Case-Control Analysis of Chronic Ankle Instability in Female College Athletes

Erica H. Zabkar, MS, ATC; Timothy J. Zinke, MS, ATC; Gary B. Wilkerson, EdD, ATC

THE UNIVERSITY of TENNESSEE CHATTANOOGA

BACKGROUND AND PURPOSE

- Lateral ankle sprain (LAS) is the most common acute musculoskeletal injury in college athletics[1]
  - LAS accounts for 15% of injuries reported to the NCAA injury surveillance database
- Up to 50% of patients who sustain an acute LAS never fully recover pre-injury functional capabilities[2]
- Chronic ankle instability (CAI) appears to result from both ligament laxity and impaired neuromuscular control
  - Anterolateral rotary instability (ALRI), due to ligament laxity, is often a consequence of acute LAS[3]
  - Posterior tibialis (PT) dysfunction has been associated with ALRI[4]
  - Performance capabilities of the core musculature have been related to ankle biomechanics[5]
- The purpose of this study was to compare factors that differentiate college athletes with CAI from matched control athletes, which could improve methods for assessment and therapeutic management of ankle dysfunction

PARTICIPANT CHARACTERISTICS

- 14 NCAA Division-I female athletes participated (Table 1)
  - Age (19.8 ± 1.1 years), Weight (66.6 ± 8.0 kg), Height (170.9 ± 7.1 cm), BMI (22.7 ± 1.4)
- 7 cases had a history of multiple sprains and/or a score ≤24 on the Cumberland Ankle Instability Tool (CAIT)[6]
- 7 controls were recruited, who were matched as closely as possible to cases (sport, age, height, weight)

Table 1

	1a	1b	2a	2b	3a	3b	4a	4b	5a	5b	6a	6b	7a	7b
Sport	BB	BB	VB	VB	BB	BB	SB	SB	SB	SB	TN	TN	SC	SC
Age	21	20	18	20	22	21	20	19	21	19	19	19	19	19
Ht (cm)	182.9	177.8	182.9	172.7	170.2	167.4	175.3	167.6	157.5	167.6	170.2	162.6	170.2	167.6
Wt (kg)	87.3	78.2	70.5	70.0	66.8	60	63.6	63.5	55.9	62.7	63.6	62.7	64.7	62.3
BMI	26.1	24.7	21.1	23.4	23.1	21.3	20.8	22.5	22.5	22.2	22.0	23.6	22.4	22.1

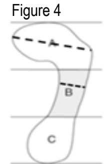
a: case; b: control — BB: Basketball; VB: Volleyball; SB: Softball; TN: Tennis; SC: Soccer

Figure 1

Figure 2

Figure 3

Figure 4



FWI = Line B / Line A

METHODS

- Horizontal trunk hold (HTH; Figure 1) and estimated mass moment of inertia (MMOI) derived from screening data
- Ankle assessments were performed for both right and left extremities of both cases and controls:
  1) Foot and Ankle Ability Measure - Sport (FAAM-S)
  2) Cumberland Ankle Instability Tool (CAIT)
  3) Ultrasound images of PT tendon
  4) Inversion torque from hand-held dynamometer (Figure 2)
  5) Anterior ankle laxity from KT-1000 Arthrometer (Figure 3)[7]
  6) Foot width index (FWI) measurement (Figure 4)[8]
- PT height (red line) divided by width (yellow line) to calculate cross-sectional height/width ratio (Figures 5 & 6)
- Means and standard deviations for the 8 variables are presented in Table 2
- Univariable cross-tabulation analyses performed to assess strength of associations with CAI classification
- Factors combined to create 2-factor CAI "screening" assessment and 2-factor CAI "follow-up" assessment
  - Screening factors chosen on the basis of simplicity, lack of equipment requirement, and predictive power
  - Follow-up factors chosen on the basis of wide accessibility to the necessary equipment and predictive power

RESULTS

- 4 factors were identified that demonstrated a very strong association with CAI; Odds Ratio = 15 (Table 3)
- 2-factor screening model (MMOI and HTH): both factors positive identified 5 of 7 CAI cases (Figure 7)
  - Fisher's exact one-sided p = .05; Sensitivity = 71%; Specificity = 86%; Odds Ratio = 15
- 2-factor follow-up model (Inversion torque and PT ratio): either or both positive identified all CAI cases (Figure 8)
  - Fisher's exact one-sided p = .01; Sensitivity = 100%; Specificity = 71%; Odds Ratio = 33*

  * Estimated Odds Ratio: 0.5 added to each cell of 2x2 table to avoid division by zero

Table 2

Predictor	Cases		Controls	
Torque (Nm)	14.86	±5.02	21.54	± 6.17
KT-1000 (mm)	9.61	± 2.18	7.27	± 1.71
PT Ratio	0.41	± 0.05	0.58	± 0.08
MMOI (kg·m²)	203.55	± 48.52	189.32	± 29.37
FWI	0.45	± 0.06	0.41	± 0.08
HTH (s)	53.71	± 29.46	55.57	± 42.56
CAIT	16.86	± 7.06	28.14	± 1.22
FAAM	24.43	± 10.98	31.71	± 0.49

Table 3

Predictor	Cut-Point	OR	Sn	Sp
Torque	≤19.5	15.0	.86	.71
KT-1000	≥7.6	15.0	.86	.71
PT Ratio	<0.43	15.0	.71	.86
MMOI	≥181.0	15.0	.86	.71
FWI	>0.40	8.0	.86	.57
HTH	≤ 86.0	4.5	.86	.43

Figure 5

Figure 6

Figure 7

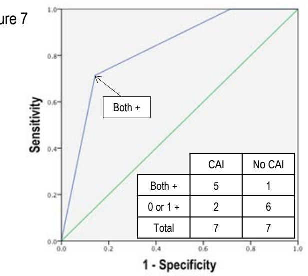
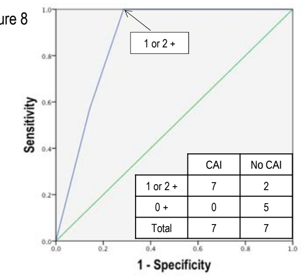


Figure 8



CLINICAL RELEVANCE

- Fatigue-induced reduction of core muscle control and an elevated center of mass may impose high ankle loads
  - Optimal core muscle endurance (e.g., HTH > 86 s) may offset high external moment created by high MMOI
- Pre-participation screening (core tests, anthropometric measures, surveys) may facilitate early CAI detection[6]
  - Athletes identified as high-risk for CAI progression should receive more sophisticated follow-up assessment
- Poor invertor strength and degenerative changes in the PT tendon may exacerbate chronic ankle dysfunction
  - Therapeutic interventions to improve core muscle control and increase invertor strength may be beneficial
  - Eccentric strengthening of the PT may prevent progression of tendinopathy[9]

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