

Society of Orthopaedic Medicine

Summary of literature reviewed April - June 2007

Debbie Cox

Gombatto, Collins, Sahrman, Engsborg, Van Dillen (2007). Patterns of lumbar region movement during trunk lateral bending in 2 subgroups of people with low back pain. Physical Therapy 87 (4) p 441-54 PMID17374634 (Trial)

The background to this study gives a description of the movement system impairment (MSI) means of classifying low back pain. This system is based on different low back pain sub groups demonstrating different movement patterns during clinical testing. This system allows examination of potential mechanisms underlying different low back pain (lbp) problems and provides a basis for classification specific interventions.

MSI is based on the kinesiopathologic model that musculoskeletal back pain develops when movements and alignments are repeated in the same direction across daily activities.

This system classifies the direction of movement and alignment that appears to be associated with symptoms into 1 of 5 subgroups, lumbar flexion, extension, rotation, rotation with flexion and rotation with extension

This study used instrumented measures (6 camera 3 dimensional motion measurement system) to examine the validity of the clinical observation that lumbar movement patterns during trunk lateral bending are different between the 2 lbp subgroups of rotation and rotation with extension

44 subjects with chronic or recurrent lbp were recruited. Subjects all participated in sport that involved lumbar pelvic rotation at least 2x a week and that aggravated symptoms. 75% of subjects were classified as rotation with extension and 25% as rotation.

Self reported outcome measures of demographic and low back pain history questionnaire, numerical rating scale of symptoms, Oswestry disability questionnaire; a racquet sports activity questionnaire and Baecke habitual activity questionnaire were also used.

Clinical examination consisted of a series of test movements for which a judgement was made as to whether lumbar movement pattern or alignment was different from an operationally defined standard and lbp symptoms were monitored

The rotation with extension group displayed an asymmetric movement pattern during trunk lateral bending the rotation group displayed a symmetric pattern. Equal proportions of subjects in the 2 groups reported an increase in pain during the test movement. There were also differences in end range motion between the 2 groups.

Asymmetry occurred early in the rotation with extension sub group and may be an important factor in pain production in this group. Functional activities are commonly performed in early to middle ranges and this could contribute to an accumulation of tissue stress on daily activities resulting in micro trauma and lbp symptoms. The rotation with extension sub group displayed more asymmetry than the rotation sub

group in trunk lateral bending. Differences in movement patterns between subgroups may suggest different mechanisms underlying pain production.

Reasons for differences in movement strategies between groups have not been identified. Suggestions are, motor control factors such as altered timing in trunk muscle activation, biomechanical factors such as passive tissue stiffness or end range extensibility as a result of micro trauma similar to the concept of neutral zone changes. Understanding the factors responsible for differing movement patterns in lbp patients may help establish effective classification and treatment methods

The authors suggest there is a need to examine specific movement patterns in an individual patient that may be related to lbp and to use specific physiotherapy interventions to modify movement patterns. Patterns demonstrated in sub groups of lbp patients could be used to guide selection of appropriate interventions for particular groups of patients.

Potential sources of error in this study acknowledged by the authors are unequal distribution of men and women between sub groups, higher Oswestry scores in the rotation with extension group, smaller number of subjects in the rotation sub group. These differences were not found to contribute to the differences in movement pattern between the 2 groups on analysis.

Further possible sources of error were the testing of kinematic measure for reliability on a non back pain population and movement artefacts associated with the type of skin markers used.

All subjects in this study participated in rotation related sport these findings may therefore not be generalisable to the whole lbp population.

Cleland, Glynn, Whitman, Eberhart, Macdonald, Childs (2007). Short term effects of thrust versus no thrust mobilization/manipulation directed at the thoracic spine in patients with neck pain: a randomised controlled trial. Physical Therapy 87(4) p 431-40 PMID 17341509

Thoracic spine manual therapy has been suggested as treatment for neck pain. This study compared the effect of thoracic thrust manipulation with non thrust mobilisation in patients with mechanical neck pain. Also frequency, type and duration of side effects were compared between groups

A power calculation was done to determine sample size and 60 patients aged 18-60 with mechanical neck pain were recruited from consecutive patients referred to outpatient orthopaedic physical therapy clinics in America over a 13 month period. Subjects were randomly assigned to treatment with thrust or non thrust technique and given cervical mobilisation exercises to carry out. The proportion of subjects receiving workers compensation was higher in the thrust group.

The primary outcome measure was neck disability index (NDI). Secondary outcome measures were numerical pain rating scale (NPRS) and global rating of change scale

(GROC). Self reported measures of pain diagram and fear avoidance beliefs questionnaire (FABQ) were also used.

NDI & NPRS were repeated 2-4 days after initial examination in addition to GROC and an additional questionnaire regarding time of onset, duration, nature and severity of side effects.

Intention to treat analysis was carried out with subjects analysed in the group to which they were allocated. Subjects in the thrust group exhibited greater reduction in disability and pain. They also had higher GROC scores. Reported side effects in both groups were aggravation of symptoms, muscle spasm and headache in addition the non thrust group reported neck stiffness and radiating symptoms beginning within 24 hrs of interventions and lasting 24hrs or less and described as mild in severity. No serious complications were reported

The authors acknowledge this study to have weaknesses,

- Lack of long term follow up
- The standardised treatment program used may not be generalisable to other mobilisation or manipulation techniques.
- It was not possible to blind the clinician or patient to the technique being delivered

The authors conclude that thoracic spine thrust mobilisation gives greater short term reductions in pain and disability than does thoracic non thrust mobilisation in subjects with neck pain.

Falla, Jull, Russell, Vicenzino, Hodges (2007) Effect of neck exercise on sitting posture in patients with chronic neck pain. Physical therapy 87 (4) p 408-17 PMID 17341512 (Trial)

The background to this study is the implication of poor sitting posture in the development of chronic neck pain. It compares cervical and thoracic sitting posture during a computer task in subjects with chronic neck pain and controls. The effect of 2 different exercise regimes on the ability of subjects with chronic neck pain to maintain an upright cervical and thoracic posture during the task was also assessed.

58 subjects with chronic neck pain assessed as none severe with the neck disability index (NDI) and 10 controls were recruited. Changes in cervical and thoracic upright posture during a computer task were measured. Neck pain subjects were randomised into 1 of 2 exercise intervention groups. A group that received training of the craniocervical flexor muscles or a group that received endurance-strength training of the cervical flexor muscles.

Neck pain subjects demonstrated a more forward flexed head posture throughout the duration of the task not shown in the control group. Following the exercises the craniocervical flexor training group demonstrated a reduction in postural change throughout the computer task.

Chronic neck pain patients have a reduced ability to maintain an upright posture when distracted. Following craniocervical flexor training ability to maintain neutral cervical posture during the same task is improved.

Witvrouw, Mahieu, Roosen, McNair (2007) The role of stretching in tendon injuries. British journal sports medicine. 41 (4) p 224-6 PMID 17261561 review.

This paper gives a useful revision and overview of the structure and function of musculotendon units. It summarises briefly the evidence for the role of eccentric and ballistic stretching exercises in the rehabilitation and prevention of tendon injuries. It may be necessary to refer to some of the original papers quoted for a more detailed account of the evidence from which conclusions are drawn.

The majority of studies measure the compliance of the whole muscle-tendon unit few have examined the effect on tendons. Dynamometer measurements, combined with ultrasonography can give an appreciation of stretch within human tendons. Static and ballistic stretching has shown different effects on passive resistive torque and tendon stiffness. There are no clear reasons for this, but it may be related to the effect of stretching on the contractile elements versus the tendon

Tendon has two functions, tensile force transmission, and storage and release of elastic energy during locomotion. Storage and release being particularly important in some sports and activities.

The elasticity of tendon structures influences the amount of energy it is able to store. Prevention and rehabilitation programmes for tendon injuries should therefore aim to increase tendon elasticity. Ballistic stretching has been shown to significantly increase tendon elasticity.

The authors recommend future research should examine tendon stiffness after an eccentric programme, and should evaluate the beneficial effect of ballistic stretching in an eccentric training programme, and in the prevention and rehabilitation of tendon injuries.

Van den Bekerom and Raven (2007) The distal fascicle of the anterior tibiofibular ligament (AITFL) as a cause of tibiotalar impingement syndrome: a current concepts review. Knee surgery, sports traumatology, arthroscopy 15 (4) PMID 17237964 (review)

Anterolateral impingement is rare occurring in only 3% of ankle sprains. There are 3 possible causes, meniscoid lesion, synovitis and impingement of the distal fascicle of the AITFL. This article reviews the anatomy, pathogenesis, symptoms and treatment of AITFL impingement. Most studies reviewed in this article were in vitro therefore not accounting for the effects of muscle tone and weight bearing.

The tibiofibular syndesmosis is established by 3 ligaments, the interosseous ligament, the posterior inferior tibiofibular ligament and AITFL which is the weakest. A separate distal fascicle of the AITFL is a normal finding in some people.

Post traumatic anterolateral laxity following injured anterior talo fibular ligament (ATFL) may result in anterior extrusion of the talar dome in dorsiflexion resulting in AITFL impingement. The AITFL can also vary in width, length and obliquity. Longer, wider fascicles or fibular insertion far from the joint increasing the likelihood of impingement.

Following ATFL injury the normal posterior shift of the talus during dorsiflexion may not occur. This results in the talus staying in contact with the AITFL bending the fascicle. Anteroposterior laxity of the ankle particularly in dorsiflexion may also increase. Contact between the accessory fascicle and the talus has also been observed during eversion of the foot. Contact between the AITFL and an abraded area of articular cartilage of the talus has been observed at arthroscopy. However some contact between the anterolateral corner of the talus and the ATFL can be normal.

Diagnosis of AITFL impingement is made in the presence of chronic ankle pain in the anterolateral aspect of the ankle following inversion injury. The ankle must be stable with normal x-rays and point tenderness on the anterolateral aspect of the talar dome and AITFL. There may be an audible popping sensation and aggravation of pain with dorsiflexion and eversion and/or pain at the beginning of plantarflexion/inversion. In patients with both impingement and instability it may be impossible to distinguish the source of the pain.

Differential diagnoses for continuing lateral ankle pain following inversion injury include osteochondral fracture, lateral instability, ruptured peroneal tendon, synovitis and ligamentous impingement of the anterior aspect of the ankle which is uncommon.

6 months of conservative treatment is advised before surgery is considered which can include arthroscopic debridement of the soft tissue lesion, debridement of abraded articular cartilage on the talar dome, excision of soft tissue overgrowth and osteophytes and resection of the distal fascicle of the AITFL

Chang, Chang, Chien, Chung, Hsu (2007) Effectiveness of two forms of feedback on training a joint mobilisation skill by using a joint translation simulator. Physical therapy 87 (4) p 418-30 PMID 17341511 (RCT)

High levels of inter-therapist variability in the amount of force delivered during joint mobilisation techniques have been reported and has been attributed to differences in perceptions of initial and final resistance during mobilisation procedures. Despite this there has been very little published data on the magnitude of applied external force during joint mobilisation. There is no consensus in the literature as to where in the load- displacement curve initial and final resistance occur during passive movement testing.

Accurate perception of tissue resistances is a motor skill that must be developed in order to carry out safe and effective joint and soft tissue mobilisation. These skills are most frequently learned via instructor demonstration and students practicing on each other. The nature of feedback associated with this method is subjective, delayed, qualitative and verbal. Assessment is commonly carried out by both immediate and delayed retention tests after time spent learning and practicing the skill.

Previous studies have demonstrated augmented, quantitative feedback is helpful in motor skill acquisition. This study investigated whether quantitative feedback enhanced the learning of joint mobilisation techniques. A joint translation simulator was used to compare the effects of concurrent and terminal feedback.

36 undergraduate physiotherapists were randomly assigned to no feedback (control), concurrent feedback and terminal feedback groups. No indication is given in the report of the randomisation procedure used.

The simulator used provided resistance based on data for glenohumeral joint specimens. Subjects were instructed to provide a specific grade of force and were given quantitative graphic feedback via a monitor on their applied force either during (concurrent feedback group) or after (terminal feedback group) the trial.

A full description of the joint translation simulator, glenohumeral joint values used and how it was set up individually for each subject along with a full description of the mobilisation technique the subjects were instructed to carry out is given in the article

Assessments were made during learning (skill acquisition) and of skill retention 10 minutes and 5 days after the skill acquisition phase. A full description of statistical analysis is given.

The concurrent feedback group appeared more accurate during early skill acquisition. Both feedback groups performed more accurately than the control group but one feedback group did not appear to be overall superior to another

Feedback groups had less variability and were more consistent than the control group. Feedback facilitates achievement of the task by providing information to help the student determine if they are performing the skill correctly. It can also help motivate by comparing performance to the goal they are trying to achieve. In this study quantitative augmented feedback demonstrated an immediate guiding effect and enhanced technique learning during the skill acquisition phase.

Students in this study initially tended to overestimate the levels of force required. Training students to accurately gauge initial and final resistance in this way may help them deliver safe effective manual therapy. They will as a result use grading that is consistent with the load –displacement curve. However the authors acknowledge this does not necessarily have influence the treatment outcomes of interventions delivered.

In addition a simulator does not allow for changes in load displacement behaviour that occurs in tissues subjected to repeated mobilisations, or for differing responses in the presence of pathology, pain, inflammation or muscle spasm.

September, Schwelanus, Collins (2007) Tendon and ligament injuries: the genetic component. British journal of sports medicine 41 (4) p 241-6 PMID 17261551 (review)

Recent studies have suggested there may be a genetic component to tendon and ligament injuries. If specific genotypes associated with increased risk of injury to specific tendons and ligaments can be identified then strategies can be implemented to prevent injuries in individuals at higher risk. This article summarises the evidence for a genetic component in achilles tendon, rotator cuff and anterior cruciate ligament injuries.

Variants of genes which have an important role in regulating collagen fibre assembly, fibre diameters and regulation of tissue response to mechanical load have been shown to be associated with Achilles tendinopathies and Achilles tendon ruptures. The article gives a lot of detail regarding the specific genes involved and their precise functions.

There exists a spectrum of connective tissue disorders with a genetic component. One end being disorders with major health implications (osteogenesis imperfecta, Ehlers–Danlos syndrome, Marfan’s syndrome) where genetic factors are the major determinants of severity and prognosis. At the other end are complex, multifactorial conditions development of which is determined by complex interactions between genes and the environment. The identification of the genes predisposing an individual to an increased risk of developing a multifactorial condition is more difficult.

Achilles tendon injuries

ABO blood grouping has been investigated as a biochemical marker for injuries to the Achilles tendon, and to a lesser extent other tendons and ligaments. Blood group O or the A/O ratio appears to be associated with Achilles tendon ruptures and Achilles peritendinitis in some studies. An association with ruptures of biceps long head, extensor pollicis longus and quadriceps has also been shown. The literature regarding ABO blood grouping as a predisposing factor to Achilles tendon injury is inconclusive as in some populations no association has been found.

Variations in genes that encode structural proteins including various types of collagen, proteoglycans and glycoproteins may be involved in Achilles tendon injuries. Glycoprotein involved in the regulation of cell–matrix interactions and assembly of collagen fibres is found in tendon tissue and can be affected by such genetic variations.

Connective tissues such as tendons are predominantly made up of extracellular matrix, the synthesis, degradation and maintenance of which depend on the presence of cells within it. A continuous remodelling process maintains tendon health. Genes encoding proteins involved in the biological processes associated with remodelling may also be involved in the process of injury but no link has yet been demonstrated. This may therefore be a direction for future research.

The authors summarise the aetiology of Achilles tendon injuries is multifactorial, and it is therefore important that future studies investigate the interactions of the different intrinsic and extrinsic risk factors eg environmental factors, body weight, exposure to physical activity.

Rotator cuff and ACL tears

Studies providing evidence relating to a genetic component in rotator cuff and ACL injuries have been based on information collected from patients, siblings and matched controls.

Relative to a control group siblings have more than twice the risk of developing rotator cuff tears and nearly five times the risk of experiencing symptoms. Patients with an ACL tear are twice as likely to have a relative with an ACL tear and more than twice as likely to have a first-degree relative with an ACL tear.

No association has been found between the ABO blood groups and rotator cuff impingement or ACL ruptures.

Paesold, Nerlich, Boos (2007) Biological treatment strategies for disc degeneration: potentials and shortcomings. European spine journal 16 (4) p 447-68 PMID 16983559 (review)

Treatment modalities using cell-based tissue replacements, genetic modifications or a combination to affect biological repair are starting to be applied in the field of musculoskeletal medicine. Clinical trials of gene therapy for rheumatoid arthritis, orthopaedic bone and soft tissue tumours, muscular dystrophy, haemophilia and osteogenesis imperfecta have already taken place. Application of such techniques to intervertebral disc degeneration is in its very early stages.

Lumbar intervertebral discs undergo very extensive destructive changes with age however difficulties arise when trying to differentiate normal from pathological degeneration. The intervertebral disc has been cited as a predominant source of LBP because extensive destructive changes eventually lead to an ankylosed motion segment.

This article contains a good revision and summary of lumbar disc anatomy and physiology. The nucleus pulposus of degenerated discs has a decreased water and proteoglycan content and the gel-like appearance is lost with replacement by fibrocartilaginous tissue. There is a consequent reduction in disc hydrostatic properties and flexibility. Cell proliferation has been observed in the nucleus with lacunae formation containing multi-cell clusters half of which show signs of necrosis and some of apoptosis (programmed cell death) the result is cell loss from the disc.

Degenerative changes of the annulus fibrosus are less obvious, but result in irregular lamellae with the collagen and elastin networks becoming more disorganized with cleft and fissure formation.

Neo-vascularization of the inner portions of the disc has also been described possibly accompanied by nerve fibres; however, it is not completely clear at which stage of degeneration neo-vascularization occurs. This is an important area for future research as the interplay between neo-vascularization and neo-innervation could be of relevance regarding pain sensation in degenerate discs.

The link between mechanical load and disc degeneration is controversial. Animal studies suggest mechanical load can induce disc degeneration. Human studies have failed to prove a strong causal link between occupational exposures and disc degeneration. The mechanism involved must therefore be more complex. However injuries do occur when normal forces are applied to abnormally weak tissues, or when abnormally high forces are applied to normal tissues.

A strong familial predisposition for disc degeneration has been demonstrated, twin studies have shown heritability between 52 and 74% for lumbar disc disease. Genetic variations (polymorphisms) identified affect encoding for proteins of the extracellular matrix that influence integrity and stability. Disc cells have the potential to produce the inflammatory cytokines necessary to mediate and propagate an inflammatory reaction. Polymorphisms in the gene encoding for the pro-inflammatory cytokine have been associated with an increased risk of disc bulges and degenerative changes in the disc. They may also be involved in pain production in degeneration associated low back-pain. Variations in matrix degrading enzymes have also been identified

The intervertebral disc is the largest avascular tissue in the human body. A large extracellular matrix requires maintenance from a relatively fragile nutrient supply. The outer annulus may be supplied with nutrients from blood vessels in the adjacent longitudinal ligaments; the supply of the nucleus pulposus cells is almost completely dependent on diffusion via the vertebral end plate capillary network. With degeneration cartilaginous endplates become calcified and nutrient supply is even more restricted. Removal of metabolic waste, i.e. lactic acid is also affected and accumulation results in a lowered pH inside the disc. Low oxygen concentrations combined with acidic pH significantly affect proteoglycan synthesis rates leading to a fall in proteoglycan content and disc degeneration. Disorganization of disc matrix is a prevalent feature of disc degeneration.

Nerve growth factor (NGF) has been identified exclusively in painful discs compared to non-painful discs. It is possible that in addition to neo-vascularization, neo-innervation may occur in degenerate discs. As it only appears to occur in painful discs then it is a possible mechanism of pain production in painful degenerate discs. Direct treatment to inhibit the action of NGF may therefore be a possibility.

Biological treatment strategies aim to deliver biologically active factors to the disc that drive regeneration or prevent degeneration these could include,

- Direct injection of an active substance into the intervertebral disc matrix.
- Direct gene therapy where resident cells are genetically modified in situ to express beneficial genes
- Indirect gene therapy where genetically modified cultivated cells are then implanted into degenerate disc.
- Augmentation of degenerated intervertebral discs by implantation of bone-derived stem cells.

Technical difficulties arise due to the short-term effect of injected substances as they are metabolised. Pharmacological slow-release systems require further investigation.

In summary intervertebral discs are highly specialized and undergo massive alterations during degeneration. For normal function a mechanically stable structure with a highly specialized matrix is required. Poor nutrient supply in the adult disc contributes to disc cells having difficulty maintaining the matrix. A combination of mechanical stress and nutrient restriction creates a hostile environment where death of matrix maintaining cells results in matrix disorganisation. The clinical application of gene therapy and tissue engineering techniques to regenerate intervertebral discs is a long way off. Therapies targeting pro-inflammatory signalling pathways transforming a symptomatic to an asymptomatic disc are a little nearer

LLopis and Padron (2007) Anterior knee pain. European journal radiology 62 (1) p 27-43 PMID 17350782 (review)

It is worth looking at the original article to view good examples of imaging particularly magnetic resonance imaging (MRI) of lesions responsible for anterior knee pain. This is a descriptive article of imaging findings that can be useful in the diagnosis and management of anterior knee pain.

In anterior cruciate (ACL) and posterior cruciate (PCL) rupture treated both surgically and conservatively cartilage degeneration can be seen and most commonly occurs at the articular surface of the medial femoral condyle in ACL deficiency. It is most likely due to ACL deficiency leading to posterior tibial translation and increased pressure over the anteromedial compartment.

Causes of anterior knee pain post ACL reconstruction that can be identified with imaging are,

- Arthrofibrosis, a contracture of retro patellar fat pad and patellar tendon.
- Cyclops lesion, bone and/or fibrous tissue lying anterior to the anterior cruciate ligament graft in the tibial tunnel.
- Infrapatellar contraction syndrome, a fibrous hyperplasia in the peripatellar tissues

Bipartite patellar is a normal asymptomatic variant and often bilateral it can occasionally become painful due to overuse or acute injury. The most common location of bipartite patella is in the superolateral corner at the insertion of the vastus lateralis, and is also the commonest site of symptoms. On X-ray corticated margins help to differentiate bipartite patellar from patellar fracture.

NB Patellar sleeve avulsion fracture is a rare but important lesion in children where the unossified inferior pole plus a small amount of bone is avulsed along with a sleeve of retro patellar articular cartilage and periosteum.

Stress fractures of the patella are rare and occur predominately at the junction of the middle and distal one third of the patella. Initial radiographs can be normal, more chronic cases show sclerotic edges.

Chondromalacia is softening of articular cartilage. MRI provides excellent soft tissue differentiation and shows internal cartilage structure, surface defects and underlying bone marrow oedema. Cartilage lesions can be classified using MRI,

- Subchondral injuries have intact cartilage surface
- Osteochondral fractures have disrupted cartilage surface with cortical bone
- Pure chondral injuries where underlying subchondral bone is intact.

Detached or displaced chondral surface flaps along with cartilage thinning can also be seen.

Osteochondritis dissecans commonly occurs in the femoral sulcus at the inner aspect of the medial condyle, but can also appear in the patella. MRI enables diagnosis of the cartilage lesion and fragment stability to be diagnosed using the following grading system,

- Stage 1. Stable lesion in continuity with the host bone, covered by intact cartilage
- Stage 2. Partial discontinuity of the lesion, stable on probing
- Stage 3. Complete discontinuity of the lesion but fragment is not dislocated
- Stage 4. Dislocated fragment

For patellar tendinopathy imaging assessment can be performed with plain films, ultrasound (US) and MRI. On plain films dystrophic calcifications within the tendon and fragmentation of the tendon's insertion due to repetitive traction can be seen as Sinding–Larsen–Johansson disease, at the inferior patellar pole or Osgood Schlatter's disease at the proximal tibial tubercle. US and MRI give morphological internal information about the tendon. However morphological changes on imaging do not always correlate to clinical complaints, imaging findings being demonstrated in asymptomatic athletes.

Characteristic US features in patellar tendinopathy are focal or diffuse hypoechogenicity which may represent dystrophic ossification, tendon thickening and irregularity at insertions (patellar or tibial) and swelling of the surrounding tendon and structures.

Colour Doppler US examination frequently reveals neovascularization in chronic painful patellar tendinopathy in the deep posterior portion of the patellar tendon, adjacent to the lower pole of the patella in the classical distribution of injury at the osteotendinous junction.

Hoffa's or infra patellar fat pad is an intraarticular, but extrasynovial structure, richly vascularized and innervated and can be a cause of anterior knee pain inferior to the pole of the patella.. It can become painful in association with patellar tendinopathy, ligament reconstruction, meniscus tear or malalignment. It can hypertrophy and become inflamed due to impingement between the femoral condyles and tibial plateau during knee extension. On imaging bowing of the patellar tendon from the mass of the fat pad is seen. Fibrous tissue transforming into fibrocartilaginous tissue can be seen which occasionally can ossify. Isolated Hoffa's fat pad oedema is significantly associated with trochlear abnormalities.

The most common form of patellar malalignment is rotational with the patella tilted lateral side down. Patella alta or baja, and abnormal position of the tibial tuberosity are other forms of patellar malalignment. Alignment problems can be identified by measurements obtained from the axial or sunrise view (also known as skyline view)

on radiographs, from the axial CT plane and from the lateral radiographs of the knee. Measurements taken from images and used to help diagnose alignment problems include Q angle, tibial tubercle-trochlea groove distance sulcus angle (angle between femoral condyles a measure of trochlear depth), congruence angle, the lateral patellofemoral angle and the lateral patellar displacement.

Synovial plica is a redundant fold in the synovial lining of the knee present in 60–80% of the population and most commonly located as infrapatellar (ligamentum mucosum), suprapatellar and mediopatellar plica. Injury to the plica leads to inflammation, fibrosis, tissue proliferation and tensile changes in the plica. This process can alter joint mechanics and lead to further knee pathology. On MRI, plicae appear as lineal low signal intensity structures surrounded by joint fluid.

In iliotibial band syndrome MRI shows significant thickening of the iliotibial band over the lateral femoral condyle, a small bursa deep to the iliotibial band in the region of the lateral condyle may also be seen along with oedema in the surrounding structures.

There is a high prevalence of associated findings on imaging that require clinical correlation in order to instigate appropriate management. These include pathological enthesial conditions such as bone or chondral avulsion, bone marrow oedema or chronic enthesopathic changes, cortical remodelling, cortical defects or subcortical cysts. Peritendinous findings are also frequent and include peritendinous irregularity with oedema, oedema within the pre-patellar or Hoffa fat pad. Other associated findings include retinacular tears and chondromalacia.

Heijne and Werner (2007) Early versus late start of open kinetic chain (OKC) quadriceps exercises after ACL reconstruction with patellar tendon or hamstring grafts: a prospective randomized outcome study. Knee surgery Sports traumatology arthroscopy 15 (4) p402-14 PMID 17219226 (clinical trial)

There is no evidence regarding whether rehabilitation protocols for ACL reconstruction should be specific to type of graft used. The aim of this study was to evaluate the clinical outcome with early (4th post op week) versus late (12th post op week) start of OKC exercises for the quads in patients with either patellar or hamstring tendon grafts.

In patients with patellar tendon graft there was no difference in anterior knee laxity between those patients who commencing early OKC quadriceps exercises compared with those who started OKC exercises later.

In patients with hamstring tendon graft early start of OKC quadriceps exercises was associated with a significant increase in anterior knee laxity when compared to subjects initiating OKC quadriceps exercises later and to patients reconstructed with patellar tendon graft.

No postoperative laxity values were measured directly after the surgical procedure therefore the influence of surgery on anterior knee laxity was not known and is a potential limitation of the study.

The differences in anterior knee laxity were small and may not necessarily be clinically relevant. However in sports where high precision and knee stability is important, even a small increase in anterior knee laxity may be significant. A more positive pivot shift in the early quadriceps training group was also noted.

Early introduction of OKC exercises for quadriceps did not increase quadriceps muscle torques for either patellar tendon or hamstring tendon graft patients. When comparing quadriceps strength between the 2 graft types the hamstring tendon group was significantly stronger than that of the patellar tendon group most likely due to damage associated with harvesting of the patellar tendon graft interfering with quadriceps function.

No difference in anterior knee pain between patients operated with patellar tendon or hamstring tendon grafts was found using a validated anterior knee pain score.

Hamstring ACL reconstructed knees with early start of OKC quadriceps exercises showed significantly greater side-to-side differences in anterior knee laxity when compared with patellar tendon ACL reconstructed knees.

The authors conclude early start of OKC quadriceps exercises after hamstring graft ACL reconstruction resulted in significantly increased anterior knee laxity in comparison with both late start and with early and late start after patellar tendon graft ACL reconstruction. Also early introduction of OKC exercises for quadriceps did not influence quadriceps muscle torques regardless of graft type. It appeared as if the choice of graft affected the strength of the specific muscle more than the type of exercises performed. In the light of these findings the authors suggest rehabilitation for patients with hamstring graft ACL reconstructed knees should not include early start of OKC exercises for quadriceps. However this study was not able to determine the appropriate time for starting OKC quadriceps exercises for patients who have undergone ACL reconstruction with hamstring tendon graft.