Fall 2019

# Rehabilitation Following a Total Joint Replacement in a Patient with Drug-Induced Parkinsonism and Schizoaffective Disorder: A Complex Case

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## Abstract

**Background:** Rehabilitation research frequently focuses on single pathologies. However, it is relatively common for people to experience more than one impairment (i.e. orthopedic and neurological) that impacts physical therapy treatment. **Case Description:** A 72-year-old male presented to physical therapy 5 days after receiving a reverse total shoulder arthroplasty (RTSA). He also had a diagnosis of schizoaffective disorder and demonstrated several parkinsonian characteristics as side effects of antipsychotic medication including shuffling of gait, festinating, and poor movement initiation. **Intervention:** Following a thorough evaluation, we decided to treat the patient for both shoulder rehabilitation and movement related dysfunction. Shoulder rehabilitation followed his surgeon's prescribed protocol and movement dysfunctions were treated with interventions appropriate for Parkinson's Disease (PD). **Outcome Measures:** The patient was assessed using the Timed Up and Go (TUG), Tinetti Performance Oriented Mobility Assessment (POMA), Dynamic Gait Index (DGI), Berg Balance Assessment (BBA), 4 Square Step Test (4SST), and 6 Minute Walk Test (6MWT). **Discussion:** The patient progressed through Stage 1 and part of Stage 2 of his protocol, demonstrating significant improvements in passive range of motion during his plan of care. Impairments in coordination and movement amplitude remained, however. The PD intervention approach led to notable improvement in the POMA and 6MWT and near-clinically significant improvement was achieved in the BBS and the TUG. The patient's gait endurance improved drastically, walking 230% further than at baseline without any safety concerns. This case report suggests that an individual with movement dysfunction can successfully rehabilitate both a common orthopedic procedure and objectively improve balance, gait, and coordination in the presence of other cognitive deficits. Furthermore, it supports the use of PD rehabilitation interventions to treat drug-induced parkinsonism.

**Keywords:** Physical Therapy; rehabilitation; reverse total shoulder arthroplasty, drug-induced parkinsonism, schizoaffective disorder, orthopedics, neurology

## Introduction

A significant amount of the available literature for rehabilitation of various diseases and dysfunctions are focused on people with a single diagnosis. However, many people are plagued with multiple diagnoses. This complicates the treatment approach for providers who aim to make evidence-based clinical decisions to provide these individuals optimal care. Though exact incidence is unknown, it is relatively common for individuals to have concurrent orthopedic and neurological impairments. Such as is the case in this report, it would not be completely unusual for someone to present with a reverse total shoulder arthroplasty (RTSA) in the presence of drug-induced parkinsonism (DIP).

RTSA is an increasingly common procedure to treat derangement of the shoulder joint, particularly in cases with irreparable rotator cuff damage. Despite its increasing popularity, there is little consensus on best practices for rehabilitation other than that physical therapy is beneficial in optimizing patient outcomes[1]. There is also evidence suggesting that physical therapy can improve subjective and objective measures of function in mid-to-long term periods following surgery[2]. Protection of the surgical repair and gradual increases of range of motion (ROM) and strength are typical goals for RTSA rehabilitation, but how this is accomplished varies and has little consensus among rehabilitation professionals[1-4]. There is no available literature on the efficacy of physical therapy interventions on individuals with drug induced parkinsonism.

No substantive body of literature has explored the rehabilitation of combined orthopedic and neurologic conditions. Due to the plethora of combinations of orthopedic and neurologic conditions one may have, we may be forced to settle for case report or small sample size studies to assess the effectiveness of various rehabilitation interventions. This case report will highlight the challenges of concurrently rehabilitating a RTSA and DIP in a multi-disciplinary setting with a patient with schizophrenia, highlighting the complexities of rehabilitation when both orthopedic and neurological conditions are present.

## Case Description

Mr. G was a 72-year-old male with a history of schizoaffective disorder who was evaluated for physical therapy approximately 8 months following a fall in which he suffered a right proximal humerus fracture/dislocation. He was initially treated nonoperatively due to the presence of psychosis but developed a fracture malunion with heterotopic bone ossification. Despite physical therapy interventions, he still experienced significant pain and dysfunction. With his psychosis better managed with medication, he received a reverse total shoulder arthroplasty 5 days before he was evaluated by physical therapy for both post-operative shoulder care and balance, locomotion, and fall risk reduction training to maximize his safety and independence in preparation for returning to his assisted living facility (ALF).

At baseline, this patient resided in an ALF that he moved into following his fall 8 months ago. There, he reported receiving assistance with medication management, meal preparation, laundry, and cleaning. He ambulated without an assistive device at baseline but had experienced several falls in the 6 months leading up to his evaluation.

In addition to his schizoaffective disorder, Mr. G has a past medical history of coronary artery disease (CAD), Non-ST-elevation myocardial infarction (NSTEMI), anxiety, hyperlipidemia (HLD), compulsive gambling, sleep apnea, and moderate cognitive impairment. His schizoaffective disorder was well managed with medications and he had not had a psychotic episode in more than 6 months.

## Reverse Total Shoulder Arthroplasty: Operation and Rehabilitation

Reverse total shoulder arthroplasty (RTSA) is a commonly used surgical approach for a variety of derangements of the glenohumeral joint. It is a favored approach over the more traditional total shoulder arthroplasty (TSA) in cases of extensive, irreparable rotator cuff damage but also as an option

for avascular necrosis of the glenohumeral joint, complex fractures, inflammatory arthritis with an intact rotator cuff, and arthritis following previous shoulder surgery[1,4]. Though this operation has been performed for more than 30 years and has steadily grown in popularity, there is a surprising paucity of evidence outlining best-practice guidelines for physical therapy intervention and its role in recovery following a RTSA procedure. A recent systematic review of available guidelines and protocols concludes that the only consensus between them is that physical therapy plays an important role in optimizing patient outcomes[1].

Current rehabilitation protocols are primarily based on early work done by Hughes and Neer in 1975 and to date there are no peer-reviewed, randomized control trials to assess the efficacy of them[1,4]. This has resulted in the development of protocols that aim to balance exercise and rest to promote optimal healing and protection of repaired tendons in conjunction with appropriate tissue loading to optimize outcomes. A central tenet of rehabilitation protocols (evidenced by universal adherence to these goals) is protection from combined shoulder extension, adduction, and internal rotation due to risk of instability and possible prosthesis dislocation as well as to allow scar formation in the areas of greatest weakness[1].

In this case study, a RTSA protocol was used that follows many of these same principles (Table 1). In the general population, evidence suggests that physical therapy can positively affect long-term follow-up (~5 years) for shoulder ROM and some aspects of ADL performance but has no significant effect on DASH scores[2]. However, there is good evidence of positive outcomes with short-term rehabilitation following RTSA[2]. Physical therapy also plays a significant role in preventing prosthesis dislocation by providing education on the safest movement patterns and promoting optimal healing and strengthening to maximize the chance of a positive outcome[3]. These findings indicate that early physical therapy intervention is crucial to maximizing outcomes in RTSA patients.

**Table 1 – Mr. G's prescribed RTSA protocol**

| ***Phase I (0-6 weeks)*** | ***Phase II (6-12 weeks)*** | ***Phase III (12+ weeks)*** |
|---|---|---|
| ➢ Week 1 Ice 3-5 x's per day for 15 minutes each.<br>➢ May shower but not soak surgical arm.<br>➢ May eat, type, write, brush teeth with sling in place.<br>➢ Sling with abductor pad for full 6 weeks.<br>➢ Codman's exercises 3-5x's per day.<br>➢ AROM hand, wrist, elbow and scapular squeezes.<br>➢ PROM into flexion-table slides, pulleys progressing to AAROM supine cane exercises in flexion.<br>➢ No ER for 6 weeks, no abduction >45 degrees. | ➢ D/C sling.<br>➢ MD recheck at 6 weeks.<br>➢ Start PROM/AROM all planes, gradually progressing ER and abduction.<br>➢ Joint mobilization all planes PRN.<br>➢ Add isometrics all planes PRN progressing (beginning 6-8 weeks) to isotonic exercises per pt tolerance by 12 weeks post-op. | ➢ Progress to more active strengthening, power and endurance to patient's tolerance (No theraband).<br>➢ Capsular stretching to gain maximal ROM.<br>➢ Avoid impact activities such as contact sports, hammering, free weight training. |

**Drug Induced Parkinsonism**

*Definition and Prevalence*

Adverse Drug Reactions (ADRs) are defined as "a response to a drug which is noxious and unintended, and which occurs at doses normally used in man for the prophylaxis, diagnosis, or for modification of physiological function". Antipsychotic medications, frequently used in the treatment of mental illnesses such as schizophrenia or bipolar disorder, are common producers of ADRs. As many as 73.7% of people on antipsychotic medications have been reported to experience at least one extrapyramidal symptom (EPS)[5]. Drug-induced parkinsonism (DIP) – the onset of parkinsonian symptoms caused by pharmacological side effects instead of true Parkinson's Disease (PD) – is one of these potential side effects and has been reported in 46%, 36.1%, 23.2%, and 20% of people using antipsychotic medication[5-8].Tardive dyskinesia (TD), tremors, sedation, drug induced parkinsonism (DIP), and bradykinesia are just a few of the many possible side effects of antipsychotic drugs. Rigidity (65-100%), bradykinesia (25-80%), and resting tremor (35-85%) are the most common symptoms in those who have ADRs. Some evidence supports the notion that DIP presents symmetrically, however 30-54% of cases have asymmetric symptoms[6,9].

Mechanistically, schizophrenia is associated with imbalances of dopaminergic activity in the brain. At its simplest level, it is believed that antipsychotic medications are effective in schizophrenic symptom management because they act as D2 dopamine receptor (D2R) antagonists. However, the therapeutic window for interfering with D2 receptor activity is small, and too much attenuation of D2R activity is the most likely culprit for the emergence of extrapyramidal symptoms such as DIP and TD[10]. Antipsychotic medications vary in their mechanism of action on D2Rs. Those that bind more loosely to D2Rs and dissociate more quickly are less likely to cause EPS, however they are also more likely to cause symptom re-emergence[11].

The exact prevalence of DIP is difficult to estimate due to inherent challenges in distinguishing its clinical features from idiopathic PD and other movement disorders. However, evidence suggests that DIP occurs only slightly less frequently than PD itself. In one study, 0.09% to 1.7% of people in the general population had DIP compared to 0.37% to 1.9% of people who had PD. Another found DIP prevalence rates at 2.7% and 1.7% compared to that of PD with 3.3% to 4.5%, respectively. Given the similarities in presentation between these two pathologies and high likelihood of misdiagnosis, accurately confirming these statistic is inherently challenging[12].

The prevalence and likelihood of developing DIP is also influenced by the type of antipsychotic medication. First generation (typical) and second generation (atypical) antipsychotics are two classes of drugs that act via different mechanisms and have different affinities for D2Rs. 20-35% of patients taking typical and atypical antipsychotics develop DIP, with an increasing likelihood of developing it with older age. Approximately 40% of patients on the antipsychotic chlorpromazine exhibited parkinsonism, and there is evidence to suggest that DIP is the second leading type of parkinsonism, second only to PD itself[12].

Physical therapy interventions for PD have been heavily studied. Evidence supports physical therapy's efficacy in improving various metrics of gait speed, endurance, and balance in addition to measurable change in quality of life and functional mobility questionnaires[13-15]. However, these findings have limited statistical significance and our understanding of physical therapy best-practice in the PD population continues to be primarily anecdotal and theoretical. To date, there is no literature that this author is aware of that evaluates the efficacy of physical therapy intervention in patients with DIP.

**Examination and Evaluation**

Due to the complex nature of Mr. G's case, his full evaluation took place over several sessions. First, his shoulder was assessed for skin and scar integrity, signs of infection, and fit of shoulder abduction sling that his surgeon's staff fitted him with following surgery. There were no signs of infection or red flags and the sling was slightly adjusted to promote improved cradling of the arm, thus decreasing the amount of muscular activation at the shoulder joint. He denied pain, stating that any pain he feels now is significantly less than the daily pain he experienced before surgery. However, he was taking Oxycodone for pain management.

Functionally, Mr. G was able to transfer from sit to supine with minimal (min) to moderate (mod) assistance of one at the trunk and left lower extremity and he was standby assist (SBA) for supine to sit. He was able to perform a stand pivot transfer without an assistive device from a wheelchair to the treatment mat with supervision to SBA.

Next, Mr. G's gait was evaluated. He ambulated without an assistive device for 143 feet with SBA. His gait was slow with a prominent shuffling-progressing-to-festinating pattern. He also exhibited minimal arm swing, fixed forward gaze, and decreased awareness of his environment.

During the next therapy session, Mr. G was assessed on a variety of gait and balance objective measures. He scored a 19/28 on the Tinetti Performance Oriented Mobility Assessment (POMA), 21/24 on the Dynamic Gait Index (DGI), and took 11.7 seconds to complete the Timed Up and Go (TUG). These findings indicated a high, moderate, and moderate fall risk, respectively[16-20]. His performance on the DGI was surprising to the therapist, as his movement quality appeared markedly improved compared to subjective baseline assessment during the first session. In retrospect, this was the beginning of an emerging pattern of Mr. G demonstrating his best movement quality on objective tests when he was aware of being tested, suggesting that level of focus and awareness of the situation was a significant factor in his movement abilities.

Throughout evaluation sessions, Mr. G presented with numerous parkinsonian symptoms including minimal facial expression, general flat affect, slowed movements, and shuffled gait with festinating tendencies. No resting tremor was present, however. Interestingly, Mr. G seemed largely unaware of some of these deficits, particularly to his gait deficits and movement speed. At this point, it was determined that enough data had been collected to develop targeted treatments to address specific deficits.

**Clinical Impression and Plan**

Between the findings of Mr. G's evaluation, the complexity of his case, and his goal of returning to his prior level of function at his ALF, it was determined that seeing him twice daily for formal physical therapy sessions was most appropriate. Though his shoulder was the primary reason for his admission to a transition care unit, his risk for falls and subsequent re-injury was too high to ignore. Thus, the most appropriate treatment was determined to be one 45-minute session and one 30-minute session daily – one in the morning and one in the afternoon – with one session focusing on shoulder rehabilitation and the other addressing gait, balance, and mobility deficits. Shoulder rehabilitation operated within the confines of his post-surgical protocol, and gait, balance, and mobility deficits were treated using interventions traditionally used in rehabilitation of Parkinson's Disease.

In total, physical therapy services were provided for a span of 8 weeks and 6 days with Mr. G being seen twice daily from Monday through Friday each week. He did not receive skilled therapy services on weekends. While being treated in physical therapy, he also received skilled occupational therapy services to improve activities of daily living (ADLs), assess and improved cognitive status, and provide assistive equipment to minimize the need for further assistive services upon his return to his ALF. Social work services were also received to coordinate his progress towards discharge.

**Intervention**

*Period 1 (11 Days)*

The first period of treatment was characterized by gaining an understanding of Mr. G's baseline level of function and movement patterns. At the beginning of this time period, Mr. G was walking outside of sessions with supervision to standby assist with wheelchair escorts to sessions. He demonstrated excellent compliance with wearing his shoulder abduction sling.

Mr. G consistently demonstrated the same parkinsonian symptoms present in the evaluation with gait and balance activities. To address this, a variety of tasks promoting movement awareness, speed, symmetry, and amplitude were employed. NuStep training was initiated first to begin improving cardiovascular conditioning and teach Mr. G various principles of movement symmetry and amplitude. Another early emphasis was placed on practicing gait with frequent education to make Mr. G aware of his greatest movement deficits, namely slow speed, small step length, shuffling, and festinating in crowded areas. At this time, he was able to ambulate 350 feet without a rest break.

To address stride length, step counting over fixed distances (20 feet and 40 feet, respectively) with instructions to decrease the number of steps required to cover the total distance with each repetition was completed with good success with Mr. G reducing his step counts by three to six steps. Walking forward over canes set various distances apart from each other also challenged step length.

To improve step patterning and gait awareness, four cone weaving drills were completed. These caused Mr. G to walk in weaving, figure-8, side stepping, and sharp turning patterns. These tasks were difficult, requiring moderate cueing and CGA to Moderate Assistance of 1 Person (ModAx1) to assist with staying upright. Despite clear instructions to avoid hitting cones, Mr. G demonstrated poor spatial awareness and ran into cones on several occasions. Canes set in various configurations were also used to challenge Mr. G's step patterning.

Pathfinding tasks were used to practice maintaining gait improvements while performing functional tasks. Mr. G was asked to find specific pictures on the first floor of the facility without assistance other than directions for what to find. He was able to locate the pictures, but at the cost of gait quality: shuffling, festinating, path deviations, poor awareness of his surroundings (i.e. not noticing others in the hallway), and slow movement speed immediately returned when his focus was distracted from gait patterning itself.

Other utilized treatments included forward cone tapping, standing therapeutic exercises, and 4-square-step pattern stepping. Each of these revealed that Mr. G has great difficulty shifting his weight, especially on the right side. These findings became more significant in future time periods.

For shoulder treatment, emphasis was placed on passive shoulder range of motion, which was measured at 86 degrees of flexion and 45 degrees of abduction by the end of this time period. Passive horizontal adduction motion was also performed and but was not formally measured. Mr. G was also instructed in active elbow, wrist, and finger motion as it became evident that he had significant atrophy and edema from disuse during the course of his proximal humerus fracture recovery, causing significant impairments in function and dexterity in the elbow, wrist, and hand. He required moderate cueing to perform these activities and, when he did, small movement amplitude was noted. Manual assistance was provided to improve amplitude with little to no carryover to repetitions completed by Mr. G alone. Codman's exercises and seated overhead pulleys were attempted, however neither were completed due to inability to appropriately motor plan and hold onto the pulley with his right hand, respectively.

*Period 2 (13 Days)*

This period of Mr. G's rehabilitation resulted in significant improvements in his status but also unveiled other concerns affecting his return to prior level of function. Objectively, Mr. G completed the

TUG in 10.06 seconds (below reported clinically meaningful difference threshold)[20], 20/24 the DGI (one point decrease from the first period), and 25/28 on the POMA, a notable improvement from baseline.

At the beginning of this period, dynamic gait and weight shifting tasks were progressed. Stepping over hurdles, cone tapping, distracted gait (counting backwards from 100 by 7s), sudden changes in gait speed, tapping markers on the floor, and variable stepping patterns were all completed with mixed results and SBA to ModAx1. During one weight shifting tasks, a near fall requiring maximum assist of one person (MaxAx1) was caused when Mr. G stepped across his body and was not able to correct the resulting postural sway. He was frustrated by this incident and by many of these tasks in general, but improvements in his performance and steadiness were notable both objectively and subjectively.

Despite improvements in most areas, weight shifting proved to be a greater challenge. Throughout this period, increasing time was placed on it, using many of the aforementioned tools listed earlier in this section as well as visual feedback from mirrors, video analysis, and therapist demonstration. An apparent fear of his center of mass shifting too far in any direction seemed to be the greatest limiting factor with weight shifting. As a result, he had very little tolerance to standing on one leg and had difficulty initiating lifting of the right leg, manifesting as a freezing pattern. Deficits in weight shifting did not impact his gait tolerance or endurance, but they negatively affected his balance and ability to maneuver between static postures and correct shifts in his center of mass.

Mr. G's gait tolerance, on the other hand, rapidly improved during this period. At the beginning of it, he tolerated up to 500 feet of walking with SBA to CGA. By the end of it, he was able to walk 2000 feet with supervision assist on variable surfaces with the need of only one to two short rest breaks. Rapid improvements in this area afforded the therapist more time and repetition to practice things like gait quality and reintegration into gait in community settings. Much time was spent educating Mr. G on strategies for identifying and correcting deficits in gait. Mr. G's gait quality tended to deteriorate the longer he walked. He was able to recognize these changes with moderate consistency, so he was instructed to stop, pause, and re-start his gait with big, reciprocal stepping to restore normal gait. Within session, Mr. G consistently demonstrated decreased ability to sustain gait with large steps and no shuffling or festinating. Though the amount of time he could sustain walking without decreased stride length, increased shuffling, or onset of festinating pattern decreased throughout the duration of each session, however, he gradually showed improvements with recognition of gait breakdown and duration of walking time without decrement in quality throughout this time period.

Multi-surface walking was eventually introduced. Mr. G was challenged by walking on grass, mulch, cement, wood, sand, loose rock, and stairs. He was able to transition between surfaces without significant alterations in gait most of the time. Of greater issue was his lack of attention devoted to changes in surface integrity. He would frequently walk and fail to recognize and prepare for new surfaces appropriately, forcing him to reactively adjust to his environment. This never resulted in any falls or near falls, however during this time period minimal gains were made regarding improving his awareness to walking surfaces and his surroundings in general.

Instances of poor awareness like these were early signs of another pattern that became clear during this period of rehabilitation. Mr. G had very poor performance retention from day-to-day. Major declines in gait quality and movement performance were noted following weekends as well as on mornings during the week in which he felt tired. Though he had some insight that his performance declined with greater than 24 hours without skilled therapy, he did not demonstrate the ability to correct it without cueing and skilled therapy. This generated concerns regarding his potential to sustain balance and gait improvements without the continuation of skilled physical therapy services upon discharge to his ALF.

We also began to notice new parkinsonian movement patterns throughout this time period. Jaw line tremor, mild right hand tremor, flat affect, lack of left arm swing (even with corrective cueing), and

intermittent bradykinesia were all more frequent and noticeable during this time. An assessment of Mr. G's medical chart did not reveal any neurological evaluations in the 12 years of available documentation. Discussions were initiated with his attending physician at this time to express concerns of parkinsonian symptoms and to suggest further consideration for a possible neurological evaluation.

*Period 3 (7 Days)*

During Period 3, dynamic balance and gait training were advanced. Due to improved and plateauing performances in Mr. G's initially selected objective measures, this period included taking baseline measures in the Berg Balance Assessment (BBA), 6 Minute Walk Test (6MWT), and 4 Square Step Test (4SST) to further assess deficits in static balance, walking endurance, and dynamic balance, respectively. He scored the following: 41/56 on the BBA, 281 meters on the 6MWT, and 13.6 seconds on the 4SST. The BBA was particularly revealing, demonstrating very poor static balance and weight shifting performance. This test is a highly valid method of assessing balance in patients[21].

Multi-surface training was progressed, and significant time was allotted to stepping, weight shifting, and improving movement-related parkinsonian deficits. Several sessions included walking with varying stride length and gait speed over the same variable surfaces previously listed. Though his gait did not show significant decreases in quality and he did not have any near falling incidents, he still required SBA due to lack of awareness of changing surface integrity despite regular cueing to promote improved awareness. To address deficits in weight shifting identified in the BBA, toe tapping on an 8 inch step and step ups onto a foam surface were completed. Mr. G had difficulty initiating stepping with his right leg, a freezing pattern that was likely related to both his parkinsonian presentation and his discomfort shifting weight onto the left leg. He was also tasked with stepping on and off a foam surface forward, backwards, and laterally. During this task, he had poor spatial awareness and regularly failed to clear the pad with his foot and occasionally missed the pad completely, despite moderate cueing encouraging heightened awareness.

To address static balance deficits, Mr. G completed static standing, weight shifting, and reaching tasks on a foam surface. When performing static tasks on the foam pad, Mr. G tended to lean posteriorly. Cueing to correct this posture with utilization of a mirror had minimal success in creating noticeable change.

Finally, Mr. G showed minimal improvements in dynamic walking tasks. Despite regular cueing, he was unable to demonstrate improved spatial awareness, safety cues, and task-appropriate weight shifting. Of note, during this time period Mr. G began verbalizing concerns of decreased voice projection and sleep quality. Furthermore, he had several occasions of being unable to rise from a chair without assistance. Though he reported this was due to new shoulder pain in his non-surgical arm, we noted a freezing presentation. This prompted follow-up with his physician to further express concerns of parkinsonian symptoms. At this time, we were assured that parkinsonian symptoms were caused by the type and dosage of his medication. He also indicated that dosing could not change due to this patient's history of relapsing into psychosis with decreased doses.

Phase I of shoulder rehabilitation was completed during this time period. Mr. G passively achieved 116 degrees of shoulder flexion and 45 degrees of shoulder abduction (the maximum allowed in this phase). He advanced the use of pulleys, modified Codman's exercises using the parallel bars, and he became tolerable to anterior to posterior, posterior to anterior, inferior, and lateral shoulder joint mobilizations. His passive motion up to this point was smooth, absent of any clicking, clunking, or other mechanical symptoms. Some sharp pain was noted in the shoulder near end range passive flexion.

*Period 4 (12 Days)*

Period 4 showed continued improvement in gait and balance performance, and Mr. G progressed into Phase II of his shoulder rehabilitation protocol. Objective tests were reassessed with an improvement to 339 meters on the 6MWT, 44/56 on the BBA, 11.23 seconds on the TUG, and a return baseline on the DGI, scoring 21/24. Though improvements were made in three of these four tests, none of them reached a clinically meaningful level of change for PD or other parkinsonism populations. Mr. G continued demonstrating little improvement in weight shifting during toe tapping tasks, still requiring moderate verbal and tactile cues to perform effective weight shifting. Reactive cueing was introduced with Mr. G weaving through a series of cones and then being instructed on which direction to turn and walk as fast as he can. This was met with good success but did not cause lasting change.

Phase II of Mr. G's shoulder protocol was advanced as able. During this time period he reached 126 degrees of shoulder flexion, 103 degrees of shoulder abduction, and -4 degrees of shoulder external rotation. All measurements were taken passively. Passive joint mobilizations were continued. Isometric exercises were initiated into shoulder flexion, abduction, and external rotation at various joint angles. These exercises caused little pain near full shoulder adduction but was more painful as the arm was elevated. A key portion to this period's shoulder rehabilitation was promoting self-initiated movements. This included seated table slides promoting forward flexion, specifically performing forward leans, side to side sliding, and circles in clockwise and counterclockwise directions. Movement amplitude was minimal unless moderate cueing was provided.

During this time period, greater inter-professional collaboration was initiated to discuss the remaining factors limiting Mr. G from discharging to his ALF. These discussions included the physical therapy, occupational therapy, physician, and social work teams. At this time, the greatest limiting factor was occupational therapy's concerns with his ability to perform ADLs such as dressing, bathing, and self-care during toileting given his limited right shoulder function and overall slow movement speed and lack of initiation. Conversations with Mr. G about increasing ALF services to help him transition to his prior level of function raised concerns about finances. Mr. G had great anxiety regarding this issue; though his level of financial stability was unknown, interactions with him and his visiting family members gave the impression that he could afford increased services. From a physical therapy perspective, Mr. G was functionally safe to discharge to his ALF and continue in-facility physical therapy to advance his RTSA protocol. Despite still achieving scores that would indicate moderate fall risk with some activities, Mr. G's ability to safely ambulate and transfer suggested that he had the skillset to remain safe in his ALF, especially with assistive services for some tasks. However, at this time occupational therapy did not feel comfortable with considering discharge given his ADL limitations in the context of his goals of completely returning to prior level of function (PLOF) upon return to his ALF. At this time, it was apparent that Mr. G was not yet ready to discharge.

*Period 5 (7 Days)*

By the end of this period of therapy, Mr. G had maintained many of his previous gains but still struggled to make new, significant improvements in gait and balance performance. He was able to walk greater than 0.5 miles on variable surfaces in a single session with only a few short breaks along the way. Though he was able to demonstrate increased walking distances before apparent breakdown of gait, he still was unable to complete walking sessions without shuffling, shortening his stride, and showing inability to correct gait deterioration without moderate cueing. For example, in one session he was able to walk 3x1000 feet; however, he was frequently cued to "re-start" to increase stride length. In another session he walked 1500 feet with an emphasis on increasing amplitude of arm swing, but the cognitive demands of this cueing seemed to overwhelm Mr. G and cause greater deterioration of gait quality.

To assist with functional gait, pathfinding exercises were performed. Though cognitively he was able to complete tasks, he still assumed a shuffling and occasionally festinating gait when focused on a task other than his gait (in this case pathfinding) and in crowded areas. Cane walking tasks were also continued to practice navigating community obstacles and improve spatial awareness. He performed these stepping tasks with frequent mistakes, stepping on canes and demonstrating poor spatial awareness. When performing foam pad stepping and balance tasks, he had several instances that required significant assistance to prevent a fall; each of these events was a result of poor awareness of his position and foot placement on the pad despite cueing to bring attention to the risks at hand. Though these performances were not necessarily a decrease in overall performance, the lack of improvement in gait quality during longer walks and poor spatial awareness and assessment of risk largely remained constant.

Regarding shoulder rehabilitation, Mr. G saw improvement in exercise advancement and overall performance. Isometrics in shoulder flexion, extension, external rotation, and abduction were completed manually and with anchored theraband resistance. He showed marked improvement in his ability to grip the pulley handles, though he still needed minimum to moderate assistance for positioning of the arm. Table slides with an incline and with targets to improve reaching ability were completed successfully, though movements were slow and primarily small in amplitude. Mr. G expressed satisfaction with his shoulder progress during this time period. Given his continued progress in this area and notable plateau in gait, balance, and coordination tasks, it was determined that the final steps required to discharge Mr. G were going to be approached in the next few sessions.

*Period 6 (7 Days)*

The final period of Mr. G's rehab provided the finishing touches on his plan of care, ultimately resulting in discharge. Several lengthy discussions were had with both Mr. G by both physical and occupational therapy to discuss the details of discharge including his financial and safety concerns. It was concluded that Mr. G was comfortable using his financial resources to increase his number of services at his ALF, at least in the short term, to assist with getting his shoes on and off, toileting, and dressing. He also was ultimately comfortable with his ability to safely navigate the facilities, though he expressed a fear of having to return to the hospital in the incidence of another fall. He also had significant concerns about motivation to continue working on exercises to prevent a significant decline in function following discontinuation of daily services. He was educated on strategies to make exercise a habit and use his family as a motivational resource. Following these discussions, we called the nursing staff at Mr. G's ALF to discuss his various needs and prep them for his return to their care.

His final treatment sessions addressing balance, coordination, and gait emphasized increasing amplitude of arm swing, walking endurance, and overall physical strength with standing exercises. He was able to walk up to 1649 feet in 9 minutes and 10 seconds without the need to rest; per his typical performance, Mr. G had deterioration of gait quality throughout this walk. A final 4-square step test was performed with Mr. G averaging 17.8 seconds over two trials, both of which caused significant balance perturbations. This was discouraging to him, as it was a notable decrement in performance compared to his baseline test several weeks ago.

Mr. G's shoulder rehabilitation continued to progress in a linear fashion throughout his final sessions. He progressed to performing isotonic exercises with theraband resistance, performing shoulder circles, external rotation, flexion, extension, and abduction. He was able to complete table slide reaching and wiping exercises with improved, but still slow, speed. Unfortunately, he still required moderate assistance to increase elbow, wrist, hand, and finger movement amplitude, as his self-selected amplitude was minimal in nature. He was discharged during Phase II of his RTSA protocol, and we communicated with his ALF to coordinate 2-3 in-facility physical therapy treatments per week

until his protocol was completed and he reached his functional goals. He was also provided with a home exercise program with clear written and pictorial instructions for maintaining lower extremity strength gains. His active assisted range of motion (AAROM) measurements at the time of discharge were 123 degrees of flexion, 91 degrees of abduction, and -3 degrees of external rotation.

**Outcomes**

As has been outlined up to this point, Mr. G's course in physical therapy demonstrated notable improvement but also variable and plateauing performance over his 8-week plan of care. Due to the complex and evolving nature of this case, objective measures were not taken uniformly throughout his plan of care. All utilized objective measures were not assessed during the initial evaluation period; this can largely be attributed to Mr. G outperforming therapist expectations, thus warranting new measures to be completed at later dates. Furthermore, not all measures were assessed during the discharge period due to the time-consuming nature of completing numerous tests while also providing appropriate discharge preparation. Without planned services for gait, balance, and coordination following discharge it was ultimately decided that all measures did not need to be assessed in his final days in this unit. Other measures were not re-tested due to previous satisfactory testing scores that did not warrant further treatment time being given to reassessment. His performance is summarized in Table 2.

**Table 2 – Summary of Objective Measures**

| Test | Initial Score | Discharge Score | MDC (for PD unless noted) | Comments |
|---|---|---|---|---|
| **TUG** | 11.7 seconds | 11.29 seconds^ | 3.5 seconds[20] | Slower than a population of community dwelling males age 70-79 with various medical ailments (9 sec +/- 3 sec)[17]. |
| **POMA** | 19/28 | 25/28+ | 4.2 (in older adults)[16] | Average score for elderly, healthy males aged 65-79 is 26.21[22] |
| **DGI** | 21/24 | 21/24 | N/A | Definitive cutoff score for falls: (19/24)[18,19]. |
| **BBA** | 41/56 | 44/56^ | 5.0 | Within one standard deviation (SD) of normal (50 +/- 7) for people with parkinsonism[17]<br>Scored significantly lower compared to community dwelling males in his age group (54 +/- 3)[17]<br>Score indicates a moderate fall risk and a likely risk for a future fall[23,24] |
| **4SST** | 13.6 seconds | 17.8 seconds | N/A | Score indicates a likely occurrence of a future fall[25]<br>Far below the cutoff for increased risk for falls in PD patients (> 9.68 seconds) [25,26]<br>In the threshold for risk of multiple falls in the older adults classification (> 15 seconds)[25,26]<br>Significantly worse than the average person with PD on Levodopa[25] |
| **6MWT** | 281 m | 339 m | N/A | Comes barely short of a MCID in people with parkinsonism but still achieved a MCID for geriatric and stroke populations[27,28]<br>Final performance was significantly less than the normative values for males in his age group[17] |

*+Meets minimal detectable change; ^Does not meet minimal detectable change; N/A - Data not available*

**Discussion**

The purpose of this case study was to highlight the challenges of rehabilitating a post-operative orthopedic procedure in a multi-disciplinary setting with a patient who has both psychological and movement related dysfunction. Due to the complexity and unique nature of this case, there is no available literature that assesses important factors in rehabilitating someone with Mr. G's combination

of medical factors that impacted his plan of care. In fact, the primary diagnoses to be addressed in this plan of care – RTSA and drug-induced parkinsonism symptoms – have very little literature regarding rehabilitation on their own.

Treatment for Mr. G's shoulder strictly followed the outlined restrictions in the protocol prescribed by his surgeon. Though current RTSA protocols are heavily influenced by work completed decades ago and are rarely tested in randomized controlled trial settings, they are nonetheless similar in design, effective at minimizing risk of dislocation, and have been shown to improve short-term outcomes in patients[2-4]. During his time in this transitional care setting, Mr. G effectively progressed through Phase I and early Phase II of his protocol. His greatest challenges were met when tasked active participation tasks. Flat affect, slow movement speed, and poor initiation proved a challenge in progressing AAROM and AROM. As he progressed with Phase II, several of the same deficits noted in balance, gait, and coordination training were experienced: poor initiation of movement, little self-initiation, and overall poor retention of short-term improvements. Decreased elbow, wrist, and hand function also played a significant role with very little improvement seen during his plan of care. It is unknown what challenges Mr. G experienced in later phases of rehabilitation.

There is no known evidence suggesting best practice for rehabilitating balance, gait, and coordination in an individual with DIP. However, the pathophysiology of DIP has many similarities to Parkinson's Disease itself. For this reason, it was assumed that evidence-based treatments for PD would also be effective – at least to some degree – with parkinsonian presentations such as those involved with DIP and that it would be appropriate to treat Mr. G with these interventions.

Unfortunately, though physical therapy interventions are a crucial portion to management of PD itself, the available evidence does not provide clear best practice interventions. For example, the National Institute for Health and Care Excellence (NICE) simply encourages healthcare professionals to refer people in the early stages of PD to a physical therapist for assessment, education, and advice, and to offer "disease-specific physiotherapy for people who are experiencing balance or motor functional problems"[29]. This section will provide a more thorough analysis of evidence-based treatment interventions for PD.

Two systematic reviews and meta-analyses support that physical therapy ('physiotherapy' is used in the official publication; this terminology is used interchangeably with 'physical therapy' in this case report) has significant positive short term (< 3 months) effects on performance with gait speed, two or six minute walk test, freezing gait questionnaire, timed up and go test, functional reach test, BBA, and Unified Parkinson's Disease Rating Scale (UPDRS) scores[13,14]. The authors conclude that this translates to improved gait velocity, functional mobility, and balance. Unfortunately, due to low quality evidence for minimal clinically important differences in these outcome measures and relatively low effect sizes in several of these objective measures, there is some uncertainty as to the true impact physical therapy has on each of them. Only gait speed, BBS, and UPDRS scores were determined to be at levels that can be deemed clinically important. These details aside, there is clear evidence that physical therapy interventions produce greater short-term outcomes than no physical therapy at all.

Unfortunately, due to the myriad treatment approaches used throughout hundreds of studies used in systematic reviews and meta-analyses for rehabilitation in PD provide, no recommendations for specific exercise interventions are provided. General findings such as cueing or treadmill training showing improvements in gait speed and LSVT BIG interventions improving UPDRS scores are reported, but this leaves readers with little clinically useful information[15].

Despite limited literature outlining specific interventions for PD, there is evidence for various treatment modalities having positive, measurable effects in rehabilitating those with the disease. A Dutch Review[30] assessed numerous treatment modalities and assessed their effects on PD patients. This population has reduced muscle strength and power compared to healthy peers. Resistance

training increases muscle strength and endurance in people with PD and may improve gait and functional mobility performance. Treadmill training for aerobic fitness is likely to improve gait velocity, stride length, aerobic endurance, and walking economy[30,31]. Balance training interventions (both with and without concurrent strength, joint mobility, and gait training) have been shown to decrease the number of falls in people with PD.

Many theoretical concepts can be used to, at least in part, explain the mechanisms that make such a wide variety of physical therapy interventions effective in the PD population. Possible benefits primarily arise from the principles of neuroplasticity. Exercise can increase synaptic strength, strengthen and create new circuitry, and influence the number of neurotransmitters. Glutamatergic and dopaminergic dependent processes can also be augmented by physical activity, modifying cortical excitability. Dopaminergic signaling has been shown to improve with physical activity, likely due to increased number and binding potential of D2 dopamine receptors. Exercise has also been shown to decrease oxidative stress, a molecular process known to contribute to neurodegenerative procesess[32].

Literature exploring the benefits of physical therapy and exercise in PD patients paints an unclear picture of the long-term effects of changes made in therapy. Typically, benefits of no more than three months are noted[13-15,32]. The chronic neurodegenerative nature of PD may be one explanation for this. Decreased consolidation and retention in motor learning in PD patients may also play a role[33]. Many studies also have inadequate follow-up measures leaving some level of unknown to assessing true long-term outcomes. However, one often overlooked – and modifiable – factor in this equation may be the intensity, specificity, and complexity of the training stimulus. One pilot study revealed that intense physical therapy entailing two daily sessions for five days per week for four weeks discovered measurable benefits during a 12 month follow-up with reduced doses of Levodopa needed in the subjects[34]. Structured, supervised exercise of regular frequency has also been shown to maintain improvements made in therapy up to 24 months following the start of treatment[35]. These findings suggest that one barrier to sustained improvement in PD patients is inadequate frequency or intensity of exercise.

With the utilization of PD rehabilitation principles in Mr. G's plan of care, rapid improvements in gait tolerance and quality were noted. However, inconsistent performance, poor retention, and a plateau of improvement were hallmarks of his plan of care. This could be attributed a variety of factors. Mr. G may have reached his maximum potential given his moderate level of medication-induced sedation and parkinsonian presentation. Alternatively, a lack of clear-cut evidence-based interventions for both PD and parkinsonism may have resulted in care that did not adequately address his deficits. A more plausible answer to his deficits is that people in early stages of PD – a rough equivalent to Mr. G's status at the time of this case study – demonstrate poor learning and lack of consolidation with visuomotor tasks[33]. People with PD can adapt their movement to a visual task at the same rate as age-matched controls, however their retention and adaptation rate have not been shown to improve with subsequent sessions compared to the same control group. This evidence strikingly resembles Mr. G's performance throughout this case: adequate ability to complete and improve with a variety of balance, gait, and coordination tasks within session but significant breakdown of these gains with greater than 24 hours of rest. This should be considered with PD and parkinsonian patients in all settings, as this evidence suggests that expectations should be adjusted accordingly to accommodate for poor learning and retention.

One key to Mr. G's successful discharge was a committed care team. There is little doubt that frequent communication between healthcare providers and the patient resulted in a timely, safe discharge back to his ALF. Given his complex presentation, it would have been easy to perpetually treat his deficits. In his hospital unit there was little pressure to discharge people and it would not have been difficult to achieve nearly endless justification to continue medical services. Despite some

disagreement along the way, medical doctors, physical therapists, occupational therapists, social workers, and family all played a major role in preparing and successfully completing discharge at an appropriate time. This collaboration maximized his chance to return to his previous level of function and regain as much independence as possible.

Secondarily, this case report supports the use of traditional PD rehabilitation interventions for the treatment of DIP. Using these interventions, notable improvement was demonstrated in the POMA and 6MWT and near-clinically significant improvement was achieved in BBS and the TUG. Quality aside, Mr. G's gait endurance improved drastically, improving from less than 500 feet of ambulatory tolerance to walking 1649 feet without a rest break without any safety concerns. This improvement has major implications for improving Mr. G's independence, activity tolerance, and chance to succeed upon discharge.

Based on this case's results, we have a few recommendations. With patients presenting with DIP, or any kind of parkinsonism, utilizing best-practice principles from published PD rehabilitation literature is an appropriate and likely effective treatment approach given the dearth of available literature for specific sub-types of parkinsonism. Alternative forms of cueing and education should be explored to maximize the potential for task retention. This may come via increased assisted living services, maintenance therapy sessions, increased use of extrinsic cueing, family education, home educational videos, or other strategies to promote better long-term performance. In the end, however, there will likely be a ceiling effect to rehabilitation given the consistent and/or progressive nature of the pathophysiology in parkinsonism.

Given the prevalence of DIP[12,36], future research should address the distinct differences between patients with PD and DIP in rehabilitation settings. Further research is also needed to better understand the mechanisms behind poor retention of motor tasks in the PD population, as this could have major impacts on intervention selection. Finally, the body of literature exploring the effects of DIP and cognitive deficits as comorbidities rather than primary rehabilitation targets would be beneficial to better understand the role of cognition and movement disorder in rehabilitation of common orthopedic procedures.

**Conclusions**

This case study suggests that an individual with DIP can successfully rehabilitate both a common orthopedic procedure and objectively improve balance, gait, and coordination in the presence of other cognitive deficits. A key tenet to maximizing outcomes in a patient like this is a consistent, individualized therapy approach that incorporates many members of a healthcare team who can share their expertise and make collective, educated decisions. It should also be noted that evidence for the rehabilitation of PD patients is at least moderately useful in the rehabilitation of DIP. Further research is necessary to better understand rehabilitation in PD and various types of parkinsonism to better understand the role of cognitive deficits in recovery from orthopedic surgery and movement disorder. In a broader context, this case sheds light on the complexities of patients with orthopedic and neurological conditions and provides a framework to addressing these concurrent deficits in a variety of conditions.

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