Proprioception can be appreciated and measured consciously by a complex system involving quick adapting and slow adapting mechanoreceptors. These are thought to mediate the sensations of joint movement and joint position. The ability to measure proprioception has become important because there may be patients with knee pathologies with and without good proprioception and the ability to differentiate between these subgroups helps with targeting treatment and monitoring rehabilitation.

Various measurement techniques have been used to test joint proprioception. The most common are: active or passive joint position reproduction (Felson et al., 2009); detecting the initiation of a passive movement (Lephart et al., 1992); detecting a sensation of vibration (Shakoor et al., 2008); measuring the delay of muscle contraction (Beard et al., 2000); reproducing a muscle force (Dover and Powers, 2003) and postural sway (Swanik et al., 2004). Although usually performed in open chain, some tests have used the closed chain mode (Stillman and McMeeken, 2001). Unfortunately, there is no clear consensus as to which method is the most reliable, valid orclinically relevant and they may be confounded by factors such as patient memory, reaction time, concentration, as well as joint pain. There is some evidence that assessing vibration sense has little correlation to joint position reproduction (Rombaut et al., 2010), (Erande et al., 2010 unpublished study) and that at least five repetitions are needed to achieve stable data for joint position reproduction (Allison and Fukushima, 2003; Selfe et al., 2006).

Some of the above techniques have detected proprioceptive differences between healthy knee joints and those with osteoarthritis (OA) (Bennell et al., 2003; Shakoor et al., 2008) and those with anterior cruciate ligament (ACL) deficiency (Corrigan et al., 1992). The rationale for linking patellofemoral pain syndrome (PPFS) and proprioception deficit developed as a result of histological analyses of the lateral retinacula of subjects with PPFS (Sanchis- Alfonso et al., 1999). The discovery of diffuse small nerve damage and neuromata within the retinaculum was thought to originate from the tension and pressure of the mal-aligned patellofemoral joint; the resultant altered proprioceptive input may cause sudden patellar instability resulting in PPFS. On this basis, both proprioception training and patellar taping were recommended in patients with PPFS to correct the problem (Sanchis- Alfonso and Rosello- Sastre, 2000).

Subsequently, two studies have confirmed the association between abnormal proprioception and PPFS by finding differences in the proprioceptive status of patients with PPFS and healthy subjects (Baker et al., 2002; Callaghan et al., 2008) and differences between symptomatic and asymptomatic knees with PPFS (Baker et al., 2002). This indicates that motor control and proprioception techniques should be considered as treatment approaches for PPFS in addition to biomechanical and physiological strategies. The improvement in proprioception status after a training programme in healthy, athletic subjects may be important in preventing neuromuscular injury (Panicis et al., 2008) but as yet it is unclear whether proprioception exercises can prevent PPFS. Furthermore, it has been noted using active and passive joint position reproduction, that not all patients with PPFS have poor proprioception. This implies that there may be a sub-group of patients who have both PPFS and poor proprioception (Callaghan et al., 2008); which is cause and which is effect remains uncertain until prospective studies are undertaken.

Proprioception testing has been used as an outcome measure to monitor therapy. This has shown an association between symptom changes and proprioception status after treatment with patellar
braces (Van Tiggelen et al., 2004), patellar taping (Callaghan et al., 2008) and exercise training programmes (Panics et al., 2008).

These results indicate that there may be other more subtle mechanisms at work through skin, tendon and muscle stimulation to account for the improvement of a joint position task.

Proof of these subtle mechanisms can be found by functional Magnetic Resonance Imaging (fMRI) which provides an opportunity to examine brain activity in areas associated with proprioception, co-ordination and motor control (Callaghan et al., 2010). The fMRI technique has also been able to show during a proprioception task an increase in brain activation in the cerebellum and decreased activation in the supplementary motor cortex. Tape applied across the patellar without any intended patellar displacement or realignment during a proprioception task caused the primary sensorimotor and supplementary motor cortices to have significantly increased bilateral activity whereas the primary sensorimotor cortex had decreased activity (see Fig. 1).

The results seem to suggest that taping can have a subtle, non-mechanical effect on the knee by affecting the areas of the brain concerned with co-ordination, decision making and motor control.

There are several key messages:

- There are a variety of methods to test for proprioception status; there is no consensus as to the most reliable or valid.
- There are differences in proprioception testing using joint position reproduction between healthy knees and those with PFPS.
- Joint position reproduction can demonstrate an association between symptom changes and proprioception. This can be improved with taping and is not necessarily due to biomechanical reasons.

References


