ASSESSMENT OF UPPER EXTREMITY SUPPORT WHEN ANALYZING GAIT IN A 56-YEAR-OLD MAN DIAGNOSED WITH A CEREBROVASCULAR ACCIDENT

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ABSTRACT

Background and Purpose. This retrospective case report describes the effect of upper extremity support, provided by Kinesiotape, on the gait quantity and quality, as upper extremity function is often related to gait efficiency. **Case Description**. The participant is a 56-year old man, diagnosed with a cerebrovascular accident, affecting the basal ganglia and corona radiate superimposed on chronic cystic encephalomalacia. His impairments include decreased left hemiparesis, resulting in decreased functional mobility with a grade I acromioclavicular (AC) joint separation. **Outcomes**. The patient made gains in strength and range of motion, as well as functional improvements in the 6-Minute Walk Test and Rancho Los Amigos Observational Gait Analysis. The Sub-Acute Functional Independence Measure indicated increase in functional mobility. **Discussion.** Kinesiotape positively affected the patient's quality of life and functional mobility. **Conclusion.** In this study, Kinesiotape was effective as an external upper extremity support for a grade 1 AC subluxation, for a patient with upper extremity strength less than 3/5.

Suggested Key Words: Kinesiotape, upper extremity, hemiplegia, ambulation

Assessment of Upper Extremity Support When Analyzing Gait in a 56-year-old man diagnosed with a Cerebrovascular Accident

A cerebrovascular accident (CVA) is commonly referred to as a stroke, or an interruption in the blood supply to the brain. There are two major classifications of CVA, ischemic and hemorrhagic. An ischemic stroke is caused by a blood clot in an artery to the brain. The clot may either begin in an artery in the brain causing decreased circulation, or the clot may originate in the body, break off and travel through the circulatory system until becoming lodged in an artery of the brain. The clot can initially cause damage to the brain due to lack of oxygen, leading to cell damage and/or death. In a hemorrhagic stroke, weak blood vessels in the brain rupture allowing for an excess of blood; which damages the cells of the brain. In both cases, risk factors for CVA include atrial fibrillation, diabetes, family history and heart disease. Some medications have also been linked to CVA, as they increase risk for blood clots. Unmodifiable risk factors for CVA include increasing age, gender and race. While men are more at risk for CVA, women are more prone to fatality from CVA. The incidence of CVA in African American's is two times that of Caucasian Americans, as is fatality rate. Preventable CVA risk factors also include alcohol use, smoking, high blood pressure, high cholesterol, sedentary lifestyle and unbalanced diet.[1] In the United States alone, it is estimated that 2.6% of the population, approximately 5.8 million non-institutionalized adults reported a diagnosis of stroke in their medical history.[2] This does not include the estimated 140,000 deaths per year that are attributed to stroke in the United States. [3]

The basal ganglia is a structure located deep within the telencephalon, in the anterior portion of the brain. The basal ganglia controls cognition, coordination of movement and voluntary movement. An area of white matter surround the basal ganglia is called the corona radiata. This area of the brain contains sheets of neural axons that are responsible for communicating to and from the cerebral cortex and for processing conscious information.[4] Due to location of these areas, associated impairments to the corticobulbar and corticoponite tracts may also include cranial nerve

impairments to facial and tongue motor function as well as sternocleidomastoid and trapezius control. Damage to the corticospinal tract, which is in similar proximity, results in fine motor impairments, spasticity and change in superficial reflexes.[5] A CVA involving the basal ganglia and corona radiata would therefore likely present with impairments in cognition, coordination and voluntary movements, particularly skilled movements of the distal extremities. Cystic encephalomalacia is a condition in which the tissues of the brain become soft due to an excess of blood delivered to the tissue. This pathology becomes chronic when the damaged is unrepaired over time. This softened area of the brain is often referred to as a 'hole' in that it is no longer functioning. Labeling this condition as chronic, explains that the damaged tissue is attributed to previous injury to the tissue, and that is has not or will repair. The diagnosis of right CVA involving the basal ganglia and corona radiate superimposed on a chronic cystic encephalomalacia will present with left sided deficits to the above-mentioned areas.[6]

Upper extremity function post right-sided CVA, can cause a general decrease in function of the left side, due to damage to motor and sensory neurons. Changes in muscle tone, motor control, proprioception and dysesthia are associated impairments that can lead to decreased joint integrity if not managed appropriately. When addressing upper extremity function post CVA, interventions are done to treatment to these impairments and to prevent further injury caused by the presence of these impairments. With decreased muscle strength and abnormal sensation, the upper extremity is at risk for subluxation as it rests against the forces of gravity. Interventions to strengthen the extremity to provide structural control, as well as treatment to support the arm when performing activities where it is not directly being used, are necessary in the programming of therapeutic rehabilitation. When performing functional activities such as bed mobility, transferring and ambulating, the integrity of the upper extremities function should be addressed to prevent damage.

Upper extremity function plays a large role in quality and efficiency of ambulation. Arm swing, in particular, is associated with both an increase in stability and a decrease in energy expenditure when assessing gait. Several research reports state

that the availability of arm swing is a global stabilizer in prevention of loss of balance.[7, 8, 9,10] For these reasons, it is considered an essential component of 'normal gait.' When a weak upper extremity is addressed therapeutically in gait, two options are available. If the extremity is not at risk of damage due to flaccidity and the downward pull of gravity, it can be positioned in a manner to promote proximal with distal stability. If proximal stability is not present, the upper extremity must be stabilized to prevent damage. External stabilization is most commonly applied in the form of an upper extremity sling, as gait abnormalities are decreased with use.[11] While a sling provides the support needed to prevent damage, risk of flexion contractures are present if the extremity remains fixed in one position.[4] Additionally, there is no promotion of muscle activity of the extremity, as it is fixed and supported.

Developed in the 1970's, Kinesiotape (KT) is a product that has recently gained recognition for its use with Olympic athletes. This product is widely used in physical rehabilitation as both for prevention from injury, as well as a treatment to injured muscles or joints. KT is an elastic cotton fiber material that is adheres to skin with an acrylic adhesive. It is unique in that it is latex free and breathable, allowing one application to last for 3-4 days, even with showers.[12] Application of this product in strips of I, T or Y shaped tape with a stretch of 30-40% is indicated to provide stimulus positional stimulus to the skin, align fascia, lift fascia or soft tissue to create space for pain or inflammation, provide sensory input or facilitate lymph drainage.[13] Inventors of the product explain that is can be used as a sole intervention, as well as in conjunction with other therapeutic rehabilitation techniques. In the rehabilitation of a hemiplegic patient, KT offers proprioceptive feedback, promotion of weak muscle contraction and stability to a joint.[14]

When addressing deficits of a hemi paretic shoulder joint, once proximal stability has been maintained, focus must be moved to proximal mobility. Once proximal function of the shoulder has been achieved, more distal areas can be addressed. This joint-by-joint progression from shoulder to fingers is designed to mimic the process by which we gain upper extremity function in natural development.[15] By promoting muscle

activity of the proximal musculature of the joint and creating a stable foundation for movements distally, the overall function and performance of the arm is increased. For these reasons, it is practical to progress a recovering upper extremity from a fixed external support to a support that offers less stability while promoting increased mobility. An appropriate progression of support begins with use of a sling, which provides stability without mobility, to a support that would allow for mobility once stability has been established. The use of KT is an appropriate progression for upper extremity support as is provides minimal stability while promoting muscle activity and allowing for movement.

As approved by the Institutional Review Board of the Sage Colleges in Troy, NY, medical records of a patient diagnosed with a right CVA involving the basal ganglia and corona radiate superimposed on a chronic cystic encephalomalacia were reviewed to assess the effectiveness of upper extremity supports during ambulation. The purpose of this retrospective case report is to evaluate the effect of using external support to assist weak scapular muscles on gait.

Case Description

The patient is a 56 year-old male who was admitted to a hospital's acute rehabilitation unit after diagnosis of a right CVA 3-days prior. The patient's physical therapy examination and intervention sessions that followed were performed by the student physical therapist, observed by the staff clinician on site.

History: The patient's pertinent medical history included a previous CVA (2007), hypercholesterolemia, hypertension, diabetes, depression, smoking and alcohol abuse.

Prior Function

The patient lives with his wife in a split-level home. The patient drove short distances and performed activities of daily living without assistance, other than cooking, prior to admission. The patient ambulated without an assistive device prior to admission, but had experienced multiple falls, mainly on uneven and outdoor surfaces. The patient required use of one handrail to ascend and descend stairs. The patient

stated that he retired following his previous CVA and spends his free time performing auto and small machine repair.

Systems Review

The patient was alert and oriented to person, place and time. The patient was impulsive and verbose. The patient's cardiovascular screen revealed a history of high blood pressure and cholesterol. The patient was an active smoker prior to admission. The patient reported both urinary urgency and impotence dating to previous cerebrovascular accident. The patient reported no difficulty in swallowing, bowel movement or gastrointestinal irritation. The patient did not present with impairments to the pulmonary or endocrine systems. Neurologically, the patient communicated with slightly slurred speech, ataxic movement patterns and reported memory lapses. The patient reported numbness in left lower extremity and burning sensation in left upper extremity.

Tests and Measures

At the time of admission the patient's passive range of motions, with the exception of his left ankle, were within functional limits.[16] The patient presented with active range of motion deficits in the left shoulder, elbow, wrist and hand, as listed in Figure 1. His left lower extremity strength was decreased at the hip and knee, absent below the ankle. Manual muscle test results are listed in Figure 2.[17] The patient's left upper extremity was flaccid. The patient's reflex response at the left brachioradialis, wrist flexors and extensors as well as at each distal phalanges were hyporeflexive. The patient's left foot however, was hyperreflexive. The patient presented with a grade I acromioclavicular separation in the left anterior shoulder. [16] The patient reported abnormal sensation in both the left upper and lower extremity, sensory testing was inconclusive, as the patient was unable to refrain from guessing during the examination. The patient reported pain of 10/10 on the VAS scale in the left upper extremity, pain of 8/10 in the left lower extremity.[18]

The patient was tested using the Sub Acute Subscale of the Functional Independence Measure (FIM). The Sub Acute Subscale of the FIM is a trained observer-rated measure of the ability of a patient to perform functional mobility activities including bed mobility, transfers and ambulation. Rating of performance is based on both manual assistance required and use of assistive device.[19] The Functional Independence Measure has a reliability of .81 in the assessment of adults post CVA.[19] The patient performed bed mobility including supine to and from sitting with use of 1 bedrail and contact guard, bed mobility is performed with impulsivity and loss of balance when sitting, a FIM score of 3. The patient was unable to sit at edge of the bed without use of right upper extremity for balance, with feet touching the floor. The patient performed a stand pivot transfer to and from bed to wheelchair without assistive device and contact guard of two, a FIM score of 3. Again, this transfer was performed impulsively and unsafely. The patient's standing balance was poor. The patient was able to ambulate 5 feet with moderate assistance of two, a FIM score of 0. Stair management was not tested due to safety concerns, a FIM score of 0.

As ambulation ability, measured in both quality and endurance, was a major focus during physical therapy, two outcome measures were used to provide adequate qualitative and quantitative measures. Quantitative measure was performed on a weekly basis, as the patient participated in the Six-Minute Walk Test. The test was performed as dictated by protocol, in a 100' hallway with hard tile flooring. The patient performed this task 4 days post admission while donning an upper extremity sling, then on the same day of the week for each test that followed while donning Kinesiotape instead of an upper extremity sling. Testing was performed at the beginning of his first therapy session of that day. The patient was instructed to walk as far as he could in 6 minutes, resting either sitting or standing when necessary, but resuming walking as quickly as he was able to.[20] Results of the Six Minute Walk Test are listed in Figure 3. The Rancho Los Amigos Observational Gait Analysis (RLA) was also administered with performance of the 6 Minute Walk Test. Quality of ambulation, as it effects both energy conservation and risk of falls, was assessed via the RLA.[21] The RLA examines gait

deviations in the three phases of ambulation, weight acceptance, single leg support and swing limb advancement. The RLA Gait Analysis is a visual analysis from the trunk down to the toes, classifying deviations into major and minor for each joint. Toe movement was not evaluated, as the patient was unable to perform this test barefoot, due to hospital regulation. Additionally, excessive upper extremity weight bearing on an assistive device can be identified as a 'major problem' in this qualitative gait analysis. Results of the RLA are listed in Figure 4.

Evaluation

The patient presented with significant functional mobility deficits, as a result of a right CVA. The patient's left upper and lower extremity motor control and sensory sensation were impaired. Sitting and standing balance, ambulation and ability to transfer were decreased and of concern due to lack of safety awareness and impulsivity. As the patient presented with a grade I AC separation, he was prescribed an upper extremity sling to both support his left upper extremity and prevent future injury. The patient was anticipated to require maximum length of stay at acute rehab unit, with a possibility of sub acute care required for safe discharge.

Diagnosis: American Physical Therapy Association Practice Pattern

Primary – 5D: Impaired Motor Function and Sensory Integrity Associated With Non-progressive Disorders of the Central Nervous System - Acquired in Adolescence or Adulthood [22]

The patient's primary pattern was chosen based on the diagnosis of cerebrovascular accident, and his impairments, which include both motor and sensory deficits.

Secondary – 6A: Primary Prevention/Risk Reduction for Cardiovascular/Pulmonary Disorders [22]

The patient's secondary pattern was chosen based on his previous diagnoses of hypertension and hypercholesterolemia. The patient also led a sedentary lifestyle and was smoking 1 pack of cigarettes per day prior to

admission. This practice pattern was included to address the need for patient education each day.

Prognosis

By this time the patient was expected to improve in functional mobility, including bed mobility and transfers, to all for performance with use of assistive device alone. The patient was also expected to gain ambulation and stair management skills to allow performance with use of assistive device and contact guard. Prior to discharge, the patient's functional mobility would be reevaluated, as sub-acute rehabilitation may be required to ensure a safe discharge. The patient would benefit from extended physical therapy, through home based services or sub-acute rehabilitation dependent on discharge planning, to address deficits in strength, range of motion, balance, motor planning and functional mobility that will not be achieved in sub acute rehabilitation due to length of stay.

Plan of Care

The patient's estimated length of stay in the acute rehab unit was 14-21 days, which was the maximum allowed based on diagnosis. At the time of the initial evaluation, it was projected that the patient would receive physical therapy a minimum of 5 days per week, 1.5 hours per day, with a focus on therapeutic exercise, training in bed mobility, balance, transfers, gait and activities of daily living, neuromuscular reeducation and modalities as needed.

Short Term Goals

1. The patient will perform sit to and from supine in bed with use of 1 bedrail and minimal assistance within 1 week.
2. The patient will perform sit to and from stand transfers from wheelchair to hemi walker with contact guard within 1 week.

3. The patient will ambulate 25’ with hemi walker and moderate assistance of 1 within 1 week.

Long Term Goals

1. The patient will perform sit to and from supine in bed with 1 bedrail and supervision within 3 weeks.
2. The patient will perform sit to and from stand from wheelchair to large base quad cane with supervision within 3 weeks.
3. The patient will ambulate 300’ with large base quad cane and contact guard within 3 weeks.

Interventions

Figure 5, the Physical Therapy Treatment Chart, displays the interventions performed to and with the patient over each treatment day. Treatment day 1 began the day following the patient’s admission, as the initial evaluation is not included as treatment. The patient’s date of discharge is not included in the treatment chart, as formal treatments were not performed per hospital protocol. X’s are marked in each aspect of patient care that was addressed on a particular day. Treatment was performed in two sessions daily. The following are descriptions of the interventions performed.

Functional Mobility – In the acute rehabilitation unit, functional mobility is defined as any and all training related to bed mobility, wheelchair training, transfers and ambulation. Aspects of balance, coordination and planning were incorporated into functional activities to address problem solving. The patient was placed into situations where he would not be able to perform an activity safely, such as transferring in an unsafe manner, to ensure motor planning was incorporated into his rehabilitation. The patient was asked to perform the transfer to challenge his ability to problem solve the appropriate way to position himself or to request assistance if needed. Treatments included in this category include rolling, transferring from supine to sitting and shifting

in a seated position for bed mobility. Pre-ambulation training consisted of standing balance, weight shifting in standing and step practice in parallel bars and at edge of bed. Wheelchair mobility was performed in both transfers to and from the wheelchair and efficient use of a one-arm drive wheelchair. Community mobility, both wheelchair and ambulation, were incorporated a to allow the patient to problem solve in new environments, as well as to ensure his ability to perform mobility on a variety of surfaces including uneven sidewalks, ramps and grass.

Upper Body – Sling application was taught by demonstration at the above-mentioned facility. Therefore sling application was included in treatment, particularly during the initial week of treatment to allow adjustment time for best fitting. Upper extremity weight bearing and passive range of motion, performed by both patient and therapist, were used to strengthen the shoulder joint and prevent development of muscle contractures due to decreased use. Massage was also performed to decrease pain, anxiety as well as reduce negative effects of tone.[23]

Neuromuscular re-education (NMR: LUE) was used to facilitate muscle contraction via electrical stimulation. Electrical stimulation applied proximally at the upper back and shoulder initially to promote scapular control. This treatment was performed in 15-minute increments, or as tolerated by the patient. Stimulation was performed on the infraspinatus, deltoid, supraspinatus and teres minor. As proximal mobility was gained, distal muscles of the upper extremity, biceps and triceps, were coupled in a reciprocal manner while performing activities involving patterns of neuromuscular facilitation (PNF), including patterns D1 Flexion and D2 Extension. NMR: LUE was successful in initiating muscle contraction through the distal extremity, though carryover to active initiation was successful only to the muscles originating above the elbow. The patient was unable to engage the musculature of the distal arm without assistance of the electrical stimulation therefore functional electrical stimulation (FES) was not used in treating the patient's left hand. As the patient began to gain the ability to engage muscles of the left upper back and shoulder complex, the use of an upper extremity sling was discharged and the patient transitioned to the use of Kinesiotape to

support his left acriomioclavicular joint.[13] This transition was made to both encourage muscle activity as well as decrease the gait deviations that were exaggerated by the use of the sling.[11]

Kinesiotape Application was applied to the patient's left upper back and arm in 3 manners. Initially, KT was applied to prevent shoulder subluxation. For this application, an I-shaped KT strip is initiated at the muscle belly of the deltoid muscle, pulled with a 50% stretch over the acromioclavicular (AC) joint, and grounded just lateral of the neck. The goal of this application was to support the AC joint, as the patient reported pain across the joint line. KT application to prevent AC joint separation, as described Stockheimer and Kase, allowed the patient to continue to perform upper extremity activity while protecting joint integrity. This application was used for 5 days, discontinued once the AC joint presented with decreased laxity. A second Y-strip was applied to the upper trapezius, from insertion to origin with a 30% stretch, to promote muscle shortening and strengthening. The upper trapezius application was applied for 8 days, as was the third tape application. This third KT, also a Y shape, was applied to the supraspinatus, in the same manner as the second strip.[13] Tape applications two and three were worn during all functional activities including walking and transfer training, as well as while performing upper extremity strengthening activities. The taping techniques that promote strengthening were also donned during upper extremity weight-bearing activities and functional electrical stimulation. The applications of KT were checked on a daily basis (KT Skin Check), as the patient reported hypersensitivity in the LUE, and was unable to decipher irritation. Ultimately, KT application was discontinued due to skin irritation in the form of a small blister on the patient's left shoulder. While the rehabilitation team agreed that external rubbing against the hospital bedrail was likely cause for the irritation, use was discontinued to prevent further skin breakdown.

Lower Body – Lower extremity range of motion activities, both active and active assisted, were performed by the patient to promote full range with proprioception. Techniques including PNF, patterns D1 Flexion and Extension, were implemented to gain

active range of motion and increase functional independence. Once mobility was gained in these patterns, slow reversals and rhythmic stabilization techniques were introduced to gain strength with the new available range. Additional strengthening exercises were performed in supine, seated and standing. While all lower extremity muscles were addressed, a focus was placed on hip flexion and knee extension of the left lower extremity. Neuromuscular re-education (NMR: LLE): The patient's left quadriceps muscle was stimulated while performing quadriceps dominant exercises. Once muscular control was achieved, functional electrical stimulation was used to facilitate gait and stepping patterns. Once proximal control was achieved in a functional movement pattern, electrical stimulation was applied in the same manner distally, to the anterior tibialis, as the patient lacked dorsiflexion control. As this intervention was not tolerated well by the patient, use was discontinued. Stretching and massage of the lower extremities was focused around the hip joint, as the patient was relatively sedentary outside of treatment. Again, PNF techniques were incorporated into treatment, particularly hold relax. Stretching with PNF technique allowed the patient to actively participate and incorporate the mind-body connection into this portion of therapy, which is usually a passive process.

Patient Education – On a daily basis, patient education is delivered to all patients being treated at a rehabilitation unit. Topics discussed in patient education for this particular case include application of upper extremity sling, safety awareness, quality of movement, personal goal setting and modification to previous daily activities of leisure. In addition, the patient received education on a home exercise program, which was performed independently in the hospital, then modified for home. Family meetings also took place in preparation for the patient's discharge. These meetings included team meetings with the patient and family to discuss progress as well as home evaluations with the family alone. Caregiver education was also provided for the family, teaching body mechanics for transfers, ambulation and stair management. The family was also instructed on appropriate assistance for home.

Outcomes

The patient's manual muscle testing and range of motion upon completion of treatment in sub-acute rehabilitation are as follows. The patient's gains in active range of motion of the left upper and lower extremities are listed in Figure 1.

The patient's gains in strength, as measured by manual muscle testing include 3/5 left shoulder and 2/5 elbow (from 1/5), 5/5 right hip and knee from 4/5, 4/5 left hip and knee from 2-/5 and 3/5 and left ankle 2/5 and foot 3/5, from 0/5 and 2/5 respectively, as listed in Figure 2.

Following standard practice of the acute rehabilitation facility, the Functional Independence Measure Sub-Acute Subscale was used as an outcome measure to classify the patient's ability to perform bed mobility, transfers, ambulation and stair management.[23] At discharge, the patient was performing bed mobility independently with the use of 1 bed rail, a score of 6. This transfer improved in that he no longer required contact guard, and the performance was controlled without impulsivity. The patient performed transfers from sit to and from stand with contact guard, a score of 5. This transfer he was previously unable to perform due to lack of sitting balance. The ambulated on indoor surfaces with a short base quad cane and contact guard for community distances (300 feet or more), a score of 4. His gains in ambulation were some of the most remarkable improvements made, as the patient required assistance of two to ambulate 5 feet upon admission. This gain represents improved functional independence as well as increased strength, coordination, endurance and balance. The patient ambulated on outdoor, uneven surfaces with a short base quad cane and minimal assistance for distances less than 100 feet. The patient performed stair management with one stair rail and contact guard to minimal assistance on 20 stairs with appropriate step-to pattern, a score of 4. Neither outdoor ambulation nor stair management were performed during the patient's initial evaluation, as the activities were deemed unsafe at that time.

Ambulation ability, measured by quantitatively via the 6 Minute Walk Test, was performed on a weekly basis. As previously described, the patient performed this task four days post admission, then on the same day of the week for each test that followed, at the beginning of his first therapy session of that day. The test was performed with assistive device, progressing from a hemi-walker during the first test to a large base quad cane on the final trial. Additionally, the patient's left arm was supported by an upper extremity sling in the initial and second trial, and by KT in the final trial. The patient's results are listed in Figure 3.

Figure 4 offers visual explanation of the patient's change in gait quality. The RLA examines gait deviations in the three phases of ambulation, weight acceptance, single leg support and swing limb advancement.[20] This outcome measure was taken at baseline while donning an upper extremity sling and during the patient's final Six-Minute Walk Test, donning KT. Baseline results are recorded in the dark green column, final results in the light green column in Figure 4.

The patient and his family had previously expressed concerned regarding return to 'normal function' after discharge, the Stroke Specific Quality of Life (SS-QOL) questionnaire was completed to address the patient's perception of home post discharge.[25] The SS-QOL was developed as stroke specific patient-centered outcome measure, as one did not previously exist. The measure includes 12 domains though 49 patient-centered questions. The following areas are addressed in this outcome measure include self-care, mobility, upper extremity function, work, vision, language, thinking, personality, mood, energy, family and social roles. Higher scores indicate better functioning, on a scale of 1 to 5. While each domain does not correlated directly to non-stroke specific quality of life assessments, construct validity correlated with the Barthel Index and the SF-36, two measures previously used for this population.[26] Most notable however is the predictive value the SS-QOL offers, as performing this assessment 1-month post CVA with a score higher than 2.97 predicts a higher overall quality of life.[27] The SS-QOL was re-evaluated by its creators to assess the test-retest and inter-rater

reliability with stroke survivors. Both demonstrated excellent reliability, with correlation scores of 0.92.[26]

The patient reported that he required no assistance or change (score of 5) for self-care and mobility with assistive device, thinking, language and personality. The patient reported a little assistance or change (score of 4) needed with vision, energy, mood and family roles. The patient reported a lot of help or change (score of 2) in work and family roles, and total help (score of 1) for upper extremity function. With an overall average score of 3.8, the patient's predictive post-CVA health-related quality of life was high.

The patient met both his short term and long-term goals at discharge. His long-term goals include performance of sit to and from supine in bed with 1 bedrail and supervision. This goal he exceeded, as he was able to perform bed mobility independently with use of a bedrail. Performance of sit to and from stand transfers from wheelchair to LBQC and supervision was not achieved, as the patient was unable to consistently perform this transfer safely. He did exceed the goal of assistive device used, as he was discharged using a SBQC. At discharge, contact guard was required to ensure the patient had locked the brakes on his wheel chair and placed his SBQC in a location that would not impede his transfer. The patient met his goal for ambulation, requiring CG and SBQC to ambulate community distances of 300 feet or more.

The patient was discharged from sub-acute rehabilitation not requiring the use of an upper extremity sling or support. While this data cannot be measured by quantitative means other than strength, the psychological benefits to the patient are directly related to quality of life post discharge. The patient stated many times throughout his treatments that he perceived the use of a sling as a weakness or "handicap." The increased independence the patient gained by discharging use of the upper extremity sling allowed him to perform ADL's including dressing and grooming without assistance. Furthermore, allowing the patient to actively support his left upper extremity can prevent musculoskeletal impairments such as contracture and disuse atrophy.

Discussion

This case report based on medical records assesses the use of upper extremity support as it relates to gait in 56-year-old man diagnosed with a CVA. While the use of KT has become increasing popular in sports rehabilitation, its use in neuromuscular rehabilitation is only emerging in the research. One benefit of use in this field; is the ability to use KT in conjunction with other modalities. For this particular patient, KT was applied to proximal shoulder and back musculature, while electrical stimulation was used for the biceps and triceps during neuromuscular reeducation. The goal of these applications, in addition to promoting muscle strengthening, was to assist the patient's scapular stabilizers without use of a bulky external support, such as an upper extremity sling. The KT tape, unlike a traditional external support, assists the muscles it is applied to in contracting. The upper extremity sling, while useful in supporting a weak joint, does not address impairment on the muscular level. In addition to the gains in normalcy of gait pattern, the patient reported proprioceptive and tactile stimulation provided from the tape that gave him better awareness of his left arm in relation to his body. The patient also reported that the tactile input from the KT decreased pain and sensitivity in his arm. As Thelen described from his research, KT is effective in reducing shoulder pain, particularly for abduction. This study however, did not note changes in range of motion or strength based on the application.[14] Ottenbacher however reports that scapular kinematics can be positively affected by application of KT to support the joint. This report cites positive changes in scapular motion, muscle performance and pain associated with improper alignment of the joint.[19] When treating neuromuscular impairments directly, Jaraczewska and Long report an increase in body awareness, function and appropriate muscle activity with decreased compensatory movement provided from multiple applications of KT.[28] This report also places a focus on performance of functional activities while wearing the KT. As application of KT in this manner to a patient lacking mechanical stability secondary to hemiparesis has not been reported on in the current literature, supporting evidence is not available to reinforce this treatment. Prior to application, it was hypothesized that the KT would provide

adequate external support of the upper extremity, while encouraging muscle activity and providing proprioceptive input. While use of the product was discontinued 3 days prior to the patient's discharge, due to development of skin irritation around the application, the patient transitioned successfully from KT to an unsupported left upper extremity. While the patient's upper extremity strength and range of motion did not fully return prior to discharge, the patient was successful in maintaining acromioclavicular stability against gravity. The patient's gait pattern was positively affected by this proximal upper extremity stability, as evident by a decrease in compensatory motion of the trunk and hips during ambulation as well as a decrease in weight bearing through the upper extremity on an assistive device. The patient's increased left upper extremity proximal stability also positively affected his ability to perform bed mobility, transfers and activities of daily living. At the time of discharge, the patient was able to use his left upper extremity to partially support his body while performing transfers, rather than bracing his arm during transfers, which was required for safety during his initial evaluation.

Visual observation of the patient's posture and body mechanics greatly improved with the application of KT. The patient was better able to align his body in an upright position when standing, versus a forward flexed and left side guarded position he maintained without it. The patient's left shoulder strength also increased following use of KT. All notable gains in left upper extremity strength were in areas that the tape either supported or assisted via application. While the patient did not regain full function of his left upper extremity, the goal of the KT application was to assist in muscle re-education to provide stability to the shoulder joint without use of assistive device. This goal was met prior to discharge. While a cause and effect relationship cannot be assumed to be a direct relationship between increased strength and KT alone, as other interventions were used in the patient's treatment, muscle activity in these areas appears to be positively effected by the product.

The use of KT as an alternative to an upper extremity sling also offered psychosocial benefits to the patient. The patient frequently reported frustration in

donning and doffing of his upper extremity sling during the first week of physical therapy. The patient grew aggravated at times when his sling would catch on articles of clothing or become stuck underneath him when performing bed mobility. The patient was also unable to successfully don the upper extremity sling without assistance, decreasing his overall independence. As discussed in *Self-Care Self-Efficacy, Quality of Life and Depression After Stroke,* functional independence and ability to perform self-care are the strongest indicators of increased quality of life post-CVA.[29] The patient reported that his 'magic tape' provided the support he needed, without having to look as though there was something wrong with his arm. This feature of the KT was very desirable to the patient, as society's view of his impairment was a concern. The patient also reported a decrease in abnormal sensation with use of the KT. The product allowed to the patient to have a better understanding of where his arm was in space, as the Kinesiotape provided a tactile input the patient had previously been lacking.

The patient's gains in ambulation are the most notable in both quantity and quality. The 6 Minute Walk Test results depict a steady progression in ambulation quantity. The patient's progress is also evident by a decrease in rest breaks as well as a decreased in physical assistance and the use of an assistive device, which offers less stability. The quality of the patient's ambulation increased as well, as shown by the RLA Gait Analysis, which depicted gait with major impairments in multiple joints initially, and major impairments only at the ankle at discharge. While Yavuzer reports that the use of an arm sling in hemi paretic patients with AC subluxation decreased excessive motion through the center of gravity, in this case the opposite was shown.[11] The patient ambulation with greater deviation while donning the sling, as shown in the initial RLA analysis with major deviations in trunk flexion and lateral lean away from his hemi paretic side. While researchers such as Acar and Karatas confirm an increase in balance while donning an arm sling, they emphasize that this tool is useful only while the upper extremity is flaccid.[7] Bruijn et al's research suggests that while arm swing may not enhance gait stability, it does increase the ability to right ones self from perturbation or loss or balance, a component that is essential for safety in an ambulation patterned

marked with impairments.[30, 31] Furthermore, the patient reported significantly increased confidence in ambulation without physical assistance. The patient vocalized his satisfaction with the Kinesio Tape application, stating that it 'allowed his arm to move freely but still feel like it's supported.' While donning the upper extremity sling previously, he had struggled to adapt to lack of left arm swing in ambulation, moving the shoulder girdle, trunk and pelvis as one fixed segment.

The patient's SS-QOL score 1-month post CVA suggests that his transition to home will not be negatively impacted due to personal view of health related quality of life.[32] As reported for patients suffering mild to moderate strokes, the SS-QOL is both reliable and valid in measuring self reported health related quality of life. While the patient was able to recognize areas in which his independence was limited or lacking, his overall score suggests high function.

Strengths of this study include the assessment of a newer product, KT, to assist in muscle strength, proprioception and pain reduction when applied to a patient with a neurologic condition. The use of multiple outcome measures to assess not only quantity but also quality of movement, are useful in providing a realistic view of the patient's ability. The outcome measures used in the study are also reliable and valid.

Weaknesses of this study include a lack of follow-up post intervention. The study is limited due to a sampling methods and size. The patient in this study also survived a previous CVA, no baseline measurements on function were available to compare to. While the use of the KT is a strength of this study; it can also be considered a weakness, as it was combined with multiple interventions. Without a control group to test real change related to the KT alone, only inference on its success can be made.

Conclusion

The purpose of this retrospective case report is to evaluate the effect of using external support, in the form of KT, to assist weak scapular muscles and how that relates to gait in a patient receiving treatment for impairments related to a right-sided CVA. Improvements in strength to the scapular muscles include an increase in shoulder

flexion, abduction and adduction. Most notably, at the time of discharge, the patient no longer required external support for the left acromioclavicular joint, which initially presented with a grade 1 subluxation. The patient's improvements in gait include increased ambulation endurance, which is directly related to increased quality of gait, as the more efficiently ambulation is performed, the longer duration it can be performed for. The patient met all of his goals prior to discharge, including ambulation of 300 feet with use of a LBQC, and performance of bed mobility and transfers with assistive device and supervision.

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Appendix

Figure 1: Left Upper and Lower Extremity Active Range of Motion

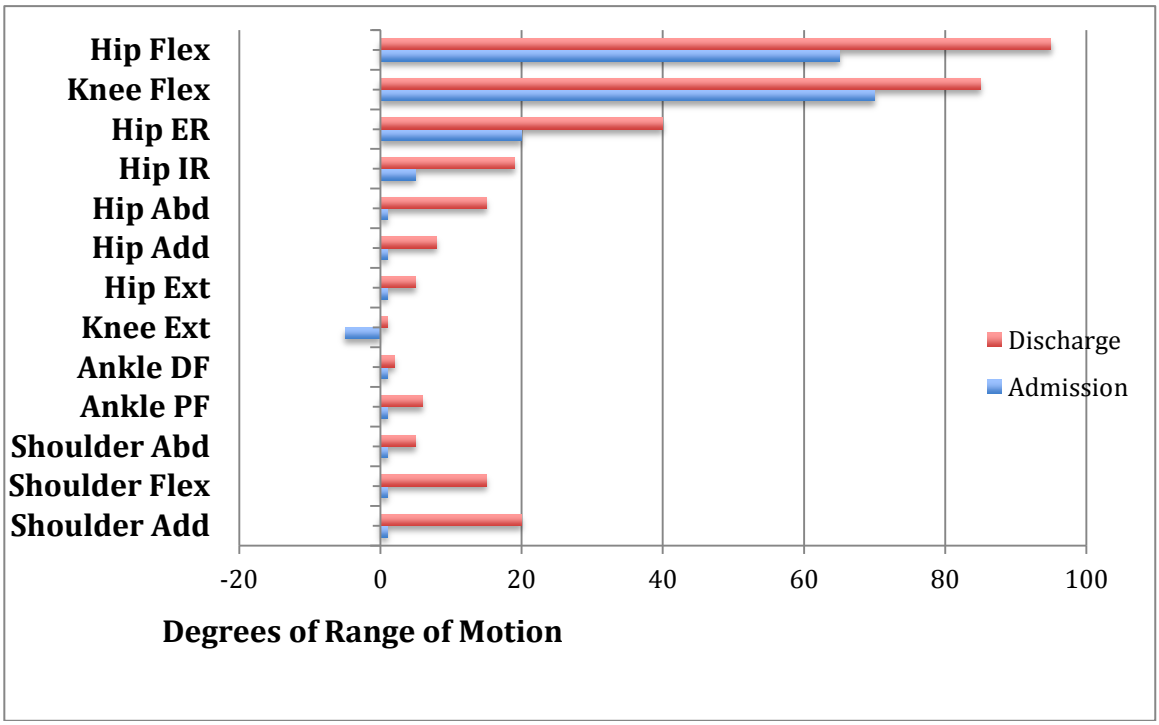

Figure 2: Manual Muscle Tests of the Upper and Lower Extremities

Upper Body	Right Shoulder	Left Shoulder	Right Elbow	Left Elbow	Right Wrist	Left Wrist	Right Hand	Left Hand
MMT: Initial	4/5	1/5	4/5	1/5	4/5	0/5	4/5	0/5
MMT: Discharge	4/5	**3/5**	4/5	**2/5**	4/5	0/5	4/5	0/5

Lower Body	Right Hip	Left Hip	Right Knee	Left Knee	Right Ankle	Left Ankle	Right Foot	Left Foot
MMT: Initial	4/5	2-/5	4/5	3/5	4/5	0/5	4/5	2/5
MMT: Discharge	**5/5**	**4/5**	**5/5**	**4/5**	4/5	0/5	4/5	**3/5**

Figure 3: 6-Minute Walk Test Results

Week	Distance	Device	Assistance	Comments
1	77’	Hemi-walker	CG - Min A	4 standing rest breaks
2	146’	LBQC	CG	1 seated rest
3	303’	LBQC	CG	No rest breaks

Figure 4: Rancho Los Amigos Gait Analysis Initial and Discharge

	Weight		Single Limb		Swing Limb Advancement			
Left Limb Referenced	*IC*	*LR*	*MdSt*	*TSt*	*PSw*	*ISw*	*MSw*	*TSw*
Trunk								
Lean: Forward	X		X		X		X	
Lateral Lean: Right					X	X	X	
Pelvis								
Hikes					X	X	X	
Tilt: Anterior	x	x	x	x				
Lack Backward				X				
Excess Forward								
Ipsilateral Drop					X	X	X	
Contralateral Drop	X		X					
Hip								
Flexion: Limited	X					X	X	X
Inadequate			X	X				
Rotation: External	x	x	x	x	x	x	x	x
Abduction	x	x	x	x	x	x	x	x
Knee								
Flexion: Limited					X	X		
Wobbles	X		X	X				
Hyperextension	X		X	X				
Excess Contralateral								
Ankle								
Excessive Plantar						X	X	X
Eversion					x	x	x	x
No heel off				X	X			
Drag						X	X	X

Admission	
Discharge	
Major Impairment	X
Minor Impairment	x
Non-indicative Field	

IC	Initial Contact
LR	Loading Response
MdSt	Mid-Stance
TSt	Terminal Stance
PSw	Pre-Swing
ISw	Initial Swing
MSw	Mid-Swing
TSw	Terminal Swing

Figure 5: Physical Therapy Treatment Chart

	Treat 1	Treat 2	Treat 3	Treat 4	Treat 5	Treat 6	Treat 7	Treat 8	Treat 9	Treat 10	Treat 11	Treat 12	Treat 13	Treat 14	Treat 15	Treat 16
Functional Mobility																
Bed Mobility	X	X	X		X		X									
Pre-Ambulation	X	X	X	X												
WC Mobility	X	X		X	X		X	X		X						
Transfer Train		X	X		X	X	X	X	X	X	X	X	X	X	X	X
Gait Train			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Balance			X	X		X	X		X	X	X	X		X		X
Problem Solve			X	X	X		X		X	X		X	X	X	X	X
Comm Mobility						X		X						X	X	X
Stair Mgmt							X				X		X		X	X
Car Transfer															X	X
Coordination								X	X	X		X			X	X
Floor Transfer														X	X	
Upper Body																
UE Sling Application	**X**	**X**	**X**	**X**	**Upper Extremity Sling Discharged**											
UE Wb'ing		X		X		X		X		X		X		X		
LUE ROM		X	X	X	X	X	X	X	X	X	X	X	X	X		
LUE Massage			X		X		X		X							
LUE AAROM				X	X	X	X	X	X							
NMR: LUE					X	X	X		X		X		X		X	
KT Application							**X**		**X**			**X**				
KT Skin Check							**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**		
LUE Stretch			X		X		X		X	X	X		X	X		X
LUE Strength					X		X		X		X	X	X	X	X	X
Lower Body																
LLE ROM	X	X	X	X		X		X		X						
LLE Massage	X	X	X				X									
LLE Stretching		X				X	X		X	X						
RLE Strength		X		X			X	X			X					
RLE ROM			X	X	X	X										
NMR: LLE			X		X		X	X								
LLE AAROM			X		X		X	X			X	X	X			
BLE Strength			X	X		X	X	X	X	X	X	X	X	X	X	
LLE Strength			X	X	X		X	X	X	X		X		X	X	X
Education																
Patient Ed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Family Meeting					X			X			X				X	X
Caregiver Ed										X			X		X	X

Figure 5 Key: *WC – wheelchair; Comm – community; UE – upper extremity; RUE – right upper extremity; LUE – left upper extremity; LE – lower extremity RLE – right lower extremity; LLE – left lower extremity; BLE – bilateral lower extremity; Wb'ing – weight bearing; NMR – neuromuscular re-education; ROM – range of motion; AAROM – active assisted range of motion; Ed – education*

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October 6, 2011

Amy Glasser
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IRB PROPOSAL # 11-12-003
Reviewer: Susan C. Cloninger, Chair

Dear Amy:

The Institutional Review Board has reviewed your application and has approved your project entitled "Assessment of Upper Extremity Support When Analyzing Gait in a 56 year old man Diagnosed with a Cerebrovascular Accident." Good luck with your research.

When you have completed collecting your data you will need to submit to the IRB Committee a final report indicating any problems you may have encountered regarding the treatment of human subjects

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

Please let me know if you have any questions.

Sincerely,

Susan C. Cloninger

Susan C. Cloninger, PhD
Chair, IRB

SCC/nan

Cc. Dr. Laura Gras