Case Review: A Comparison of Functional Outcomes in Two Participants Post Tumor Resection

A Capstone Project for PTY 768
Presented to the Faculty of the Department of Physical Therapy
Sage Graduate School

In Partial Fulfillment
of the Requirements for the Degree of
Doctor of Physical Therapy

Benjamin Lefkovits
May, 2010

Approved:

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Program Director, Doctor of Physical Therapy Program

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Abstract

Background and Purpose: The incidence of brain tumors is increasing and physical therapists in all settings are required to treat people with different forms of cancer. Therapists should be able to understand not only the rehabilitative techniques that will work toward achieving a return to functional baseline, but they need to understand the signs and symptoms, prognosis, surgical outcomes and adjuvant therapies that may also be necessary for the treatment of certain cancers. The purpose of this case report was to describe the differences in clinical presentations and functional outcomes, post surgery, of two people with brain tumors. The question of why the two had different presentations will be explored. Case Description: Participant A was a 44 year old male with a diagnosis of malignant melanoma stage III, with metastasis to his brain. Participant B was a 46 year old male with a diagnosis of primary brain tumor from astrocytoma grade IV (GBM). They had tumors in similar areas of the brain, underwent similar surgical procedures to remove the tumors and underwent adjuvant treatment post surgery. However, they presented to physical therapy very differently. Outcomes: Participant A was found to have larger motor and neurological deficits following surgery as compared to participant B. Participant A presented with weakness and impaired coordination in his right upper and lower extremities; impaired balance; and he required maximum assist of 2 to ambulate 40 feet with a rolling walker. Participant B presented with normal strength, balance, and coordination. He was independently ambulating without an assistive device 400 feet and was able negotiate a flight of stairs independently. Discussion: Even though GBM is one of the more devastating diagnoses of brain tumors; size, location, and number of tumors was a much greater indicator of function post surgery in these 2 men.

Background and Purpose

A brain tumor is a mass or growth of abnormal cells in the brain.[1] Some tumors are non-cancerous or benign, while others are cancerous or malignant. The American Cancer Society estimates that in 2009, 22,070 malignant tumors of the brain or spinal cord [12,010 in men and 10,060 in women] will be diagnosed and an estimated 12,920 of those diagnosed [7,330 men and 5,590 women] will die from their tumors.[2]

A brain tumor is considered primary if the tumor begins in the brain. It is considered secondary or metastatic if it begins in another part of the body.[1] Primary tumors receive their names from the type of cells involved. Primary tumors include schwannomas, astrocytomas (gliomas), ependymomas, ependymoblastomas, medulloblastomas, meningiomas, neuroblastomas, oligodendrogliomas, and pineoblastomas.[1] Secondary brain tumors are far more common than primary brain tumors. Any cancer has the potential to spread to the brain, but the ones that are most prevalent are from the breast, colon, kidney, lung, skin (melanoma), nerve tissue, and connective tissue.[1]

The World Health Organization (WHO) has classified tumors by cells or tissues of origin and have divided them into nine categories: tumors of neuroepithelial origin, tumors of cranial and spinal nerves, tumors of the meninges, hematopoietic tumors, germ cell tumors, cysts and tumor like lesions, anterior pituitary tumors, local extension of regional tumors, and metastases. Neuroglial tumors or gliomas, comprise the largest group of primary Central Nervous System (CNS) neoplasms. They are classified as tumors of neuroepithelial origin and include astrocytomas, oligodendrogliomas, and ependymomas. Of this group, astrocytomas are the majority.[3]

Low-grade astrocytic tumors are usually slow growing and are not likely to spread. With surgery, grade 1 astrocytic tumors can be removed and when removed completely, they are not likely to come back. Grade 2 astrocytomas can be removed surgically but often return. High-grade astrocytic tumors are more likely to grow faster and spread to other parts of the brain. It is common for the tumor to come back after initial treatment.[4] Grade IV astrocytomas are also known as glioblastoma multiforme (GBM).[3] These types of CNS tumors grow quickly and are formed in the glial or supportive tissue of the brain and spinal cord. The frontal and temporal lobes are most commonly affected. There are no known risk factors for glioblastomas and the etiology is unknown.[4]

Glioblastomas make up about 20% of all primary brain tumors and about 50% of astrocytomas. They occur more commonly in older adults, and affect males more than females. These tumors can develop from lower-grade astrocytomas (WHO grade 2) or anaplastic astrocytomas (WHO grade 3). However, they are more likely to manifest without any evidence of a less malignant precursor lesion or "de novo."[4]

There is less than a 5%, 5-year survival rate for people with GBM. Those less than 40 years of age have an 18 month survival rate of 50%; those between the ages of 40-60 have an 18 month survival rate of 20%; and those older than 60 years have a survival rate of only 10%. Median survival duration is 8.4 months and only 10-15% live longer than 10 months. Presenting signs and symptoms of GBM include headache (30-50%), seizure (30-60%), focal neurologic deficits (40-60%), and mental status changes (20-40%). Most presenting symptoms are secondary to compression and infiltration of surrounding brain tissue, vascular compromise, and increased intracranial pressure.[4]

Melanomas are neoplasms of the skin originating from melanocytes. It most commonly affects the skin, oral cavity, esophagus, anal canal, vagina, meninges, or the eye. The incidence rate for melanoma is doubling every 10-20 years, and epidemiologists are considering it a melanoma epidemic. Melanoma accounts for 5% of all cancers (1 in 75 people), and in 2002, accounted for 53,600 new cases, leading to 7400 deaths. Melanoma has caused more deaths than any other skin disorder. It mainly affects adults 40-60 years of age, and females greater than males, however there is a greater mortality rate among men.[5]

Malignant melanoma can spread quickly and without cause, and can become life-threatening earlier on in their development. This makes it a more serious problem than other skin cancers. Studies have shown that there is an increased incidence of melanoma metastasizing to the brain. About 40-60% of people with melanoma end up with brain metastasis. The incidence begins to increase in those aged 45-64, but is highest in people over the age 65. Deeper lesions with more distant metastasis have a 5-year survival rate of 30%. However with metastasis to the brain, lungs, bones and CNS, survival rate is typically less than one year.[5]

Prognostic factors that are favorable for brain surgery include age less than 65 years, Karnofsky score greater than 70, a single tumor, tumor size greater than 3 cm, surgical accessibility, good tumor localization, and control of extra cranial disease.[6] For people undergoing surgery and radiation therapy for a single metastases, there are two major factors that have been shown to influence the likelihood of survival. The most important variable is the extent of the systemic disease, as the progression of the disease outside of the nervous system is the major cause of death. The other is the person's

neurological condition prior to craniotomy. The time between the date of diagnosis of the primary neoplasm and that of the brain metastasis has not been shown to have a statistically significant influence on survival post surgery. To make comparisons between various modes of therapy of metastatic brain tumors, the above factors must be taken into account, in addition to looking into other variables such as age, sex, and histological diagnosis.[7]

Over the past few decades, surgery has become important for the local control of brain metastases. In the past, Whole Brain Radiation Therapy (WBRT) was the "gold standard" in the treatment of intracranial metastases.[6] A study by Patchell and colleagues[8] randomized 48 participants who had single brain metastases to either a surgery and WBRT (25 patients) group, or to a group who only received WBRT(23 patients). The study was evaluating the local recurrence and survival rates among the two different groups. Outcomes from the study showed that the group that had the addition of surgery, demonstrated a reduction in the local recurrence from 52% to 20% (p, 0.02), and this led to an improvement in the median survival from 15 to 40 weeks (p =0.001). People in this group also demonstrated that they remained functionally independent for a longer period of time than those treated with WBRT alone (38 weeks compared with 8 weeks; p = 0.005). In conclusion, this study has demonstrated the importance in the addition of surgery to the treatment in people with single metastases. With the use of combined therapy over the past two decades, the overall prognosis of brain metastasis has improved.[6]

One study examined the common neurologic problems in adults with brain tumors admitted for inpatient rehabilitation at acute rehabilitation centers. The most common

deficits in this group included impaired cognition (80%), weakness (78%), visual-perceptual deficit (53%), sensory loss (38%), and bowel and bladder dysfunction (37%). Seventy five percent had three or more concurrent neurologic deficits, and 39.2% had five or more deficits. At the time of discharge, the average admission FIM score of 67.2 increased to 87.1. Similar gains were seen between individuals who had primary brain tumors and metastatic disease. This study supports the benefits of comprehensive and interdisciplinary rehabilitation for people with primary as well as metastatic brain tumors.[9]

Previous studies have looked into rehabilitation outcomes in people with brain tumors and acute stroke. The studies were designed to investigate functional outcomes after hospital rehabilitation of those surviving craniotomy for primary brain tumor excision compared with those post stroke. Results found that functional gains for individuals with glioma measured by increases in discharge FIM scores compared to admission FIM scores were 17.2 as compared to 21.8 for patients with a stroke. They also found that the average length of stay was 23 days for those with a glioma and 75.4 days for those with a stroke. With these results the authors were able to conclude that people with brain tumors are able to achieve good functional outcomes over a shorter length of stay.[10]

The incidence of brain tumors is increasing. This may be due to the advances in technology in detecting smaller tumors in the brain. The risk of developing cancer is also increasing with age. The number of metastatic brain tumors appears to be rising due to the fact that there are more effective treatments being found for primary cancers and people are now able to live longer who have cancer. As the incidence increases, physical

therapists in a variety of settings will be treating people with different forms of cancer. Therapists should be able to understand not only the rehabilitative techniques that will work to achieve a return to the person's functional baseline, but they need to also understand the signs and symptoms, prognosis, surgical outcomes and adjuvant therapies that also may be necessary for the treatment of certain cancers and the outcomes to be expected from their patients.

This case study will describe the clinical presentations and functional outcomes of two people; one with diagnoses of primary brain tumor from astrocytoma grade IV (GBM), the other with malignant melanoma stage III, with metastasis to the brain. These two particular people were chosen because they had tumors in similar areas of the brain, underwent similar surgical procedures to remove the tumors and underwent adjuvant treatment post surgery. However, the two individuals presented to physical therapy very differently. The question of why the two had different presentations post surgery was explored.

Case Description

The participants in this study were two males with different forms of brain tumors who were seen in physical therapy after craniotomy for tumor resection. From this point on the participant who had brain tumor secondary to melanoma metastasis will be referred to as participant A, whereas the participant who had a brain tumor secondary to GBM will be referred to as participant B. Human subjects approval was obtained through the Sage College's Institutional Review Board.

Participant A was a 44 year old male with Stage III melanoma who worked as a heavy machinery operator. He had a social history consisting of minimal alcohol use,

tobacco use for 20 years (2 packs per day) however had quit approximately 6 years ago, and denied any drug use. He had no immediate family history of malignancy. He underwent surgical biopsy of the left forearm in April 2008 which revealed melanoma. In May 2008, he underwent left axillary lymph node dissection and pathology tests indicated he had melanoma involving 1 of 15 resected lymph nodes. He then underwent radiation therapy to the left axilla in June 2008 and began adjuvant interferon therapy in September 2008. Interferon therapy was held at week 26 due to neuropathy and weight loss and restarted one month later with a 33% dose reduction.

He was admitted to the emergency department on June 16, 2009, with uncontrolled tremors in the right upper extremity, difficulty with fine motor skills, and short term memory lapses. He stated that he had an episode of his right arm tingling circumferentially while at work, and then saw his right arm move without his control and jerk while his hand curled together. This episode lasted about 10 minutes and then resolved without intervention however afterwards his hand "felt strange." He denied that any of these symptoms spread to his face or legs.

Initially symptoms that brought him to the emergency department were thought to have been from interferon therapy, as he has had neuropathy in the past, however symptoms of tonic seizure of the right arm, and clumsiness with activities of daily living were new. Computed Tomography (CT) findings upon admission showed two hyperdense masses in the left cerebral hemispheres. The first was a 2.7 x 2.8 cm mass in the left frontal lobe, with surrounding hypodensity consistent with edema. The second mass in the left parietal corticomedullary junction measured 1 x 1 cm with a small amount of surrounding edema and mass effect on the left occipital horn.

Neurological exam was remarkable for mild incoordination of the right hand and right pronator drift without sensory abnormalities. His history was very concerning for focal sensori-motor seizures. The Karnofsky performance test was performed and he received a score of 90 meaning he was able to carry on normal activities with minor signs and symptoms of disease. The neurological team felt symptoms were secondary to edema and mass effect from his cerebral masses. Given his history of melanoma, metastatic disease was the most likely etiology. He was placed on dexamethasone and underwent surgical removal of the larger tumor on June 16, 2009. Plan was for three sessions of gamma knife radiation therapy in an outpatient setting, to treat the remaining tumors not removed through surgery.

Participant B was a 46 year old with no significant past medical history except for 5 surgeries to the right shoulder. His father had a history of hypertension, and his mother died from a left frontal lobe astrocytic tumor. He has a brother and a sister who have hypertension, and has three children who are all healthy. He does not use tobacco or alcohol.

He was self referred, secondary to neurological problems that began on April 6, 2009. While at work, he reported passing out for approximately 3 minutes after standing up. Upon waking he reported his right hand was numb and felt "funny." Symptoms disappeared the following day without intervention. On May 6, 2009 he experienced another episode during work in which his right hand and leg became numb, but the sensation went away after five minutes. On May 7, 2009 while at work he became diaphoretic, dizzy, and could not use his right hand. The participant had an MRI which revealed an enhancing mass in the left frontal gyrus near the right arm homunculus with

surrounding edema. He was self admitted after another incidence of right hand numbness and was placed on Keppra. He had a stereotactic biopsy which showed a 2 cm malignant glioma in the left parietal lobe, with findings suggestive of GBM. The participant at this time was evaluated using the Karnofsky Performance Scale where he received a score of 100. The participant had gross total surgical resection of left parietal tumor on June 17, 2009. This confirmed that he had a glioblastoma with necrosis and microvascular proliferation. The plan was for field radiation therapy with concurrent and adjuvant temozolomide chemotherapy once he was home and recovered from surgery.

Outcome Measures

Clinicians and researchers use the Functional Independence Measure (FIM) instrument to monitor the recovery of functional ability by people undergoing rehabilitation. The FIM assessment includes 18 activities of self-care, sphincter control, transferring, locomotion, communication, social interaction, and cognition. To rate the FIM assessment, members of an interdisciplinary team observe someone performing 18 activities and rate his or her ability to perform each activity based on a seven-point ordinal scale (1= totally unable, 7= totally independent). The difference between the sum of the 18 ratings (range= 18-126) and the maximum possible FIM rating (126) provides a gauge of the amount of assistance required. FIM has been found both a valid and reliable tool to use with people with brain tumors both pre and post surgery. ICC values for the total FIM was .97 while ICC values for FIM subscales ranged from .85 to .98, except for social cognition. Kappa scores for noncognitive items ranged from .49 (bowel movement) to .93 (grooming).[11]

The Karnofsky Performance Scale Index (KPS) is another outcome measure commonly used with people with brain tumors. It is used to classify people according to their functional impairments. This can be helpful in comparing effectiveness of different therapies and to assess the prognosis in individual people. Individuals are graded from 0-100 based on their ability to carry out normal activities without the need for special care. As the KPS score decreases so too does the survival of the patient. It has been shown that people with a KPS greater than 70 have an 18-month survival rate of 34%, while those with a KPS of less than 70 have an 18-month survival rate of 13%.[12,13]

Other outcome measures that can be used with this population include sensation, pain, range of motion, strength, balance, functional activities and gait. Pain was measured using the Visual Analog Scale (VAS). This is an instrument that tries to measure a characteristic or attitude, across a continuum of values, that cannot easily be directly measured. The VAS is typically a horizontal line, that is 100 mm in length, and contains words such as no pain at one end of the line and very severe pain at the other end. The participant places a mark on the line that they feel represents their perception of their current state of pain. The VAS score is determined by measuring in mm from the lefthand end of the line to the point that the participant marks. This is a highly subjective type of assessment, and is of most value when looking to see the change within individuals. These assessments are not as good for comparing across a group of individuals at one time.[14] There are currently no studies focusing on validity and reliability of the VAS.

Sensation was tested using a gross dermatome screen. This was done by having the participant close his eyes, and using the tip of a pen, asking him to identify me where on the body he was being touched. All of the dermatomes on the upper and lower

extremities were touched bilaterally at least twice throughout the test. Speed and dermatomes were varied throughout the test to make it more difficult to guess. The number of incorrect tries was counted and specific dermatomes were further tested if the participant was having difficulty. There are currently no studies looking into the validity and reliability of light touch sensation alone.

Strength was measured grossly on all upper and lower extremity myotomes using manual muscle testing. The participant was sitting at the edge of the bed in a posture appropriate for gross muscle testing so that the muscle works against gravity. A screening test was performed by asking the participant to move the body part through the full available range of motion. Strength is graded based on the use of palpation or through the observation of a muscle contraction. It is progressed through grades based on the participants ability to move their limb through the available range of motion either in a gravity eliminated position or against gravity. If the limb could be moved to full range of motion against gravity, the examiner would then perform a break test according to the procedures by Daniels and Worthingham.[15] While the manual muscle test is the most widely used method to assess muscle function, its reliability and accuracy are questionable. It is suggested that the same examiner should perform manual muscle tests on each subject or across multiple subjects. While not entirely accurate, manual muscle testing scores do correlate well with results from handheld dynamometers, implying that both are valid measures of muscle strength.[16-18]

Sitting balance was measured using some simple tasks, with or without the use of the participant's upper extremities for support, while sitting on the edge of the bed. If this could be done for 30 seconds, minimal to maximum perturbations were given. Standing

balance was tested first by having the participant stand for 30 seconds with eyes open and feet shoulder width apart. This was then progressed to feet together for 30 seconds eyes open, feet together with eyes closed, and then tandem stance with eyes open and eyes closed. Balance strategies were observed and perturbations were added to the sternum if the participant was able to maintain the position. There are currently no studies looking into the reliability and validity of these tests alone. However these tests are found along with other tests in many functional balance tests such as the Berg Balance Scale and the Tinetti Performance Oriented Mobility Assessment.[19]

Functional activities, including bed mobility, sit to stand transfers, ambulation and the ability to ascend and descend a flight of stairs were measured through observation and amount of physical assistance was documented. Independent was defined as requiring zero assistance, supervision as requiring someone close by, contact guard as having hands on for support or tactile cues, minimal assist as requiring 25 % assistance, moderate assistance as requiring 50% assistance, maximal assist as requiring 75% assistance, and total assist as requiring 100% assistance and the participant was unable to help. There are currently no studies looking into the reliability and validity of these measures of assistance.

Surgeries

Both participants underwent craniotomies to remove larger tumors in the left parietal region. Participant A was in surgery for one hour and fifty minutes, while Participant B was in surgery for one hour and thirty minutes. MRI reports showed that participant A had multiple tumors that were more extensive and overlapping multiple lobes, where as participant B had a tumor that was more focal and superficial. Participant

A not only had a more extensive tumor necessitating deeper resection under the central sulcus, he also had two other smaller tumors. Only the larger tumor was removed, and two smaller tumors were still present.

Evaluation

The nature of impairments in both participants is complex due to the tumor itself, the systemic effects of cancer, the treatments used to combat the tumor, and the side effects of corticosteroids to treat cerebral edema. Metastatic tumor growth in the brain depends on complex organotropic factors, as well as passive vascular delivery of tumor cells. Slightly more than 50% of the time, metastases are multiple, and are not solitary. Primary melanoma, as well as primary lung and breast tumors, are more likely to produce multiple metastases. The prognosis for people with GBM or 3 or more brain metastases is equally poor and these people typically have poor outcomes. It is important that therapeutic considerations be individualized. A person's neurologic status, the extent of the systemic tumor, the number and location of brain metastases, and how sensitive the tumor is to radiation and chemotherapy are all relevant factors that must be looked into for a prognosis to be made. Even those with the best prognostic factors will often die within 18-24 months. Of relevance to prognosis is the fact that those who are found to have a solitary brain metastasis on imaging, and who undergo treatment by surgical resection, have a chance of survival for greater than 1 year that is doubled. For these reasons, along with his prolonged time in surgery due to multiple and more extensive tumors, it was expected that participant A will have more impairments after surgery compared to participant B.[6, 7]

The frontal lobe of each hemisphere controls the initiation of voluntary movement, usually on the opposite side of the body. It is also the dominant hemisphere where language and writing are controlled. Intellectual functioning, thought processes, goal orientated behavior, judgment, interpretation of emotion and memories are other activities controlled by the frontal lobes. Tumors in this lobe can cause a variety of symptoms including hemiparesis, seizures, short-term memory loss, impaired judgment and personality or mental status changes. Lesions in this area can also cause Broca's aphasia, impaired production of nonverbal communication. It is also very common to see gait disturbances and communication difficulties. With tumors located towards the base of the frontal lobe, it is common to see loss of smell and impaired vision.[20, 21]

Sensations including pain, temperature, touch, pressure, size, shape, and proprioception are all received and interpreted by the parietal lobe. It processes sensations and provides perception relation to body schema. Some other activities include hearing, reasoning, and memory. Tumors located in this lobe can result in spatial disorders such as difficulty with body orientation in space or recognition of body parts. Contralateral somatosensory loss, hemiplegia, homonymous hemianopia, agnosia, astereognosis, and apraxia can also occur with lesions in this area. Language disturbances, loss of the ability to read, and the ability to do arithmetic/calculations can also be altered. [20, 21]

Both Participant A and B had tumors in the left frontal and parietal lobes that were removed during surgery. It is expected that both participants would display the impairments and functional limitations which correspond to the location of their tumor as discussed previously. The most pertinent of symptoms that relate to physical therapy

would be the right sided hemiparesis, inability to initiate movements, difficulty with proprioception, and gait disturbances.

Typically with complete resection of brain tumors, individuals are relieved of their symptoms and once intracranial pressure is reduced, all signs and symptoms are eliminated. If no adverse outcomes occur, these participants can be discharged from the hospital within a few days. Gamma Knife Radiosurgery has been shown to be very effective and shrinking and dissolving tumors that are otherwise inoperable by traditional standards. Some of the main benefits from this type of surgery are that there is little to no pain, no blood loss, there is no physical trauma to the body or incision site which leads to a decrease risk of infection. The procedure also requires less than a 24 hour hospital stay for most participants, and is less costly than traditional surgeries. Additionally, the radiation exposure is both brief and targeted to only the lesion.[22]

Outcomes Following Surgery

Participant A was seen in physical therapy 2 days following the surgical resection. He was alert and orientated to person, place, and time. He was able to answer all history questions and was easily able to follow simple commands during the physical therapy evaluation. He reported minor pain from the surgical site (3/10 VAS). Range of motion examination was within normal limits throughout upper and lower extremities bilaterally. Strength tests demonstrated gross weakness in the right upper extremity (4/5 on manual muscle break test), as well as the right lower extremities (3+/5 at the hip and knee and 4/5 dorsiflexion). Motor control tests revealed impaired coordination of right upper extremity movements. He had difficulty controlling the arm while lifting it over his head. At one point, he even hit himself in the head during the test. He also demonstrated

dysmetria with finger to therapist's finger test, as well as dysdiodocokinesia during rapid alternating pronation and supination with the right upper extremity.

He was able to sit without loss of balance at the edge of the bed without upper extremity support and was able to remain balanced for at least one minute with minimum perturbations to the sternum. He was able to transfer from sit to stand with minimal assistance and required minimal assistance to remain standing for one minute. He was unable to maintain Rhomberg stance or one legged stance.

The participant required use of a rolling walker and maximum assistance of two therapists to walk forty feet with a step to gait pattern. One therapist assisted at the pelvis with use of a gait belt and assisted with placement of participant's right upper extremity on the assistive device. The other therapist performed maximum assistance to the right lower extremity to facilitate gait mechanics and to prevent the right knee from "buckling." He was unable to sense what he was doing and felt he did not have the strength to perform the activity. It took 15 minutes to complete ambulation and he was feeling very fatigued after therapy. It was assessed that he was well below his functional status at baseline and would require acute rehabilitation once medically stable and discharged from hospital.

Participant B was seen by physical therapy post op day 2 from surgical resection of GBM. He received a KPS score of 70 initially post op, which increased to 90 during neurology follow up. Post operative course was unremarkable per neurology notes. He was alert and orientated to person place and time, and able to follow multi-step commands appropriately. He did not report any pain at that time secondary to pain medications.

Range of motion exam was within normal limits throughout upper and lower extremities bilaterally. Strength was within normal limits throughout except for bilateral shoulder flexors (4+/5) and bilateral hip flexors (4+/5). He was able to move all extremities in isolation with no signs of dystonia, dysmetria or incoordination during motor control exam.

Participant B was able to sit at edge of bed for one minute without perturbations with supervision. He was able to stand with feet together with eyes open and closed for 20 seconds, and demonstrated ankle and hip strategy response to mild-moderate perturbations. He was able to perform all functional activities including bed mobility, sit to stand transfers, and dressing and feeding independently and was able to ambulate 400 feet without assistive device with normal pace and gait pattern independently. He was also able to ascend and descend a flight of stairs with step over step pattern without use of railing. He had no further acute physical therapy needs and was to be discharged to home once medically stable.

Discussion

Functional outcomes following craniotomy for these two case studies are with this author's expectations. Even though both diagnoses have shown to have poor outcomes, and that GBM in the research is one of the more devastating diagnoses of brain tumors; size, location, and number of tumors was a much greater indicator of function post surgery, than looking into diagnoses alone.

When surgical techniques are required, favorable prognostic factors for brain surgery include; age less than 65 years, Karnofsky score greater than 70, a single tumor, tumor size greater than 3 cm, surgical accessibility, good tumor localization, and control

of extra cranial disease.[6] These factors correlate well with the outcomes of the participant with GBM and his improved outcomes following surgery as compared to participant with malignant melanoma.

It is also shown that metastatic brain tumors to the brain tend to be more diffuse and deeper than other brain tumors requiring more extensive surgical techniques to remove the tumors, and leaving the person with more functional impairments post surgery.[23] The participant with malignant melanoma required a deeper resection into the brain to remove the larger of the tumors; however multiple smaller tumors were left untouched, as they were spread into multiple lobes and were too small for surgical techniques. This meant that this participant had remaining tumors that were causing neurological impairments which were going to require radiation therapy to remove. The participant with malignant melanoma was less than 65 years of age however, did not meet the positive surgical outcome criteria with multiple tumors that were not accessible for surgery, along with having melanoma that was not under control.

The devastating truth about both of these types of cancers is however, that recurrence rates are high, and the prognosis is poor. Even though both participants were able to successfully remove the larger tumors through surgery, and with follow up radiation, remove all the tumors, survival rates are very low for these populations. Those with GBM between the ages of 40-60 have an 18 month survival rate of 20%. Median survival duration is 8.4 months and only 10-15% live longer than 10 months.[4] People with malignant melanoma who have deeper lesions with more distant metastasis, 5 year survival rate is 30%. However with metastasis to the brain, lungs, bones and CNS,

survival rate is typically less than one year.[5] These statistics go to show that, the outcomes between these 2 participants may not be so different in the long term.

The outcomes following surgery correlated well with what the author had anticipated with participant A, however not with participant B. Participant A demonstrated right sided weakness, trouble initiating movments, gait disturbances, and issues with proprioception which were as expected because of the location of his tumors. Participant B did not show as much of the functional limitations that would have been expected from the location of his tumor which the author feels had more to do with the fact that he had positive prognostic factors following surgery such has age less than 65, single lesion that is easily located and removed with surgery.

One limitation to this study was the physical therapy setting these participants were seen and treated in. The author would have liked to been able to perform this case study in the rehab setting where more long term results could be obtained. Participant A was discharged to a sub-acute rehab setting where he was receiving 3 hours of rehabilitation per day. This is the setting that where you will expect to see the biggest improvements in function with this participant.

Daily improvements in strength, balance, motor control, gait, and cognitive status can be seen as the person is more medically stable and motor learning is achieved through repetition of activities. This participant should be able to make gains and reach his functional baseline as long as the surgical techniques to eliminate the tumors were successful. However through the research that has been conducted, the recurrence rate for this type of tumor and the fact that it has already metastasized, gives this participant a poor prognosis as described earlier in this paper.

Limitations also include the lack of reliability and validity of the outcome measures used. In the setting that this case study was performed, time is a limiting factor. There are outcome measures that could have been used had time not been a factor, that have good reliability and validity. The tests used in this setting are more used as quick screens to determine function, and are less likely to have validity and reliability studies done on them alone.

First and foremost, research has shown the Karnofsky Performance Scale Index (KPS) is a great outcome measure commonly used with people with brain tumors. Its ability to classify people according to their functional impairments can be very helpful in comparing effectiveness of different therapies and to assess the prognosis in individual people. In a more long term setting, where more aggressive physical therapy could be given, measurements of more functional gains in the individual with malignant melanoma could have been obtained, and improvements could have been documented. Due to time constraints in the inpatient setting, this outcome measure was not used on both participants.

For sensory testing had time not been an issue, a more thorough investigation of which type of sensation was diminished would have been beneficial. This could have been done with testing the degree of loss with the use of Semmes Weinstein Monofilaments, perceptions of hot/cold touch, pain, light vs. deep touch, stereognosis, proprioception, and kinesthetic sense. With the use of these tests, there can be a better understanding of the neurological deficits that are occurring, and interventions can be taken to improve these deficits or safety issues can be addressed.

Outcomes measures that are focused on balance and coordination would also have been very beneficial for this participant population. Such measures as the Berg Balance Scale, The Functional Reach Test, the CTSIB, Tinnetti, or the timed up and go, can be used to identify those with balance deficits and who are at risk for falls. The participant with malignant melanoma would have benefitted from the tasks involved in these tests, as they represent common activities of daily living, and repetition of these tasks could have shown improvements in this participants function in the long run.

While the incidence of cancer is increasing and current medical care is allowing those with cancer to live longer, it is crucial that more research on best physical therapy practice for this population be researched. Long term care facilities such as acute and sub-acute rehabilitation facilities should do further research on interventions, commonly used outcome measures, and case by case progress with therapy so that this group can be treated with the proper and best care available. It is also important for physical therapists to be aware of the different types of cancers, signs and symptoms most commonly seen with cancer, and interventions and patient care that can be utilized to better the prognosis of their client's lives. Lastly, expected outcomes following diagnosis of cancer or post surgery should not be based on diagnosis alone, as this paper shows there are a multitude of factors that correlate with positive and negative outcomes with cancer and surgery.

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