ORIGINAL ARTICLE

Functional ankle control of rock climbers

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Objective: To evaluate whether rock climbing type exercise would be of value in rehabilitating ankle injuries to improve ankle stability and coordination.
Methods: A group of 25 rock climbers was compared with a group of 26 soccer players. All were male, uninjured, and exercised three to four times a week. Active ankle stability was evaluated by one leg stand stabilometry (measurement of migration of the centre of gravity) and measurements of maximum strength of ankle isokinetic concentric flexion and extension (Cybex).
Results: The rock climbers showed significantly better results in the stabilometry and greater absolute and relative maximum strength of flexion in the ankle. The soccer players showed greater absolute but not relative strength in extension.
Conclusion: Rock climbing, because of its slow and controlled near static movements, may be of value in the treatment of functional ankle instability. However, it has still to be confirmed whether it is superior to the usual rehabilitation exercises such as use of the wobble board.

Ankle sprain is one of the most common sports injuries. Soccer players are particularly susceptible to distortion or rupture of the lateral ankle ligaments. Functional treatment in cases where an invasive procedure is not indicated is standard, and return to sport is achieved in due time.[1] However, functional ankle stability depends not only on intact ligaments but far more on muscular control, coordination, and proprioception of the joint.[2–7] Rehabilitation of ankle sprains therefore aims to improve muscular function to prevent further injuries. Different techniques and exercises have therefore been established.

Rock climbing has become a very popular sport. Indoor climbing walls are now available even in smaller cities and provide access to a broad population. Rock climbing has recently been used as therapy or rehabilitation for different indications. Bouldering walls, on which rope-less climbing just above a well padded floor is possible, enable a physiotherapist to stand directly behind the patient and give advice about movements and climbing tasks. Climbing movements are mostly slow, well controlled, have low impact, and offer many different positions of the tibiotalar and subtalar joints. Rock climbing requires mostly isometric control for many different positions of the ankle joint and would therefore be ideal for the rehabilitation of ligament injuries such as ankle sprains (fig 1).

To determine whether regulated rock climbing exercises could be useful in the rehabilitation of ankle sprains, functional active ankle stability in similar groups of rock climbers and soccer players were compared. Maximum strength of muscles controlling the ankle joint and their coordination were measured. These two variables have been shown to predict accurately active muscular control, as well as weakness and instability, of the ankle joint. To our knowledge, no similar study has been performed.

MATERIALS AND METHODS

Subjects

Fifty two ankle joints of 26 recreational male soccer players (mean (SD) age 27 (3.7) years, range 19–34) were compared with 50 ankle joints of 25 male recreational rock climbers (mean (SD) age 32 (8.6) years, range 17–45). The inclusion criterion was exercise three to four times a week (6–12 hours) in the chosen sport: rock climbers trained for 7.4 (1.5) hours a week and soccer players for 6.5 (0.3) hours a week. Exclusion criteria were acute or chronic injuries or instability of the ankle joint or other compromising injuries or overuse syndromes that would allow the subject to perform the sport at the time of the tests. Soccer players

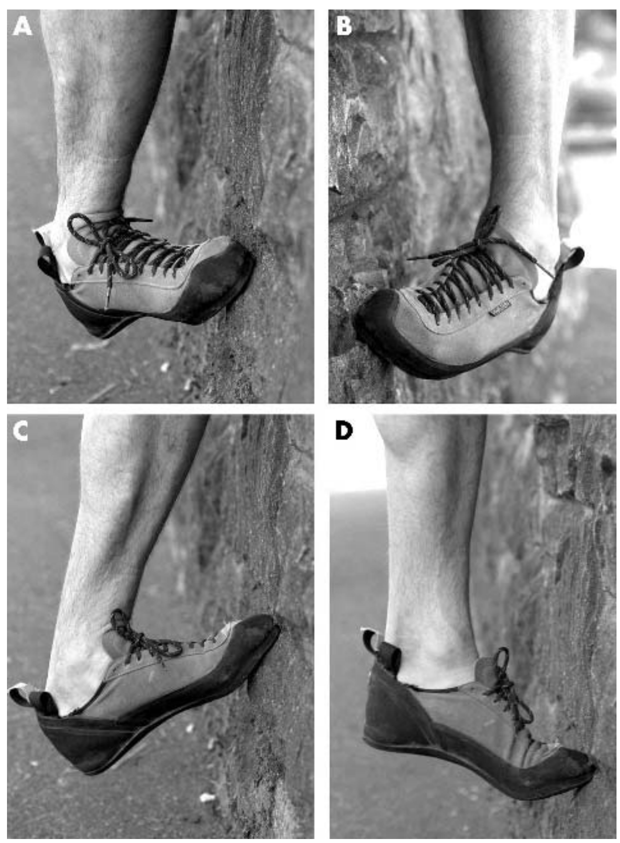

Figure 1 During rock climbing, the foot has to be held isometrically in many different positions. Supinated (A) and pronated (B) position of the ankle of a climber with a typical climbing shoe. Slope (C) and tip (D) stand with extension or flexion. Consent was obtained for publication of this figure.

Figure 2 Stabilometry: subject performing a one leg stand on a three point force plate while the postural sway is recorded continuously by a personal computer. Consent was obtained for publication of this figure.

who had previously had an injury (ankle sprain) but without actual pain or sensation of instability at the time of the measurements were included in the study group. The soccer players had participated in their sport for 18 (5.9) years, and the rock climbers for 10 (6.3) years. Body mass index (kg/m^2) was 23.8 (2.0) for the soccer players and 22.5 (2.3) for the rock climbers. All participants provided informed written consent.

One leg stand stabilometry

Stabilometry is a method of measuring ability to stand quietly on one leg by recording migration of the centre of gravity. It is accepted to be an objective and quantitative method for the evaluation of lower limb and ankle instabilities.[2 8 9] The measuring device (TUV, Munich, Germany) consists of a triangular force plate with three transducers, which continuously measures the actual position and migration of the vertical force component. The signal is reinforced, recorded with 50 Hz, and the data stored by a personal computer. A circular area that includes 95% of the positions of the centre of gravity is averaged every 10 seconds and is expressed as the radius of that area in mm. The accuracy of the measurement device is 1 mm.

All subjects performed a one leg stand for one minute. Before the start of the measurements, they performed a practice one leg stand for one minute. During measurements, both hands were positioned at the lateral rim of the pelvis and eyes directed horizontally to a mark in front of the subject (fig 2). Subjects were informed about the progress of the measurements after every 15 seconds. Both ankles were measured, with a short break in between. For data evaluation, the mean of the six averaged results was used.

Isokinetic flexion and extension strength of the ankle

Concentric maximum strength of flexion and extension of the ankle were determined with a isokinetic Cybex device (LMT; Leuenberger Medizinaltechnik, Zurich, Switzerland). During measurements, subjects lay prone with legs and hips immobilised. Both legs were measured with a short break in between. The device allowed flexion and extension in the plane of the ankle joint and a maximum speed of 30°/s. Five repetitions (at knee extension) of flexion and extension of the ankle joint with maximum effort were performed. Data were recorded and stored by a personal computer. Absolute and relative (Nm/kg body weight) maximum torque (Nm) and power (W) were evaluated.

Statistical evaluation

The parametric data were evaluated by the two tailed Student's *t* test. Results were considered significant at $p<0.05$.

RESULTS

One leg stand stabilometry

Table 1 shows ankle stabilometry and strength of the two groups of subjects. The mean (SD) radius of the 95% area of the migration of the centre of gravity was 12.21 (2.04) mm (range 9.0–18.67) in the soccer players and 11.19 (2.11) mm (range 7.17–16.67) in the rock climbers. The results for the rock climbers were significantly better ($p = 0.015$).

Isokinetic flexion and extension of the ankle

Maximum and relative strength

Absolute values for maximum torque of flexion of the ankle joint was 114.3 Nm in soccer players and 133.71 Nm in rock climbers (table 1). The results for the rock climbers were significantly better ($p<0.001$). The relative values for maximum torque of flexion of the ankle joint were 1.52 Nm/kg body weight in the soccer players and 1.85 Nm/kg body weight in the rock climbers. Again the results for the rock climbers were significantly better ($p<0.005$).

The absolute values for maximum torque of extension of the ankle joint was 39.9 Nm for the soccer players and 37.4 Nm for the rock climbers. The results for the soccer players were significantly better ($p = 0.046$). The relative values for torque extension of the ankle joint were 0.53 Nm/kg body weight for the soccer players and 0.52 Nm/kg body weight for the rock climbers. There was no significant difference ($p = 0.313$).

Power

Absolute values of power of torque of flexion of the ankle joint was 42.3 W for the soccer players and 47.2 W for the rock climbers (table 2). The results for the rock climbers were significantly better ($p = 0.005$). The relative values of power of torque of flexion were 0.56 W/kg body weight for the soccer players and 0.65 W/kg body weight for the rock climbers. Again the results for the rock climbers were significantly better ($p<0.001$).

The absolute values of power of torque of extension of the ankle joint were 16.0 W for the soccer players and 14.6 W for the rock climbers. The results for the soccer players were

Table 1 Ankle stabilometry and strength of rock climbers and soccer players

Group	Migration of centre of gravity (mm)	Maximum strength of flexion: Absolute (Nm)	Maximum strength of flexion: Relative (Nm/kg body weight)	Maximum strength of extension: Absolute (Nm)	Maximum strength of extension: Relative (Nm/kg body weight)
RC (n = 50)	11.2 (2.1)	133.7 (22.5)	1.85 (0.2)	37.4 (7.1)	0.52 (0.07)
SP (n = 52)	12.2 (2.0)	114.3 (23.3)	1.52 (0.3)	39.9 (5.4)	0.53 (0.06)
p Value	0.023–0.015	<0.001	<0.005	0.046	0.313

Values are mean (SD). Student's *t* test was used to obtain the p values.
RC, Rock climbers; SP, soccer players.

Table 2 Power of ankles of rock climbers and soccer players

Group	Power of flexion		Power of extension	
	Absolute (W)	Relative (W/kg body weight)	Absolute (W)	Relative (W/kg body weight)
RC (n = 50)	47.2 (8.2)	0.65 (0.1)	14.6 (3.2)	0.2 (0.03)
SP (n = 52)	42.3 (9.4)	0.56 (0.12)	16.0 (2.4)	0.21 (0.03)
p Value	0.005	<0.001	0.017	0.83–0.83

Values are mean (SD). Student's *t* test was used to obtain the p values.
RC, Rock climbers; SP, soccer players.

Take home message

Rock climbing may have a beneficial effect in improving functional stability in soccer players and other athletes participating in "stop and go" disciplines, who are particularly prone to ankle sprains and subsequent functional instability. However, further research is required to see if rock climbing is in fact superior to the methods used at present.

significantly better (p = 0.017). There was no significant difference between the two groups for relative power of torque of extension (p = 0.083).

DISCUSSION

Functional stability is the main target after acute or chronic injury to the ankle joint for return to sport and for reduction of the probability of further injury.[10] Although still debated, functional stability may be improved by use of an ankle brace[11–16] or taping.[16–22] Taping is most important during the first few weeks after injury to prevent further distortions.[20] For long term improvement and to prevent dependence on external stabilisation, functional stability can be improved and maintained by training of coordination, proprioception, and strength of the ankle stabilising muscles using wobble boards, ankle disks, or similar devices.[3 5 10 23]

Rock climbing simulates similar ankle exercises but in a more isometric, slow, and controlled manner because the upper extremities are also involved to maintain equilibrium and can take a considerable part of the body weight if necessary. Such "safe exercises" would represent an ideal method of rehabilitation in the early period after ankle injury. A climbing board of 2 m height and 1 m width would be appropriate. It could be easily mounted in a physiotherapists' room and used also for the treatment of the upper extremities or back.

The stabilometry recordings for the rock climbers, which represent functional stability,[2] were significantly better (p = 0.015) than those for the soccer players. Absolute and relative maximum strength of flexion was also significantly better in rock climbers ($p<0.001$). Only absolute maximum strength of extension was, barely, better (p = 0.046) in soccer players, and there was no difference in relative maximum strength of extension (p = 0.313). According to this the power of extension and flexion was similar. The slightly stronger extension in soccer players can be explained by the repetitive exercise of these muscles while shooting. These results show that rock climbing, with a similar period of training, leads to better functional ankle stability and strength than soccer playing. Further research is needed to see if it is superior to established methods of rehabilitation of ankle instability.

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