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Analyzing the accelerated Physical Rehabilitation of a Patient Status Post Periacetabular Osteotomy and Femoral Derotation Osteotomy

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ANALYZING THE ACCELERATED PHYSICAL REHABILITATION OF A PATIENT STATUS POST PERIACETABULAR OSTEOTOMY AND FEMORAL DEROTATION OSTEOTOMY

by

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This Scholarly Project, submitted by Zachary Burtsfield in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

Steven Haberer, PT, DPT — 10/14/20

(Graduate School Advisor) — Date

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(Chairperson, Physical Therapy) — Date

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Signature **Zachary Burtsfield**

Date 10/11/2020

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ABSTRACT

Background and Purpose The purpose of this case is to analyze the accelerated treatment of a periacetabular osteotomy in a patient who requires up to six surgical corrections to his femoracetabular joint compared to a standard treatment protocol **Case Description** The patient was a 20 year old martial artist presenting with bilateral hip dysplasia seeking physical therapy following a periacetabular osteotomy with a femoral derotation osteotomy. **Intervention** therapeutic exercise and neuromuscular reeducation techniques were included in treatment to improve range of motion, strength, balance, and gait. **Outcomes** The patient was able to increase range of motion and strength to within functional limits and was progressing toward independent gait without assistive devices. **Discussion**. The patient progressed to the third phase of a four phase treatment protocol in 5 weeks of physical therapy placing him about two weeks ahead of protocol, and the patient was cleared to schedule his next hip surgery prior to PT discharge.

CHAPTER I

BACKGROUND AND PURPOSE

Hip dysplasia is the malalignment of the femur and acetabulum causing damage to the femoroacetabular joint.[1] While many patients with hip dysplasia may be diagnosed and receive treatment during childhood, adult diagnosis is not uncommon. The primary symptoms are anterior hip pain, a painful snapping/clicking/popping sensation, and soreness on the lateral hip due to overuse of the hip abductors and flexors.[1] Hip dysplasia in adults is the leading cause of hip osteoarthritis as the malalignment of the femoroacetabular joint causes more rapid deterioration than in healthy hips.

The International Hip Dysplasia Institute recognizes the Periacetabular Osteotomy (PAO) as the most common surgical procedure to treat Adult Hip Dysplasia[1]. Other common nomenclature for this procedure include the Ganz Osteotomy[1] and Bernese Periacetabular Osteotomy[2], both names derivative of the foundational procedure performed by Reinhold Ganz, MD and Jefferey Mast, MD in Bern, Switzerland in 1984.[3] The benefit of this procedure as compared to its alternatives, namely the total hip arthroplasty, is the preservation of the patient's natural femoroacetabular joint, thus avoiding potential complications with artificial joint components. In 2016, a group of researchers evaluated the first 63 patients who received the PAO between 1984 and 1987 to determine the survival of the osteotomy at an average of 29 years post-operatively.[4] Survival was defined as not converting to total hip arthroplasty, no progression of osteoarthritis, and a Merle d'Aubigne-Postel Score (a common hip functional outcome measure) of below 15. At 10 years post-op the survival was 88%, at 20 years 61% ,

and 29% at 30 years post-op, this demonstrates favorable results.[4] The longevity of the periacetabular osteotomy is an important factor for adolescent and young adult patients as the alternative is a total hip arthroplasty (THA), which can require revisions in up to 50% of patients in that age category.[5]

The PAO provides a cost-effective alternative to total hip arthroplasty to treat developmental dysplasia of the hip. The National Health Service (NHS) designed a cost effectiveness study based on data collected in a systematic review, including average cost of the surgeries, and quality of life scores after 30 years post operation. The NHS reports that the average cost per THA is $32,790 for all grades of dysplasia, while a PAO had a cost ranging from $26,592 to $33,465 depending on grade of dysplasia.[6] This article also recognizes that the PAO received higher quality of life scores for grade 1 dysplasia, and was more cost-effective when viewing cost of surgery per quality of life point for grades 1 and 2.[6] The only data supporting a THA being more cost effective than a PAO was for grade 3 hip dysplasia. This makes sense as the point of a PAO is to preserve the natural femoroacetabular joint and the more damaged the joint is prior to surgery the less the perceived benefit would be by the patient. It is also important to understand that research conducted in a 2019 meta-analysis predicted that a 25 year survivorship of a THA is expected in only 58% of patients.[7] While we saw that 25 year survivorship of a PAO was between 29% and 61% in the article mentioned above, only 43% of those patients converted to THA.[4] The conversion from PAO to THA also eliminates the health risks associated with THA revision including aseptic loosening, dislocation, infection, and iliopsoas tendonitis.[8]

While looking at the sequencing of the periacetabular osteotomy, the procedure is performed with the patient positioned supine on the operating table, where an incision is made laterally on the thigh.[9] Some musculature, including tensor fascia latae, rectus femoris and gluteus minimus tendons, must be detached to have appropriate access to the joint capsule.[9] The osteotomy starts by creating a notch in the ischium, avoiding the ischial tuberosity, this notch is made without cutting the full thickness of the bone.[9] The pubis is the first bone to be osteotomized, followed by the supraacetabular cuts made to the ilium, which allows the acetabulum to break toward the ischium where it was notched during the first step. At this point a screw is inserted into the supraacetabular bone in order to aid proper placement of the acetabulum. Lastly, the final cut is made, and the acetabulum is repositioned to be optimal for the patient's particular anatomy using x-ray to guide the surgeon. Once in optimal position wires and screws are inserted to permanently secure the acetabulum in place. In some instances, bone fragments may be packed into the open space between the pelvic bone and the acetabulum to ensure proper fusion. This process is detailed in figure 1.

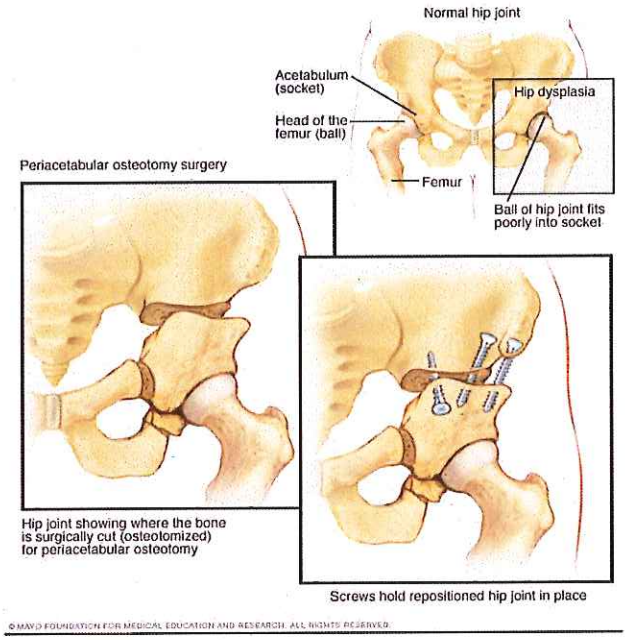


Figure 1: Step by Step visual of the Periacetabular Osteotomy
Reprinted from: Mayo foundation for medical education and research

In a number of PAO patients, femoral derotational osteotomy may be indicated to correct femoral torsion to optimize the mechanics of the femoroacetabular joint and will be performed at the same time as the PAO. This procedure is started with a single 5 cm incision just proximal to the greater trochanter, at which point the femur is penetrated by an intramedullary saw as shown in Figure 2.[10] The intramedullary saw is used to osteotomize the femur from the

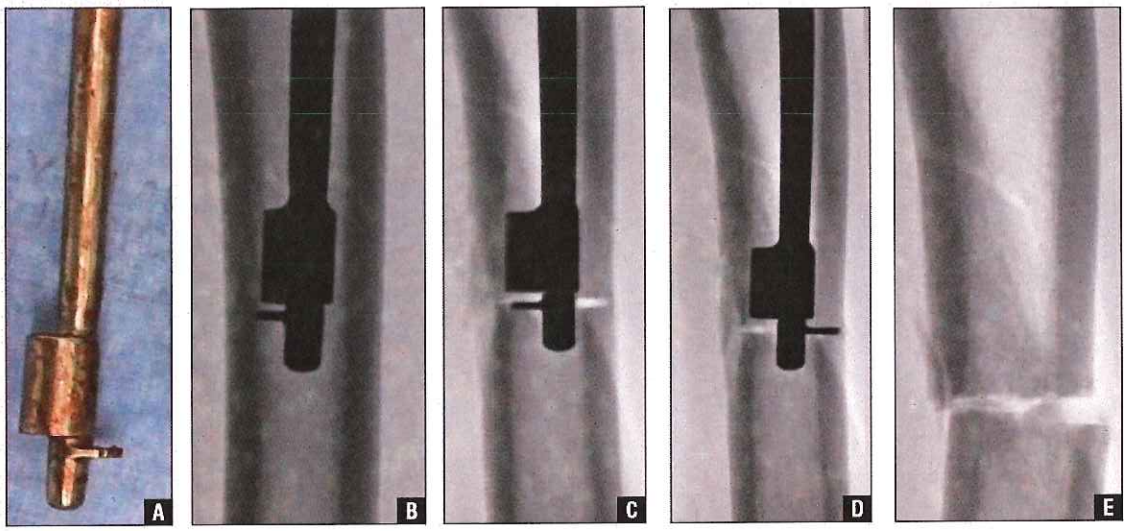


Figure 2. Intermedullary saw and demonstration of the Femoral Derotation Osteotomy
Reprinted from: *Percutaneous Femoral Derotational Osteotomy for Excessive Femoral Torsion by* Mei-Dan O, Mcconkey MO, Bravman JT, Young DA, Pascual-Garrido C.

medullary canal. Once the bone is osteotomized two pins are inserted into the femur at the lesser trochanter and supracondylar region of the distal femur. Using fluoroscopy, the two pins, and a goniometer is used to position the femur in optimal alignment. At the point of optimal alignment, fixation will be facilitated by hardware. The hardware can be an expandable intramedullary nail rod which runs the length of the femur, or plates and screws on the lateral surface of the femur. After the two segments of the femur are fixated, the guide pins are removed.

The purpose of this case study is to discuss and review the role of physical therapy status post periacetabular osteotomy with a femoral derotation osteotomy in a patient who is utilizing an accelerated rehabilitation protocol. The rehabilitation needed to be accelerated to minimize

the patient's time away from work and community functions while still receiving bilateral hip arthroscopies to address his femoroacetabular impingement and bilateral PAOs to address his hip dysplasia. This particular case study observes the patient following his first PAO through the first three stages of rehabilitation. This case will analyze the accelerated rehabilitation of this particular patient compared to the expected recovery timeline.

CHAPTER II

Case Description

The patient was a 20-year-old white male who had developmental dysplasia of the hip affecting both femoroacetabular joints. The patient reports being asymptomatic until age 18 when he recalled insidious onset of anterior hip pain and restrictions in his range of motion bilaterally. These symptoms increased in severity as time went on. The patient lived a very active lifestyle that included high-level martial arts training and competition, cycling, and weight training. The patient had two jobs before surgery: a martial arts trainer for 15 hours a week and a manual labor job that usually accounted for 50 hours a week depending on the project. Before seeking medical attention for his hip pain, he was laid-off by his manual labor employer due to the risk of injury on the job. His hip pain was causing him to have a poor form for essential work tasks like lifting, shoveling, operating machinery, and walking long distances.

The patient was 6'1" and 192 lbs at the pre-operative appointment making his BMI 25.3 which is within normal parameters. His past medical history included a martial arts related grade II right ankle sprain (5 years previous) and bilateral pincer type femoroacetabular impingement syndrome with labral damage diagnosed at the same time as his developmental dysplasia of the hips in his late teens. Non-orthopedic past medical history was unremarkable. The patient was presented with a plan for surgical treatment to address both his femoroacetabular impingement syndrome (FAIS) and his developmental hip dysplasia (DDH). The patient would undergo a right hip arthroscopy to address his FAIS and damage to his labrum, then have twice-weekly visits with physical therapy until his range of motion (ROM),

strength, and comfort with full weight-bearing had improved enough to undergo his right periacetabular osteotomy.

Pre-operatively it was unknown if the patient would require a femoral derotation osteotomy, but the likelihood was that he would be undergoing both procedures and the patient was prepared and educated on both. Following the PAO and femoral derotation, the patient would see physical therapy twice to three times a week until his right lower extremity (LE) strength, ROM, and gait without an assistive device were normalized, at which point he would follow the same surgical interventions on the left lower extremity starting with a hip arthroscopy.

The outpatient PT's chart review found that the patient had a two-night stay in the hospital post-operatively where he was seen by OT, PT, nursing, and a MD. He showed no signs of post-anesthesia delirium and his vitals were stable. The patient communicated he was having pain which was addressed by opioid pain medication dispensed by nursing staff at regular time increments. The patient was given instructions on sit to stand and car transfers before discharge from the hospital and was given a home exercise plan that included passive range of motion to ninety degrees hip flexion, heel slides (limited to 70 degrees hip flexion), gluteal sets, quadriceps sets. The patient was also given axillary crutches with instructions to use the axial crutches for 4 weeks non-weight-bearing on the right leg, then begin toe-touch weight-bearing with the crutches. Post-surgical precautions included no forced hip extension or external rotation for 8 weeks, and hip flexion limited to 70 degrees for 6 weeks, and then 90 degrees of flexion until 8 weeks.

Upon subjective questioning in outpatient PT, it was revealed that the patient's home environment had to be adapted due to the surgery, so he surrendered his lease on a second-floor apartment and moved in with his mother in a two-level house with one 8 inch entry step without

a railing. The main floor contained a bedroom and a bathroom with a tub shower combo. The patient reported that he would get a ride to his grandparent's house over 15 miles away to use their walk-in shower rather than attempt to clear his tub. He expressed difficulty with completing pain-free car transfers as well. His mother drove a minivan which was preferable to transfers to his girlfriend's small sedan but both parties had to coordinate to get the patient to his different appointments. The patient self-reported ice and ibuprofen to be the main methods of pain modulation, but if the pain was severe, he would use his prescription-strength medication as needed.

Outpatient physical therapy orders to evaluate and treat were initiated by the physician's assistant and the patient was first seen by PT 4.5 weeks post-operation. The patient presented non-weight-bearing (NWB) on the right with bilateral axillary crutches. A systems review was performed and as expected the integumentary and musculoskeletal systems were affected by the procedure. The patient's wounds were healing well and were nearly closed. Minor loss of sensation at the incision site for the femoral derotation was noted. Blood pressure was 118/70 mmHg and heart rate was 74 bpm. The patient was independent with sit to stand transfers utilizing one leg and both armrests, with the only difficulty being reaching for and handling his crutches during single-leg stance. The patient reported that his pain level was high that day, ranging from 5/10 to 7/10 in the morning but after taking prescription pain medication his pain was down to a 3/10 by the time of his appointment. The patient filled out the lower extremity functional scale (LEFS) and scored 18/80 indicating 78% impairment in his activities of daily living and sports activities.

The patient was in a sitting position with the right knee extended for the subjective history

Table 1 Initial Range of Motion

and was asked to demonstrate a sit to stand, ambulate to a therapy plinth 10 feet away, stand to sit, and sit to supine, all of which the patient was able to do independently while using his upper extremities. The head of the bed was elevated by 15 degrees due to the patient reporting slight discomfort in the supine position. In this position, initial passive range of motion was assessed by the PT while following the limitations listed for phase I in the rehabilitation protocol. Range of motion can be found in Table 1 below.

	Left	Right (affected)
Flexion	115	55
Extension	10	Neutral
Internal Rotation	35	20
External Rotation	20	10
Abduction	35	25
Adduction	10	neutral

Traditional manual muscle testing was deferred due to the rehabilitation protocol guidelines, however, some LE strength was measured by observing post-surgical exercises, for example, the patient had at least ⅗ strength of the quadriceps to complete a long arc quad, and at least ⅖ for hamstring strength in order to complete heel slides. The patient's bed mobility was assessed and the patient was able to lay supine, left side-lying with pillows between his legs, and prone with pillows under his hips. The patient was then educated on and instructed to ambulate with toe-touch weight-bearing in a 3-point gait pattern with bilateral axillary crutches. The patient was able to verbalize and demonstrate an understanding of the new gait pattern.

The information gathered in the examination process can be processed using a physical enablement model. In our case, the ICF was used and can be viewed in the appendix. Upon evaluation the patient's problem list included pain, decreased right hip range of motion, decreased right lower extremity strength, decreased mobility, surgical incisions and impaired gait. Goals for this patient included increasing range of motion and strength to within normal limits by 6 weeks in order to have less difficulty with his ADLs, progressing to FWB to progress to a normal gait pattern by 10 weeks, and be able to negotiate 15 stairs to return to his apartment by 12 weeks. The patient needed to reach the goals of having a normalized gait pattern and be pain-free to proceed with the same surgeries on the left lower extremity. All of these goals would help the patient progress towards living a pain-free lifestyle including returning to work and enrolling in college courses.

CHAPTER III

INTERVENTION

The interventions that were prescribed to the patient included a mix of therapeutic exercise, therapeutic activity, and neuromuscular re-education. The rehabilitation was based on a four-phase protocol that could span up to 20 weeks post surgery. In the case of athletes, a fifth phase is added for return to sport activities. The phases in order are: maximum protection and pain control, range of motion restoration and preparation for full weight bearing (FWB), Normalize gait and improve strength, advanced strengthening, and return to sport.[11] Each phase of the rehabilitation included certain precautions, which were all adhered to by the patient and the physical therapist. These can be found in detail in the appendix.

Outpatient therapy sessions occurred 3 times per week for 5 weeks, and each session lasted 30-40 minutes. The patient was instructed by the physician to take pain medication an hour prior to therapy appointments, and it was left to the patient's discretion to choose between ibuprofen and his prescription pain medication. The patient consented to engage in treatment prior to every appointment, and each treatment was discussed and rationalized with the patient to increase patient compliance and understanding.

Phase one exercises consisted of primarily open chain exercises that are typical for post-operative exercises for hip procedures. These included glute sets, hamstring sets, quad sets, short arc quads, and ankle pumps. In addition to these exercises, passive range of motion of the hip was to be done multiple times a day to avoid general stiffness and contracture of the hip

flexors. This phase also included normalizing gait pattern with assistive devices. In this patient's case he used bilateral axillary crutches. The majority of this phase was completed prior to the patient's first outpatient therapy appointment. Following the physical therapy evaluation at 4.5 weeks post-op, it was cleared by the patient's physician to progress to phase two of the protocol: ROM restoration and preparation for FWB.

Phase two exercises began with active range of motion of the hip, beginning in open chain movements. Progression for ROM was based on patient tolerance, progressed from gravity assisted motion to antigravity motions in open chain, and then into closed chain activities such as quadruped rocking. The closed kinetic chain encourages functional stretching, and in the case of quadruped rocking, it has been shown to stretch the posterior capsule, thus improving range of motion in flexion and internal rotation.[12] Another benefit of the exercise includes reducing compressive forces on the anterior joint surface. The quadruped rocking exercise is performed with the patient weight bearing equally through both hands and knees, and having the patient shift their weight caudally by bringing their pelvis towards their ankles. The patient may hold for 10 seconds at the point of stretch without pain.

Another goal of this phase is to introduce weight bearing activities, progressing towards FWB in order to decrease reliance on the assistive device. For this purpose, weight bearing was progressed from the quadruped weight rocking exercises to standing weight bearing activities. Standing weight shifts with normal base of support in the parallel bars was the starting point and progressed to semi tandem stance weight shifts with parallel bars, focusing on reducing the reliance on the upper extremity for support. As the patient was able to increase weight bearing, the patient progressed to ambulating with one axillary crutch contralateral to the injury using a modified two-point gait pattern. From there, weight-bearing was increased by attempting a

single leg stance in the parallel bars, with focus on reducing the need for upper-extremity assist. Once this was achieved, muscle endurance for single leg stance and balance were the focal point. Balance was addressed with activities like cone tapping with feet, Romberg stance on 2" foam, tandem stance on 2" foam, and single leg stance, progressing to single leg stance on 2" foam. The target for each of these balance exercises was to maintain balance for one minute. Once the full minute was no longer challenging, the exercise was modified with the patient closing his eyes. Once full weight bearing and satisfactory static balance were achieved on the affected leg, gait training with a single point cane in a modified two-point gait pattern was initiated.

Another focus of, phase two activities was strengthening of the hip musculature in preparation of weight bearing activities. Similar to the mobility exercises above, the progression of exercises started with open kinetic chain activities and moved to closed chain activities. An increase in resistance and repetitions was also utilized to tailor the exercises to challenge the patient. Exercises like the standing single leg march, long-arc quad and prone hamstring curl were resisted using ankle weights. Weight would be adjusted once the patient could complete three sets of 12 repetitions without difficulty at the current resistance. Once open chain exercises were deemed to be too easy, closed chain exercises like lunges, calf-raises, mini-squats, bridges, step-up, and step downs were initiated. In addition to lower extremity strengthening core strengthening was initiated with planks, side planks, and bird dogs. Phase three was initiated with the patient but not completed before the patient was cleared for his next surgery. Phase three activities included gait training, hip abduction strength, and balance activities for the patient. The patient was able to begin reducing his reliance on the single point cane for ambulation and was able to begin gait training without an assistive device,

although the patient could only handle short distances. The patient was working on hip abduction strength in side-lying with ankle weights and standing with resistance bands. The patient was also instructed in dynamic balance activities including retro-walking, side stepping, and walking with head turns.

CHAPTER IV

OUTCOMES

The outcomes for the patient were favorable. The overall goal for rehabilitation was to improve lower extremity ROM, strength, and function to a point where the patient could ambulate comfortably without an assistive device. Reaching that milestone acted as the indicator that he was ready to begin the surgical treatment on his left lower extremity. Objective and subjective data were collected to analyze the patient's progress. Objective measures included ROM, manual muscle test (MMT) strength, the patient's use of an assistive device, and the LEFS. Subjective data included pain rating and patient self-reporting functional limitations or difficulty with tasks.

Right hip ROM was measured every third visit using a goniometer. Range of motion at 9 weeks can be found in detail in Table 2 below. The patient reported having no right hip pain at rest and 2/10 pain with certain activities. The most painful activity for the patient was attempting to ambulate without an assistive device. The patient progressed his assistive device usage from bilateral axillary crutches to a single axillary crutch to a SPC in a 6 week span. He preferred the SPC to the single axillary crutch as it was less cumbersome, and was ambulating with a single point cane (SPC) at all times at the end of data collection and displayed an uncompensated Trendelenburg gait upon walking without an assistive device in the physical therapy gym. The patient reported little to no difficulty with car transfers, although he did

remark that it was easier to transfer into his mother's minivan than into his girlfriend's sedan, in which the seat sits much lower, requiring more hip flexion ROM.

Table 2 Initial Range of Motion compared to Range of Motion and manual muscle test strength at 9 weeks post-surgery.

	Initial Range of Motion	Range of Motion (9 weeks)	MMT Strength (9 weeks)
Flexion	55 Degrees	113 Degrees	4/5
Extension	0 Degrees	25 Degrees	4/5
Internal Rotation	20 Degrees	35 Degrees	3/5
External Rotation	10 Degrees	53 Degrees	3/5
Abduction	25 Degrees	41 Degrees	4/5
Adduction	0 Degrees	20 Degrees	4/5

The patient also reported no difficulty clearing his bathtub in order to take a shower at his home, which eliminated the need to travel to his grandparents for the walk in shower. The patient was able to improve his form for sit to stand transfers as well. He was able to bear weight equally through both extremities and rise from sitting to standing with no upper extremity assistance. The patient did prefer to have one hand on his SPC during sit to stand transfers as he felt that it minimized risk of dropping his cane.

Manual muscle test strength was not performed at initial evaluation due to post-surgical restrictions but was measured prior to discharge and those measurements can be found in Table 2 The LEFS Score recorded 9 weeks post surgery was 44/80 as compared to 18/80 at initial evaluation. It is important to keep in mind that 20 points on the LEFS concern sport activities like running and hopping, which the patient would not be expected to be able to complete at this point in his recovery. The LEFS was utilized due to it's well documented validity and test-

retest reliability which was found to have an intraclass correlation of 0.92 for patients following orthopedic surgery.[14]

Goals that were met during outpatient physical therapy included reaching 110 degrees of hip flexion, achieve a hip rotation arc of 80 degrees or more, decrease assistive device use to a SPC or less, and MMT strength of at least 4/5 for hip flexion, abduction and extension. A goal of increasing LEFS score by 30% was achieved and the patient was able to demonstrate independence with his home exercise plan (HEP). The lone goal that was not met was normal and pain-free gait without an assistive device, which was the last goal to meet before the patient was able to begin surgical treatment on his left hip.

The patient suffered no ill effects from the interventions. Each exercise was monitored for patient response and was modified if needed to be challenging but tolerable. The patient was very compliant with exercises and there were no instances of non-compliance, as would be expected with a trained martial artist. He took an active role in his rehabilitation, and was eager to learn about the healing process, and showed good understanding of why the rehabilitation protocol restricted some activities for a set amount of time. The patient was very responsive to both verbal and physical cueing during treatment sessions, and that knowledge carried over to future treatment sessions. The patient expressed satisfaction with the care and treatment received and was pleased to be able to resume activities that were previously too painful such as swimming and cycling.

CHAPTER V

DISCUSSION

During the outpatient episode of care, the patient was able to gain significant range of motion and strength in his right lower extremity. This allowed the patient to make progress towards his functional goals including increasing his functional mobility and being independent with his activities of daily living (ADLs). The patient's last remaining goal to meet for this episode of care was to have a pain-free normalized gait pattern on all surfaces. It is noteworthy that the data collection on this patient stopped at 9.5 weeks post-operative due to the student physical therapist departing to return to his academics. The implication of the PT departure is that the patient data was not collected through discharge, so the outcomes discussed may have changed by the patient's discharge.

It is also worth noting that the patient in this case study followed a modified version of the rehabilitation protocol for a number of reasons. The addition of the femoral derotation osteotomy caused the patient to be non-weight-bearing for over a week longer than is standard for a PAO. In addition, the patient's hip dysplasia and FAI were bilateral so the treatment plan had to be modified to facilitate additional surgeries. The typical rehabilitation plan would be to progress through the first four phases continuously. As stated before, the patient's rehabilitation had a modified structure to accommodate his lifestyle. For this patient after Phase II was completed he would have a break in physical therapy to undergo a hip arthroscopy on the left to address the FAI, and then return to physical therapy to address both hips. From that point on he

would have physical therapy visits lasting one hour in order to rehabilitate both hips at their respective phases in the rehab protocol. Around the time his right hip would be in phase 4 of rehab the PAO procedure would be performed on the left hip.

The outcome findings indicated that the patient was indeed having a successful recovery and would in all likeliness make a return to a high level of function. Bogunovic et al found in their 2014 systematic review that 97% of patients were satisfied with their recovery from surgery and 71% of active PAO patients returned to pre-surgical or higher levels of function.[13] The most limiting factor listed in that study was hip pain after surgery, which the patient in this case study did not report.

There are aspects of this case that could have been improved if done again. The obvious factor being data collection; having data through the entire episode of care would have been optimal. Data collected for the entire recovery process of both legs, for a grand total of 6 surgical procedures would have been even more interesting for both the researcher and the reader. Following the patient through all phases of rehabilitation is a staple in similar case studies but was not possible in this instance. Another improvement would be increasing the number of functional outcome measures completed by the patient. The lower extremity functional scale (LEFS) was the one completed by the patient, which is good for its excellent test-retest validity and covers a broad spectrum of activities from basic ADLs to sports activities like jumping and sprinting. If done again I would suggest using the Harris Hip Score (HHS) in addition to the LEFS in order to be able to compare this case to literature more accurately. Much of the research available utilizes the HHS as the primary functional measure and it would have been interesting to analyze the progress of this patient with that data. Having access to the functional outcome measure scores taken preoperatively would have been optimal but did not

come to fruition. Strength testing was completed prior to PT departure but was not recorded previous to that, which does not allow for analysis of growth. Furthermore, documentation of patient education should have been better recorded for inclusion in the intervention section.

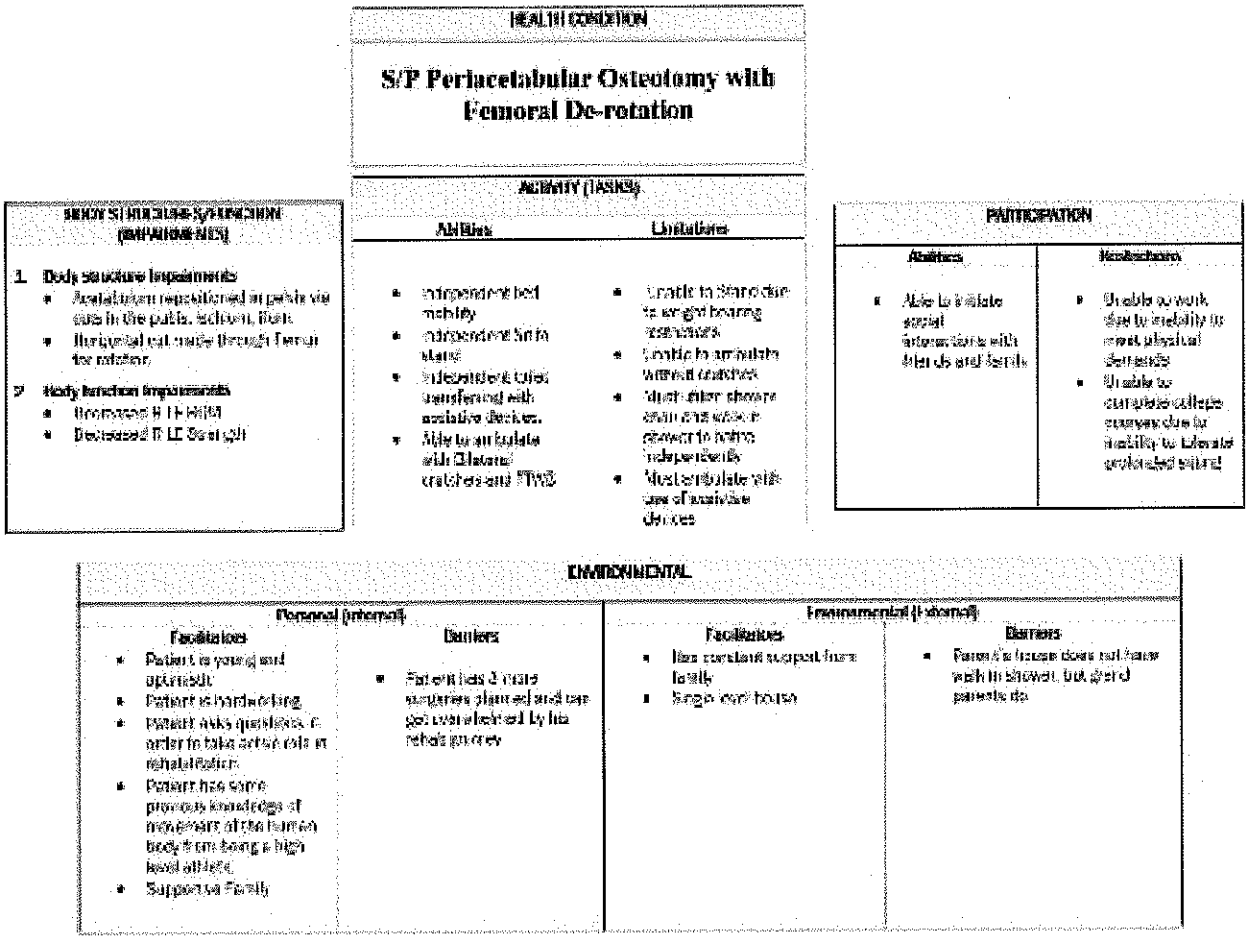
The treatment provided was satisfactory in the eyes of the patient, his family, and the therapist. The patient was especially excited that preserving his natural femoroacetabular joint meant a decreased likelihood of future corrective surgeries for his hips. This gave the patient opportunities to continue school, martial arts, and work as he had planned, and with less modifications and financial burden than that of a total hip arthroplasty. Further research could be done concerning patients who require a bilateral PAO to determine what is the most efficient way to rehabilitate the patient to return to their prior level of function

Reflective Practice

Reflecting on my practice, there are some areas that I would have improved my practice. The first area I would have improved is collecting measurements consistent with other scholarly literature about this diagnosis. An example would be using the Harris hip score for a functional assessment in addition to or in replacement of the LEFS, as that would have allowed me to compare outcomes to the literature more objectively. I also would have liked to included Sahrmann style strength testing and treatment for the abdomen in order to ensure the patient had proper stabilization of the pelvis.

The other retroactive change I would make is ensuring that I could have collected data for the entire episode of care. Because my clinical affiliation ended before the patient discharged, I was not able to collect data from after my date of departure, which means that the outcomes could have changed without my knowledge. I addition to this, this case study only covers the rehabilitation of one surgery out of four to six scheduled for this patient. A case study observing the entire treatment process including rehabilitation for all completed surgeries and the outcomes for both treated lower extremities.

APPENDIX


HEALTH CONDITION
S/P Periacetabular Osteotomy with Femoral De-rotation
BODY STRUCTURE/FUNCTION (IMPAIRMENTS)
1. Body structure impairments
Avulsion repositioned at pelvis via cuts in the pubis, ischium, ilium
Horizontal cut made through femur for rotation
2. Body function impairments
Decreased R LE Strength
ACTIVITY (TASKS)
Abilities
Independent bed mobility
Independent Sit to stand
Independent bed transferring with assistive devices.
Able to ambulate with Elbow crutches and TWB
Limitations
Unable to stand due to weight bearing restrictions
Unable to ambulate without crutches
Must utilize shower chair and wash shower to bathe independently
Must ambulate with use of assistive devices
PARTICIPATION
Abilities
Able to initiate social interactions with friends and family
Limitations
Unable to work due to inability to meet physical demands
Unable to complete college courses due to inability to elevate operated extremity
ENVIRONMENTAL
Personal (internal)
Facilitators
Patient is young and optimistic
Patient is hardworking
Patient asks questions in order to take active role in rehabilitation
Patient has some previous knowledge of precautions after having body cast due to being a high level athlete
Supportive family
Barriers
Patient has 2 more surgeries planned and has got overwhelmed by his rehab journey
Environmental (external)
Facilitators
Has constant support from family
Single level house
Barriers
Patient's house does not have walk in shower, but plans to

PHASE I (Surgery to 6 weeks)

Appointments	• Surgery will require an inpatient hospital stay of 2-5 days • Inpatient rehabilitation begins post-op day 1, with emphasis on gait training and protection of the surgical limb • Physician appointment scheduled 3 weeks after hospital discharge • First outpatient rehabilitation appointment should be 3 weeks after discharge • Second appointment 6 weeks after discharge
Rehabilitation Goals	• Protection of the post-surgical hip through limited weight bearing and education on avoiding pain • Reduce pain to 0/10 at rest and with walking • Normalize gait with assistive device • Restore leg control
Precautions	• Avoid prolonged sitting for more than 1 hour with hips flexed to 90° or greater • Avoid walking distances to point of fatigue • Anterior hip precautions: no hip extension past neutral, avoid external rotation (ER), no crossing the legs • No active hip flexion with long lever arm, such as active SLR • No open chain isolated muscle activation, such as side lying hip abduction or prone hip extension • Protective foot flat weight bearing, no more than 20# of body weight, with axillary crutches • CPM for 8 hours per day, range of motion (ROM) set from 0° of extension to 30° of flexion, at speed of 1. This can be increased after 1 week gradually up to 90° as the patient tolerates. This will typically be discharged at the first post-operative appointment.
Suggested Therapeutic Exercises	• Passive range of motion (PROM) • Supine abdominal setting, prone abdominal setting with pillow under hips, quad sets, ankle pumps • Isometric hip exercises: abduction, adduction, internal rotation, ER, bridge without lifting hips. Prone heel squeeze with pillow under hips • Short arc quads, long arc quads, standing hamstring curls • Can begin pool walking, chest deep, at 6 weeks
Cardiovascular	• Upper body circuit training or upper body ergometry (UBE)
Progression Criteria	• Normal gait with assistive device and minimal to no pain • May be advanced to Phase II prior to 6 weeks per physician

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PHASE II (begin after meeting phase I criteria. Usually 6-12 weeks after surgery)

Appointments	• Rehabilitation based on patient progress, 1 times every 1-2 weeks
Rehabilitation Goals	• Normalize gait without device, progressing to WBAT first then from 2 crutches to 1 crutch to no device • Demonstrate good core control, adequate pelvic stability, and no pain with ADLs • Ascend/descend an 8" step with good control and no pain
Precautions	• Use assistive device until gait is non-antalgic • Symptom provocation during ADLs and therapeutic exercise • Avoid post-activity swelling or muscle weakness • Active hip flexion if symptomatic, especially SLR. Impingement of iliopsoas on pubic osteotomy site after PAO is common and can cause tendinopathy. • Faulty movement patterns and postures
Suggested Therapeutic Exercises	• Open chain AROM: standing hip abduction and hip extension to neutral • Hip AROM with stable pelvis: bent knee fall out, heel slide, prone windshield wiper • Prone lying progressing to prone knee bending, then to prone posterior pelvic tilts to facilitate recovery of functional hip extension • Closed chain work: squats, step ups, step downs, static lunge stance, leg press • Balance and proprioceptive work: narrow stance double leg work, single leg, single leg with contralateral lower extremity resistance, Romanian deadlift, upper extremity reaches • Upper extremity resistance training in lunge stance: single arm rows, single arm punches with and without pelvic rotation
Cardiovascular Exercise	• UBE, swimming laps with pull buoy, walking in the pool (chest height water is 75% unweighted, waist height is 50% unweighted)
Progression Criteria	• Normal gait on all surfaces without device • ROM that allows for carrying out functional movements without unloading affected leg or pain, while demonstrating good control • Able to ascend/descend 8" step with good pelvic control • Good pelvic control while maintaining single leg balance for 15 seconds

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PHASE III ((begin after meeting phase II criteria. Usually 12-16 weeks after surgery)

Appointments	• Rehabilitation based on patient progress, 1 times every 2-3 weeks
Rehabilitation Goals	• Optimize ROM • Improve core strength, adequate performance of level III on Sahrmann core test • Improve lower extremity strength, particularly proximally, to 5/5 • Pain-free ADLs • Demonstrate symmetry to uninvolved side with higher level single leg balance tests, such as y-balance test
Precautions	• No ballistic or forced stretching • Avoid painful end range hip flexion. Due to change in orientation of acetabulum a little restriction is end range hip flexion is expected • Be cautious with repetitive hip flexion activities, such as treadmill and StairMaster. Sahrmann testing should not be used as an exercise progression. • Avoid lumbar and pelvic compensations with functional movement • No impact activities until patient is at least 3 months out from surgery and demonstrates adequate hip and lower extremity control
Suggested Therapeutic Exercise	• Gait and functional movement drills • Non-impact LE and core strength work, with progression from quadruped to standing, double leg to single leg, and single plane to multiplane • Focus on hip abduction strengthening: side lying and functional closed chain • Continue aggressive hip rotator strengthening: lunge stance single arm rows and punches with and without pelvic rotation • Balance and proprioceptive training • Progress hip ROM without pain. While manual therapy/joint mobilization may be appropriate, some patients dealt with hip instability prior to surgery so these techniques should be used with caution • When strength is adequate, Impact control exercises beginning 2 feet to 2 feet, progressing from 1 foot to other and then 1 foot to same foot then progress from single plane drills to multi-plane drills • Sport/work specific balance and proprioceptive drills • Stretching for patient specific muscle imbalances
Cardiovascular Exercise	• Cycling, elliptical, deep water running • Avoid pelvic compensations
Progression Criteria	• Level III on Sahrmann core test • 5/5 lower extremity strength • Good pelvic control with single limb activities • Hip ROM adequately meets demands of all ADLs

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PHASE IV (Begin after meeting Phase III criteria. Usually 16-20 weeks after surgery)

Appointments	• Rehabilitation based on patient progress, 1 time every 3-4 weeks
Rehabilitation Goals	• Independence with exercise program • Abolish post exercise soreness • Able to walk long distances, > 1 mile, without limp • Pass appropriate functional tests prior to return to sport
Precautions	• Maintain adequate strength base
Suggested Therapeutic Exercises	• Continue aggressive hip and core strength work • High level balance and proprioceptive training • Maximize ROM • Introduce plyometrics, running, and cutting • Sport/work specific balance and proprioceptive drills • Stretching for patient specific muscle imbalances
Cardiovascular Exercise	• Specific to sport
Progression Criteria	• Pain-free with rehab • Pass appropriate functional testing to ensure safety with return to sport

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