Abstract

Purpose. The purpose of this case report was to describe the effects of a 6-week physical therapy program consisting of strengthening exercises, balance training, stretching and self-managing education of an adult with bilateral knee osteoarthritis (OA) and cerebral vascular accident (CVA) during an outpatient episode of care.

Case Description. The individual was a 62-year-old female with a history of bilateral knee osteoarthritis and recent history of mild CVA. The subject participated in a 6-week physical therapy program consisting of strengthening exercises, balance training, stretching and self-managing education. The subject was seen 3 times a week, with a day of recovery between each therapy session. The Lower Extremity Functional Scale (LEFS), Berg Balance Scale (BBS), Manual Muscle Test (MMT), Time Up and Go (TUG), Numeric Pain Rating Scale (NPRS), 10-Meter Walk Test (10MWT) and Five Time Sit to Stand Test (FTSST) were used to assess progress in this subject.

Outcomes. Outcome measures were used at evaluation and were administered every two weeks. The Timed Up and Go improved from 22 seconds to 12 seconds. The Five Time Sit to Stand Test improved from 39 seconds to 16 seconds, while the Berg Balance Scale improved from 43 to 52 points. Lower Extremity Functional Scale improved by 9 points and gait speed improved by 0.27m/s. The Numeric Pain Rating Scale was monitored throughout the course of treatment, which served as a guide that pain was not exacerbated and that the exercise program was well tolerated by the subject.

Discussion and Conclusions. This case report describes an exercise program that significantly decreasing pain, while improving balance, functional strength, and gait kinematics with no adverse effect in a subject with bilateral knee osteoarthritis with recent mild CVA. We believe that a significant reduction of pain induces a better functional performance in the subject with OA and CVA.

Introduction

Knee osteoarthritis (OA) has been known to be the leading cause of disability in the United States. [1)] Knee OA is a disease, in which, articular cartilage of the knee loses elasticity along with compressive stiffness and leads to conduction of compressive forces to bone, leading to wearing away of the cartilage. Knee OA also consists of damage to the meniscus and periarticular muscle. [1)] These physiological changes lead to stiffness, swelling, weakness and pain, which in turn can make it hard for a person to perform certain aspects of everyday life like walking, standing, negotiating stairs, and getting up from a chair. Studies have demonstrated that post-menopausal women tend to have more severe knee OA, which is even higher in the overweight population.[1)] Major risk factors for OA are a history of cardiovascular disease, walking abnormality, careers that involve squatting or kneeling, cancer, and diabetes.[2)] People with knee pain that is attributed to OA often present with weakness in the muscles of the lower extremities surrounding the hip, knee, and ankle joints. [2)]

Moreover, because of decreased strength, balance is often affected and individuals have poor static and dynamic balance. They often ambulate with a wide base of support,

have decreased step length and stance time on the affected limb due to pain. In addition, decreased dynamic balance has been correlated to an increase in pain levels.[3] Evidence suggest that closed chain and open chain exercises help improve strength along with improved gait kinematics.[3] While it is known that exercise is helpful at reducing pain, along with improving strength and balance, the optimal exercise prescription varies in research. The strongest predictor of disease progression in the knee is varus malalignment.[4] OA can be exacerbated when there is a sudden onset of weakness, like what occurs following a stroke.

A Cerebral Vascular Accident (CVA) is an abrupt decrease or loss of neurological function due to disturbance of blood flow to the brain. A CVA is also known as a stroke and there are two major types of strokes consisting of hemorrhagic and ischemic strokes. [5] These have further been categorized into three etiological categories: embolus, thrombosis or hemorrhagic. Hemorrhagic strokes involve a rupture of a vessel and lead to blood leaking in different parts of the brain, whereas an ischemic stroke is a blockage to a vessel which leads to decreased blood flow to the brain.[5] A stroke can lead to death, but even if an individual survives, many aspects of their lives will be affected. Some impairments brought on by a stroke are motor, sensation, cognition, language changes and even level of consciousness depending on type, location and severity of the stroke. A stroke normally causes motor changes that are manifested as hemiparesis (weakness) or hemiplegia (paralysis) and these are typically on the side opposite of the site of the stroke.[6]

Different impairments will arise because disruption of blood flow to a certain blood vessel will have different effects on the individual. Strokes are the leading reason of long-term disability in the United States. [5] Risk factors for stroke are hypertension, abnormal heart rhythm, diabetes mellitus and heart disease, along with older age and obesity.[5],[6]

There is little research regarding the effects of physical therapy in patients with knee OA with recent onset of CVA. Motor deficits accompanied by knee OA tend to affect many patients as some of their risk factors overlap. Many individuals suffer from rapid progression of their knee OA following even a mild stroke due to abnormal joint pressures put on the

joints, decreased muscular stability, and abnormal gait pattern secondary to weakness. A study titled “The impact of knee osteoarthritis on rehabilitation outcomes in hemiparetic stroke patients” concluded that in stroke rehabilitation the presence of symptomatic knee OA was correlated to poorer progress in functional ambulation.[5), 6), 7)]

The purpose of this case report is to describe the effects of a 6-week physical therapy program consisting of strengthening exercises, balance training, stretching and self-managing education in an individual with knee OA following a mild left sided subacute CVA.

Case Description:

Patient History and Systems Review

The subject was a 62-year-old African American female who presented to outpatient physical therapy with a medical diagnosis of bilateral knee OA and right hemiparesis status post left CVA two months prior to physical therapy evaluation. The subject is a retired nurse and lives in her home with her husband and two dogs. She had a mild stroke and the only residual deficit was mild right hemiparesis. The subject reported having slight pain in the knees with certain activities before the stroke, but pain did not limit her in ambulating in the community. After the stroke, the subject reports having intense pain in the knees with activities like standing from a chair, walking for short distances, and going up and down stairs. The subject had history of hyperlipidemia and hypertension, but was on medication. Subject had a Body Mass Index of 36.9, which is classified as obese.[7)] Her goals for physical therapy were to decrease pain in the knees during ambulation and to be able to perform an exercise program after to improve her overall health.

Examination

Berg Balance Test (BBS)

The BBS is used to assess balance in the elderly population with static, dynamic, and functional balance. The BBS is composed of 14 items and each one is scored on a 0-4 scale. The subject performs task as instructed by the administrator and then a score is given based on the person’s capability to perform the task. A higher score on the BBS is indicative of better performance, whereas a lower score is indicative of poor performance.[8)] The subject

scored 43 out of 56 points on initial evaluation. A score of less than 45 indicates that the person is at greater risk for falls. Mao et al. reported the BBS to have excellent predictive validity.[9] Liston and Brouwer found the BBS to have excellent test-retest reliability (ICC = 0.98).[10]

Five Time Sit to Stand Test (FTSST)

The FTSST looks at the areas of functional mobility and strength. During this test, the subject is asked to stand from a standard height chair (18 inch) five times and the time is recorded.[11] The subject was able to complete the FTSST on evaluation day with a time of 39 seconds. A score of greater than 12 seconds is indicative of higher risk of falls. Lin et al. reported excellent test-retest reliability (ICC = 0.96) and Beninato et al. reported excellent construct validity with FTSST.[12, 13]

Lower Extremity Functional Scale (LEFS)

The LEFS examines different areas such as strength, range of motion (ROM) and quality of life (QOL). The LEFS composed of 20 items and each one is scored on a 0-4. A higher score means better ability of a person to complete a task.[14] The patient score was 18 on initial evaluation. Minimal detectable change (MDC) for this test is 9 points. Verheijde et al. demonstrated that the LEFS has adequate to excellent validity and excellent test-retest reliability (ICC = 0.96) in people with strokes.[15]

Timed Up and Go (TUG)

The TUG assesses balance, ability to walk and fall risk in older adults. The patient rises from a chair, walks 3 meters then turns around and returns to the chair and sits down.[16] The patient completed the TUG in 22 seconds. Research shows that greater than 14 seconds indicates a higher risk for falls in older patients with stroke. [17] Kennedy et al. in 2005 demonstrated that the TUG has excellent test-retest reliability (ICC = 0.75). Knorr et al. in 2010 reported that the TUG had excellent construct validity when correlated with BBS.[17]

10-Meter Walk Test (10MWT)

The 10MWT is used to assess gait speed, which can be a predictor of fall risk and safe community ambulation. The subject walks a distance of 10 meters while being timed by the

administrator. This test is prepared by measuring a distance of 14 meters. Then marks are placed at 0 meters, 2 meters, 12 meters and 14 meters. Individual is instructed to walk from 0 meters, but timer should start at 2 meters and end when subject crosses the 12-meter mark in order to get a more accurate representation of the patient's actual gait speed. Higher gait velocities have been correlated to better quality of life and less fall risk than low gait velocities. The 10MWT has been shown to have excellent convergent validity with BBS and TUG.[18), 19)] A change of .10 m/s in 10MWT reflects substantial meaningful change in an individual. This subject's time at evaluation was 0.83 m/s in the 10 MWT. According to a study by Collen in 1990, the 10MWT is believed to have excellent test-retest reliability (ICC = 0.95 to 0.99).[19)] Tyson & Connell reported the 10MWT to have excellent validity.[20)]

Numeric Pain Rating Scale (NPRS)

NPRS has shown to be a reliable way to rate pain among knee OA population in this age range.[21)] The NPRS is an 11-number scale where 0 means no pain and 10 is maximal pain.[21)] The patient rated her pain in her knees at 8/10, which falls under the category of severe pain. The minimal detectable change is a change in 2 levels. A study done by Jensen and McFarland in 1993 reported the NPRS to have excellent reliability (r = 0.79- 0.92), while Bryce et al. suggested that the NPRS is a valid scale to use.[22), 23)]

Manual Muscle Test (MMT)

MMT is a way of measuring muscular strength of specific muscles or a muscle group.[24)] A number or a description is given to a muscle group after a manual test is performed.[25)] The subject presented with weakness in right hip flexion, extension, abduction and adduction; right knee flexion and extension; right ankle dorsiflexion and plantarflexion. Manual muscle testing was found to have excellent test-retest reliability for the right side (ICC = 0.98) in patients with OA.[26)] However, validity for MMT has not yet been established.[24)] Subject had tightness in hamstrings and plantarflexors assessed in supine position. Also, tightness in the quadriceps, which was assessed in the prone position.

Intervention

The individual received physical therapy for 60 minutes three times a week for six weeks. Treatment for this patient consisted of strengthening exercises, balance training, cardiovascular endurance, stretching and self- managing education. For the cardiovascular aspect of the intervention, the subject used a recumbent stationary bike for 5 minutes at the beginning of the session with slight resistance at a comfortable pace. After the recumbent bike, the patient performed a stretching regime that consisted of standing gastrocnemius stretch, hamstring stretch with forward lean, and quadriceps stretch prone. She stretched her hamstrings while sitting on the edge of the mat with addition of a forward trunk lean. She performed bilateral plantarflexor stretch on standing incline. Then, she performed prone quad stretch using a strap (Table 1).

Strengthening exercises aimed to target hip, knee and ankle stabilizers consisted of bridges, clamshells, side-lying hip abduction, total gym machine, and side stepping (theraband). Functional activities consisted of sit to stands, gait training and step training. The subject performed 1 set of 10 sit to stands from a standard height chair (18 inches), without use of upper extremities. Also, she performed stepping over cones for a distance of 3 meters four times. The subject then performed step training on a 6 inch step with both legs for 2 sets of 15 reps (Table 1).

Balance training was composed of the following positions: narrow base of support, semi-tandem, tandem on foam and floor with eyes open and eyes closed. The subject was to perform each position for 2 minutes and was allowed to return to testing position if she lost her balance at any time (Table 1). Self-managing education was provided to decrease effects of OA and how to manage her symptoms. She was educated on the importance of staying active, while avoiding excessive fatigue and repetitious weight bearing activities like going up and down stairs. The subject was also informed on the importance of a balanced diet and adequate sleep on her symptoms.[7)] Education was presented to the subject with the goal of improvement in diet and weight loss, in order to achieve less stress placed on weight bearing through her joints. Sleep can have an effect on mood and fatigue levels, which can negatively impact pain and pain perception.[6)] She was supervised by a physical therapist

and progressed the reps, sets, and resistance as tolerated. Balance was also progressed according to the subject's improvement in performance with static and dynamic balance. The subject was compliant and only missed one day due to conflicting appointment with her neurologist.

Outcomes

Information from the outcome measures was gathered at evaluation and each one was administered every two weeks for a period of six weeks (Table 3). The subject improved in the BBS from 43/56 to 52/56, while the LEFS improved from 18/80 to 27/80. The TUG decreased from 22 seconds to 12 seconds along with the FTSST, which decreased from 39 seconds to 17 seconds. Moreover, 10MWT improved from .83 m/s to 1.1 m/s and NPRS decreased from 8/10 to 2/10. MMT improved in right and left lower extremities from 4-/5 to 4+/5 (Table 2). The subject had decreased gait variations during TUG and 10MWT and had significantly decreased tightness in quadriceps, hamstrings and plantarflexor musculature.

Discussion

The purpose of this case report was to describe the physical therapy management of an adult with knee OA and CVA during an outpatient episode of care. The subject presented with bilateral knee pain and antalgic gait pattern without any assistive device prior or after the stroke. Bilateral knee pain secondary to OA appears to have been accelerated after the stroke as her gait kinematics had changed due to decreased strength on the right lower extremity. Specifically, she rated her pain using the NPRS to be an 8 out of 10 with activity and a 3 out of 10 with rest. After the intervention, the subject showed improvements in functional strength, balance, gait speed, and decrease in pain. OA can be considered to be a "wear and tear" type of disease, it can be exacerbated by factors such as sustaining a CVA.[7] There are many aspects of a person's life that a stroke can affect, one of which, can be the way a person walks. This can lead to decrease in stability and increase in abnormal pressure put on the weight bearing joints.[5),6)] This subject had modifiable and non-modifiable risk factors for stroke and knee OA, but appeared to be motivated to address the modifiable risk factors to decrease exacerbations of OA.[2),6)]

Furthermore, MMT revealed improvements in muscles of her bilateral lower extremities, which can be confirmed by performance in the FTSST. The subject was a tall obese woman and as a result, had difficulty with this particular movement, but was able to complete the test independently. The subject was able to decrease her time in the FTSST by 56%, which demonstrated improvement in lower extremity functional strength and better joint stability. This can be attributed to improvement in strength, but also to improvements in balance and pain, because it is possible that the patient struggled on initial evaluation due to high pain levels or lack of balance during FTSST not just decreased strength. However, the subject is still above 12 seconds, which puts her at higher fall risk than healthy older adults her age.[11] Evidence supports the FTSST as being a good indicator of motor performance in addition to dynamic balance. [27] There were improvements in the TUG and BBS. Research shows that a change of 2.5 points in the BBS is clinically meaningful and that the cut off for fall risk is 45/56.[8] The subject achieved both principles by improving her score from 43/56 to 52/56 on the BBS. During the final assessment of the TUG, the patient completed the test in 12 seconds. According to evidence, this score puts her at a decreased risk for falls as a score greater than 14 seconds is indicative of higher fall risk.[16]

The subject demonstrated noteworthy improvement in gait speed and reported less pain during rest and activity according to the 10MWT and NPRS respectively. A two-point change in the NPRS is considered to be a minimal detectable change. The pain in bilateral knees decreased to 2/10 with activity post intervention. This could have also been attributed to the self-managing techniques that the patient was educated on. She improved her gait speed by 0.27 m/s as this is greater than 0.10m/s, which is the minimal detectable change for this outcome.[18] Evidence reports that the 10MWT has excellent convergent validity with BBS and TUG.[18),19] The subject also had decreased hyperextension of her right knee during stance phase of gait. The subject also demonstrated increased continuity of steps and symmetrical gait pattern with increased step length bilaterally. However, she demonstrated slight increase in flexion of the knees during gait this was probably done to decrease loading of the knee joints.[6] She used this form of compensation to decrease knee extension moment

in the gait cycle as there is less joint loading which could lessen pain in the knees during ambulation. This compensation increases energy expenditure as muscles like the glutes, quadriceps and gastrocnemius and soleus have to be active to provide dynamic support to the joints.[28), 29)] The LEFS demonstrated improvement as MDC is 9 points, which was achieved as subject's score went from 18/80 to 27/80.[14)] As a result, we believe that a significant reduction of pain may be positively transferred to utilize muscle strength so that the subject showed a significantly better functional performance.

This case report has limitations, as the patient missed one therapy session and showed up late on five therapy sessions. This impacted the patient's ability to participate in the full session and forced the therapist to skip certain interventions on those days. Perhaps the results on the outcome measures had been better if the patient had not missed therapy and been on time to therapy sessions in order to take full part of the encounter. The LEFS likely had a ceiling effect as the subject had improvement in functional mobility and ADL's, however, there are certain items in the LEFS like running, hopping and others that she was unable to do and her score reflected it.[14)] In retrospect, perhaps we should have used another outcome measure in place of the LEFS. Adding a 6-Minute Walk Test would have been a good way to track cardiovascular improvements.

In conclusion, individuals recovering from stroke can experience life changing situations. OA in weight bearing joints, specifically the knee joints, can prolong and limit recovery of a patient in stroke rehabilitation.[27)] As explained by Wood et al. in "Holding me back", arthritis can cause increased pain leading to activity limitation and frustration.[27)] This case report gives insight into a physical therapy exercise program in a patient with bilateral knee pain due to OA with a recent history of CVA. The subject completed the therapy program with improvements in gait speed, functional strength, static and dynamic balance and pain. There is research regarding stroke and regarding knee OA, but there is a need for future research regarding specific exercise interventions and guidelines along with outcome measures for neurological involved patients with exacerbation of knee OA.

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Tables

Table 1. Exercise program

Intervention at evaluation	**Sets, Reps, Time (hold)**	**Intervention at six weeks**	**Sets, Reps, Time (hold)**
Recumbent bike	Level 1, 5 mins	Recumbent bike	Level 4, 5 mins
Bridges	3 sets, 10 reps, 3 sec	Single leg bridge	3 sets, 10 reps, 5 sec
Side-lying abduction	2 sets, 10 reps, 3 sec	Side-lying abduction	3 sets, 10 reps, 5 sec, 2 lb weight
Clamshells	2 sets, 10 reps, 3 sec	Clamshells	2 sets, 15 reps, 3 sec, blue TB
Side stepping (L&R)	1 minute (yellow	Side stepping	4 minutes (blue

	TB)	(L&R)	TB)
Total gym	2 sets, 10 reps, level 15	Leg press machine	2, sets, 10 reps 50 lbs
Hamstring stretch	1 set, 3 reps, 30 sec	Hamstring stretch	1 set, 3 reps, 30 sec
Gastrocnemius stretch	1 set, 3 reps, 30 sec	Gastrocnemius stretch	1 set, 3 reps, 30 sec
Quad stretch	1 set, 3 reps, 30 sec	Quad stretch	1 set, 3 reps, 30 sec
Sit to stand	1, set, 10 reps, No UE support	Sit to Stand	No UE support
Cone stepping	1 set, 4 reps, 3 meters	Cone Stepping	2 sets, 3 reps, 3 meters
Step training	2 sets, 15 reps, 6 inch step	Step training	2 sets, 15 reps, 8 inch step
NBOS (EO/EC; floor/foam)	2 min		
Semi-tandem (EC/EC; floor/foam)			2 mins
Tandem (EO/EC; floor/foam)			2 mins

Table 2. The manual muscle testing of the lower extremities across time from evaluation to discharge.

Table 3. Pain scale and functional assessments results.

Muscle	**MMT at evaluation**	**MMT at 2 weeks**	**MMT at 2 weeks**	**MMT at 2 weeks**
Hip Flexion	R: 4-, L: 4+	R: 4-, L: 4+	R: 4+, L: 4+	R: 4+, L: 4+
Hip Extension	R: 4-, L: 4+	R: 4-, L: 4+	R: 4, L: 4+	R: 4+, L: 5
Hip Abduction	R: 4-, L: 4	R: 4-, L: 4	R: 4, L: 4	R: 4+, L: 4+
Knee Extension	R: 4-, L: 5	R: 4-, L: 5	R: 4, L: 5	R: 4+, L: 5
Knee Flexion	R: 4+, L: 5	R: 4+, L: 5	R: 4+, L: 5	R: 5, L: 5
Ankle Dorsiflexion	R: 4+, L: 5	R: 4+, L: 5	R: 4+, L: 5	R: 5, L: 5
Ankle Plantarflexion	R: 4, L: 4+	R: 4, L: 4+	R: 4, L: 4+	R: 4, L: 4+

	NPRS	**TUG (sec)**	**10MWT (m/s)**	**FTSST (sec)**	**BBS**	**LEFS**
Initial eval	8/10	22	0.83	39	43	18
Week 2	7/10	14	1.0	26	47	19

Week 3	4/10	13	1.1	17	50	25
Week 6	2/10	12	1.1	16	52	27