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Analysis of Muscle Strength Dorsal Flexor, Plantar Flexor, Invertor, and Evertor on Sportsman with Chronic Ankle Injury (CAI)

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Introduction: Chronic ankle injury (CAI) on the athlete would be risk of repetitive injuries on the same leg. Analyzing the muscle strength of the ankle movement is expected to be a baseline data in the prevention of recurrent injuries. **Method:** Quantitative study of multivariate analysis, chronic ankle injury sample identified with chronic ankle instability tools (CAIT) <24 points and normal ankle (NA). Muscle strength measured dorsal flexor (DF), plantar flexor (PF), evertor (EV), and invertor (IN) using dynamometer (Newton (N)). **Results:** total participants were 29 individuals (31% male and 68% female) with mean age 19,86 ± 5,180 years. Samples taken from participant obtained 58 ankles divided into two groups CAI n = 26 and NA n = 32. Mean of DF strength CAI 21.04 ± 4.501 N and NA 21.44 ± 4.206 N, the average PF strength CAI 21.83 ± 3,364 N and NA 22,48 ± 4,323 N, mean of IN strength CAI 12,58 ± 3,402 and NA 14,52 ± 5,156, and mean of EV CAI 11,81 ± 3,371 N and normal 13,59 ± 4,634 N. Multivariate Tests p = 0.355> 0.05, Tests of Between-Subjects Effects Dorsal Flexor p = 0.729> 0.05, Plantar flexor p = 0,528> 0.05, invertor p = 0.105> 0.05, and evertor p = 0.106 > 0.05. **Conclusion:** There is no difference in muscle strength of the dorsal flexor, plantar flexor, invertor, and evertor between chronic ankle injury (CAI) conditions with normal ankle. To improve the analysis, physiotherapists need to conduct a proprioception and sport functional outcome.

Keyword: Chronic Ankle Injury, muscle strength, chronic ankle sprain.

Introduction

Chronic ankle injury (CAI) was defined as pain on ankle joint, ankle instability, and joint movement restriction after acute injury (Bonnel *et al.*, 2010). Some opinions suggest that this injury was caused by repetitive injury on the same ankle more than twice incident. The severity of this injury at grade two or three ankle sprained means that there were more than torn two ligaments. Healing time that needed is about eight weeks to three months. Athletes who experienced with this condition usually still able to do practice with ankle support to reduce the pain and protect the ankle joint (Hiller *et al.*, 2011; Kobayashi and Gamada, 2014). Under these condition athletes would be risk in repeated ankle injury and need to prevent for maintain the joint mobility and stability. This condition would be a caused new injury such as ankle impingement and structural changes of the tibia and talus becomes larger than normal.

Data explained that for 11 years during UEFA champion league there were 1080 incidence of ankle injuries with ratio 0,7-1/1000 hour training (Waldén, Hägglund and Ekstrand, 2013). 20%-40% Incidence of lateral ankle sprain was the big number type of injury in various sports (Sawkins *et al.*, 2007; Waldén, Hägglund and Ekstrand, 2013).

Subjective complaint that they feel ankle becoming unstable, pain, and joint movement restriction. Hertel (2002) described pathomechanics of CAI that there were two theories that ankles could be unstable is mechanical instability and functional instability. Mechanical instability as a result of anatomic changes such as pathological laxity, arthrokinematics restrictions, degenerative changes and synovial changes. Functional instability as a result neuromuscular changes caused articular mechanoreceptor damage in lateral ankle sprains

such as impaired proprioception, impaired neuromuscular control, strength deficits, and impaired postural control.

Inflammation on acute response will damage collagen structure and effect to reduce function of joint receptor (mechanoreceptor) (Wu *et al.*, 2015). Fink *et al (*2008) explained that immobilization on acute injury will effect to systemic inflammation caused reduce the tetani contraction, atrophy, and increase the histological structure. Petersen et al (2007) in this condition muscle spindle cannot be stimulated for muscle contraction, where it decreased extrafusal alpha and gamma motoric would reduce the tendon stretch reflex which muscle can replace the function of ligaments as joint stabilizer. In addition to the motoric function, sensory system reduction affected to joint position feeling (proprioception) caused by increased nociceptor (pain) at the ankle joint (Willems *et al.*, 2002; Marcora *et al.*, 2012; Proske and Gandevia, 2012).

Base on above explanation on acute response will be affect to CAI condition to four muscle group strength on ankle joint mover dorsal flexor (DF), plantar flexor (PF), evertor (EV), and invertor (IN). Normally four muscle group must have good contraction ratio between eccentric and concentric (eccentric > concentric) to minimize force while running, jumping and cutting. CAI condition change physiological ratio eccentric less than concentric contraction (eccentric < concentric) it means that muscle could not control ankle joint movement when changing the axes of motion associates with biomechanics of the ankle (Kaminski and Hartsell, 2002; Yildiz *et al.*, 2003; Corona *et al.*, 2008). Reduction of ratio muscle contraction will affect the joint functional stabilizer caused of neuromuscular imbalance and joint proprioception (Giannini *et al.*, 2014; Kobayashi and Gamada, 2014). Functional stabilization is the key for CAI to recover and prevent injury in sport activities.

The aim this analyze to study the difference strength of dorsal flexor, plantar flexor, evertor, and invertor on ankle joint with and without CAI.

Method

Inclusion criteria CAI were 1) active sportsman/athletes with ages 15-25 years, 2) had history ankle injury more than 1 times, 3) still feeling pain and joint unstable, 4) Cumberland ankle instability tool (CAIT) < 24 point. Assessment addition were had positive anterior drawer test, posterior drawer test, talar tilt test, and dorsal flexion restriction. Exclusion criteria were acute ankle injury and another injury except ankle injury. Strength measurement using handheld dynamometer. Group CAI and NORMAL will inserted in variable KONDISI to analyze with Statistical Product and Service Solution 21 (SPSS) Software.

Results

Participant in this study were obtained on sport area at Universities of Pelita Harapan, Tangerang, Indonesia as many as 29 participants. Their ankle will be as sample with the amount of ankle joints was 58 ankle and divided into two groups, CAI groups n= 26, and NORMAL group n= 32. Distribution participants were 31% male and 69% female, means ± standard of deviation of ages 19,86±5,180, body height 166,17±6,541 cm, body weight 60,89±11,53 Kg, and type of sport 55,2 % basketball and 44,8% marathon. (Table 1)

Multivariate test explains that value of Pillai, Wilks Lambda, Hotelling , and Roy's p = 0,355 (>0,05). It concluded dorsal flexor, plantar flexor, evertor, and invertor had a same strength between CAI and normal ankle. (table 2)

The effect between subject explained on KONDISI row independent variable, dependent variable inversion p = 0,105 (>0,05), eversion 0,106 (>0,05), dorsal flexor 0,729 (>0,05), and plantar flexor 0,528 (>0,05). It concludes same as multivariate test result that there was no difference strength each muscle between CAI and normal ankle. (table 3)

Table 1. Participants description

A.	**Participants n = 29**	**Percentage**	
1.	Sex		
	a. Man	31%	
	b. Women	69%	
2.	Sport Type		
	a. Basket	55,2%	
	b. Marathon	44,8%	
3.	Mean of Age	19,86±5,180 years	
4.	Mean of Body Weight	60,89±11,53 Kg	
5.	Mean of Body Height	166,17±6,541 cm	
B.	**Ankle Joints n = 58**	**Sample**	
1.	Chronic Ankle Injury (CAI)	n = 26	
2.	Normal Ankle	n = 32	
C.	**Mean of Muscle Strength**	**Mean CAI (N)**	**Mean Normal (N)**
1.	Dorsal Flexor	21,04±4,501	21,44±4,206
2.	Plantar Flexor	21,83±3,364	22,48±4,323
3.	Invertor	12,58±3,402	14,52±5,156
4.	Evertor	11,81±3,371	13,59±4,634

Table 2. Multivariate Tests[c]

Effect		Value	F	Hypothesis df	Error df	Sig.	Noncent. Parameter	Observed Power[b]
Intercept	Pillai's Trace	.975	525.257[a]	4.000	53.000	.000	2101.029	1.000
	Wilks' Lambda	.025	525.257[a]	4.000	53.000	.000	2101.029	1.000
	Hotelling's Trace	39.642	525.257[a]	4.000	53.000	.000	2101.029	1.000
	Roy's Largest Root	39.642	525.257[a]	4.000	53.000	.000	2101.029	1.000
KONDISI	Pillai's Trace	.078	1.125[a]	4.000	53.000	.355	4.501	.329
	Wilks' Lambda	.922	1.125[a]	4.000	53.000	.355	4.501	.329
	Hotelling's Trace	.085	1.125[a]	4.000	53.000	.355	4.501	.329
	Roy's Largest Root	.085	1.125[a]	4.000	53.000	.355	4.501	.329

a. Exact statistic
b. Computed using alpha = .05
c. Design: Intercept + KONDISI

Table 3. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	INVERSION	53.916[a]	1	53.916	2.711	.105
	EVERSION	45.760[c]	1	45.760	2.698	.106
	DF	2.284[d]	1	2.284	.121	.729
	PF	6.200[e]	1	6.200	.403	.528
Intercept	INVERSION	10529.192	1	10529.192	529.491	.000
	EVERSION	9255.760	1	9255.760	545.742	.000
	DF	25881.043	1	25881.043	1373.993	.000
	PF	28165.942	1	28165.942	1829.353	.000
KONDISI	INVERSION	53.916	1	53.916	2.711	.105
	EVERSION	45.760	1	45.760	2.698	.106
	DF	2.284	1	2.284	.121	.729
	PF	6.200	1	6.200	.403	.528
Error	INVERSION	1113.588	56	19.886		
	EVERSION	949.757	56	16.960		
	DF	1054.837	56	18.836		
	PF	862.213	56	15.397		
Total	INVERSION	11968.750	58			
	EVERSION	10488.000	58			
	DF	27269.000	58			
	PF	29426.500	58			
Corrected Total	INVERSION	1167.504	57			
	EVERSION	995.517	57			
	DF	1057.121	57			
	PF	868.414	57			

a. R Squared = .046 (Adjusted R Squared = .029)
b. Computed using alpha = .05
c. R Squared = .046 (Adjusted R Squared = .029)
d. R Squared = .002 (Adjusted R Squared = -.016)
e. R Squared = .007 (Adjusted R Squared = -.011)

Discussion

Based on multivariate analysis that was identified all primary mover muscle for ankle joint did not different between CAI and normal ankle. Santos and Liu (2008) analyzed the instability of ankle joint factor was evertor muscle strength becoming decrease but there was negative correlation with ankle proprioception. Hiller et al (2010) did systematic review meta-analysis explained that there was no significant difference of evertor and invertor muscle strength on CAI condition.

Fox et al (2008) performed an eccentric strength analysis of dorsal and plantar flexor using an isokinetic machine that observed peak power in both muscles. They explained that the strength of dorsal and plantar flexor muscles showed no difference to the functional stability of the ankle joint.

Hertel, (2008) explained that any strength deficits associated with CAI are likely attributable to differences in motoneuron pool excitability and recruitment rather than actual musculotendinous unit damage. Such deficits would seem to indicate spinal, or possibly supraspinal, motor control deficits. The depression of alpha motoneuron pool excitability of the peroneal muscles during resting states among individuals who have CAI also casts considerable doubt on the feedback-only model of articular sensorimotor control.

The biggest problems on ankle injury were tear of the lateral side ligament (ATFL, PTFL, and CFL) caused joint instability. CAI condition will be at risk for individuals who will experience repetitive damage and pain. Bonnel et al (2010) explains that the patomechanics of CAI conditions is the destruction of their destructive mechanical stabilizer structure (ligaments) in the proprioceptive deficiency of the foot presentation joints.

CAI is one of type ankle injury which was experienced by active sportsman/athletes and there was risk to be repeated injury. This ankle muscle strength analysis provides information that CAI was not affected by muscle strength in each prime mover. With the result that clinician need consideration for CAI not to decided increasing muscle strength on rehabilitation programs. To develop hypotheses, we need to do observed proprioception function and study case with rehabilitation protocol for CAI.

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