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Rehabilitation following a Distal Fibular Fracture in a 16 Year Old Female Athlete: A Case Report.

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Rehabilitation Following a Distal Fibular Fracture in a 16 Year Old Female Athlete: a Case Report.

by

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This Scholarly Project, submitted by Brett Morlock 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.

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(Graduate School Advisor)

(Chairperson, Physical Therapy)

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Title Rehabilitation Following a Distal Fibular Fracture in a 16 Year Old Female Athlete: a Case Report.

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Signature Brett Morlock

Date 9/8/15

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ABSTRACT

Background and Purpose:
Distal fibular fractures are an uncommon injury in athletes, they are produced by repetitive stress to the fibula often due to overuse. The purpose of this case report is to discuss the rehabilitation following a distal fibular fracture of a young, female athlete and how the rehabilitation prepared the patient to return to her sports.

Case Description:
The patient is 16 year old Caucasian female who participated in both cheerleading and gymnastics. She sustained a left distal fibular fracture while performing a stunt in cheerleading. The patient was referred to physical therapy following six weeks of activity modification and rest.

Intervention:
The patient's plan of care included interventions that focused on lower extremity strengthening focusing on the left ankle and bilateral hip musculature, balance, jumping and running.

Outcome:
The patient returned to her sports with no pain or difficulty following six weeks of intensive physical therapy.

Discussion:
The patient obtained great results and her results fit in with former literature on fibular fractures.

CHAPTER I

BACKGROUND AND PURPOSE

"Stress fractures are relatively uncommon injuries, accounting for approximately 1% to 7% of all athletic injuries. The incidence of these injuries is rising due to earlier and longer participation in sports, the emergence of more extreme sporting activities, and the heightened awareness of the diagnosis."[1 p.481] Distal fibular fracture prevalence is minimal in athletes and is caused by repetitive and excessive stress to the fibula, often due to overuse. It is common in runners, jumping sports, gymnastics, cheerleading, and dancing in adolescent girls.[2] A cross-sectional study done of 5,461 girls aged 11-17 years old showed that 2.7% had a history of fibular stress fractures.[2]

There is little research on distal fibular fracture rehabilitation in athletes following either a non-surgical or surgical approach to fix the fracture. Most research will group together multiple different types of ankle fractures in adults and report them as a conglomeration of "ankle fractures." In addition, there is a vast amount of research on ankle fractures following a surgical approach. An article by Porter, May and Berney goes on to discuss the functional outcomes of athletes who underwent ORIF (Open-Reduction Internal Fixation) of their ankle fractures sustained in sporting events.[3] However, there is little research on ankle fractures following a non-surgical approach, much less specifically on a non-surgical approach to a distal fibular stress fracture.

The common etiology of stress fractures includes a drastic recent increase in physical activity or repeated excessive activity with limited rest.[4] "Depending on the injury, healing time for stress fractures can vary from 4 to 12 weeks or longer from the time activity is restricted. Treatment should begin as soon as the injury is suspected, because delayed treatment has been correlated with prolonged return to activity."[4 p. 44] "Stress fractures of the foot and ankle can be divided into low and high risk based upon their propensity to heal without complication".[1 p.481] Those fractures in the high risk category include the medial malleolus, navicular, talus, fifth metatarsal base, and sesamoid bones.[1] A lateral malleoli stress fracture is ranked in the low-risk category along with the calcaneus, cuboid, and cuneiform bones, and usually does not require surgical intervention for healing, but it also depends on the demand of the patient.[1] There have also been both intrinsic and extrinsic risk factors identified for sustaining a stress fracture. Intrinsic risk factors for stress fractures include: the patient's anatomy and biology including cavus feet, leg length discrepancies, excessive forefoot varus tarsal coalitions, a prominent posterior calcaneal process, tight heel cords, poor bone density or vascular supply, and abnormal hormonal levels.[1] Extrinsic risk factors for stress fractures include: type of activity, excessive/new training regimen, poor equipment/footwear, improper technique, type of training surface, and sleep deprivation.[1]

Management of a stress fracture can include the following: reduce activity to the level of pain-free functioning, stretch and strengthen supporting structures in rehabilitative program, increase activity in a graduated fashion after several weeks of rest and improved symptoms, use pneumatic compression device or other biomechanical stress-relieving measures for lower-extremity stress fractures, encourage cross training to maintain cardiovascular fitness, consider surgery for patients with recalcitrant or high-risk stress fractures.[4] A review of 320 cases of stress

fractures in athletes showed that conservative treatment of stress fractures in athletes is satisfactory in the majority of cases.[5] Conservative treatment could consist of "activity restriction and a stepwise return to sport."[6 p.109] A study showed both location of the injury and severity determined by imaging should be considered for prediction of return to sport time.[7] Return to sports time was significantly longer in high-grade fractures than in low-grade fractures.[7] Another article written reflects the same ideology that "stress fracture management should take into consideration the injury site (low risk versus high risk), the grade (extent of micro damage accumulation), and the individual's competitive situation."[8 p.26] The prognosis for athletes to return to their full sport following a distal fibular fracture is an average of 6.8 weeks following 6-12 weeks of abstention from all activity.[3]

The purpose of this case study is to discuss the rehabilitation of a young female athlete following a left distal fibular fracture. This case report is of a 16 year old Caucasian female who participated in both cheerleading and gymnastics. She sustained a left distal fibular fracture, refer to Figure 1, during cheerleading. She received the non-surgical approach as her fracture was deemed a low-risk fracture and abstained from her prior level of activity for six weeks in which she wore a CAM (Controlled Ankle Motion) boot. She was expected to return to her sports following six weeks of rehabilitation after the initial six weeks of activity modification. There was no specific screening criteria used for patient selection for this case study. The patient was referred to the facility from her doctor and the patient was accepted for care.

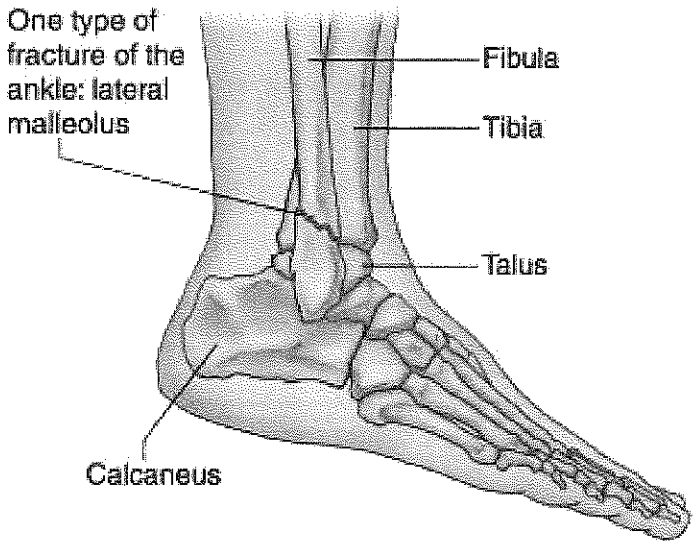

Figure 1. One type of fibular fracture[9].

CHAPTER II

CASE DESCRIPTION

Examination, Evaluation and Diagnosis

Chief Complaint

The patient reported to physical therapy (PT) six weeks after the initial injury. She was performing a stunt in cheerleading when she was thrown into the air and was not caught properly, she then landed on her left ankle "unnaturally". Unfortunately, she was unable to describe the exact way she landed on her ankle. She had an X-ray performed immediately following the injury where it was confirmed she had sustained a fractured left distal fibula. A study done showed the characteristics of stress fractures in young athletes under 20 years old and concluded those cases who visited the hospital within 3 weeks had a statistically significant lower return time to sports than those who waited more than 3 weeks after the onset of symptoms.[10] They stated it is important to educate young athletes that continuous pain lasting over 3 weeks is a warning signal to the body and that early diagnosis leads to early recovery.[10] A systematic review of diagnostic accuracy of various imaging modalities for suspected lower extremity stress fractures concluded that conventional radiographs are likely to result in false negatives upon initial presentation, particularly in the early stages of stress fracture, and in some cases may not reveal an existing stress fracture at any time.[11] It is safe to say that if the patient had sustained a distal fibular stress fracture, it may not have been revealed immediately on her initial radiograph.

History/Past Medical History

The patient was a 16 year old female with no significant past medical history. The patient was 5'4", weighed 105 pounds, and had a BMI of 18.0. Her current functional status at the time is as follows: the patient had decreased strength (especially in her hips and ankles bilaterally), decreased single leg balance, decreased aerobic capacity, and was able to ambulate at a functional distance with no assistance and no pain. She was in excellent physical condition prior to her injury, but following the injury her cardiovascular ability was decreased due to limiting her activity level for six weeks. The patient enjoyed horseback riding and was unable to do so following her injury. The patient wore a CAM boot for six weeks following the initial injury as prescribed by her physician, she was then referred to PT after those initial six weeks had been completed. She presented to PT with an ankle brace that was recommended by her physician. The patient was able to drive herself to appointments in her own car in order to accommodate having her parents take time out of their work day to bring her to appointments. She had no previous treatments for this diagnosis and had no significant past medical history warranting physical therapy. The patient's goal for physical therapy was to return to her sports with no pain or difficulty, as well as, return to horseback riding.

Medication

The patient was taking ibuprofen as needed for pain control per doctor's orders throughout the duration of treatment. Side effects of ibuprofen include: abdominal pain, heartburn, itching skin, pain or discomfort in chest, upper stomach, or throat, nausea, noisy/rattling breathing, shortness of breath, swelling of face, fingers, hands, feet, lower legs, or ankles, troubled breathing at rest and with exertion, unusual bleeding or bruising, unusual

tiredness or weakness, weight gain, blurred vision, confusion, dizziness, lower back or side pain, muscle twitching, and seizures.[12]

Tests and Measurements

The patient's gross range of motion (ROM) of the lower extremities (L/E) presented with full active range of motion (AROM) of the hips, knees, and ankles bilaterally. The patient's gross strength of the lower extremities measured by manual muscle test (MMT) is shown in Table 1.

Table 1. Strength of Lower Extremities Measured by MMT

	Right	Left
Hips	Abduction: 4/5 Flexion: 4/5 Extension: 4/5	Abduction: 4/5 Flexion: 4/5 Extension: 4/5
Knees	Flexion: 5/5 Extension: 5/5	Flexion: 5/5 Extension: 5/5
Ankles	Dorsiflexion: 5/5 Inversion: 5/5 Eversion: 5/5 Plantarflexion: 5/5	Dorsiflexion: 5/5 Inversion: 4/5 Eversion: 4/5 Plantarflexion: 4/5
Gastrocnemius/Soleus	Single Leg Calf Raises: 25	Single Leg Calf Raises: 11

Several special tests were performed to assess for ligamentous injury, these included the Talar Tilt Test, the Kleiger's External Rotation Test, and the Syndesmosis Squeeze Test of the leg. The Talar Tilt Test was performed to assess the calcaneofibular ligament (CFL) and the anterior talofibular ligament (ATFL). The Kleiger's test was performed to assess the deltoid ligament of the foot. The Syndesmosis Squeeze Test of the leg was performed as well to test for instability between the tibia and fibula. The results of all of the special tests are shown in Table 2. A study by Rosen and Brown gave sensitivity, specificity, and likelihood ratios for the manual Talar Tilt Test[13], which are shown in Table 2. Another study by Schwieterman, Columber, and

Cook gave sensitivity, specificity, and likelihood ratios for both the Kleiger's External Rotation Test and the Syndesmosis Squeeze Test of the leg[14], also shown in Table 2.

Table 2. Special Test Results

Test Name	Positive/Negative	Sensitivity (95% CI)	Specificity (95% CI)	Likelihood Ratios (95% CI)
Talar Tilt	Negative bil.	0.49 (.34-.64)	0.78-0.88	(+) 2.23-4.14 (-) 0.58-0.66
Kleiger's External Rotation	Negative bil.	0.20 (0.04-0.56)	0.85 (0.71-0.93)	(+) 1.31 (0.32-5.41) (-) 0.94 (0.69-1.30)
Syndesmosis Squeeze Test of the Leg	Negative bil.	0.30 (0.08-0.65)	0.93 (0.81-0.98)	(+) 4.60 (1.08-19.55) (-) 0.75 (0.50-1.13)

Bil=bilaterally, CI=Confidence Interval

Systems Review

The patient's integumentary, musculoskeletal, and neuromuscular systems were screened as deemed necessary. An integumentary screen of the lower extremities was performed with the following results; the patient's skin integrity was good with no signs of breakdown and her skin color was normal with no signs of bruising. Palpation of the left lateral ankle showed slight tenderness and swelling of the lateral malleolus.

To accompany the aforementioned musculoskeletal screen, the patient's posture was assessed as well. The patient's gross symmetry/posture showed from the anterior view: rounded shoulders, hunched posture in sitting, and her right shoulder lower than left; from the posterior view, there was nothing significant; from the lateral view the patient presented with rounded shoulders and a forward head posture.

A neuromuscular balance screening was also performed to assess the patient's static and dynamic balance to gain baseline data since she participates in gymnastics and cheerleading and balance is a key factor in those two sports. The results are displayed in Table 3. The patient's ambulation of level surfaces and up and down stairs was good. The patient was also oriented x4 (person, place, time, and situation).

Table 3. Initial Balance

Balance Test Position	Balance Grade
Sitting Balance	Good (able to sit safely unsupported for 2 minutes)
Standing Static Balance	Good (able to stand safely for 2 minutes)
Standing Dynamic Balance	Right Single Leg Stance: Good (>60 seconds) Left Single Leg Stance: Fair (<8 seconds)

Evaluation

The patient's signs and symptoms were consistent with the medical diagnosis of a left distal fibular fracture. The patient showed signs of weakness in her lower extremities which was expected due to her inability to exercise for six weeks. The patient also had mild balance deficits on her left side due to her inability to hold a single leg stance for more than eight seconds. She had no functional limitations such as self-care and home management, but she did have activity/participation restrictions in which she was unable to perform in her sports of cheerleading and gymnastics. Her coach was waiting for confirmation from PT that she could return to sport. She was also unable to ride her horses per her doctor's orders. The patient was in need of increasing the strength of bilateral hips, legs, and ankles, as well as improve her dynamic balance in order to land safely in sports and decrease the chance of future injuries.

The patient's problem list included: 1) Decreased strength of bilateral lower extremities, especially the left ankle. 2) Decreased dynamic balance. 3) Minimal tenderness to touch. 4)

Slight swelling of the left lateral malleolus. The ICD-9 code for this diagnosis is 824: Fracture of ankle.[15]

Prognosis and Plan of Care

The patient's prognosis was excellent due to her motivation to return to her sports and prior level of function, as well as her increased motivation to return to riding horses. The patient displayed fair strength in her lower extremities and fair single leg balance on her left leg which helped her prognosis. Her anticipated duration and frequency of intervention was 2-3x/week for up to 6 weeks as needed.

Her rehabilitation goals included: Short term goals (all to be met within 2 weeks)—Following PT intervention 1) the patient will be independent with her home exercise program (HEP) in order to continue to progress in therapy sessions. 2) the patient will obtain a 4+/5 MMT in all hip, knee, and ankle motions in order to have increased strength for activities of daily living such as ambulation and exercising. 3) the patient will be able to hold a single leg stance on bilateral legs for 1 minute in order to decrease her risk of falling.

Long term goals (all to be met within 6 weeks)—Following PT intervention 1) the patient will be independent with the advancement of her HEP in order to decrease the risk of injury in the future and maintain gains made in physical therapy treatment. 2) the patient will demonstrate a 5/5 MMT in all hip, knee, and ankle motions in order to have increased strength to return to her sports and decrease risk of injury in the future. 3) the patient will be able to run and jump with no pain or difficulty in order to return to her sports and maintain a healthy lifestyle.

The discharge criteria for the patient included being able to run and jump with no difficulty or pain, and feeling comfortable returning to her sports with no pain or difficulty.

The patient's plan of care included improving gross LE strength and balance, focusing more on the left side, especially the left ankle. We worked together to understand the exercises to be performed and for her to understand what she could and could not be doing both in sport and in the community throughout her treatment. Throughout the patient's treatment she was re-examined following the same procedures as stated above. She was re-examined periodically to determine if progress was being made and to make sure there were no other injuries occurring, such as a CFL, ATFL, deltoid ligament, or syndesmosis injury. Through these re-examinations, progression of exercises was determined, as well as, how much longer she may require PT services before she could return to her sports.

Intervention

The patient performed a vast amount of strengthening and balance exercises during her rehabilitation in order to help increase her lower extremity strength and balance, as well as become comfortable with running and jumping with no pain or difficulty again in order to return to her sports. The interventions that were performed are listed in Table 4.

Table 4. Interventions Performed

Intervention	Repetitions	Time in Rehabilitation
4-Way Ankle Theraband	3x10 ea, Red TB	Initial eval and HEP with Theraband progression
SL Stance Even Ground*	3x45 sec holds	Initial eval through 1st week
Hip Exercises: Clam shells, abd and ext, fire hydrants with Theraband*	Goal: 60 sec holds, progress to next Theraband when 60 sec hold complete	Initial evaluation and HEP with Theraband progression
DL Calf Raises	3x10	1st-2nd week
Goblet Squats with Dumbbells	3x10	2nd-5th week
DL RDLs with weight	1x10 (one time only)	2nd week
SL RDLs progressed into a T	2x10 ea leg	2nd-5th week and HEP
DL Leg Press on Plyo-Press*	3x10 increasing weight as needed	2nd-3rd week
SL Stance on Airex Pad progressing to looking different directions, eyes closed, playing catch with tennis ball*	3x45 sec holds	2nd-4th week
Elliptical	5 min	2nd-5th week
SL Bench Squat with tennis ball support	3x10	3rd week, one time only
4-Way SL Stance Reach*	3x1 reach ea direction	3rd-5th week and HEP
Step Downs*	3x10 left, 1x10 right	3rd-5th week and HEP
Walking Alternating Lunges	2x20 yards	3rd-6th week
Lateral Walking with Theraband*	2x20 yards	3rd-5th week
SL Calf Raises	3x10 ea leg	3rd-6th week and HEP

SL Leg Press on Plyo-Press*	3x10 left, 1x10 right increasing weight as needed	3rd-6th week
Plyo-Press Leg Press Jumping*	3x10	5th week, one time only
DL Squat Jump*	3x10	5th-6th week
Box Jumps up and down*	3x10	5th-6th week
SL Stability Hops*	2x10 ea leg	5th-6th week
Treadmill with and without brace	5-8 min	5th-6th week
Carioca	2x20 yards	5th-6th week
Lateral Shuffling	2x20 yards	5th-6th week
High Knees	2x20 yards	5th-6th week
SL Line Jumps*	3x10 sec	6th week, one time only

TB=Theraband, SL=Single Leg, Abd=Abduction, Ext=Extension, DL=Double leg, RDL=Romanian Dead Lift, HEP=Home Exercise Program, Ea=Each, Sec=Seconds
**Denotes key exercises*

Some of the key exercises the patient performed were the single leg (SL) stance exercises, the Plyopress leg press and jumping exercises, the box jump exercises, the step downs, and the hip exercises. The SL stance exercises were very beneficial to this patient because they helped her regain strength and proprioception in her ankle again. Upon initial examination of this patient, she was unable to hold a SL stance on her left leg for more than 8 seconds, thus demonstrating the need for SL stance exercises to be incorporated into her rehabilitation. Along with the 4-Way ankle exercises with Theraband she was given in her home exercise program, she was also given SL stance to practice. These exercises helped increase her ankle strength and allowed for her to practice her SL stance and work on her balance. The patient improved significantly within the first week on her SL stance and was able to progress the exercise by the second week. The progression to an Airex Pad was more difficult for the patient. She started initially by just holding the SL stance for 30-45 seconds, then progressed to looking different

directions which was more difficult for her. Once she was able to look different directions without much difficulty, she progressed to SL stance on the Airex Pad with her eyes closed. After this progression, she moved on to playing catch with a tennis ball while holding the SL stance, initially throwing the ball at her midline and progressing to throwing lateral, up, and down. Once she began improving on the Airex Pad, she progressed to a 4-Way SL Stance Reach exercise which was quite difficult for her initially. This exercise included holding a SL stance while reaching in front, to either side, and behind her with her other leg and tapping either her heel or toe on the ground before coming back to midline, and she had to perform this three times each direction. This was a great exercise to help improve her balance and coordination, as well as, leg strength as she would have to perform partial single leg squats for some of the directional reaches. This exercise was sent home with her in her HEP following rehabilitation.

The Plyo-Press Leg Press exercises were also very beneficial to this patient. She started with double leg (DL) leg press because she had never lifted weights before and this was the safest option to start her training. The DL leg press helped increase the strength in the patient's quadriceps as well as teach the patient proper knee control during the lift. Once she had become comfortable with the DL leg press, she progressed to the SL leg press. Since she had some strength deficits in her lower extremities, this exercise was beneficial because it helped her gain back the strength she had lost from altering her normal activity for the six weeks she was in a CAM boot. It also helped her gain more control over her lower extremities and continued to teach her proper knee control. The patient performed three sets of 10 repetitions on the left leg and only one set of 10 repetitions on the right leg due to her injury being on the left side of her body. One of her goals was to increase her overall lower extremity strength and these exercises helped her to achieve that goal. Also, one reason why the Plyo-Press leg press exercises were

chosen over back squats to help strengthen the lower extremities, especially the quadriceps, was because the Plyo-Press leg press was a safer option for the patient who had never lifted weights before, it also allowed for proper form and knee control to be taught during the exercises. Another reason was because the plan was to have her perform Plyo-Press jumping exercises in the future to help her transition to jumping vertically again. By performing the leg press exercises, the patient was familiar with the machine which helped for a more smooth transition into the jumping exercises.

As stated above, the patient eventually transitioned into the Plyo-Press jumping exercises. Since the patient had not performed any jumping activities for approximately 11 weeks prior to beginning this exercise, it allowed for the patient to test her jumping abilities in a controlled environment. This exercise is also performed in an anti-gravity position, or horizontally. This proved to be very beneficial to the patient because she did not have the added effects of gravity pulling her down while she was trying to learn how to land softly and correctly. The Plyo-Press jumping exercises also allowed for weight to be taken off so the patient was landing with less force through her ankles. Not only did this exercise provide the aforementioned benefits, but it also allowed for the patient to assess if she had any pain in her ankle during the jumping and landing. She initially had minimal pain with the first few repetitions, but the pain subsided and she no longer had any pain with the rest of the repetitions. This was the first step in returning the patient to jumping exercises, which are important in the sports she partook in, gymnastics and cheerleading. Once the patient felt comfortable with the Plyo-Press jumping exercises, she transitioned into vertical jumping.

Vertical jumping was a big step for the patient. Once again, she had some pain with the initial repetitions, but it eventually subsided and she no longer had pain going forward with the

exercises. She started off with DL squat jumps to help her become comfortable with jumping vertically again as well as to help her learn how to land properly from a jump with a soft landing, good knee control, and going into a partial squat with the landing to help absorb the shock of the jump. This instruction of how to properly land from a jump was needed, and beneficial, for the patient due to her participation in gymnastics and cheerleading which involves an immense amount of jumping and landing. If she would be able to learn how to properly land from a jump, she would have a decreased chance of injury or re-injury in the future. She was transitioned into box jumping, both up on the box and down from the box, to help increase her strength of the lower extremities, control of jumping and landing, and her proprioceptive awareness of her lower extremities. Box jumping was beneficial to her because it allowed for her to practice landing from an increased height which will occur in her sports. She was started on an 8 inch box, then moved up to a 12 inch box, and ended with a 18 inch box over the two weeks that these were performed. A study done comparing plyometric versus resistive exercises after acute lateral ankle sprains showed that both plyometric and resistive training improve isokinetic evertor and invertor peak torques and functional performance of athletes.[16] The functional test measures of the plyometric group were significantly higher than that of the resistive group.[16] The study concludes that plyometrics were more effective than resistive exercises in improving functional performance of athletes after later ankle sprains.[16] The patient's rehabilitation consisted of a mixture of plyometric and resistive exercises and she found these to be very beneficial to her and they helped her feel more comfortable in returning to her sports.

Another key exercise the patient performed was the step down. In this exercise, the patient stands on a step with one leg and does a squat to touch the opposite heel down on the ground and then come right back up to a SL stance, and then repeats. Some things to watch for

are that the knee on the stance leg does not go over the toes and the knee does not "buckle" or move medially during the squat or the returning phase, thus, maintaining good knee control. The patient was started on a smaller step, 4 inches, in order to get the proper technique and knee control down. Once this became too easy for the patient, she was transitioned into a higher step, 6 inches, until she could maintain good knee control and balance while performing an even deeper squat. The patient was then transitioned into an 8 inch step. This exercise was very good for helping the patient regain strength in her lower extremities, increase her balance and proprioception, and allowed her to focus on maintaining good knee control. By the second week of performing this exercise, the patient was able to identify when her knee collapsed in, even slightly, without having to be told it did. This exercise was also sent home with the patient as part of her HEP because it has great benefits all around and is an easy exercise to do in the home because she was able to perform it in a stairwell.

One of the best group of exercises the patient performed were the hip exercises. She performed clam shells in which she would lie on one side with her knees and hips bent slightly and would lift her top knee off of her bottom knee keeping her feet touching, she would then hold this position for a goal of 60 seconds and then turn over and perform it on the opposite side. The key to this exercise was to make sure her hip did not roll backward throughout the exercise. The patient also performed hip abduction and extension in the sidelying position with a goal of holding the position for 60 seconds then turning over and performing the exercise on the opposite side for another 60 seconds. Once again, the key to this exercise was to make sure her hip did not roll backward. She also performed fire hydrants in the quadruped position (all 4's, hands and knees). The patient would get in the quadruped position, then abduct her hip and have slight extension as well and would hold the position for 60 seconds, then perform it on the

opposite side. The key to this exercise was to make sure the patient did not roll her hip upward as she brought her hip into abduction and extension, she was to maintain straight hips. The patient began with no Theraband at first until she was able to hold for 60 seconds in each of the positions, she then began to add Theraband (lighter resistance to heavier resistance) once she was able to complete the goal of 60 second holds. This was a great exercise for the patient due to her weak hip strength bilaterally that was noted upon her initial examination. These three exercises help to increase the strength of the hip/gluteal muscles, or the lateral rotators and hip extensors/abductors.

The most remarkable benefit from this set of exercises was that once her hips started to become stronger, the rest of her lower extremity control and strength seemed to fall in line. Once her hips became stronger, I noticed a marked increase in her knee control, balance, and overall lower extremity strength. Her other exercises became easier for her and we were able to progress her through other exercises much more quickly than anticipated. A study done on the effects of a hip strengthening program on mechanics during running and single-leg squatting showed that when the females in the study increased their hip abductor and external rotator strength, there was a significant improvement in single-leg squat mechanics, though there was not a significant difference in running mechanics.[17] The same effects were noticed in this patient. When her hip strength started to increase, her single-leg squat mechanics improved during the step-down exercise and therefore started to decrease her chance of knee or ankle injury in the future. This set of exercises was taught to her on the initial examination date and were sent home with her as part of her HEP. The following week she was asked to perform the exercises again to re-check and make sure she was performing them correctly. Minor adjustments were made and she was

told to continue working on them as part of her HEP. She continued to work on them at home and the benefits were immense throughout her rehabilitation.

Outcomes

The patient's fracture healed nicely and her strength and balance improved to her baseline or slightly better than her baseline, according to the patient. She had improved balance in her left ankle joint as well as improved strength and control in bilateral lower extremities. She had increased her amount of working out she does throughout the week to help her improve her strength, balance, and endurance for her sports. The patient returned to her sports and riding her horses with no pain or difficulty. The results of her initial and final outcome data are described in Table 5 and Table 6.

Table 5. Initial and Final Strength Outcome

	Initial Right	Initial Left	Final Right	Final Left
Hips	Abduction: 4/5 Flexion: 4/5 Extension: 4/5	Abduction: 4/5 Flexion: 4/5 Extension: 4/5	Abduction: 5/5 Flexion: 5/5 Extension: 5/5	Abduction: 5/5 Flexion: 5/5 Extension: 5/5
Knees	Flexion: 5/5 Extension: 5/5	Flexion: 5/5 Extension: 5/5	Flexion: 5/5 Extension: 5/5	Flexion: 5/5 Extension: 5/5
Ankles	Dorsiflexion: 5/5 Inversion: 5/5 Eversion: 5/5 Plantarflexion: 5/5	Dorsiflexion: 5/5 Inversion: 4/5 Eversion: 4/5 Plantarflexion: 4/5	Dorsiflexion: 5/5 Inversion: 5/5 Eversion: 5/5 Plantarflexion: 5/5	Dorsiflexion: 5/5 Inversion: 5/5 Eversion: 5/5 Plantarflexion: 5/5
Gastrocnemius/ Soleus	Single Leg Calf Raises: 25	Single Leg Calf Raises: 11	Single Leg Calf Raises: 25	Single Leg Calf Raises: 25

Table 6. Initial and Final Balance Outcome

	Initial Balance Grade	Final Balance Grade
Sitting Balance	Good (able to sit safely unsupported for 2 minutes)	Good
Standing Static Balance	Good (able to stand safely for 2 minutes)	Good
Standing Dynamic Balance	Right Single Leg Stance: Good (>60 seconds) Left Single Leg Stance: Fair (<8 seconds)	Right Single Leg Stance: Good Left Single Leg Stance: Good

The patient was re-tested three times throughout her rehabilitation. The aforementioned special tests, Talar Tilt, Kleiger's, and the Syndesmosis Squeeze Test of the Leg, were all performed on each re-examination. All of the tests were negative for the injuries that they test for each time they were re-tested. The patient's strength was re-tested during each re-examination and the final results are shown in Table 5. The patient's strength increased during each re-examination until they were all rated at a 5/5 MMT for each action tested. The patient always had full AROM and PROM since the initial examination.

The patient did not have any impairments or functional limitations at discharge. She was able to return to her sports with no pain or difficulty, but was urged to ease back into her sports in order to prevent re-injury. Upon the patient's first arrival to the physical therapy clinic, she filled out a clinimetric scale called FOTO (Focus On Therapeutic Outcomes) to assess her current functional status. A study was performed to assess the reliability and validity of the FOTO in clinical use. The study was performed on 266 adults who were referred to clinics for acute work rehabilitation, work conditioning/hardening, or a Functional Capacity Evaluation.[18] The results showed internal consistency reliability coefficients for the health status scores ranged from 0.57 to 0.89 and construct validity was supported.[18] Unfortunately, the initial score of her results from the FOTO were not received for this case report, nor were the results from the

following two times she completed it at halfway through her treatment and at the end of her treatment. However, it was suspected she showed improvement in her FOTO score based off of the great success she had in her rehabilitation.

The patient achieved all of her anticipated goals. Her outcomes exceeded what was expected of her. She was able to perform the 4-Way SL Stance Reach which went beyond her goal of holding a SL stance for one minute on bilateral legs. She achieved a 5/5 MMT strength rating in all of the motions tested which exceeded the goal of a 4+/5 rating. She was completely independent with all of her HEP exercises and had great compliance with them. It was noticeable that she was compliant with them because when asked to perform some of the exercises during our treatment sessions she was able to complete them with no difficulty and she stated she worked on them every day, and the results showed she was compliant.

Throughout the patient's rehabilitation, she was educated about what she should and should not be doing during performance to help reduce the risk of injury not only in her ankle, but her knees as well. She was educated on proper knee control during exercises and how it will prevent her from sustaining injuries in the future. She was also educated on how to perform exercises properly throughout her treatment because she had never lifted weights before. This opportunity was used to instill proper lifting techniques for exercises which will help prevent her from injury in the future. Lastly, she was educated on how to properly land from a jump, which is very important in the sports she participates in. By learning how to properly land from a jump, the patient is less likely to re-injure her ankle in the future, as well as, less likely to sustain another type of injury from a bad landing. The patient was very satisfied with the treatment she received and she was very satisfied with her ability to return to her sports with no pain or difficulty.

CHAPTER III

DISCUSSION

The patient's great results were due to her motivation to return to her sport, doing everything she was asked to do during her PT sessions and doing them correctly, and following her HEP diligently. PT focused on isolating certain muscle groups to strengthen them, as well as, work on specific interventions for improving her balance, which is a key component to her ability to participate in her sports.

My patient was able to return to her sports within three months after her injury occurred, which is consistent with the literature.[3,7] The articles stated the average time for a patient who had a stress fracture to return to their sport was two to four months.[3] My patient did not have surgical intervention because she was in the low-risk stress fracture category which usually does not require surgical intervention.[1] My patient was different from the articles I was able to find, however, because she did not have surgical repair of her stress fracture, whereas in the articles I found they discussed return to play in those who had surgical intervention for their stress fractures. My patient did, however, fall into the category of the quickest stress fracture to return to sport, with a distal fibular fracture. The patient also fell in line with the treatments immediately following a distal fibular fracture which is to abstain from any prior activity for 6-12 weeks in order for the fracture to heal properly.[19] My patient abstained from her sports for 6 weeks and was in a CAM boot for those 6 weeks to help take pressure off of the foot and to allow a better environment for the fracture to heal. The patient was similar to the findings in the

literature reports I researched due to her non-activity level she underwent for 6 weeks immediately after her injury, as well as how it took her six weeks after her non-activity timeframe to regain her strength and balance and was able to return to her sports again which was slightly under the average time frame of 6.8 weeks for a patient with a distal fibular fracture to return to their sport.

Future directions for research could include writing a protocol to follow with specific interventions to perform with everyone who has this diagnosis and compare how fast they are able to return to their sport with no pain or difficulty.

Reflective Practice

If I were to have an identical patient in the future, during my initial examination history taking I would try as hard as possible to get a better picture of how the injury was sustained. In this instance, I was slightly confused as to how the injury was actually sustained because the patient was not able to fully describe how she landed on her foot following the stunt that was performed. If I am able to attain a better understanding, I will be able to determine exactly which structures may have been involved and will be able to guide my examination better.

Through my research of special tests, I would either not perform the Talar Tilt test due to its low sensitivity and specificity, or combine the test with even more tests than I did with this patient. This will allow me to gain a better understanding of structures in the foot/leg that may or may not have been involved in the injury. I would also implement a functional test such as the Y-Balance Test in order to gain better baseline data for my patient's balance. Then I would periodically test the patient with the Y-Balance Test to see how much improvement they are making. A study done reported that the lower quarter Y-Balance Test has been recommended as

a measure of dynamic postural control in the clinical setting.[20] The facility I was at had access to a Y-Balance Test and a study done on active service members reported "the Y-Balance Test showed good interrater test-retest reliability with an acceptable level of measurement error among multiple raters."[21 p.1264]

Changes to my plan of care would include incorporating more sport specific exercises. I would have to research more about the specific sport the patient participates in, this case it was gymnastics and cheerleading and I did not know too much about those sports, therefore I was not able to make very sport specific exercises for the patient to perform. I would also research more advanced exercises to add to my repertoire for this diagnosis and other diagnoses that I could use similar exercises for.

I would seek further evidence on plyometric exercises during rehabilitation of an injury. This would give me a better understanding of the benefits and dangers of plyometric exercises, as well as give me more ideas for exercises I could perform with my patients should I deem plyometric exercises necessary.

During the patient's rehabilitation, I would not refer them to another discipline unless it was necessary. The two disciplines I could see referring to during the rehabilitation would be the primary care physician if I suspected something was wrong with the healing of the fracture, and the other discipline I could see referring to would be a podiatrist. I would refer to a podiatrist for fitting of shoe insoles if the patient was having increased discomfort in her feet from her shoes. Following rehabilitation, I would refer the patient to an athletic trainer in order to continue strength and balance training to help perform better in sports. The athletic trainer would then be able to perform more sport specific exercises with the patient after they have healed from the injury.

The cost for physical therapy sessions was reasonable based on the outcomes. The total cost of PT services totaled $973.91, and since the patient pays approximately 20% of the reimbursement for PT services, which totaled $811.59, the patient paid a total of $162.32 for her physical therapy treatment. The patient was in high school and was covered under her parent's insurance, therefore, the patient did not pay for the treatments herself. The professions of the parents were unknown to me, so I was unable to determine the financial hardship the PT services may have caused them. The total cost to the patient of $162.32 over six weeks is a reasonable amount of money to pay for the benefit that therapy provided the patient. The patient became stronger in her lower extremities, improved her balance significantly, learned about proper knee control during sports, was able to return to her sports at the end of PT, and learned the value of working out and how it benefits her performance in sports. I believe I provided exceptional service to this patient relative to the cost/benefit ratio. I introduced the patient to new exercises that will help her in her sports and helped the patient achieve the above mentioned benefits.

I do not see where I could have reduced the costs to the patient throughout her treatment. I kept the treatment sessions to 30 minutes and the only modality that was used was ice. I believe the frequency of treatment worked well for the patient and benefitted her greatly. I would not have decreased the frequency for the patient. Overall, I believe I kept the cost to the patient low and did not use anything that would not have been needed.

This case impacted my future professional development goals. Should I work in orthopedic PT at some point in my career, this case helped me realize there is a vast amount of exercises that I can research and implement into the care of my patients. This case also helped me realize I need to research different sports that I may encounter with my patients so I can learn how to make exercises more sport specific and be able to find the best exercises for the patient's

sport they participate in. It also helped me realize that if I am going to work in orthopedic PT in my career, I will want to become board certified in sports PT. It will help to increase my credentials and will help me to gain more knowledge in orthopedic PT.

REFERENCES

1. Mayer S, Joyner P, Almekinders L, Parekh S. Stress Fractures of the Foot and Ankle in Athletes. *Sports Health: A Multidisciplinary Approach* [serial online]. November 2014;6(6):481-491. Available from: SPORTDiscus, Ipswich, MA. Accessed December 9, 2014.
2. Available at: http://web.a.ebscohost.com/dynamed/detail?vid=3&sid=d6c85e3a-284a-424e-a81c-c78d9ff897f9@sessionmgr4002&hid=4101&bdata=JnNpdGU9ZHluYW1lZC1MSVZFJnNjb3BlPXNpdGU=#db=dme&AN=114442. Accessed December 9, 2014.
3. Porter D, May B, Berney T. Functional Outcome after Operative Treatment for Ankle Fractures in Young Athletes: A Retrospective Case Series. *Foot & Ankle International* [serial online]. September 2008;29(9):887-894. Available from: SPORTDiscus, Ipswich, MA. Accessed December 9, 2014.
4. Patel DS, Roth M, Kapil N. Stress fractures: diagnosis, treatment, and prevention. *Am Fam Physician.* 2011;83(1):39-46.
5. Matheson GO, Clement DB, Mckenzie DC, Taunton JE, Lloyd-smith DR, Macintyre JG. Stress fractures in athletes. A study of 320 cases. *Am J Sports Med.* 1987;15(1):46-58.
6. Ferry AT, Graves T, Theodore GH, Gill TJ. Stress fractures in athletes. *Phys Sportsmed.* 2010;38(2):109-16.

7. Dobrindt O, Hoffmeyer B, Ruf J, et al. Estimation of return-to-sports-time for athletes with stress fracture - an approach combining risk level of fracture site with severity based on imaging. *BMC Musculoskelet Disord.* 2012;13:139.
8. Diehl JJ, Best TM, Kaeding CC. Classification and return-to-play considerations for stress fractures. *Clin Sports Med.* 2006;25(1):17-28, vii.
9. Available at: http://www.mdguidelines.com/images/Illustrations/fr_ankle.jpg. Accessed September 5, 2015.
10. Ohta-fukushima M, Mutoh Y, Takasugi S, Iwata H, Ishii S. Characteristics of stress fractures in young athletes under 20 years. *J Sports Med Phys Fitness.* 2002;42(2):198-206.
11. Wright AA, Hegedus EJ, Lenchik L, Kuhn KJ, Santiago L, Smoliga JM. Diagnostic Accuracy of Various Imaging Modalities for Suspected Lower Extremity Stress Fractures: A Systematic Review With Evidence-Based Recommendations for Clinical Practice. *Am J Sports Med.* 2015.
12. Available at: http://www.drugs.com/sfx/ibuprofen-side-effects.html. Accessed December 12, 2014.
13. Rosen AB, Ko J, Brown CN. Diagnostic accuracy of instrumented and manual talar tilt tests in chronic ankle instability populations. *Scand J Med Sci Sports.* 2014.
14. Schwieterman B, Haas D, Columber K, Knupp D, Cook C. Diagnostic accuracy of physical examination tests of the ankle/foot complex: a systematic review. *Int J Sports Phys Ther.* 2013;8(4):416-26.
15. Guide to Physical Therapist Practice. 2nd ed. *Phys Ther.* 2003; 81:13-738.

16. Ismail M, Ibrahim M, Youssef E, Shorbagy K. Plyometric Training Versus Resistive Exercises After Acute Lateral Ankle Sprain. *Foot & Ankle International* [serial online]. June 2010;31(6):523-530. Available from: SPORTDiscus, Ipswich, MA. Accessed March 24, 2015.
17. Willy RW, Davis IS. The effect of a hip-strengthening program on mechanics during running and during a single-leg squat. *J Orthop Sports Phys Ther.* 2011;41(9):625-32.
18. Hart DL. The power of outcomes: FOTO Industrial Outcomes Tool -- Initial assessment. Work. 2001;16(1):39-51.
19. Hetsroni I, Mann G. Fibula Stress Fractures: A Treatment Review. *Operative Techniques In Sports Medicine* [serial online]. April 2009;17(2):112-114. Available from: SPORTDiscus, Ipswich, MA. Accessed December 9, 2014.
20. Kang MH, Kim GM, Kwon OY, Weon JH, Oh JS, An DH. Relationship Between the Kinematics of the Trunk and Lower Extremity and Performance on the Y-Balance Test. PM R. 2015;
21. Shaffer SW, Teyhen DS, Lorenson CL, et al. Y-balance test: a reliability study involving multiple raters. Mil Med. 2013;178(11):1264-70.