CHAPTER I

INTRODUCTION
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Pain is a complex perception that differs enormously among individual patients, even those who appear to have identical injuries or illnesses. In 1931, the French medical missionary Dr. Albert Schweitzer wrote, "Pain is a more terrible lord of mankind than even death itself." Today, pain has become the universal disorder, a serious and costly public health issue, and a challenge for family, friends, sports players and health care providers who must give support to the individual suffering from the physical as well as the emotional consequences of pain.

Pain is inevitable, but suffering is optional. For many athletes, pain is a normal everyday experience and success is often achieved in spite of pain. So there is a need to find out what's the best strategy for coping with overcoming and managing pain.

Pain is synonymous with sport. Endurance athletes relish the challenge of 'pushing through pain' while boxers expect to fight on regardless of a jarring blow to the chin. Adulation is reserved not just for the star rugby player, but anyone who can play through pain and contribute to the team. Winners and heroes overcome pain. Losers don’t. But the price of pain can be high. Pain both demands attention and creates fear. (Matt Lancaster et al, Pain Journal, 2005)

Willis and Campbell (1992) indicate that pain is associated with dropout among sports participants. Van Raalte and Brewer (1996) stated that some athletes are using drugs to moderate pain caused by athletic injuries. It can restrict the ability to concentrate on performance and take away the opportunity to compete. Pain can even end sporting careers. The relationship between pain
and sport is filled with challenges for sportsmen and women as well as those who support them. However, although pain of some description is no stranger to most athletes, it’s still a curious phenomenon in many ways. Particularly, it is needed to analyse how the components of pain influencing the sportsman and how those components can be holistically managed to carry on with sports and achieve success.

Past and contemporary authors of sport psychology have given very little attention to the psychological and functional aspects of pain. Recent studies have resolved out the components of pain and ways of multimodal management of pain. The experience of pain is closely associated with affective distress. This may range through anxiety, fear, anger and depression. The fact that pain represents danger raises the level of anxiety. In the longer term, pain promotes impairment and disability. Impairment and disability lead to the restriction of a person’s ability to participate in day-to-day social activities. Over a period of time cumulative effects of ongoing impairment and disability lead to a series of events nominated as secondary losses (Banks and Kerns 1996). Secondary loss refers to the effect of pain in various domains of daily life. These include loss of work and leisure activities, interference in and loss of intimate relationships, financial strife, unemployment and loss of self esteem. Thus, it can be inferred that pain is not an isolated phenomenon; rather it affects a person globally.

THE CONCEPT OF PAIN

The International Association for the Study of Pain defines it as, an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage. There are two basic types of pain, acute and chronic;

**Acute pain**, for the most part, results from disease, inflammation, or injury to tissues. This type of pain generally comes on suddenly, for example, after trauma or surgery, and may be accompanied by anxiety or emotional distress.
The cause of acute pain can usually be diagnosed and treated, and the pain is self-limiting, that is, it is confined to a given period of time and severity. In some rare instances, it can become chronic.

**Chronic pain** is widely believed to represent disease itself. It can be made much worse by environmental and psychological factors. Chronic pain persists over a longer period of time than acute pain and is resistant to most medical treatments. It can, and often does, cause severe problems for players.

**BRIEF HISTORY OF PAIN**

Ancient civilizations recorded on stone tablets accounts the treatments used for pain are pressure, heat, water, and sun. Early humans related pain to evil, magic, and demons. Relief of pain was the responsibility of sorcerers, shamans, priests, and priestesses, who used herbs, rites, and ceremonies as their treatments.

The Greeks and Romans were the first to advance a theory of sensation, the idea that the brain and nervous system have a role in producing the perception of pain. But it was not until the middle Ages and well into the Renaissance-the 1400s and 1500s-that evidence began to accumulate in support of these theories. Leonardo da Vinci and his contemporaries came to believe that the brain was the central organ responsible for sensation. Da Vinci also developed the idea that the spinal cord transmits sensations to the brain.

In the 17th and 18th centuries, the study of the body-and the senses-continued to be a source of wonder for the world's philosophers. In 1664, the French philosopher René Descartes described what to this day is still called a "pain pathway." Descartes illustrated how particles of fire, in contact with the foot, travel to the brain and he compared pain sensation to the ringing of a bell. In the 19th century, pain came to dwell under a new domain of science in paving the
way for advances in pain therapy by inventing pain relieving drugs. Before long, anesthesia, both general and regional was refined and applied during surgery. Thus, pharmacology was the only option then for treating pain. After 19th century, non-pharmacological treatments came into the science. Physiotherapy was one among those which developed gradually, which uses heat, cold, water, current, magnet for the treatment of pain and other several conditions. As the 21st century unfolds, however, advances in pain research are creating a better understanding of pain, along with greatly improved treatments to keep it in check.

**ADVANCE THEORIES OF PAIN CONTROL**

**Specificity Theory** consider pain as an independent sensation with specialised peripheral sensory receptors called as nociceptors, which respond to damage and send signals through pathways in the nervous system to target centres in the brain. These brain centres process the signals to produce the experience of pain.

**Pattern Theory** consider that peripheral sensory receptors, responding to touch, warmth and other non-damaging as well as to damaging stimuli, give rise to non-painful or painful experiences as a result of differences in the patterns of the signals sent through the nervous system

**Gate Control Theory** Melzack and Wall highlighted that pain messages are carried by the specific nerve fibres that can be blocked before reaching the brain by the actions of other nerves and psychological factors (Brannon and Feist, 2000, Polnik 1999, Goleman and Gurin, 1993). Melzack and Wall suggested that when pain signals first reach the nervous system, the pain messages are sent to the thalamus and the 'gate' opens to allow the pain messages to be sent to superior centers in the brain (Brannon and Feist, 2000). However, the gate may remain closed if neurons come in contact with pain signals, the neurons has the ability to overpower the pain signals which results in
the gate remaining closed (Brannon and Feist, 2000). Pain signals can also be stopped if the hypothetical gate remains closed as our natural painkiller, endorphins, blocks the pain signals from getting to the brain (Goleman and Gurin, 1993). Melzack and Wall (cited in Bromley and Adams, 1998) highlights that previous memory of how the prior painful situation was handled, supportive support members, positive thinking of pain, distraction, prior conditioning, cultural values, boredom, stress, negative thinking, poor pain coping skill may allow the gate to open or to remain closed by affecting the central control system.

**PAIN PATHWAY**

There are two types of nerves, Afferent which is ascending transmit impulses from the periphery to the brain which have First Order neuron, Second Order neuron, Third Order neuron. Efferent which is descending transmit impulses from the brain to the periphery. First Order Neurons are stimulated by sensory receptors and end in the dorsal horn of the spinal cord. They are A-alpha, non-pain impulse, A-beta, non-pain impulses, A-delta, pain impulses, C Pain impulses.

Second Order Neurons receive impulses from the FON in the dorsal horn at Lamina II, Substantia Gelatinosa which determines the input sent to T cells referred as transmission cells from peripheral nerve and then pain travel along the spinothalamic tract & pass through Reticular Formation and ends in thalamus. Second Order Neuron Types are Wide range specific -Receive impulses from A-beta, A-delta, & C, Nociceptive specific - Receive impulses from A-delta & C.

Third Order Neurons begins in thalamus and ends in specific brain centers in cerebral cortex. They perceive location, quality, and intensity and allow feeling pain, integrating past experiences & emotions and determining reaction to stimulus.
Descending Neurons - Descending Pain Modulation

Transmit impulses from the brain through corticospinal tract in the cortex to the spinal cord lamina, Periaqueductal Gray Area release Endogenous opioid peptides - endorphins & enkephalins. Nucleus Raphe Magnus release serotonin. The release of these neurotransmitters inhibits ascending neurons. Stimulation of the PGA in the midbrain & NRM in the pons & medulla causes analgesia.

PAIN TRANSMISSION

The primary afferent nociceptor is activated by a noxious stimulus. The message is transmitted over the small-diameter axons where they enter the spinal cord via both the dorsal and ventral spinal roots. Cells in the spinal cord are then activated, and the signal is transmitted to the brainstem, thalamus, and cortex where modulating factors occur and where the conscious perception of pain takes place.
FIGURE 1
PATHWAY OF PAIN TRANSMISSION AND MODULATION

Spinal and supraspinal pathways of pain

Cerebral cortex

Thalamus

Fibres to hypothalamus

Fibres to periaqueductal grey matter

Fibres to reticular formation

Forebrain

Midbrain

Periaqueductal grey matter

Locus coeruleus

Medulla

Nucleus reticularis gigantocellularis (NE)

Nucleus raphe magnus (5-HT)

Inhibitory dorsal columns

Spinal cord

Dorsal root ganglion

C fibres

Aδ fibres

Ascending nociceptive fast (red) and slow (green) pathways.
Descending inhibitory tracts (blue).
5-HT, 5 hydroxytryptamine; NE, norepinephrine
PAIN MODULATION

Pain transmission is subject to several modulating factors within the nervous system. These include the synergistic effects of the products of inflammation, the inhibiting effects of large diameter non nociceptive afferent fibers, and chemical modulation by catecholamines, substance P, serotonin, and the endorphins. Substance P is a neurotransmitter located in the polymodal nociceptors. Any stimulus strong enough to activate the C fibers also elicits the release of substance P into the cerebrospinal fluid. In experimental models, depletion of substance P from a polymodal nociceptor results in analgesia to noxious stimuli in the area subserved by the treated nerve.

In 1965, Melzack and Wall proposed a gate-control theory of pain perception. Although the "gate" is not completely understood, the large-diameter fibers have a lower threshold for stimulation and can inhibit stimulation of the C-fiber nociceptors when they are activated. The most significant findings in recent years regarding endogenous mediation of pain have been the discovery of opiate receptors in the brain and of endogenous morphine-like compounds, the endorphins. By the mid-1970s, opioid receptors were identified, followed by the discovery of the first two endorphins, leucine and methionine enkephalin. (G.Browne et al, 1976)

Recent work has shown that analgesia may be caused by stimulation of certain areas of the brain, such as the peri-aqueductal gray area. These areas of the brain also have high concentrations of endorphins. It is also theorized that there are at least three types of opiate receptors: mu, delta, and kappa. This information may help explain differing potencies and side effects of the opioid analgesics and help explain differing perceptions of pain. (Crook.J et al, 1989)

Serotonin is a neurotransmitter that is involved with depression and plays a role in the modulation of pain. Descending pathways terminate on the spinal cord in areas close to spinal cord cells that are responsive to painful stimuli.
There is a high concentration of serotonin in these terminal axons and stimulation of these cells inhibits the pain-responsive cells and, therefore, pain transmission. Pain fibers enter the spinal cord at the dorsal root ganglia and synapse in the dorsal horn. From there, fibers cross to the other side and travel up the lateral columns to the thalamus and then to the cerebral cortex.

The pain signal is modulated at multiple points in both segmental and descending pathways by many neurochemical mediators, including endorphins such as enkephalin and monoamines such as serotonin, norepinephrine. These mediators interact in poorly understood ways to exaggerate or reduce the perception of and response to pain. Psychological factors are important modulators. They not only affect verbal expression of pain but also generate neural output that modulates neurotransmission along pain pathways. Psychological reaction to protracted pain interacts with other CNS factors to induce long-term changes in pain perception.

PATHOPHYSIOLOGY OF ACUTE PAIN

Acute pain is a physiological response that warns us of danger. The process of nociception describes the normal processing of pain and the responses to noxious stimuli that are damaging or potentially damaging to normal tissue. There are four basic processes involved in nociception such as transduction, transmission, perception, modulation. (McCaffery and Pasero, 1999).

Transduction of pain - Transduction begins when the free nerve endings of C fibres and A-delta fibres of primary afferent neurones respond to noxious stimuli. Nociceptors are exposed to noxious stimuli when tissue damage and inflammation occurs as a result of, for example, trauma, surgery, inflammation, infection, and ischemia. The chemical mediators activate the nociceptors to the noxious stimuli. In order for a pain impulse to be generated, an exchange of sodium and potassium ions during de-polarisation and re-polarisation occurs at
the cell membranes. This results in an action potential and generation of a pain impulse.

**Transmission of pain** - The pain impulse is then transmitted from the spinal cord to the brain stem and thalamus via two main nociceptive ascending pathways. These are the spinothalamic pathway and the spinoparabrachial pathway. The transmission process occurs in three stages. The pain impulse is transmitted as first stage from the site of transduction along the nociceptor fibers to the dorsal horn in the spinal cord, second stage from the spinal cord to the brain stem, third stage through connections between the thalamus, cortex and higher levels of the brain, multiple areas in the brain where they are processed.

**Perception of pain**

Perception of pain is the end result of the neuronal activity of pain transmission and where pain becomes a conscious multidimensional experience. The multidimensional experience of pain has affective-motivational, sensory-discriminative, emotional and behavioral components. When the painful stimuli are transmitted to the brain stem and thalamus, multiple cortical areas are activated and responses are elicited. These areas are as follows:

The reticular system: This is responsible for the autonomic and motor response to pain and for warning the individual to do something.

Somatosensory cortex: This is involved with the perception and interpretation of sensations. It identifies the intensity, type and location of the pain sensation and relates the sensation to past experiences, memory and cognitive activities.

Limbic system: This is responsible for the emotional and behavioral responses to pain for example, attention, mood, and motivation, and also with processing pain and past experiences of pain.
Modulation of pain - The modulation of pain involves changing or inhibiting transmission of pain impulses in the spinal cord. The multiple, complex pathways involved in the modulation of pain are referred to as the descending modulatory pain pathways and these can lead to either an increase in the transmission of excitatory pain impulses or a decrease in transmission i.e inhibition. Descending inhibition involves the release of inhibitory neurotransmitters that block or partially block the transmission of pain impulses, and therefore produce analgesia. Endogenous pain modulation helps to explain the wide variations in the perception of pain in different people as individuals produce different amounts of inhibitory neurotransmitters. Endogenous opioids are found throughout the central nervous system and prevent the release of some excitatory neurotransmitters, for example, substance P, therefore, inhibiting the transmission of pain impulses.

PATHOPHYSIOLOGY OF CHRONIC PAIN

Chronic pain can be a major problem for some people and affect their quality of life. It can be caused by alterations in nociception, injury or disease and may result from current or past damage to the peripheral nervous system, CNS, or may have no organic cause (Calvino and Grilo, 2006). The exact mechanisms involved in the pathophysiology of chronic pain are complex and remain unclear. It is believed that following injury, rapid and long-term changes occur in parts of the CNS that are involved in the transmission and modulation of pain (Ko and Zhuo, 2004).

A central mechanism in the spinal cord, called ‘wind-up’, also referred to as hypersensitivity or hyperexcitability, may occur. Wind-up occurs when repeated, prolonged, noxious stimulation causes the dorsal horn neurones to transmit progressively increasing numbers of pain impulses. The patient can feel intense pain in response to a stimulus that is not usually associated with pain, for example, touch. This is called allodynia. This abnormal processing of pain within the PNS and CNS may become independent of the original painful event. In
some cases, for example, amputation, the original injury may have occurred in the peripheral nerves, but the mechanisms that underlie the phantom pain are generated in both the PNS and the CNS.

COMPONENTS OF PAIN

Pain is a signal from the body to the brain that tells you that something is wrong. There are three components of pain such as physical or biological, psychological, and functional. The researchers recognized that pain may occur in the absence of tissue damage and is impacted by emotional or psychological factors.

Pain is a total biopsychosocial experience. You hurt physically. You psychologically respond to the pain by thinking, feeling, and acting. You think about the pain and try to figure out what is causing it and why you’re hurting. You experience emotional reactions to the pain. You may get angry, frightened, or frustrated by your pain. You talk about your pain with family, friends, and coworkers who help you to develop a social and cultural context for assigning meaning to your personal pain experience, which leads to taking appropriate action.

Successful pain management systematically approaches the treatment of pain at three levels simultaneously, biological, psychological and functional/social. This means using physical treatments to reduce the intensity of the physical pain. It also means using psychological treatments to identify and change the thoughts, feelings, and behaviors that are making the pain more intense or distressing and replacing them with positive thinking, as well as feeling and behavior management skills that can reduce the intensity of the pain.
The Physical Component of Pain

Biological pain is a signal that something is going wrong with your body. The biological, or physical, pain sensations are critical to human survival. Without pain you would have no way of knowing that something was wrong with your body. So without pain you would be unable to take action to correct the problem or deal with the situation that is causing the pain. There are some unfortunates that are born with a compromised pain system and most of them suffer serious problems as a result.

The Psychological Component of Pain

Psychological Pain results from the meaning that you assign to a pain signal. The psychological symptoms include both cognitive and emotional that often leads to suffering. Most people are not able to differentiate between the physical and psychological symptoms. For effective pain management you need to learn all you can about your pain. In the 1970s (Gamsa 1994), behavioral therapies and cognitive theories were employed to explain the relationship of psychological factors and pain. Fordyce looked at pain as a reflexive response to an antecedent stimulus. He also postulated that pain behaviors depend on contingent reinforcement and can be learned by observing ‘pain models’. In this behavioral model, factors like emotional state and other psychosocial variables are not considered. Cognitive approaches to pain look at the meaning of pain to the patients themselves. This cognitive model also looks at the beliefs, self-efficacy, problem solving, and coping abilities of the person. In the last 25 years, both cognitive and behavioral approaches have been combined and used extensively in pain management programmes. This brief overview highlights the shift from a linear to a multicausal model. In a biopsychosocial model, psychological and emotional factors play an important role in the continual experience of pain. The fact that psychosocial factors are considered so important in maintaining pain, leads to the assumption that psychiatric illnesses will be more common in patients with pain.
**Model of Psychopathology**

Gatchel (1996) has proposed a model of the development of psychopathology in low back pain over a period of time. This model looks at pain in three stages. Stage 1 represents the initial psychological distress, which is associated with fear and anxiety. This is a natural emotional reaction. When the pain continues beyond the acute period which is 2–4 months, it leads into stage 2. This stage is associated with phenomena like depression, distress, anger, somatization and learned helplessness. Stage 3 is the acceptance of the "sick role" and consolidation of "abnormal illness behavior". Gatchel (1996) hypothesizes that the specific nature of the psychological problems that develop in stage 2, depend on the individual's pre-morbid personality and psychological characteristics. They suggest that there is no specific "pain prone personality". The patient who suffers from persistent emotional problems passes onto stage 3, where the "sick role" is established and the patient is excused from his/her duties. This model hypothesizes that a constitutional vulnerability in the presence of stress can perpetuate chronic pain and triggers a depressive disorder.

**FIGURE 2**

MODEL OF PSYCHOPATHOLOGY

![Diagram of Model of Psychopathology](image)
The Functional Component of Pain

Social and Cultural Pain, results from the social and cultural meaning assigned by other people or your culture/society as a whole to the pain that you are experiencing, and whether or not the pain is recognized as being severe enough to warrant a socially approved sick/injured role.

PAIN IN SPORTS

Remember that following an acute injury, such as an ankle sprain, pain receptors are first stimulated by the mechanical stress and strain placed upon the tissue. ‘Inflammatory soup’ soon floods the tissue leading to peripheral sensitization. Several hours later, similar chemicals will also lead to spinal modulation. Pain and sensitivity to movement and pressure increase over a period of a few hours, the time between the transition from the original mechanical pain (which may pass) to the maximum sensitized state may provide athletes with a ‘window of opportunity’ to shrug off their pain and continue competing. (Science 1965)

However, this mechanism is probably only the tip of the iceberg. When you are totally focused on your opponent, or consumed by the contest, supraspinal and spinal modulation may act to inhibit the transmission or limit the awareness of the pain signal. We’ve all heard stories of sportsmen and women who have continued despite an injury which should have caused them to stop: a boxer with a broken hand, rugby players with torn ligaments, a long jumper with a strained hamstring etc. In the cut and thrust of competition, the pain system can ‘shut the gate’, and athletes are able to continue in spite of injured tissue. However, once your attention is drawn back to the acute pain particularly following competition, awareness of the pain becomes strong again, especially if this also coincides with an increase in peripheral and spinal modulation. Acute sensitization is a normal, helpful process to encourage you to stop using the injured tissue and avoid further damage. (Topical Issues in Pain 1, 1998)
Our individual sensitivity to pain is in part explained by our genetic makeup, while studies involving twins have shown that learned behaviors are also important. Again, the division of pain into real and mental is unhelpful and the variation in pain between two athletes with the same injury lies at all levels of the pain system. Even for the same athlete, pain sensitivity varies under different circumstances, and perhaps not surprisingly, can become significantly less during competition. It’s also worth noting that different groups in society may have significantly different pain responses, and this applies within sport. A study performed 40 years ago demonstrated that contact sport athletes could tolerate experimental acute pain for longer than non-contact athletes, while both groups could tolerate more acute pain than non-athletes (Sport Journal 2003).

With serious injuries that are likely to result in a significant period of time out of the sport, athletes will often experience emotional disturbances. Researchers (Hardy, C.J., & Crace, R.K., 1990) suggest that athletes often follow a five-stage process following injury – Denial, Anger, Bargaining, Depression, Acceptance and reorganization.

Finally, the athlete moves towards an acceptance of the injury and focus is directed to rehabilitation and a return to sports activity. This stage tends to mark the transition from an emotional to a problem-coping focus as the athlete realizes what needs to be done to aid recovery. The timescale for progression through these stages can vary considerably and setbacks during rehabilitation can lead to further emotional disturbance. In cases of very serious injury and ones in which the emotional reactions are prolonged, the skills of a clinical psychologist might be required.

A number of other reactions to injury can be caused by being sidelined and having plenty of time to worry. In one study, researchers found evidence that fear of re-injury, anxiety, and questioning of their own abilities to recover were reported by a significant number of injured athletes. More recent research (Pizzari, T., McBurney, H., Taylor, N.F., & Feller, J.A. 2002) which investigated
the subjective experiences of patients following ACL reconstructions, highlighted fear of re-injury as having associations with those who did not adhere to the rehabilitation programme. This fear may be linked to a reduction in self-motivation for such patients and avoidance rather than approach behaviors. Thus, what appears to be lack of motivation on the part of the injured athlete might actually be a symptom of emotional distress. Although these findings only represent qualitative data, there are implications for future researchers to establish if interventions to reduce this fear of re-injury might improve the adherence to rehabilitative programmes. Physiotherapists can help to provide short-term goals in the form of daily exercises that should be performed by the athlete. Goal achievement is especially good for increasing an athlete’s self-confidence.

ASSESSMENT OF PAIN

Traditional Pain Assessment Tools - Unidimensional

FIGURE 3
0 – 10 Numeric Rating Scale

0 = No Pain, 1-3 = Mild Pain (nagging, annoying, interfering little with ADLs)
4-6 = Moderate Pain (interferes significantly with ADLs), 7-10 = Severe Pain (disabling; unable to perform ADLs). McCaffery, M., & Beebe, A.et al; (1993).
Directions: Ask the patient to indicate on the line where the pain is in relation to the two extremes. Measure from the left hand side to the mark.

Multi-Dimensional Assessment of Pain

Unidimensional assessment is too simplistic for a problem as complicated as pain. Because of the complexities of the individual's experience of pain, the assessment needs to be multidimensional. A multidimensional assessment explores physical, psychological, social, cultural and spiritual components of pain.

Assessment is the cornerstone of pain management. Management is aimed at eliminating, reducing or interfering with the cause of pain. This is determined by conducting a thorough multidimensional assessment.
Physiotherapists usually spend more time with an individual with pain than any other health care professional and therefore have the ability to perform a holistic assessment.

Pain Assessment – Emotional

FIGURE 6
Wong–Baker Faces Pain Rating Scale

Indications: Adults and children (> 3 years old) in all patient care settings.

Ask the patient to choose the face that best describes how he feels. Be specific about the pain location and at what time pain occurred. (Wong, D. and Whaley, L. et al;1986)
Pain Assessment in Children

FIGURE 7

COLOURED ANALOG SCALE

Colored Analog Scale staff side (left) and child side (right)

2nd International Paediatric Pain Symposium
McGill, 1991
Dallas Pain Questionnaire

Name________________________
Date_________________ Date of Injury______________

Please read: This questionnaire has been designed to give your health care provider information as to how your pain affects your daily activities. Be sure that these are your answers. Do not ask someone else to complete this questionnaire for you. Please mark an “X” along the line that expresses your thoughts from 0-100 in each section.

Section I: Pain and Intensity
To what degree do you rely on pain medications or pain relieving substances for you to be comfortable?
None Some All the time
0%(____:____:____:____:____:____)100%

Section II: Personal Care
How much does pain interfere with your personal care (getting out of bed, teeth brushing, dressing, etc)?
None(no pain) Some I can’t get out of bed
0%(____:____:____:____:____:____)100%

Section III: Lifting
How much limitation do you notice in lifting?
None Some I can’t lift anything
0%(____:____:____:____:____:____)100%

Section IV: Walking
Compared to how far you could walk before your injury or back trouble, how much does pain restrict walking now?
The same Almost the same Very little I cannot walk
0%(____:____:____:____:____:____)100%

Section V: Sitting
Back pain limits my sitting in a chair to:
None Some I can’t sit at all
0%(____:____:____:____:____:____)100%
## Section VI: Standing
How much does pain interfere with your tolerance to stand for long periods?

<table>
<thead>
<tr>
<th>None (same as before)</th>
<th>Some</th>
<th>I can't stand</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% (0:0:0:0:0:0:0:0)</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

## Section VII: Sleeping
How much does pain interfere with your sleeping?

<table>
<thead>
<tr>
<th>None (same as before)</th>
<th>Some</th>
<th>I can't sleep at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% (0:0:0:0:0:0:0:0)</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

## Section VIII: Social Life
How much does pain interfere with your social life (dancing, games, going out, eating with friends, etc.)?

<table>
<thead>
<tr>
<th>None</th>
<th>Some</th>
<th>No activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% (0:0:0:0:0:0:0:0)</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

## Section IX: Traveling
How much does pain interfere with traveling in a car?

<table>
<thead>
<tr>
<th>None</th>
<th>Some</th>
<th>I can't travel</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% (0:0:0:0:0:0:0:0)</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

## Section X: Vocational
How much does pain interfere with your job?

<table>
<thead>
<tr>
<th>None</th>
<th>Some</th>
<th>I can't work</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% (0:0:0:0:0:0:0:0)</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

## Section XI: Anxiety/Mood
How much control do you feel that you have over demands made on you?

<table>
<thead>
<tr>
<th>Total (no change)</th>
<th>Some</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% (0:0:0:0:0:0:0:0)</td>
<td>100%</td>
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</tbody>
</table>

## Section XII: Emotional Control
How much control do you feel you have over your emotions?

<table>
<thead>
<tr>
<th>Total (no change)</th>
<th>Some</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% (0:0:0:0:0:0:0:0)</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>
Section XIII: Depression
How depressed have you been since the onset of pain?

Not depressed Overwhelmed by significantly depression

0%(____:____:____:____:____:____:____:______)100%

Section XIV: Interpersonal Relationships
How much do you think your pain has changed your relationships with others?

Not changed Drastically changed

0%(____:____:____:____:____:____:____:______)100%

Section XV: Social Support
How much support do you need from others to help you during this onset of pain (taking over chores, meals, etc)?

None All the time needed

0%(____:____:____:____:____:____:____:______)100%

Section XVI: Punishing Response
How much do you think others express irritation, frustration or anger toward you because of your pain?

None Some All the time

0%(____:____:____:____:____:____:____:______)100%

PAIN MANAGEMENT IN SPORTS PLAYERS

Background

It has been argued that interventions based on a medical model have had a limited effect in the management of chronic pain and its consequences in players. (Waddell, 1992). One of the problems, for example, has been the failure to differentiate acute and chronic pain, pain often being viewed as a symptom of tissue damage. Use of a multidimensional model acknowledging the complexity of the development of pain and its presentation has proved to be a more appropriate model in many circumstances (Waddell, 1992). In 1976 Wilbert Fordyce used the behavioral model as a basis to explain the development of pain
disability and put forward a therapeutic approach to the behavioral management of pain.

Denis Turk applied cognitive principles in 1983 and subsequently the cognitive-behavioral approach has been the basis of the main development in pain management. Although programmes may differ in content depending on staff and time available, they are mostly similar in their statement of aims. The cognitive-behavioral approach has been used in the United Kingdom since the early 1980s and in particular over the last ten years has become widely used and evaluated (Williams et al, 1994).

Pain management is described here as the use of a multidimensional cognitive behavioral approach to manage pain and its consequences in sports players. The PMP is delivered in a group setting by an interdisciplinary team, the core members of which are a clinical psychologist, a physiotherapist and a medical practitioner specializing in pain (Pain Society, 1996). Other professionals may be included in the team, such as an occupational therapist or nurse. Cognitive-behavioral PMPs use the normal rather than disease model of human behaviors as a working hypothesis about the origin of some behaviors, and to identify important maintaining variables (Harding & Williams, 1995).

Aims of Pain Management Programmes

i) Improve fitness, mobility and posture and counteract the effects of the disuse in sportsmen

ii) Return to more normal and satisfying sport activities

iii) Counteract unhelpful beliefs and improve mood and confidence to improve sport specific performance

iv) Avoid adverse drug effects and reduce unhelpful drugs

v) Improve stress management and sleep

vi) Reduce effects of pain on family and improve social relationships

vii) Independence and maintenance of treatment gains

(Harding & Williams, 1995)
Need of Psychological and Functional Component to be diagnosed & treated

Researchers stated that MRI findings of severe damage to the discs or nerves is associated with the experience of pain, studies have failed to demonstrate a clear relationship between the majority of tissue damage observed on MRI and the patient’s pain (Physical Therapy, 1998). What’s more, almost 40% of people who have no history of back pain have abnormal, damaged spines at more than one spinal level when scanned using MRI. Likewise, the damage shown by ultrasound investigations of athletes with painful patella tendons does not necessarily correspond directly to the degree of pain experienced by the athlete (Journal Ultrasound in Medicine, 2000).

This doesn’t mean that identifying the injured structure is not important or that it isn’t crucially involved in your pain. But looking to tissue damage alone which is both frequent and often quite subtle in sporting injuries to explain the relationship between pain and sporting performance is probably not sufficient.

Although the process of rehabilitation has traditionally been viewed as ‘physical’ in nature, it is now considered a multi-faceted process involving. Over the last decade, researchers have become increasingly interested in the psychological impact of injury and how athletes react to being hurt. This has spawned an advancement of knowledge about the psychological adjustments made by athletes during times of injury, and the subsequent impact of these on mental state and adherence to rehabilitation programmes. Although ideally the psychological support of injured athletes should be provided by psychology professionals, in practice it is very often administered informally by physiotherapists. Although physiotherapists generally consider psychological components of injury as important, recent research suggests that most feel limited in their abilities to deal with these concepts and consider additional training as necessary. (Pearson, L., & Jones, G., 1992)
INTERFERENTIAL THERAPY

IFT uses the transcutaneous application of alternating medium-frequency, 1 KHz-100 KHz electrical currents, amplitude modulated at low frequency for therapeutic purposes. The basic principle of Interferential Therapy is to utilize the significant physiological effects of low frequency of <250pps electrical stimulation of nerves without the associated painful and somewhat unpleasant side effects sometimes associated with low frequency stimulation.

Principles of IFT

To produce low frequency effects at sufficient intensity and at sufficient depth, patients can experience considerable discomfort in the superficial tissues i.e. the skin. This is due to the impedance of the skin being inversely proportional to the frequency of the stimulation. In other words, the lower the stimulation frequency, the greater the impedance to the passage of the current & so, more discomfort is experienced as the current is ‘pushed’ into the tissues against this barrier. The skin impedance at 50Hz is approximately 3200 whilst at 4000Hz it is reduced to approximately 40. The result of applying a higher frequency is that it will pass more easily through the skin, requiring less electrical energy input to reach the deeper tissues & giving rise to less discomfort. Medium frequency currents encounter less resistance than low frequency currents and therefore are more comfortable at the higher intensities necessary for treatment.

Interferential therapy utilizes two of these medium frequency currents, passed through the tissues simultaneously, where they are set up so that their paths cross & they literally interfere with each other. This interaction gives rise to interference current or beat frequency which has the characteristics of low frequency stimulation in effect the interference mimics low frequency stimulation.
INTERFERENCE OF CURRENTS IN IFT

MEDIUM FREQ. 1 + MEDIUM FREQ. 2 = LOW FREQUENCY Combination

\[ \text{Intensity} \]
\[ \text{Frequency 1} \]
\[ \text{Intensity} \]
\[ \text{Frequency 2} \]

\[ \text{Intensity} \]
\[ \text{Combination} \]
\[ \text{Time} \]
Treatment Parameters:

Beat Frequency:

The exact frequency of the resultant beat frequency can be controlled by the input frequencies. If for example, one current was at 4000Hz and its companion current at 3900Hz, the resultant beat frequency would be at 100Hz, carried on medium frequency 3950Hz amplitude modulated current.

FIGURE 9

BEAT FREQUENCY

By careful manipulation of the input currents it is possible to achieve any beat frequency that you might wish to use clinically. Modern machines usually offer frequencies of 1-150Hz, though some offer a choice of up to 250Hz or more. To a greater extent, the therapist does not have to concern themselves with the input frequencies, but simply with the appropriate beat frequency which is selected directly from the machine.

Frequency Sweep:

Nerves will accommodate to a constant signal & a sweep or gradually changing frequency is often used to overcome this problem. The principle of using the sweep is that the machine is set to automatically vary the effective
stimulation frequency using either pre-set or user set sweep ranges. The sweep range employed should be appropriate to the desired physiological effects (see below). It has been repeatedly demonstrated that 'wide' sweep ranges are ineffective whenever they have been tested or evaluated in the clinical environment. The pattern of the sweep makes a significant difference to the stimulation received by the patient. Most machines offer several sweep patterns, though there is very limited 'evidence' to justify some of these options. In the classic 'triangular' sweep pattern, the machine gradually changes from the base to the top frequency, usually over a time period of 6 seconds – though some machines offer 1 or 3 second options. In the example illustrated, the machine is set to sweep from 90 to 130Hz employing a triangular sweep pattern. All frequencies between the base and top frequencies are delivered in equal proportion.

**FIGURE 10**

**Sweep Frequency**

<table>
<thead>
<tr>
<th>Trapezoidal Sweep Pattern</th>
<th>Triangular Sweep Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Trapezoidal Sweep Pattern" /></td>
<td><img src="image2" alt="Triangular Sweep Pattern" /></td>
</tr>
</tbody>
</table>

Quadripolar and Bipolar Method of Application: The use of 2 pole IFT stimulation is made possible by electronic manipulation of the currents - the interference occurs within the machine instead of in the tissues. There is no known physiological difference between the effects of IFT produced with 2 or 4 electrode systems. The key difference is that with a 4 pole application the interference is generated in the tissues and with a 2 pole treatment, the current is 'pre modulated' i.e. the interference is generated within the machine
unit (Ozcan et al, 2004). Whichever way it is generated, the treatment effect is generated from low frequency stimulation, primarily involving the peripheral nerves. There may indeed be significant effect on tissue other than nerves, but they have not as yet been unequivocally demonstrated. Low frequency nerve stimulation is physiologically effective and this is the key to IFT intervention.

FIGURE 11

QUADRIPOlar METHOD OF APPLICATION

Stimulation can be applied using pad electrodes and sponge covers which when wet provide a reasonable conductive path, though electro conductive gel is an effective alternative. The sponges should be thoroughly wet to ensure even current distribution. Self adhesive pad electrodes are also available. The suction electrode application method has been in use for several years, and whilst it is useful, especially for larger body areas like the shoulder girdle, trunk, hip, knee. Care should be taken with regards maintenance of electrodes, electrode covers and associated infection risks (Lambert et al 2000).
The electrical current is applied to the affected area using four electrodes. The four electrodes are placed in such a way that the two currents produced cross each other in the affected area. Where the two currents meet, they actually 'interfere' with each other; hence the name "interferential". The electrodes will usually be used with a damp sponge placed between the electrode and the patient's skin or a conductive gel may be used. During treatment you will feel a tingling or "pins and needles" sensation at the contact area of the sponges and may also feel the tingling sensation throughout the area being treated. This sensation may continue for a brief period following treatment as well. The intensity of the current should be increased within the patient's comfort level. A stronger current will usually have a more beneficial effect but the intensity should not be turned up so high as to cause pain.

The Physiological Effects of IFT

i) The stimulation of local nerve cells that can have a pain reducing/anesthetic effect due to potentially blocking the transmission of the pain signals or by stimulating the release of pain reducing endorphins

ii) An increase in localized blood flow which can improve healing by reducing swelling, the additional blood flowing through the area takes edematous fluid away with it and as a result helps remove damaged tissue and bring nutrients necessary for healing to the injured area

iii) Relaxation of muscle spasms can be achieved through external application of an electrical current, overcoming some of the muscle inhibition often caused by local injury and swelling.

iv) Increased permeability of the cell membrane which helps ion movement to and from cells thus promoting healing.
The Therapeutic Effects of IFT

i) Pain Relief

ii) Muscle Stimulation

iii) Reduction of oedema

iv) Increased local blood flow

v) stimulating healing and repair

vi) Special cases – e.g. stress incontinence.

Pain Relief:

Electrical stimulation for pain relief has widespread clinical use. Logically one could use the higher frequencies (90-130Hz) to stimulate the pain gate mechanisms & thereby mask the pain symptoms. Alternatively, stimulation with lower frequencies (2-5Hz) can be used to activate the opioid mechanisms, again providing a degree of relief. These two different modes of action can be explained physiologically & will have different latent periods & varying duration of effect. It remains possible that relief of pain may be achieved by stimulation of the reticular formation at frequencies of 10-25Hz or by blocking C fibre transmission at >50Hz. A good number of recent studies (e.g. Hurley et al 2004, Johnson and Tabasam 2003, Walker et al 2006, McManus et al 2006, Jorge et al 2006) provide substantive evidence for a pain relief effect of IFT.

Muscle Stimulation:

Stimulation of the motor nerves can be achieved with a wide range of frequencies. Clearly, stimulation at low frequency (e.g. 1Hz) will result in a series of twitches; whist stimulation at 50Hz will result in a tetanic contraction. There is limited evidence at present for the ‘strengthening’ effect of IFT (though this evidence exists for some other forms of electrical stimulation), though the paper by Bircan et al (2002) suggests that it might be a possibility.
On the basis of the current evidence, the contraction brought about by IFT is no ‘better’ than would be achieved by active exercise, though there are clinical circumstances where assisted contraction is beneficial. For example to assist the patient to appreciate the muscle work required. For patients who can not generate useful voluntary contraction, IFT may be beneficial as it would be for those who, for whatever reason, find active exercise difficult. There is no evidence that has demonstrated a significant benefit of IFT over active exercise.

Blood flow:

The elegant experimentation by Noble et al (2000) demonstrated vascular changes at 10–20Hz, though was unable to clearly identify the mechanism for this change. The stimulation was applied via suction electrodes, and the outcome could therefore be as a result of the suction rather than the stimulation, though this is largely negated by virtue of the fact that other stimulation frequencies were also delivered with the suction electrodes without the blood flow changes. The most likely mechanism is via muscle stimulation effects, IFT causing muscle contraction which brings about a local metabolic and thus vascular change. The possibility that the IFT is acting as an inhibitor or sympathetic activity remains a theoretical possibility rather than an established mechanism.

Based on current available evidence, the most likely option for IFT use as a means to increase local blood flow remains via the muscle stimulation mode, and thus the 10-20 or 10-25Hz frequency sweep options appears to be the most likely beneficial option.

Oedema:

IFT has been claimed to be effective as a treatment to promote the reabsorption of oedema in the tissues. The preferable clinical option in the light of the available evidence is to use the IFT to bring about local muscle
contractions which combined with the local vascular changes that will result could be effective in encouraging the reabsorption of tissue fluid. The use of suction electrodes may be beneficial.

A study by Jarit et al (2003) demonstrated a change in oedema following knee surgery in an IFT group, though the patients did the circumferential knee measures and circumferential knee measurement is not an especially reliable method for identifying oedema as such. The Christie and Willoughby study (1990) failed to demonstrate a significant benefit on ankle oedema following fracture and surgery. The treatment parameters employed are unlikely to be effective given the information now available. If IFT has a capacity to influence oedema, the current evidence and physiological knowledge would suggest that a combination of pain relief (allowing more movement), muscle stimulation and enhanced local blood flow is the most likely combination to be most effective.

Precautions:

Care should be taken to maintain the suction at a level below that which causes damage / discomfort to the patient. If there is abnormal skin sensation, electrodes should be positioned in a site other than this area to ensure effective stimulation. Patients who have marked abnormal circulation. For patients who have febrile conditions, the outcome of the first treatment should be monitored. Patients who have epilepsy, advanced cardiovascular conditions or cardiac arrhythmias should be treated at the discretion of the physiotherapist in consultation with the appropriate medical practitioner. Treatment which involves placement of electrodes over the anterior chest wall

Contraindications:

i) Patients who do not comprehend

ii) Patients with Pacemakers
iii) Patients who are taking anticoagulation therapy or have a history of pulmonary embolism or deep vein thrombosis should not be treated with the vacuum electrode applications.

iv) Patients whose skin may be easily damaged or bruised.

v) Application over the trunk or pelvis during pregnancy.

vi) Active or suspected malignancy.

vii) Application over carotid sinuses, eyes, anterior aspect of the neck.

viii) Dermatological conditions e.g. dermatitis, broken skin.

ix) Danger of haemorrhage.

x) Transthoracic electrode application.

xi) Avoid active epiphyseal regions in children.

**TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION (TENS)**

TENS is a form of electrical stimulation with surface electrodes to modulate pain perception. TENS is a safe, non-invasive, drug-free method of pain management. It is used to offer a better quality of life for people with pain. Developed in the late 1960's, the TENS stimulator is a battery-powered device which transmits an electrical impulse through lead wires and surface electrodes to underlying nerves. The stimulator converts the direct current of the battery into pulses of stimulation. Most stimulators feature adjustable settings to control amplitude or intensity of stimulation by controlling voltage, current, and pulse width or duration of each pulse.
Electrodes are placed at specific sites on the body for treatment of pain. The current travels through electrodes and into the skin stimulating specific nerve pathways to produce a tingling or massaging sensation that reduces the perception of pain.

**FIGURE 12**

**TENS EQUIPMENT**

![TENS Equipment Image](image)

**TENS Parameters**

I - Frequency or Rate – Modes of TENS (Currier & Nelson 1991; Kahn, 1991)

1. **Traditional TENS** or **Hi TENS**

   Usually uses stimulation at a relatively high frequency (90 - 130Hz) and employ a relatively narrow (short duration) pulses (start at about 100ms) though as mentioned above, there is less support for manipulation of the pulse width in the current research literature. The stimulation is delivered at ‘normal’ intensity - definitely there but not uncomfortable. 30 minutes is probably the minimal effective time, but it can be delivered for as long as needed. The main pain relief is achieved during the stimulation, with a limited ‘carry over’ effect – i.e. pain relief after the machine has been switched off.
2. Acupuncture TENS or Lo TENS

Use lower frequency stimulation (2-5Hz) with wider pulses (200-250ms). The intensity employed will usually need to be greater than with the traditional TENS - still not at the patient’s threshold, but quite a definite, strong sensation. As previously, something like 30 minutes will need to be delivered as a minimally effective dose. It takes some time for the opioid levels to build up with this type of TENS and hence the onset of pain relief may be slower than with the traditional mode. Once sufficient opioid has been released however, it will keep on working
after cessation of the stimulation. Many patients find that stimulation at this low frequency at intervals throughout the day is an effective strategy. The 'carry over' effect may last for several hours, though the duration of this carry over will vary between patients.

FIGURE 15

Low-Frequency TENS Stimulation Pattern

FIGURE 16

Acupuncture TENS or Lo TENS

Acupuncture (Low frequency or ACUTENS) TENS using stimulation at a low frequency typically between 2 - 6 Hz (pps)
3. Brief Intense TENS:

This is a TENS mode that can be employed to achieve a rapid pain relief, but some patients may find the strength of the stimulation too intense and will not tolerate it for sufficient duration to make the treatment worthwhile. The pulse frequency applied is high in the 90-130Hz band and the pulse duration is also high (200ms plus). The current is delivered at, or close to the tolerance level for the patient - such that they would not want the machine turned up any higher. In this way, the energy delivery to the patients is relatively high when compared with the other approaches. It is suggested that 15 - 30 minutes at this stimulation level is the most that would normally be used.

4. Burst Mode TENS:

The machine is set to deliver traditional TENS, but the Burst mode is switched in, therefore interrupting the stimulation outflow at rate of 2 - 3 bursts / second. The stimulation intensity will need to be relatively high, though not as high as the brief intense TENS, more like the Lo TENS. It is proposed that the application of BURST mode TENS can effectively stimulate both the PAIN GATE and the OPIOID mechanisms simultaneously.

5. Modulation Mode TENS:

In modulation mode, the machine delivers a less regular pattern of TENS stimulation in an attempt to reduce or minimize the accommodation effects of regular, patterned stimulation. Machines offer different methods of varying the stimulation pattern – some vary the frequency, some vary the intensity and some vary the pulse duration, and some machines offer a choice between these methods, though the research evidence to date does not favour one variation method over another. This potentially most useful for patients who use TENS for hours a day, if for no other reason than accommodation occurs at a slower rate and therefore less intensity adjustment may be required.
II – Waveforms *(Kahn, 1991)*

A) Square / rectangular
   i) Instantaneous rise
   ii) Less skin irritating as approaches sine wave form
   iii) For nerve damage associated with pain pathology
   iv) For hypersensitive and chronic pain patients
   v) Delayed, long-lasting analgesia

B) Triangular / spike
   i) Rapidly rising, but not instantaneous
   ii) More skin irritating therefore requires frequent movement of electrodes or shorter treatment times to avoid skin irritation
   iii) For acute pain or resistant tissue
iv) Immediate, short lasting pain relief

C) Asymmetric Biphasic

**FIGURE 18**

Asymmetric Biphasic Waveform

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**III - Pulse width or Duration** *(Kahn, 1991; Hecox et al, 1994)*

Definition: the length of time the current is actually acting on the patient in each individual pulse, unit as microseconds.

Pulse width Indications
i). 50µs Large myelinated fibers respond more effectively  
ii). 100 - 150µs Normal neuromuscular system  
iii). 200 µs Small myelinated fibers respond more effectively  
iv). 200 – 300 µs Patients with neurological damage

**IV - Amplitude or Intensity**

i). TENS units intensity ranges form 1 mA to 100 mA  
ii). Ideal intensity = patient perceived comfortable sensation  
iii). TENS is only effective when the patient actually feels the stimulus  
iv). Patients need to increase the intensity when the body accommodates to the stimulus (when they don’t feel the stimulation anymore)
**Indications**

- Osteoarthritis
- Cervical spondylosis
- Low back pain
- Fibrositis/Myofascial pain syndromes
- Tendinitis/Bursitis
- Carpal Tunnel syndrome
- Radiculopathy
- Peripheral nerve injuries
- Phantom limb pain
- Post operative pain
- Spinal cord disorders
- Pain in the terminally ill
- Labour pain
- Reflex Sympathetic Dystrophy

**Electrode Placement:**

In order to get the maximal benefit from the modality, target the stimulus at the appropriate spinal cord level, appropriate to the pain. Placing the electrodes either side of the lesion or pain areas, is the most common mechanism employed to achieve this. There are many alternatives that have been researched and found to be effective most of which are based on the appropriate nerve root level:

a) Stimulation of appropriate nerve root

b) Stimulate the peripheral nerve, best if proximal to the pain area

c) Stimulate motor point, innervated by the same root level

d) Stimulate trigger point or acupuncture point

e) Stimulate the appropriate dermatome, myotome or sclerotome
If the pain source is vague, diffuse or particularly extensive, one can employ both channels simultaneously. A 2 channel application can also be effective for the management of a local + a referred pain combination – one channel used for each component. The low frequency TENS can be effectively applied to the contralateral side of the body.

TENS – Physiological and Therapeutic Effects

There are 4 theories about the Physiological effects of TENS:

i). Gate control theory (Melzack and Wall, 1985)

When an electrical current is applied to a painful area, transmission of the perception of pain via small diameter fibers to the brain is inhibited by the activity of the large diameter, fast-conducting highly myelinated, proprioceptive sensory nerve fibers, closing the gate to the pain perception to the brain which is stimulated by CONVENTIONAL or HIGH TENS – short term effect.

FIGURE 19
GATE CONTROL MECHANISM
2. Opiate-mediated control theory

ES reduces the activity of the nociceptive flexion reflex and transmission in the spinothalamic tract in cats and nonhuman primates by opiate mediated mechanism. ES has been shown to increase the levels of endorphins circulating in the CSF of patients with neurological disorders.

3. Local vasodilatation of blood vessels in ischemic tissues (Leandri et al, 1986)

Myofascial pain background: Trigger points develop in a muscle or fascia when there is a loss of local blood flow (ischemia) due to an acute insult or scar tissue remaining from an earlier injury. Leandri et al found that TENS causes local vasodilatation to the ischemic area and therefore is thought to relieve pain through this mechanism.

4. Stimulation of acupuncture points causes a sensory analgesia effect (Melzack, 1988)

Acupuncture background: Acupuncture is based on energy lines (meridian) and entry points (acupuncture points). Melzack theorizes that stimulation of these points using TENS causes a sensory analgesia effect by inhibiting or changing the pain evoked nerve impulses at several levels in the nervous system.

CONTRAINDICATION

- Someone with a pacemaker
- Someone with undiagnosed pain.
- Someone with a heart condition
- On head or neck of someone with epilepsy
- Someone with venous or arterial thrombosis or thrombophlebitis
- Someone with indwelling phrenic nerve or urinary bladder stimulators
- Near operating diathermy device
- Around the head
- On the eyes
- Over mucosal surfaces
- Using electrodes on infected (inflamed) skin
- Electrodes across the chest of a patient with cardiac disease
- Electrodes should not be placed near carotid artery (sinus) in the anterolateral region of the neck. There is a potential risk that stimulation at this site might cause heart block by exciting the vagus nerve.

**PRECAUTIONS**

- Areas of skin irritation, damage or lesions
- Areas with impaired sensation
- Over abdominal, lumbosacral or pelvic regions during pregnancy other than for labor/delivery
- Tissues vulnerable to hemorrhage or hematoma
- Athletes should not be permitted to participate in sports while under the influence of TENS analgesia
- Extreme caution is needed with patients taking narcotic medication or who are known to have hyposensitive areas.
- Incompetent patients may not be able to manage the device and it must be kept out of reach of children.
- For patients with diagnosed malignancies that have been diagnosed as terminal,
PULSED ELECTROMAGNETIC FIELD THERAPY

Therapy with pulsating electromagnetic fields is a relatively new and very effective form of physical therapy. It is not a miracle, but simply a biophysical modality used for accelerated therapeutic purposes.

PEMF is a very efficient and simple therapy method. By influencing the patient either generally or locally with a magnetic field packed in impulse bundles, the cellular functions can be improved considerably. The pulsating magnetic field has a high biological effectiveness, and is being used in the medical field as a means of therapy and as a diagnostics tool.

FIGURE 20

PEMF EQUIPMENT

History of Magnet Therapy

Magnet therapy has a long history in traditional folk medicine. Reliable documentation tells us that Chinese doctors believed in the therapeutic value of magnets at least 2,000 years ago, and probably earlier than that. In sixteenth century Europe, Paracelsus used magnets to treat a variety of ailments. Two centuries later, Mesmer became famous for treating various disorders with magnets.
In the middle decades of the twentieth century, scientists in various parts of the world began performing studies on the therapeutic use of magnets. From the 1940s on, magnets became increasingly popular in Japan. Yoshio Manaka, one of the influential Japanese acupuncturists of the twentieth century, used magnets in conjunction with acupuncture. Magnet therapy also became a commonly used technique of self-administered medicine in Japan. For example, a type of plaster containing a small magnet became popular for treating aches and pains, especially among the elderly. Magnetic mattress pads, bracelets, and necklaces also became popular again, mainly among the elderly. During the 1970s, both magnets and electromagnetic machines became popular among athletes in many countries for treating sports-related injuries.

These developments led to a rapidly growing industry creating magnetic products for a variety of conditions. However, the development of this industry preceded any reliable scientific evidence that static magnets actually work for the purposes intended. In the United States, it was only in 1997 that properly designed clinical trials of magnets began to be reported. Subsequently, results of several preliminary studies suggested that both static magnets and electromagnetic therapy may indeed offer therapeutic benefits for several disorders. These findings have escalated research interest in magnet therapy.

**Types of Magnet Therapy and Their Uses**

The term magnet therapy usually refers to the use of static magnets placed directly on the body, generally over regions of pain. Static magnets are either attached to the body by tape or encapsulated in specially designed products such as belts, wraps, or mattress pads. Static magnets are also sometimes known as permanent magnets.

Static magnets come in various strengths. The units of measuring magnet strength are gauss and tesla. One tesla equals 10,000 gauss. A refrigerator magnet, for example, is around 200 gauss. Therapeutic magnets measure
anywhere from 200 to 10,000 gauss, but the most commonly used measure 400 to 800 gauss.

Therapeutic magnets come in two different types of polarity arrangements: unipolar magnets and alternating-pole devices. Magnets that have north on one side and south on the other are known, rather confusingly, as unipolar magnets. Bipolar or alternating-pole magnets are made from a sheet of magnetic material with north and south magnets arranged in an alternating pattern, so that both north and south face the skin. This type of magnet exerts a weaker magnetic field because the alternating magnets tend to oppose each other. Each type of magnet has its own recommended uses and enthusiasts.

A special form of electromagnetic therapy, repetitive transcranial magnetic stimulation is undergoing particularly close study. rTMS is designed specifically to treat the brain with low-frequency magnetic pulses. A large body of small studies suggests that rTMS might be beneficial for depression. It is also being studied for the treatment of amyotrophic lateral sclerosis, Parkinson's disease, epilepsy, schizophrenia, and obsessive-compulsive disorder.

The Physiological Effects of PEMF

i) Pain and Inflammation
ii) Stimulation
iii) Increase Circulation

Magnetic fields cannot be absorbed; therefore, it is difficult to produce field-free spaces when magnetic fields strike a material. We differentiate between paramagnetic substances, in which a bundling or a concentration of magnetic field lines occur, and the diamagnetic substances, in which a decentralization of the field lines results.

The patient's body is only insignificantly diamagnetic and paramagnetic; basically, it is neutral. So whenever field lines impact on the organism or on parts
of it they absolutely permeate these areas. Compared to known methods, this is the first important discovery. Within the range of magnetic fields, all parts of the body are penetrated completely by the field lines.

Human and animal organisms consist of a large number of cells which function electrically. If there is no electrical potential left in the cell, it is no longer viable. These cells have a basic or rest potential that is necessary for normal cellular metabolism.

Diseased or damaged cells have an altered rest potential. If the ions, electrically charged particles surrounding the cells move into an area of pulsating magnetic fields, they will be influenced by the rhythm of the pulsation. The rest potential of the cell is proportional to the ion exchange occurring at the cell membrane.

The ion exchange is also responsible for the oxygen utilization of the cell. Pulsating magnetic fields can dramatically influence the ion exchange at the cellular level and thereby greatly improve the oxygen utilization of diseased or damaged tissues. The deterioration of the oxygen utilization is known to be a problem in several medical branches, especially delayed healing and arthritis of joints.

The Therapeutic Effects of PEMF

Pain Relief

Pulsed magnetic field therapy has been shown to bring about a reduction of pain, which again is due to action at the cellular level. Pain is transmitted as an electric signal, which encounters gaps at intervals along its path. The signal is transferred in the form of a chemical signal across the synaptic gap and this is detected by receptors on the post-synaptic membrane. A charge of about -70mV exists across the inner and outer membranes, but when a pain signal arrives it raises this to +30mV. This action causes channels to open in the membrane,
triggering the release of a chemical transmitter and allowing ions to flow into the synaptic gap. The cell then re-polarizes to its previous resting level. Research by Warnke (2003) suggests that PMFT affects the quiescent potential of the membrane, lowering it to a hyper-polarized level of -90mV. Transmission is effectively blocked since the pain signal is unable to raise the potential to the level required to trigger the release of the chemical transmitter. Again, the frequency of the applied magnetic field is important, as the most effective frequency to produce this effect was found to be a base frequency of 100Hz pulsed at between 5 and 25 pulses per second.

From clinical experiments, we know that Pulsating Magnetic Fields can reduce pain sensations almost immediately. This is due in part to the increase in the oxygen partial pressure in the terminal tissue and the increase in the local perfusion and velocity of the capillary blood flow alleviating the accumulation of metabolites due to small vascularization and blood flow which is transmitted by the sympathetic nervous system.

Resolution of soft tissue injuries:

Over the past few years, research has shown that its effectiveness is not through heat production - as is the case with some modern treatments - but is at the cellular level. One significant outcome of this is the effect it has on soft tissue injuries. As early as 1940 it was suggested that magnetic fields might influence membrane permeability. It has since been established that magnetic fields can influence Adenosine Tri-phosphate production; increase the supply of oxygen and nutrients via the vascular system; improve the removal of waste via the lymphatic system; and help to re-balance the distribution of ions across the cell membrane. Healthy cells in tissue have a membrane potential difference between the inner and outer membrane. This causes a steady flow of ions through its pores. In a damaged cell the potential is raised and an increased and an increased sodium inflow occurs. As a result, interstitial fluid is attracted to the area, resulting in swelling and oedema.
The application of PMFT to damaged cells accelerates the re-establishment of normal potentials (Sansaverino) increasing the rate of healing and reducing swelling. This can help to disperse bruising also. A magnetic field pulsed at 5Hz with a base frequency of 50Hz can have the same effect as an ice pack in that it causes vasoconstriction.

**Orthopedics, Traumatology & Rheumatology**

For example, the department of rheumatology at Addenbrookes Hospital carried out investigations into the use of PMFT for the treatment of persistent rotator cuff tendinitis. The treatment was applied to patients who had symptoms refractory to steroid injection and other conventional treatments. At the end of the trial, 65% of these were symptom free, with 18% of the remainder being greatly improved.

Lau, School of Medicine, Loma University, USA reported on the application of PMFT to the problems of diabetic retinopathy. Patients were treated over a 6-week period, 76% of the patients had a reduction in the level of numbness and tingling. All patients had a reduction of pain, with 66% reporting that they were totally pain-free. Many research studies, including Lau, reported on the application of PMFT for conditions such as sports injuries and for patients with joint and spinal problems. Although these are too numerous to mention individually, in almost every instance there was a reduction, if not complete resolution of symptoms. Soft tissue injuries and joint pains tended to be resolved within 5 days of treatment. Patients with cervical problems and low back pain were also successfully treated, whereas previous treatment with ice, traction and other therapies had been unsuccessful.

**Neurological Conditions**

In yet another trial, the effect of applying PMFT to sufferers of Multiple Sclerosis was investigated (Geseo) 70% of sufferers had a reduction of
weakness, pain and spasticity, with 50% reporting improvement of their bladder incontinence.

**PEMF Parameters**

The field must be pulsed, with low frequency to achieve the best effect. Different conditions require different frequencies. For example, 5Hz causes vasoconstriction whilst 10Hz and above causes vasodilatation. Biological effectiveness is achieved in just 10 minutes for most injuries, so that long treatment sessions are not required. When used at the correct level there are no recorded side effects. (YIP YU LAP et al). The value of pulsed magnetic field therapy in the treatment of pain was tested in a simple longitudinal study. In 22 patients with chronic pain refractory to conventional conservative methods, PEMF at 60 Gauss, 10 Hz was administered for 20 minutes per day for 10 days. Pain was assessed by use of a linear pain analogue scale, before and after each treatment session of the course. All patients showed significant subjective pain improvement after treatment.

**Contraindications and Precautions**

There are no contraindications to Magnetic Therapy except in cases of hemorrhage or where electrical implants are in use. In contrast to chemical medicaments, there is no overdosage, at least within the field range that are presently used for treatments. The PMF therapy is a heatless therapy, therefore, all implants, except heart pacemakers can be treated. Hospitals use PMF therapy to accelerate the healing of patients with pins and bone plates because no damaging heat is produced in the implants. Fractures can be treated even through a plaster cast, since magnetic fields permeate all materials. PMFT is not yet recommended for use during pregnancy or in the presence of tumors.
Need of Regular Treatment Protocol Given to Controls

The regular treatment protocol which was given for all the subjects irrelevant of their groups include rest, isometric exercises, compression using crepe bandage or support to the affected part using bands.

Isometric Exercises

Isometric exercise also known as static strength training is a form of exercise involving the static contraction of a muscle without any visible movement in the angle of the joint. This is a type of strength training in which the joint angle and muscle length do not change during contraction. Isometric exercises can be used for general strength conditioning and for rehabilitation where strengthening the muscles without placing undue stress on the joint is warranted. Both sub maximal and maximal isometric muscle actions can increase isometric strength and induce muscular hypertrophy. In practice, maximal isometric exercises are used for strength and conditioning and sub maximal exercises are used for rehabilitation.

Some actions within a wide variety of sports require isometric or static strength. Examples include climbing, mountain biking and motocross for grip and upper body strength, Judo, wrestling, alpine skiing for static strength required to stabilize the upper and lower body, shooting, gymnastics and horseback riding.

Compression – Crepe Bandage or Support

Compression – Crepe Bandage is an elastic bandage available in different widths for applying in upper & lower limbs to protect the injured joints or painful part. The main function of crepe bandage is to reduce edema & venous pooling
by exerting pressure more than the intra capillary pressure. Particularly its beneficial during the acute phase rehabilitation.

REASON FOR SELECTION OF THE TOPIC

In the field of Sports Physiotherapy, therapists have to deal with multiple problems; pain is one of the most concerned among them because it not only affects the player physically but also mentally. It is stressful and hinders further performance of the player if untreated. It is simple to say pain in one word, but it is having multiple components which have to be effectively and individually treated. So this reason leads the investigator to select this topic.

REASON FOR THE SELECTION OF VARIABLES

In the field of Sports Physiotherapy, there are lots of treatment options for pain management. Among them, the investigator had selected Interferential therapy, Transcutaneous Electrical Nerve Stimulation, Pulsed Electromagnetic Field Therapy as intervention modalities. While reviewing the related literature, studies found were more supporting that these modalities help better in managing the pain in non athletic patients. Hence, the investigator had chosen these variables to find out the effect of them in players.
STATEMENT OF THE PROBLEM

The purpose of the study is to analyze the effect of Interferential therapy, Transcutaneous Electrical Nerve Stimulation, Pulsed Electromagnetic Field Therapy in the management of the Physical, Functional, Psychological aspects of pain in sports players.

SIGNIFICANCE OF THE STUDY

Pain is the resultant of the conflict between a stimulus and the whole individual. Pain is unpleasant, Pain is a sensory experience, Pain is an emotional experience and Pain is a warning signal for actual or potential tissue damage. Such described pain is a very serious problem for players making them distress, depressed, unable to participate in events, unable to perform better. Presently, there are so many approaches for pain management both pharmacologically and non-pharmacologically. Even though there are many choices, the need of this study is to find out which therapy helps in managing all the aspects or components of pain, which therapy improves pain threshold or tolerance, which therapy does not give adverse effects physically.

HYPOTHESES

1. It was hypothesized that there was significant effect of Pulsed Electro Magnetic Therapy in the management of all the aspects/components of pain such as Physical, Functional and Psychological component of pain.

2. It was hypothesized that there was significant effect of Interferential Therapy in the management of the Physical component of pain than Transcutaneous Electrical Nerve Stimulation.
3. It was hypothesized that there was significant effect of Transcutaneous Electrical Nerve Stimulation in the management of the Psychological component of pain than Interferential Therapy.

4. It was hypothesized that there was significant effect of Pulsed Electro Magnetic Therapy in the improvement of disability index than Interferential Therapy, Transcutaneous Electrical Nerve Stimulation.

**DELIMITATIONS**

The study was delimited in the following aspects; One hundred and thirty six players were selected at random as the population for the study and they were volunteers both male & female who were aged between 18 years to 32 years.

One hundred and thirty six subjects selected for the study were players who were having complaints of pain due to any sports related musculoskeletal sub-acute and chronic conditions such as soft tissue injuries, first degree strain, first degree sprain, recurrent injuries & strain, overuse syndromes, altered biomechanics and poor posture. They were University level players involved in Cricket, Volley ball, Badminton, Table Tennis, Football, Long distance running, Sprinting, High jump, Long jump, Triple jump, Swimming, Javelin throw, Discus Throw, Weight Lifting, Hockey, Kho kho, Kabaddi and Basket ball. Players with acute injuries, fracture, dislocation, subluxation, spinal, head, and visceral injuries were not included. The subjects selected were players who were playing not less than 1 year in their relevant sports.
LIMITATIONS

Certain factors like the influencing variables such as gender, type of sports, Pre-injury fitness level, motivational factors, climatic conditions, environmental factors and the intervening variable which may have an effect on the results of the study was limited