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Peroneal Reaction Time Measurements in the diagnosis of Ankle Joint Instability

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PERONEAL REACTION TIME MEASUREMENTS IN THE DIAGNOSIS OF ANKLE JOINT INSTABILITY

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INTRODUCTION

The ankle joint is a location that is prone to injuries in sports activities as well as in daily life. Even though the initial injury – an excessive inversion event causing an ankle sprain or ligament injury – can be treated effectively with conservative measures or with surgical procedures, a certain percentage of patients may develop recurrent problems which are termed chronic ankle instability. The problem is quite common especially in young persons participating in high-risk sports demanding a high level of jumping and directional changes.

In the literature, a distinction has been proposed between mechanical and functional instability. The term mechanical instability is more or less clearly defined in terms of increased talar tilt and/or anterior talar drawer due to a mechanical insufficiency of the lateral ligaments. The functional instability, however, is more difficult to diagnose as it has been described as a feeling of giving way, recurrent inversion events and a tendency for swelling after joint loading. No clear-cut criteria or parameters have been proposed and are generally accepted for routine clinical use. The problem is complicated by the fact that these two entities may appear separate but also in a combination in patients.

The cause for the functional instability problem is thought to be related to a neuromuscular insufficiency –some kind of strength deficit – and/or a proprioceptive problem caused by impairments of sensory structures and their feed-back.

The lateral ankle ligaments are the passive stabilizing structure that are not strong enough to withstand unprotected loading of the joint in inversion. Therefore, the peroneal muscles are the active stabilizers that should prevent excessive joint motion and prevent damage to the ligament complex. If the activity of the peroneal muscles (peroneus longus and brevis) appears in a timely fashion, their eversion moment can help to counteract the inversion movement and prevent an impending injury.

METHODS

This fact has lead to research interest that concentrates on the assessment of the respective muscle activity, especially peroneal reaction times (PRT). Measurements are usually performed with surface electromyography that can be recorded from both muscles, the peroneus longus and brevis. An established injury simulation model is a trap-door or tilting platform that induces a sudden inversion, usually limited to a range of 30° (Fig. 1). This extent is not harmful for the subjects but is demanding enough to elicit a reactive response from the muscles of the lower leg.

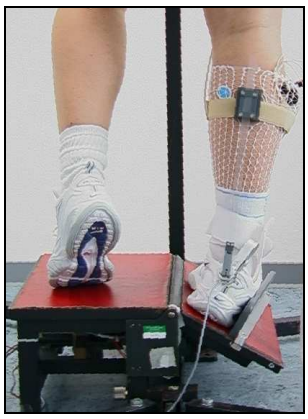

Fig. 1: Set-up for peroneal reaction time measurements on a tilting platform

Electrodes are placed in a bipolar arrangement with an inter-electrode distance of 20 mm on the muscle belly of the peroneus longus (approx. 3 cm below the head of the fibula) and the peroneus brevis (approx. 10 cm above the lateral malleolus). These locations were prepared with abrasive paste and cleaned with alcohol to ensure skin impedance below 6 MΩ. The electrodes were connected to the amplifier unit and A/D-converted at 1000 Hz per channel for raw signal storage (Noraxon MyoSystem & MyoResearch).

In the first stages, the signals were semi-automatically analyzed with self-developed software that detected the onset of muscle activity when the average baseline activity ± 2 standard deviations were exceeded (Fig. 2). More recently, a similar approach was incorporated in the MyoResearch software allowing convenient data processing.

RESULTS

These procedures were applied in healthy subjects as well as in patients that were referred to the hospital for treatment of chronic ankle instability. We used the approach to distinguish patients with and without proprioceptive deficits who might benefit more from neuromuscular exercises than from surgical reconstruction of the ligaments (Rosenbaum et al. 2000). The knowledge about the potential neuromuscular cause of ankle instability lead to the development and application of exercise programs for injury prevention which were evaluated with reflex latency measurements (Eils et al 2001).

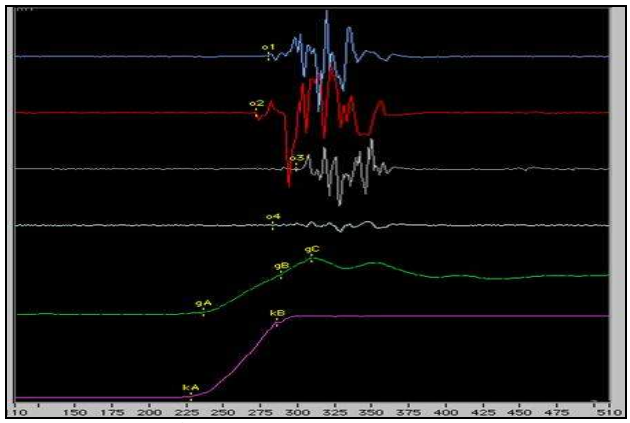

Fig. 2: Example of the EMG signals (PB=blue, PL=red, TA=gray, MG=white) and rearfoot angle (=green) from a single measurement.

DISCUSSION

Even though the is some evidence that peroneal reaction times may benefit from proprioceptive exercises, i.e. lead to a shorter reflex latency it has to be realized that even normal reaction patterns are too slow to effectively prevent lateral ligament overloading. Therefore, only pre-activated muscle activities anticipating the potentially dangerous situation appear to be able to prevent ankle injuries (Konradsen et al., 1997). These effects might be supported by passive stabilizers that provide external support to the ankle joint.

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