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Case Report

The Effects of Manual Therapy and PRIMFIT Unstable Surface Balance Training on Walking Gait Cycle Post an Acute Grade 3 Inversion Ankle Sprain: A Case Study

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Abstract

This case demonstrates the effectiveness of a rehabilitation product and protocol that incorporates manual therapy and unstable surface training. The purpose of this case study was to evaluate the effect of a four- week unstable training protocol using PRIMFIT product in conjunction with manual physical therapy on walking gait in a 17- year old, grade 3 ankle sprain with multiple ligament tears. A PRIMFIT protocol was designed and performed bi-weekly under supervision of a physical therapist and also bi-weekly by the patient independently. Patient's walking gait was tested once a week using an OPTOGAIT System. The patient demonstrated significant clinical and statistical improvement in all gait and time parameters measured by OPTOGAIT system, as well as increased ankle mobility, decreased swelling and markedly decreased pain. For this patient, a combination of manual therapy techniques, PRIMFIT product and rehabilitation Exercises were able to significantly improve and normalize walking gait in addition to eliminating swelling and pain. However, further research is needed with additional cases, especially those with similar or other injuries to develop the efficacy of the PRIMFIT product and protocol.

Background

Ankle sprains result in the tearing of ligaments within the ankle, especially on the laterally side due to the inversion of the foot [1]. The inversion injury occurs as a result of foot rolling underneath the ankle [2]. Lateral ankle sprains are prevalent in athletes with a very high reinjury rate [2]. A review of literature on ankle injuries in different sports world wide provided an epidemiological summary from various sports [3]. Depending on the level or grade of pain, the person with an ankle sprain, may have difficulty with weight bearing activities [4]. This specific case report is a classic

presentation of complications due to Ankle Sprain Grade 3 and a potential development of cellulitis, if untreated. Cellulitis is a serious bacterial infection of the skin. The bacteria spread where the injury has occurred, invading the subdermal layer of the skin. Upon spread, the bacteria multiply and make chemicals that cause inflammation [2]. The symptoms are soreness, redness, swelling, blisters, and skin dimpling. Treatment includes antibiotics, resting, elevation of the affected limb as well as daily progressive checks for analgesia and cellulitis [3]. Adolescents participating in various sporting activities are prone to various musculoskeletal pains that

can lead to other injuries [5]. Our study examined the role of manual therapy and PRIMFIT, a new injury prevention and rehabilitation product in addition to a rehabilitation protocol designed for pain relief and the anticipated quick return to normal play or activity. The effects of manual therapy especially as an analgesic effect, have been previously studied in hip, spine or knee rehabilitation but results were inconclusive [6,7]. Similarly, manual therapy with physical therapy weren't found to improve clinical economy in ankle fractures [8]. We hope that the introduction of the PRIMFIT product and accompanying rehabilitation program, coupled with manual therapy, would provide additional and valuable information on effectively managing pain for patients with grade 3 ankle sprains. Our study hypothesized that at the end of the intervention period, the subject would have a normal and symmetrical walking gait, improved hip and knee functional control during stance along with clinical and statistical improvement in all walking gait parameters without symptoms.

Case Study

Our single clinical case involved a 17-year-old male high school cross country and track and field athlete who suffered a grade 3 left ankle sprain with multiple ligaments tears, bone contusion and cellulitis. The patient was hospitalized for 10 days due to left ankle infection and hematoma. The patient was presented to physical therapy two weeks post hospitalization. The patient had been instructed after physician's diagnosis to use a weight bearing boot for four weeks during rehabilitation. At presentation, the patient exhibited significant limited active and passive range of motion, 1+ Pitting Edema, noticeable left lower extremity atrophy and slow, antalgic and unsymmetrical walking gait.

Intervention

We measured the different gait and time parameters of the participant over a period of four weeks. We designed a PRIMFIT-specific protocol that contained a dozen sessions that were vital for determining the participant's weekly progression. We employed the designed sessions in conjunction with the manual therapy to address Range of Motion (ROM), functional strength of the participant, as well as examine abnormality in his walking gait. The protocol of twelve sessions over a period of four weeks was specifically designed using the PRIMFIT product in conjunction with manual therapy technique to address limited Range of Motion (ROM), decreased functional strength and abnormal observational walking gait. In addition, we used manual therapy, a form of therapy that involves the application of manual force with techniques that are predetermined to improve injury. Manual therapy has been used for a series of musculoskeletal pain conditions including osteoarthritis [5]. Manual therapy sometimes included massage

therapy, which is a commonly used pain intervention. Manual therapy is controlled by the therapist performing exercises to the patient. Elsewhere manual therapy has been examined for effect on walking speed [6]. In addition to manual therapy, physical therapists tend to prescribe therapeutic exercise, to patients to perform independently. Our study is the first to examine the effect of using the PRIMFIT dynamic balance protocol product with manual therapy in the case described.

Our PRIMFIT dynamic balance program consisted of four dynamic balance and functional strength exercises including: [1] tandem walk-forward and back on an 8' line [9] lateral weight shift with high knee to chest [8] single leg Romanian dead lift [2] sprinter step on 12" step with high knee to chest. During the weekly progression testing, we employed the OPTOGAIT measurement system (Microgate Corporation, Italy), one of the premier functional and rehabilitation testing protocols for determining different functional, strength and fitness parameters. The OPTOGAIT systems have been previously tested and conform to reliability and validity requirements in testing spatial and temporal gait parameters [9, 10, 11]. (Table 1)

Day	Program Supervised by Physical Therapist OR Program Independently Performed by Athlete or with Coach's Supervision
Day 1 Day 3	Tandem Walk, Lateral Weight Shift with Knee to Chest, Single Leg Dead Lift, Sprinter step on 12" step with high Knee to Chest
Day 2 Day 4	Tandem Walk, Lateral Weight Shift with Knee to Chest, Single Leg Dead Lift, Sprinter step on 12" step with high Knee to Chest

Table 1: PRIMFIT Dynamic Balance and Functional Strength Exercises.

Results

The patient demonstrated a significant clinical and statistical improvement in all Gait and Time Parameters measured by OPTOGAIT as indicated in tables 2, 3 and 4. In addition, the patient exhibited increased ankle mobility, decreased swelling and eliminated pain at the conclusion of the four-week intervention with bi-weekly physical therapy and individual rehabilitation exercises. The athlete's gait parameters for both left and right leg were assessed for improvements at week 4 using week 1 as baseline. There was significance in the gait improvements for left leg ($M = 1.1$, $SD = 7.7$); $r = .932$, $p = 0.021$, and right leg ($M = 1.7$, $SD = 8.2$); $r = .924$, $p = 0.025$. Our results of a two tail paired T-test for week 1 and week 4 demonstrated statistical significance at $p < 0.05$.

Parameters	Week 1	Week 2	Week 3	Week 4
Step Length (in)	1'10.7 (1.7),CV 7.4%	2'02.4 (1.3), CV 4.8%	2'05.1 (0.8) CV 2.6%	2'05.5(0.7)CV 2.1%
Stance Phase (%)	67.5 (1.8), CV 2.7%	64.1(1.2), CV 1.8%	64.1 (1.2) CV 1.9%	61.8 (3.4) CV 5.4%
Swing Phase (%)	32.5 (1.8),CV 5.6 %	35.9 (1.2), CV 3.2%	35.9 (1.2) CV 3.3%	38.2 (3.3) CV 8.7%
Single Support (%)	29.9 (2.2), CV 7.3%	34.0 (1.6), CV 4.8%	35.1 (1.3) CV 3.6%	38.6(3.9) CV 10.1%
Load Response (%)	17.8 (1.8),CV 10.4%	14.9 (1.5), CV 10.3%	14.7(0.9) CV 6.1%	11.7(3.8) CV 32.9%
Pre-Swing (%)	19.7 (1.9),CV 9.7%	15.2 (1.1), CV 7.2%	14.2(1.1) CV 7.6%	11.6(3.4) CV 29.2%
Step Time (m/s)	0.618 (0.052), CV 8.4%	0.538 (0.022), CV 4.1%	0.580(0.016)CV2.8%	0.588(0.012)CV 2%
Speed (ft/sec)	2.93 (0.08), CV	4.12 (0.08), CV 1.9%	4.11(0.06) CV 1.5%	4.10(0.11) CV 2.7%

Table 2: OPTOGAIT Measures of Lengths, Gait, Time and Speed parameters of Left Leg over 4 weeks. CV, Coefficient of Variation.

Parameters	Week 1	Week 2	Week 3	Week 4
Step Length (in)	1'10.7 (1.7),CV 9.2%	2'01.6 (1.2), CV 4.8%	2'03.9 (0.8) CV 2.9%	2'04.7(0.8)CV 2.6%
Stance Phase (%)	69.9 (2.3), CV 3.3 %	66.1 (1.5), CV 2.3%	64.9 (1.2) CV 1.8%	61.4 (3.9) CV 6.4%
Swing Phase (%)	30.0 (2.1), CV 6.9 %	33.9 (1.5), CV 4.5%	35.1 (1.2) CV 3.3%	38.6 (3.9) CV10.1%
Single Support (%)	32.5 (2.0), CV 6.1%	35.9 (1.2), CV 3.4%	35.9 (1.2) CV 3.2%	38.2 (3.4) CV9.0%
Load Response (%)	19.7 (1.9), CV 9.6%	15.2 (1.1), CV 7.2%	14.2 (1.1) CV 7.5%	11.5(3.4) CV 29.4%
Pre-Swing (%)	17.8 (2.0), CV 11.0%	14.9 (1.6), CV 10.6%	14.7 (0.9) CV 6.4%	11.6(3.9) CV 33.5%
Step Time (m/s)	0.566 (0.044), CV 7.8%	0.514 (0.021), CV 4.1%	0.576(0.018)CV3.1%	0.593(0.016)CV2.7%
Speed (ft/sec)	2.92 (0.020), CV 6.8%	4.12 (0.07), CV 1.7%	4.11(0.07) CV 1.7%	4.11(0.06) CV 1.5%

Table 3: OPTOGAIT Measures of Lengths, Gait, Time and Speed parameters of Right Leg over 4 weeks. CV, Coefficient of Variation.

Parameters	Week 1	Week 2	Week 3	Week 4
Step Length	16.3%	3.4%	4.0%	2.8%
Stance Phase (%)	3.6%	3.0%	1.3%	0.6%
Swing Phase (%)	7.8%	5.4%	2.3%	1.1%
Single Support (%)	8.7%	5.7%	2.3%	0.9%
Load Response (%)	10.8%	2.0%	3.5%	1.1%
Pre-Swing (%)	9.7%	1.9%	3.6%	0.4%
Step Time (m/s)	8.4%	4.5%	0.7%	0.9%
Speed (ft/sec)	0.3%	0.0%	0.0%	0.2%

Table 4: OPTOGAIT Measures of Lengths, Gait, Time and Speed parameter differences between Left and Right Leg.



Figure 1: PRIMFIT Unstable Surface Training Product.



Figure 2: Beginning phase of the knee to chest.

Discussion

There are a number of rehabilitation programs that are used either independently or as a combination with manual therapy techniques [6]. Some of the programs have been tested for their reliability and claimed improvements in progressive rehabilitation in different patients [6,11]. It is also very common for rehabilitation programs to be conducted without evaluating the level of clinical significance [12]. Our study is the first to report the effectiveness of manual therapy, PRIMFIT product, its rehabilitation program as validated by the OPTOGAIT system. This intervention resulted in significant improvements in all gait and time parameters.

Conclusion

It is vitally important that our intervention of manual therapy in conjunction with dynamic balance training using an unstable surface PRIMFIT product provided an effective rehabilitation

procedure to improve asymmetrical and inefficient walking gait status post immobilization and significant atrophy. The exercises that were prescribed for the patient indicated that the patient was able to significantly improve and normalize walking gait in addition to eliminating swelling and pain. Further research in the rehabilitation of other injuries using this specific PRIMFIT product and rehabilitation program, is encouraged to determine the effectiveness in those given cases.

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