CHAPTER I

INTRODUCTION
INTRODUCTION

Sport and exercise are very beneficial to health. They can reduce the risk of heart disease, stroke and obesity and help to beat depression. However, exercise can also cause injuries, particularly if you do not prepare properly, or use proper safety equipment. It is very important to warm up before exercise, and to cool down afterwards. The term sports injury refers to the kinds of injuries that commonly occur during sport or exercise. Some sports require supervision from a qualified professional, or someone who is able to administer first aid.

Most people get sports injuries through accidents, but professional and competitive athletes often develop overuse injuries. An overuse injury is usually a sprain, strain or fracture to part of the body that has been used repetitively. An example of this is a javelin thrower, who may be vulnerable to arm and shoulder injuries.

A ‘sports injury’ can be defined as an injury that occurs during sporting activities or exercise. This can be broadened to include injuries affecting participation in sports and exercise and affecting athletes of all ages and all levels of performance. Patients who seek medical attention at sports injury clinics represent the spectrum from top professional to recreational athletes. Even though we can identify the mechanism of an injury and its pathoanatomical correlate or diagnosis, its consequences may be very different for different athletes.

If you are a professional player, there may be loss of earnings and the risk of losing your contract and even your career. If you are a club manager, it may mean losing an important player, perhaps at a crucial time, and the financial costs of a replacement player. If you are the team doctor, physiotherapist, fitness trainer or coach, you will want to know how the injury will affect your plans for the
players’ ongoing dietary and physical training programmes. If you are the medic in charge, it will mean having to convince not only the player but also the club’s other staff that you have the situation under control. The stakes are high. If a player goes back too early, they risk relapse or further injury but if they are held back, they might ask for a second opinion.

During the past 20 years, there has been significant growth in participation of organized athletics by adolescents and preadolescents. More than 30 million individuals between the ages of 6 and 21 years are involved in non scholastic athletic programs, and an additional 5.35 million children and young adults participate in organized interscholastic sports. Benefits of sports participation for children include confidence building, learning team and fair play, establishing patterns of a lifelong focus on fitness, providing a controlled outlet for youthful energy, optimizing sports-specific skills, and, occasionally, advancing education through sports-based scholarships. Nonetheless, the increased emphasis on sports participation has also lead to an increased incidence of the injuries related to sports. Children and adolescents are a unique cohort of athletes. They are actively learning and developing new skills, not only honing established skill levels. Their bodies are actively growing and changing, exposing them to unique injuries not seen in adults. For example, variability in the timing of skeletal maturity can lead to size mismatch in similar-aged competitors.

For younger athletes trying to establish themselves in their sport, an injury can result in major family-related conflicts. Over-ambitious or over-protective parents and pressure from coaches and team-mates can put stresses on to a young athlete not able to participate in their sport. For recreational athletes, injuries may mean loss of regular physical and social activities and problems with general health, such as blood pressure, insulin control or secondary problems to the lower back from limping. A shoulder injury from squash may cause difficulties for a builder or plumber with their own business or raise concerns about the safety of a police officer or firefighter.
The importance of sport and exercise and the consequences of an injury must be emphasized by whoever provides treatment and advice. They must appreciate and understand but provide evidence-based advice. To tell a keen recreational tennis or golf player that they have to stop playing because of an injury must be thoroughly considered advice. There are very often a number of options for consideration during recovery from even a very serious injury. Complete rest is seldom motivating and may be ill-advised because of the detrimental effect rest has on tensile tissue strength and general fitness, and such rest’s potentially fatal consequences for some patients.

An 80 year old keen, regular golfer, suffering from a painful knee due to a meniscus tear, could die from the inactivity caused by the injury. With arthroscopy, that knee could be operated on and fixed within fifteen minutes, allowing him to play golf a week or two later; it would be a shame and very wrong to tell him to stop playing golf. For doctors, the keys to success are consulting evidence-based criteria for the definition and diagnosis of an injury, using reliable examination techniques, considering the background and fitness level of the patient, and being prepared to admit to a lack of knowledge and to refer the patient to someone who may know more. They must recognize the changes and developments that are occurring in sports medicine and the cultural differences that exist in the management of these injuries. Doctors should not take the view that sports injuries are self-inflicted and tell their patients to 'stop doing these silly things'. In societies threatened by obesity, osteoporosis and a general decline in fitness due to inactivity, exercise and sport are potent means of keeping the population fit and healthy.

Most sports injuries are specific to the sport and the level of participation: for example, 70 per cent of keen runners will be affected by a lower limb injury during their career, usually through over use; soccer players have a high risk of traumatic ankle or knee injuries from tackles. The incidence of injury in soccer is
between 15 and 20 injuries per thousand activity hours, with the highest risk during games. The figures are somewhat higher for rugby between 20 and 40 injuries per thousand activity hours and with higher risks of upper limb injuries, in particular those of the shoulder joint. Golf is a low risk sport but a knee or shoulder injury can affect performance and the ability to walk a five kilometer course. Within any particular sport, different positions and roles carry different risks. For example, in cricket a fast bowler may struggle to perform with a minor knee injury to his stance leg or a fielder may be hampered by a minor shoulder injury, while a batsman can perform well with both these injuries.

We must all, athletes, administrators and medical personnel alike, educate ourselves about the principles of exercise on prescription and different training methods and improve our understanding of the demands and impact inflicted by different sports. Thus, injured athletes can have an individualized recovery programme, based on current concepts and based on evidence.

COMMON CAUSES OF SPORTS INJURIES

The most common cause of sports injuries is overuse, which is generally due to faulty training methods: The exerciser does not allow for adequate recovery after a workout or does not stop exercising when pain develops. Every time muscles are stressed by an intensive workout, some muscle fibers are injured and others use up their available energy, which has been stored as the carbohydrate glycogen. More than 2 days are required for fibers to heal and glycogen to be replaced. Because only uninjured and adequately nourished fibers function properly, closely spaced, intensive workouts eventually require comparable work from fewer healthy fibers, increasing the likelihood of injury. Stopping exercise at the first sign of pain, which precedes most wear-and-tear injuries, limits the injury to these fibers, resulting in a quicker recovery. However, continuing to exercise with pain tears more fibers, extending the damage and delaying recovery.

Structural abnormalities can make a person susceptible to a sports injury by stressing parts of the body unevenly. For example, when the legs are unequal in length, unequal forces are placed on the hip and knee. Habitually running
along the sides of banked roads has the same effect; repeatedly hitting the slightly higher surface increases the risk of pain or injury on that side and increases the forces acting on the other leg, exposing it to injury as well. A person who has an exaggerated curve in the lower spine (lordosis) may have back pain when swinging a baseball bat or golf club.

Excessive pronation—a rolling onto the outside of the feet after they strike the ground—is the cause of most foot, leg, and hip injuries. Some degree of pronation is normal and prevents injuries by helping distribute the foot’s striking force throughout the foot. However, excessive pronation can cause foot, knee, and leg pain. In people with excessive pronation, the ankles are so flexible that the arches of the feet touch the ground during walking or running, giving the appearance of flatfeet. A runner with excessive pronation may have knee pain when running long distances.

The opposite problem—too little pronation—can occur in people who have rigid ankles. In these people, the foot appears to have a very high arch and does not absorb shock well, increasing the risk of developing small cracks in the bones (stress fractures) of the feet and legs. The way in which the legs are aligned on the hip bone (pelvis) can produce pain in the legs, particularly in women with wide hips. Such women develop knocked knees, with a tendency for the knee caps to be pushed outward from the midline. This force on the knee caps causes pain. Wide hips also can result in increased tension on a structure called the iliotibial band, causing pain over the outer part of the pelvis and down the outer side of each thigh.

Muscles, tendons, and ligaments tear when subjected to forces greater than their inherent strength. For example, they may be injured if they are too weak or tight for the exercise being attempted. Joints are more prone to injury when the muscles and ligaments that support them are weak, as they are after a sprain. Bones weakened by osteoporosis may fracture easily.

Many injuries are caused by chronic wear and tear, which results from repetitive motion that stresses susceptible tissues. Such is particularly the case in people with structural abnormalities that stress certain parts of the body more than others. In addition, sports injuries are more likely when people do not warm up properly (exercising muscles at a relaxed pace) before an intense workout. Improper technique while exercising is a major contributor to sports injuries. Performing exercises in ways that place joints at unstable angles increase the
impact on tender structures, or overstretch ligaments are common causes of sports injuries. Exercises performed too quickly or with an excessive load on the muscles can also lead to injury while the person is training.

Prevention of sports Injuries

Allowing at least 2 days between intensive workouts or alternating workouts that stress different parts of the body can help prevent chronic injury. Some training programs alternate a hard workout one day with rest or an easy workout the next. The person can also change the type of exercise to stress different body parts. If an athlete trains twice a day, each hard workout should be followed by at least three easy ones (for instance, a hard morning workout should be followed by an easy workout in the afternoon and two easy workouts the next day). Only swimmers can perform both a hard and an easy workout every day without injury. The buoyancy of the water helps protect their muscles and joints.

Warming up before beginning strenuous exercise helps to prevent injuries. Exercising at a relaxed pace for 3 to 10 minutes warms the muscles enough to make them more pliable and resistant to injury. This active method of warming up prepares muscles for strenuous exercise more effectively than passive methods such as warm water, heating pads, ultrasound, or an infrared lamp. Passive methods do not increase blood circulation significantly.

Stretching exercises do not generally seem to prevent injuries, but they do lengthen muscles so they can contract more effectively and perform better. To avoid damaging muscles when stretching, a person should stretch after warming up or exercising, and each stretch should be comfortable enough to hold for a count of 30.

Cooling down—gradually slowing down before stopping exercise—prevents dizziness by keeping blood flowing. When strenuous exercise is stopped abruptly, blood may collect (pool) in the leg veins, temporarily reducing the flow of blood to the head. The result may be dizziness and even fainting. Cooling down also helps remove waste products, such as lactic acid, from the muscles, but it does not seem to prevent next-day muscle soreness, which is caused by damaged muscle fibers.
Strengthening exercises help prevent injuries. Regular endurance (aerobic) exercise neither enlarges nor strengthens muscles significantly. The only way to strengthen muscles is to exercise against progressively greater resistance, as in performing a sport more intensely, lifting progressively heavier weights, or using special strength training machines. Rehabilitation exercises to strengthen healed muscles and tendons are usually done by lifting or pressing against resistance, in sets of 8 to 12 repetitions, no more often than every other day.

Shoe inserts (Orthotics) can often correct foot problems such as excessive pronation. The inserts, which may be flexible, semirigid, or rigid and may vary in length, should be fitted into appropriate running shoes. Orthotics are used in place of the inserts found in the shoes at the time they are purchased. Good running shoes have a rigid heel counter (the back part of the shoe that surrounds the heel) to control movement of the back of the foot, a support across the instep (saddle) to prevent excessive pronation, and a padded opening (collar) to support the ankle. The shoe must have adequate space for the insert. Orthotics usually reduces the shoe's width by one letter size; for example, a D width shoe with an Orthotics becomes a C width shoe.

**Soft Tissue Injury Management for the first 48 Hours to 72 Hours**

So remember R.I.C.E.R. for early return to play!

RICER Stands for:

R - Rest, I - Ice, C - Compression, E - Elevation, R - Referral

Rest

How

- remove the athlete from the field
- rest from activity.

Moving the injured part:

- will increase the blood flow and bleeding to the injury site
- may cause the blood clot to dislodge, and begin bleeding again
- may cause more tissue damage.

Ice
Apply ice:

- directly over the injury and surrounding tissue for 10 to 20 minutes every 2 hours

**HOW**

- ice in a wet towel or plastic bag
- frozen cup of water continuously moved over the area
- a commercial ice pack
- iced water in a bucket

**Why**

- ice decreases swelling
- ice decreases pain.

Do not apply ice directly to the skin, always wrap in a wet towel or wet cloth to avoid ice burns.

**Compression**

**How**

- apply a firm, elastic, non-adhesive bandage
- if using an ice pack, the compression bandage is applied over the ice pack and above and below the injury site to hold it in place and provide compression
- even when you are not icing, the compression bandage should remain directly over the injury site, above and below
- release the compression prior to sleep.

**Why**

- reduces swelling and bleeding at the injury site.

**Elevation**

**How**

- raise the injured area above the level of the heart whenever possible.

**Why**

- elevation decreases bleeding, swelling and pain.
Referral

How

- refer to an appropriate health care professional for definitive diagnosis and continuing management

The R.I.C.E.R. Regime should be repeated for the first 48 to 72 hours

During the first 48-72 hours make sure that you do NO HARM to the injury.

No

H - Heat, A - Alcohol, R - Running, M - Massage

Heat

such as sauna, spa, hot water bottle, hot shower/bath, hot liniment rubs etc. increases bleeding

Alcohol

Increases swelling

Running

Running or exercising too soon can make the injury worse

Massage

Massage or the use of heat rubs in the first 48-72 hours increases bleeding and swelling
Ultrasound Therapy

Ultrasound is a therapeutic modality that has been used by physical therapists since the 1940s. The waves are generated by a piezoelectric effect caused by the vibration of crystals within the head of the wand/probe. The sound waves that pass through the skin cause a vibration of the local tissues. This vibration or cavitation can cause a deep heating locally though usually no sensation of heat will be felt by the patient. In situations where a heating effect is not desirable, such as a fresh injury with acute inflammation, the ultrasound can be pulsed rather than continuously transmitted.

Ultrasound (US) is a form of MECHANICAL energy, not electrical energy and therefore strictly speaking, not really electrotherapy at all but does fall into the Electro Physical Agents grouping. Mechanical vibration at increasing frequencies is known as sound energy. The normal human sound range is from 16Hz to something approaching 15-20,000 Hz (in children and young adults). Beyond this Upper limit, the mechanical vibration is known as ULTRASOUND. The frequencies used in therapy are typically between 1.0 and 3.0 MHz (1MHz = 1 million cycles per second) and the wave length is 1.5mm at 1MHz and 0.5mm at 3 MHz.

**Figure (1)**

Ultrasonic Wave Form With Compression and Rarefraction

![Ultrasound Waveform with Compression and Rarefraction](image-url)
Sound waves are LONGITUDINAL waves consisting of areas of COMPRESSION and RAREFACTION. Particles of a material, when exposed to a sound wave will oscillate about a fixed point rather than move with the wave itself. As the energy within the sound wave is passed to the material, it will cause oscillation of the particles of that material. Clearly any increase in the molecular vibration in the tissue can result in heat generation, and ultrasound can be used to produce thermal changes in the tissues, though current usage in therapy does not focus on this phenomenon (Williams 1987, Baker et al 2001, ter Haar 1999, Nussbaum 1997, Watson 2000, 2008). In addition to thermal changes, the vibration of the tissues appears to have effects which are generally considered to be non thermal in nature, though, as with other modalities (e.g. Pulsed Shortwave) there must be a thermal component however small. As the US wave passes through a material (the tissues), the energy levels within the wave will diminish as energy is transferred to the material. The energy absorption and attenuation characteristics of US waves have been documented for different tissues.

FIGURE-2
ULTRASOUND BEAM PLOT

Example of an Ultrasound Beam Plot
The US beam is not uniform and changes in its nature with distance from the transducer. The US beam nearest the treatment head is called the NEAR field, the INTERFERENCE field or the Frenzel zone. The behaviour of the US in this field is far from regular, with areas of significant interference. The US energy in parts of this field can be many times greater than the output set on the machine (possibly as much as 12 to 15 times greater). Beyond this boundary lies the Far Field or the Fraunhofer zone. The US beam in this field is more uniform and gently divergent. The 'hot spots' noted in the near field are not significant. For the purposes of therapeutic applications, the far field is effectively out of reach.

Ultrasound Transmission through the Tissues

All materials (tissues) will present impedance to the passage of sound waves. The specific impedance of a tissue will be determined by its density and elasticity. In order for the maximal transmission of energy from one medium to another, the impedance of the two media needs to be as similar as possible. Clearly in the case of US passing from the generator to the tissues and then through the different tissue types, this can not actually be achieved. The greater the difference in impedance at a boundary, the greater the reflection that will occur, and therefore, the smaller the amount of energy that will be transferred. Examples of impedance values can be found in the literature e.g. Robertson et al 2007, Ward 1986.

The difference in impedance is greatest for the steel/air interface which is the first one that the US has to overcome in order to reach the tissues. To minimise this difference, a suitable coupling medium has to be utilized. If even a small air gap exists between the transducer and the skin the proportion of US that will be reflected approaches 99.998% which means that there will be no effective transmission.
The coupling media used in this context include water, various oils, creams and gels. Ideally, the coupling medium should be fluid so as to fill all available spaces, relatively viscous so that it stays in place, have an impedance appropriate to the media it connects, and should allow transmission of US with minimal absorption, attenuation or disturbance. For a good discussion regarding coupling media, see Casarotto et al 2004, Klucinec et al 2000, Williams 1987 and Docker et al 1982. At the present time the gel based media appear to be preferable to the oils and creams. Water is a good media and can be used as an alternative but clearly it fails to meet the above criteria in terms of its viscosity. There is no realistic (clinical) difference between the gels in common clinical use (Poltaowski and Watson 2007). The addition of active agents (e.g. anti-inflammatory drugs) to the gel is widely practiced, but remains incompletely researched.
Absorption and Attenuation

The absorption of US energy follows an exponential pattern - i.e. more energy is absorbed in the superficial tissues than in the deep tissues. In order for energy to have an effect it must be absorbed, and at some point this must be considered in relation to the US dosages applied to achieve certain effects (Watson et al 2008).

Figure (5)
Exponential energy Absorption in a Medium
To achieve a particular US intensity at depth, account must be taken of the proportion of energy which has been absorbed by the tissues in the more superficial layers.

As the penetration (or transmission) of US is not the same in each tissue type, it is clear that some tissues are capable of greater absorption of US than others. Generally, the tissues with the higher protein content will absorb US to a greater extent, thus tissues with high water content and low protein content absorb little of the US energy (e.g. blood and fat) whilst those with a lower water content and a higher protein content will absorb US far more efficiently. Tissues can be ranked according to their relative tissue absorption and this is critical in terms of clinical decision making (Watson, 2008).

Figure (6)
Penetration of Ultrasound Therapy in Human body

Increasing Protein Content gives Increasing Absorption

Best absorption in TENDON, LIGAMENT, FASCIA
JOINT CAPSULE and SCAR TISSUE
Although cartilage and bone are at the upper end of this scale, the problems associated with wave reflection mean that the majority of US energy striking the surface of either of these tissues is likely to be reflected. The best absorbing tissues in terms of clinical practice are those with high collagen content – LIGAMENT, TENDON, FASCIA, JOINT CAPSULE, SCAR TISSUE (Watson 2000, 2008, Watson & Young, 2008, ter Haar 1999, Nussbaum 1998, Frizzel & Dunn 1982)

The physiological effects of ultrasound are almost identical to those of Pulsed Shortwave and Laser therapy – the key difference however, is that ultrasound energy is preferentially absorbed in different tissue to the other modalities – as summarized in the below diagram

**Figure (7)**

<table>
<thead>
<tr>
<th>Tissue Absorption</th>
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<tbody>
<tr>
<td><strong>ULTRASOUND</strong></td>
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<tr>
<td>Dense collagen</td>
</tr>
<tr>
<td>based tissues</td>
</tr>
<tr>
<td>Ligament</td>
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<tr>
<td>Tendon</td>
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<tr>
<td>Fascia</td>
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<tr>
<td>Joint capsule</td>
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<tr>
<td>Scar tissue</td>
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<tr>
<td><strong>PULSED SHORTRWAVE</strong></td>
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<tr>
<td>Wet, ionic, low</td>
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<tr>
<td>impedance tissues</td>
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<tr>
<td>Muscle</td>
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<tr>
<td>Nerve</td>
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<tr>
<td>Areas of oedema,</td>
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<tr>
<td>haematomas,</td>
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<td>and effusion</td>
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<tr>
<td><strong>LASER</strong></td>
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<tr>
<td>Superficial</td>
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<tr>
<td>Vascular Tissues</td>
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<td>Open wounds</td>
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<tr>
<td>Muscle</td>
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<td>Nerve</td>
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| Tendon sheath...


The Physiological effects of US are generally divided into THERMAL & NON-THERMAL.

THERMALEFFECT

In thermal mode, US will be most effective in heating the dense collagenous tissues and will require a relatively high intensity, preferably in continuous mode to achieve this effect. Nussbaum (1998) and ter Haar (1999).
Lehmann (1982) suggests that the desirable effects of therapeutic heat can be produced by US. It can be used to selectively raise the temperature of particular tissues due to its mode of action. Among the more effectively heated tissues are periosteum, collagenous tissues (ligament, tendon & fascia) & fibrotic muscle (Dyson 1981). If the temperature of the damaged tissues is raised to 40-45°C, then a hyperaemia will result, the effect of which will be therapeutic. In addition, temperatures in this range are also thought to help in initiating the resolution of chronic inflammatory states (Dyson & Suckling 1978).

**NON-THERMAL EFFECT**

CAVITATION in its simplest sense relates to the formation of gas filled voids within the tissues & body fluids. There are 2 types of cavitation - STABLE & UNSTABLE which have very different effects. STABLE CAVITATION does seem to occur at therapeutic doses of US. This is the formation & growth of gas bubbles by accumulation of dissolved gas in the medium. They take apx. 1000 cycles to reach their maximum size. The `cavity' acts to enhance the acoustic streaming phenomena (see below) & as such would appear to be beneficial. UNSTABLE (TRANSIENT) CAVITATION is the formation of bubbles at the low pressure part of the US cycle. These bubbles then collapse very quickly releasing a large amount of energy which is detrimental to tissue viability. There is no evidence at present to suggest that this phenomenon occurs at therapeutic levels if a good technique is used. There are applications of US that deliberately employ the unstable cavitation effect (High Intensity Focussed Ultrasound or HIFU) but it is beyond the remit of this summary.

ACOUSTIC STREAMING is described as a small scale eddying of fluids near a vibrating structure such as cell membranes & the surface of stable cavitation gas bubble (Dyson & Suckling 1978). This phenomenon is known to affect diffusion rates & membrane permeability. Sodium ion
permeability is altered resulting in changes in the cell membrane potential. Calcium ion transport is modified which in turn leads to an alteration in the enzyme control mechanisms of various metabolic processes, especially concerning protein synthesis & cellular secretions. The result of the combined effects of stable cavitation and acoustic streaming is that the cell membrane becomes 'excited' (up regulates), thus increasing the activity levels of the whole cell. The US energy acts as a trigger for this process, but it is the increased cellular activity which is in effect responsible for the therapeutic benefits of the modality (Watson 2000, 2008, Dinno et al 1989, Leung et al 2004).

MICROMASSAGE is a mechanical effect which appears to have been attributed less importance in recent years. In essence, the sound wave travelling through the medium is claimed to cause molecules to vibrate, possibly enhancing tissue fluid interchange & affecting tissue mobility. There is little, if any hard evidence for this often cited principle.

Ultrasound Application in relation to Tissue Repair

One of the therapeutic effects for which ultrasound has been used is in relation to tissue healing. It is suggested that the application of US to injured tissues will, amongst other things, speed the rate of healing & enhance the quality of the repair (Watson 2006).
INFLAMMATORY PHASE

During the inflammatory phase, US has a stimulating effect on the mast cells, platelets, white cells with phagocytic roles and the macrophages (Nussbaum 1997, ter Haar 1999, Fyfe & Cahal 1982, Maxwell 1992, Watson 2008). For example, the application of ultrasound induces the degranulation of mast cells, causing the release of arachidonic acid which itself is a precursor for the synthesis of prostaglandins and leukotreine – which act as inflammatory mediators (Mortimer & Dyson 1988, Nussbaum 1997, Leung et al 2004). By increasing the activity of these cells, the overall influence of therapeutic US is certainly pro-inflammatory rather than anti-inflammatory. The benefit of this mode of action is not to ‘increase’ the inflammatory response as such (though if applied with too greater intensity at this stage, it is a possible outcome.
(Ciccone et al 1991), but rather to act as an "inflammatory optimiser" (Watson 2007, 2008). The inflammatory response is essential to the effective repair of tissue, and the more efficiently the process can complete, the more effectively the tissue can progress to the next phase (proliferation). Studies which have tried to demonstrate the anti inflammatory effect of ultrasound have failed to do so (e.g. El Hag et al 1985 Hashish 1986, 1988), and have suggested that US is ineffective. It is effective at promoting the normality of the inflammatory events, and as such has a therapeutic value in promoting the overall repair events (ter Haar 99, Watson 2008). A further benefit is that the inflammatory chemically mediated events are associated with stimulation of the next (proliferative) phase, and hence the promotion of the inflammatory phase also acts as a promoter of the proliferative phase.
Employed at an appropriate treatment dose, with optimal treatment parameters (intensity, pulsing and time), the benefit of US is to make as efficient as possible to earliest repair phase, and thus have a promotional effect on the whole healing cascade. For tissues in which there is an inflammatory reaction, but in which there is no ‘repair’ to be achieved, the benefit of ultrasound is to promote the normal resolution of the inflammatory events, and hence resolve the ‘problem’ This will of course be most effectively achieved in the tissues that preferentially absorb ultrasound – i.e. the dense collagenous tissues.

PROLIFERATIVE PHASE

During the proliferative phase (scar production) US also has a stimulative effect (cellular up regulation), though the primary active targets are now the fibroblasts, endothelial cells and myofibroblasts (Ramirez et al 1997, Mortimer and Dyson 1988, Figure (11)

Effect of Ultrasound Therapy in Proliferation Phase

REMODELLING PHASE

During the remodeling phase of repair, the somewhat generic scar that is produced in the initial stages is refined such that it adopts functional characteristics of the tissue that it is repairing. A scar in ligament will not ‘become’ ligament, but will behave more like a ligamentous tissue. This is achieved by a number of processes, but mainly related to the orientation of the collagen fibres in the developing scar (Culav et al 1999, Gomez et al 1991, Watson, 2003) and also to the change in collagen type, from predominantly Type III collagen to a more dominant Type I collagen. The remodelling process is certainly not a short duration phase – research has shown that it can last for a year or more – yet it is an essential component of quality repair (El Batouty et al 1986, ter Haar 1987).
The application of therapeutic ultrasound can influence the remodeling of the scar tissue in that it appears to be capable of enhancing the appropriate orientation of the newly formed collagen fibers and also to the collagen profile change from mainly Type III to a more dominant Type I construction, thus increasing tensile strength and enhancing scar mobility (Nussbaum 1998, Wang 1998). Ultrasound applied to tissues enhances the functional capacity of the scar tissues (Nussbaum 1998, Huys et al 1993, Tsai et al 2006, Yeung et al 2006). The role of ultrasound in this phase may also have the capacity to influence collagen fiber orientation as demonstrated in an elegant study by Byl et al (1996), though their conclusions were quite reasonably somewhat tentative.

The application of ultrasound during the inflammatory, proliferative and repair phases is not of value because it changes the normal sequence of events, but because it has the capacity to stimulate or enhance these normal
events and thus increase the efficiency of the repair phases (ter Haar 99, Watson 2007, 2008, Watson & Young, 2008). It would appear that if a tissue is repairing in a compromised or inhibited fashion, the application of therapeutic ultrasound at an appropriate dose will enhance this activity. If the tissue is healing ‘normally’, the application will, it would appear, speed the process and thus enable the tissue to reach its endpoint faster than would otherwise be the case.

CONTRAINDICATIONS:

- Do not expose either the embryo or fetus to therapeutic levels of ultrasound by treating over the uterus during pregnancy.
- Malignant tissues.
- Tissues in which bleeding occurring.
- Significant vascular abnormalities including deep vein thrombosis, emboli and severe arteriosclerosis / atherosclerosis.
- Hemophiliacs not covered by factor replacement.

Application over:

- The eye
- The stellate ganglion
- The cardiac area in advanced heart disease & near PaceMaker
- The gonads
- Active epiphyses in children

PRECAUTIONS:

- Always use the lowest intensity which produces a therapeutic response
- Ensure that the applicator is moved throughout the treatment (speed and direction not an issue)
- Ensure that the patient is aware of the nature of the treatment and its expected outcome
• If a thermal dose is intended, ensure that any contraindications that apply have been considered
• Caution is advised in the vicinity of a cardiac pacemaker or other implanted electronic device
• Continuous ultrasound is considered unwise over metal implants

HAZARDS:

Reversible blood cell stasis can occur in small blood vessels if a standing wave is produced while treating over a reflector such as an air/soft tissue interface, soft tissue/bone or soft tissue/metal interface whilst using a stationary applicator. Continuous movement of the treatment head negates this hazard. Treatment with a stationary treatment head is considered bad practice.
LASER THERAPY

The term LASER is an acronym for the Light Amplification by Stimulated Emission of Radiation. In simple yet realistic terms, the laser can be considered to be a form of light amplifier - it provides enhancement of particular properties of light energy.

Figure (13)
LASER Wave

Laser light will behave according to the basic laws of light, in that it travels in straight lines at a constant velocity in space. It can be transmitted, reflected, refracted and absorbed. It can be placed within the electromagnetic spectrum according to its wavelength/frequency which will vary according to the particular generator under consideration.

There are several aspects of laser light which are deemed to be special and are often referred to in the literature. These include monochromacity, coherence and polarisation. There remains some doubt as to exactly how essential these particular aspects of laser light are in relation to the therapeutic application of this energy form. Monochromacity is probably the most important factor, as many of the therapeutic effects have been noted in
various trials with light which is non-coherent. Additionally, it is thought that the polarisation is soon lost within the tissues & may therefore be less important than was thought at first.

Figure (14)

LASER Wave Form

PARAMETERS

Most LLLT apparatus generates light in the Red Visible & Near Infrared bands of the EM spectrum, with typical wavelengths of 600-1000nm. The mean power of such devices is generally low (1-100mW), though the peak power may be much higher than this.

The treatment device may be a single emitter or a cluster of several emitters, though it is common for most emitters in a cluster to be non laser type devices. The beam from single probes is usually narrow (≈1mm-6 or 7mm) at the source. A cluster probe will usually incorporate both higher and lower power emitters of different wavelengths.
Figure (15)

LASER Therapy Applicator Head

The output may be continuous or pulsed, with narrow pulse widths (in the nano or micro second ranges) and a wide variety of pulse repetition rates from 2Hz up to several thousand Hz. It is difficult to identify the evidence for the use of pulsing from the research literature, though it would appear to be a general trend that the lower pulsing rates are more effective in the acute conditions whilst higher pulse rates work better in more chronic conditions.

Many texts make reference to the types of generators according to the gas contained within the tube, but in therapy applications, most modern apparatus utilised laser diodes, most commonly made of Gallium Aluminium Arsenide (GaAlAs) in which the ratio of the constituents determines the wavelength of the output or alternatively, laser LED's of various kinds.
Research biologists describe the healing process in the following way.

1. Reduced blood flow deprives human tissue of oxygen and glucose.
2. The powerhouse of the cell (the mitochondria) needs this oxygen and glucose to manufacture energy (ATP.)

Without ATP (adenosine triphosphate) the cell cannot function (e.g. a muscle cell cannot contract or relax, nerve cells cannot transmit vital signals) and it cannot repair components of the cell that have been damaged.

Simply stated,

**NO OXYGEN + NO GLUCOSE ≠ NO ENERGY ≠ NO HEALING.**

**The Solution**

Laser therapy bypasses the blood stream and delivers laser energy to light receptors (photoreceptors) within the mitochondria. The mitochondria accept this energy and use it to create ATP, which the cell can use to power the healing process.

**LASER STIMULATION OF MITOCHONDRIA ≠ ENERGY PRODUCTION (ATP) ≠ HEALING**
Treatment with the Avicenna Laser is pain-free. The patient experiences only a gentle warming spa-like sensation over the surface of the skin.

**Light Absorption in the Tissues**

As with any form of energy used in electrotherapy, the energy must be absorbed by the tissues in order to have some effect. If exactly the same amount of energy left the tissues which was introduced into them, it is difficult to rationalise what kind of effect might have been achieved. The absorption of light energy within the tissues is a complex issue, but generally, the shorter wavelengths (ultraviolet & shorter visible) are primarily absorbed in the epidermis by the pigments, amino & nucleic acids. The longer IRR wavelengths (>1300nm) appear to be rapidly absorbed by water & therefore have a limited penetration into the tissues. The band between (i.e. 600-1000nm) are capable of penetration beyond the very superficial epidermis & are, in part at least, available for absorption by other biological tissues.

LLLT when applied to the body tissues, delivers energy at a level sufficient to disturb local electron orbits & result in the generation of heat, initiate chemical change, disrupt molecular bonds & produce free radicals. These are considered to be the primary mechanisms by which LLLT achieves its physiological & therefore therapeutic effects and the primary target is effectively the cell membrane (see below).

Although much of the applied laser light is absorbed in the superficial tissues, it is proposed that deeper or more distant effects can be achieved, probably as a secondary consequence via some chemical mediator or second messenger systems, though there is limited evidence to fully support this contention.

The actual penetration of LLLT at common wavelengths is a widely debated point & it is common to find widely varying values cited in the
literature. It is often claimed that because laser light is monochromatic, polarised & coherent it is capable of greater penetration than 'normal' (or non-coherent) light. This should give penetration depths of 3-7mm for visible red light & some 30-40mm for IRR laser light.

The fact that the polarisation appears to be lost in the tissues, as is much, if not all of the coherence, will result in a shallower penetration. King cites a more realistic penetration depth for 630nm light to be 1-2mm, whilst at 800-900nm one could expect penetration depths of 2-4mm. (Penetration depth in this context refers to the depth of the tissues to which 37% of the light at the surface is able to penetrate). A very small % of the light energy available at the surface will be available at 10mm or more into the tissues.

Laser - Tissue Interaction

As with many other forms of energy delivered to the patient under the umbrella of electrotherapy, the primary effects are divided into thermal and non thermal. LLLT is generally considered to be a non thermal energy application, though one must be careful to appreciate that delivery and absorption of any energy to the body will result in the development of heat to some extent. Non thermal in this context really relates to the non accumulative nature of the thermal energy.

Photobioactivation is a commonly used phrase in connection with LILT - meaning the stimulation of various biological events using light energy but without significant temperature changes. Much, if not all the cited work on therapeutic laser consider these photobioactivation effects. Some authors have proposed that there are other terms which are preferable to photobioactivation including photobiostimulation and photobiomodulation. It provides for a great semantic argument, but assume at this point that therms are generally interchangeable.
Many of the early ideas of photobioactivation were proposed by Karu who reported & demonstrated several key factors. She notes in her 1987 paper that some biomolecules (DNA, RNA) change their activity in response to irradiation with low intensity visible light, but that these molecules do not appear to absorb the light directly. The cell membrane appears to be the primary absorber of the energy which then generates intracellular effects by means of a second messenger / cascade type response. The magnitude of the photoresponse was deemed to be determined at least in part by the state of the cells/tissues prior to irradiation, summarised in a simple statement that 'starving cells are more photosensitive than well fed ones'. The laser light irradiation of the tissues is seen then as a trigger for the alteration of cell metabolic processes, via a process of photosignal transduction. The often cited Arndt-Schults Law supports this proposal.

The list of cellular & more general physiological effects is extensive, but it must be considered realistically in that much of the work relates to *in vitro* experimentation with no direct proof that the results are directly related to living mammalian tissues *in vivo.*

The following list of physiological & cellular level effects is compiled from several reviews & research papers.

Altered cell proliferation

Altered cell motility

Activation of phagocytes

Stimulation of immune responses

Increased cellular metabolism

Stimulation of macrophages

Stimulation of mast cell degranulation

Activation & proliferation of fibroblasts
Alteration of cell membrane potentials
Stimulation of angiogenesis
Alteration of action potentials
Altered prostaglandin production
Altered endogenous opioid production
Decreased pain levels
Reduced inflammation

**Dose Calculations**

Most research groups and many manufacturers, recommend that the dose delivered to a patient during a treatment session should be based on the ENERGY DENSITY rather than the power or other measure of dose. Energy Density is measured in units of Joules per square centimetre (J/cm\(^2\)). One of the most significant inhibitors to the more widespread adoption of laser Therapy in the clinical environment relates to the difficulty in getting these ‘effective’ laser doses to work on a particular machine. Few devices enable the practitioner to set the dose in J/cm\(^2\). Some will provide Joules, some Watts, some watts/cm-2 etc etc. It is currently argued that Joules (i.e. Energy) may in fact be the most critical parameter rather than Energy Density. The debate is not yet resolved, and the energy density will be used here, mainly because the published research almost exclusively cites it, and therefore, it may be of more use when it comes to trying to replicate an evidence based treatment dose.

Some machines offer ‘on board’ calculations of this dose, whilst other machines require the operator to make some simple calculations based on several considerations:
- output power (Watts)
irradiation area (cm²)
time (seconds)
If PULSED - pulse width, frequency and power settings

Table 1
POWER SETTINGS IN LASER THERAPY

<table>
<thead>
<tr>
<th>ENERGY DENSITY (J/cm²)</th>
<th>=</th>
<th>Total amount of energy (J) / Irradiation area (cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL ENERGY (J)</td>
<td>=</td>
<td>Average Power (Watts) x Time (sec)</td>
</tr>
<tr>
<td>AVERAGE POWER (Watts)</td>
<td>=</td>
<td>Peak power (W) x Frequency (Hz) x Pulse Duration (sec)</td>
</tr>
</tbody>
</table>

(only needed for pulsed output)

There are various alternative methods for calculating these doses, but those cited above offer a reasonably simple method should one be needed.

Most authorities (including the current CSP guidelines) suggest that the ENERGY DENSITY per TREATMENT SESSION should generally fall in the range of 0.1 - 12.0 J/cm² though there are some recommendations which go up to 30 J/cm². It has been previously suggested that a maximal (single treatment) dose of 4 J/cm² should not be exceeded. The evidence would not support that contention. Again as a generality, lower doses should be applied to the more acute lesions which would appear to be more energy sensitive.
Suggested Treatment Application

Table (2)
LASER Dosage

<table>
<thead>
<tr>
<th>Application</th>
<th>Laser Type</th>
<th>Energy Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRIGGER POINT</td>
<td>HeNe, GaAs</td>
<td>1-2 J/cm²</td>
</tr>
<tr>
<td>Superficial</td>
<td>HeNe, GaAs</td>
<td>0.5-2 J/cm²</td>
</tr>
<tr>
<td>Deep</td>
<td></td>
<td>0.5-1 J/cm²</td>
</tr>
<tr>
<td>EDEMA REDUCTION</td>
<td>GaAs, GaAs</td>
<td>0.05-0.1 J/cm²</td>
</tr>
<tr>
<td>Acute</td>
<td></td>
<td>0.5-1 J/cm²</td>
</tr>
<tr>
<td>Subacute</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WOUND HEALING (SUPERFICIAL TISSUES)</td>
<td>HeNe, HeNe</td>
<td>0.5-1 J/cm²</td>
</tr>
<tr>
<td>Acute</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WOUND HEALING (DEEP TISSUES)</td>
<td>GaAs, GaAs</td>
<td>0.5-1 J/cm²</td>
</tr>
<tr>
<td>Acute</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCAR TISSUE</td>
<td>GaAs</td>
<td>0.5-1 J/cm²</td>
</tr>
</tbody>
</table>
Therapeutic Benefits of Laser Therapy

Numerous clinical studies and research trials have been conducted on the beneficial effects of laser therapy for a whole host of clinical conditions. The following is a simplified list of the more widely studied biological effects of Laser Therapy.

Laser Therapy Effect: Pain Relief

Laser Therapy relieves pain through several different biological mechanisms. 1) Laser Therapy blocks the pain signals transmitted from injured parts of the body to the brain. This decreases nerve sensitivity and significantly reduces the perception of pain. 2) Laser Therapy also reduces pain by reducing inflammation and swelling. 3) Laser Therapy also reduces pain by increasing the production and release of endorphins and enkephalins which are natural pain-relieving chemicals within our bodies.

Laser Therapy Effect: Improved Nerve Function

Laser light speeds up the process of nerve cell reconnection which decreases the time necessary for nerve cells to heal after an injury. Laser Therapy also increases the amplitude (strength) of action potentials (signals sent along nerve fibers) which improves overall nerve and muscle function. Both of these reasons explain why Laser Therapy is so beneficial at reducing the symptoms related to nerve injury – namely sharp pain, numbness, tingling and burning.

Laser Therapy Effect: Inflammation Reduction

Laser Therapy causes the smaller arteries and lymph vessels of the body to increase in size – a mechanism called vasodilation. This increased vasodilation allows inflammation, swelling and edema to be cleared away from
injury sites more effectively. Vasodilation of lymph vessels also promotes lymphatic drainage which also aids in this vital healing process. Bruising is often resolved more quickly as a result of this particular biological effect.

**Laser Therapy Effect: Faster Wound Healing**

Laser therapy stimulates the production of fibroblasts which are the building blocks needed to create collagen. Collagen is the essential protein required to replace old tissue or to repair damaged tissue. Because of this effect Laser Therapy is effective at treating open wounds and burns.

**Laser Therapy Effect: Accelerated Tissue Repair and Cell Growth**

Photons of light emitted by therapeutic lasers penetrate deeply into the tissues of the body to stimulate the production centers of individual cells. This stimulation increases the energy available to these cells causing them to absorb nutrients and expel waste products more rapidly. This dramatically accelerates the repair of injured tissue leading to faster tendon, ligament and muscle healing.

**Laser Therapy Effect: Improved Blood Flow**

Laser Therapy significantly increases the formation of new capillaries (tiny blood vessels) within damaged tissues. With more capillaries bringing more blood to the injury site healing is sped up, wounds are closed more rapidly and scar tissue formation is reduced.

**Laser Therapy Effect: Increased Metabolic Activity**

Laser Therapy also has a profound impact on individual blood cells that pass through the laser beam during treatment. The laser light significantly increases the oxygen and nutrient load capacity of the red blood cells (RBCs). This allows for increased metabolic activity and production of certain specific
enzymes. Both of these effects can be felt across the entire body and are not just limited to the area exposed to the laser light.

**Laser Therapy Effect: Reduced Formation of Scar Tissue**

Laser Therapy reduces the formation of scar tissue (fibrous tissue) following tissue damage related to cuts, burns and surgery. Laser Therapy is able to reduce this formation by speeding up the healing process, improving the blood flow to the injured area and more effectively carrying away waste products – all are mechanisms mentioned above. Faster healing always leads to less scar tissue formation.

**Laser Therapy Effect: Enhanced Immune Function**

Photons of laser light are directly absorbed by chromophores (molecular enzymes within cells) that are embedded within most cells of the body. This laser light absorption activates a specific enzymatic process that triggers the production of ATP. ATP (adenosine tri-phosphate) is the single most important form of energy that powers ALL chemical reactions within ALL cells of the body. Higher energy production leads to faster and more efficient function – especially true of immune-specific cells that are exposed to Laser Therapy. This improved efficiency aids the immune system in fighting off undesirable microbes and pathogens.

**Laser Therapy Effect: Acupuncture Point Stimulation**

Laser Therapy is also an effective alternative to traditional Acupuncture treatment. Traditional Acupuncture delivers therapeutic effects through the mechanical stimulation of "Acupuncture Points" throughout the body. This is achieved by piercing the Acupuncture Points with needles and then twisting the needles by hand, tamping them or connecting them to electrical stimulation
devices. Laser Therapy may be used to stimulate the same Acupuncture Points without the need for invasive needling or similar mechanical stimulation.

**Strapping and Taping**

Strapping and taping techniques are some of the most important and most visible skills a physiotherapist, sports therapist or athletic trainer working with sports men and women can have. Strapping and taping techniques can help prevent injury as well as protect the athlete from re-injury whilst returning to sport.

**The role of strapping and taping**

Strapping and taping techniques are some of the most important and most visible skills a physiotherapist, sports therapist or athletic trainer working with sports men and women can have.

Strapping and taping techniques can help prevent injury as well as protect the athlete from re-injury whilst returning to sport. The role of tape is to limit the movement in an injured joint to prevent excess or abnormal movement. In addition it should provide support to the muscles surrounding the joint that may be under additional strain due to the ligament injury.

Another benefit of taping is thought to be the enhanced proprioception (or kinaesthetic feedback) that the tape provides during movement (or in other words it is thought to improve co-ordination). For example if a taped ankle starts to invert (turn over) during a jump then the tape will restrict this and inform the body that it needs to contract muscles to prevent this movement in the ankle. Without this feedback the athlete may be unaware the ankle has started to invert and land on it badly injuring it again.

Tape should only be used in conjunction with a proper rehabilitation programme including stretching, mobility and strengthening exercises.
Tape can also be used to protect unstable joints where repeated or severe ligament damage has resulted in stretching of the ligaments and joint laxity. For examples athletes who repeatedly suffer ankle sprains due to laxity of the joint may benefit from taping or wearing an ankle brace to support the joint because the ligaments have been stretched too much to do their job properly. Tape is also used to secure protective pads and dressings.

**Types of sports strapping tape**

There are many different types of tape used for strapping and taping in sport. The three main types used are zinc oxide tape, elastic adhesive bandage and elastic cohesive bandage.

**Zinc oxide tape**

Zinc oxide tape is usually white (sometimes tan or brown) in colour, non elastic and sticky. It is given the common name zinc oxide tape due to the glue containing zinc oxide (although other types of tape may have glue containing zinc oxide. It comes in a variety of widths and is easy to tear (honest!). It is used in a variety of applications, particularly limiting the range of movement of a joint or protecting the skin against blisters. Sometimes underwrap (a soft foam type tape) is used underneath zinc oxide tape to protect the skin. Best results are obtained from applying tape directly to the skin but on particularly hairy clients who choose not to shave this is the next best option. When using underwrap a skin adhesive is required to ensure the underwrap sticks as well as possible to the skin. Zinc oxide tape should never be used to surround or enclose muscles as these are likely to expand during exercises and result in restricted blood flow to the area.
Elastic Adhesive Bandage

Elastic adhesive bandage or EAB as it is often known is an elastic material type tape that is adhesive and will stick to skin. It comes in a variety of widths but most common is 2 inch (5cm) and 3 inch (7.5cm). EAB is too strong to be torn with the fingers and should be cut with scissors or special tape cutters. EAB is particularly useful for taping around muscles as they will expand during exercise and the tape will allow this to some extent. It is often used to apply anchors from which zinc oxide tape is applied to restriction joint movement.
Cohesive bandage

Cohesive bandage is an elastic bandage which will stick to itself but not the skin. It does not have any sticky or adhesive layer to make it stick to skin. Cohesive bandages come in a wide variety of colours, are elastic and are very easy to tear with the fingers. They are commonly used for wrapping joints, finishing off and covering tapings and for compression to injured joints or muscles.

BASIC TAPING METHODS

Taping for Plantar Fascitis

Step 1

- Starting on the inside of the foot apply a strip of zinc oxide tape as shown below.
- The tape should be about 2 cm in width. Note you should finish up at the same point you started from.
- Try not to get any wrinkles in the tape as this could cause blisters.
Step 2

- Next do the same starting on the outside of the foot and finishing on the outside of the foot.
- You should have a crossed pattern as shown on the left.
- Then repeat these first two steps overlapping with tape until you have applied two pieces of tape each side.
Step 3

- Finally cover what you have just done with a number of shorts strips of tape that go across the underneath of the foot.
- Again be careful not to wrinkle the tape or do it too tight.

Figure (25)

Taping Plantar Fascitis Step 3

Step 4

- You might like to finish it off with a small piece of tape across the top of the foot connecting each side to secure it.
- This is what it should look like when finished.

Figure (26)

Taping Plantar Fascitis Step 4
Achilles Tendon Taping

The purpose of this taping is to support the Achilles tendon by not allowing it to over stretch.

**Step 1**

Apply under wrap tape onto sprayed legs or just shave the leg to enable the tape to stick and not take half your leg with it when you pull it off.

Apply two 'anchor' 5cm stretch tapes above the bulk of the calf muscle and two around the mid foot.

![Achilles Taping step 1](image)

**Step 2**

Lie face down with the lower leg supported to allow the foot to point slightly as shown below.

Apply a strip of stretch tape from the foot anchor to the calf anchor applying slight stretch. Do not stick the tape to the tendon.
Step 3

Apply another strip of stretch tape starting at the outside top of the calf anchor and going down and across the calf and under the heel. From here (the outside of the ankle), pass the tape up and across the calf to finish on the inside of the calf anchor.

Step 4

Finish off by applying a strip zinc oxide tape over the anchors to secure the ends.
Do not pass this tape all the way around the calf or foot as it does not stretch when the calf muscle expands as it contracts.

A third strip can be wrapped just above the ankle as shown to secure the vertical strips.

**Ankle Taping Techniques**

The following ankle taping techniques was used to provide support for the ankle and also particularly beneficial following a lateral ligament sprain of the ankle, or, to prevent an ankle sprain. Generally it is recommended that the ankle is shaved 12 hours prior to taping (to prevent painful removal of hairs and skin irritation). The skin should be cleaned removing any grease or sweat. Low irritant Fixomull tape should be applied as an under-wrap to reduce the likelihood of skin irritation with rigid sports tape over the top of this. Some or all of these ankle taping techniques may be applied to tape the ankle and provide the support required for the individual.

**Anchor**

Place a strip of tape around the lower 1/3 of the shin (figure 1). This should be applied gently to prevent circulatory problems and is used as a fixation point for the other ankle taping techniques.

**Figure (30) – Ankle Taping Anchor**
Stirrups

Keeping the foot and ankle in a neutral position (foot and toes pointing vertically upwards), start the tape at the level of the anchor on the inner aspect of the ankle and lower leg. Begin this ankle taping technique by following the black arrows (figure 2) and conclude this taping technique at the level of the anchor at the outer aspect of the ankle and lower leg by firmly following the white arrows (figure 3). Do 2-3 stirrups just slightly forwards and backwards of each other depending on the amount of support required.

Figure(31) – Beginning of Stirrup (Inner Ankle) Figure (32) – End of Stirrup (Outer Ankle)

Figure-of-6’s

Keeping the foot and ankle in a neutral position, start the tape at the level of the anchor on the inner aspect of the ankle and lower leg. Begin this ankle taping technique by following the black arrows (figure 4) and conclude this taping technique by firmly following the white arrows to the inner aspect of the ankle (figures 4,5). Do 1-3 Figure-of-6’s slightly forwards and backwards of each other depending on the amount of support required.
Reverse Figure-of-6's

Keeping the foot and ankle in a neutral position, start the tape at the level of the anchor on the outer aspect of the ankle and lower leg. Begin this ankle taping technique by following the black arrows (figure 6) and conclude this taping technique by firmly following the white arrows to the outer aspect of the ankle (figures 6, 7). Do 1-3 Reverse Figure-of-6's slightly forwards and backwards of each other depending on the amount of support required.
Half Heel Lock

Keeping the foot and ankle in a neutral position, start the tape at the level of the anchor on the inner aspect of the ankle and lower leg. Begin this ankle taping technique by following the black arrows (figures 8,9) and conclude this taping technique by firmly following the white arrows back to the inner aspect of the ankle.

Reverse Half Heel Lock

Keeping the foot and ankle in a neutral position, start the tape at the level of the anchor on the outer aspect of the ankle and lower leg. Begin this ankle taping technique by following the black arrows (figure 10,11) and conclude this taping technique by firmly following the white arrows back to the outer aspect of the ankle.
Quadriceps Taping Technique

The following technique was used for the subjects with quadriceps strain

**Step 1**

The athlete is positioned by placing a 1.5 inch roll of tape under the heel to bend the knee. Ideally the thigh should be shaved but if this is not an option then apply spray adhesive and underwrap. Wrap from the bottom upwards.

**Step 2**

Apply a strip of 2 inch non stretch white tape either side of the area to be supported. Place a foam pressure pad over the site of injury.
**Step 3**

Using 1.5 inch non stretch white tape start the first support strip on the anchor, just below the area of injury on the inside of the leg and apply it across and up at 45 degrees. Repeat this from the other side.

*Figure (43)*

Quadriceps Taping -Step-3

**Step 4**

Repeat these strips up the thigh, overlapping by half the width of the tape until the area is fully covered.

Note, the support strips do not go completely around the thigh.

The support can be covered again with underwrap to help prevent it moving around (optional).
Step 5

Close the entire taping with 6 inch elastic crepe bandage (non-adhesive). Wrap from the bottom upwards.
The athlete should contract the thigh whilst this is being done to avoid the bandage being applied too tightly.

Taping Technique for Hamstring Strain

The aim of this taping is to provide compression to a strain or contusion in the acute stage.
Step 5

Close the entire taping with 6 inch elastic crepe bandage (non-adhesive). Wrap from the bottom upwards.
The athlete should contract the thigh whilst this is being done to avoid the bandage being applied too tightly.

Taping Technique for Hamstring Strain

The aim of this taping is to provide compression to a strain or contusion in the acute stage.
Step 1

- The athlete should be standing. Ideally the hair should be shaved from the back of the thigh.
- Apply adhesive spray and under wrap starting at the bottom and work up.

Step 2

- Apply a pressure pad over the site of the injury.
- Using 2 inch non stretch zinc oxide tape apply one anchor strip on the outside of the injury and another on the inside.

Figure (46)
Hamstring Taping-Step-2

Step 3

- Using 2 inch non stretch tape again apply the first compression strip from just below the site of injury on the inside anchor upwards and across at 45 degrees.
- The next supporting strip goes from the outside anchor just below the site of injury and crosses the first strip as it passes upwards to the inside of the thigh again at 45 degrees.
Figure (47)
Hamstring Taping-Step-3

**Step 4**
- Repeat the above overlapping each strip by half working upwards until the entire area is covered.
- Note the strips do NOT go completely around the thigh as this would stop circulation of blood.
- The taping is covered with under wrap to help prevent it from moving.

Figure (48)
Hamstring Taping-Step-4

**Step 5**
- Close the entire taping with 6 inch crepe type compression bandage.
• Starting at the bottom wrap the tape around working upwards at 45 degrees applying a tug on the bandage at the 45 degree angle. Then as it comes around the thigh and back down at 45 degrees apply another tug.
• Work upwards crossing at 45 degrees all the way.
• Ensure the athlete tenses muscles in the thigh when this is being done to allow for muscle expansion after the job is finished.

**Taping for Knee Medial Collateral ligament Sprain**

The aim of this taping is to provide support to the medial collateral ligament. This may be important if the athlete has an unstable knee or laxity in the joint. Tape will provide support. It may also be useful to protect the area when gradually returning to full fitness. Do not tape if unsure of the injury or why the taping is being used.

**Step 1**
• Prepare the leg by shaving or applying the spray adhesive followed by underwrap.
• Place a roll of tape or similar under the heel of the athlete to achieve the correct position for taping.
• The calf, knee and thigh need to be covered. This will help the tape stick properly and protect the leg from pain hair removal when removing the tape.
• Once the leg is bent, ensure the toes face inwards slightly so the lower leg is partially rotated inwards (not shown).

**Step 2**
• Using two or three 7.5 cm strips of elastic tape apply anchors to the mid / upper thigh of the athlete.
• Ensure the athlete contracts both the calf and thigh muscles while the anchors are applied so blood flow is not restricted later on.
• Repeat the above applying two 7.5cm elastic anchors to the middle of the calf muscle.
• Again ensure muscles are contracted when this is done.
• The taping will have more support if these anchors can attach to the skin - the leg will need to be shaved for this.

Figure (49)
Knee Taping-Step-2

Step 3
• Using 5cm elastic tape apply a strip of tape from the outside of the lower leg, upwards and inwards crossing the joint line of the knee (but staying below the knee).
• Pull firmly upwards when applying this strip to stretch it before applying it to the upper anchor

Figure (50)
Thigh Taping-Step-3

Step 4
• Using 5cm elastic tape apply a second strip of tape starting on the inside of the calf anchor.
• The tape passes up across the knee joint line and above the kneecap.
• Again stretch the tape firmly before fixing on the upper anchor.

**Figure (51)**
Knee Taping-Step-4

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**Step 5**
• Repeat both of the above taping strips with non stretch 3.8 cm zinc oxide tape.

**Step 6**
• Complete the taping by applying strips of 7.5 cm elastic tape over the original anchors to close the taping off.
• Avoid finishing a tape strip on the inside of the thigh as may peel off due to friction of the legs.

**Elbow Taping**

The following elbow taping techniques were used to provide support to the elbow. Generally it is recommended that the elbow is shaved 12 hours prior to taping (to prevent painful removal of hairs and skin irritation). The skin should be cleaned removing any grease or sweat. Low irritant Fixomull tape should be applied as an under-wrap to reduce the likelihood of skin irritation with rigid sports tape over the top of this.

**Anchors**

Keeping the elbow in a slight bend, tape around the upper arm and forearm just above and below the elbow (figure 1). Keep the arm and forearm
muscles contracted during this process and apply the tape gently to prevent circulatory problems. Anchors are used as a fixation point for other elbow taping techniques.

**Figure (52)**
Elbow Anchors

Medial Crosses Taping for Medial Epicondylitis

Keeping the elbow in a slight bend (approximately 30 degrees), start the tape at the level of the arm anchor on the inner aspect of the elbow by following the black arrows (figure 2). Conclude this elbow taping technique at the level of the forearm anchor by firmly following the white arrows (figure 2). 3 pieces of tape should be used forming a cross (figure 2). Do 1 - 2 medial crosses depending on the amount of support required.

**Figure (53)**
Medial Epicondylitis Taping
Lateral Crosses Taping for Lateral Epicondylitis

Keeping the elbow in a slight bend (approximately 30 degrees), start the tape at the level of the arm anchor on the outer aspect of the elbow by following the black arrows (figure 3). Conclude this elbow taping technique at the level of the forearm anchor by firmly following the white arrows (figure 3). 3 pieces of tape should be used forming a cross (figure 3). Do 1 - 2 lateral crosses depending on the amount of support required.

Figure (54)
Lateral Epicondylitis Taping- Lateral Crosses

Wrist Taping Techniques

The following wrist taping techniques may be used to provide support for the wrist and are particularly beneficial following a sprained wrist, or, to prevent a sprained wrist. Generally it is recommended that the wrist is shaved 12 hours prior to taping (to prevent painful removal of hairs and skin irritation). The skin should be cleaned removing any grease or sweat. Low irritant Fixomull tape should be applied as an under-wrap to reduce the likelihood of skin irritation with rigid sports tape over the top of this.

Some or all of these wrist taping techniques may be applied to tape the wrist and provide the support required for the individual.

Anchors

Place a strip of tape around the palm of the hand just below the four fingers and a strip of tape around the forearm, just before the wrist (figure 1).
This should be applied gently to prevent circulatory problems and is used as a fixation point for the other wrist taping techniques.

**Figure 55—Wrist Anchors**

**Dorsal Crosses**

Keeping the wrist in a neutral position (wrist should be bent backwards slightly - about 30 degrees), start the tape at the level of the forearm anchor on the back of the wrist by following the black arrows (figure 2). Conclude this wrist taping technique at the level of the palm anchor by firmly following the white arrows (figure 2). 2 pieces of tape should be used forming a cross - one beginning from the inner wrist and travelling to the outer hand, the other beginning from the outer wrist, travelling to the inner hand (figure 2). Do 1-2 dorsal crosses depending on the amount of support required.
Palmer Crosses

Keeping the wrist in a neutral position (wrist should be bent backwards slightly – about 30 degrees), start the tape at the level of the forearm anchor on the palm side of the wrist by following the black arrows (figure 3). Conclude this wrist taping technique at the level of the palm anchor by firmly following the white arrows (figure 3). 2 pieces of tape should be used forming a cross - one beginning from the inner wrist and travelling to the outer palm, the other beginning from the outer wrist, travelling to the inner palm (figure 3). Do 1-2 palmer crosses depending on the amount of support required
Dorsal Straight Lines

Keeping the wrist in a neutral position (wrist should be bent backwards slightly – about 30 degrees), start the tape at the level of the forearm anchor on the back of the wrist by following the black arrows (figure 4). Conclude this wrist taping technique at the level of the palm anchor by firmly following the white arrows (figure 4). 2 – 3 pieces of tape should be used each overlapping the adjacent layer by approximately 50%

Figure 58—Wrist Dorsal Straight Lines

Palmer Straight Lines

Keeping the wrist in a neutral position (wrist should be bent backwards slightly – about 30 degrees), start the tape at the level of the forearm anchor on the palm side of the wrist by following the black arrows (figure 5). Conclude this wrist taping technique at the level of the palm anchor by firmly following the white arrows (figure 5). 2 – 3 pieces of tape should be used each overlapping the adjacent layer by approximately 50% (figure 5).
General Wrist Taping for excellent support

The following is a general recipe that may be used by physiotherapists to provide excellent support to the wrist and to prevent wrist injury (figures 6, 7):

1. Palm Anchor x 1
2. Forearm Anchor x 1
3. Dorsal Crosses x 1 – 2
4. Palmer Crosses x 1 – 2
5. Dorsal Straight Lines x 2 – 3
6. Palmer Straight Lines x 2 – 3
7. Repeat Palm Anchor x 1
8. Repeat Forearm Anchor x 1

Reason for selecting the topic

As we discussed early, soft tissue injuries are commonly seen in sports injuries, which make the sports man unable to continue the game and prevent his future participation in the game.

Sports seem like a fun way of burning extra calories to lose weight, but according to a U.S. Consumer Product Safety Commission report, sports injuries among baby boomers increased by 33 percent from 1991 to 1998 & increased by
56 percent from 1999 to 2009. (U.S. Consumer Product Safety Commission, April 2009) There were about 276,000 hospital emergency room-treated injuries to persons 35 to 54 in 1991 compared to more than 365,000 sports injuries to persons of these ages in 1998. The number of injuries keeps increasing every year. In 2006, the National Electronic Injury Surveillance System (NEISS) reported over half a million injuries just for basketball. Another two million injuries were associated with bicycling, football, other sports.[ National Electronic Injury Surveillance System (NEISS) On-line]

So this is the time to work in this area in order to help the sports man to recover from the injury as early as possible by formulating a effective treatment protocol.

**Reason for selection of variables**

In the management of soft tissue injuries lot of treatment options are available. As per review of literature there studies supporting LASER therapy, ultrasound therapy and Taping were individually used in the management of soft tissue injuries. Hence the investigator had chosen these variables to formulate an effective protocol by combining taping with electro therapy to get good and early recovery in the soft tissue injuries.

**Statement of the problem**

The aim of the study is to evaluate the efficacy of taping technique, LASER therapy & and ultrasound therapy in the management of soft tissue injuries in sports.
Significance of the study

There are various protocols in physiotherapy practice for the treatment of soft tissue injuries.

The significance of this study is to formulate the effective protocol in order to facilitate good recovery and make the players back to the field as early as possible and also to find the role of taping, ultrasound therapy and LASER therapy in such early recovery. So it will be useful for the physiotherapist to effectively manage the soft tissue injury & facilitate early recovery.

Hypothesis

- It was hypothesized that Combination of Ultrasound Therapy & taping group (A) will be the best effective combination in the treatment & good recovery of soft tissue injuries.

- It was hypothesized that Ultrasound Therapy is more effective than LASER in treatment & good recovery of soft tissue injuries.

- It was hypothesized that Taping as an adjunct in any protocol will facilitate good recovery in soft tissue injuries.
DELIMITATION

Delimitation of this topic as follows:

The population for the study which was selected at random were 163 subjects who were volunteers both male & female, aged between 18 years to 30 years and playing not less than 2 year in their relevant sports.

DEPENDENT VARIABLES
1. Pain
2. Tenderness
3. Range of motion
4. Functional Assessment.

INDEPENDENT VARIABLES
1. Ultrasound therapy
2. LASER Therapy
3. Taping
4. Soft Tissue Manipulation
LIMITATION

Certain factors like intervening variables such as game involved, gender, training mode, sports skill required by the game, fitness level, body composition, climatic conditions which may have an influence on the study was limited.