Neuromuscular training for rehabilitation of sports injuries: a systematic review

CRD summary
The authors concluded that proprioceptive and neuromuscular interventions after knee and ankle joint injuries can be effective for prevention of recurrent injuries and improve joint functionality. Evidence appeared to support the authors’ conclusions, but assessment of multiple outcomes, differences between studies and small numbers of studies that reported specific outcomes make the reliability of the conclusions uncertain.

Authors’ objectives
To evaluate the effectiveness of proprioceptive and neuromuscular training programmes for the rehabilitation and treatment of post-traumatic or postsurgical knee, ankle and shoulder joint injuries.

Searching
Cochrane Bone, Joint and Muscle Trauma Group Register, Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, PEDro, and Scopus were searched from 1966 to October 2007 for studies reported in English or German. Search terms were stated. Reference lists were screened.

Study selection
Randomised controlled trials (RCTs) and non-randomised controlled trials (CCTs) were eligible if they compared proprioceptive and neuromuscular training interventions (balancing, plyometric and perturbation exercises) with no proprioceptive and neuromuscular training interventions. Patients needed to be aged under 65 years. Eligible patients had an acute sports-related injury (within six months) or chronic instability (more than one giving way episode or sprain in the last two years) of the knee, ankle or shoulder joint in a post-traumatic or post-surgery condition. Outcomes of interest were: recurrent injury rate; postural control; proprioception; pain; episodes of giving way; joint laxity; active and passive knee range of motion; function scores; swelling; muscle strength; and neuromuscular activity.

Most of the included studies evaluated balance training with recurrent voluntary or involuntary destabilisation while exercising. Most studies compared proprioceptive and neuromuscular training with no intervention; some studies used electromyostimulation or strength training as the control intervention. Treatment was conducted from one to five times weekly over periods that ranged from four to 12 weeks. Patients had a mean age from 18 to 30 years and had knee or ankle joint injuries; most had chronic or functional ankle instability. About two-thirds of patients were male. All of the knee injury studies involved patients with anterior cruciate ligament ruptures; two of these studies involved conservative treatment and the third study involved surgical treatment.

Two reviewers independently selected studies. Disagreements on inclusions were resolved by consensus, with help from all the reviewers if required.

Assessment of study quality
Study validity was assessed using the following nine items of the van Tulder scale: acceptable randomisation method; allocation concealment; baseline comparability; blinded assessment; avoidance or similarity of cointerventions; acceptable compliance (75% or more); acceptable drop-out rate (<25% at six months and <30% beyond six months); similar timing of outcome assessment; and intention-to-treat (ITT) analysis. Studies that scored 50% of the maximal 9 points were considered to be high quality.

Two reviewers independently assessed validity. Disagreements were resolved by consensus among the reviewers.

Data extraction
Where possible, standardised mean differences (SMDs) and 95% confidence interval (CIs) were calculated for continuous data and odds ratios (ORs) with 95% CIs were calculated for dichotomous data. Where studies reported more than one variable for one outcome, standardised mean differences were pooled.

Two reviewers independently extracted data using prespecified forms. Disagreements were resolved by discussion.
Methods of synthesis
The studies were grouped by site of injury and outcome and combined in a narrative synthesis.

Results of the review
Fifteen studies were included (525 patients). These consisted of 13 RCTs and two CCTs. Sample size ranged from 19 to 71 patients.

Study quality: Quality scores ranged from 2 to 7 out of 9 points. Three studies scored at least 50% and were classified as high quality; these studies all involved patients with anterior cruciate ligament rupture. Common areas of methodological weakness included allocation concealment, compliance and intention-to-treat analysis.

Rehabilitation after ankle injury (12 studies): Nine studies included patients with chronic ankle instability. Proprioceptive and neuromuscular training interventions were associated with a significant reduction in giving way episodes (one of one study), recurrent sprains (three of four studies) and ankle joint functionality (two of two studies). There was no difference between proprioceptive and neuromuscular training and control for muscle strength (two studies), electromyographic measures (two studies) and oedema (one study). Conflicting results were reported for postural control (nine studies), ankle joint position sense (three studies) and muscle reaction time (two studies).

Rehabilitation after knee injuries (three studies): Studies were of patients with anterior cruciate ligament injury. Patients who received conservative treatment proprioceptive and neuromuscular training interventions were associated with positive effects on knee joint functionality (two studies), knee giving way episodes (one study), jumping performance (one study) and muscle reaction time to sudden perturbation (one study). There were mixed effects on daily living and sports activity (one study) and no difference between proprioceptive and neuromuscular training and control in knee laxity (one study) or muscle strength (one study).

For patients who underwent anterior cruciate ligament reconstruction, there was no significant effect of proprioceptive and neuromuscular training interventions on knee joint functionality, knee range of motion or jumping performance (one study).

Authors' conclusions
Proprioceptive and neuromuscular interventions after knee and ankle joint injuries can be effective for the prevention of recurrent injuries and improve joint functionality.

CRD commentary
The review question was clearly stated and inclusion criteria were appropriately defined. Several relevant sources were searched, but no attempts were made to minimise publication bias and some language restrictions were applied. Appropriate methods were used to minimise reviewer error and bias during the review process. Study validity was assessed and results were reported. Differences between studies made a narrative synthesis appropriate. The review evaluated multiple outcomes without specifying primary outcomes, which increased the probability of positive findings arising by chance. The synthesis of ankle injury studies did not highlight evidence from higher-quality studies and this made it difficult to judge the strength of the evidence. Evidence appeared to support the authors' conclusions, but assessment of multiple outcomes, differences between studies and small numbers of studies that reported specific outcomes make the reliability of the conclusions uncertain.

Implications of the review for practice and research
Practice: The authors did not state any implications for practice.

Research: The authors stated that there was a need for high-quality studies to evaluate the long-term effects of proprioceptive and neuromuscular training after knee, ankle and shoulder joint injuries and examine the relationship of treatment effects to amount and intensity of training. Studies should use standardised methods of assessing outcomes and analysing data and examine the physiological adaptation response to training.

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