

Correlation between the Foot and Ankle Disability Index (FADI) Score and Strength of HIP and Knee Muscles in Subjects with Unilateral Chronic Ankle Instability

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Abstract: ***Background:** Researches have proved that deficits in ankle strength do not correlate highly with chronic ankle instability (CAI) and muscular weakness exists at proximal joints in these individuals. As strength deficits can lead to functional limitations, this study aimed to find if there is any correlation between the isometric strength of abductors and extensors of the hip and flexors and extensors of the knee of the involved side in subjects with unilateral CAI with the Foot and Ankle Disability Index (FADI) score. **Methods:** 30 subjects with unilateral CAI took part. FADI score (expressed as percentage) and isometric strength was obtained for aforementioned muscles using a strain gauge. **Results:** There existed no correlation between the strength measures and FADI score. **Conclusion:** Clinicians must assess both functional limitations and strength of proximal muscles separately as they do not correlate with each other.*

Keywords: hip strength, knee strength, chronic ankle instability, FADI scale, correlation

1. Introduction

The incidence of soft-tissue injuries has increased owing to greater emphasis on physical fitness and recreation.¹ In both athletic and non-athletic population, ankle sprains are a fairly common injury² and 70-85% of these sprains are inversion type or lateral ankle sprains.^{1,2} Individuals who suffer repetitive sprains have been reported to have residual instability or chronic ankle instability (CAI). It is characterized by recurrent ankle sprains and a feeling of ankle 'giving way'.^{3,4}

CAI may be caused due to mechanical ankle instability, functional ankle instability or a combination of both.⁵ Pathologic laxity, impaired arthrokinematics and synovial and degenerative changes cause mechanical instability^{5,6} whereas impairments in proprioception, strength & neuromuscular control lead to functional instability.⁵

Evidence shows that neuromuscular changes take place in the involved ankle, in the ipsilateral limb proximally in individuals with CAI.⁷⁻¹¹ Beckman and Buchanan (1995) found altered hip muscle recruitment patterns and postural strategy after inversion ankle injury.⁷ In another study on unilateral CAI, arthrogenic muscle response was studied and ipsilateral facilitation of quadriceps and bilateral inhibition of hamstrings was found.⁸ Friel et al (2006) also showed that ipsilateral hip abductor strength reduced after inversion ankle sprain.⁹ Another study assessed concentric torque production and found strength deficits in flexors and extensors of the knee in subjects with CAI and no strength deficits in flexors and extensors of the hip.¹⁰ Garg et al assessed isometric muscle strength and found deficits in hip abductors and knee flexors whereas no deficits were found in hip extensors and knee extensors.¹¹

Individuals with CAI suffer from symptoms that limit their activities of daily living and recreation.¹² Most clinicians measure primary impairments such as pain, reduced ROM, weakness etc.¹³ Since today's practice aims at improving quality of life, functional limitations should also be assessed quantitatively.¹⁴

The Foot and Ankle Disability Index (FADI) can be used to assess functional limitations related to foot and ankle conditions. FADI is a region specific self-report of function with 2 components: FADI main which assesses activities of daily living and has 26 items and FADI Sport which assesses tasks that are essential to sports and has 8 items. The FADI and FADI Sport are scored separately as percentages, with 100% representing no dysfunction.¹³

Ankle strength does not correlate strongly with CAI¹² and there is weakness in hip and knee muscles in subjects with CAI (as discussed previously); so we questioned if strength of abductors and extensors of hip and flexors and extensors of knee would correlate with the FADI score (a tool for measuring functional limitations) in subjects with unilateral CAI. This study aimed to find this and we hypothesized that there would be significant correlation between strength measures and FADI score. Hubbard et al (2007) found correlation among multiple measures in subjects with CAI and found most significant correlations between functional instability measures.¹⁵ But in literature, there exists no relation between subjective report of function and strength of proximal muscles (both of which are measures of functional instability) in individuals with CAI.

2. Methods

Subjects

Thirty subjects (18 women and 12 men) with unilateral CAI (age 24.1 ± 1.9 years, height 162.1 ± 8.6 cm, weight 60.4 ± 8.4 Kg) participated in the study after signing informed consent.

Subjects who had a history of unilateral lateral ankle sprain at least 6 months prior to study; who were not under any supervised physiotherapy rehabilitation; who said yes to 4 items on the Ankle Instability Instrument (AII) (besides history of ankle sprain); and who self-reported disability on any 2 items of the Foot and Ankle Disability Index (FADI) main were included in the study.^{4,8} Both AII and FADI main are valid and reliable questionnaires for assessment of CAI.^{13,16} The FADI sport subscale was not used as athletes were excluded. Subjects were also excluded if they had a history of bilateral ankle sprain, concomitant ankle fracture, significant injury/surgery to low back or lower extremity, neurological disorders (balance disorders) and systemic disorders (like diabetes mellitus, cardiac disease, kidney disease, venous disorder).^{8,13}

Instruments and Procedure

The isometric strength was measured using a strain gauge (goldtech). It is a reliable and valid tool for measuring strength.¹⁷ A strap was attached to the subject's body part and it was attached to the strain gauge via a chain that was perpendicular to the limb segment. So, the strain gauge was always held perpendicular to the limb segment and was attached to an immovable object.^{17,18} The positioning is discussed below:^{18,19}

Hip Abductors (Figure 1): Subject was supine with the hip and knee of test limb extended and kept in neutral rotation and 0° of abduction. The opposite limb was flexed at hip and knee. The strap was attached proximal to the distal femoral condyle.

Hip Extensors (Figure 2): Subject was prone on a table that could split (similar to a traction table). Pelvis was stabilized, knee of the test limb was flexed to 90° and strap was attached proximal to distal femoral conyle.

Knee Extensors and Flexors (Figure 3,4): Subject was in high sitting with knee flexed to 90° , arms kept folded across the chest and strap was attached proximal to the ankle.

After positioning, the subject was asked to force i.e. push or pull in the desired direction (viz. hip abduction for hip abductors). For the purpose of warm-up, subject was asked to perform 3 repetitions at 60% of maximal effort. For main readings, he/she was instructed to take 1 to 2 seconds to reach maximal effort and to maintain that effort for 3-4 seconds.^{20,21} 3 trials with a rest of 60 seconds between each were given. Mean of 3 readings was taken as the measure of isometric strength in Kilograms-force. It was later normalized to body mass for data analysis.²⁰ Assessment was performed by the same examiner using the same instrument for all tests.



Figure 1: Measurement of hip abductor strength



Figure 2: Measurement of hip extensor strength



Figure 3: Measurement of knee extensor strength



Figure 4: Measurement of knee flexor strength

3. Results

SPSS Version 16 was used for data analysis. Pearson correlation coefficient 'r' was calculated between the FADI score (%) and the normalized strength of muscles of the involved side in CAI subjects. A p-value ≤ 0.05 was considered as significant. From table 1, it is clear that there was no significant correlation (r) between the FADI score (in %) and the strength of hip abductors, hip extensors, knee extensors and knee flexors of the involved side of subjects with CAI.

Table 1: Correlation between strength and FADI score

Variable 1 (Strength)	Variable 2	Pearson r	p value (2-tailed)
Hip Abductor	FADI (%)	-0.056	0.770
Hip Extensor	FADI (%)	-0.066	0.727
Knee Extensor	FADI (%)	-0.090	0.638
Knee Flexor	FADI (%)	-0.207	0.271

4. Discussion

We found no significant correlation between the FADI main score (expressed in percentage) and strength of these 4 proximal muscles although strength deficits and functional limitations often coexist. To our knowledge, any relation between these variables has never been established before in subjects with CAI.

Hubbard et al (2007) found correlation among various measures of functional and mechanical ankle instability in subjects with CAI and demonstrated that FADI scores correlated with measures of static balance ($r=0.45$ to 0.65) but did not correlate with measures of dynamic balance.¹⁵ They found it surprising as functional limitations correlated with static balance that is not as 'functional' a measure as dynamic balance. They also found that strength of hip abductors and extensors correlated with performance on star excursion balance test (SEBT, a measure of dynamic balance) whereas ankle strength did not correlate with SEBT scores.¹⁵ Although, multiple correlations were found, they could not provide adequate explanation for the presence or absence of these relationships.

Only isometric strength of muscles was assessed in our study. Though, it has an important predictive relationship with functional capacity,²⁰ there are more aspects of muscle performance such as concentric, eccentric strength, endurance, power that were not found in our study. It is quite possible that these too may be a contributor to functional limitations and might correlate with the FADI score.

Research has shown that FADI sport is more sensitive in detecting differences in subjects with and without CAI.¹⁷ We did not use it in our study as our population was non-athletic. Perhaps, this is also one of the reasons why we obtained no correlation..

Even though weakness exist in certain proximal muscle groups (as proved by previous researches), an absence of correlation may indicate that this weakness might be significant yet subtle so as to not cause functional limitations, or these limitations may depend strongly on some other factor like impairment in proprioception, arthrokinematics, postural control and/or capsuloligamentous laxity.

Absence of any correlation between these 2 variables means that these two are dichotomous in nature and should be assessed separately in subjects with CAI. One cannot get an insight of proximal muscle strength by just evaluating functional limitations using FADI.

5. Conclusion

The results of the study clearly indicate that there is no correlation between the FADI score and the strength of proximal muscles in subjects with unilateral CAI. Thus, clinicians should assess both functional limitations and muscular strength in these patients as assessment of one does not tell us about the other one.

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