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Impact of Chronic Ankle Instability Following Ankle Sprain on Ankle Dorsiflexion, Heel Lift Function, and Quality of Life

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Abstract

Background: Chronic ankle instability (CAI) post-sprain leads to persistent functional deficits. This study evaluated CAI's specific impact on ankle dorsiflexion, heel lift function, stability, broader functional impairments, and quality of life. **Methods**: A case–control study enrolled 100 CAI patients (post-ankle sprain) and 100 healthy controls. Ankle strength (isokinetic dynamometer), stability (pressure plate), maximum dorsiflexion/plantar flexion ROM (mobility meter), functional limitations (0–10 activity scale), pain (VAS), coordination (Agility T-test, figure-of-eight test), and quality of life (FAOS) were compared. ANOVA and Mann–Whitney U tests were used. **Results**: Compared to controls, the CAI group showed significantly reduced ankle dorsiflexion strength (114.53 $\pm$ 10.47 N vs. 156.34 $\pm$ 13.26 N), heel lift strength (78.69 $\pm$ 5.44 N vs. 105.45 $\pm$ 8.28 N), stability scores (4.73 $\pm$ 0.52 vs. 8.65 $\pm$ 0.71 points), and ROM (dorsiflexion: 16.49° $\pm$ 1.23° vs. 22.35° $\pm$ 1.65°; plantar flexion: 27.58° $\pm$ 6.51° vs. 43.27° $\pm$ 5.45°). CAI patients reported higher activity limitation (6.34 $\pm$ 1.25 vs. 2.16 $\pm$ 0.55) and pain (5.37 $\pm$ 1.02 vs. 0.23 $\pm$ 0.01) and prolonged Agility T-test (11.24 $\pm$ 1.37 s vs. 7.51 $\pm$ 1.16 s) and figure-of-eight (16.35 $\pm$ 1.67 s vs. 12.43 $\pm$ 1.39 s) times. FAOS subscale scores (symptoms, daily activities, sports, pain) were significantly lower in the CAI group. All $p < 0.05$. **Conclusions**: CAI significantly compromises ankle dorsiflexion, heel lift strength, stability, and functional mobility, correlating with increased pain, activity restriction, and diminished quality of life. Rehabilitation should prioritize neuromuscular re-education, strength restoration, and dynamic stability training to improve outcomes.

Keywords: ankle sprain; CAI; ankle dorsiflexion movement; foot lifting function

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1. Introduction

Ankle sprains represent a prevalent injury both in sports and daily activities, predominantly affecting the ligaments surrounding the ankle joint, especially the lateral ligament [1,2]. While many cases of ankle sprains resolve with appropriate treatment, a considerable subset of patients develops chronic ankle instability (CAI), perpetually compromising their motor function and overall quality of life. CAI sufferers often endure recurrent ankle sprains, accompanied by pain and swelling, impeding mobility and elevating the risk of re-injury [3,4]. Crucially, ankle dorsiflexion and heel lift functions play pivotal roles in maintaining normal walking and running mechanics. Ankle dorsiflexion facilitates toe movement towards the tibia, pivotal for activities such as walking, stair negotiation, squatting, and jumping. Conversely, heel lifting engages the calf muscles, notably the gastrocnemius muscles, enabling individuals to rise onto their toes and propel themselves during ambulation and running. Consequently, impairments in these functions profoundly impact an individual's athletic prowess and daily mobility. Research indicates discernible deficiencies in ankle dorsiflexion and heel lift among CAI patients, attributed to incomplete recovery, muscle atrophy, or changes in neuromuscular control after ligament injury. In addition, CAI diminishes both dynamic and static stability of the ankle joint, thereby compromising balance ability and gait patterns [5–7]. Understanding the specific ramifications of CAI post-sprain on ankle dorsiflexion and heel lift functions is paramount for devising targeted rehabilitation regimens and preventive strategies. By bolstering the strength of pertinent muscle groups, enhancing neuromuscular control, and fortifying joint stability, CAI patients can recover normal ankle function, mitigate re-injury risks, and improve their overall quality of life. This paper delves into the profound impact of CAI post-sprain on ankle dorsiflexion and heel lift function, elucidating the specific influence of CAI through a comparative analysis between CAI patients and a healthy control group.

2. Materials and Methods

2.1. General Information

Between March 2022 and October 2023, 100 patients diagnosed with CAI subsequent to ankle sprain were enrolled in the study. All patients exhibited persistent functional or mechanical instability of the ankle joint, confirmed through a standardized diagnostic protocol involving clinical history, physical examinations, and imaging assessments. The cohort comprised 56 male and 44 female patients. Additionally, 100 healthy individuals undergoing routine physical examinations were recruited as the control group. The study received approval from the pertinent ethics review committee of the hospital, and all participants provided informed consent in accordance with the study protocol.

2.2. Inclusion Criteria

Patients in the experimental group were aged between 30 and 60 years, regardless of gender, and presented with a documented history of ankle sprain, subsequently diagnosed by a physician as CAI, based on the following criteria: (1) recurrent episodes of ankle instability or "giving way" for ≥6 months post-initial injury; (2) positive anterior drawer test or talar tilt test indicating mechanical instability; (3) functional deficits confirmed by single-leg balance test or Star Excursion Balance Test (SEBT); and (4) imaging evidence (stress radiography or MRI) of ligamentous laxity or chronic injury. The control group comprised individuals aged between 30 and 60 years, regardless of gender, with no history of ankle fracture or significant ligamentous injury (though complete recovery from minor prior sprains without residual instability was permissible if asymptomatic for >1 year and confirmed by clinical and imaging assessments to have normal joint integrity), no history of diagnosed CAI, normal ankle joint function, and no reported ankle pain, instability, or mobility limitations. They were capable of completing the requisite tests and questionnaires. Baseline functional status was assessed using the Kofoed Ankle Function Score and the American Orthopedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scoring System to ensure groups were comparable on general ankle health not specific to CAI symptomatology for controls and to characterize the experimental group.

2.3. Exclusion Criteria

Exclusion criteria encompassed individuals with severe cardiovascular, metabolic, or neurological disorders; those who had undergone ankle surgery or received ankle-related treatments (such as physical therapy) within the preceding 6 months; individuals currently experiencing acute ankle injury or other acute lower limb injuries; those with known psychological or cognitive impairments; pregnant women or those intending to conceive during the study period; and patients who declined to provide informed consent.

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2.4. Analysis of Ankle Joint Strength and Stability

An isokinetic muscle strength tester (IsoMed2000, D&R Ferstl GmbH, Hemau, Germany) and a pressure plate system (Model: FDM-S, Zebris Medical GmbH, Isny, Germany) were employed to evaluate ankle joint strength and stability. Subjects were positioned in a semi-recumbent posture, with the seat backrest inclined at 45°. The hip joint was flexed at 80°, the knee joint flexed at 110°, and the ankle joint plantarflexed at 10°. The torso was securely fixed to the chair, with both shoulders tightly pressed against the backrest. The tested foot and thigh were placed on the adapter and secured with straps, while both hands were crossed over the chest. During testing, the range of motion (ROM) for ankle inversion and eversion was set from 25° of inversion to 20° of eversion (as shown in Figure 1). Maximum strength tests for dorsiflexion and plantar flexion were conducted, with four trials performed to record peak values. Stability assessment using the pressure plate system involved patients standing on the plate unilaterally for a fixed duration of 30 s, during which the system recorded center of pressure (COP) coordinates. Sway amplitude was quantified as the total path length of the COP (in mm). Stability scores were derived from the COP path length and the area of the 95% confidence ellipse of COP displacement, calculated by the manufacturer's software (Zebris FDM Software Suite (version 3.0)), and presented as a dimensionless index (points), where a lower score indicates better stability. The reliability of the isokinetic dynamometer for ankle assessment was validated with intraclass correlation coefficients (ICC) ranging from 0.78 to 0.98 [8].

Figure 1. Ankle strength and stability testing setup. Positioning of participants on the IsoMed2000 dynamometer and pressure plate system (D&R Ferstl GmbH, Hemau, Germany, and Zebris Medical GmbH, Isny, Germany, respectively), ensuring ankle joint alignment with the rotational axis during dorsiflexion and plantar flexion strength assessments.

2.5. Ankle Joint Activity Limitation, Pain Score, and Range of Motion

Maximum ankle joint range of motion (ROM) for dorsiflexion and plantar flexion was measured using a joint mobility meter in both groups. Patients were positioned comfortably, ensuring a natural ankle joint alignment. For dorsiflexion measurement, the center point of the fixed mobility meter was aligned with the ankle joint's axis, with one arm along the calf's fibrous tendon and the other parallel to the sole. Patients slowly dorsiflexed their foot until reaching the maximum pain-free range, with the mobility meter reading recorded at this point. Similarly, for plantar flexion measurement, the operation was repeated in the opposite direction, with the maximum plantar flexion angle recorded. The degree of activity limitation was assessed using a self-reported Activity Limitation Scale (ALS). Patients rated their perceived limitation in performing daily activities due to their ankle condition on a scale from 0 (no limitation) to 10 (severe limitation preventing most activities). The average activity limitation scores for both groups were documented. The degree of pain was assessed using the Visual Analog Scale (VAS), where patients rated their pain levels on a scale ranging from 0 (no pain) to 10 (most severe pain). The average pain scores for both groups were documented.

2.6. Agility T-Test and Figure-8 Test

Ankle joint movement coordination was evaluated using the Agility T-test and Figure-8 test. The Agility T-test required patients to traverse forward, sideways, and backwards along a T-shaped route measuring 10 m in length with a transverse component of 5 m. Each participant performed one complete trial, and the time taken to complete this sequence was recorded. In the Figure-8 test, two circular markers with a diameter of 1.5 m were positioned, and patients were instructed to navigate the figure-of-eight route around the circles for three consecutive repetitions, with the total completion time noted.

2.7. FAOS Scale for Quality of Life Assessment

Quality of life was evaluated using the Foot and Ankle Outcome Score (FAOS), specially designed for ankle and foot problems. The FAOS contains 42 items distributed across five subscales: pain (9 items), other symptoms (7 items), daily activities (17 items), sports and leisure activities (5 items), and ankle-related quality of life (4 items). Each item is scored from 0 to 4 based on the patient's actual experiences, with higher scores indicating milder symptoms or better function within the corresponding domain. Upon completion, the raw scores are transformed into standardized scores ranging from 0 to 100 for analysis and comparison.

2.8. Statistical Analysis

All numerical data were presented as mean $\pm$ standard error (SE). Continuous variables were compared using analysis of variance (ANOVA). Normally distributed data were analyzed using the Least Significant Difference (LSD) test for pairwise comparisons, while non-normally distributed data were analyzed using the Mann–Whitney U test. Categorical data were compared using the chi-square (χ^2) test. Statistical analyses were performed using SigmaStat Version 3.1 (Systat Software, Inc., Chicago, IL, USA), with significance set at $p < 0.05$.

3. Results

3.1. Comparison of General Patient Data

General patient data revealed that in the control group, the male-to-female ratio was 60:40, with an average age of 45.72 $\pm$ 6.36 years and a mean BMI of 22.45 $\pm$ 1.38 kg/m^2. This group included 10 cases of essential hypertension, 8 cases of diabetes, 22 cases of smoking history, and 35 cases of alcohol consumption. In the experimental group, the male-to-female ratio was 56:44, with an average age of 47.36 $\pm$ 5.61 years and a mean BMI of 23.51 $\pm$ 1.79 kg/m^2. This group's CAI diagnosis stemmed from previous ankle sprains, with specific ligament injury classifications (Calcaneofibular Ligament (CFL) Injury and Anterior Talofibular Ligament (ATFL) Injury) detailed in Table 1, characterizing the nature of the initial injuries leading to CAI. CFL/ATFL injuries were graded by MRI: Level I (mild fiber tear), Level II (partial rupture), and Level III (complete rupture). The group also included 13 cases of hypertension, 6 cases of diabetes, 26 cases of smoking history, and 31 cases of alcohol consumption. No significant differences were observed in general patient data between the two groups ($p > 0.05$) for the demographic and comorbidity variables listed, nor for baseline Kofoed Ankle Function Score and AOFAS Ankle-Hindfoot Scoring System points (Table 1).

Table 1. Statistics of patient general data.

Parameter	Control Group (n = 100)	Experimental Group (n = 100)	T Value/χ^2 Value	p-Value
Gender (male: female)	60:40	56:44	0.322	0.570
Age (years)	45.72 ± 6.36	47.36 ± 5.61	5.227	0.335
BMI (kg/m^2)	22.45 ± 1.38	23.51 ± 1.79	6.671	0.412
Hypertension (%)	10 (10.00%)	13 (13.00%)	0.459	0.498
Diabetes (%)	8 (8.00%)	6 (6.00%)	0.295	0.587
Smoking (%)	22(22.00%)	26 (26.00%)	0.552	0.457
Drinking (%)	35 (35.00%)	31 (31.00%)	0.370	0.543
CFL Injury Classification (n) [a]			N/A	N/A
Level I	0	39		
Grade II	0	35		
Grade III	0	26		
ATFL injury Classification (n) [a]			N/A	N/A
Level I	0	37		
Grade II	0	40		
Grade III	0	23		
Kofoed Ankle Function Score (points)	73.29 ± 10.17	72.67 ± 10.46	0.425	0.672
AOFAS Ankle-Hindfoot Scoring System (points)	60.12 ± 8.23	60.82 ± 8.99	−0.574	0.566

Note: [a] CFL (Calcaneofibular Ligament) and ATFL (Anterior Talofibular Ligament) injury graded by MRI: Level I (mild), II (partial), III (complete rupture). Statistical comparison for these specific rows is not applicable (N/A) for between-group differences in injury presence/distribution as it is a defining characteristic. Abbreviations: BMI, Body Mass Index; AOFAS, American Orthopedic Foot and Ankle Society.

3.2. Ankle Strength and Stability Analysis

The isokinetic muscle strength tester and pressure plate system were employed to assess ankle strength and stability. Comparisons revealed that the ankle dorsiflexion strength, heel lift strength, and ankle stability scores were significantly lower in the experimental group than in the control group ($p < 0.05$, Table 2).

Table 2. Strength and stability analysis of the ankle joint.

Group	Ankle Dorsiflexion Strength (N)	Heel Lift Force (N)	Ankle Stability Score (Points)
Control group (n = 100)	156.34 ± 13.26	105.45 ± 8.28	8.65 ± 0.71
Experimental group (n = 100)	114.53 ± 10.47	78.69 ± 5.44	4.73 ± 0.52
T value	23.024	25.227	43.219
p-value	<0.001	<0.001	<0.001

3.3. Maximum Range of Motion of Ankle Joint

The mobility meter detected the maximum range of motion of the ankle joint, with findings indicating that the experimental group exhibited reduced dorsiflexion and plantar flexion ranges compared to the control group ($p < 0.05$) (Table 3).

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Table 3. Maximum range of ankle joint motion.

Group	Maximum Range of Motion of Dorsiflexion (°)	Maximum Range of Motion of Plantar Flexion (°)
Control group (n = 100)	22.35 ± 1.65	43.27 ± 5.45
Experimental group (n = 100)	16.49 ± 1.23	27.58 ± 6.51
T value	27.502	18.614
p-value	<0.001	<0.001

3.4. Ankle Joint Activity Limitation and Pain Score

Ankle joint activity limitation and pain scores were higher in the experimental group compared to the control group ($p < 0.05$). Detailed data are provided in Table 4.

Table 4. Ankle joint activity limitation and pain score.

Group	Activity Limitation Score (0–10 Scale)	Pain Score (0–10 VAS)
Control group (n = 100)	2.16 ± 0.55	0.23 ± 0.01
Experimental group (n = 100)	6.34 ± 1.25	5.37 ± 1.02
T value	−29.334	−50.156
p-value	<0.001	<0.001

Abbreviations: VAS (Visual Analog Scale).

3.5. Evaluation of Coordination Function of Ankle Joint Movement

Assessment of ankle joint movement coordination function via the Agility T-test and Figure-8 test revealed that the experimental group exhibited longer completion times compared to the control group ($p < 0.05$) (Table 5).

Table 5. Evaluation of ankle joint movement coordination function.

Group	Agility T-Test Completion Time (s)	Completion Time of Figure-8 Test (s)
Control group (n = 100)	7.51 ± 1.16	12.43 ± 1.39
Experimental group (n = 100)	11.24 ± 1.37	16.35 ± 1.67
T value	−20.286	−17.355
p-value	<0.001	<0.001

3.6. FAOS Scale for Quality of Life Assessment

The quality of life was evaluated using the FAOS scale, with scores for symptoms, daily activities, sports and leisure, and pain found to be lower in the experimental group than in the control group ($p < 0.05$). For a visual representation, see Figure 2, and for detailed scores, refer to Table 6.

Table 6. Foot and Ankle Outcome Score (FAOS) scale for quality of life assessment.

Group	Symptom Score	Daily Activity Score	Sports Leisure Score	Pain Score
Control group (n = 100)	94.35 ± 4.27	91.62 ± 3.88	87.34 ± 3.67	90.56 ± 3.20
Experimental group (n = 100)	72.48 ± 2.63	70.44 ± 2.16	65.23 ± 2.49	75.22 ± 4.88
T value	43.505	49.631	52.662	26.427
p-value	<0.001	<0.001	<0.001	<0.001

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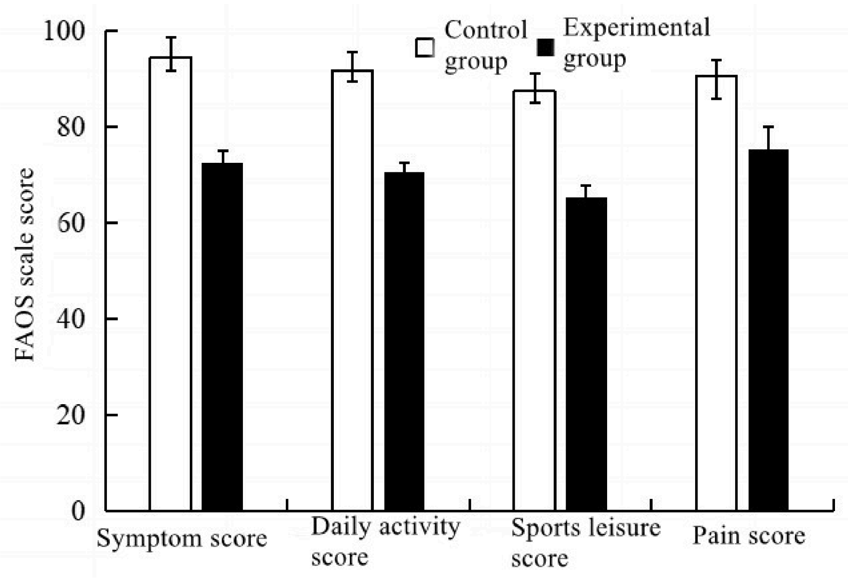

Figure 2. FAOS quality of life subscale scores. Comparison of experimental and control groups across FAOS (Foot and Ankle Outcome Score) domains (symptoms, daily activities, sports/leisure, pain), with significantly lower scores in the CAI group ($p < 0.05$).

4. Discussion

Ankle sprains rank among the most prevalent injuries encountered in both daily life and sports activities, especially among athletes [9]. While the majority of ankle sprains achieve full recovery with appropriate treatment, approximately 20% to 40% of individuals may develop CAI. CAI often stems from incomplete healing of the joint capsule and ligaments following the initial sprain, leading to diminished mechanical stability of the ankle joint [10–12]. Additionally, impairments in the sensory-motor control system can contribute to functional instability, characterized by diminished proprioception, prolonged reaction times, and improper muscle control. These alterations render the ankle joint susceptible to abnormal movement under weight-bearing conditions, heightening the risk of re-injury [13–15]. Consistent with these findings, Peng et al. [16] reported that patients with chronic ankle instability exhibit significant deficits in ankle strength and stability, while Mahmoud et al. [17] emphasized that abnormal muscle strength, dynamic balance, and physical function in CAI patients can be restored through targeted interventions. Effective management of CAI revolves around enhancing ankle joint stability and function. Treatment modalities encompass physical therapy, muscle strengthening, balance and coordination improvement, and the use of braces [18]. Understanding the intricate relationship between ankle sprains and CAI holds significant implications for preventing long-term ankle injuries and devising efficacious treatment and rehabilitation protocols [19,20].

This study aims to investigate the impact of CAI on ankle function by recruiting patients with CAI subsequent to ankle sprains. Results revealed notable deficits in ankle flexion strength, heel lift strength, stability, range of motion, and motor coordination function among CAI patients compared to controls, thereby underscoring the substantial influence of CAI on ankle function. The compromised ankle dorsiflexion and heel lift strength underscore the far-reaching effects of this condition on lower limb function. Recurrent ankle sprains, pain, and swelling experienced by CAI patients not only compromise joint stability but also detrimentally affect the strength of surrounding muscle groups [21,22]. Hoch et al. [23] further demonstrated that impaired proprioception in CAI patients contributes to reduced weight-bearing dorsiflexion range of motion and altered landing mechanics, while Alghadir et al. [24] identified pain, episodes of joint instability, and deficits in neuromuscular control as primary factors perpetuating CAI. This muscular weakness may stem from various factors: prolonged instability may lead to reduced usage of the affected ankle joint, culminating in muscle atrophy and diminished strength. Furthermore, CAI may disrupt the neuromuscular control system, impeding normal muscle activation and coordination, thereby diminishing power output. Ankle flexion strength is important for propelling the body forward, while heel lift strength is pivotal for generating propulsion during walking and running. Diminished strength in these aspects may impede patients' performance in daily activities and sports. For instance, patients may experience instability while walking, find stair negotiation arduous, and struggle to exert themselves effectively during running and jumping [25]. These restrictions not only curtail patients' activity range but also impinge on their social engagement and overall quality of life. Diminished ankle stability represents a hallmark feature of CAI patients, with objective quantitative assessments attainable via pressure plate system testing. This instability often correlates with deficits in proprioception and muscle reflex regulation [26–28]. Proprioception denotes an individual's ability to perceive the position and movement of body parts, vital for maintaining joint stability and executing precise movements. CAI patients may experience compromised perception of ankle joint position and movement due to the injury or functional decline of nerve receptors, thereby hampering timely and appropriate muscle response and further compromising stability. Weakened stability not only heightens the risk of recurrent ankle sprains but also may engender excessive reliance on surrounding ankle joint structures, thereby augmenting strain on other joints such as the knee and hip, potentially precipitating new pain and injuries.

CAI patients often contend with restricted ankle joint range of motion, stemming from various factors such as chronic inflammation, joint capsule contraction, ligament scarring, or muscle tension. These biomechanical alterations not only reduce ankle joint flexibility but may also precipitate changes in overall lower limb movement patterns, thereby impacting patients' motor function and quality of life [29,30]. Reduced activity range impedes fundamental daily activities like walking, running, jumping, and stair climbing, rendering these simple tasks more arduous and laborious. In addition, limited ankle movement may prompt compensatory adjustments in adjacent joints and muscles, elevating the long-term risk of other musculoskeletal conditions. In terms of motor coordination and agility, the Agility T-test and Figure-8 test serve as vital tools for evaluating dysfunction in CAI patients. These evaluations necessitate swift and precise directional changes and body control, offering an ideal means to gauge lower limb function and overall motor proficiency. CAI patients typically exhibit prolonged completion times in these assessments, reflecting diminished ankle stability, strength, and motor control capability. Such decline in motor function not only curtails patients' engagement in sports and leisure pursuits but may also impinge on their social activities and overall life contentment. The FAOS scale furnishes a comprehensive tool for evaluating the quality of life among CAI patients, encompassing dimensions such as pain, symptoms, daily activities, sports, leisure pursuits, and ankle-related quality of life. Goulart et al. [31] validated the utility of FAOS in assessing posture control and muscle strength in CAI patients, while Negahban et al. [32] more recently confirmed its utility in patients with chronic ankle instability, highlighting that lower FAOSs correlate with functional limitations in this population. The study by Chui et al. [33] also emphasized the impact of CAI on FAOS subscales, particularly sports and recreation, aligning with our findings. Furthermore, another research by Vuurberg et al. [34] has shown that even after surgical intervention for CAI, FAOS scores, while improved, may not always reach levels of uninjured controls, underscoring the persistent nature of functional deficits. Scores across these dimensions for CAI patients generally fall below those of healthy counterparts, emphasizing the extensive impact of CAI on patients' quality of life. Pain and persistent feelings of instability may curtail patients' engagement in daily

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and sports activities, heighten the risk of falls, and diminish participation in social and leisure pursuits, consequently diminishing overall life satisfaction.

In summation, this study identified significant functional impairments in patients with chronic ankle instability (CAI) following ankle sprains. First, the experimental group demonstrated markedly reduced ankle dorsiflexion strength, heel lift strength, and stability compared to the control group, as quantified by isokinetic muscle strength testing and pressure plate analysis. Second, restricted ankle joint range of motion—particularly in dorsiflexion and plantar flexion—was observed in CAI patients, correlating with heightened activity limitations and pain. Third, diminished motor coordination, evidenced by prolonged Agility T-test and Figure-8 test completion times, highlighted deficits in dynamic control. Finally, FAOS scale evaluations revealed lower scores across symptoms, daily activities, sports participation, and pain in CAI patients, underscoring the pervasive impact on quality of life. These findings collectively emphasize that CAI detrimentally affects biomechanical function, mobility, and psychosocial well-being. Rehabilitation strategies must prioritize restoring ankle strength, enhancing proprioceptive control, and improving functional coordination to mitigate long-term disability and improve patient outcomes.

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Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

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References

1. Mederake, M.; Hofmann, U.K.; Ipach, I. Arthroscopic modified Broström operation versus open reconstruction with local periosteal flap in chronic ankle instability. *Arch. Orthop. Trauma Surg.* **2022**, *142*, 3581–3588. [CrossRef] [PubMed]
2. Han, S.; Lee, H. Effects of anticipation on joint kinematics during inversion perturbation in individuals with chronic ankle instability. *Scand. J. Med. Sci. Sports* **2023**, *33*, 1116–1124. [CrossRef]
3. Suttmiller, A.M.B.; Cavallario, J.M.; Baez, S.E.; Martinez, J.C.; McCann, R.S. Perceived Instability, Pain, and Psychological Factors for Prediction of Function and Disability in Individuals with Chronic Ankle Instability. *J. Athl. Train.* **2022**, *57*, 1048–1054. [CrossRef]
4. Kawabata, S.; Ozone, K.; Minegishi, Y.; Oka, Y.; Terada, H.; Takasu, C.; Kojima, T.; Kano, T.; Kanemura, N.; Murata, K. Chronic Ankle Joint Instability Induces Ankle Sensorimotor Dysfunction. A Controlled Laboratory Study. *Am. J. Sports Med.* **2024**, *52*, 739–749. [CrossRef]
5. Kowalczyk, M.; Truszczyńska-Baszak, A. The impact of fatigue on static balance in people with chronic ankle instability. *Acta Bioeng. Biomech.* **2023**, *25*, 151–160. [CrossRef]
6. Sadakuni, D.; Takeuchi, K.; Tsukuda, F.; Komatsu, T. Change in dynamic postural control after a training program in collegiate soccer players with unilateral chronic ankle instability. *J. Sports Med. Phys. Fit.* **2022**, *62*, 238–243. [CrossRef]
7. Martinez, B.; Sauers, A.; da Conceição Souza, V.; de Oliveira, J.; Yi, L.C. Responsiveness of the Brazilian IdFAI questionnaire in patients with chronic ankle instability. *Physiother. Theory Pract.* **2022**, *38*, 3045–3054. [CrossRef]
8. Gonosova, Z.; Linduska, P.; Bizovska, L. Reliability of Ankle–Foot Complex Isokinetic Strength Assessment Using the Isomed 2000 Dynamometer. *Medicina* **2018**, *54*, 43. [CrossRef]
9. Kosik, K.B.; Hoch, M.C.; Hartzell, J.T.; Bain, K.A.; Slone, S.; Gribble, P.A. Jump landing among chronic ankle instability individuals who did or did not attend rehabilitation at the time of injury. *Phys. Ther. Sport* **2022**, *57*, 26–32. [CrossRef] [PubMed]

10. Abbasi, L.; Panahi, F.; Zarei-Kurdshooli, Z.; Yazdi Yahya-Abadi, F. The effect of perturbation training with and without applying the dry needling on leg muscles in patients with chronic ankle sprain. *J. Bodyw. Mov. Ther.* **2023**, *35*, 233–237. [CrossRef] [PubMed]
11. Luthfi, A.; Nakasa, T. Risk Factors for the Recurrence of Instability After Lateral Ankle Ligament Repair. *Foot Ankle Int.* **2023**, *44*, 617–628. [CrossRef]
12. Oh, M.; Lee, H.; Han, S.; Hopkins, J.T. Postural control measured before and after simulated ankle inversion landings among individuals with chronic ankle instability, copers, and controls. *Gait Posture* **2024**, *107*, 17–22. [CrossRef]
13. Su, T.; Wang, A.H.; Guo, Q.W.; Zhu, Y.C.; Jiang, Y.F.; Hu, Y.L.; Jiao, C.; Jiang, D. Both Open and Arthroscopic All-Inside Anatomic Reconstruction with Autologous Gracilis Tendon Restore Ankle Stability in Patients with Chronic Lateral Ankle Instability. *Arthrosc. J. Arthrosc. Relat. Surg.* **2023**, *39*, 1035–1045. [CrossRef]
14. Mullins, J.F.; Hoch, M.C.; Gribble, P.; Heebner, N.; Kosik, K.; Westgate, P.; Nitz, A.J. Examination of Dry Needling Dose and Effect Duration for Individuals with Chronic Ankle Instability. *J. Manip. Physiol. Ther.* **2023**, *46*, 132–142. [CrossRef] [PubMed]
15. Yu, P.; Mei, Q.; Xiang, L.; Fernandez, J.; Gu, Y. Differences in the locomotion biomechanics and dynamic postural control between individuals with chronic ankle instability and copers: A systematic review. *Sports Biomech.* **2022**, *21*, 531–549. [CrossRef] [PubMed]
16. Peng, D.; Tang, H.; Mao, M.; Song, Q.; Mao, D.; Wang, J.; Sun, W. Correlations of strength, proprioception, and dynamic balance to the Cumberland Ankle Instability Tool Score among patients with chronic ankle instability: A cross-sectional study. *BMC Musculoskelet. Disord.* **2024**, *25*, 970. [CrossRef]
17. Mahmoud, W.S.; Radwan, N.L.; Ibrahim, M.M.; Hasan, S.; Alamri, A.M.; Ibrahim, A.R. Effect of blood flow restriction as a stand-alone treatment on muscle strength, dynamic balance, and physical function in female patients with chronic ankle instability. *Medicine* **2023**, *102*, e35765. [CrossRef] [PubMed]
18. Hiller, C.E.; Beckenkamp, P.R. Effect of Braces on Performance in the Context of Chronic Ankle Instability. *Foot Ankle Clin.* **2023**, *28*, 145–154. [CrossRef]
19. Tee, E.; Melbourne, J.; Sattler, L.; Hing, W. Evidence for Rehabilitation Interventions After Acute Lateral Ankle Sprains in Athletes: A Scoping Review. *J. Sport Rehabil.* **2022**, *31*, 457–464. [CrossRef]
20. Kosik, K.B.; Song, K.; Gribble, P.A.; Hoch, M.C.; Srinath, A. Joint Stabilization Surgery for Chronic Ankle Instability and Medial Ankle Osteoarthritis: A Critically Appraised Topic. *J. Sport Rehabil.* **2022**, *31*, 351–355. [CrossRef]
21. Simpson, J.D.; Koldenhoven, R.M. Lower extremity joint kinematics of a simulated lateral ankle sprain after drop landings in participants with chronic ankle instability. *Sports Biomech.* **2022**, *21*, 428–446. [CrossRef]
22. Yoshimoto, K.; Noguchi, M. Varus-Tilted Distal Tibial Plafond Is a Risk Factor for Recurrent Ankle Instability After Arthroscopic Lateral Ankle Ligament Repair. *Foot Ankle Int.* **2022**, *43*, 796–799. [CrossRef]
23. Hoch, M.C.; Farwell, K.E.; Gaven, S.L.; Weinhandl, J.T. Weight-Bearing Dorsiflexion Range of Motion and Landing Biomechanics in Individuals with Chronic Ankle Instability. *J. Athl. Train.* **2015**, *50*, 833–839. [CrossRef] [PubMed]
24. Alghadir, A.H.; Iqbal, Z.A. Effect of Chronic Ankle Sprain on Pain, Range of Motion, Proprioception, and Balance among Athletes. *Int. J. Environ. Res. Public Health* **2020**, *17*, 5318. [CrossRef]
25. Zhang, J.; Yang, K.; Wang, C.; Gu, W.; Li, X.; Fu, S.; Song, G.; Wang, J.; Wu, C.; Zhu, H.; et al. Risk factors for chronic ankle instability after first episode of lateral ankle sprain: A retrospective analysis of 362 cases. *J. Sport Health Sci.* **2023**, *12*, 606–612. [CrossRef]
26. Simpson, J.D.; Stewart, E.M.; Macias, D.M.; Chander, H.; Knight, A.C. Individuals with chronic ankle instability exhibit dynamic postural stability deficits and altered unilateral landing biomechanics: A systematic review. *Phys. Ther. Sport* **2019**, *37*, 210–219. [CrossRef]
27. Suphasubtrakul, T.; Lekskulchai, R.; Jalayondeja, C. Balance, strength and physical activity after ankle sprain: Comparison between children with chronic ankle instability and copers. *Phys. Ther. Sport* **2024**, *65*, 49–53. [CrossRef]
28. Wagemans, J.; Taeymans, J.; Kuppens, K.; Baur, H.; Bleakley, C.; Vissers, D. Determining key clinical predictors for chronic ankle instability and return to sports with cost of illness analysis: Protocol of a prospective cohort study. *BMJ Open* **2023**, *13*, e069867. [CrossRef] [PubMed]
29. Pechlivani, C.; Grammatikopoulou, D.; Antonoglou, G.; Pelopidas, T.; Varvarousis, D.N.; Vrettakos, A. Lateral Ankle Instability after Rotational Injury: A Case Report. *J. Orthop. Case Rep.* **2023**, *13*, 137–141. [CrossRef] [PubMed]
30. Koldenhoven, R.; Simpson, J.D.; Forsyth, L.; Donovan, L.; Torp, D.M. Utility of Gait Biofeedback Training to Improve Walking Biomechanics in Patients with Chronic Ankle Instability: A Critically Appraised Topic. *J. Sport Rehabil.* **2022**, *31*, 819–825. [CrossRef]
31. Goulart Neto, A.M.; Maffulli, N.; Migliorini, F. Validation of Foot and Ankle Ability Measure (FAAM) and the Foot and Ankle Outcome Score (FAOS) in individuals with chronic ankle instability: A cross-sectional observational study. *J. Orthop. Surg. Res.* **2022**, *17*, 38. [CrossRef] [PubMed]
32. Negahban, H.; Daghiani, M. Comparing the effects of ankle integral and conventional physiotherapy on pain, range of motion, balance, disability, and treatment effectiveness in patients with chronic ankle instability: Randomized controlled trial. *Clin. Rehabil.* **2023**, *37*, 362–372. [CrossRef]

33. Chui, V.W.; Tong, A.H.; Hui, J.Y.; Yu, H.H.; Yung, P.S.; Ling, S.K. Prevalence of ankle instability in performers of Chinese classical dance: A cross-sectional study of 105 Chinese dancers. *BMJ Open Sport Exerc. Med.* **2022**, *8*, e001413. [CrossRef] [PubMed]
34. Vuurberg, G.; Reilingh, M.L.; van Bergen, C.J.A.; van Eekeren, I.C.M.; Gerards, R.M.; van Dijk, C.N. Metal Resurfacing Inlay Implant for Osteochondral Talar Defects After Failed Previous Surgery: A Midterm Prospective Follow-Up Study. *Am. J. Sports Med.* **2018**, *46*, 1685–1692. [CrossRef] [PubMed]

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