A nearly full-recovery from AVM hemorrhagic stroke 17 years after insult using a new integrated neurodevelopmental approach

A case report

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Abstract

Rational: With the prevalence of stroke increasing in the USA and the world along with increased survival and longevity due to medical advancements, it has become increasingly necessary to look at the chronic phase of stroke recovery. Previous paradigms of stroke treatment have proven ineffective when looking at 10, 15, or 20 years of survival post insult.

Patient Concerns: The patient, being a young man just out of high school, was concerned with his overall morbidity. He was highly concerned with the quality of life he could expect as a stroke survivor with a life expectancy of 60 years or more.

Diagnoses: C was diagnosed with a hemorrhagic AVM stroke that impacted several regions of the brain, particularly the right occipital and temporal lobes as well as bilateral motor control. C experienced severe hypertonicity of the musculature and significant vertigo.

Interventions: This study investigated a novel approach to chronic-phase stroke rehabilitation using traditional child motor-learning techniques, play, and proprioceptive-building activities in addition to current stroke rehabilitation techniques. During an initial six-month period, followed by a three-year period, the participant used motor-developmental learning activities as well as traditional strength, gait, and balance training. During the initial phase of treatment, clinically-significant improvements were recorded along with self-reported lifestyle enhancements. These gains continued throughout the three-and-a-half year process.

Outcomes: C regained the ability to free-walk in small bouts and went from the use of a walker to canes. He regained use of his hands and removed a large portion of his vertigo. Of specific interest was the participant’s ability to progress from using a walker to driving, returning to school, and starting a family.

Lessons: This study lays the groundwork for future studies into this type of therapeutic approach as well as highlighting the ability of chronic-phase stroke patients to recover well into the second decade post stroke. After the initial six month period, as gains were being observed, a more formal measurement process was begun for a second six-month period. Initial measurements of progress were taken every six weeks using the Fugl-Meyer test, the Berg Balance Test, the Barthel Index, and the Stroke Specific Quality Of Life scale. Results showed clinically significant improvements in all areas of recovery.

Abbreviations: 
ACSM = American College of Sport Medicine, FMA = Fugl-Meyer Assessment, IRB = Institutional Review Board, SSQOLS = Stroke Specific Quality of Life Scale.  

Keywords: balance, chronic, neurodevelopmental, proprioception, rehabilitation, stroke

1. Introduction

Stroke, in all forms, is currently the primary cause of disability among American citizens, and the third leading cause of death.[1-4] Stroke is also one of the major causes of both morbidity and mortality in the United States and can lead to motor disabilities ranging from mild to severe.[1] The Northern Manhattan Study suggested that, “considering the staggering prevalence of stroke, the burden of post-stroke disability is of primary public health importance.”[5]

Each year 780,000 people suffer a new or recurrent stroke.[6] Of these, 2 out of 3 will survive, and more than half will endure long-term disabilities. In 2009, an estimated 5.8 million Americans were living with disabilities caused by stroke. Not only is stroke a leading cause of disability in our country, the incidence of stroke increases approximately 1.75% per year.[7] Research also indicates advances in medical science results in an annually increasing survival rate among stroke patients. Such an increase of survivorship creates a higher cost to society due to lost employment as well as a greater demand on rehabilitation centers, families, and other caregivers.[8]

With medical costs ever increasing, the ability to rehabilitate chronic-phase stroke patients without physical therapists and a medical facility could have far-reaching implications. Stroke survivors could potentially work with certified trainers and health specialists to increase their independence and quality of life without the need for expensive equipment and medical personnel.
2. History

In 1990, C was an average 16-year-old Midwest high school student. He ran track, played a little basketball, and was trying to figure out what he wanted to do when he graduated. On a cool autumn day he went to the school nurse during lunchtime to complain of a persistent headache. She found nothing wrong and C decided to “rough it out” until school ended.

When he got home from school, C was met by his mother. He told her he was not feeling well and was going to lie down. He made it halfway down the hall before collapsing.

Three months later he awoke in the Saint Louis, MO Children’s Hospital having undergone brain surgery to repair the damage caused by a hemorrhagic stroke brought on by an arteriovenous malformation. C received damage to the right occipital lobe, the left occipital lobe, the right temporal lobe, and slight damage to the right frontal lobe. He could not feed himself, sit up in bed, and had reverted to infantile reflex actions which, much to the nursing staff’s discomfort, included trying to suckle whenever a female nurse attended him.

After intensive physical and occupational therapy, C was able to return home. He had lost most of his muscle mass, could not self-transfer, could ambulate for short distances using a walker and a personal aid, and could eat with the aid of assistive devices. It was informed this was the best outcome he would achieve and further treatment was pointless.

Eight years later, after travelling to several clinics for treatment and therapy, including an experimental program in Prague, C could walk using the walker, speak, eat, and take care of some limited personal hygiene. He was still unable to stand unassisted, rise from the floor, and had significant vertigo and fear of heights. Several therapists and doctors told him he would never progress beyond the level of recovery achieved at that point. He was engaged to be married but was unable to work and his fiancée acted as a caregiver.

Upon examination, C showed strong ocular dependencies, ongoing muscle spasms throughout his lower extremities, unending muscular tone in his left leg, hip, and lower back. This often resulted in significant spasm and cramping. He would routinely freeze in movement, especially when trying to walk, as antagonistic muscle groups fought for control. He could remain thus frozen for minutes. C was unable to stand, even with assistance, if an object or person moved across his field of vision. As a result, he was afraid of falling and rarely stood.

Despite these limitations, C introduced himself to me with the statement, “I want to run a 6-minute mile again and dunk!” I suggested we start by developing free-standing.

3. Methods

All treatment methods were reviewed and approved by the University of Missouri, St. Louis, College of Education Institutional Review Board; the University of Missouri, St. Louis University Institutional Review Board; and the Belleville Community Institutional Review Board (used by St. Elizabeth’s Hospital and Memorial Hospital). An informed consent was completed by C and was reviewed by all IRBs, along with a medical release form and a physician’s release form.

I began treating C with a combination of standard resistance training, as prescribed by the American College of Sport Medicine, balance exercises, and a new treatment using neurodevelopmental activities that parallel those used with developing children. The concept was simple: do not treat C as someone with a damaged brain, rather treat him as a child with a developing brain. I informed C this was a novel approach and he decided it was worth trying as other therapies were showing no progress. At the time his only other option was having selected nerves severed to relieve muscle tone and spasm, a process he did not approve.

Using child-play activities, we performed patty-cake, did reaching games similar to Head-Shoulders-Knees-and-Toes, and a variety of proprioceptive balance games designed to cause cross-hemisphere integration.

I worked with C 3 times per week for 1-hour sessions. The sessions took place at a local fitness center as well as a hospital rehabilitation center.

Exercise sessions began with a cardiovascular warm up using a NuStep exercise machine. The NuStep integrates contralateral movements of the arms and legs to provide active and passive cross integration of all major muscle groups. The warmup was followed by floor exercises, including passive and active stretching, especially stretching of agonist and antagonist muscle sets. Cross crawling in a supine position was used to begin muscular regeneration while adding cross-neural communication through the midline.

Sitting exercises were done in either an armless chair, or on a stool with no support on any side. C was constantly reminded to keep his posture straight and to keep his gaze focused ahead in an attempt to limit visual dependency. Once C was able to sit without sway, I began lightly pushing C forward, back, and to either side, causing a need to regain posture and stabilize. This progressed to movement while seated, beginning with body-weight and slowly adding either free weights or resistance bands.

The next progression was tossing or bouncing a 55cm Swiss ball to C, causing him to reach out, catch, stabilize, and then throw the ball back. He had the most difficulty moving his arms up and to his left, so extra emphasis was added to left-side exercises.

At this level, Swiss stability ball exercises were added. The stability ball exercises were identical in progression to the seated exercises, with the exception of adding an intentional fall and recovery from the ball. As C still experienced a severe fear of falling, the Swiss Ball was surrounded with gymnastics mats until there was a 6-in or less distance from the ball to the top mat. C was then encouraged to intentionally slide off the ball onto the mats.

I helped him at first and this progressed to him falling on his own. After a week of purposeful, controlled falling he was no longer afraid of falling and some of his muscle spasm ceased.

When C was relatively stable on the ball, he progressed to exercises where he was standing by a wall or leaning on a wall or other support structure. C used the wall for balance and visual support while performing various actions of balance and coordination. These included lifting 1 foot off the ground, dorsiflexion and plantarflexion, knee raises, squats, and leg raises.

Standing exercises progressed in a similar fashion to the seated and stability ball exercises with special attention paid to removal of postural sway. I acted as a stabilizer at first, allowing C to hold my arms or shoulders. Once able to stand with aid, he progressed to standing with only 1 hand holding on, and then, free standing.

Once free standing was achieved, we progressed to standing patty-cake-type games. Since C had such strong ocular dependency, I began to move around him while he was free standing, forcing him to remain focused and not allow his brain to be distracted by the movement.

Ambulation progressed in similar lines to that used for standing balance. Focus was paid to upright posture, lack of sway, heel-to-toe stepping, standard gait patterns, and looking
4. Measures

Fortunately, there are a number of assessment tools to track the progress of individuals undergoing stroke rehabilitation. Through use of these tests researchers and clinicians can determine, not only the efficacy of the treatment, but also the effectiveness of the treatment upon a stroke victim’s overall quality of life. This study used the following:

The Fugl-Meyer Assessment (FMA) is a stroke-specific, performance-based assessment. It is designed to assess motor function, balance, sensation, and joint function in stroke patients with hemiplegia. It is widely considered one of the most accurate measures of clinical and research settings to measure independence among stroke survivors.

The Berg Balance Test is a 14-item test designed to measure balance among patients with impaired balance function. The test assesses a variety of activities of daily living by assessing the performance of functional tasks. It is widely used to assess the effectiveness of interventions. An increased change of 8 points is considered a significant change in function. Increases in daily function correlate with increases in self-reliance and quality of life.

The Barthel Index uses 10 weighted items to measure independence and activities of daily living, such as feeding, bathing, grooming, dressing, and bowel control. The Barthel Index has been extensively studied and is widely used in a variety of clinical and research settings to measure independence among those suffering from stroke and other neurological issues. It is widely used in stroke research to assess an intervention’s improvement in overall quality of life among stroke survivors. An increase of 1.85 points in an area is considered clinically significant.

The Stroke Specific Quality of Life Scale (SSQOLS) specifically measures the quality of life of those who have suffered a stroke. The test has been repeatedly validated and found to be reliable, and is used in research and clinical settings. It is recognized by the American Stroke Association as a valuable assessment tool. The SSQOLS defines and measures quality of life across a spectrum of 12 areas, including energy, language, mood, mobility, self-care, thinking, and productivity. An increase of 1.2 points per area is considered clinically significant.

5. Results

Two pre-intervention measurements were taken 6 weeks before beginning the formalized intervention and immediately before this intervention. It should be noted that gains had already been anecdotally observed before formal measurements were taken. Measures of all tests were then taken every 6 weeks including a post-intervention measurement 6 weeks after that.

No formal measurements were taken during the remaining 3 years. All measurements were taken by a fully licensed, trained, and experienced physical therapist. By the end of the 6 months, C showed clinical improvements, as defined by each test, in all 4 of the tests. Results can be seen in Table 1.

In the first 2 months, as his strength and confidence improved, C went from using a walker to using 2 canes. He was able to navigate small areas without assistance, and his increased strength allowed him to stand from a sitting position without aid. He was able to self-feed, self-groom, and handle all ordinary daily tasks of living.

By the end of the third month, C was no longer afraid of falling and was able to navigate his small house without his fiancé’s aid. His outlook improved and he was able to play in the backyard with his dog. At week 14, he reported walking alone across the street to his parent’s house.

At the end of 6 months, C was able to walk down the aisle at his wedding. He was able to dance 1 dance with his bride and 1 with his mother.

I continued working with C for 3 years before relocating to a new area. At the end of 3 years C was able to walk unassisted for short periods and get up from the floor unassisted. He was able to pass a driving exam and returned to school. He has since completed his master’s degree and is gainfully employed. His wife had a daughter, and he can get on the floor and play with his child as well as help with childcare.

When interviewed about his experiences, C responded that the results were “amazing. I was able to go back to school. I can drive again and take care of myself. It’s been life changing. You know, my parents or my wife don’t have to take care of me. (Wife) can do her own things and not worry about me. I can take care of (children) and it’s good. I got my Master’s degree. I’m working. I never thought I would be able to live like this.”

6. Discussion

This case study was unique in its approach to treatment as well as working with someone so far past initial stroke insult. However, it shows clearly that improvement in movement, outlook, quality of life, and self-sufficiency can be made long after initial stroke impact. The process holds potential insight into how the brain reconnects or develops post-damage nerve lines. The protocol used is one that could be easily adapted for widespread use.

There are significant limitations to this case in terms of reproduction. It was only 1 person and one who suffered insult at a young age; there was an 8-year gap between initial therapy and the new protocol; and the treatment required a significant amount of time. However, despite these limitations the dramatic results are worthy of future investigation. At the time of this article, a pilot study is occurring with a larger group of individuals with varying degrees of insult and varying degrees of chronic-phase recovery ranging from 4 to 15 years post stroke.

Table 1

| Measure          | Pre-test 1 | Pre-test 2 | Test 3 | Test 4 | Test 5 | Post test | Clinical sig. | Report sig. |
|------------------|------------|------------|--------|--------|--------|-----------|----------------|-------------|
| Fugl-Meyer       | 90         | 90         | 110    | 112    | 115    | 116       | NA             | Yes         |
| Berg Balance     | 22         | 24         | 39     | 39     | 42     | 44        | Yes            | Yes         |
| Barthel Index    | 68         | 68         | 78     | 80     | 85     | 95        | Yes            | Yes         |
| SSQOLS Scale     | 190        | 192        | 202    | 203    | 204    | 208       | Yes            | Yes         |

SSQOLS = Stroke Specific Quality of Life.
In 3 years, C went from someone who needed 24-hour care and help in all aspects of daily living to a full-time employee, husband, father, and productive member of society.

6.1. Clinical significance

As C showed clinically significant changes in all areas of performance and lifestyle, these results show a potential to treat chronic-phase stroke patients in nonclinical settings using standard equipment. Any personal trainer certified by the American College of Sport Medicine, or another organization using ACSM guidelines, would have the background to then learn these techniques. There is a current study investigating this very concept.

In addition, license therapists and clinicians could easily adapt their programs to this new paradigm and continue to treat chronic-phase stroke patients or help those patients learn to enhance their own exercise programs.

The ability to take long-term care out of expensive medical facilities and into nonclinical setting with well-trained exercise specialists should be further investigated. In addition, the cost savings to society as a whole, as well as health insurance companies, could provide the fiscal foundation to ensure ongoing exercise programs and life improvements for this rapidly growing population.

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