a sixty-two year old male who presented to PT with CLBP for the previous forty years secondary to a work-related lifting incident. One month prior to the therapy examination, he began experiencing radicular symptoms in his left lower extremity more than his right. The patient visited the doctor and was referred to outpatient therapy for six treatments of aquatic PT intervention.

Outcomes: Subjectively, post-treatment Numeric Pain Rating Scale measurements improved (6/10 from 9/10), Oswestry Disability Index measurements regressed (44% from 40%) and Quality of Life Scale for Chronic Pain measurements showed no change. Objectively, post-treatment active range of motion measurements revealed improvement in lumbar flexion and bilateral lumbar rotation, but regression in lumbar extension and bilateral lumbar side-bending. The gross strength assessment revealed improvement in left ankle dorsiflexion (4+/5 to 5/5) and plantarflexion (4+/5 to 5/5), regression in right and left hip flexion (5/5 to 4+/5 and 4+/5 to 4-/5) , and no change in bilateral hip extension.

Discussion: Further investigation is warranted to analyze if a limited number of visits for aquatic PT intervention improves the impairments and QOL for patients with CLBP and radiculopathy. Manuscript word count: 3,500

Background and Purpose

Chronic lower back pain (CLBP) is one of the most common conditions encountered in the outpatient physical therapy (PT) setting.[1] While some studies suggest up to 40% of physician referrals are for low back pain (LBP) in a specified clinic, physical therapists are often challenged to ameliorate CLBP in a limited number of visits.[2] When a patient has CLBP, alterations to structures surrounding the lumbar spine are not the only places that are affected; neurochemical modifications, cortical remapping of larger pain areas, an increased response to noxious stimuli, and psychological reconstructing occur at the cerebral level altering an individual's perception of pain.[3]

Intensive aquatic PT intervention over a long duration has been shown to improve pain levels, disability, and Quality Of Life (QOL) measurements, but little is understood about the effects of a non-intensive aquatic PT intervention program over a short duration.[4] Due to the buoyant nature of the water and warm temperature in therapy pools, patients who participate in aquatic therapy programs can decrease axial loading among the joints and experience an analgesic effect due to the increased pool temperature;[5] however, it is theorized by this author that short-term intervention will not help this patient population return to their prior level of function (PLOF) secondary to limited therapy visits and a limited time frame to rehabilitate.

In the outpatient PT setting, outcome measures such as the Oswestry Disability Index (ODI) and the Numeric Pain Rating Scale (NPRS) are used to monitor a patient's subjective improvement or regression in functional activity performance and overall pain levels, respectively.[6,7] While the ODI measures functional improvement and the NPRS monitors change in pain levels, an improvement in both may not be indicative of improvement in a patient's QOL secondary to chronic pain and cortical remapping of more brain area associated with pain. A modification to the Quality of Life Scale (QOLS), the Quality of Life Scale for Patients with Chronic Pain (QOLS-CP), is an outcome measure that helps

individuals assess the impact that chronic pain has on daily activities.[8] By utilizing the ODI, NPRS, and QOLS-CP, a better understanding of how aquatic PT can improve a patient's QOL can be realized.

In theory, if a patient follows the exercise protocols during his or her episode of care, he or she should show consistent improvements in most subjective and objective measurements. Furthermore, if a patient has sufficient PT visits, he or she should ideally show signs of improvement in most outcome measurements. The purpose of this case report was to document if six PT visits with aquatic intervention for a patient with CLBP and radiculopathy improved a patient's subjective and objective impairments in relation to his QOL.

Case Description: Patient History and Systems Review

Upon entrance to the clinic, the patient signed an informed consent allowing the use of medical information and video footage and received information on the institution's policies regarding the Health Insurance Portability and Accountability Act. The patient was a 62 year old male, retired United States veteran, who was referred to outpatient PT with a lingering issue of CLBP and radiculopathy. Forty years prior to the initial evaluation, he reported moving furniture at work when he felt discomfort in his lower back while lowering the furniture to the ground. Though he did not have exacerbated levels of pain forty years ago, his LBP became worse as the years progressed. One month prior to the initial evaluation, the patient began experiencing tingling, burning, and shooting sensations that originated in the lumbar spine and radiated to the medial surface of his feet bilaterally, where the left (L) lower extremity (LE) was more greatly impaired than the right (R) LE. After visiting a doctor at the United States Department of Veteran Affairs (VA), the patient was referred to outpatient PT for CLBP with bilateral radiculopathy where the LLE was more impaired than the RLE.

The medical history consisted of a L rotator cuff repair, L knee arthroscopy, cervical spinal fusion, diabetes mellitus, high blood pressure, history of smoking, family history of prostate cancer and

heart disease. His medications included Lisinopril, Metformin, Gabapentin, Meloxicam, Tamsulosin, and Avodart. The patient had frequent complaints of the inability to sit and stand for long periods of time secondary to pain, which the patient reported as an NPRS level of 9/10 on the day of the initial evaluation. His goal was to be able to sit and stand for extended periods of time in order to attend fishing trips with his close friends.

Clinical Impression 1

Following the subjective history and systems review, it was theorized by this author that the referring VA doctor's diagnosis, CLBP with bilateral radiculopathy where the LLE was more impaired than the RLE, was consistent with the patient's chief complaints, activity limitations and participation restrictions. Further tests and measures planned for the examination included: gross strength assessment of the lower quarter, goniometric measurements for active range of motion (AROM), Slump test, and Straight Leg Raise (SLR). Psychometric properties of the aforementioned tests and measures can be viewed in Appendix 1.[6,7,9-16] Deep tendon reflexes and a gait assessment were to be utilized in addition to the previously mentioned tests and measures to confirm the diagnosis provided. Differential diagnoses were not generated secondary to the VA doctor's referring medical diagnosis.

The reasons the patient was selected for this case report were three-fold. First, because over 25% of all PT discharges are for LBP,[1] the patient was a representation of this frequently seen population in the outpatient PT setting. Second, because there was a limited time frame for this author's presence due to a 12-week clinical rotation, the patient's entire episode of care was able to be monitored. The referring VA doctor prescribed six PT visits for the patient, thus an ample opportunity was presented to investigate the entirety of this case. Third, the selection of a patient who was ambitious to improve his goals, impairments, and QOL was necessary to justify the need to attend the limited number of PT visits

prescribed. Due to the expiration of the PT script after three weeks, it was necessary to select a patient who had the potential to be compliant with attending his PT sessions.

Examination - Tests and Measures

At intake, the ODI indicated 40% disability and the patient scored 3/10 on the QOLS-CP indicating a decrease in activity secondary to pain in both home and community activities.[6,8] Reliability and validity for the QOLS-CP is not yet known. The original QOLS, however, has been shown to have high internal consistency reliability, high test-re-test reliability, and a high correlation of convergent and discriminant construct validity in relation to the Life Satisfaction Index.[8,13] Since the QOLS-CP was constructed from the basis of the original QOLS, it is presumptively argued by this author that this outcome measure is both reliable and valid for this case report. The QOLS-CP can be viewed in Appendix 2.

Upon request to ambulate to the examination room, the patient was observed having a slightly antalgic gait pattern with no assistive device, an increased lumbar lordosis, anterior pelvic tilt and increased stance time on his RLE; a decrease in trunk rotation and decreased hip extension bilaterally was observed during the gait assessment. A Slump Test was performed to investigate the possibility of impingement of the dura of the spinal cord or the nerve roots.[14] The test was negative bilaterally for neural involvement, but hamstring tightness was more prevalent in the LLE as compared to the RLE. A SLR special test was then chosen to distinguish between hamstring tightness, sciatic pain or central involvement of the nervous system.[14] The patient had no reproduction of symptoms with the R hip passively flexed, but he experienced exacerbations of LBP and sciatic involvement with his L hip passively flexed. While in the range for positive symptoms of the LLE, an adduction component was added that exacerbated pain symptoms in his distal thigh. An abduction component was added after, but revealed negative symptoms for hamstring tightness. When an adduction component was added and an

increase in pain symptoms occurred, it indicated possible central involvement in the nervous system,[17] which was consistent with the referring VA doctor's diagnosis.

An AROM assessment revealed musculoskeletal impairments. Diminished lumbar flexion and bilateral rotation measurements were observed, but the most noticeable deficit was L side-bending compared to R side-bending [Table 1]. A gross strength assessment also revealed impairments in bilateral LEs, where the LLE was more impaired than the RLE. Patellar and Achilles reflexes were examined, with diminished reflexes observed in bilateral LEs. Tenderness to palpation was reported in the erector spinae musculature in addition to the third, fourth and fifth lumbar transverse processes bilaterally, where the L side revealed more tenderness than the R.

Table 1.
Initial Evaluation and Final Evaluation Lumbar Range of Motion and Strength Values

Active Lumbar Range of Motion		
Lumbar Motion	Measurement at Initial Evaluation (Degrees)	Measurement at Final Evaluation (Degrees)
Flexion	78	80
Extension	25	18
Side-bending Right	40	25
Side-bending Left	28	26
Rotation Right	34	56
Rotation Left	34	51
Gross Strength Measurements		
Motion Tested	Initial Evaluation Strength Test Grade	Final Evaluation Strength Test Grade
Right Hip Flexion	5/5	4+/5
Left Hip Flexion	4+/5	4-/5
Right Hip Extension	4-/5	4-/5
Left Hip Extension	3+/5	3+/5
Right Knee Extension	5/5	5/5
Left Knee Extension	5/5	5/5
Right Knee Flexion	5/5	5/5
Left Knee Flexion	5/5	5/5
Right Ankle Dorsiflexion	5/5	5/5
Left Ankle Dorsiflexion	4+/5	5/5
Right Ankle Plantarflexion	5/5	5/5
Left Ankle Plantarflexion	4+/5	5/5

(Gross strength measurements were obtained via manual muscle testing)

Clinical Impression 2

Based on the information provided in the initial examination, the referring diagnosis of LBP with bilateral radiculopathy, where pain in the LLE was greater than the RLE, was confirmed due to the consistency of signs and symptoms, positive SLR special test, gross strength impairments, AROM impairments, diminished reflexes, tenderness to palpation, impaired gait, and impaired ability to perform functional activities. Difficulty performing activities of daily living (ADLs), such as sitting, standing or walking for long periods of time, were hypothesized secondary to CLBP, as indicated by his pre-treatment scores on the ODI and QOLS-CP. A PT diagnosis of "Lumbago" (ICD-9 code of 724.2) and "Lumbosacral Neuritis or Radiculitis" (ICD-9 code of 724.4) was given as a result from the findings of the examination.

The patient was appropriate for this case report because he sought improvement in his current pain symptoms and gave the impression of the desire to return to his PLOF of being able to stand, sit, ambulate, and participate in recreational exercise. Based on the findings from the examination and the VA doctor's order, the plan of action was to retain the patient and proceed with aquatic PT intervention. Due to the understanding of his current condition, voiced intention with attending PT sessions, and motivation to improve his LBP and radicular symptoms the patient was a good candidate for PT intervention with subsequent good prognostic implications. Potential barriers to his prognosis consisted of a limited number of PT visits and exacerbated pain levels secondary to long drives of 30 minutes traveling to attend PT.

After deciding to retain the patient after doctor referral, the plan for PT intervention consisted of two visits per week over a three week span. It was important to note that the physician's order called for a total of six visits. Since the initial evaluation qualified as one visit, there were a total of five visits that the patient would receive PT intervention. During the three week span, the patient would receive aquatic

PT intervention. Follow-up for re-evaluation on AROM measurements, gross strength testing, ODI scores, NPRS scores, and QOLS-CP scores would be assessed on the patient's sixth and final visit.

In a study by Baena-Beato et al,[4] patients who experienced aquatic PT intervention typically demonstrated an improvement in their LBP symptoms, disability ratings, and QOL measurements. By providing less compressive, tensile and shearing forces in an aquatic/ unweighted environment, patients were able to re-explore greater ranges of motion, strengthen the proper musculature and provide stability and relief to the areas that exacerbated their pain and radicular symptoms.[4] If the same principle were to be applied to this case, it was theorized by this author that the patient could meet the goals set for him by the PT [Table 2] in addition to his personal goals of increased sitting and standing tolerance.

Table 2.
Physical Therapy Goals and Status at Discharge

Physical Therapy Goals	Status at Discharge
Short-Term Goals	
1. After two weeks from the initial evaluation, the patient will be independent with his home exercise program in order to provide stability and proper length-tension relationship of the trunk musculature.	Met
2. After two weeks from the initial evaluation, the patient will improve NPRS levels to 7/10 in order to improve his quality of life.	Met
Long Term Goals	
1. After three weeks from the initial evaluation, the patient will improve bilateral gluteal gross strength to 4/5 in order to improve ease of gait during stance phase and improve trunk stability.	Not Met
2. After three weeks from the initial evaluation, the patient will improve L side bending AROM to 40 degrees in order to improve his ability to perform ADLs that require lifting.	Not Met

Abbreviations: NPRS = Numeric Pain Rating Scale, L = Left, ADLs = Activities of Daily Living, ADLs = Activities of Daily Living

Intervention

Coordination of care included communication with the referring doctor from the VA and primary care physician through written notes. In addition to the PTs at the clinic, the patient was seen by the physical therapist assistants (PTAs) during aquatic treatment. Re-evaluation of his progress was performed by one of the PTs on the sixth visit. The PTAs administered aquatic therapy intervention and subsequently provided daily documentation.

Procedural interventions for this patient included patient-related instruction, therapeutic exercise, and aquatic therapy. Following the examination, the patient-related instruction included the interpretation of the signs, symptoms and impairments observed. After explaining the findings of the examination and his impairments, the patient was given a home exercise program (HEP) focused on strengthening core and hip musculature [Table 3]. Before the examination concluded, he was informed of the importance and benefits of performing his HEP and aquatic therapy exercises after his episode of care due to his limited number of visits.

Table 3.

Exercise Flow Sheet and Home Exercise Program

	Intervention	Rx Day 2	Rx Day 3	Rx Day 4	Rx Day 5	Rx Day
Warm-up Exercises	**Ambulation (Clockwise and Counter Clockwise)**	3 minutes of forward walking in one direction around the perimeter of the pool, then switch and forward walk in other direction	3 minutes of forward walking in one direction around the perimeter of the pool, then switch and forward walk in other direction	3 minutes of forward walking in one direction around the perimeter of the pool, then switch and forward walk in other direction	3 minutes of forward walking in one direction around the perimeter of the pool, then switch and forward walk in other direction	*Patient Declined Treatment After Re-Evaluation*
	Side Step	3 minutes of side stepping on one side of the pool	3 minutes of side stepping on one side of the pool	3 minutes of side stepping on one side of the pool	3 minutes of side stepping on one side of the pool	*Patient Declined Treatment After Re-Evaluation*
Strengthening and AROM Exercises	**3 Way Hip Kicks (Flexion, Abduction and Extension)**	2 minutes (motions in succession), then switch legs	2 minutes (motions in succession), then switch legs	3 minutes (motions in succession), then switch legs	3 minutes (motions in succession), then switch legs	*Patient Declined Treatment After Re-Evaluation*

	Heel Raises (bilateral at same time)	2 minutes consecutively	2 minutes consecutively	3 minutes consecutively	3 minutes consecutively	*Patient Declined Treatment After Re-Evaluation*
	Squats	*Held and discontinued due to exacerbated pain levels*				*Patient Declined Treatment After Re-Evaluation*
	Leg Press with Noodle	2 minutes consecutively on one leg, then switch	2 minutes consecutively on one leg, then switch	2 minutes consecutively on one leg, then switch	2 minutes consecutively on one leg, then switch	*Patient Declined Treatment After Re-Evaluation*
	Step Ups	1 minute on one leg, then switch to the other leg	1 minute on one leg, then switch to the other leg	2 minutes on one leg, then switch to the other leg	2 minutes on one leg, then switch to the other leg	*Patient Declined Treatment After Re-Evaluation*
	Trunk Rotation with Noodle	2 minutes consecutively (both right and left)	2 minutes consecutively (both right and left)	3 minutes consecutively (both right and left)	3 minutes consecutively (both right and left)	*Patient Declined Treatment After Re-Evaluation*
	Bicycles (Seated)	Continuous for 2 minutes	Continuous for 2 minutes	*Discontinued due to exacerbated levels of pain*	*Discontinued due to exacerbated levels of pain*	*Patient Declined Treatment After Re-Evaluation*
	Scissors (Seated)			Continuous for 2 minutes	Continuous for 2 minutes	*Patient Declined Treatment After Re-Evaluation*

	Hip Internal/ External Rotation (done concurrently)	2 minutes continuously	2 minutes continuously	*Not performed on this visit due to exacerbated levels of pain*	2 minutes continuously	*Patient Declined Treatment After Re-Evaluation*
Stretching and Nerve Glide Exercises	**Long Arc Quads with Dorsiflexion**			Continuous for 2 minutes on one leg then switch	Continuous for 2 minutes on one leg then switch	*Patient Declined Treatment After Re-Evaluation*
	Hamstring Stretch (Standing)	3 sets of 30 second holds on one leg, then switch	3 sets of 30 second holds on one leg, then switch	3 sets of 30 second holds on one leg, then switch	3 sets of 30 second holds on one leg, then switch	*Patient Declined Treatment After Re-Evaluation*
Home Exercise Program	**Pelvic Tilts**: 3 sets of 10, 2 times performed daily **Lateral Trunk Rotation**: 3 sets of 10, performed within pain-free range, performed 2 times daily **Glut Sets**: 3 sets of 10, performed 2 times daily					

Abbreviations: Rx = Treatment Day, Gray Box = Treatment Not Yet Administered

One of the main concepts utilized for the creation of the patient's intervention program was the concept of Regional Interdependence (RI). The theory of RI relies on the concept that seemingly unrelated impairments in anatomical regions of the body, regardless of proximity, have the potential to contribute to the patient's primary problem.[18] For example, the patient presented with pain and radiculopathy that originated in the lumbar region and presented with greater deficits in the LLE; however, he demonstrated deficits bilaterally in AROM, strength, reflexes, posture, gait and was tender to palpation in the L3-L5 paraspinal musculature and transverse processes. In addition to treating the lumbar spine directly, strengthening musculature surrounding the joints of the lower half of the body to absorb joint reaction forces during static and dynamic loading would likely aid in subsiding pain and radicular symptoms.

The patient's aquatic therapeutic exercises were solely based in the water and followed the general format of a warm-up, strengthening and AROM exercises, then stretching and nerve glide exercises. Stretching was performed at the end of the intervention session because it has been theorized by Shrier et al that pre-activity stretching did not reduce the risk of further injury and would be more appropriate after sufficient blood flow to the impaired areas occurred.[19] A description of the exercises and their purposes can be viewed in Table 4.[18,20-24] The warm-up activities were selected to help increase the patient's exercise capacity, promote beneficial metabolic and cardiopulmonary functions, and reduce the risk for long-term clinical complications.[25] Since the patient had a personal and family history of cardiovascular complications, acclimation to the pool temperature and aquatic warm-up exercises were important.

Following warm-up activities, aquatic therapy exercises were performed by the patient in order to improve his AROM and strength impairments. Hip, knee, ankle, and trunk exercises were administered during this portion of the session interventions. The hip musculature plays an important role within the kinetic chain for ambulation, stabilization of the trunk and pelvis, and in transferring ground reaction force vectors from the LEs.[26] If the same concept was applied to this particular patient with improved strength in the hip, knee, ankle, and trunk, ground reaction force vectors have the potential to be distributed more evenly among the joints, reducing pain, and improving his ability to sit and stand for longer periods of time. Based on the RI theory and this author's clinical judgement, exercises were targeted proximal to the patient's main area of complaint, his lumbar spine; however, adjacent joints were still exercised in hopes to eventually absorb ground reaction force vectors secondary to eventual longer periods of patient standing or sitting.

Table 4.

Interventions and Purpose

Intervention (In Order of Daily Use)	Purpose
1. Ambulation	By ambulating around the pool in an unweighted aquatic environment with warm water, an improvement of blood flow to the trunk and LE musculature would help increase the temperature of the impaired musculature, promote smoother contractions, and increase the speed on nerve transmission.[20]
2. Side Step	In addition to the potential benefits of cardiovascular health, strengthening of the hip abductors, based on the concept of RI, helped stabilize hip, lumbar and LE joints during closed-chain activities such as gait.[18]
3. Way Hip Kicks (Flexion, Abduction and Extension)	By strengthening the large muscles at the hip responsible for static and dynamic stability, the patient was able to work towards his goal of standing for longer periods of time. Furthermore, the patient used his core musculature and contralateral LE to maintain proper balance and joint alignment. Therefore, this exercise was functional for both the stance and swing phase of gait. An increase in exercise duration from two minutes to three minutes was performed when the patient adapted to the proper posture of the exercise and could tolerate two consecutive minutes of exercise with greater ease.
4. Heel Raises (bilateral at same time)	Though an initial 4+/5 plantarflexion strength grade is significant enough to propel the human body during the stance phase of gait, normal strength grading is needed in both LEs in order to deploy a proper balance strategy during unexpected dynamic circumstances during ambulation.[21] An increase in exercise duration from two minutes to three minutes was performed when the patient noted that the heel raise exercise was easy to perform.
5. Leg Press with Noodle	A unilateral LE leg press with the blue pool noodle was used to simulate the squatting motion since he was unable to perform a bilateral squat due to exacerbated pain symptoms. The purpose of the leg press exercise was to improve the patient's gluteal musculature strength.
6. Step Ups	The step ups, which provide the same clinical, kinematic and therapeutic reasoning as the leg press with the pool noodle, were performed at one minute intervals on each LE and increased to two minutes when the patient developed more muscular endurance.
7. Trunk Rotation with Noodle	The trunk rotation exercise with the pool noodle was utilized due to the patient's decrease in bilateral rotation AROM. In addition to potential AROM gain, the additional purpose of this exercise was to stabilize the lumbar spine and strengthen trunk musculature. An increase from two minutes of lumbar rotation to three minutes was demonstrated when he reported that the exercise was becoming easier to perform.
8. Bicycles (seated)	Bicycles, which consisted of a continuous peddling motion while in the seated position, were originally administered to work on the core musculature and endurance in the seated position. On the third visit, the patient noted exacerbated levels of pain in his low back with radiating symptoms to his left LE. The exercise was discontinued based on his symptoms.
9. Scissors	Seated scissors, a continuous abduction and adduction motion, replaced the bicycle exercise. This exercise was performed for 2 minutes in order to stabilize bilateral hip joints while simultaneously stabilizing the lumbar spine by utilizing the trunk musculature.
10. Hip Internal Rotations and External Rotations (done concurrently)	Hip internal rotations and external rotations were performed simultaneously in the seated position. By performing this exercise, core musculature activation needed to occur to keep the patient's lumbar spine and body in a stable position. Furthermore, by strengthening the rotators of the hip, he would have more proximal stability during static standing activities and the stance phase of gait.[22] This exercise was held on the third visit secondary to pain and reapplied on the fourth visit when pain symptoms were not as apparent.
11. Long Arc Quads	Long arc quads with dorsiflexion were added to the program on the patient's fourth visit. This exercise enabled the patient to perform a neural glide, strengthen the knee joint, and stretch the posterior LE musculature. The purpose of this exercise was to reduce neural tension and decrease the chance of future neurodynamic impairments.[23]
12. Hamstring Stretch (Standing)	There is a correlation between LBP and hamstring tightness, so the patient would benefit from improvement in hamstring flexibility.[24]

Abbreviations: LE = Lower Extremity, RI = Regional Interdependence, AROM = Active Range of Motion, LBP = Low Back Pain

The intervention sessions concluded with modified versions of neural glides and stretching in the water. The nervous system must be able to adapt to various mechanical loads throughout the day, so it was important to "glide" the sciatic nerve, which could have been contributing to the patient's tight hamstrings. This was addressed by having the patient perform long arc quads with maintained ankle dorsiflexion. Due to a correlation between low back pain and hamstring tightness, it was thought that stretching the hamstring musculature could be beneficial to the patient.[24] By emphasizing proper length-tension relationships and enabling sciatic mobility, the patient had a better chance of reducing his pain and promoting more mobility. With his nervous system's potentially impaired ability to adapt, the patient could become vulnerable to neural edema, ischemia, fibrosis, and other abnormalities that could cause neurodynamic defects.[23] The neural glides and stretching exercises were appropriate ways to take further preventative action, have the patient cool-down, and conclude the intervention session.

Outcomes

Measurements were taken on the patient's sixth and final visit prior to entering the therapy pool. Subjectively, post-treatment NPRS measurements improved, ODI measurements regressed and QOLS-CP measurements showed no change [Table 5]. Objectively, post-treatment AROM measurements revealed improvement in lumbar flexion and bilateral lumbar rotation, but regression in lumbar extension and bilateral lumbar side-bending [Figure 1]. The gross strength assessment revealed improvement in L ankle dorsiflexion and plantarflexion, regression in bilateral hip flexion, and no change in bilateral hip extension [Figure 1]. The patient met his short-term PT goals, but failed to meet either of his long-term PT goals [Table 2]. It is worth noting that the patient declined treatment after the re-evaluation measurements secondary to forgetting his swim attire. He was given the opportunity to participate in treatment later that day, but did not show to the clinic.

Table 5.

Subjective Outcome Measures and Status at Discharge

Outcome Measure Used	Score at Initial Evaluation	Score at Final Evaluation	Status at Discharge
NPRS	9/10	6/10	Improvement
ODI	40%	44%	Regression
QOLS-CP	3/10	3/10	No Change

Abbreviations: ODI = Oswestry Disability Index, QOLS-CP = Quality of Life Scale for Patients with Chronic Pain

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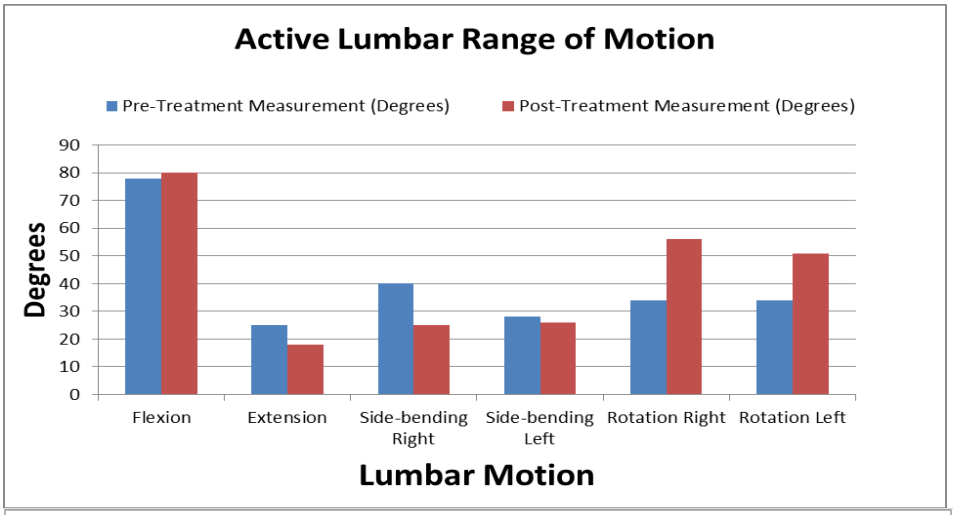
255

256 **Figure 1.**

257 **Objective Outcome Measurements**



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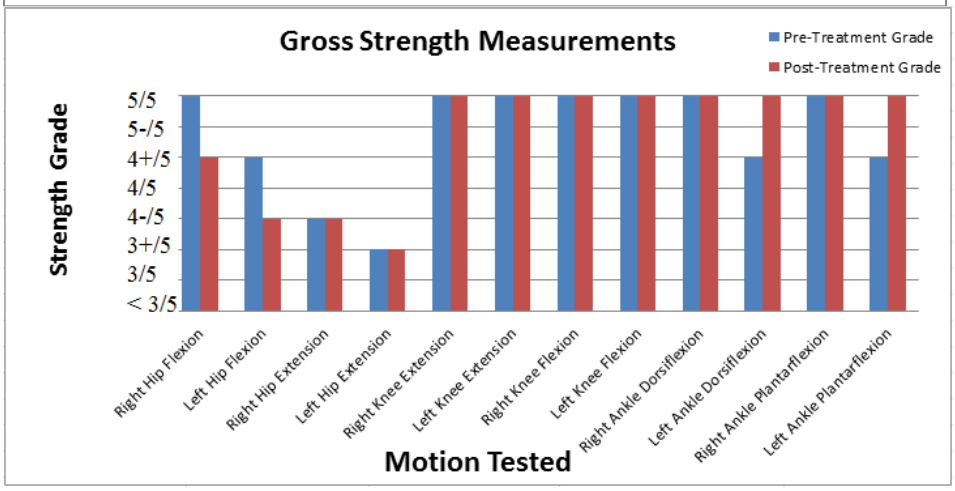

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260 *(Range of Motion measured via goniometry, Gross Strength measured via manual muscle testing)*

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Discussion

While he made good progress with NPRS measurements, bilateral lumbar rotation AROM, and L ankle plantar flexion and dorsiflexion strength, the patient demonstrated no improvement in QOLS-CP and bilateral hip extension strength measurements. Furthermore, the patient demonstrated regression in ODI, lumbar extension, bilateral lumbar side-bending, bilateral hip extension, and R hip flexion measurements. Assuming the patient was compliant with his HEP and honest with his subjective outcome measurements, there were a multitude of theories that could potentially explain the outcomes of this patient's case.

Theory One: Insufficient Treatment Time

If the patient had the opportunity to participate in additional PT treatment sessions, it is plausible that he may have met his PT and personal goals. Given that this case is chronic, and the onset was forty years ago, there was a high probability that there was musculoskeletal degeneration and cortical remapping occurring as the years progressed. It was theorized by this author that, if an individual's limbic system and posterior parietal cortex were sending and interpreting pain signals for forty years,[3] it would be difficult to reverse the process in the given three week timeframe. The attempt to correct the musculoskeletal abnormalities contributing to the problem was executed, but, in order to have underlying mechanisms return to normal, such as cortical remapping, sufficient time for healing is needed.

Theory Two: Clinician Error

Given it was the same practitioner for the initial evaluation and the re-evaluation, the possibility for intrarater error was present. Additionally, this author may have selected ineffective exercises for aquatic PT intervention. Depending on what the clinical error may have been, the patient's outcomes were likely dependent on the plan of care developed by the practitioner. The squats and seated bicycle were the two exercises that exacerbated the patient's pain symptoms the most; therefore, it is possible that these exercises may have caused the patient to regress on the day of the re-evaluation.

Theory Three: Outcomes were Patient-Dependent

While the aforementioned theories could have been true, it was possible that the patient aggravated his symptoms and did not report the incident. Though it was unfortunate on the day of the re-evaluation, events that aggravated the patient's symptoms could have given the impression that PT was not effective. However, since the patient demonstrated improvements in some subjective and objective measurements, the author deemed this unlikely.

All of the previously mentioned theories could be true, so it would be difficult to give a definitive statement that six PT visits is sufficient or insufficient treatment for a patient with CLBP and radiculopathy in relation to his QOL. While it is encouraging that the patient reported an improvement in his NPRS level, it should not be ignored that he regressed in his ODI scores and showed no change on the QOLS-CP. If the patient did not perceive himself as "improving," "regressing," or "not changing" in a majority of the three measures, there was a good chance that there was some form of incongruence among them. Perhaps the undefined "one through nine" on the NPRS, the length of the ODI, or the simplicity of the QOLS-CP could have caused the patient to choose inaccurate measurements. Regardless of the reason and based on these subjective measurements, it cannot be definitively stated that this patient subjectively perceived his QOL as "improving" from PT intervention after six visits.

The patient's objective measurements were as inconsistent as his subjective measurements. While some motions improved quicker than others, it was odd that regression occurred in a widespread manner. Again, any of the above theories could have been true, but AROM and strength measurements rarely show signs of regression in the "improving" patient. As a result, it cannot be definitively stated that PT intervention improved this patient's subjective and objective measurements after six visits.

Further investigation is warranted to analyze if a limited number of PT visits for aquatic intervention improves the impairments and QOL for patients with CLBP radiculopathy. While the

current approach is sufficient at obtaining subjective and objective measures, modifications to the current approach may be needed to gain a better understanding on how to treat patients with CLBP.

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Appendix 1

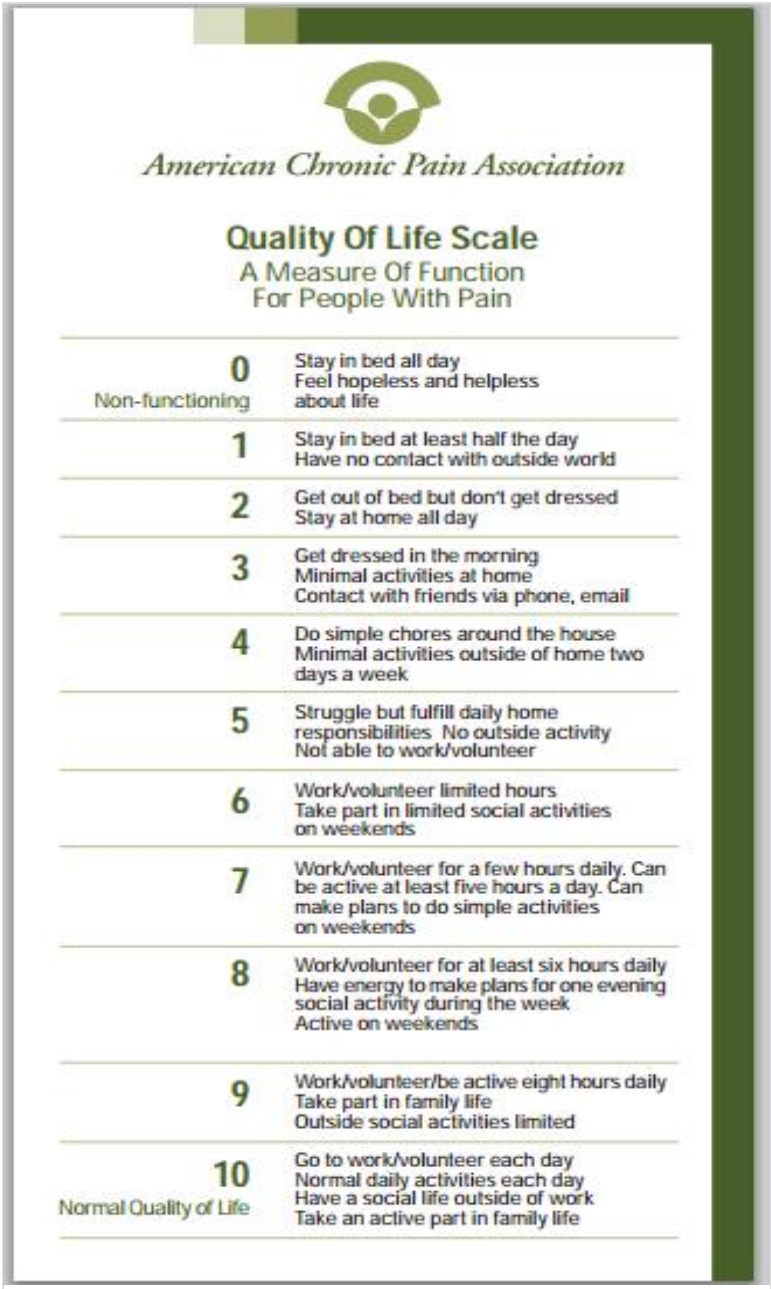
Psychometric Properties of Outcome Measures, Special Tests, and Tests and Measures

Measure Used	Psychometric Properties
NPRS	Test-Retest Reliability: Excellent test-retest reliability when using 2 times a week (for more than a week) for patients with chronic pain (r=0.79-0.92).[9] Interrater Reilability: Excellent interrater reliability with 100% agreement between two raters scoring.[7] Face Validity: 15.9% of the tested population preferred the NPRS while the remaining 84.1% showed preference to another pain scale to measure pain levels.[7]
ODI	Test-Retest Reliability: Excellent test-retest reliability for patients with lower back pain (ICC=0.97; 95% CI).[6] Criterion Validity: Excellent correlation between improved vs. non-improved patients with lower back pain (ROC=0.75; 95% CI). Adequate correlation between Health Transition Item anchor, ODI change, and Satisfaction anchor (rho=0.46).[10] Content Validity: MDC was selected as the most appropriate MCID threshold value by comparing potential MCID value calculations and verifying with two different anchors.[11]
QOLS	Reliability: The original QOLS had high internal consistency reliability ($\alpha = 0.82 – 0.92$) and high test-retest reliability ($r = 0.78$ to $r = 0.84$) in the original 15-item questionnaire.[12] Validity: Convergent and discriminant construct validity showed high correlations between total score on QOLS and the Life Satisfaction Index ($r = 0.67$ to $r = 0.75$).[13]
SLR	Sensitivity: 0.91 for identifying disc herniations.[14]
Slump Test	Sensitivity: 0.84 for identifying herniated discs, neural tension, or other neurodynamic alterations.[14]
Manual Muscle Testing	Reliability: Good to excellent intrarater reliability ($r = 0.67 - 1.00$).[15]
Goniometry	Intrarater Reliability: As high as $r = 0.90$.[16] Interrater Reliability: As high as $r = 0.70$.[16]

Abbreviations: NPRS = Numeric Pain Rating Scale, QOLS = Quality of Life Scale, SLR = Straight Leg Raise, ROC = Receiver Operating Characteristic, CI = Confidence Interval, rho = Spearman Rho Value Value, α = Alpha Value r= Correlation Coefficient

Appendix 2

Quality of Life Scale for Patients with Chronic Pain



American Chronic Pain Association

Quality Of Life Scale

A Measure Of Function
For People With Pain

0 Non-functioning	Stay in bed all day Feel hopeless and helpless about life
1	Stay in bed at least half the day Have no contact with outside world
2	Get out of bed but don't get dressed Stay at home all day
3	Get dressed in the morning Minimal activities at home Contact with friends via phone, email
4	Do simple chores around the house Minimal activities outside of home two days a week
5	Struggle but fulfill daily home responsibilities No outside activity Not able to work/volunteer
6	Work/volunteer limited hours Take part in limited social activities on weekends
7	Work/volunteer for a few hours daily. Can be active at least five hours a day. Can make plans to do simple activities on weekends
8	Work/volunteer for at least six hours daily Have energy to make plans for one evening social activity during the week Active on weekends
9	Work/volunteer/be active eight hours daily Take part in family life Outside social activities limited
10 Normal Quality of Life	Go to work/volunteer each day Normal daily activities each day Have a social life outside of work Take an active part in family life

The Quality of Life Scale for Patients with Chronic Pain was one of the outcome measures administered to the patient at the initial evaluation and re-evaluation. The patient was asked to circle the number that most accurately described his symptoms.