SPORT
MEDICINE MANUAL

11

PRINCIPLES OF REHABILITATION

PRINCIPLES AND METHODS OF REHABILITATION

11

A. Introduction

There can be different approaches to successfully treating musculoskeletal injuries in the athlete. While the professional approach may vary, consistent rehabilitation concepts can be utilized to capitalize on specific training regimes, promote recovery of the injured region, and minimize the consequences of the injury.

Through an assessment, the clinician develops a rehabilitation plan that includes the mechanism of injury, an appreciation of factors that would perpetuate the problems, and a framework of the functional anatomy. In short, the clinician is developing a plan to guide the recovery process.

Manual therapy techniques, such as massage, articular mobilisations, and assisted stretching, can be introduced in situations where the clinician has specific training. Other rehabilitation techniques, such as electromodalities, may have clinical, empirical, or scientific support in the specific case.

Part of the emphasis in athletic conditioning should be on preventing injuries (eg. strengthening, flexibility, and massage) so that the need for rehabilitation is diminished.

During rehabilitation, specific exercise schedules focusing on range of motion, muscle function, and performance characteristics are introduced and gradually intensified according to the estimated exercise tolerance of the injured region. The maintenance of cardio-respiratory fitness and that of uninjured regions is addressed during recovery. Drills to maintain performance skills without aggravating the injury have become an accepted component of rehabilitation.

In addition to the knowledgeable evaluation of the athlete and the skilful application of rehabilitation techniques, there are interpersonal aspects of rehabilitation that can influence the degree of success. Injury and rehabilitation are both physically and emotionally demanding for the athlete. The athlete's personal response to injury can be complicated by the reactions of teammates, coaches, medical staff, and media.

Psychosocial Issues

The team often fulfils a social need for the individual. Athletes need to determine if they want to remain close or distant to the team during rehabilitation. Some athletes benefit from working in parallel to teammates and having their encouragement. (see Unit 14 - Psychology, section D).

Physical exertion fulfils a psychological need for many individuals, so a sudden decrease in exercise immediately changes the emotional well being of the athlete. Alternative activities may fill this void in addition to improving upon technical and physical needs.

The external and internal drives to succeed need to be redirected into the rehabilitation process. The athlete's emotional levels may correlate with his or her perception of progress in rehabilitation, and the frustration level of not being able to pursue his/her goals. Therefore, if short-term goals are met, the patient feels "in control" of the environment which reinforces success and self-confidence.

Education

Each person working with the athlete has the opportunity to become an educator. The goals of education include patient compliance, and effective application of a self-directed exercise protocol. The knowledgeable athlete can communicate more readily and perhaps achieve a higher quality in their rehabilitation programme.

In the role as educator, the clinician must be an active listener to the athlete. Information can be exchanged to enhance the process. The education process enables the athlete to have confidence and trust in the health care professional.

Often rehabilitation programmes are very complex, involving numerous exercises and treatments. Written material might be the only way for the athlete to remember it all.

Informed consent by the athlete in the treatment process is an educational imperative. The athlete should be aware of risks and benefits with regards to treatment and return to competition.

Teamwork

Any time an athlete is injured, there might be one or several professionals involved in the athlete's care and coaching. Regardless of their profession, there should be collaboration amongst all regarding the progress of the athlete. Ideally, this would involve communication with the athlete, health care professionals, and the coaching staff. However, disclosure of confidential patient information should be handled within the ethical guidelines of each profession.

If potential conflict, duplication or insufficiency exists, designation of roles is achieved by communication. Contradictory information, and lack of coordination of rehabilitation are two common complaints of athletes.

At times, one needs to reinforce the athlete's responsibilities in the rehabilitation team: he/she must demonstrate commitment, compliance and communication.

B. Common Modalities Used In Rehabilitation

a. Massage

Massage is an age-old process that involves stimulation of the tissues by means of rhythmically applying both pressure and stretching. Pressure compresses the soft tissues whereas stretching applies tension to it. The application of massage to fatigued, aching, stiff muscles to enhance recovery has been used for many centuries.

There are five general massage treatment techniques. They can be summarized as follows:

i. Effleurage - a very light massage is administered with the flat of the hand and fingers. A deeper stroking utilizing the same technique can also be used.

ii. Petrissage - this involves kneading, grasping, then compressing, rolling and squeezing the muscle tissue.

iii. Tapotement - this technique utilizes percussion movements that are a series of tapping, slapping or hacking movements. Hacking involves the alternating striking of the patient with the edge of the hands.

iv. Vibration - with this technique, the hand is kept in contact with the athlete to produce a trembling, vibratory forward and backward motion.

v. Friction - firm finger pressure is applied to or across the muscles or tendons. This produces a therapeutic movement over a very small area. It is a commonly used technique with lateral epicondylitis and rotator cuff tendonitis. Deep friction massage can also be very effective over trigger points to reduce spasms and over acupressure points.

Massage is contraindicated or performed with extreme care in:

- recent muscle injuries <48 hours (strains or contusions)
- infected regions
- fractures
- acute joint swelling
- unexplained pain; pain with neurological symptoms and signs; extreme pain on touch or movement
- over an open wound, skin rashes, or burns
- bleeding disorders

b. Strengthening

Strength in athletic performance is used to move the athlete, to propel objects, and to provide resistance against external forces.

Athletes tend to concentrate on building strength of the prime movers (the agonist muscles) that are fundamental to their sport. A more appropriate view of strengthening goes beyond the prime mover muscles. Often, the weak links in performance, rehabilitation, and injury are the muscles that are co-activated with the prime muscles to stabilize, to position the segments, and to provide proprioceptive feedback. The co-activated muscles may also have roles in performance. Their injury leads to weakness of the general region affecting the prime agonist muscles.

The injured and non-injured limbs may need to be exercised independently with separate working weights. Specific exercises can decrease the possibility of compensation through use of the stronger side.

Strengthening of muscles results through progressive resistance exercises that can be either static or dynamic.

Isometric (static) exercises are those performed without producing joint motion, and may be the least effective method to increase strength. However, there are some instances when they are the best choice. For certain joints, such as the patellofemoral joint, forces applied through the full range of motion may aggravate a pre-existing condition. The patellofemoral joint is loaded from 90° to 60° of extension and can increase patellofemoral pain because of the compressive load. Exercising the joint through pain, in this example, is contraindicated. The central nervous system responds to the production of pain with this exercise, by sending messages to the muscles in the area to stop working. This is the exact opposite effect of the intention of the exercise. In the early phases of rehabilitation with patellofemoral pain, isometric strengthening of the vastus medialis is indicated. Once the individual can tolerate resistance throughout the full range of motion, dynamic or isotonic exercises can begin.

Isometric exercises are also prescribed for proximal stabilizing muscles. For example, the trunk muscles maintain stability of the spine and position of the trunk as they resist forces on the extremities. Athletes rely heavily on trunk stability during most sports, so there is a trend towards isometric exercise of the abdominal and spinal muscles with external positioning feedback to the athlete. Isometric exercises can also be part of a proprioceptive retraining programme as described below.

Dynamic strengthening occurs when a joint is moved through a range of motion against a resistance, such as with isotonic, isokinetic, and functional strengthening exercises.

- Isotonic exercise consists of both concentric and eccentric work. Concentric exercise occurs when the muscle shortens while performing work. Eccentric exercise occurs when the muscle lengthens while performing work. The demands on the athlete can be categorized according to the mode of contraction because the types of training determine performance gains. In addition, rehabilitation of the athlete depends on incrementally restoring the physical demands of the sport. Eccentric exercise has been consistently linked to injury as discussed in the case histories (ie. Unit 4 C 1. Distal radial fracture case history). Therefore, a programme that builds on the eccentric exercise capacity of the region can help prevent injury.

- Isokinetic exercise employs an accommodating variable resistance where contraction occurs at a constant speed and with variable resistance that matches the force applied. Isokinetic exercise is commonly used to build strength throughout the entire range of motion. Isokinetic training machines (Biodex or Cybex) that are used in rehabilitation can mimic the athlete's motions. For example, a water polo player undergoing shoulder rehabilitation can begin exercising in a lower arm position, but as pain resolves, the exercise position can be moved to imitate throwing.

- Functional exercises can be beneficial in rehabilitation because of the direct relationship of the exercise, under very controlled conditions, to the demands of the sport. The resourcefulness of the clinician and the coach can be challenged by the need to retrain individuals for unique situations. For example, the eccentric contractions found in throwing events can be incrementally trained using elastic cords to provide resistance.

c. Flexibility

Increasing the range of motion through stretching can have a number of beneficial effects for the athlete. Although it is easy to see how long-term flexibility programmes are essential in sports like rhythmic gymnastics, all sports or events benefit from flexibility training. For example, faster runners require more range of motion in the hip and ankle to extend their stride length. Additionally, at the extremes of the range, strength is greatly diminished. So if the athlete is working well within their mid-range, they will be able to exert higher forces compared to a person working at their extreme range.

Lack of flexibility is believed to cause several types of overuse injuries such as strains of the quadriceps and hamstrings muscles, or Achilles tendinosis and the friction syndromes of the iliotibial tract. Inadequate range of motion is believed to increase the compressive forces at anatomical pulleys leading to inflammation.

Lack of flexibility may also lead to postural problems and back pain. A general stretching programme is beneficial to musculoskeletal health, especially in the older athlete. Aging generally decreases flexibility and increases the stiffness of muscles and tendons. In older athletes, the composition of tendon and other connective tissues change at a biochemical level to create thicker cross-linked structures.

Stretching during the warm-up phase of a workout, in addition to increasing range of motion, acclimatizes the musculoskeletal tissues to the motion required for the sport. Warm-up stretching is a mechanism to reduce injuries and improve performance. A warm-up programme consists of light aerobic work to increase circulation and extremity temperature, and a series of stretches (repeated about 5 times each) emphasizing the sport-specific requirements. Generally, the stretches are held between 20 and 30 seconds.

Rehabilitation of an injury generally requires a stretching programme to enhance range of motion. While the tissue is healing, it tends to shorten and the components are not organized in the same manner as normal tissue. The healing tissue reorganizes in response to gentle stresses, including stretching. A flexibility programme during rehabilitation requires more frequent (up to five times a day) periodic exercises throughout the day.

d. Proprioception

Proprioception refers to a sense of joint position. It has generally been used as a term that describes the ability to accurately position the extremities during activity. Proprioception includes postural control, balance and coordination.

Proprioception exercises have been used to improve coordination and activation of the muscles in a specific area. Such proprioception exercises also include methods to improve sensory feedback of the motion. Alteration in proprioception, secondary to injury, may include a subjective sense of weakness (decreased activation), poor coordination as evidenced by poor balance, and altered position sense.

The most studied examples of proprioceptive deficits following injury occur in the lower extremities. Joint mechanoreceptors play a critical role in normal reflex coordination of muscular tone utilized in posture and movement. Injury causes poor position sense as demonstrated in recurrent ankle sprains. For example, a common history includes poorly coordinated landings after jumping for a ball. A goal of rehabilitation includes the proper positioning of the ankle and foot during landing. As well, muscle co-activation should be used to stabilize the ankle.

Variations on pain-free balance exercises can be used to increase muscular activation and restoration of movement patterns. A one-legged standing balance with eyes closed can be a good starting point for the athlete. Soft surfaces can be used to increase the balance challenge, and soft surfaces can be used to practise one-foot landings later on. Wobble boards have been used extensively for rehabilitation of knee and ankle ligament injuries (Figure 11.1). Adding complexity to the balance activity by adding another task produces more reliance on internal feedback mechanisms.

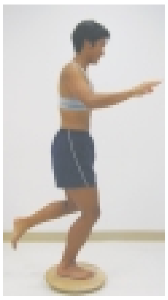

Figure 11.1 Wobble board exercise.

Upper extremity proprioceptive exercises have been developed to facilitate the coordinated motion of the scapular muscles and the muscles that control the glenohumeral joint. Included in this category are exercises that produce weight-bearing through the upper extremity during motion of the shoulder. For example, the athlete may press a basketball very firmly against the wall with the injured side, and then proceed to trace patterns with the basketball.

e. Mobilisations

Clinical specialists have developed a series of techniques that are directed at improving joint motion. In general, joints have translations and rotations of opposing bones. The relationship between the rotations and translations during a functional movement has been described as coupled motion. Often the injured patient cannot perform an exercise that would recover the coupled movements in an articulation. Therefore, clinicians apply forces and torques in prescribed directions to mobilize the joint.

Mobililization is the use of graded oscillatory techniques to increase the range of motion of a joint. A manipulation requires a skillful passive high-velocity, low-amplitude thrust movement of a joint (peripheral or spinal) beyond its physiological limit of motion but inside the limit of its anatomical integrity, with the purpose to restore motion and function. Several professional groups utilize mobilisations and manipulations for the treatment of spinal and peripheral joint problems. The most common side effect of manipulation is a short-term increase in pain, but more significant side effects, such as vertebral artery damage from manipulation of the cervical spine have been described in the literature.

Nerve tissue must freely move within the body and in relationship to its mechanical interfaces. Neural tissue that is sensitized by mechanical or chemical irritation will produce symptoms as a consequence of minor stimuli such as movement or compression. The most vulnerable sites for problems affecting movement of the nervous system are:

- soft tissue and osseous tunnels ie. intervertebral foramen, carpal tunnel, supinator muscle for radial nerve
- nerve branching ie. superficial and deep peroneal nerve, superficial and deep radial nerve
- where the nervous system is relatively fixed ie. peroneal nerve at fibula head, ulnar nerve at elbow, C6, T6, L4

Athletes will describe their pain symptoms in any of the following terms:

- burning
- crawling
- tight/strangling feeling
- dragging/pulling
- tight cord
- vague
- deep

A specialized method of mobilisation that is directed at treating dysfunction of nervous tissue motion is neuromeningeal mobilisation. Mobility of the nervous system and it’s surrounding neuromenigeal tissue can be tested and gently treated by specifically sequencing a series of movements of the spine and limbs in order to bias various branches of the peripheral and central nervous system. The Straight Leg Raise (Lasegue’s Test) is an example of biasing the sciatic nerve. Further testing can be done by several differential tests while the primary test is maintained or the range of motion of the test is decreased to the point of removal of signs and symptoms ie. passive neck flexion; passive internal rotation of the leg; and passive ankle dorsiflexion. Care is required for testing and treatment because the nervous system is very susceptible to further injury when it is inflamed.

f. Taping

The primary goal of taping in the management of sports injury is to provide support and protection to soft tissues while minimizing limitation to function. Taping techniques can play a role in both injury prevention and injury management. Prophylactic techniques focusing on injury prevention may be used to support areas subject to repeated or excessive stresses, or joints that have a previous history of injury. Taping in the early management of sport injury may be used to secure dressings or splints in place, provide protection and/or provide compression.

Taping using an open technique (Figure 11.2) or elastic tape are most appropriate in the early stage. In the later stages of injury management, taping may be used to minimize stress on injured tissues, to optimize healing, and/or to enable the athlete to return to modified or full activity. Because of its properties, elastic tape not only limits unwanted motion, but if correctly applied, provides compressive forces to limit swelling without compromising circulation.

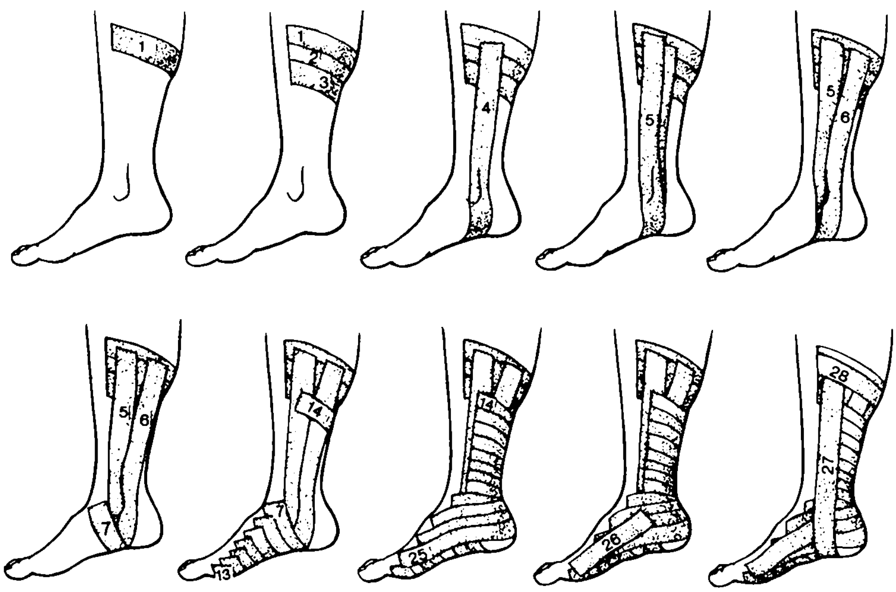

Figure 11.2 Open basketweave ankle technique.

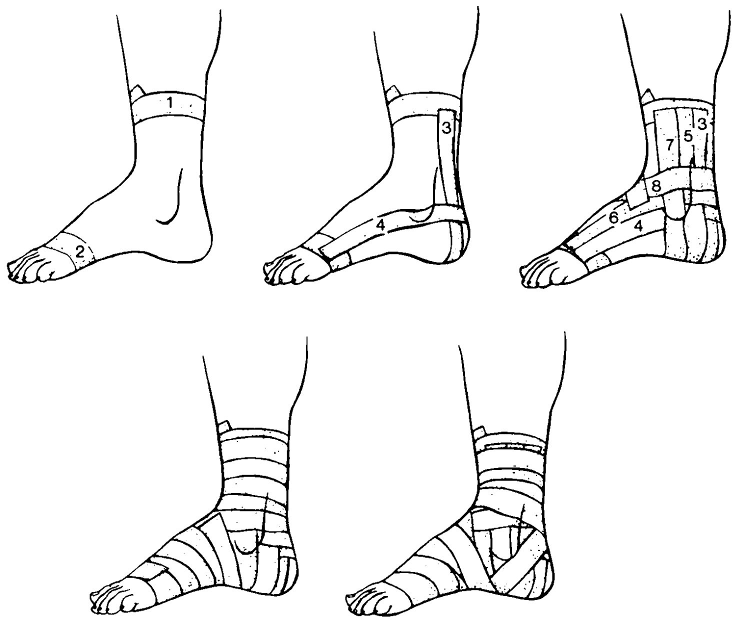

Figure 11.3 Closed basketweave ankle technique.

Taping using a closed technique (Figure 11.3) is often appropriate for return to activity, however, this is not always the case. Some examples of situations requiring caution include:

- whenever further assessment is required
- immediately following an acute injury
- functional disability (ie. limitations in mobility, strength, stability, balance and/or coordination)
- acute swelling
- after cold application
- chronic taping of an athlete pre-puberty (ages 10-14) may adversely affect epiphyseal development
- taping at night may reduce peripheral circulation
- be aware of sport specific guidelines as some sports disallow taping or padding in competition
- if you are unsure or unfamiliar with an athlete's condition or the required taping technique

If the decision has been made to apply a taping technique, the skin should be prepared appropriately. This may include shaving the hair off the area, washing and drying the skin, bandaging cuts or blisters, and spraying the area evenly with a thin layer of skin adherent. Underwrap should only be used in the case of skin breakdown or tape allergy. Areas of potential friction should be covered with a lubricated heel and lace pad. The position of the athlete for any technique should be considered in order to maximize effectiveness. The structure to be taped should be in a position of minimal tension. The athlete should be supported and comfortable at a height appropriate for the taper. Tape removal should be done taking care not to damage the skin. Using bandage scissors or tape cutters and slow removal with counter pressure to the skin will help. Skin should always be checked for skin irritation or signs of an allergic reaction (ie. blistering, peeling) following tape removal.

g. Electrical Muscle Stimulation (EMS)

EMS is used when a patient is unable to do an active contraction or when the active contraction is not performed effectively (eg. when swelling in the knee, secondary to injury, systemic disease or surgery, tends to inhibit the vastus medialus obliquus component of the quadriceps). EMS is used frequently to augment re-education of muscle.

Electrical current is used to depolarize the nerve that creates an action potential and subsequent muscle contraction. Several currents are used to stimulate the motor nerves. The ones most commonly seen in physiotherapy clinics are those that exhibit pulsatile currents.

Voluntary muscle contractions tend to recruit muscle fibres asynchronously, first the slow twitch oxidative fibres, followed by fast twitch fatigue resistant fibres, and finally, by fast twitch glycolytic fibres. This produces a smooth coordinated movement.

EMS tends to recruit all the motor units corresponding to the nerve which has been depolarized. As all the motor units fire at the same time, the muscle fibres of those motor units contract virtually at the same time. This synchronous rather rapid contraction often is described as a cramping or knotting sensation by the patient.

Considerations for selecting a pulse frequency include:

- 30-50 pulses per second leads to tetany
- frequency should be kept at the lowest rate that achieves tetany
- a higher frequency is more comfortable but leads to fatigue (this varies with the individual)
- the muscle should be contracted voluntarily during EMS as this improves slow twitch activity (increases the completeness of the contraction)

Considerations for the cycle of stimulation and rest include:

- 1:1 cycle is said to fatigue the muscle far more rapidly than a 1:5 cycle (eg. 10 seconds on, 10 seconds rest versus 10 seconds on, 50 seconds rest)
- the patient should rest between contractions

Considerations for electrode placement include:

- one electrode goes on motor point (greatest density of terminal end-plates on muscle)
- skin resistance is lowest at motor point
- one electrode goes over the nerve to the muscle
- usually a carbon impregnated piece of vinyl is used as an electrode
- conducting gel or a wet sponge is placed between the skin and electrode to decrease skin resistance

Most EMS machines employ a biphasic waves which means the electrons flow in both directions. Therefore the positive and negative electrode are interchangeable. If a monophasic wave is used where the electrons always move in the same direction, the polarity is important. The cathode (negative) goes over the motor point and the anode (positive) goes over the nerve. The monophasic wave may cause skin irritability under the electrodes (acid under the positive and basic under the negative).

There are contraindications to using EMS. It should not be used over skin rashes, infections or open wounds. The electrodes should not be placed near malignant tumours or over the thorax in patients with a pace maker or over the abdomen during a pregnancy. The patient must be able to understand and follow directions and have normal skin sensation.

Examples where EMS could be effective include:

- enhance contraction where there is reflex inhibition: 50-100Hz; if one wants to augment the vastus medialis of the quadriceps muscle, the patient can be asked to work with the machine for 15 minutes using a 10 second on, 10 second rest cycle. This can either be done in sitting with active knee extension or using a progressive squat programme

- supplement contraction in post-injury or post-surgical states when the limb is immobilized: 50-100Hz

- influence pain when it is secondary to muscle spasm: 1-50Hz

- strained or torn muscles: use EMS electrodes over the damaged area of the muscle to help obtain contraction in the damaged muscle fibers and avoid interfiber adhesions. (eg. torn hamstring in 100 meter sprinter)

h. Therapeutic Ultrasound (US)

US is a wave of mechanical energy that is produced when electrical energy is applied to a crystal which then vibrates at a set frequency. The frequency generally varies between 0.75 MHz and 3.0 MHz. The smaller the frequency is, the greater the depth of penetration of the US beam. The size of both the US crystal and the transducer face also affects the depth of penetration. The larger the sound head, the greater the depth. The mechanical energy of US can produce mechanical effects in the tissue such as decreased stiffness or the energy can be transformed to have a thermal effect. US may be administered in either continuous or pulsed modalities.

Body tissues that are high in water, protein, and collagen absorb US waves. Bone is not a good medium to absorb US waves.

The main uses of ultrasound include:

- increase angiogenesis
- haematoma resorption (no earlier than one week post injury)
- decrease local inflammation and edema (chronic or acute)
- decrease scar tissue, contractures and adhesion formation
- phonophoresis (driving a drug through the skin)
- wound healing (around periphery of wound)

Variables to consider with US application:

- size of sound head
- frequency
- intensity (measured in watts)
- pulse or continuous application
- duration
- how long between applications (insonation interval)

It is extremely important that the US head be kept moving at all times while in continuous mode.

A contraindication to using US is with an actively haemorrhaging contusion. Cautions when using US are:

- areas near the heart, central nervous system, any endocrine organ, special sense organs, reproductive organs
- infections
- open epiphysis
- prosthetic device and/or surgical screws/plates
- areas of altered sensation

Examples for using US include:

- acute and subacute tenosynovitis, tendinosis, synovitis: following ice routines of the first 24 to 48 hours; continuous US 0.5-1.0 watts per centimeter squared (W/cm^2)
- contusions of ligaments of muscle: 24 to 36 hours after injury; pulsed 0.5-1.5 W/cm^2, after 36 hours; continuous into subacute and chronic
- scarring following contusion associated with muscle strain: continuous 1.5-3.0 W/cm^2

i. Laser Therapy

Laser utilizes light amplification by stimulated emission of radiation. The therapeutic lasers are non-invasive, non-thermal, visible light and infrared (IR) low power units. These low power ("soft-cold") lasers are not capable of causing thermal changes in the target tissue and include krypton, helium, neon and gallium arsenide units. Low-power therapeutic lasers stimulate tissue but are not capable of destroying tissue unlike, for example, the high power (hot) carbon dioxide laser used in surgery (a "light knife"). The IR laser gives a treatment depth of 1.5 cm. Doses of laser are measured in joules per square cm.

Figure 11.4 Laser therapy.

There are three properties of the laser that give it a therapeutic advantage over normal light. These include:

i. monochromaticity - only one characteristic wavelength and colour of light is emitted
ii. coherence - photons arrive at the target tissue synchronously
iii. parallel transmission - no divergence of the photons making up the laser which, in turn, focuses the light energy

There is potential for retinal damage on prolonged, indirect laser exposure or from direct stimulation of the eye. The operator and patient should wear protective glasses designed for the laser machine. The photons produced by the laser are absorbed by the target tissue causing several purported therapeutic effects including:

- acceleration of collagen synthesis
- pain control, similar to results using needle acupuncture or by reducing the formation of prostaglandinspain
- promotion of wound healing, particularly to the skin. It is thought that the laser energy plays a role in the three phases of wound healing: inflammation, proliferation and contraction/ maturation of scar tissue
- control and decrease edema formation
- softening of scar tissue
- nerve regeneration
- immunosuppression/immunostimulation

Indications that would suggest the use of lasers include:

- chronic and acute pain (post-traumatic injury)
- osteo- and rheumatoid arthritis
- granulation tissue formation in wound healing
- reduction of edema enhancement of collagen deposition
- acute and chronic tendonitis and ligament sprains
- peripheral nerve regeneration

Contraindications for using lasers include:

- pregnancy (not over the abdomen and pelvis)
- malignancy
- retinal damage
- concurrent use of medication that produces photosensitivity

Precautions when using laser include:

- do not over-stimulate the tissue
- do not expose the tissue to densities above nine joules per square cm
- do not stimulate near a pacemaker or on patients suffering from poor calcium assimilation (due to the laser effect on the sodium-calcium pump)
- do not use on pain of unknown etiology
- do not use on patients with acute vascular disturbances, pre-infarctive states, nor with acute inflammation with evidence of sepsis or infection

Treatment can be given on a daily basis and should last for 10-20 sessions depending on their effectiveness.

j. Interferential Current (IFC)

IFC is a very effective modality for controlling pain and edema. It has also been used for the treatment of haematoma, chronic lesions of ligament and trigger points in myofascial or fibrositic syndromes. IFC utilizes two sinusoidal currents of 3900-5100 Hz that sum to produce one low frequency current between 1-250 Hz. The advantage of IFC is that it is a medium frequency current that can overcome skin resistance and allow low frequency currents to reach the deeper tissues. Specifically, two medium frequency, unmodulated, alternating currents are applied simultaneously through paired electrodes to produce a vibration where they cross, which is a modulated, alternating current with a beat frequency equal to the difference between the medium frequency currents. Four electrodes are applied so that the currents cross through the lesion. Usually one frequency is fixed and the other is varied, to produce the desired treatment frequency.

For relief of pain, 10-15 minutes of 100 Hz constant stimulation can produce analgesia for longer than one hour. Fine vibration sensory stimulation of nerve endings inhibit pain. IFC is also effective in the treatment of reflex sympathetic dystrophy through inhibition of the sympathetic system. In addition, IFC increases vasodilation and decreases pain. For reflex sympathetic dystrophy, stimulation is from the segmental levels down. For conditions such as migraine, neuralgia, stump complications following amputation, or post-herpetic pain, IFC applied at the 90-100 Hz level for 10-15 minutes is effective.

For reducing edema, 10-15 minutes at 1-100 Hz or 1-10 Hz rhythmic contraction with suction electrodes is effective. Edema can be reduced by alternate excitation-relaxation of tissues which results in hyperemia and increased cellular activity and changes in cellular permeability. IFC also increases venous return and lymphatic flow due to muscle stimulation.

For chronic ligament lesions, IFC can be used with ultrasound and active motion to decrease pain.

Trigger-point pain in myofascial syndromes can be treated with constant 100 Hz or rhythmic 1-100 Hz stimulation.

Contraindications for use of IFC include patients with a pacemaker, deep vein thrombosis, infective conditions, over malignant tumours, or over the uterus during pregnancy. Use IFC cautiously in the treatment of haematoma, as it could cause vasodilation and increase the risk of re-haemorrhage. IFC should not be used in the first 24 hours after acute injury. Burns are a side effect of IFC, and those using this modality must be constantly on the alert for the complication.

k. Traction

Traction has been used for centuries in the treatment of painful spinal conditions. The goals of traction include reduction of radicular signs and symptoms associated with conditions such as nerve root impingement, disc protrusion, lateral stenosis, degenerative disc disease, degenerative facet joint disease, and subluxations (ie. spondylolisthesis). Other goals include reduction of muscle guarding/spasm via prolonged stretch; reduction of joint pain via neurophysiologic pathways (gating mechanism); and increasing the range of motion via distraction or mobilisation of joint surfaces. Precautions include symptoms that increase with manual traction, joint hypermobility, and acute inflammation. Contraindications include: spinal infections, spinal malignancies, and spinal cord pressure.

Cervical Traction

Manual traction may be used to both treat and assess the status of the cervical spine. Manual techniques and hand position vary depending on the level of focus, from occipital to specific segmental distraction. Positioning the patient in supination has been shown to be a preferable position as compared to sitting. Grading of the force applied manually is subjective, however, care is taken to use the least amount of force that is clinically effective.

Mechanical traction machines are used to create a pulling force. Occipital halters are commonly used to apply distraction to the cervical spine. The angle of pull varies according to target tissue. For maximal perpendicular facet separation, the angle would be zero degrees at the atlantooccipital joint and increasing amounts of extension to C-6, C-7. For increasing intervertebral space, it is generally accepted that about 25º of flexion is optimal. Too much flexion has been shown to decrease intervertebral space because of encroachment of the ligamentum flavum on the intervertebral foramen. For some disc problems, a neutral spine is indicated because it causes the ligaments to be lax and the traction can be transmitted more completely to the disc. In terms of application, intermittent traction seems to be more comfortable for most patients than static traction. Facet problems appear to respond well to shorter and equal on-time versus off-time, and herniated disc problems to longer on-time than off-times or sustained pulls. The amount of recommended weight varies with the source, however, it is generally accepted that to produce elongation of the spine, 10-15 kg is necessary. Recommended treatment times vary dependent upon the underlying pathology; degenerative joint disease approximately 25 minutes; disc protrusion no more than 8 minutes to avoid disc imbibing excessive fluid and increasing intradiscal pressure; and for muscular relaxation, 20 to 25 minutes. The frequency of treatment should be greater in the more acute phase, as in the presence of neurologic findings.

Lumbar Traction

Manual traction, as with the cervical spine, may be used as an assessment and/or treatment tool. It can be done with the patient placed in a side-lying or supine position. The physiotherapist can perform a segmental locking of the spine to focus traction in one specific region of the lumbar spine. The physiotherapist uses the upper extremities to localize the movement and provides a caudal force via gentle lunging of the lower extremities. In supine lying, a belt can be used to apply traction. The belt should encircle both the patient and therapist, with the therapist gently leaning back on the belt to apply the traction. To provide general lumbar spine traction, the belt can be placed around the patient’s knees.

Mechanical traction machines are used to create a pulling force. The amount of recommended tension varies substantially in the literature. Sources vary from one fourth of body weight and up. Higher values have also been sited, maximally 185 kg, with scant discussion regarding tissue tolerance. Lumbar traction can be applied in either a supine or prone position depending on the underlying pathology and patient comfort. With the patient in supination, the knees and hips can be flexed to varying degrees depending on the target level of segmental distraction, with the lower extremities supported on a stool. The physiologic differences between static and intermittent traction are poorly understood. Facet joint dysfunction appears to respond better to shorter and equal on/off times, and herniated discs to longer on/off times. The principles of treatment time and frequency are similar to those described in the cervical region. However, more research is required to confirm the efficacy of each programme. Recently, inversion traction has gained popularity. Inverted traction exposures usually start at 70-90 seconds and are progressively increased to 2-3 minutes with rest intervals of similar time periods, such that the maximum treatment time would be between 10-30 minutes. Contra-indications to this form of traction include hypertension and glaucoma. Occasionally, inversion therapy can aggravate asthma and migraine attacks and increase gastric reflux in an individual with a hiatus hernia.

Fig 11.4 a) Cervical and b) lumbar traction.

l. Ice

The therapeutic and physiological effects of cold include the reduction of pain through an anaesthetic effect, decreased swelling, reduced muscle spasm by the slowing of nerve conduction, decreased muscle spindle excitability and a reduction in the metabolic needs of the injured tissues. In the initial phase of injury treatment, ice should be applied for 15 minutes every 2-3 hours for the first 48 hours following the injury (depending of recurrent effusion). There are various techniques of cold application or cryotherapy. These include:

- ice packs utilizing crushed or shaved ice in a disposable plastic bag or a moist towel
- immersion in ice water of approximately 3° C
- ice massage; place water in a styrofoam cup, allow it to freeze, and then to rub the skin in a circular manner; ice massage therapy lasts up to 10 minutes and should be repeated every 3 hours. A light coating of oil applied to the skin will minimize the risk of an “ice burn”

The contraindications for cryotherapy include circulatory disturbances such as hypersensitivity to cold or Raynaud’s disease. Caution must be used with ice massage or ice packs over superficial nerves, such as the common peroneal nerve at the head of the fibula. Prolonged icing or immersion ice therapy can lead to frostbite. Cryotherapy should be combined with compression, particularly in muscle strains, and early therapeutic exercises, as a part of early rehabilitation.

m. Compression

Compression can be achieved by a number of techniques, most commonly by athletic tape or tensor support. Adhesive taping provides support for the joint while achieving sufficient compression to control edema. There is a definite art to adhesive taping. The technique includes preparation of the area to be taped with shaving, followed by the application of a tape adherent and then a protective under-wrap that will be between the skin and tape in selected areas of friction. The specific taping technique must allow for additional post-injury swelling. This can be accomplished by leaving an open anterior section on ankle taping. Further discussion of taping technique and principles can be found in section “f.” in this unit. When adhesive tape is unavailable, compression may be applied with cotton crepe bandages directly to the injury and then progressing proximally, covering 2/3 of the previous turn.

n. Elevation

Elevation is an important phase of the initial injury management to control swelling. The objective is to reduce post-injury edema by improving venous return and lymph flow. The duration and frequency of elevation depends on the degree that swelling is recurring. Generally, 20 minutes every 3 hours would be adequate. Elevation for very extended time periods can result in difficulty with the peripheral blood vessels adapting to increased vascular pressure later. Rhythmic muscle contractions through isometric or gentle active exercise can augment lymph flow.

o. Contrast Baths

Alternating cold and hot baths may be commenced 48 hours post-injury as long as there is no danger of the heat increasing bleeding. The alternate use of heat and cold can increase circulation, enhance the elimination of inflammatory exudate, stimulate healing and improve range of motion. This technique involves two containers, one of which is filled with ice cold water or an ice slush (3º-10º C) and one with warm water (38-44º C). The sprained ankle, for example, is placed in the cold bath for one minute and then transferred to the warm bath for three minutes. This alternation between cold and hot would be repeated for 10-20 minutes.

Finally, in the first 24 hours post injury, RICE (rest, ice, compression, and elevation) is the best treatment. It is important to do no HARM (no heat, no aspirin or alcohol, no running or further activity, and no massage). Each can increase bleeding.

C. Injury Prevention

Injury can be disastrous for the athlete. Prevention of sports injury in the elite athlete should be the primary consideration for everyone involved (eg. athlete, coach, therapist, physician, family). It is often an injury that terminates an elite athlete's participation in sport.

Physicians and therapists working with elite athletes are recognized for their expertise in the management of musculoskeletal dysfunction. They also have an important role to play in the prevention of sports injury. They must have an understanding of the risk factors potentially predisposing an athlete to sports injury, the pre-participation evaluation used for the identification of the risk factors, and the strategies used to prevent sports injury. The coaches and athletes must be educated regarding potential risks and prevention strategies.

Injury prevention can be classified into primary, secondary and tertiary levels of prevention.

- The primary level of prevention refers to the specific strategies used to prevent injury from occurring.

- The secondary level of prevention refers to the early detection of injury, and the prevention of increasing the severity of injury, of developing any complications, and the prompt administration of appropriate therapy.

- The tertiary level of prevention refers to the restoration of function and the prevention of recurrence by the administration of an appropriate rehabilitation programme.

Risk Factors for injury in Sport

Risk factors for injury in a particular sport are often characterized as extrinsic or intrinsic (see Table 11.1). Extrinsic risk factors are the exposure to a particular sporting activity, the equipment used and the prevailing environmental and sport specific conditions. Intrinsic risk factors are the physical and psychological characteristics of the athlete.

Intrinsic risk factors that may be modified with intervention in the effort to prevent injury, are often referred to as modifiable risk factors. It is essential to understand, however, that a risk factor for injury in sport does not necessarily mean that a causal relationship exists. Rather, a risk factor may predispose an athlete to a particular injury. It is the strength of the association between a risk factor and injury outcome that will determine whether or not that factor is predictive of injury.

Table 11.1 Risk factors for injury in sport.

Extrinsic Factors		**Intrinsic Factors**	
		Non-modifiable	**Potentially modifiable**
-sport played (contact/no contact) -rules -goal/aim of sport -playing time -level of play (recreational/elite) -postition played	-playing surface (type/condition) -weather -time of season/time of day -equipment (protective/footwear)	-previous injury -age (maturational stage) -sex -somatotype	-fitness level -pre-participation sport specific training -flexibility -strength -joint stability -biomechanics -balance/proprioception -warm-up activity -psychological/psycho--social factors

Extrinsic Risk Factors

Skills that are specific to a sport, either performed correctly or incorrectly, may be a significant factor in the pattern and frequency of injuries occurring in athletes of that sport. The repetitive nature of long distance running events may lead to musculoskeletal overuse injuries in the lower extremities linked to fatigue and stress. The running, pivoting and contact involved in basketball, may lead to more acute musculoskeletal lower extremity injuries.

The specific technique used to perform particular sports skills may also contribute to particular injuries in particular sports. For example, the pitching action in baseball may be performed using different techniques that will each stress the shoulder and elbow in a different manner. Technical factors may need to be discussed between the coach and medical practitioner (or therapist) in an attempt to prevent potential injury. The position played in a team sport may also contribute to particular patterns of injury. These patterns may be identified and potentially addressed by training techniques practiced by the athlete.

The rules and aim of the sport may also contribute to injury in specific sports. There is some evidence that illegal play in some sports such as hockey and soccer is closely associated with increased levels of injury. Promoting a high standard of refereeing for any sport is essential. In sports like diving, gymnastics or figure skating, where the aim is to undertake as difficult a routine as possible, such ambition may increase the athlete's risk of injury. The athlete and coach will ultimately be responsible for these decisions.

Other conditions that may contribute to injury include the playing surface (type/condition), weather, time of day and time of season. There is some evidence to suggest that artificial turf may potentially increase the risk of particular injuries in field sports. The condition of the playing surface may contribute to specific injury patterns (ie. a wet playing field, uneven playing surface, or varying ice conditions in winter sports). The athlete may alter their strategy or technique for varying conditions, possibly increasing the risk of injury. The weather may predispose an athlete to injuries and illness (ie. heat cramps, hyperthermia, hypothermia). The time of day an athlete trains or competes may be important with respect to levels of fatigue. The time of season has been shown to contribute to increased levels of particular injuries in particular sports (ie. increased risk of groin/abdominal strain injury in pre-season hockey).

Equipment plays a significant role in both the prevention and contribution to injury in sport. There is ongoing research addressing, for example, the benefits of a full-face shield in ice hockey, mouth guards in contact sports and knee braces in basketball. Mandating particular equipment in particular sports, however, often involves decisions at many levels (ie. athlete, coach, sports association). Examples of how equipment may contribute to injury includes the longevity of running shoes (ie. reduced shock absorption capability with increased mileage) and string types and racquet size used in tennis. Recommendations on equipment should be guided by the knowledge of the mechanism of injury and the biomechanics of the task (see Unit 15 - Biomechanics) in conjunction with advice from the coaching staff.

Intrinsic Risk Factors

Potentially, medical practitioners can have the greatest impact on injury prevention by addressing the modifiable intrinsic risk factors in elite and non-elite athletes.

There are numerous potential intrinsic risk factors that cannot be modified. Nevertheless, the knowledge of their contribution to injury may assist in the early detection of injury, development of rehabilitation strategies used to prevent re-injury, and training strategies to prevent injury. Such risk factors will include age, physical maturation, gender and somatotype.

Previous injury is well documented to be a significant risk factor for subsequent injury. Identification of previous injury and the resultant impact on the musculoskeletal system should be identified during the pre-season evaluation and addressed with appropriate rehabilitation strategies. In addition, training strategies may vary for athletes at different maturational stages due to the potential increased risk of growth plate injury in the skeletally immature athlete (see Unit 2, section A, and Unit 8 - Children in Competitive Sports).

Historically, physical therapists have been very diligent in encouraging athletes to maintain or improve flexibility in order to prevent injury. However, there is surprisingly little research evidence to support this strategy. In fact there is no strong evidence that increased flexibility or stretching is associated with decreased rates of strain, sprain or overuse injury across all sports or levels of competition.

Physical therapists are also very diligent in the prescription of specific strengthening exercises to prevent injury. Although there is some evidence of an association between decreased specific muscle strength and specific muscle strain injury in elite athletes in sport, there is not enough evidence in the scientific literature to support decreased muscle strength, globally, as a risk factor for injury in all sports. Imbalance of muscle strength may also be an important factor contributing to specific injuries in specific sports.

There is some evidence that joint instability is associated with specific injury in specific sports. The contribution of mechanical instability and/or functional instability, however, is unclear. The protective use of knee and ankle braces in specific sports to prevent injury of an unstable joint is also controversial. There is also controversial evidence regarding the contribution of biomechanical malalignment to injury in various sports. It is generally accepted in the sports medicine community, however, that biomechanical analysis is crucial in the development of training techniques and improvement in equipment and footwear for athletes (see Unit 15 - Biomechanics).

Proprioception and balance training is a well-accepted component of any sports injury rehabilitation programme. There is some evidence to support decreased balance ability as a risk factor for specific injury in specific sports. There is also some evidence to support proprioceptive balance training strategies (ie. balance board training) in the prevention of specific injury in specific sports.

Warm-up is essential prior to any intense sporting activity. There is evidence to support the effect of warm-up activity on the physiological processes necessary to prepare a muscle for intense physical activity. There is also evidence of increased risk of injury in some sports in players who had not warmed up, however, this is clearly difficult to study in the elite athlete population where warm-up activity is generally ingrained in the athlete's preparation routine.

There is increasing evidence that psychological and psychosocial factors may play a role in the precipitation of athletic injury. For example, there is evidence to support the view that stressful life events are a risk factor for injury in sport. Intense training in itself will have a significant impact on the athlete from both a psychological and psychosocial perspective. The involvement of a sports psychologist is increasingly common with many athletes competing at an elite level.

Return to Sport Activity

The decision to return to sport following an injury and subsequent rehabilitation is crucial in the prevention of re-injury. Supportive taping or bracing may be part of the return to sport plan. Some general principles guiding this decision include:

- full and pain-free range of motion of affected joint
- 85-90% "normal" muscle strength (in comparison with uninjured limb or pre-injury strength assessment)
- adequate proprioceptive function (ie. as assessed by balance ability)
- graduated return to pre-injury sporting activity (ie. increasing time and intensity of performance) pain-free

D. References

For further information, refer to the following web sites:

http://www.sportmed.ucalgary.ca/ACL/
http://physio-net.com/