

[Athletic Training]



Mechanical Joint Laxity Associated With Chronic Ankle Instability: A Systematic Review

Mitchell L. Cordova, PhD, ATC,*† JoEllen M. Sefton, PhD, ATC, CMT,‡ and Tricia J. Hubbard, PhD, ATC*

Context: Lateral ankle sprains can manifest into chronic mechanical joint laxity when not treated effectively. Joint laxity is often measured through the use of manual stress tests, stress radiography, and instrumented ankle arthrometers.

Purpose: To systematically review the literature to establish the influence of chronic ankle instability (CAI) on sagittal and frontal plane mechanical joint laxity.

Data Sources: Articles were searched with MEDLINE (1966 to October 2008), CINAHL (1982 to October 2008), and the Cochrane Database of Systematic Reviews (to October 2008) using the key words *chronic ankle instability and joint laxity*, *functional ankle instability and joint laxity*, and *lateral ankle sprains and joint laxity*.

Study Selection: To be included, studies had to employ a case control design; mechanical joint laxity had to be measured via a stress roentogram, an instrumented ankle arthrometer, or ankle/foot stress-testing device; anteroposterior inversion or eversion ankle-subtalar joint complex laxity had to be measured; and means and standard deviations of CAI and control groups had to be provided.

Data Extraction: One investigator assessed each study based on the criteria to ensure its suitability for analysis. The initial search yielded 1378 potentially relevant articles, from which 8 were used in the final analysis. Once the study was accepted for inclusion, its quality was assessed with the PEDro scale.

Data Synthesis: Twenty-one standardized effect sizes and their 95% confidence intervals were computed for each group and dependent variable. CAI produced the largest effect on inversion joint laxity; 45% of the effects ranged from 0.84 to 2.61. Anterior joint laxity measures were influenced second most by CAI (effects, 0.32 to 1.82). CAI had similar but less influence on posterior joint laxity (effects, -0.06 to 0.68) and eversion joint laxity (effects, 0.03 to 0.69).

Conclusion: CAI has the largest effect with the most variability on anterior and inversion joint laxity measurements, consistent with the primary mechanism of initial injury.

Keywords: ankle injury; joint laxity; chronic ankle instability; ankle sprain

In the United States, 23 000 physically active individuals incur lateral ankle sprains on a daily basis.⁸ The impact of this common injury is substantial, with pain, disability, and time lost from work and activity estimated to result in 1.2 million physician visits per year and an annual health care cost approximating \$3.8 billion.⁸ In an assessment of the impact of lateral ankle sprains in National Collegiate Athletic Association athletes during a 16-year period, 14% of all injuries reported were lateral ankle sprains.¹⁴ The recurrence rates for these

injuries are alarming as well, with estimates as high as 70%.³⁹ Owing to the tendency for repeated lateral ankle sprains to occur with the continued lingering signs and symptoms associated with functional deficits, patients ultimately develop a condition termed *chronic ankle instability* (CAI).¹⁰

Although the exact cause of CAI remains unknown, substantial mechanical joint¹⁶ and sensorimotor elements¹¹ are thought to be at play. Mechanical instability of the talocrural and talocalcaneal articulations accompanies acute lateral

From the *Biodynamics Research Laboratory, Department of Kinesiology and Center for Biomedical Engineering Systems, University of North Carolina at Charlotte, Charlotte, North Carolina, and the †Neuromechanics Research Laboratory, Department of Kinesiology, Auburn University, Auburn, Alabama

†Address correspondence to Mitchell L. Cordova, PhD, Professor and Chairperson, Department of Kinesiology, University of North Carolina at Charlotte, 226-A Belk Gymnasium, Charlotte, NC 28223 (e-mail: mcordova@uncc.edu).

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ankle sprains and occurs because of the disruption of the anterior talofibular, calcaneofibular, and posterior talofibular ligaments, which provide passive restraint for the lateral ankle complex.¹⁰ Acute lateral ankle sprains are frequently trivialized, and adequate rehabilitation does not follow. Patients can then develop pathological joint laxity that makes the lateral ankle-subtalar joint complex vulnerable to repetitive injury and, ultimately, the development of CAI. Early work investigating the influence of functional ankle instability (FAI) and CAI on joint displacement used a qualitative approach in which manual stress testing of the ankle-subtalar joint complex was performed.^{5,33} Although this initial research was important in trying to describe joint laxity changes in patients suffering from CAI, it was limited in that the specific degree of joint laxity was difficult to establish. Stress radiography, established thereafter, was important in allowing joint laxity to be measured more accurately.^{29,30,40} However, the reliability and validity of manual stress tests with or without stress radiography have been questioned,^{6,7} leading to the development of instrumented arthrometers and custom-made mechanical devices that can precisely quantify joint kinematics noninvasively.^{14,17,22,23}

Previous investigations have established the relationships between linear and angular joint displacement and functional ability in CAI,²⁰ as well as correctly classifying CAI patients.¹⁹ Although this work has been important in understanding the relationship of CAI and mechanical joint laxity, the overall effects that CAI may have on joint laxity have not been adequately summarized.³⁷

METHODS

Study Search Strategy

MEDLINE (1966 to October 2008), CINAHL (1982 to October 2008), and the Cochrane Database of Systematic Reviews (to October 2008) were searched using the keywords *chronic ankle instability and joint laxity*, *functional ankle instability and joint laxity*, and *lateral ankle sprains and joint laxity*. Articles were additionally obtained by cross-referencing published articles from the database searches. Collectively, the search produced 1378 potentially relevant articles, which were further screened for inclusion.

Study Selection Criteria

The following criteria were used for study evaluation and inclusion: a case control or quasiexperimental design investigating the effects of CAI or FAI on mechanical joint laxity; mechanical joint laxity measured via stress roentogram, instrumented ankle arthrometer, or ankle/foot stress testing device; anterior, posterior, inversion, or eversion ankle-subtalar joint laxity measured with the techniques just cited; and the means and standard deviations or standard errors provided for each quantitative mechanical joint laxity measurement for the CAI or FAI group and the matched healthy (control) group.

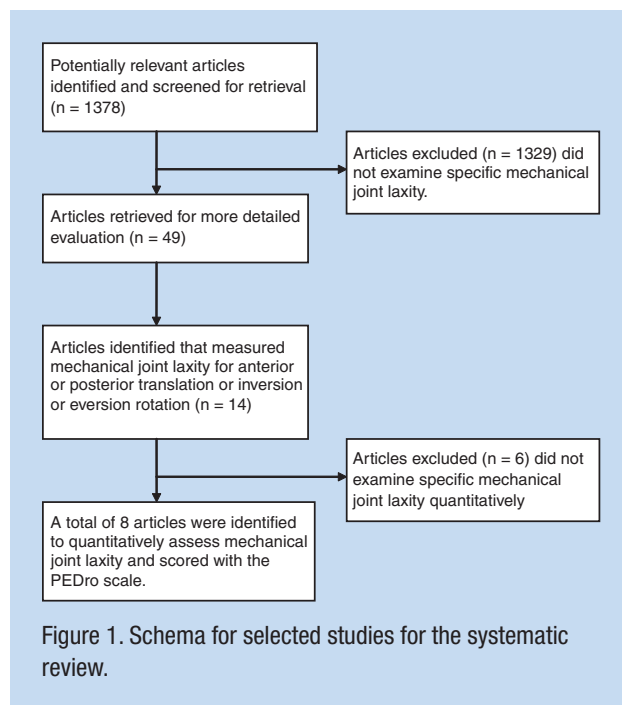


Figure 1. Schema for selected studies for the systematic review.

A single examiner identified and screened the 1378 studies for potential inclusion in the analysis, of which 1329 were excluded because they did not assess ankle-subtalar joint laxity; 49 potential articles were retrieved and analyzed further. Fourteen studies were identified that measured either mechanical joint laxity in the anterior or posterior direction or joint laxity during inversion or eversion movement. Of these 14 articles, 6 were excluded because they examined joint laxity with subjective/qualitative methods. Therefore, the systematic review included 8 studies that objectively measured joint laxity, from which multiple effects were used to systematically investigate CAI/FAI effects (Figure 1).

Assessment of Study Quality

All studies selected for inclusion in the analysis were evaluated with the PEDro scale (ie, methodological quality of randomized controlled trials [RCTs] and non-RCTs).²⁷ The 11-item checklist yields a PEDro score based on a 10-point scale in which large values indicate a higher-quality study design.²⁷ A maximum score of 10 can occur for an RCT if all of the established criteria in the checklist are met, whereas a maximum score of 8 can be achieved for non-RCTs. Two authors assessed the 8 studies that met the criteria so that agreement regarding the PEDro score could be established for each study used in the analysis.²⁷

Data Analysis/Extraction

Standardized effect sizes were calculated to establish the effect of CAI/FAI, compared to healthy control groups, on mechanical joint laxity measurements taken for anterior

and posterior translations as well as inversion and eversion rotations. The effect sizes were computed by subtracting the healthy group mean from the CAI/FAI mechanical joint laxity mean for each movement and dividing that sum by the standard deviation of the healthy condition.^{2,4,31} Thus, a positive effect represents greater mechanical joint laxity, whereas a negative effect represents decreased joint laxity. The 95% confidence interval (CI) provides information concerning the variability of the observed effect size, its precision, as well as the accuracy with which the interval contains the population parameter (ie, the true value). The standardized effect sizes were interpreted according to the guidelines established by Cohen⁴ in which values < 0.20 are trivial or not substantial, 0.20 and 0.49 are small but substantial, 0.50 and 0.79 are moderate, and ≥ 0.80 are large.

RESULTS

A total of 21 effects from 8 studies^{15,17,19,24-26,36,38} were used in the analysis to investigate the effects of CAI/FAI on mechanical joint laxity in the sagittal and frontal planes (Table 1). The PEDro scores for these studies ranged from 4 to 6, with an average rating of 5. Studies across this analysis did not investigate the same effects. As such, some studies investigated only the effects of CAI on anterior joint laxity, whereas others investigated the influence of CAI on anterior and inversion joint laxity. Specifically, 4 studies investigated the effects of CAI/FAI on anterior joint laxity^{17,19,24,36}; 3 investigated posterior joint laxity^{17,19,24}; 8 investigated inversion joint laxity^{15,17,19,24-26,36,38}; and 3 investigated eversion joint laxity.^{17,19,24}

CAI and Anterior Joint Laxity

Four studies^{17,19,24,36} analyzed the effects that CAI/FAI had on anterior joint laxity (mean PEDro score, 5.8) (Table 2). The standardized effect sizes ranged from 0.32 to 1.82, indicating that CAI/FAI results in greater anterior joint laxity compared to a healthy condition. Two studies^{17,36} demonstrated nearly identical effects, 0.32 and 0.33, which are considered small but clinically relevant, whereas the other 2 investigations^{19,24} exhibited much larger effects, 1.82 and 1.16, with greater variability even though they used same methodology and instrumentation. In 3 of the 4 studies, the 95% CI for each effect did not cross zero, indicating that CAI/FAI patients do exhibit significant increases in anterior joint laxity when compared to healthy controls.

CAI and Posterior Joint Laxity

Three studies analyzed CAI/FAI on posterior joint laxity measures^{15,17,19} (mean PEDro score, 6.0) (Table 3). For posterior joint laxity measures, the point estimates for the standardized effect sizes ranged from -0.06 to 0.68 and were not nearly as large as those observed for anterior joint laxity. Two of these studies^{15,17} demonstrated positive moderate effect sizes indicative of greater laxity in the CAI/FAI group compared to the healthy control group, whereas the other study¹⁹ revealed

an insubstantial effect (-0.06) demonstrating that CAI/FAI patients have less posterior joint laxity compared to that of healthy patients. The 95% CIs^{17,19} of 2 studies confirmed no significant differences between CAI/FAI patients and healthy controls on posterior joint laxity, whereas the study that did produce the largest effect¹⁵ showed that CAI/FAI patients exhibit significant increases in posterior joint laxity in comparison to healthy controls.

CAI and Inversion Joint Laxity

Eight studies^{15,17,19,24-26,36,38} provided 11 effects in which the influence of CAI/FAI on inversion joint laxity measures could be analyzed (PEDro score, 5.0) (Table 4). The point estimates calculated for this effect were positive, indicating that, collectively, CAI/FAI patients demonstrate larger amounts of inversion joint laxity compared to healthy patients. Three studies^{25,36,38} characterized frontal plane inversion joint laxity with 2 separate measures—talar tilt and subtalar tilt rotation. These studies were published within 3-year time span and used nearly identical methodology in quantifying inversion joint laxity measurements. There was a considerable amount of variability in the range of standardized effect sizes calculated (0.06 to 2.61). Forty-five percent of the total effects calculated within these studies demonstrated large values, ranging from 0.84 to 2.61^{15,25,36,38}; of these 5 large effects, 3 were very large, ranging between 1.80 and 2.61.^{15,38} Of the 11 effects computed, 4 (36%) were trivial or not substantial, with the range being 0.06 to 0.21,^{17,19,25,26} whereas 2 (18%) were small but substantial, 0.31 and 0.37; finally, 2 (18%) effects were deemed moderate, 0.84 and 0.92. Regarding the 95% CI, 3 of 11 effects (27%) did not cross zero, indicating that CAI/FAI patients do exhibit significant increases in inversion joint laxity compared to healthy controls.

CAI and Eversion Joint Laxity

Three studies analyzed eversion joint laxity (mean PEDro score, 6.0) (Table 5).^{15,17,19} All of the effect sizes were positive, indicating greater eversion joint laxity in patients with CAI/FAI compared to healthy controls. For the eversion joint laxity measures, the standardized effect sizes ranged from 0.03 to 0.69. The low range of the effect sizes for eversion laxity was similar to that observed for inversion joint laxity; however, the high end of the eversion range (0.69) was not nearly as close to that observed for inversion (2.61). The 3 effects represented magnitudes that were trivial (0.03),¹⁷ small (0.22),¹⁹ and moderate (0.69).¹⁵ The 95% CIs indicate that none of the effects demonstrated significant differences between CAI/FAI patients and healthy controls on eversion joint laxity.

DISCUSSION

The physical examination remains the primary means to diagnose the musculoskeletal pathology of ankle injuries. Manual stress testing of the passive joint structures is essential. The anterior drawer and inversion talar tilt tests are essential

Table 1. Selected studies for review.^a

Research Study	PEDro Score	Study Design	Participants, n	Inclusion Criteria	Measurement Technique	Joint Laxity Measures
Hubbard et al ¹⁷	6	Quasiexperimental (intact group), within subject	51 unilateral FAI	Respond <i>yes</i> to select items on questionnaire	Instrumented ankle arthrometer and stress radiography with a Telos device	Total anteroposterior displacement, total internal-external rotation (abduction-adduction), anterior laxity, talar tilt laxity (stress radiography)
Hubbard et al ¹⁹	6	Case control, between subject	30 unilateral CAI, 30 controls	Respond <i>yes</i> to select items on questionnaire	Instrumented arthrometer	Anterior, posterior, inversion, and eversion laxity
Hubbard ¹⁵	6	Case control, between subject	16 unilateral CAI, 16 controls	Respond <i>yes</i> to select items on questionnaire; personal interview	Instrumented arthrometer	Anterior, posterior, inversion, and eversion laxity
Lentell et al ²⁴	5	Quasiexperimental (intact group), within subject	34 unilateral CAI	Screened for unilateral CAI that has plateaued	Stress radiography with manual stress test	Inversion laxity via talar tilt
Louwerens et al ²⁵	4	Case control, between subject	22 bilateral CAI, 11 unilateral CAI, 10 controls	Frequent inversion trauma and sensations of giving way	Stress radiography with custom mechanical device	Talocrural tilt and subtalar tilt
Lui et al ²⁶	5	Quasiexperimental (intact group), within subject	15 unilateral CAI	> 2 episodes of severe unilateral sprain within 10 yrs of study	Instrumented ankle arthrometer	Anterior and inversion laxity
van Hellemond et al ³⁶	4	Quasiexperimental (intact group), within subject	15 unilateral CAI	Frequent inversion trauma and sensations of giving way	Stress radiography with a Telos device	Talocrural tilt and subtalar tilt
Yamamoto et al ³⁸	4	Case control, between subject	23 unilateral CAI, 80 controls	None provided	Stress radiography with a Telos device	Talocrural tilt and subtalar tilt

^aCAI, chronic ankle instability; FAI, functional ankle instability.

for determining the sagittal and frontal plane mechanical joint stability.³² Although the physical examination is performed to assess a patient's level of mechanical joint laxity, it relies extensively on the practitioner's level of experience and on the sensitivity of the test itself. The literature has shown that the sensitivity of the anterior drawer test varies between 32% to 80%,^{3,35} with the talar tilt test at 52%.³

Due to the inherent limitations of quantifying ankle-subtalar joint complex stability with manual stress testing during a

physical examination, the use of stress radiography has been advocated.^{6,28,32} Mechanical positioning tools may provide more reliable assessments of joint laxity.^{12,25,28,32,38} Instrumented ankle arthrometers may provide a more reliable and valid method for quantifying sagittal plane translation and frontal plane rotation of the ankle-subtalar joint complex in healthy and CAI patients.^{13,15,17-19,22,23}

Research investigating CAI and the tendency toward accelerated joint surface degradation leading to posttraumatic

Table 2. Anterior joint laxity and effect sizes by group.

Study	Variable	Control	CAI/FAI ^a	Effect Size ^b
Hubbard ¹⁵	Anterior displacement, mm	11.8 ± 0.9	13.4 ± 1.9	1.82 (1.41, 2.24)
Hubbard et al ¹⁹	Anterior laxity, mm	11.9 ± 1.9	14.1 ± 2.3	1.16 (0.48, 1.83)
Hubbard et al ¹⁷	Anterior displacement, mm	11.1 ± 3.2	12.1 ± 3.1	0.32 (-0.56, 1.20)
Lui et al ²⁶	Anterior drawer flexibility, mm/N	0.15 ± 0.06	0.17 ± 0.05	0.33 (0.30, 0.37)

^aCAI, chronic ankle instability; FAI, functional ankle instability.

^b95% confidence intervals in parentheses.

Table 3. Posterior joint laxity and effect sizes by group.^a

Study	Control	CAI/FAI ^b	Effect Size ^c
Hubbard ¹⁵	4.1 ± 1.2	4.9 ± 1.1	0.68 (0.10, 1.24)
Hubbard et al ¹⁹	5.2 ± 1.6	5.1 ± 1.2	-0.06 (-0.64, 0.50)
Hubbard et al ¹⁷	7.2 ± 1.6	7.7 ± 1.7	0.32 (-0.11, 0.75)

^aVariable for each study: posterior displacement, mm.

^bCAI, chronic ankle instability; FAI, functional ankle instability.

^c95% confidence intervals in parentheses.

Table 4. Inversion joint laxity and effect sizes by group.

Study	Variable	Control	CAI/FAI ^a	Effect Size ^b
Hubbard ¹⁵	Inversion rotation ^o	32.3 ± 1.8	35.6 ± 2.9	1.80 (0.9, 2.7)
Hubbard et al ¹⁹	Inversion laxity ^o	34.1 ± 3.9	34.9 ± 4.9	0.21 (-1.2, 1.6)
Hubbard et al ¹⁷	Inversion rotation ^o	32.3 ± 1.8	35.6 ± 2.9	0.14 (-1.53, 1.82)
Lui et al ²⁶	Inversion flexibility, deg/N-m	9.01 ± 2.4	9.19 ± 2.4	0.07 (-1.3, 1.4)
Lentell et al ²⁴	Talar tilt ^o	4.0 ± 2.7	5.0 ± 2.9	0.37 (-0.5, 1.2)
Louwerens et al ²⁵	Talar tilt ^o	2.6 ± 3.9	6.2 ± 4.8	0.92 (-1.5, 3.3)
	Subtalar tilt ^o	10.1 ± 3.4	10.3 ± 3.8	0.06 (-2.0, 2.1)
Yamamoto et al ³⁸	Talar tilt ^o	4.6 ± 3.1	12.7 ± 8.2	2.61 (1.93, 3.29)
	Subtalar tilt ^o	5.2 ± 2.6	10.3 ± 2.9	1.96 (1.39, 2.53)
van Hellemond et al ³⁶	Talar tilt ^o	6.3 ± 4.3	7.6 ± 5.4	0.31 (-1.86, 2.48)
	Subtalar tilt ^o	7.7 ± 2.6	9.8 ± 3.2	0.84 (-0.46, 2.13)

^aCAI, chronic ankle instability; FAI, functional ankle instability.

^b95% confidence intervals in parentheses.

Table 5. Eversion joint laxity and effect sizes by group.

Study	Variable	Control	CAI/FAI ^a	Effect Size ^b
Hubbard ¹⁵	Eversion rotation ^o	22.3 ± 2.8	24.2 ± 4.7	0.69 (−0.66, 2.03)
Hubbard et al ¹⁹	Eversion laxity ^o	20.6 ± 4.5	21.6 ± 4.7	0.22 (−1.39, 1.83)
Hubbard et al ¹⁷	Eversion rotation ^o	24.8 ± 3.1	24.9 ± 3.2	0.03 (−0.82, 0.88)

^aCAI, chronic ankle instability; FAI, functional ankle instability.

^b95% confidence intervals in parentheses.

ankle osteoarthritis^{1,21} will continue to be a substantial challenge faced by those in the orthopaedic community.^{9,34}

CAI and Anterior Joint Laxity

The 4 studies that assessed the influence of CAI on joint laxity displayed disparate results, with 2 revealing small effects^{17,26} and with 2 demonstrating large effects.^{15,19} Data from Hubbard et al^{15,19} demonstrate good precision because the boundaries for the CIs are narrow, whereas the effect observed from Lui et al²⁶ is 3 to 6 times smaller than those observed in the other investigations,^{15,19} but their point estimate also contains a narrow CI, indicative of precise and significant effect. Hubbard et al¹⁵ measured anterior joint laxity with an instrumented ankle arthrometer and defined it as a function of joint deformation according to a fixed load (125 N). Lui and colleagues²⁸ also used an instrumented arthrometer but defined anterior joint laxity as the slope of the linear portion of the load deformation curve, which may account for the difference in the calculated effects sizes between the 2 investigations.

It is not surprising that small to very large effects of anterior joint laxity were identified in patients with CAI compared to healthy controls, because talocrural joint laxity is often the debilitating outcome of recurrent lateral ankle injuries.^{5,12,21,24,25} Both the anterior talofibular and the calcaneofibular ligaments play a primary role in providing passive restraint to the talocrural complex. Sequential sectioning of the anterior talofibular and calcaneofibular in a cadaveric model does increase anterior talar translation.²³ Compared to uninjured controls, patients with CAI demonstrated significant anterior drawer laxity and greater talar tilt with supination stress.¹² Clinicians sometimes assume that the lateral ankle ligaments heal following injury, but talocrural joint laxity may persist if these ankles are not adequately treated.^{12,24,25} Rehabilitation programs need to emphasize sufficient time for anterior ligament healing and provide a graded therapeutic exercise regime that restores joint range of motion, muscles strength, and sensorimotor control.

CAI and Posterior Joint Laxity

The magnitude of effects derived from the 3 studies examining the influence of CAI on posterior joint laxity

ranged from trivial (−0.06) to moderate (0.68).^{15,17,19} The largest effect observed (0.68) was from the Hubbard study¹⁵ that investigated ligament laxity in 16 patients with unilateral CAI. Average posterior displacement in the injured ankle was 7.7 mm, compared to 7.2 mm in the control ankle. Although the magnitude of the point estimate can be viewed as being moderate, interpretation of the upper limit of the interval estimate (ie, the 95% CI) indicates that the true effect could be as high as 1.24 and as low as 0.10. This suggests that CAI patients who sustain more than 1 unilateral ankle sprain and frequent episodes of ankle giving way (at least once a month) may present with significantly greater posterior laxity compared to that of matched controls. A smaller effect (0.32) was observed in 51 patients with self-reported unilateral FAI.¹⁷ Differences in patient inclusion criteria may account for larger differences in the posterior joint laxity measurements and a different magnitude of effect.¹⁷ Surprisingly, in a similar investigation based on the same inclusion criteria and ankle ligament laxity measurement device,¹⁹ CAI had a much smaller and negative effect (−0.06) compared to healthy controls. CAI patients did not demonstrate any difference in posterior joint laxity compared to healthy controls.

The effects of CAI on posterior joint laxity have been studied less than anterior joint laxity. The passive tissues that provide restraint against posterior translation of the talocrural complex are not injured nearly as often.¹ The evidence from this analysis suggests that patients with CAI do not have a large amount of posterior joint laxity. Clinically, posterior joint laxity does not generally pose a challenge to the practitioner when treating patients with CAI. However, clinicians do need to be cognizant of its existence and the limitations that it can impose to the successful rehabilitation of the chronically unstable ankle.

CAI and Inversion Joint Laxity

Inversion joint laxity is widely investigated in patients with CAI because it is the primary mechanism of injury (combined plantar flexion and inversion). In this review, 11 effects from 8 investigations focused on inversion: 3 investigations measured inversion rotation or laxity^{17,19,15}; 4, talar and subtalar tilt^{24,25,36,38}; and 1, inversion flexibility.²⁶ Four used an instrumented ankle arthrometer^{17,19,15,26} to measure inversion

joint laxity. Instrumented ankle arthrometry was developed so that ligament laxity of the ankle-subtalar joint complex could be assessed in a more reliable and valid way. The other 4 investigations grouped in the inversion joint laxity analysis measured talar tilt and subtalar tilt angles.^{24,25,36,38} Three^{25,36,38} used a mechanical hinge device to stabilize the patient while a stress radiograph was taken. The other investigation used a manual stress radiography test.²⁴ Because of the differences in the variables measured and the methodologies, the calculation of effect sizes allows for direct meaningful comparison among these studies.

The effects for inversion joint laxity were the largest; 5 of the 11 ranged from 0.84 to 2.61.^{15,25,38} The magnitude of these effects suggests that CAI demonstrated the greatest influence on inversion joint laxity. The largest effect size, 2.61(95% CI [1.9 to 3.3]), was from data in the Yamamoto et al³⁸ investigation for talar tilt. When this effect size and its interval estimate are evaluated closely, the magnitude of the effect suggests that CAI increased inversion joint laxity 2.61 standard deviation units beyond the control mean. Perhaps even more important is the interpretation of the interval estimate. The width of the interval indicates excellent precision, with the likelihood that the effect of CAI on laxity is even higher (3.3). The CIs for the large effects did not cross zero, suggesting that CAI ankles demonstrated significantly greater inversion joint laxity when compared to that of matched controls.

Although 45% of the total effects were large, a surprisingly proportion (36%) were trivial. These effects were derived from inversion flexibility,²⁶ inversion rotation,¹⁷ inversion laxity,¹⁹ and subtalar tilt.²⁵ The CIs for the point estimates were relatively wide and did cross zero. These characteristics suggest an overall lack of precision of the sample statistic to the population parameter, as well as the lack of statistic significance between CAI and control groups. Of the 11 effects, 2 (18%) were moderate.^{25,36} Neither were significant, and each interval estimate demonstrated a lack of precision, principally because of the relatively small samples employed in the studies relative to the amount of random error generated in the measurement. It is not surprising that the largest and most significant effects observed in patients with CAI were reflected in the inversion joint laxity measures owing to the high incidence and recurrence of the lateral inversion ankle sprain. Clinicians should direct rehabilitation programs toward firmly restoring joint stability either through improved immobilization techniques or through exercises that better focus on enhancing dynamic joint stability.

CAI and Eversion Joint Laxity

Medial ankle sprains and eversion ankle injuries are not nearly as common as the lateral ankle injury. In the current analysis, 3 studies provided 3 effects that were grouped to provide an assessment of CAI/FAI influences on eversion joint laxity.^{15,17,19} The point estimates from the studies represent a trivial effect (0.03), a small effect (0.22), and a moderate effect

(0.69). The medial ankle ligaments are rarely involved in the common lateral ankle sprain, only 2 of the 3 studies yielded very small effects.^{17,19} Their 95% CIs, the true population effect for eversion laxity could yield a value as high as 1.83. For the eversion rotation variable,²⁴ a moderate effect (0.69) produced a 95% CI of -0.66 to 2.03. The data show that small to moderate eversion joint laxity persists in patients who suffer from CAI.

Summary

This systematic review suggests that CAI has the greatest influence on inversion joint laxity, followed by anterior joint laxity. The magnitude of these effects, along with their 95% CIs, suggests that these effects are very large. Posterior and eversion joint laxity is present in those with CAI, but the effects are not nearly as profound.

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