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Progressive Strength Training for Pain Management, Functional Strength Gains, and Reduced Fall Risk in an Elderly Patient Immediately Following Hip Fracture Repair: A Case Study.

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Background and Purpose: Hip fractures in elderly patients are associated with poor functional recovery, high levels of post surgical pain, and increased fall risk during the initial stages of rehabilitation. Prior research has attempted to determine optimal treatment approaches; however no best intervention plan has been identified. This case study demonstrates an effective progressive strengthening program that placed focus on pain management, while attempting to strengthen lower extremity muscles to improve function in an older adult patient following a hip fracture. **Case Description:** The patient was an 80-year old male admitted to an inpatient rehabilitation hospital following hip fracture repair on his right lower extremity. He possessed high levels of post-operative pain that significantly limited his ability to participate in functional activities. Upon admission, functional outcome measures including the Berg Balance Scale (BERG) and Functional Independence Measure (FIM) were evaluated to be 64/126 and 6/56 respectively, both values in the range associated with high risk for poor outcomes. The patient was seen daily over the course of a three-week hospital stay and treatment consisted of an individualized progressive exercise program designed to improve his function and manage his pain. **Outcomes:** The patient demonstrated clinically detectable improvements on both the BERG balance scale as well FIM following a three-week intervention period with the exercise program being investigated. Furthermore, the patient reported decreased levels of pain and improved perceptions of overall independence upon discharge. **Clinical Relevance:** The outcomes shown in this case indicate that this particular progressive exercise protocol may be beneficial in treating patients recovering from hip fracture repair who additionally exhibit high levels of pain. Future research is needed to determine best possible implementation of specific exercises, as well as program outcomes on a larger patient population.

Key Words: Hip Fracture, Progressive Resistance Exercise, Older Adults, Functional Strength, Falls

INTRODUCTION

Hip fractures in elderly patients are associated with poor functional recovery, high levels of post surgical pain, and increased fall risk during the initial stages of rehabilitation.[1,4,8,11] Furthermore, following surgical repair of a fractured hip, decreased lower extremity strength has been shown to place patients at a higher risk for experiencing future complications during their recovery [8]. With these problems, addressing progressive hip strengthening is a top priority when designing a rehabilitation program for a patient recovering from hip fracture repair. Overgaard et al.,[8] investigated the feasibility of implementing an early progressive strengthening program in patients following a hip fracture repair. These authors indicate that lower extremity strengthening is of upmost importance, and needs to be initiated as soon as possible in this population. They justified this by showing how patients recovering from hip fracture repair typically exhibit decreased hip extension strength of nearly 50% when compared to pre-surgical values, and how these values directly correlated to decreased scores on functional independence assessments [8]. This study additionally demonstrated that unilateral hip

strength discrepancies also place patients at an increased risk for falls. Therefore, those who are recovering from a surgically repaired hip are at higher risk for re-injury, or new complications [4].

In addition to decreased strength, increased pain levels are also a major cause for concern in this patient population. Not only do high levels of pain interfere with exercise prescription and functional recovery, but they also play roles in causing depression, delirium and have the ability to decrease patient independence [9]. These complications can lead to delayed ambulation, cardiac complications, and even the need for patients to seek higher levels of care including re-admittance to inpatient rehabilitation facilities or even acute care settings [4]. Therefore, in addition to increasing strength, it is also extremely important to manage pain levels during hip fracture rehabilitation so that patients do not experience additional setbacks that prevent return to functional independence.

Gait and balance issues are another common area for concern when considering patients who have recently undergone surgical repair of a fractured hip. Frequently, these patients sustained their original injury because of an event where they lost their balance and fell. This could have happened during gait, or even simply while standing, and it is a frequent occurrence in older adults. This is why patients who have experienced a hip fracture are placed at an even higher risk to sustain another adverse event leading to re-injury. [9,11]. In a study completed by Thingstaad et al,[11] a task specific gait and balance regimen was performed in an attempt to improve overall patient functional recovery in elderly patients who have experienced a hip fracture. This research showed that use of such a program led to increased gait speed, higher levels of overall function, and increased patient confidence [11]. These outcomes highlight the need to focus on gait and balance activities when designing rehabilitation programs for patients in the early stages following hip fracture repair[11].

Older adults who have sustained a hip fracture are placed at a significant risk for decreased functional independence, future falls, and even death. Furthermore, some predictions estimate that as many as 1.5 million hip fractures will occur worldwide in a given year [9]. Therefore, it is essential for skilled rehabilitation professionals to create detailed interventions that focus not only on strengthening, but also pain management. The effectiveness of these programs and patient progress should be tracked by functional testing with valid and reliable outcome measures such as the Functional Independence Measure (FIM) and Berg Balance Scale (BERG) [5,6]. This case study report describes the implementation of an effective progressive strengthening program that placed focus on pain management, while strengthening lower extremity muscles and improving gait efficiency to improve the function of an older adult following hip fracture and resultant surgical repair.

CASE DESCRIPTION

Case History

The patient was an 80-year old male who was admitted to an inpatient rehabilitation hospital following hip fracture repair on his right lower extremity. He sustained this injury after a fall in which he was attempting to prevent his wife from a fall of her own. Following this event, the fracture was repaired using an open reduction with internal fixation (ORIF) procedure followed by rehabilitation.

Prior to this event, this patient was a previously very active. He enjoyed working on his farm, operating a family airboat, and being active around his home. The patient had experienced a left hemisphere stroke in 2010, which still caused some residual weakness on his right upper and lower extremities, but this did not limit functional independence. He was independent with all activities at home including ambulation, cooking, cleaning and bathing. He was also an independent community ambulator who enjoyed driving his truck and visiting friends. His goals for therapy included being able to “walk normal again”, “resume my active lifestyle”, and “reduce my pain”. This patient was treated over the course of a three-week period.

Examination and Evaluation

During the patient’s initial examination, the FIM and BERG were administered and scored. The Functional Independence Measure (FIM) is a widely implemented tool that is frequently used in inpatient hospital settings to track patient progress, as well as evaluate the patient’s ability to return home and thrive independently [6,7]. A detailed breakdown of FIM scoring

for its functional categories can be seen in Table 1. The BERG is another functional measure commonly used to evaluate patient fall risk [5]. This patient's presented FIM score of 64/126 upon evaluation meant that he would not be able to complete functional tasks at home without skilled assistance and he was not a candidate for discharge at that point in time. Similar to his FIM scores, the patient had very low scores on the BERG with an initial score of 6/56. This value placed the patient at an extremely high risk for a fall. Both the FIM and the BERG have been shown to be internally valid and reliable functional measures with ICC scores of 0.98 and 0.96 respectively [5,6].

Table 1. Functional Independence Measure Scoring Chart

Score	Criteria
0	Activity does not occur.
1	"Total Assistance," where the person produces less than 25% of the effort needed to complete a task.
2	"Maximal Assistance," where the person produces less than 50% of the effort needed to complete a task, but at least 25%.
3	"Moderate Assistance," where the person produces between 50% and 75% of the effort needed to complete a task, and requires no more than small degrees of helping or touching.
4	"Minimal Contact Assistance," where the person produces 75% or more of the effort needed to complete a task, and requires no more help than touching.
5	"Supervision or Setup," where the person only needs someone to standby and provided cues (without physical contact) so that they can do a task.
6	"Modified Independence," where no helper is needed and the person uses an assistive device.
7	"Total Independence," where no helper is needed and the person performs the task safely, efficiently, and without use of assistive devices.

Pain scores and manual muscle testing (MMT) values were also recorded. Both the FIM data and the BERG scores were determined to be very low, placing the patient at both an increased fall risk as well as justifying the need for skilled inpatient physical therapy to improve functional independence. In addition to the low FIM and BERG scores, the patient also verbally reported extremely high levels of perceived pain. He frequently stated that his pain was a 10/10, and that his medications were doing "nothing". Furthermore, the patient also had significant lower extremity weakness on his involved right lower extremity, including 2+/5 and 3/5 MMT scores for his hip adductors and hip extensors, respectively. The combination of all of these values placed the patient at extremely high risk for fall, as well as other complications including delayed gait and cardiac issues [2]. These factors created the need for a multifaceted rehabilitation approach designed to target each problem, with the overarching focus of progressive strengthening in a controlled manor to avoid setbacks and maximize return to functional independence.

Diagnosis and Prognosis

Gradual decline, loss of independence, and decreased vigor are often viewed as inevitable in older adults who sustain a hip fracture. However, with the correct rehabilitation plan and proper interventions, aging patients who experience a hip fracture can achieve full recovery and return to prior levels of function. In the current case, the patient was a previously active man who had goals to return to an active lifestyle and he was educated that this goal was realistic. The limiting factors in his case were determined to be his pain levels and lower extremity weakness. These factors put him at an increased risk for falls and could limit return to functional independence. Based on prior clinical experience, these patients typically spend approximately 2-3 weeks in an

inpatient setting before they are able to achieve outcomes needed to safely return home. Considering the patient's FIM and BERG scores, as well as his high pain levels and decreased MMT values, a 3-week rehabilitation stay was expected in order for this patient to achieve his goals and to safely return home.

Intervention

The main intervention provided to this patient during his stay was based on a progressive strengthening program. More specifically, this program was broken into three phases based on the primary physical therapist's prior clinical experience in working with this patient population, as well as consultation with literature and other members of the hospital's clinical staff (Table 2). Each phase lasted one week and had a specific theme that was designed to both progress the patient appropriately, as well as manage pain and fatigue. Phase one was strictly focused on isometric and gravity eliminated exercises, phase two was an introduction to functional exercise and traditional open-chain therapeutic exercise using resistance bands and free weights, and phase three focused on higher-level functional tasks as well as eccentric therapeutic exercise. All interventions were performed in the therapy gym of an inpatient rehab hospital, and although intervention time was typically completed in the morning, the patient was seen occasionally in the afternoon to accommodate other disciplines such as occupational therapy and nursing. Furthermore, all sessions lasted sixty minutes, and the patient was occasionally seen twice a day depending on scheduling.

All exercises provided throughout the progressive strengthening program were designed to specifically target hip muscular strength and increase endurance while managing pain and fatigue symptoms. A detailed breakdown of the therapeutic exercise program provided during phase 1 can be seen in Table 2. Each exercise was implemented in a manner to allow for fatigued muscle groups to recover, and to progress each exercise in a controlled manor.

Following phase 1 of the progressive exercise program, perceived pain levels reported by the patient began to improve (regularly 3-4 instead of 9-10). Considering this response, the patient's interventions were progressed into phase 2 of the rehabilitation protocol. Phase 2 focused on an introduction to functional exercises, as well as more difficult therapeutic exercises. A detailed breakdown of the therapeutic exercise program provided during phase 2 can be seen in Table 2. Again, exercise selection was based on allowing muscles groups proper recovery time, as well as attempting to provide appropriate progression.

A functional testing day occurred in the middle of phase 2 to re-asses FIM data and BERG scores. These scores showed improvements that can be observed in Table 3 of the outcomes section, and also provided justification that the patient would soon be ready for the third and final phase of the program.

The final portion of the progressive exercise program, phase 3, consisted of activities ultimately designed to maximize strength and prepare this patient for high level functional activities needed for his return to home. A detailed breakdown of the therapeutic exercise program provided during phase 3 can be seen in Table 2.

As described by Issac et al.[10], all eccentric activities were performed for 10 reps over 3 sets, and were completed on a "2 to 4" ratio where the patient would complete a concentric movement for a 2 second period, and then a subsequent 4 second lowering portion to further emphasize muscle strengthening. Their research demonstrated significant strength gains in similar patients using eccentric strengthening protocols. Gait training was progressed via increasing distance as previously mentioned, and more reps were added to sit-to-stand activities. The patient completed phase 3 at the end of the week and, FIM, BERG, strength and pain data were all recorded prior to discharge.

OUTCOMES

Upon discharge, this patient demonstrated vast improvements in both functional testing as well as strength and pain scores. Furthermore, upon questioning, he subjectively reported that he felt as if he had progressed immensely from where he started with regards to endurance, body mechanics and proper safety techniques when performing activities of daily living.

Table 2. Breakdown of Progressive Exercise Program by Phase

	Phase 1	Phase 2	Phase 3
Monday	Quad Sets Isometric Hip Abduction Isometric Hip Adduction Seated HS Curls Seated Quad Kicks	Seated Kicks with 2lbs T-band HS Curls 3-way standing hip series Heel/toe Raises	Gait Training Eccentric HS Curls Eccentric Quad Kicks Eccentric Hip Abduction Eccentric Hip Adduction
Tuesday	Isometric Hip Abduction Isometric Hip Adduction Heel Slides Gravity Eliminated Hip Abduction/ Adduction Towel Slides	Sit-to-stand Seated Kicks 2lbs T-band HS Curls Toe-taps using 2" plyometric box	Stair Training Sit-to-stands Eccentric Hip Adduction Eccentric Hip Abduction
Wednesday	Quad Sets Isometric Hip Abduction Isometric Hip Adduction Supine Resisted HS Sets	Functional Testing Day (FIM +BBS)	Gait Training Eccentric HS Curls Eccentric Quad Kicks Eccentric Hip Abduction Eccentric Hip Adduction
Thursday	Heel Slides Quad Sets Gravity Eliminated Hip Abduction/ Adduction Towel Slides Supine Resisted HS Sets	Gait training Heel/toe raises 3-way standing hip series Seated Kicks with 2lbs T-band HS Curls	Gait training Stair Training Sit-to-stand
Friday	Gravity Eliminated Hip Abduction/ Adduction Towel Slides Supine Resisted HS Sets Seated HS Curls Seated Quad Kicks	Gait training Sit-to-stands Heel/toe Raises Toe-taps using 4" plyometric box	Graduation day (FIM, BBS, MMT, Pain)

HS - Hamstring

He was confident that he was fully prepared to return home, along with the help of a strong family support system, and the functional skills he had acquired during his stay. His family also expressed confidence that they had received the needed education to be valuable resources.

Upon admission, the patient demonstrated a BERG score of 6/56. This categorized him as a high fall risk. Even more concerning was the fact that he often expressed frustration and impulsive actions, such as attempting to stand when he was not able, due to his lack of mobility and inability to perform tasks that used to be easy for him. Following a week and a half of rehabilitation he did show significant signs of improvement. At the halfway point of his stay he was able to score a 24/56 on his second BERG attempt. This score still placed him as a high fall risk, but was a large improvement from evaluation day and exceeded the minimal detectable change for an elderly patient, determined to be 4.6 by Donoghue et al for the high fall risk portion of the scale in elderly patients [5]. Ultimately, upon completion of his rehabilitation, the patient was able to score a 43/56 on his final BERG attempt. This classified the patient as a low fall risk, but not an independent community ambulator (45/56 is the cut-off for an independent community ambulator). However, he again was able to show a clinically significant MDC and was at a much lower fall risk in comparison to both

admission day, as well as the halfway point of his stay [5]. The progression of this patient's BERG scores can be seen in Table 6.

In addition to the BERG, this patient was also able to demonstrate encouraging improvements in his FIM scores as well. Upon admission he scored a 64/156. Although cut-off scores and classifications are not established for the FIM, lower scores are significantly correlated to lower functional ability upon discharge [6.] More importantly in this case however, the patient further showed significantly low scores on the gait, transfers, and stair ambulation portions of the FIM, also known as the motor sections. He was unable to perform gait training or stairs secondary to pain, and he required maximum assistance of one person for transfers leading to a total score of 2/21 on this aspect of the FIM. However, at the halfway point of his rehabilitation, the patient again demonstrated improvements. He scored a 75/156 when looking at the entire scale, but more importantly he showed large changes for the sub-categories of gait, transfers, and stair management. These trends continued over the course of the patient's final week, as he was able to score 91/156 on his final FIM evaluation (12/21 on the motor scale). He was ultimately able to increase his FIM scores on gait, transfers and stairs from "maximum assist" levels to "contact guard assist" upon discharge. While not optimal, these scores allowed the rehabilitation staff and the patient to be confident in the patient's ability to go home under the close supervision and care of his family. Improvements in FIM motor scores can be seen in Table 3.

Table 3. Weekly Progressions in Outcomes

Program Phase	1	2	3
BERG Score (Out of 56)	6	24	43
FIM: Transfers	2	4	4
Gait	0	2	4
Stairs	0	2	4

BERG: Berg Balance Scale
FIM: Functional Independence Measure

In addition to functional assessments, the patient also demonstrated significant improvements in pain and strength scores over the course of his stay as well. Upon evaluation, one of the major limiting factors in this case was the patient reporting extremely high levels of pain. This made it very difficult to provide interventions early on in the rehabilitation process, and it also created the need for the progressive exercise program being investigated. However, at the halfway point of the patient's stay he typically reported pain scores of 3-4/10. Furthermore, he felt that pain was no longer a limiting factor in his exercise. Prior to each session, the therapist would inquire about pain levels, and during the second half of his stay the patient would typically report that "its just a little stiff", or "its not bad at all". This improvement allowed the patient's interventions to progress, and led to further gains in functional independence, as well as lower extremity strength.

With the previously mentioned improvements in overall levels of perceived pain, the patient was also able to demonstrate large improvements in lower extremity manual muscle testing (MMT). Upon initial evaluation, the patient's strength was assessed to generally be 4+/5 on his uninvolved left lower extremity. However, on the involved, right lower extremity the patient was not able to demonstrate any strength measures over 3+/5. These values were limited by both pain and weakness, and as previously mentioned by Overgaard et al, placed the patient at an increased fall risk [8]. Muscles that were particularly involved included quadriceps, hamstrings, and hip abductors, as all of these groups were measured to be 2+/5 upon initial evaluation. However, at the midway point of the patient's rehabilitation stay these values increased to 3+/5, and more importantly to 4-/5 upon discharge. These values nearly matched the uninvolved left lower extremity, and reduced the patients overall fall risk to a point where he was safe to discharge home [8].

DISCUSSION

This case highlights the use of a progressive exercise program in treating a patient recovering from post surgical hip fracture coinciding with high levels of

pain and weakness. Furthermore, it highlights a common dilemma seen when treating patients who have had a hip fracture and ORIF. It is very important to implement skilled physical therapy as soon as possible to avoid de-training and functional decline.[2] Considering this, it is also essential to not push these patients too quickly, as it is very possible to elicit excessive fatigue, lose patient/caregiver trust or even elicit other serious setbacks such as re-injury of the repaired hip.

Clinical Implications

The case reports demonstrates that a progressive strengthening program can be used in conjunction with effective measures to control pain and manage fatigue in a patient following a hip fracture with subsequent ORIF. Too often following these injuries patients do not receive adequate physical rehabilitation, dosed appropriately, that will help them return to their prior active lifestyle. The exercise regimen outlined in this case report is easy to implement and requires no complex equipment. The progressive nature can help to build the patient's confidence and provide motivation through the achievement of meaningful and measurable short-term goals. One simple modification we would make would be to be more overt in our assessment and documentation of the patient's repetition maximum resistance at baseline and would record resistance and repetition progression more consistently.

Limitations

As with any study, there were limitations and complicating factors present in this case that should be addressed. First, when assessing muscular strength, an electronic dynamometer is considered to be a more precise and optimal device as compared to MMT. However, the inpatient rehabilitation facility did not possess one of these devices, nor was one available to the primary author from any other facility in the health system. Therefore, MMT was ultimately used. Additionally, one difficult situation that arose during testing was managing patient fatigue and pain levels while other disciplines (occupational therapy (OT), nursing) were treating the patient. On two instances, the patient requested to stop his PT session early due to increased pain that resulted from a difficult session with OT prior to his PT session. A meeting took place with OT to highlight these concerns, and as the case progressed this was no longer a problem. The parties agreed that higher level functional activities such as gait and transfers would be addressed during PT sessions alone.

CONCLUSIONS

The results of this case study support the use of an individualized progressive exercise program in a hip fracture repair patient experiencing high levels of post-operative pain. While managing pain, and demonstrating no significant setbacks, this particular patient was able to achieve significant increases in functional scores on the BERG as well as the FIM, all while reporting lower pain levels and exhibiting increased lower extremity strength. This patient was able to demonstrate increased hip extension strength as well as normalize side-to-side strength levels over the course of a 3-week stay. These are important considerations given the previously mentioned research by Thingstead,et al. [8,11] Additionally, the patient felt confident in his ability to go home given his decreased pain levels and increased efficiency with gait, transfers and stair management. The results of this case demonstrate that using a progressive exercise program in this patient population is not only feasible, but can be an essential element to providing quality care to a patient who would like to safely resume prior levels of function.

Future directions for research of this nature could focus on implementing this protocol across a broader patient population. A study could be designed to investigate multiple patients who have undergone conservative hip fracture repair with this progressive exercise program as the main intervention, or one similar in nature, to determine whether or not the positive outcomes seen in this particular case could apply to a larger patient population. Furthermore, it would be very interesting to investigate varying combinations of some of the exercises provided, as well as timing, to see if different approaches could lead to further strength and functional gains.

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REFERENCES

1. Beaupre, Lauren A., et al. "Maximising functional recovery following hip fracture in frail seniors." *Best Practice & Research Clinical Rheumatology* 27.6 (2013): 771-788.
2. Begum, Suraiya, and Leslie Ira Katzel. "Silent ischemia during voluntary detraining and future cardiac events in master athletes." *Journal of the American Geriatrics Society* 48.6 (2000): 647-650.
3. Conradsson, M., Lundin-Olsson, L., Lindelöf, N., Littbrand, H., Malmqvist, L., Gustafson, Y., & Rosendahl, E. (2007). Berg Balance Scale: Intrarater Test-Retest Reliability Among Older People Dependent in Activities of Daily Living and Living in Residential Care Facilities. Physical Therapy, 87(9), 1155-1163. Accessed March 17, 2016.
4. Cserháti, Péter, et al. "Hip fractures in Hungary and Sweden–differences in treatment and rehabilitation." *International orthopaedics* 26.4 (2002): 222-228.
5. Donoghue, Declan, and Emma K. Stokes. "How much change is true change? The minimum detectable change of the Berg Balance Scale in elderly people." *Journal of Rehabilitation Medicine* 41.5 (2009): 343-346.
6. Hobart, J. C., et al. "Evidence-based measurement Which disability scale for neurologic rehabilitation?." *Neurology* 57.4 (2001): 639-644.
7. Ocepek, Julija, Anne EK Roberts, and Gaj Vidmar. "Evaluation of treatment in the Smart Home IRIS in terms of functional independence and occupational performance and satisfaction." *Computational and mathematical methods in medicine* 2013 (2013).
8. Overgaard, Jan, and Morten T. Kristensen. "Feasibility of progressive strength training shortly after hip fracture surgery." *World J Orthop* 4 (2013): 248-258.
9. Resnick, Barbara, et al. "Rehabilitation Interventions for Older Individuals With Cognitive Impairment Post-Hip Fracture: A Systematic Review." *Journal of the American Medical Directors Association* (2015).
10. Selva Raj, Isaac, et al. "Effects of eccentrically biased versus conventional weight training in older adults." *Medicine and science in sports and exercise* 44.6 (2012): 1167-1176.
11. Thingstad, Pernille, et al. "Effectiveness of Task Specific Gait and Balance Exercise 4 Months After Hip Fracture: Protocol of a Randomized Controlled Trial—The Eva-Hip Study." *Physiotherapy Research International* 20.2 (2015): 87-99.