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Physical Management of Pain in Sport Injuries

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1. Introduction

The number of people both young and old engaging in sporting activities has increased in the recent times. Apart from the economic benefits of sports which drive youths to engage in competitive sports, adults and seniors are now aware of the health benefits of recreational sports. Inactivity has been linked to many chronic diseases including cardiovascular disease which is leading cause of death worldwide. Health educators are now encouraging the public to be involved in physical activities in order to promote their health. Unfortunately sports are associated with injuries whether it is for leisure or competition. Those who overdo or who are not properly trained are prone to sports injuries. Many sports injuries can be prevented if proper precautions are taken (Lachmann 1989).

If injuries are not properly managed, it could reduce the optimal performance or inability of an athlete to continue participation in sports. Nowadays many sports injuries can be treated effectively and most people who suffer injuries can return to a satisfying level of physical activity after an injury due to advancement in medical management. However, many athletes tend to ignore minor injuries or result into self-management. This always led to more damage to the body structures and makes the injury worse.

Majority of injuries sustained during sporting activities involve musculoskeletal system which include; bones, joints, tendons, ligaments and tendons (Ebnezar, 2003). The injury may be as a result of trauma from external force as it is in contact sports. This is direct trauma also known as macro trauma. Indirect trauma is due to pathology resulting from repeated sub maximal loading. Fracture of bones is less common but not unlikely (Kisner and Colby, 2007).

Signs and symptoms that follow injuries include; pain (from the chemicals released by damaged cells), swelling (from an influx of fluid into the damaged region), loss of function (because of increased swelling and pain), redness (from local vasodilation) and heat (from increased blood flow to the area), which are features of inflammatory reaction.

Pain is the major reasons why many people seek medical attention. International Association for the Study of Pain defined pain as an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage (IASP, 1994). Pain experienced from soft tissue injuries is usually related to the extent and type of trauma sustained as well as to the structures involved and an individual's perception and expression of it (O'Sullivan and Schmitz, 1994). Pain and inflammation

continue into the sub-acute phase and may fade out in the chronic stage subsiding with healing in 1 to 3 months (Schnedler, 1990).
Management of soft tissues injury is patterned along with the phases of injury.
Inflammatory phase (acute): It can last up to 72 hours. Where there are musculotendinous injuries, there is myofilament reaction and peripheral muscle fiber contraction within the first two hours.
Regeneration and repair phase (sub-acute): This fibro-elastic and collagen-forming phase lasts from 48 hours up to 6 weeks. During this time structures are rebuilt and regeneration occurs. Fibroblasts begin to synthesize scar tissue. These cells produce type iii collagen, which appears in about four days, and is random and immature in its fiber organization. Capillary budding occurs, bringing nutrition to the area, and collagen cross-linking begins. As the process proceeds, the number of fibroblasts decreases as more collagen is laid down. This phase ends with the beginning of wound contracture and shortening of the margins of the injured area.

2. Remodeling phase (Chronic stage)

This phase lasts from 3 weeks to 12 months. There is evidence of cross-linking and shortening of the collagen fibers promote formation of a tight, strong scar. It is characterized by remodeling of collagen so as to increase the functional capabilities of the muscle, tendon, or other tissues. Final aggregation, orientation, and arrangement of collagen fibers occur during this phase (Kisner and Colby, 2007).
Sports injuries are usually treated with pharmacological and non-pharmacological methods. Non pharmacological methods involve conservative methods such as physical therapy and surgery.
Physical therapy is most essential in managing the majority of the soft tissue injuries. Physical therapy should commence early so as to speed up the healing of damaged tissues and to prevent complications that could develop during chronic stage. The athlete may return to full functional activities if the treatments commence early.

3. Cryotherapy

Cryotherapy also known as cold therapy has been reported to be one of the least expensive and most used therapies recommended in the immediate treatment of the skeletal muscle injury. Among chiropractic practitioners it is the most often utilized passive adjunctive therapy.
Cryotherapy is capable of reducing effects related to the damage process, such as pain, edema, haemorrhage and muscle spasm after soft tissue injuries. Although cryotherapy may not reduce edema once it is formed but when used immediately after injury, it can prevent formation of edema. Cold is capable of diminishing secondary hypoxic injury, so there is less free protein in the tissues decreasing the tissue oncotic pressure leading to tissue swelling by decreasing metabolism and lowering permeability rate (Enwemeka et al, 2002).
The mechanism of pain relief after application of ice is not clear. The prevailing theories such as decreased nerve transmission in pain fibres, reduction of the activity of free nerve endings, increase in the pain threshold, release of endorphins and cold sensations which over-ride the pain sensation are plausible reasons provided in the literature.

One of the physiological effects of ice is vasoconstriction. When the blood vessels narrow, the amount of blood delivered to the injured area is reduced thereby reducing bleeding during injuries. Muscles always respond to injury through spasm to protect itself and prevent further damage. Ice, is also beneficial in reducing muscle spasms (Chesterton et al, 2002).
There are several procedures of application of cryotherapy ranging from gel, spray, ice packs, and immersion. Among these ice packs are most popular and safe as it prevent frost bite because of the protection of body tissue by the plastic bag (Martinez et al, 1996).

3.1 Methods of application of cryotherapy

Ice packs: Ice in this method are crushed, shaved, or chipped and put in a plastic bag applied directly to the injured area. Several authors agree that some form of protection be used to prevent frostbite. Ice pack with temperature at 0 o C (32 o F) can be applied directly to the skin to maximize the effectiveness of the cold application.
Cold-gel packs: A gelatinous substance enclosed in a vinyl cover containing water, and antifreeze (such as salt).
Chemical cold packs: These consist of two chemical substances, one in a small vinyl bag within a larger bag. Squeezing the smaller bag until it ruptures and spills its contents into the larger causes a chemical reaction producing the cold. They are ideally utilized for emergency use.
Ice immersion: A container is filled with ice and water, and the body part is immersed in it. Immersion is recommended for extremities.
Ice massage: A cube of ice is rubbed over and around the underlying muscle fiber until numb.
Ice should be used for a period of 5 minutes if being used as first aid. Prolong period of application could cause blood vessels dilation resulting into increase in hemorrhage.
At chronic stage of injury, ice may be used for 10 minutes. An individual experiences cold-burning sensation-aches-numbness during the application of ice (Erith et al, 2002).
When an exercise or manual therapy is to be used for a patient, ice are usually applied to serve as local anesthesia to reduce pain.

4. Reduction of bleeding

By cooling the surface of the skin and the underlying tissues, ice causes the narrowing of blood vessels, a process known as vasoconstriction. This leads to a decrease in the amount of blood being delivered to the area and subsequently lessens the amount of swelling. After a number of minutes, the blood vessels dilate allowing blood to return to the area. This phase is followed by another period of vasoconstriction- this process of vasoconstriction followed by dilation is known as the Hunting Response.
Although blood still flows into the injured area the amount of swelling is significantly reduced if ice is not applied. Decrease in swelling allows more movement in the muscle and so lessens the functional loss associated with the injury (Eston and Peters, 1999). The swelling associated with the inflammatory response also causes a pressure increase in the tissue and this leads to the area becoming more painful. The effects of ice causing vasoconstriction after application led to decrease in pain. Equally the conduction velocity of the nerve is reduced, thereby limiting the pain transmission of the peripheral nerves (Goodall and Howatson, 2008).

5. Reduction of muscle spasm

By reducing the cells metabolic rate, ice reduces the cells oxygen requirements. Thus when blood flow has been limited by vasoconstriction then the risk of cell death due to oxygen demands (secondary cell necrosis) will be lessened.

6. Transcutaneous electrical nerve stimulation

Electrical currents are generated by stimulating the device of transcutaneous electrical nerve stimulation (TENS) and delivered it across the skin through electrodes Figure 1. TENS is a non-invasive treatment modality that involves the application of a low-voltage electrical current for pain relief. TENS is now a popular modality in the field of physical therapy and sport medicine for managing pain.

There are much available clinical evidence concerning the use of TENS for various types of conditions relating to musculoskeletal disorders and other type of pain, such as sympathetically mediated pain, bladder incontinence, neurogenic pain, visceral pain. Although this claim has been challenged by many experts about the degree to which TENS is more effective than placebo in reducing pain (Adedoyin et al, 2005).

Melzack and Wall in 1965 provided the explanation on the mechanism of the analgesia produced by TENS in their pain gate-control theory.—Their explanation was that gate is usually closed, inhibiting constant nociceptive transmission via C fibers from the periphery to the T cell. When painful peripheral stimulation occurs, however, the information carried by C fibers reaches the T cells and opens the gate, allowing pain transmission centrally to the thalamus and cortex, where it is interpreted as pain. The gate-control theory postulates a mechanism by which the gate is closed again, preventing further central transmission of the nociceptive information to the cortex. The proposed mechanism for closing the gate is inhibition of the C-fiber nociception by impulses in activated myelinated fibers.

The Pain Gate can also be shut by stimulating the release of endogenous opioids (endorphins, enkephalins, and dynorphins), which are pain-relieving chemicals naturally released by the body in response to pain stimuli. Opioids are a naturally occurring hormone in the body. They are released in response to an injury or physical stress to reduce pain and promote a feeling of wellbeing. Much like Morphine, and related medications, opioids have a similar chemical structure, which explains their strong painkilling effects.

TENS has not only been found to be indicated for relieving both acute and chronic pain following sports injuries but also found to be enhancing tissues healing. TENS machine is very simple to use. It can be used at home by the athletes without special training. It could be applied to the painful site between 30 to 60 minutes; the machine could also be attached to the body during the performance of daily activity.

One of the main benefits of a TENS machine is that it can be used at home. Unlike most analgesic drugs TENS has little or no side effects. Pain relief drugs are effective but they can lead to several complications including: nausea, headaches, liver damage, and erosion of cartilage, stomach bleeding and stroke. Drug addiction and abuse can also be associated with the use of drugs. This is the reason why conservative treatments such as TENS are becoming more popular. TENS should not be used for people who are on pacemaker and those that develop arrhythmia of the heart.

Fig. 1. TENS Machine with electrodes placement

7. Interferential current therapy

In recent past faradic current has been used in the treatment of sport injuries for muscle re education. It is usually prescribed at early stage of injuries and when active contraction of muscles is hindered (Goats, 1990). Faradism is believed to increase muscle bulk and muscular strength especially when the muscle is made to work against resistance. Faradic current is capable of stimulating the motor nerves and cause tetanic contraction of muscles. Contraction of muscles when maintain for a period of time is capable of increasing the metabolism, with a consequent increase in the oxygen demands and nutrients and an increase of waste products, including metabolites. By the action of contraction and relaxation of muscles, there is increase in the pumping action of the veins and lymphatic vessels lying within the muscles. This mechanism is helpful in enhancing good venous and lymphatic return.

However, faradic currents like other direct and low frequency alternating currents (<1 KHz to <10 KHz) usually encounter a high electric resistance in the outer layers of the human skin. This makes the treatment of deep structures painful because a large transcutaneous current passes deeply (Adedoyin et al, 2002). Interferential current (IFC) was therefore designed to overcome this problem. Interference current is a medium-frequency current that delivers currents to deep-seated structures in order to relief pain. The machines are designed to generate an amplitude-modulated interferential wave, called beat frequency. The wave is created by two out-of-phase currents that collide with each other to generate an interferential wave with frequency between 1Hz and 250Hz.

Inferential current is primarily used to relief pain in musculoskeletal injuries. The mechanism of pain relief is similar to that of TENS. The duration of treatment should be between 30-60 minutes. Inferential currents can be applied via 2 or 4 electrodes. Quadripolar application of IFC is claimed to be created deep within the tissues whereas bipolar application is said to be distributed similarly to conventional electrical stimulation with maximal current intensities underneath the electrodes, progressively decreasing with distance (Goats, 1990).

Interferential current has been reported to be liked with stimulation of muscles, reduction of swelling and improved blood circulation and healing process. Many experts believed that TENS and IFC produced analgesic effects in a similar manner while few believed the IFC is better than TENS.

Interferential Currents should be avoided over the trunk or pelvis during pregnancy; and should be placed over the carotid sinuses and epiphyseal region in children. It should not be used for patient with pacemakers.

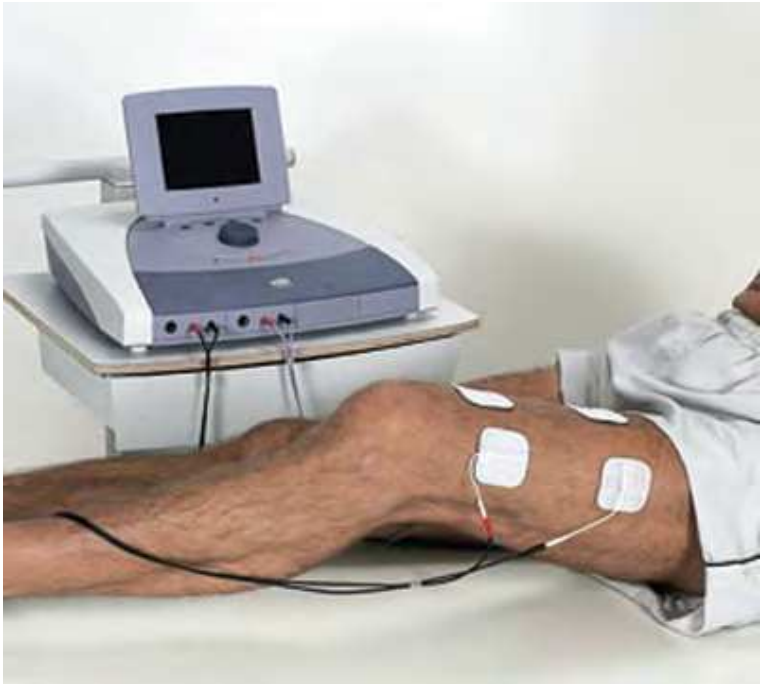

Fig. 2. Interferential Current Machine and Electrodes Placement

8. Therapeutic exercise

There is strong evidence for the use of exercise in the management of soft tissue injuries. In fact other physiotherapeutic modalities such as electrotherapy (Faradism, TENS), thermotherapy (Short wave diathermy), Actinotherapy (Ultrasound) are considered adjunct treatments. Exercise should be encouraged as soon as possible to prevent complications such as reduced range of motion, contractures, adhesions, muscles wasting and reduced strength.

Active movement can improve the integrity of joints and enhance good scar formation in muscles, tendons and ligaments, and improve the tensile strength of the mature scar.

Resisted exercise training would improve muscular strength, muscular hypertrophy, muscular endurance and power. It could also improve dynamic postural stability as related to standing balance and mobility. Resisted exercise is based on overload principle which states that for a muscle or muscle group to increase in strength, it must, on regular basis, be

challenged to overcome resistances that are greater than those that are usually encountered (Nyland, 2006).
Where a joint is immobilized, isometric exercise may be encouraged in order to protect the integrity of the joints. By contracting the muscle fibres without moving the joint, the muscle fibres are stimulated. This improves blood supply to the joint and also prevents intra articular and peri articular adhesions
Balance and coordination could also be impaired during musculoskeletal disorder because of deviation of gait especially injuries involving ankle joints. Exercise on wobble board is usually encouraged to improve static balance and strength of the lower extremities. Figure 3. Apart from being useful in stimulating the proprioceptive system and re-educate reflex posturer control, wobble board may improve the symmetry of weight distribution on the lower extremities of individuals (Adedoyin et al, 2009).
All these exercises have been found to bring about relief of pain with or without any other therapeutic analgesic modalities (Adedoyin et al, 2009).

Fig. 3. Wobble Board

9. Ultrasound

Therapeutic ultrasound is one of the most common treatments used in the management of soft tissue injuries. Ultrasound therapy is widespread in sports physiotherapy and physical therapy practice (Khanna et al, 2009).
Ultrasound consists of inaudible high frequency vibrations created when a generator produces electrical energy that is converted to acoustic energy through molecular collision and vibration. It undergoes a progressive loss of intensity of the energy during passage through the tissue (attenuation) (Tee Haar, 1987). Ultrasound frequency, wavelength,

intensity, amplitude, continuous/pulsed therapy, coupling medium, movement and angle of transducer and frequency, tissue composition and duration of treatment affect the dosage of ultrasound delivered to target tissue (Tee Haar, 1987, Speed 2001).

Ultrasound produces thermal and non-thermal physical effects (Low and Reeds, 2000). Thermal effects lead to increased blood flow, reduction in muscle spasm, increased extensibility of collagen fibres and pro-inflammatory response. Non-thermal effects of ultrasound including stable cavitation and acoustic streaming and micro massage; which are more important than thermal effects in the treatment of soft tissue lesions (Dyson and Suckling, 1978).

The sound waves are capable of penetrating into the skin and surface layers and cause tendons and soft tissues to vibrate, producing gentle healing vibrations within the affected area that soothe inflammation and relieve pain. Ultrasound waves also cause tendons and tissues to relax and increase blood flow to help reduce local swelling and chronic inflammation (Khanna et al, 2009).

The choice of parameters depends on the condition being treated. Continuous ultrasound therapy is used to treat muscle spasms, pain and to relax tense muscles. In this type of ultrasound, the sound waves transmitted create friction as they pass through muscle fibers, which in turn produce heat in the injured area. The body increases blood circulation to that area to cool it down, and this increased blood flow speeds up the healing process.

Whereas pulse ultrasound is used treat inflammations such as tendinitis and bursitis. This method of ultrasound therapy works through cavitation by transmitting vibrations that stimulate cell membranes, resulting in more rapid repair. No adverse effects have attributable to the use of appropriate therapeutic doses of ultrasound in literature. However, people with pacemakers and other electronic implants should not use ultrasound.

Other hear modalities that commonly used at chronic stage include infra-red, short wave diathermy and hot packs. Many experts believed that heat therapy can reduce pain and muscle spasm following some types of injury. Heat is sometimes recommended prior to exercise for athletes with 'stiff' muscles or in the treatment of chronic conditions in which restricted muscle or joint motion may interfere with recovery. Heat has also been found to enhance stretching of tissues by applying it to the muscles before the stretching is carried out. However, the application of heat to injured parts of the body has also been linked with increases in tissue swelling (oedema), and heat can spur metabolic activity and increase capillary blood flow, effects which may be counterproductive in the early treatment of some injuries.

10. Massage

Massage is the systematic, mechanical stimulation of the soft tissues of the body by means of rhythmically applied pressure and stretching using hands. It's performed to produce mechanical or reflexive effects such as improved range of motion, to increase circulation and lymphatic drainage, to induce general relaxation and reduce pain (Johnson, 2000). Massage has been used in managing athletes since the first Olympic games up until now. In sports, it is usually used in achieving and maintaining peak performance and to support healing of injuries (Fritz, 2004). Massage techniques include effleurage or stroking, petrissage or kneading, tapotement or percussion. Massage techniques involving effleurage, and kneading are used before sport. Massage can also be used after sport to improve the athlete's psyche and during sport in treatment of injuries. In treatment of muscle strain, massage is facilitates healing at the sub-acute and chronic stage. Controlled soft tissue

massage of scar tissue along fiber direction towards injury will promote development of mobile scars at the sub-acute stage of healing, while cross-fiber friction of scar tissue coupled with directional stroking along the lines of tension away from injury will increase strength and alignment of scar tissue at the chronic stage (Fritz, 2004).
If properly applied massage therapy can provide pain relief, Improves the flow of nutrients to muscles and joints, accelerating recovery from fatigue and injury, soothe stiff sore muscles, reduce inflammation and swelling. Massage and gentle stretching can help to maintain range of motion of joints.
The choice of the massage is specific to the athlete's sport of choice and is often focused on area prone to injuries. Sport massage is gaining popularity as useful components in a balanced training regimen. Sports massage can be used as a means to enhance pre-event preparation and reduce recovery time for maximum performance during training or after an event. There is evidence that specially designed massage promotes flexibility, removes fatigue, improves endurance, helps prevent injuries, and prepares athletes to compete at their absolute best.

11. Orthotic devices

Orthotic devices are needed during early onset of sport injuries in order to provide rest and support for the damaged structures especially joints. The devices provide support, or correct deformities and improve the movement of joints, spine, or limbs. They also provide stability of joints by limiting abnormal or excessive joint mobility. Excessive movement can worsen the injured parts and increase the pain. Knee and Ankle joints are more prone to injury than any other joints in the body. Ankle foot orthosis is commonly used to protect the ankle joints at acute stage (Figure 4).

Fig. 4. Ankle Foot Orthosis

For injuries involving the lower limbs, full weight bearing is usually discouraged as this could lead to more tissue damage. Physical therapists usually prescribe cane or crutches for non-weight or partial weight bearing during ambulation.

12. Conclusion

Individuals who engage in regular sporting activities or exercise could be involved in injuries. Injuries can have serious negative impact on athletes in their sport performance as they are affected physically, mentally and emotionally. Pain is one of the major complaints after injuries and it is the reason why athletes seek medical attention. Effective management however depends on correct diagnosis based on history and evaluation. Relieve of pain could restore function and enhance fitness, health and quality of life. Injured athletes can be effectively managed through pharmacological and non pharmacological approaches. Non pharmacologic means involve surgery and conservative managements. Surgery is usually considered when other treatments have failed. Non steroidal anti-inflammatory drugs (NSAIDs) are most commonly prescribed with success. However, these drugs have been reported to have deleterious effects on some body structure especially cartilage. Athletes are enjoined to seek physical therapy, as it plays major roles in pain management of sport injuries with little or no side effects.

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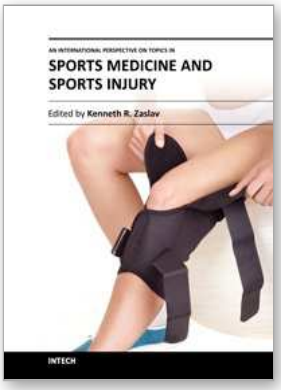

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For the past two decades, Sports Medicine has been a burgeoning science in the USA and Western Europe. Great strides have been made in understanding the basic physiology of exercise, energy consumption and the mechanisms of sports injury. Additionally, through advances in minimally invasive surgical treatment and physical rehabilitation, athletes have been returning to sports quicker and at higher levels after injury. This book contains new information from basic scientists on the physiology of exercise and sports performance, updates on medical diseases treated in athletes and excellent summaries of treatment options for common sports-related injuries to the skeletal system.

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