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Prevention of anterior cruciate ligament injuries in soccer

A prospective controlled study of proprioceptive training

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Abstract Proprioceptive training has been shown to reduce the incidence of ankle sprains in different sports. It can also improve rehabilitation after anterior cruciate ligament (ACL) injuries whether treated operatively or nonoperatively. Since ACL injuries lead to long absence from sports and are one of the main causes of permanent sports disability, it is essential to try to prevent them. In a prospective controlled study of 600 soccer players in 40 semiprofessional or amateur teams, we studied the possible preventive effect of a gradually increasing proprioceptive training on four different types of wobble-boards during three soccer seasons. Three hundred players were instructed to train 20 min per day with 5 different phases of increasing difficulty. The first phase consisted of balance training without any balance board; phase 2 of training on a rectangular balance board; phase 3 of training on a round board; phase 4 of training on a combined round and rectangular board; phase 5 of training on a so-called BABS board. A control group of 300 players from other, comparable teams trained "normally" and received no special balance training. Both groups were observed for three whole soccer seasons, and possible ACL lesions were diagnosed by clinical examination, KT-1000 measurements, magnetic resonance imaging or computed tomography, and arthroscopy. We found an incidence of 1.15 ACL injuries per team per year in the control group and 0.15 injuries per team per year in the proprioceptively trained group ($P < 0.001$). Proprioceptive training can thus significantly reduce the incidence of ACL injuries in soccer players.

Key words Anterior cruciate ligament · Proprioceptive training

Introduction

Soccer is the most popular sport in the world and is played by at least 40 million people in 150 countries [8]. Soccer injuries have been the subject of a large number of studies (e.g. [4–6, 13, 14]), and an anterior cruciate ligament (ACL) injury was found to have the longest disability time and be the most costly injury in soccer players, as determined by two Swedish insurance company studies [7, 9]. ACL injury was also shown to lead to the highest percentage of permanent disability [7]. In a controlled study Ekstrand et al. in Sweden [5] were able to demonstrate a substantial reduction in the number of injuries when they sent a special team to supervise the training of six teams in a 4th division soccer league in Sweden. The other six teams in the division served as controls. Ekstrand et al. demonstrated a 75% reduction of several different types of injuries, mostly adductor tendinitis, ankle sprains, but also to some extent knee sprains. Ekstrand did not indicate the number of ACL injuries in his two groups but has informed us (personal communication) that his total number of players (180) was too small to study the possible prevention of ACL injuries. Proprioception has been

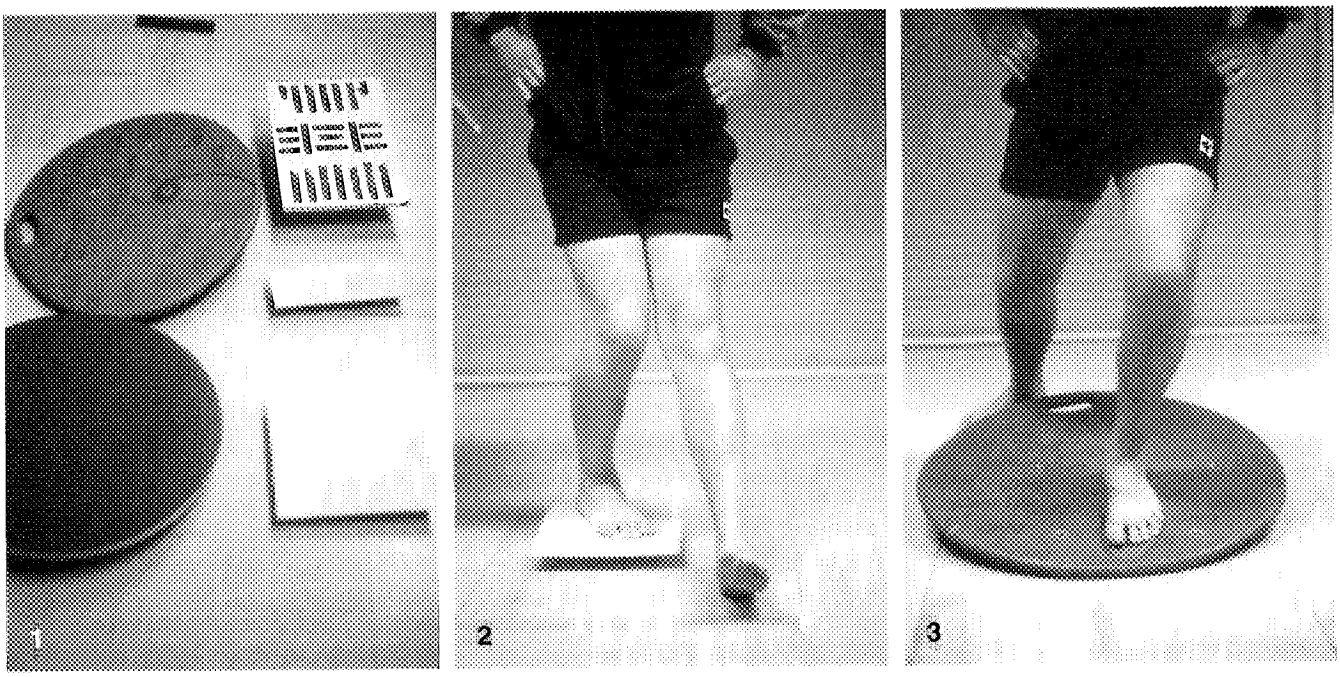

Fig. 1 The different balance and "wobble" boards used during the proprioceptive training

Fig. 2 Phase 2 of training. Posterior half-step up in an oblique plane on a rectangular balance board

Fig. 3 Phase 5. Half-step position during training on multiplanar "BAPS" board

shown to play an imporant role in rehabilitation [1–3] and in the prevention of ankle injuries [15]. The aim of the present study was to assess the ability of a proprioceptive training program to reduce the incidence of ACL injury in soccer players.

Materials and methods

Six hundred players in 40 semi-professional and amateur teams in Umbria and Marche in Italy were contacted and asked if they would participate in a controlled study of the incidence of ACL injuries. Twenty of the teams (group A) would receive a special proprioceptive training program in addition to their standard training program, while the other 20 teams (group B) were asked to train as usual. The training of the control teams contained very little if any proprioceptive training. The distribution of amateur and semiprofessional teams was the same in both groups. The age range of the players and the number of training and playing hours were comparable between the two groups.

All teams played on grass fields and used similar soccer shoes. Players with earlier knee injuries were excluded. Each of the two groups contained the same number of goalkeepers, defenders, midfielders, and forwards. All players underwent a clinical examination with special emphasis on knee laxity before the study.

The teams of group A were carefully instructed by our special team to follow a proprioceptive training program of increasing difficulty. Every day during the preseason training (a minimum of 30 days), they had to train at least 20 min per day. The training was divided into five phases (Fig. 1). Each phase consisted of 2–6 days of training. Phase 1 consisted of balance training without a board. The athletes were instructed to stand alternately on one leg for 2.5 min four times a day. Phase 2 consisted of training each leg alternately on a rectangular balance board, for the same time period each day (Fig. 2). In phase 3 the rectangular board was exchanged for a round board. In phase 4 they trained on a combined round and rectangular board, and in phase 5 the training was performed on a so-called BAPS board (Camp, Jackson, Mich.) or a similar multiplanar board (Fig. 3). Each training phase also consisted of two subphases, anterior up-step and posterior up-step exercises. During their active soccer seasons, the players were instructed to train according to the given program at least three times a week. They were also instructed to follow a neuro-muscular facilitation technique as described by Herveou and Messean [11].

All 40 teams were carefully supervised by their local sports medicine doctor or a specially instructed coach or masseur during the three subsequent football seasons. The players were promised an immediate check-up by the senior author in case of a possible knee injury in return for participating in the study. All knee injuries were recorded, and these players underwent a careful clinical examination, KT-1000 measurement, standard X-ray, magnetic resonance imaging (MRI), or computed tomography (CT)-scan. If the investigations indicated the possibility of an ACL injury, the athletes also underwent an arthroscopy. In order to make the study easier for the participating team doctors and coaches, we asked them only to record the incidence of knee injuries in the two groups.

Results

During the three seasons, a total of 10 arthroscopically verified ACL injuries occurred in group A, while 70 such injuries were recorded in group B. If these numbers are split up into injuries per team per season, group A had an incidence of 0.15 injuries per team/season, while group B had an incidence of 1.15 injuries per team/season. This difference is significant, with a chi-square value of 43.38 ($P < 0.001$).

Discussion

We have reason to believe that our recorded incidence of ACL injuries in the two groups of teams is reliable, since our hospital has been the referral hospital for all the teams engaged in this study for many years. The incidence of 1.15 ACL injuries per team season in our control group compares well with other studies, e.g., Engstroem et al. in Sweden, who in a carefully controlled prospective study of three female elite soccer teams found an ACL injury frequency of 2.3 per team per season [6]. The incidence of knee injuries has, however, been reported to be somewhat higher in women than in men [14], so the values of Engstroem et al. correspond well with ours. The frequency of injuries in our proprioceptively trained group showed a sevenfold reduction over the control group. No other parameter differed between the two groups. Since the two groups were otherwise comparable (age, experience, and training perspective), our results indicate that a program of proprioceptive training can reduce the number of ACL injuries in soccer. We have not been able to control how well the players in group A cooperated with the proprioceptive training, but the reduction of injuries implies that they did follow the instructions provided.

It has been shown that proprioceptive training is effective in preventing ankle injuries [15], but as far as we know no other controlled study of the possible prophylactic effect of proprioceptive training on the incidence of ACL injuries has been performed. Although our study involved amateur and semiprofessional teams, it is possible that our results also apply to the elite soccer player. In the above-mentioned Swedish insurance statistics [9], the incidence of injury was highest in the elite divisions.

Our data suggest that proprioceptive training should become standard in preseason training as well as during the actual playing seasons.

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