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Effect of Ankle-Foot Orthoses on Patients with Chronic Ankle Instability: A Systematic Review

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ABSTRACT

Background: Chronic ankle instability (CAI) is a disabling condition often encountered after an ankle injury. Foot orthoses have been shown to be clinically effective in the prevention and treatment of CAI, yet the physical effect of this intervention remains poorly understood. The aim of this study was to systematically review and appraise studies assessing the effects of foot orthoses on patients with CAI.

Methods: A systematic search of electronic databases including WOS, Scopus, Springer, Google Scholar, and PubMed from inception to June 2025. The keywords of foot orthoses, foot orthotics, ankle brace, and ankle instability were used to extract articles.

Results: Fourteen studies were eligible for final inclusion. Five studies demonstrate that ankle orthoses (soft/SOO, semi-rigid/SEO) improve postural stability and dynamic balance in patients with CAI 2-4 weeks. Two studies found that soft orthoses provided greater balance improvement compared to semi-rigid. Three studies found that orthoses significantly improved reach distance, particularly in the posteromedial direction. Three studies found orthoses (especially semi-rigid) significantly reduced excessive ankle inversion angles and velocities during movement. Orthoses also altered joint kinematics, reducing inversion/eversion range of motion and subtalar inversion during walking. Neuromuscular changes were reported in three studies, including reduced peroneus longus and tibialis anterior activation. Some normalization of kinematics was observed, but two studies found no differences between orthoses and controls in joint reposition sense or in any balance parameters.

Conclusions: Foot orthoses have been shown to have a positive influence on subjects with chronic ankle instability. However, their effectiveness is task-specific and influenced by the design of the orthosis, duration of use, conditions of assessment, and rehabilitation interventions being conducted simultaneously.

KEYWORDS
Chronic Ankle Instability, Foot Orthoses, Ankle, Biomechanics

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Introduction

The ankle accounts for a substantial percentage of acute sporting injuries, with sprains, in particular lateral ligament sprains, being the most common (1-4). The occurrence of repetitive ankle sprains and the feeling of the ankle ‘‘giving way’’ with slight or no perturbation has been defined as chronic ankle instability (CAI) (5). CAI is typically caused by mechanical ankle instability (MAI) and/or functional ankle instability (FAI). This frequent complication of ankle sprain is characterized by feelings of joint instability, recurrent ankle giving way, pain, swelling, muscle weakness, poor postural control, and balance performance (6-9). CAI can be associated with long-term consequences such as ankle joint osteoarthritis, decreased physical activity level and quality of life, and eventually disability (2, 10, 11). In addition, it represents a considerable financial and social burden from health care costs (2).

To prevent recurrent ankle sprains, many athletes wear foot orthoses (FOs) for training and competition. Foot orthoses can be divided into 2 categories: rigid and functional (semirigid and soft). Rigid orthoses immobilize the entire ankle, whereas functional orthoses allow some plantar- and dorsiflexion at the ankle while controlling for inversion and eversion (12). The ability of ankle orthoses to improve postural control has been attributed to several mechanisms. They provide mechanical support for the ankle joint to control excessive inversion and plantarflexion range of motion (13). In addition, they improve proprioceptive acuity by stimulating cutaneous mechanoreceptors and pressurizing the underlying musculoskeletal structures (14).

Literature recognizes the role of external support, such as soft (SOO) and semi-rigid (SEO) ankle orthoses, taping, and FOs in improving postural stability and joint kinematics in CAI patients. For instance, research demonstrates that orthotics use for a period of over 4 weeks enhances dynamic balance, particularly in the posterolateral and medial directions, with softer orthotics shown to have greater effectiveness in reducing center of pressure parameters compared to semi-rigid ones (15). Conversely, healthy subjects exhibit increased postural sway with orthotics, suggesting a particular benefit in CAI populations (16). Short-term interventions, e.g., 2-week prefabricated orthotic wear, increase postural stability, but long-term results are inadequately researched (17). Biomechanically, semi-rigid braces and taping partly restore subtalar joint kinematics by restricting excessive inversion and anterior translation during gait, yet without normalizing talocrural joint motion (18). Furthermore, FOs also change muscle activation patterns, decreasing tibialis anterior activity during landing and increasing pre-activation of the biceps femoris during walking, albeit without a significant impact on joint angles and moments (19).

In the last two decades, several studies investigating the effects of foot orthoses on patients with CAI. However, at the time of writing, no systematic review evaluating the mechanism of action of FOs in this group. So, this systematic review synthesizes evidence for the effectiveness of ankle-foot orthoses for the treatment of CAI-related impairments, comparing postural stability, joint kinematics, and neuromuscular control outcomes to guide clinical practice. The aim of this review was to investigate the effect of FOs on patients with CAI.

Materials and Methods

When performing this systematic review, we adhered to the standard PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (20).

2.1. Eligibility criteria

EndNote 20 software (Bld 14672, Clarivate, Philadelphia, PA, USA) was used for the systematic search and the processing of potentially eligible papers. A PICOS (participants, intervention, comparators, outcomes, and study design) approach was applied to define inclusion and exclusion criteria (21). To be eligible for inclusion in this systematic review, articles had to be published in peer-reviewed journals in the English language.

The articles were included in this review if, (1) the articles should investigate effect of FOs on CAI populations; (2) the articles should report parameters of kinematics, kinetics, muscle activity or dynamic postural control in the lower extremity; and (3) only full-text original articles in English language were included in this review. Articles were excluded according to the following criteria: (1) measurement of effects on acute ankle instability participants; (2) measurement of effects on simulated ankle instability.

Articles accepted for inclusion were required to be published in peer-reviewed journals and report the findings of original experimental or quasi-experimental research.

2.2. Information sources, search strategy

A systematic search of electronic databases including WOS, Scopus, Springer, Google Scholar, and PubMed was conducted in April 2025. The search terms orthotic, orthoses, and brace were used in conjunction with the term ankle instability. The search strategy was limited to articles published in the English language. Targeted searching of relevant journals also occurred following a bibliographic review of retrieved articles.

2.3. Study selection

Titles and abstracts of all citations generated by the search were assessed by two authors according to the inclusion and exclusion criteria above, with articles printed in full-text as required. The included articles were used to extract measurements of all kinetic, kinematic, electromyographic and balance parameters. Further, information about participants, study objectives, independent and dependent variables, tested conditions and conclusions were collected.

2.4. Quality assessment

The methodological quality of the included studies was evaluated by the same two authors (A.E., A.J.) using a modified version of the Downs and Black checklist for non-randomized controlled trials (22). The modified checklist includes 19 questions with eight reporting items (items 1, 2, 3, 4, 5, 6, 7, 10), two items for external validity (items 11 and 12), five items for internal validity (Bias) (items 14, 15, 16, 18, 20), three items for internal validity-confounding (items 21, 22, 25), and one item for power (item 27). The items were scored as 0 (“no” and “unable to determine”), 1 (“yes”), except for item 5 for the principal confounders which was scored 0 (“no”), 1 (“partially”), 2 (“yes”). The overall quality score of each study was calculated based on a percentage of the maximum score (20). In cases where there were discrepancies in the authors’ rating of the quality scores, consensus was reached through discussion. Studies with quality scores of 75% or higher were considered high quality, those with scores between 60% and 74% were classified as moderate quality, and those with scores of 60% or lower were categorized as low quality (23).

Results

As presented in Figure 1, the search process generated a total 378 citations for initial screening, of which 122, were excluded on review of title and abstract. 34 articles were printed in full text for further consideration, of which 14 were eligible for final inclusion.

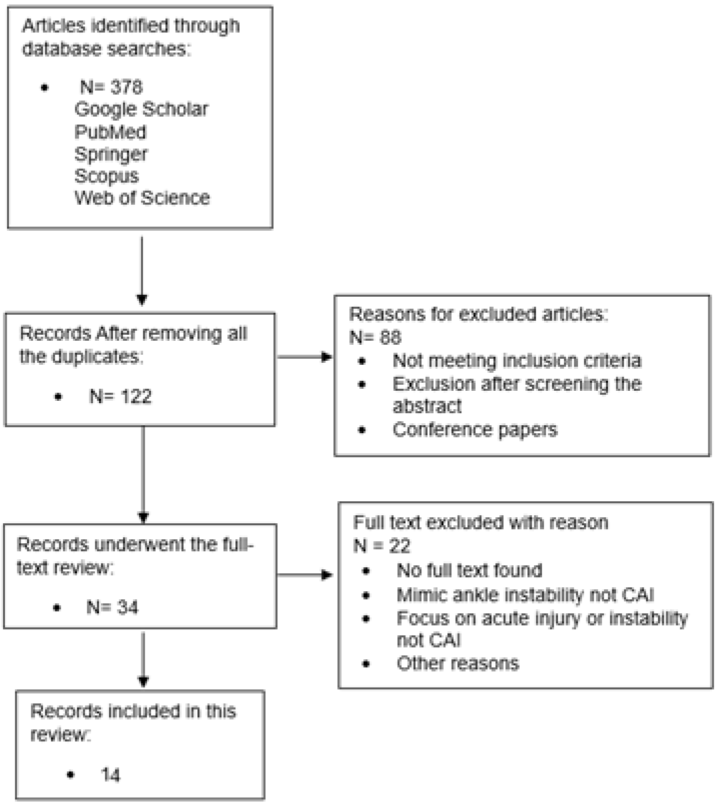

Figure 1. The flow chart of the literature inclusion in this review.

Sesma et al (15) observed that distance reached in the posterolateral and medial direction increases over the 4-week period in the orthotic condition, demonstrating an improvement on the injured side in the orthotic condition after 4 weeks of orthotic intervention.

Examining the effect of 4 weeks wearing soft (SOO) and semi-rigid (SEO) ankle orthosis on postural stability in patients with functional ankle instability (FAI) compared to a healthy control group revealed that in the FAI group, there was a tendency to lower center of pressure parameters while wearing either of the orthoses, with soft orthoses having a greater effect. Significant effect of brace was found only for the injured limb. In the healthy group, postural sway increased from no-brace condition, to SOO, to SEO (16).

Hamlyn et al., (17) determined effect of using a prefabricated orthotic for 2 weeks on postural stability in participants with FAI (1 group received the orthotic and the other was the control group). In the orthotic group, postural stability improved between test sessions. After 2 weeks, postural stability was different for the orthotic and control groups.

A study compared and analyzed the changes in the balancing abilities of athletes with chronic ankle instability who were engaged in a functional rehabilitation exercise program for which patients had to use their proprioception sense, and exercise their static and dynamic balance abilities, or who were engaged in doing functional movements while wearing foot orthotics (24). Results indicated after the four-week treatment, for joint reposition sense evaluation, external 75% angle evaluation was done, revealing that the group with the application of foot orthotics improved by -1.07±1.64 on average, showing no significant difference between the two groups. Static, dynamic and functional balancing abilities using balance masters were evaluated, revealing that the two groups improved in some items, but showing no significant difference between them.

Other study evaluated the effect of soft and semirigid ankle orthoses on dynamic balance in patients with FAI compared with healthy people (25). There were no differences among orthotics conditions in healthy people. However, normalized reach distance increased from no-orthosis to SEO to SOO in FAI patients. Differences were significant between SOO and no-orthosis (13% in anteromedial, 14%

in medial and 15% in posteromedial direction (PM)) and between SEO and no-orthosis (10% in anteromedial, 8.5% in medial and 8.5%in posteromedial direction) conditions in all 3 measured directions. The difference between soft and SEO orthoses was significant (6% difference) only in PM direction.

A study with objective of determine whether the application of a semi-rigid brace or taping of the ankle can normalize the abnormal kinematics of CAI joints during ankle internal rotation in plantar flexion demonstrated no significant difference in talocrural anterior translation and internal rotation induced by applying either a semi-rigid brace or taping. For subtalar internal rotation, observed tendency toward restoration of normal kinematics in CAI joints after applying a semi-rigid brace or taping. However, the difference was not significant (18).

Cao et al (26), utilized a dual fluoroscopic imaging system to detect the in vivo tibiotalar and subtalar joint kinematics in patients with CAI during the stance phase of walking before and after the application of a semi-rigid brace. Results showed tibiotalar joints were more inverted, and subtalar joints were more anteriorly translated, more plantarflexed and more inverted during barefooted walking on the inversion platform than during walking on the level platform. The inversion of subtalar joints was decreased after the brace application (26).

Quantifying the kinematic, kinetic and EMG immediate effects of FOs during walking and unilateral jump landing in individuals with CAI investigated individuals with CAI exhibited decreased tibialis anterior muscle activity from 19 to 38% and 39 to 99% of the landing phase during the DROP task with FOs (19). Also, increased biceps femoris muscle activity from 56 to 65% of the pre activation phase was observed during walking (19). When wearing FOs, no significant ankle and knee joints angles and moments difference was observed in any of the experimental tasks (19).

During walking with or without brace, Zhang (27) found that FAI patients had significantly less ROMs in inversion/eversion rotation of the talocrural and subtalar joint after wearing semirigid ankle brace. Laxity was observed in most of the displacements of the talocrural and subtalar joints in FAI group. The brace partly altered the ankle joints movement in opposite directions, especially joint rotation, and restricted the talocrural and subtalar joints in the dorsiflexion position during the touch down phase of walking.

Figure 2. An example of brace used in reviewed articles(18). This brace was designed to resist inversion/eversion and internal/external rotation loads while allowing dorsiflexion/ plantar flexion.

Figure 3. Another example of brace used in reviewed articles (28). A) Oppo Ankle Support with Strap; B) Active Ankle Brace.

Fuerst et al (29) analyzed ankle joint kinematics and kinetics as well as neuromuscular activation of muscles surrounding the ankle joint in participants with isolated FAI, in participants with a combination of both FAI and MAI and in a control group with healthy ankle joints. They observed maximum ankle inversion angles and velocities were significantly reduced with the semi-rigid brace in comparison to the conditions without a brace and with the soft brace. Furthermore, peroneal activation levels decreased significantly with the semi-rigid brace in the 100 m/s before and after ground contact. No statistically significant brace by group effects were found.

Zhang et al (30) explored the FAI without brace group showed significantly higher maximum inversion angles and average inversion velocities than the control group. The FAI with brace group revealed significantly lower maximum inversion angles and average inversion velocities than the FAI without brace group; this group also showed significantly higher maximum external rotation angle and average external rotation velocities than the FAI with brace and control groups. The FAI with brace group indicated significantly lower average EMG of the peroneus longus (PL) than the FAI without brace group. The subjects walked on a custom-built tilting platform that offered a 30° inversion to mimic the inversion of ankle sprain.

Table 1: Summary of the included articles related to FOs and CAI

Authors	Orthoses Design	Group, Task, Protocols	Variables	Duration	Results
Sesma et al (15), 2008	Custom-fitted for each patient using a foam impression kit from Foot Management, Inc (Pittsville, Maryland). Neutral SEO fabricated from the mold formed with the impression kit.	20 P with self-reported unilateral CAI Wear the orthotics for at least 4 hours a day to a preferred 8 hours a day for the 4 weeks between sessions. SEBT	Distance reach SEBT and Limits of Stability test. (LOST) orthotic Fitting, and the Cumberland Ankle Instability Tool (CAIT*)*	2 test sessions separated by 4 weeks.	Orthotics improved specific directional reach and self-reported stability of the injured leg over 4 weeks, but did not improve performance on the LOST test. The injured leg remained less stable than the healthy leg.

Hadadi et al (16), 2011	SOO and SEO included Arizona Ankle Orthosis (PRO Orthopedic Devices, Inc., Tucson) and Active Ankle Brace (Active Ankle System, Inc., Louisville, KY), respectively.	20 P with unilateral FAI and 20 healthy P. Balance in SLST on force platform with eyes-open was assessed for both legs while wearing no orthosis (control condition), SOO or SEO	COP	18 trials within 6 experimental conditions.	In the FAI group, COP parameters tended to decrease with both orthoses, more so with SOO. For two variables, the brace significantly affected only the injured limb. In the healthy group, postural sway increased from no brace to SOO to SEO.
Hamlyn et al (17), 2012	Quick Comfort Insole (Foot Management, Inc, Pittsville, MD),	40 P with unilateral FAI (20 control, 20 orthotic group). Balance on 1 limb with their eyes closed for 20 seconds. P in the orthotic group wearied the inserts daily and return 2 weeks later for session 3.	COP	3 sessions.	In the orthotic group, postural stability improved between sessions 1 and 2 and sessions 1 and 3. In session 3, postural stability was different for the orthotic and control groups.
Lee et al (24), 2013	Pronated foot, tpscan (biomechanic, Goyang, Korea) H type, supinated foot, lateral forefoot wedge technology at a moderate level and tpscan S type.	41 athletes assigned to two groups. Rehabilitation exercises group while the other group had the same rehabilitation exercises as well as foot orthotics.	Joint position sense of the ankle joint. Static and dynamic balancing abilities and functional balance abilities	Tested the subjects before and after the four-week rehabilitation program.	No significant difference between the two groups for joint reposition sense evaluation. For static, dynamic and functional balancing abilities revealing that the two groups improved in some items, but showing no significant difference between them.
Hadadi et al (25), 2014	SOO is a low-profile brace with two figure of eight lift straps supporting ankle medially and laterally, SEO, Arizona Ankle orthosis (PRO Orthopedic devicesinc., Tucson) and Active Ankle Brace (Active Ankle System Inc., Louisville, KY)	16 unilateral FAI and 16 healthy control P. Reach distance of participants in 3 bracing conditions were measured in anteromedial, medial and posteromedial directions of SEBT	Dynamic balance was tested with and without wearing ankle orthosis. (Reach distances)	3 trials in 3 directions	No orthotic effects were seen in healthy individuals. In FAI, reach distance increased from no-orthosis to SEO to SOO, with SOO and SEO outperforming no-orthosis. A 6% SOO–SEO difference was significant only in the PM direction.
Kobayashi et al (18), 2014	Semirigid Brace ZAMST A2-DX (Nippon Sigmax Corp, Tokyo, Japan)	14 male P with unilateral CAI. Ankle internal rotation in plantar flexion were performed for calculate abnormal kinematics	Talocrural anterior translation, talocrural internal rotation, and subtalar internal rotation.	Subjects Completed 3 cycles of foot internal–External rotation within 10 seconds.	No significant difference in talocrural anterior translation and internal rotation induced by applying either a semi-rigid brace or taping. For subtalar internal rotation, the difference was not significant

Dingenen et al (19), 2015	(1) barefoot (BF), (2) shoes only, (3) shoes with standard foot orthoses, and (4) shoes with custom foot orthoses (SCFO).	15 people (9 men, 6 women;	Onset of activity of 9 lower extremity muscles was recorded using surface electromyography and a single force plate.	Double-legged to single-legged stance was performed with eyes open and with eyes closed	Earlier muscle-activation onset times were observed in SCFO versus barefoot for peroneus longus, tibialis anterior, and both vasti muscles. Peroneus longus also activated earlier in shoes-only and standard orthoses than barefoot. Hip muscles showed no differences.
Cao et al (26), 2019	Ankle brace (Aircast A60, DJO Global, USA)	11 P with CAI walked barefooted on a level platform, barefooted on a 15° inversion platform, and with an ankle brace on a 15° inversion platform.	The joint positions during the three walking conditions	-	During inverted walking versus level walking: Tibiotalar joints were more inverted. Subtalar joints were more anterior, plantarflexed, and inverted. After brace application, subtalar inversion decreased.
Moisan et al (31), 2019	Fos made from 3.2 mm thick poly propylene with a straight ethylene-vinyl-acetate (EVA) rearfoot post, an EVA lateral bar and a 3mm multiform full-length top cover.	26 healthy p with CAI. Walking at a self-selected speed, maximal SIDE and DROP	Ankle and knee angles/moments and lower-limb EMG of the lower limb.	Five trials of five tasks with and without FOS.	In CAI, FOS reduced tibialis anterior activity during landing and increased biceps femoris activity during walking, with no significant changes in ankle or knee angles and moments.
Zhang et al (27), 2019	Semirigid ankle brace (Aircast A60 Ankle Support, DJO, Europe)	8 subjects with FAI and 10 subjects without FAI as control group. Walking with or without brace	The 6 degrees of freedom (DOF) talocrural, subtalar, and ankle joints complex kinematics	-	In the FAI group, brace use reduced inversion/eversion ROM and showed joint laxity in most talocrural and subtalar displacements. The brace partially altered joint movements oppositely and restricted dorsiflexion in both joints.
Hadadi et al (28), 2020	Oppo Ankle Support with Strap (OPPO Medical, Seattle, WA), Active Ankle Brace (Active Ankle System, Louisville, KY).	60 P with CAI were assigned to 4 groups: kinesiotaping, a SOO, a SEO, or no treatment (control group). Modified SEBT, SLHT, and SLST before and after a 4-week intervention period.	Dynamic and static balance (Reach distances)	3 correct trials.	All outcomes showed significant group differences. The control group had the poorest SEBT, SLHT, and SLST performance. No differences were found among intervention groups.

Fuerst et al (29), 2021	Soft brace (Malleo Train® S open heel, Bauerfeind AG, Zeulenroda, Germany). Semi-rigid brace (malleoloc®, Bauerfeind AG, Zeulenroda, Germany)	15 P with FAI, 15 P with FAI and MAI and 15 healthy controls performed 180° turning movements in reaction to light signals.	Ankle joint kinematics and kinetics, neuromuscular activation of muscles surrounding the ankle.	Perform 10 trials in each direction. Repeated in three series of movements.	The semi-rigid brace significantly reduced ankle inversion angles, velocities, and peroneal activation before and after ground contact, with no significant brace-by-group effects.
Eberbach et al (32), 2021	semirigid brace (MalleoLoc®, Bauerfeind AG, Zeulenroda, Germany) was composed of a plastic splint that was attached to the medial and lateral side of the ankle joint with two hook-and-loop straps	25 patients with FAI	Cartilage contact area (CCA) in the fibulotalar (CCAFT) as well as the horizontal (CCATTH) and the vertical (CCATTV) part of the tibiotalar joint.	10 lateral skater hops with and without wearing the brace before answering the VAS questions	The brace caused CCA in plantarflexion and supination across all upper ankle compartments. Axial loading had no significant effect, and perceived stability didn’t match actual joint congruency improvement.
Zhang et al (30), 2022	Semirigid ankle brace (Aircast A60 Ankle Support, DJO, Europe)	12 P with FAI and 10 healthy P. All of the subjects walked on a custom-built tilting platform that offered a 30° inversion to mimic the inversion of ankle sprain	Kinematic And EMG data	Six valid collections were conducted for each condition of each foot	FAI without brace showed higher inversion and external rotation angles and velocities than controls and braced FAI. Bracing reduced these values and lowered peroneus longus EMG compared to no-brace.

SEO: semirigid orthotics; SOO: soft orthosis; MAI: Mechanical Ankle Instability; FAI: Functional Ankle Instability; P: participants; SEBT: Star Excursion Balance Test; SLHT: single leg hop test; SLST: single leg stance test; COP: Center of pressure; SIDE: single-leg side jump, DROP: single-leg drop jump

3.3. Quality assessment

The methodological quality of the included 14 studies amounted to 67% on the modified version of the Downs and Black checklist (22). This is indicative of moderate methodological quality (Table 2). Among the 14 included studies, five were rated high quality (16, 24, 26, 29, 30), and nine moderate qualities. None of the studies reported the calculation of a priori power analysis to estimate the sample size.

Table 3. Downs and Black methodological quality assessment scores of the 14 included studies.

Author (year)	**Reporting**								**External validity**		**Internal validity (bias)**					**Internal validity (confounding)**			**Power**	**Score (%)**	**Quality**
	1	2	3	4	5	6	7	10	11	12	14	15	16	18	20	21	22	25	27		
Sesma et al (15), 2008	1	1	1	1	2	1	1	1	0	0	0	0	1	1	1	1	0	1	0	70	MQ
Hadadi et al (16), 2011	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	0	75	HQ
Hamlyn et al (17), 2012	1	1	1	0	1	1	1	1	0	0	0	0	1	1	1	1	0	1	0	60	MQ
Lee et al (24), 2013	1	1	1	1	2	1	1	1	1	0	0	0	1	1	1	1	0	1	0	75	HQ
Hadadi et al (25), 2014	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	0	1	0	60	MQ
Kobayashi et al (18), 2014	1	1	1	1	2	1	1	1	0	0	0	0	1	1	1	1	0	1	0	70	MQ
Dingenen et al (19), 2015	1	1	1	1	2	1	1	1	0	0	0	0	1	1	1	1	0	1	0	70	MQ
Cao et al (26), 2019	1	1	1	1	2	1	1	1	0	0	0	0	1	1	1	1	0	1	0	70	HQ
Moisan et al (31), 2019	1	1	1	1	2	1	1	1	0	0	0	0	1	1	1	1	0	1	0	70	MQ
Zhang et al (27), 2019	1	1	1	1	2	1	1	1	0	0	0	0	1	1	1	1	0	1	0	70	MQ
Hadadi et al (28), 2020	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	1	0	65	MQ
Fuerst et al (29), 2021	1	1	1	1	2	1	1	1	1	0	1	1	1	1	1	1	0	1	0	85	HQ
Eberbach et al (32), 2021	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	0	1	0	60	MQ
Zhang et al (30), 2022	1	1	1	1	2	1	1	1	1	0	0	0	1	1	1	1	0	1	0	75	HQ
Average score (mean (SD))																				67	MQ

1=Yes; 0=No; SD: Standard Deviation; HQ: High Quality (Score≥75%); MQ: Moderate Quality (60%≤Score < 75%); LQ: Low Quality (Score < 60%).

Discussion

This systematic review aimed to investigate the effect of wearing ankle and foot orthoses in CAI individuals from the aspects of kinematics, kinetics, muscle activity and dynamic postural control ability. FOs due to variances in materials, manufacturing methods, design, individual preferences, and rates of adherence are complex biomechanical interventions. 10 out of the 14 studies that examined the effects of FOs on kinematics, kinetics, muscle activity and dynamic postural control ability in subjects with CAI found FOs to be effective in improving biomechanical variables (15-17, 24-31). Kobayashi et al (18) reported that during ankle internal rotation in plantar flexion, there was no apparent restoration of normal kinematics in the CAI joints after application of a semirigid brace or taping.

A comparison between a group that received both ankle rehabilitation exercises and foot orthotics and another group that underwent only ankle rehabilitation exercises revealed no significant differences in static balance, dynamic balance, or functional movement balance abilities (24). They suggested that the limited effectiveness of FOs observed in their study, in contrast to others, could be attributed to two key differences. First, there was a variation in the timing and condition of reassessment, while other studies evaluated balance with the orthotics still in use after several weeks, their study conducted the reassessment after the orthotics had been removed. Second, the impact of ankle rehabilitation training may have acted as a significant confounding factor, potentially overshadowing the effects of the orthotics.

The results of a study suggest that the biomechanical effects of FOs are task-dependent (31). They revealed that, even though FOs had no effect on ankle joint angles during the drop landing on even surfaces task, the decreased tibialis anterior muscle activity could represent increased ankle stability when wearing FOs. A systematic review hypothesized that individuals with CAI present altered ankle biomechanics, such as increased ankle dorsiflexion, in order to place the talocrural joint in a tightly packed position to increase its stability (33). The limitation of this study was that the participants were only given a very short period of familiarization to FOs. The effects of FOs on biomechanics could possibly change with longer using and thus have greater effects on individuals with CAI (15, 28).

When executing the Star Excursion Balance Test (SEBT), a single leg was employed to maintain balance with the other limb reaching directional excursion as farthest as possible (15, 25, 28). Orthotics may be effective in improving performance of the SEBT in certain directions, including the anterolateral, posterolateral, and medial directions in patients with ankle instability (15, 28). Sesma et al (15) hypothesized that the orthotic provided structural support to the medial arch and allowed for more control and increased reach distances when moving from supination to pronation as the foot does during the posterolateral directions due to a shift in body weight to the support foot.

The mechanisms proposed to explain the effectiveness of ankle orthoses include providing mechanical support (13), improving sensorimotor function (34), improving ankle positioning and muscular efficiency about the ankle joint, and increasing motor neuron excitability in peroneal muscles (35). Zhang and et al (30) revealed Patients with FAI revealed larger inversion angles and velocities than normal controls during ankle sprain. Ankle braces can effectively decrease inversion angles and velocities during ankle sprain in patients with FAI and simultaneously increase external rotation angles and velocities. Moreover, braces can decrease the activity of the peroneus longus muscle during ankle sprain (30).

The calcaneofibular ligament, the cervical ligament, and the interosseous ligament were severed to simulate subtalar instability in the several cadaveric studies. Results showed that the inversion/eversion range of motion of the subtalar joints became restricted after semirigid ankle brace application (36, 37). Cao et al (26) observed that during weight loading phase, subtalar inversion significantly reduced after ankle brace application. They hypothesized that the reduction in subtalar inversion might be an important mechanism underlying the ability of ankle braces to prevent ankle sprains. Also, Zhang et al (27) showed that the proposed semirigid ankle brace could normalize the inversion/eversion ROM of the talocrural and subtalar joints of patients with FAI.

During weight loading phase, reducing inversion at subtalar joints might attribute to passive stiffness of ankle braces (36). Webster et al. reported that after muscle fatigue, the joint stiffness of braced ankles increased, whereas that of unbraced ankles decreased (38). This finding also indicates that the passive structural factors may exert stabilizing effects (39). The passive stiffness of the semi-rigid brace might contribute to the restricted inversion/eversion range of motion of the subtalar joints (26).

A study demonstrated that when foot orthotics is removed after 4 weeks use in a patient who received ankle rehabilitation exercise treatment, orthotics did not offer any additional benefits, although it provided the proper biomechanical environment of the ankle and increased plantar skin sensory signals (24). This result has an important implication. The beneficial effects of foot orthotics decrease once the orthotics device is removed even after it has been used for several weeks, leaving only the positive effects of ankle rehabilitation exercises.

It seems that there are other effective factors that can be useful in improving and preventing injuries in people with chronic ankle instability. However, the benefits of foot orthosis are undeniable. Therefore, athletes with chronic ankle instability can benefit from foot orthotics to improve performance and prevent injury.

Conclusion

In conclusion, foot and ankle orthoses provide significant biomechanical advantages for individuals with CAI. These advantages are manifested through improved joint kinematics, decreased muscle activity of primary stabilizing muscles, and enhanced dynamic postural control, especially during functional activities such as the Star Excursion Balance Test. However, their effectiveness is task-specific and influenced by the design of the orthosis, duration of use, conditions of assessment, and rehabilitation interventions being conducted simultaneously. While some did not find any added value of FOs removed after a period of use or as an adjunct to ankle rehabilitation exercises, others were shown to enhance joint stability and injury prevention. The results indicate that while the effects of FOs may not remain following cessation, their application (particularly in athletic or high-demand populations) is capable of making very real contributions to improved performance and injury reduction when correctly fitted and as part of a global rehabilitation program.

Ethical Considerations:

Compliance with ethical guidelines

This systematic review was conducted in accordance with established ethical standards and guidelines for research.

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Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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اثر اورتزهای مچ-پا بر بیماران مبتلا به ناپایداری مزمن مچ پا: یک مرور نظام‌مند

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چکیده

هدف: ناپایداری مزمن مچ پا (CAI) یک وضعیت ناتوان‌کننده است که اغلب پس از آسیب مچ‌پا مشاهده می‌شود. اورتزهای پا به‌طور بالینی در پیشگیری و درمان CAI مؤثر شناخته شده‌اند، با این حال اثر فیزیکی این مداخله هنوز به‌خوبی درک نشده است. هدف این مطالعه، مرور نظام‌مند مطالعاتی بود که به بررسی اثرات اورتزهای پا بر بیماران مبتلا به CAI پرداخته‌اند.

روش شناسی: یک جستجوی نظام‌مند در پایگاه‌های داده الکترونیکی شامل WOS، Scopus، Springer، Google Scholar و PubMed از آغاز تا ژوئن ۲۰۲۵ انجام شد. از کلیدواژه‌های «اورتز پا»، «اورتوتیک پا»، «بریس مچ پا» و «ناپایداری مچ‌پا» برای استخراج مقالات استفاده گردید.

نتایج: پنج مطالعه نشان دادند که اورتزهای مچ‌پا طی ۲ تا ۴ هفته باعث بهبود ثبات وضعیتی و تعادل دینامیک در بیماران مبتلا به CAI می‌شوند. دو مطالعه گزارش کردند که اورتزهای نرم، بهبود بیشتری در تعادل ایجاد می‌کنند. سه مطالعه نشان دادند که اورتزها به‌طور معناداری فاصله‌ی رسیدن در آزمون‌های تعادلی را به‌ویژه در جهت خلفی-میانی افزایش می‌دهند. همچنین سه مطالعه بیان کردند که اورتزها (به‌ویژه نوع نیمه‌سخت) به‌طور قابل توجهی زوایا و سرعت‌های بیش‌ازحد اینورژن مچ پا را حین حرکت کاهش می‌دهند. اورتزها موجب تغییر در کینماتیک مفاصل نیز شده و دامنه حرکتی اینورژن/اورژن و میزان اینورژن ساب‌تالار را در حین راه رفتن کاهش می‌دهند. در سه مطالعه نیز تغییرات عصبی-عضلانی از جمله کاهش فعالیت عضلات پرونئوس طویل و ساقی قدامی گزارش شد. هرچند در برخی موارد نرمال‌سازی کینماتیکی مشاهده شد، اما دو مطالعه هیچ تفاوتی بین استفاده از اورتز و گروه کنترل از نظر حس موقعیت مفصلی یا پارامترهای تعادل گزارش نکردند.

نتیجه گیری: اورتزهای پا تأثیر مثبتی بر افراد مبتلا به CAI نشان داده‌اند. با این حال، اثربخشی آن‌ها وابسته به نوع فعالیت بوده و تحت تأثیر عواملی مانند طراحی ارتز، مدت زمان استفاده، شرایط ارزیابی و مداخلات توان‌بخشی همزمان قرار دارد.

واژه‌های کلیدی

ناپایداری مزمن مچ پا، اورتزهای پا، مچ پا، بیومکانیک

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