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Effectiveness of Vestibulo-Ocular Reflex Training combined with neuromuscular training in a district-level Football player with chronic ankle instability: A case report

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Abstract

Background and purpose: Chronic ankle instability (CAI) are characterized by recurrent ankle sprains, impaired proprioception, reduced dynamic balance and fear of reinjury. This case report describes the use of vestibulo-ocular reflex (VOR) training combined with neuromuscular and conventional rehabilitation in an adolescent football player with CAI.

Case description: A 16-year-old male district-level football player with left-sided mixed (mechanical and functional) CAI completed a 4-week program (3 sessions/week) of conventional ankle rehabilitation, neuromuscular training and VOR exercises. Outcomes were the Foot and Ankle Ability Measure (FAAM), Cumberland Ankle Instability Tool (CAIT), Y-Balance Test (YBT), joint position sense (JPS) error and Tampa Scale of Kinesiophobia (TSK), measured at baseline, 4 weeks, 1 month and 3 months.

Outcomes: FAAM-Sports improved from 52% to 80% and CAIT from 17 to 25. The YBT composite reach improved from 58.7% to 72.0% (80.3% at 3 months), JPS error decreased from 5.8° to 3.2° (2.4° at 3 months), and TSK decreased from 44 to 30 (24 at 3 months). Changes in the YBT, JPS and TSK were maintained or further improved at 3 months.

Discussion: In this patient, adding VOR training to neuromuscular training was associated with improved balance, proprioception, self-reported function and reduced kinesiophobia. As a single case without a control condition, causal effects cannot be established.

Keywords: Chronic ankle instability, vestibulo-ocular reflex training, proprioception, balance, kinesiophobia, Football

Introduction

Lateral ankle sprains are among the most frequent musculoskeletal injuries in physically active people and are also common in the general population. [1] They are common in football, and a recurrence rate of 17% in male elite players raises concern about the adequacy of current rehabilitation. [2] In sporting populations, soccer had the highest proportion of participants with recurrent sprain (61%) and mechanical instability (38%). [3]

CAI arises from interacting mechanical, functional and perceived instability. [4] The International Ankle Consortium (IAC) defines it as persistent symptoms after a significant ankle sprain, with recurrent sprains, a feeling of instability and episodes of giving way. [1, 14] In a study of soccer players, 46.3% had functional ankle instability on at least one side (35.4% right, 29.7% left). [5] CAI commonly causes functional impairment and muscle weakness, together with deficits in proprioception, neuromuscular function and balance. [6]

Kinesiophobia, the fear of movement resulting from a feeling of vulnerability to painful injury or reinjury, [8] influences postural control and rehabilitation in people with CAI. [7] Vestibular and visual input contribute to postural control alongside somatosensory input, so VOR training is a plausible addition to neuromuscular rehabilitation. Cerbezer *et al*. [6] examined a combined neuromuscular and VOR program in people with CAI. To our knowledge, reports in adolescent football players that include fear of movement as an outcome are limited. This report describes such a case.

The CAIT, FAAM, TSK and YBT were chosen for their psychometric properties. The CAIT shows an ICC of 0.96 for its digital version [10] and a sensitivity of 82.9% and specificity of 74.7% for identifying unstable ankles. [11] The TSK has test-retest ICCs of 0.77 to 0.99 and good construct validity. [12] The YBT has ICCs of 0.85 to 0.91 for dynamic balance. [13]

Case Description

This report followed the CARE guidelines. Ethical approval was granted by the ethics committee of TMV's Lokmanya Tilak College of Physiotherapy. Because the patient was a minor, written informed consent was obtained from his parent or legal guardian, and the patient gave written assent after the study and intervention were explained. Patient history

A 16-year-old male district-level football player presented with recurrent left ankle sprains, pain during play and episodes of giving way. Symptoms were worse on natural grass than on artificial turf, particularly during cutting, sprinting and changes of direction. He had sustained multiple inversion sprains over the preceding 18 months and had returned to sport early after each, without structured rehabilitation. There was no history of fracture, surgery or systemic illness. Examination

Observation showed no visible deformity and mild lateral ankle swelling. There was tenderness over the anterior talofibular ligament region. Range of motion was within functional limits bilaterally. The anterior drawer and talar

tilt tests were positive on the left. Weight-bearing compression testing was pain-free, neurovascular findings were normal, and screening ruled out fracture, syndesmotic injury and neurological involvement.

Baseline FAAM was 68% (ADL) and 52% (Sports) and CAIT was 17/30, meeting IAC criteria for CAI (CAIT ≤ 24). [11, 14] Because ligamentous laxity tests were positive together with reduced balance, proprioceptive deficit and perceived instability, the diagnosis was mixed (mechanical and functional) CAI of the left ankle.

Outcome measures

- **Self-reported function and instability:** FAAM (ADL and Sports subscales) and CAIT (0 to 30; lower scores indicate greater instability).
- **Dynamic balance:** Y-Balance Test in the anterior, posteromedial and posterolateral directions, expressed as % of limb length; the composite is the mean of the three directions.
- **Proprioception:** absolute joint position error in degrees. Goniometer was used to measure the angle
- **Kinesiophobia:** Tampa scale of Kinesiophobia 17-item scale was used
- Assessments were taken at baseline, 4 weeks (post-intervention), 1 month and 3 months after the program. The treating therapist only performed the pre- post assessment

Intervention

The patient completed 4 weeks of supervised rehabilitation, 3 sessions per week, combining conventional ankle rehabilitation, VOR training and progressive neuromuscular exercise. Progression was based on symptom response and movement quality.

- **VOR training:** VOR ×1 (horizontal and vertical head movements while fixating a target), VOR ×2 gaze stabilization, and visual tracking with head movement, progressing from sitting to standing to single-leg stance. Head movements were paced by a metronome, progressing from 60 to 120 beats/min over the 4 weeks; dose and progression are given in Table 1.
- **Neuromuscular training:** static and dynamic single-leg balance, wobble board and unstable-surface training, ankle inversion and eversion strengthening, and football-specific agility and hopping drills. Strengthening dose and progression are given in Table 1

Conventional rehabilitation and home program:

Table 1: Four-week vestibulo-ocular and neuromuscular exercise progression (adapted from Cerbezer *et al.*) [6]

Component	Week 1	Week 2	Week 3	Week 4
VOR single-leg stance (arms crossed on chest; head movements paced by metronome)	60 s on hard ground; 30 s on Thera-Band stability trainer; 60 beats/min	60 s on Thera-Band stability trainer; 30 s on BOSU ball; 80 beats/min	60 s on BOSU ball; 30 s on balance disc; 100 beats/min	60 s on balance disc; 120 beats/min
Strength	4-way ankle Thera-Band 3×12; foot intrinsic strengthening (toe curl, doming); double-leg heel raises 3×12	4-way ankle Thera-Band 3×12; foot intrinsic strengthening; double-leg heel raises 3×12	4-way ankle Thera-Band 3×12; foot intrinsic strengthening; squat 2×10; lunge 2×10	4-way ankle Thera-Band 3×12; foot intrinsic strengthening; single-leg heel raises 3×12; squat 2×10; lunge 2×10
Single-leg hop with head movements (hands free, then hands on hips)	Hop 45.7 cm; 60 beats/min	Hop 68.6 cm; 80 beats/min	Hop 91.4 cm; 100 beats/min	Hop and ball catch, 5 repetitions; 120 beats/min
Single-leg ball catch with head movements	30 s on hard ground; 60 beats/min	30 s on Thera-Band stability trainer; 80 beats/min	30 s on BOSU ball; 100 beats/min	30 s on balance disc; 120 beats/min
Unanticipated hop stabilization with head movements	Time limit 5 s per move; 60 beats/min	Time limit 3 s; 80 beats/min	Time limit 1 s; 100 beats/min	Foam pad added; 120 beats/min

Outcomes

Table 2: Patient-reported outcomes

Measure	Baseline	4 weeks	1 month	3 months
FAAM-ADL (%)	68	82	86	86
FAAM-Sports (%)	52	80	81	83
CAIT (/30)	17	25	25	27
TSK	44	30	27	24

Table 3: Y-Balance Test (% limb length), left limb

Direction	Baseline	4 weeks	1 month	3 months
Anterior	62	74	78	82
Posteromedial	58	72	76	80
Posterolateral	56	70	75	79
Composite (mean)	58.7	72.0	76.3	80.3

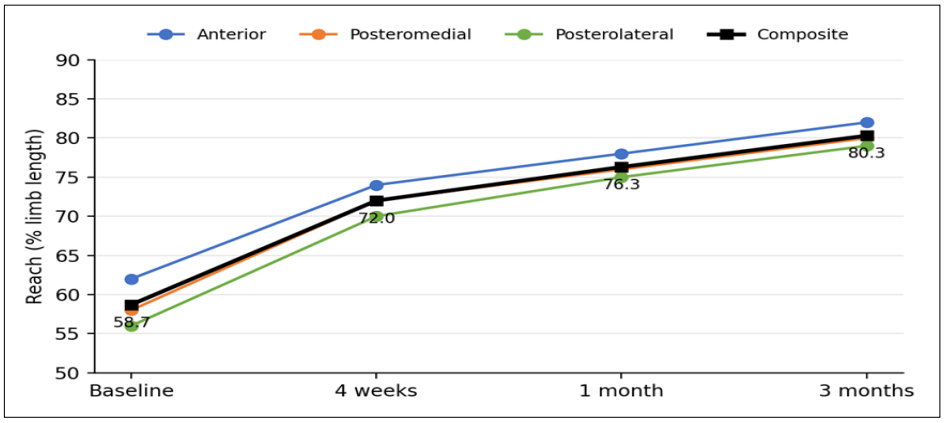


Fig 1: Y-Balance Test reach by direction and composite over time (% limb length).

Table 4: Change from baseline

Measure	Baseline	4 weeks	Change at 4 weeks	3 months	Change at 3 months
CAIT (/30)	17	25	+8 (+47%)	27	+ 10(54%)
FAAM-Sports (%)	52	80	+28 points	83	+31 points
YBT composite (%)	58.7	72.0	+13.3 (+23%)	80.3	+21.6 (+37%)
JPS error (°)	5.8	3.2	−2.6 (−45%)	2.4	−3.4 (−59%)
TSK	44	30	−14 (−32%)	24	−20 (−45%)

Because this is a single case, no inferential statistics (t-tests or p-values) were applied. Results are descriptive and are interpreted against published minimal detectable change (MDC) and minimal clinically important difference (MCID) values, which are approximately 9 points for FAAM-Sports and 3 points for CAIT. The change exceeded these thresholds. The post-intervention CAIT of 25 is just above the IAC inclusion threshold of ≤ 24. At 3-month follow-up the athlete had returned to full football participation, reported no episodes of giving way and no pain during matches, and showed greater confidence in cutting and sprinting. No adverse events occurred.

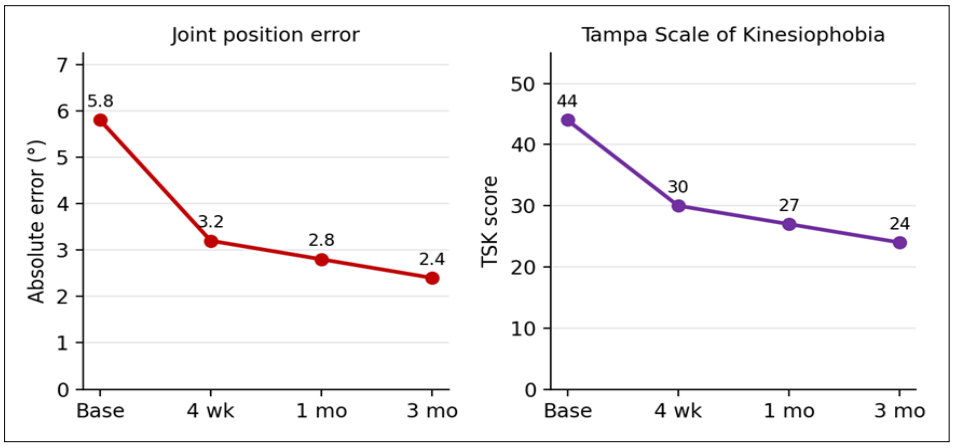


Fig 2: Joint position error and TSK score over time.

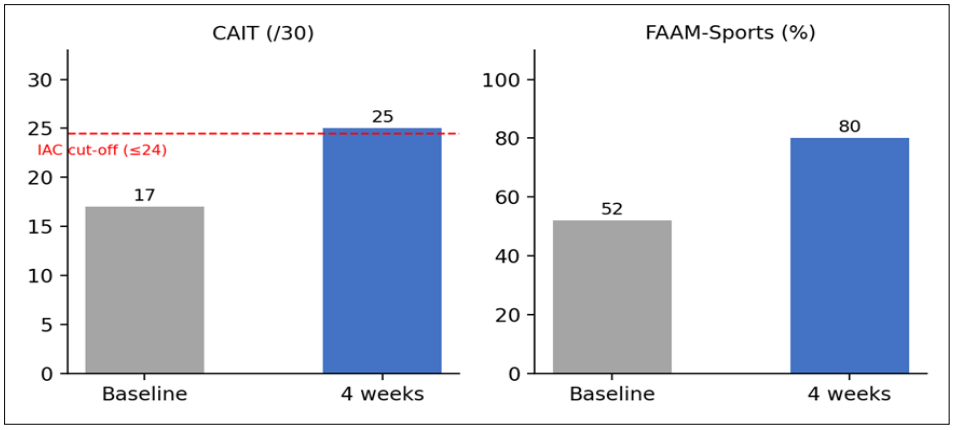


Fig 3: CAIT and FAAM-Sports at baseline and 4 weeks. [Update with 1-month and 3-month values]

Table 5: Timeline (CARE)

Time	Event
Preceding 18 months	Multiple left inversion sprains; early return to sport without structured rehabilitation
Baseline	Examination, diagnosis of mixed CAI, baseline measures
Weeks 1 to 4	Supervised program, 3 sessions/week
Week 4	Post-intervention measures
1 month after program	Follow-up measures
3 months after program	Follow-up measures; full return to sport, no giving way

Discussion

In this adolescent football player with mixed CAI, a 4-week program that added VOR training to neuromuscular and conventional rehabilitation was followed by improvements in self-reported function, instability, dynamic balance, joint position sense and kinesiophobia. The YBT, JPS and TSK values continued to improve through 3 months. The change in FAAM-Sports (+28 points) was well above the approximate MCID.

Postural control relies on integration of visual, vestibular and somatosensory input. After repeated sprains, somatosensory input from the ankle may be less reliable, and VOR exercises challenge gaze stability and sensory integration, which may have contributed to the better balance and joint position sense. Reduced fear of movement (TSK 44 to 24) may also have supported confidence during cutting and sprinting, consistent with the link between kinesiophobia and postural control in CAI. [7] These explanations are speculative. several factors limit attribution. The patient received three components together, so the effect of VOR training alone cannot be separated; natural recovery, learning effects on repeated testing and the attention of supervised rehabilitation could also contribute. The composite YBT at 3 months (80.3% of limb length) may still be below values expected in uninjured athletes, so the claim of full recovery should be made cautiously.

Limitations

This is a single case without a control condition or repeated baseline measures, so causality cannot be inferred. Outcomes were not assessed by a blinded assessor, there was no instrumented postural analysis, and home program adherence was self-reported. Follow-up was 3 months. Randomized controlled trials are needed to test this combination.

Conclusion

In a 16-year-old district-level football player with mixed CAI, adding VOR training to neuromuscular and conventional rehabilitation was associated with meaningful improvements in balance, proprioception, function and kinesiophobia, with gains maintained at 3 months. This approach may be a useful adjunct to conventional CAI rehabilitation and warrants controlled study.

Key Points

- CAI involves sensorimotor and psychological deficits beyond local ankle mechanics.
- Adding VOR training to neuromuscular rehabilitation was safe and well tolerated in an adolescent football player.
- Balance, joint position sense and kinesiophobia improved by 4 weeks and were maintained or further improved at 3 months.
- Addressing fear of movement is important for return to sport after repeated ankle sprains.

Impact Statement

Adding vestibulo-ocular reflex training to neuromuscular rehabilitation in an adolescent football player with chronic ankle instability was associated with better balance, proprioception, function and less fear of movement.

Declarations

Funding: No external funding was received. Conflict of interest: The authors declare no conflicts of interest.

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