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Comparison of Invertor and Evertor Muscle Strength in Patients with Chronic Functional Ankle Instability

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In this study we tried to measure Invertor and Evertor muscles strength with Isokinetic dynamometer to distinguish, if these muscles activate properly or not. Thirty subjects (15 healthy and 15 patients with chronic functional ankle Instability (CFAI) aged 18-30 years) participated in this study. Maximum eccentric and concentric peak Torque of invertor and evertor muscles measured with Biodex system in 2 different speeds, 60 and 120 degree per second. Statistical analysis showed that maximum eccentric peak torque of invertor muscles in both 60 and 120 degree per second differed statistical significance between two groups, as in the patients group was less than normal subjects ($p<0.05$). It means that eccentric weakness of invertor muscles will lead to CFAI.

Key words: Isokinetic, chronic functional ankle instability, muscle strength

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INTRODUCTION

Inversion injuries are the most common ankle distortion injury. Fifteen to sixty percent of ankle sprains will lead to Chronic Functional Ankle Instability (CFAI) (Douglas, 2001; Konradsen and Voigt, 1998). According to Douglas (2001), Konradsen and Voigt (1998), Kaminski and Hartsell (2002), Wilkerson (2002), Lephart and Fu (2000) and Hartel (2000 a,b) the most causes of CFAI are; muscle power deficit, Balance disorders, increased muscular response latency, less dynamic joint stability and reduced ankle joint dorsiflexion. Injury to lateral ligamentous mechanoreceptors or muscle-tendinous structures will lead to De-Afferentation phenomena in joint receptors (Lephart and Fu, 2000; Hartel, 2000).

Static and dynamic mechanisms produce ankle joint stability, in which healthy neuromuscular system and muscular contraction is responsible for dynamic stability of ankle joint (Hartel, 2002; Willems *et al.*, 2002). Disorders of this system will lead to ankle injury and subsequent instability (Willems *et al.*, 2002). Among with ankle musculature, invertor and evertor muscles with concentric and eccentric contractions have major role in joint dynamic stability (Willems *et al.*, 2002).

Recently, Biodex Isokinetic dynamometer is used as a tool for assessing the muscle strength, because of its high precision, safety and reliability (Kaminski and Hartsell, 2002).

Willems *et al.* (2002), Tropp (1986), Lentell *et al.* (1990), Schrader (1993), Bernier *et al.* (1997), Munn *et al.* (2003) and Ryan (1994) in their researches with Biodex system noticed that there is a difference between evertor and invertor muscle strength in patients with ankle sprain. The aim of this study was to measure the Invertor-Evertor muscle strength in patients with CFAI and in two different speeds; 60 and 120 degree per second which was no background in literatures.

MATERIALS AND METHODS

In this case-control study 30 male, non athletic subjects (15 healthy and 15 patients) aged between 18-30 years old with no history of lower limb fracture, surgery or balance disorder participated. For Invertor-Evertor Isokinetic test, eccentric and concentric contractions in 60 and 120 degree per second speed were done. Subjects seated on Isokinetic system, with ankle in 10 degree plantar flexion and knee in full extension. After firm fixation, range of maximum active inversion and eversion assessed in this manner:

- Concentric-Eccentric contraction for inversion movement in 60 degree per second speed.
- Eccentric-Concentric contraction for eversion movement in 60 degree per second speed.
- Concentric-Eccentric contraction for inversion movement in 120 degree per second speed.
- Eccentric-Concentric contraction for eversion movement in 120 degree per second speed.

Before starting the tests, 5 submaximal contractions were done as warm-up.

RESULTS

After data collection, statistical analysis showed these results; In 60 degree per second speed, there were no statistical differences between maximal eccentric or concentric peak torques of evertor muscles between two groups. Also in 120 degree per second speed, there was no statistical difference between maximum eccentric or concentric peak torques of evertor muscles between two groups. No statistical differences were seen between maximum eccentric or concentric peak torques of invertor muscles in 60 degree per second speed between two groups. Also no statistical differences was seen between maximum eccentric or concentric peak torque of invertor muscles in 120 degree per second speed between two groups (Table 1 and 2).

After normalization of the maximum peak torque to body weight, it was seen that in healthy subjects, invertor maximum eccentric peak torque in both speeds, was more than patients ($p<0.05$).

Table 1: Comparison of maximum peak torque of evertors in both speeds during concentric and eccentric contraction

Maximum peak torque	Normal	Patient	p-value
Concentric contraction (60 degree per second)	26.04±6.5	25.62±5.99	0.851
Concentric contraction (120 degree per second)	27.00±8.97	26.38±5.93	0.825
Eccentric contraction (60 degree per second)	25.46±6.08	25.79±5.23	0.874
Eccentric contraction (120 degree per second)	28.74±7.78	26.66±5.47	0.405

Table 2: Comparison of maximum peak torque of invertors in both speeds during concentric and eccentric contraction

Maximum peak torque	Normal	Patient	p-value
Concentric contraction (60 degree per second)	20.30±5.31	20.60±5.45	0.88
Concentric contraction (120 degree per second)	19.17±4.85	18.49±4.23	0.686
Eccentric contraction (60 degree per second)	25.46±4.07	22.26±5.21	0.072
Eccentric contraction (120 degree per second)	26.38±5.27	23.40±4.7	0.114

Table 3: Comparison of normalized maximum peak torque of invertors in both speeds during concentric and eccentric contraction

Normalized maximum peak torque to body weight	Normal	Patient	p-value
Eccentric invertors contraction (60 degree per second)	40.72±8.37	30.3±6.94	0.002
Eccentric Invertor contraction (120 degree per second)	42.02±9.31	27.88±5.93	0.005
Evertor concentric/Invertor eccentric contraction (120 degree per second)	97.6±29.74	132.93±24.96	0.001

Also in healthy subjects, maximum evertor concentric peak torque is less than maximum invertor eccentric peak torque in 120 degree per second speed (p = 0.001) (Table 3).

There was no correlation between age, height and weight with maximum concentric and/or eccentric peak torques in both groups.

DISCUSSION

This study showed that invertor muscles eccentrically deficiency could be one of the main causes of CFAI. In the other hand, evertor muscle concentric-eccentric weakness was not cause ankle functional instability. Ryan (1994) and Wilkerson *et al.* (1997) in their studies showed Isokinetic invertor strength deficiency in patients with lateral ankle sprain. To discuss about how invertor muscle weakness may lead to lateral ankle sprain, different aspects should be noticed. Acute lateral ankle sprain could damage lateral ligaments and joint capsule, which may lead to De-Afferentation phenomena. In this phenomenon due to mechanoreceptors damage, sensory inputs will diminish, subsequently efferent inputs to muscle spindle will be decreased, as Hall (1996) mentioned Invertor muscle inhibition reflex.

EMG studies showed that after lateral ankle sprain, invertor muscle motor neuron pool activation will decrease. It is one of the main causes of invertor muscle eccentric weakness after primary ankle sprain (Beynnon *et al.*, 2002).

Klinrensik and Stoeckart (1994) showed that deep peroneal nerve conduction velocity decreased after 3 weeks in patients with ankle sprain. This study showed that muscular dysfunction after primary ankle sprain, involved invertor muscles more than evertors. So in rehabilitation program the main focus must be on invertor muscles training. In this manner, ankle joint proprioception, sensory-motor integration and muscle stiffness must be considered.

Joint inflammation also contributes to ankle sprain, which may impede afferent information concerning. Joint motion and position sense (Lephart and Riemann, 2002a, b). Proprioception deficits resulting from joint pathology may have deleterious effect on dynamic retrain capabilities of muscles surrounding ankle joint. These deficits are related to functional ankle instability and limit an individual's capacity to perform activities (Lephart and Riemann, 2002b). There is coexistence between functional ankle instability and the sensory-motor deficit. This deficit will alter Alpha and Gama system activity due to ligament injury. In the other hand sensory-motor integration is the main part of motor control in all levels of central nervous system. This integration has a main role in joint stability and effect on muscle normal timing, normal level of contraction and limit excessive joint motion (Konradson and Voigt, 1997). In the case of ankle sprain, De-Afferentation phenomena could affect this integration, subsequently invertor and evertor muscles could not be activated in appropriate time or by adequate force to stabilize ankle joint (Lephart, 2002a, b).

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