MUSCULOSKELETAL STRUCTURES IN INJURIES, RECOVERY AND APPLICABLE TREATMENTS: A LITERATURE REVIEW

ABSTRACT

This article sought to provide a comprehensive and integrated view of the process of musculoskeletal injury and its rehabilitation, highlighting the importance of understanding the different tissues involved, biomechanical aspects and the appropriate choice of therapeutic resources to promote effective and functional recovery of patients. An extensive bibliographic survey was carried out, in which studies whose objectives and content were aligned with the aims of this research were carefully selected. The methodology employed consisted of a wide-ranging review of the specialised literature on the subject in question using the databases of the Latin American and Caribbean Literature in Health Sciences, PublicMedline, Medical Literature Analysis and Retrieval System on Line, Scientific Electronic Library Online, Google Scholar and books. The review provided up-to-date information on the musculoskeletal structures involved in injuries, recovery strategies and available treatments. It highlighted the importance of a multidisciplinary and personalised approach to effective patient recovery, taking into account the particularities of each injury and the need for an individualised rehabilitation plan. It is hoped that this review will contribute to expanding knowledge in this area and help to improve the care provided.

Keywords: Musculoskeletal structures; Injuries; Physiotherapy resources.

INTRODUCTION

This literature review aims to briefly but thoroughly explore the different musculoskeletal structures affected by injuries, from muscles and tendons to joints, discussing their anatomical and physiological particularities that are relevant during the injury and recovery process. In addition, the various therapeutic methods used to treat injuries will be explained, including conservative and surgical interventions, physiotherapy, rehabilitation and complementary therapies.

In order to fulfil the intended scope, soft tissues such as muscles, tendons and nerves, which commonly suffer injuries due to trauma and overload, are conceptually presented. Muscle injuries can occur as a result of work activities, sports or accidents. They can range in severity from mild stretches to severe muscle tears. It should be noted that the inflammatory response is fundamental for tissue regeneration, but one of the complicating obstacles is excessive oedema.

The structures mentioned are constituents of the musculoskeletal system, comprising the muscles and bones of the human body. They perform substantial functions for the movement, support and protection of the body and are subject to an

exacerbated multiplicity of injuries that can affect the body's function and mobility. Early diagnosis, appropriate treatment and rehabilitation are essential in order to promote recovery and prevent complications.

Martins *et al.* (2021) argued that musculoskeletal injuries are a group of pathologies that affect muscles, tendons, ligaments, joints, nerves, spinal discs, cartilage, blood vessels and soft tissues. They can be caused or aggravated by physical activity.

Injuries are a significant problem for health professionals and athletes, affecting not only sports performance, but also the quality of life of those affected. Understanding the musculoskeletal structures involved in these injuries, as well as the recovery processes and applicable treatments, is essential to promoting effective rehabilitation and preventing future complications. It is very important to know the cause and mechanism of injuries, as they are complex and depend on different factors such as the cellular response in relation to the intensity and duration of the harmful stimulus and the consequences in terms of the state and adaptability of the injured cell.

At the time of injury, biochemical and chemotactic mediators are released during the tissue repair phases, in which each phase prepares the tissue for the removal of damaged cellular components, activates the proliferation of satellite cells and forms new fibres for cell fusion. Tissue repair is comprised of 4 phases that often overlap: homeostasis, inflammatory phase, proliferative phase and finally, remodelling phase (VARUSSA, 2022).

Treatments such as contrast thermotherapy and cryotherapy can be used to accelerate muscle regeneration in the inflammatory phase. Tendons play a significant role in transmitting the force generated by the muscles to the bones. In the case of injuries such as tendonitis, which result in inflammation and limited movement, the appropriate treatment is physiotherapy rehabilitation, which is fundamental for recovery.

Subsequently, the constituents of the joints are conceptually dissected, which are cartilage, capsule and ligaments, the completeness of which is fundamental for the invariability and proper functioning of the body. A priori, the definition of articular cartilage is presented, which is considered to be a resistant and flexible tissue that lines the ends of the bones in the joints and acts as a shock absorber, reducing friction. Possible injuries to this structure result in pain, inflammation and limited range of movement, such as chondral lesions. The treatment process includes conservative

therapies and, in more serious cases, surgery.

Characterised as the fibrous structure that surrounds the joint, holding the bones together and providing stability, it is called the joint capsule. Ligaments are bands of fibrous tissue that connect the bones and reinforce the capsule. Certain injuries to the ligaments, such as sprains, can result in joint instability and pain.

The biomechanical aspects of bone tissue are also presented, emphasising the importance of density, architecture and mineralisation for resistance and support capacity. Bone tissue is rigid and provides the region in which it is located with: support for the thorax and extremities; leverage for the locomotor function of skeletal muscles; protection for vulnerable viscera (SALTER, 1985). Damage to bone structures is caused by a number of factors and therapeutic interventions include immobilisation, surgery and physiotherapy.

The stages of the inflammatory response are the acute, repair and remodelling phases. Inflammatory responses help clean damaged tissue, fight infection and promote tissue regeneration. In short, they play a key role in the wound healing process, as they are a set of protective responses against injury or infection. It is a complex process that begins with changes in microcirculation, which allows the first inflammatory cells to be recruited to the injured site (RODRIGUES, 2020).

The physiotherapeutic mechanisms employed in the treatment of injuries are concise, seeking recovery, pain relief, reduction of inflammation and improvement of function. They can encompass a multidisciplinary intervention, covering and associating different methods such as cryotherapy, thermotherapy, electrotherapy, massage therapy, acupuncture, among other therapeutic resources.

The prioritisation of relevant treatable methods depends on the degree of injury, stage of healing, symptoms and rational analysis of available therapies. The combination of different therapeutic mechanisms can be beneficial in speeding up recovery and promoting muscle regeneration in the inflammatory phase.

It should be noted that the treatment of musculoskeletal injuries requires an individualised and comprehensive approach, with the aim of promoting proper healing, recovering muscle function and preventing prolonged complications. It is hoped that this review will contribute to expanding knowledge in this area and help to improve the care provided to patients affected by musculoskeletal injuries.

METHODOLOGY

In this segment, the precepts and parameters used to review the literature on musculoskeletal structures in injuries, recovery and applicable treatments were highlighted. In order to obtain concrete and reliable results, a careful and rigorous methodological approach was adopted. We consulted academic databases, virtual libraries, scientific journals, including foreign sources, and relevant books to obtain a representative sample of academic production on the subject. In addition, selection criteria were established for the inclusion of studies in the review, taking into account the relevance, quality and reliability of the work.

An extensive bibliographic survey was carried out, in which we carefully selected studies whose objectives and content were aligned with the purposes of this research. The methodology employed consisted of a wide-ranging review of specialised literature on the topic in question using databases from the Latin American and Caribbean Literature in Health Sciences, PublicMedline, Medical Literature Analysis and Retrieval System on Line, Scientific Electronic Library Online, Google Schoolar and specific books on orthopaedics and anatomy.

The verification of the studies included the identification of trends, gaps in knowledge, divergences and convergences between the authors, as well as the synthesis of the main results and widespread repercussions. It should be emphasised that the results of the review were structured and explained in a cogent and pragmatic way, highlighting the crucial points of the literature examined. Direct and indirect quotations from the authors were used throughout to support the inferences made and to help contextualise the arguments put forward.

The literature review is an essential stage in the production of knowledge and to provide a theoretical basis for new research and academic debates. It should be emphasised that the methods and resources used in this study were essential for building a comprehensive and well-founded overview of the topic in question. It is hoped that this study will contribute to the production of knowledge and inspire new research and reflection in the area.

THEORETICAL FRAMEWORK

SOFT TISSUES: MUSCLES, TENDONS AND NERVES

Skeletal muscle has the capacity to adapt according to its cellular and phenotypic scope, and is therefore considered a mutable tissue. The muscle fibres belonging to it have the power to produce force and movements equivalent to 40% to 50% of an adult's body weight, and together they enable the body to move, from simple to complex movements. It is the only tissue in the human body that can reproduce active force. Skeletal muscle is so called because it is associated with the body's bone system (TORTORA & DERRICKSON, 2016).

In this perspective, Tortora and Derrickson (2016) explained that the types of muscle tissue are skeletal, cardiac and smooth. Skeletal muscle tissue is directly connected to the bones and moves through the skeleton. It is called striated because it has striations, called protein bands, which are responsible for the voluntary movement of the body. The cardiac muscle tissue belonging to the heart is striated and its contraction occurs involuntarily. On the other hand, smooth muscle tissue is found in the inner walls of the structures of blood vessels, intestines, stomach, respiratory tract and others. Unlike other tissues, it is not striated and has a specific regenerative capacity.

According to Ramos (2017 p.12), muscle damage is described by variations in morphological and histochemical characteristics that lead to a lack of functionality in the affected portion.

According to Santanna *et al.* (2022 p. 2) the cause of muscle damage can be considered indirect or direct. Indirect injury is related to the absence of contact and can be functional, due to mechanical overload, neurological or structural injury, which occurs when there is partial or complete muscle rupture, such as eccentric concentration injury. On the other hand, direct injury occurs at the site of contact and can cause laceration or contusion. Thus, more than 90 per cent of all sports-related injuries are contusions or strains. Muscle tears, on the other hand, are the least frequent injuries in sport.

There are various forms of injury that can occur to muscles, including sprains can occur when the muscle or tendons stretch too much due to excessive effort, at which point the muscle fibres or the entire muscle can rupture; sprains refer to the stretching or tearing of ligaments, a sprain can be mild, moderate or severe, depending on whether the ligament is partially or completely torn; muscle contractures, also known as cramps, occur when a muscle in the body contracts incorrectly and involuntarily, the contracture can occur in all parts of the body, however, the most common regions to

occur are calves, thighs and trapezius (SANTANA *et al.* 2022).

Physiotherapy sessions, the use of anti-inflammatory drugs and, in more serious cases, surgical intervention are the most common methods of treatment.

Characterised as a fibrous, thick and flexible structure that enables muscles to connect to bones. The tendon has collagen fibres that give it the ability to resist tension, playing a fundamental role in the mobility and stability of joints (MAGEE, ZACHAZEWSKI & QUILLEN, 2013).

Tendon injuries can be classified as mild, moderate or severe. Some examples are tendonitis, which is an inflammation of one or more tendons caused by excessive use of the tendon or by a serious injury. Tendonitis usually occurs in parts of the body such as the shoulder, elbow, knee and ankle, but does not prevent it from occurring in any other tendon; another is tendon ruptures, or tears, which occur when the tendon that attaches the calf muscle to the heel bone ruptures (GREENER, 2006).

Nerves are considered to be nerve fibres grouped together in the peripheral and central nervous system. These nerve fibres are made up of axons - the largest branch of the neuron - and are surrounded by a sheath, which is rich in myelin. The classification of nerves will depend on a number of criteria, such as the type of fibres they have, which can be sensory, motor or mixed, it will also depend on the location (nerves of the central nervous system or nerves of the peripheral nervous system); the origin and destination and others (TORTORA & DERRICKSON, 2016).

The most common injuries to the nerve are: trauma, wounds, traction, fractures, crushing, external compression such as weights or internal compression such as cysts and tumours, among others. An injury can result in motor paralysis and changes in skin sensitivity. Brachial plexus dysfunction involves damage to this nerve, resulting in impaired sensitivity or movement of the shoulder, arm and hand. Carpal Tunnel Syndrome is a common injury that affects the hands, resulting from compression of the median nerve. The most common symptoms are numbness in the hands, tingling and weakness in the fingers (LUIZ, 2015).

JOINTS: CAPSULE, CARTILAGE AND LIGAMENTS

According to studies by the authors Tortora and Derrickson (2016), cartilage is a rigid connective tissue, not like bone, which is why it is less flexible compared to muscle

and is not vascularised. It is important to note that it is found in various segments of the human body, including joints, invertebrate discs, ears and noses. The composition of this structure is made up of cells (chondrocytes), the extracellular matrix (lacunae), collagen fibres and proteoglycans.

In relation to the functionality of cartilage, we have, for example, structural support, absorption of impacts and sliding between bones, lining of articular surfaces, facilitating movement in the joints, in addition to these functions, another important function of cartilage is to maintain the opening of the various orifices and tubes that are present in our body, as well as participating in the process of endochondral ossification, which is when cartilage serves as a mould for the ossification of long bones, which is characterised by bone growth (MAGEE, ZACHAZEWSKI & QUILLEN, 2013).

Cartilage has three types that depend mainly on the composition of the extracellular matrix. Hyaline cartilage is found in the airways, nasal cavities, bronchioles, articular surfaces of long bones and costal cartilage. The matrix that makes up this type of cartilage has type II collagen fibrils, a homogeneous and translucent matrix (TORTORA & DERRICKSON, 2016).

As for elastic cartilage, it has elastic fibres that provide flexibility, resistance and malleability, and is found in the external auditory pavilion, epiglottis, auditory tube and forms some cartilaginous pieces found in the larynx (TORTORA & DERRICKSON, 2016).

Fibrocartilage tissue is similar to dense connective tissue and is more compact. It can be found in the pubic symphysis, invertebrate discs, ligaments, tendons and menisci. Its characteristics are mechanical resistance and little elasticity (MAGEE, ZACHAZEWSKI & QUILLEN, 2013).

Ligaments are structures rich in collagen and elastic fibres that have the function of helping to fix articulated bones. In general, they are bundles of dense fibrous connective tissue, mainly made up of collagen fibres. They have the function of connecting the bones to each other, generating stability between the joints, resistance, generating cushioning, and serving as a guide for joint movement (BARBIN, 2018).

According to Barbin (2018), other functions can be identified such as transmitting information to the spinal cord and brain, including the function of assisting in the local fixation of internal organs such as the bladder, diaphragm and uterus. The classification of ligaments varies according to their location and according to the structure they

support, thus they are classified as: articular ligaments, suspensory ligaments, multisegmental ligaments and segmental ligaments.

Barbin's (2018) studies also show that joint ligaments are essential because they act as a junction between two bone structures in a joint, join the bone ends in a joint, help limit the range of movement and prevent dislocations. As an example, they are present in the shoulders and knees.

The suspensory ligaments keep certain internal organs in their proper place, such as the diaphragm and bladder, and their location can be classified into multisegmental and segmental ligaments. Respectively, the former is formed by the anterior, posterior and supraspinous longitudinal ligaments, while the latter is formed by the ligamentsum flavum, intertransverse, ileolumbar and interspinous (BARBIN, 2018; TORTORA & DERRICKSON, 2016).

Muscles, tendons and ligaments make up the skeletal muscle system and are of fundamental importance for keeping the body in line (MAGEE, ZACHAZEWSKI & QUILLEN, 2013).

The joint capsule is a connective membrane that covers all the joints and is made up of two layers (MAGEE, ZACHAZEWSKI & QUILLEN, 2013).

In their studies, the authors Magee, Zachazewski and Quille (2013) argued that the joint cavity is the space that exists between the articular surfaces, this space has the presence of synovial fluid which in turn is responsible for lubricating and nourishing the articular cartilage, as well as absorbing shocks and serving as a barrier for cells to enter and synovial fluid to leave the joint space.

The joint capsule protects the intra-articular structures and has the function of limiting joint movement while maintaining the integrity of the cavity. Joint structures are junctions between two or more bones or rigid parts of our skeleton, their functions and shapes differ (TORTORA & DERRICKSON, 2016).

Joints are classified into three types: fibrous (synarthrosis), cartilaginous (amphiarthrosis) and synovial (diarthrosis). Fibrous joints are divided into sutures and sisdemoses, with no joint cavity, reduced or non-existent mobility and a certain amount of elasticity (TORTORA & DERRICKSON, 2016; BARBIN, 2018).

Cartilaginous joints have no joint cavity and reduced mobility, and are divided into synchondroses and symphyses. Synovial cartilage joints, on the other hand, have a

joint cavity with a capsule filled with synovial fluid, are more mobile and are present in greater quantities in the body (MAGEE, ZACHAZEWSKI & QUILLEN, 2013).

BIOMECHANICAL ASPECTS OF BONE TISSUE

We explain the characteristics of the human skeleton, which has the function of providing support and protection, made up of 206 bones conceptually divided into two parts, respectively called the axial skeleton, made up of the bones of the head, neck and trunk, and the appendicular skeleton made up of the bones of the upper and lower limbs (TORTORA & DERRICKSON, 2016).

Qualified as an anatomical structure and a physiological organ, it is rigid and provides different functions depending on the specific region. For the thorax and extremities it provides support, on the other hand it also acts as a lever for the locomotor function of skeletal muscles and protection for vulnerable viscera (SALTER, 1985).

As it is a living tissue, bone is continually remodelling itself, adapting and creating an optimised structure to support the loads it is constantly subjected to, or to repair any injuries (DALMOLIN, 2013).

This structure is made up of an organic part and an inorganic part made up of phosphate and calcium minerals. In addition, bone tissue is made up of cells and calcified extracellular material, these cells being composed of: osteocytes, mature bone cells; osteoblasts, cells that produce the organic part of the bone matrix and osteoclasts, larger cells that are mobile and responsible for regenerating bone tissue (PAULINO, 2020).

The human skeleton also has the ability to repair itself when injured. It has the ability to remould its bones in order to thicken and strengthen them in areas that are under greater strain when exposed to higher impact activities (DINIZ, 2006).

Bones are classified as long, where length predominates over width and thickness. They are made up of a diaphysis and two ends covered in hyaline cartilage. They act as a storehouse for essential minerals such as calcium and phosphorus, which are mobilised to ensure the balance of the spongy bone's functions, They also have prominences, such as tubercles, ridges and tubercles, which act as buttresses, providing support for the attachment of large muscle groups, forming levers to move the limb in various directions; these are examples of long bones: femur, tibia, fibula, humerus, radius and ulna (SERRA, 2001).

In short bones, the three dimensions of the bone, i.e. length, width and thickness, are practically the same. They have a roughly cuboid shape and are found in wrists and ankles (SERRA, 2001).

In flat bones, width and length predominate over thickness. They are made up of two plates of compact bone, with spongy and medullary bone, such as the sternum, ribs, scapula and those found in the upper part of the skull. Structures that have peculiar shapes are called irregular bones. Examples include the vertebrae, the bones of the face, the bones at the base of the skull and the bones of the pelvis. The sesamoid bones are small and enclosed in tendons, the patella being the most common (SERRA, 2001).

Bone tissue is a solid tissue that is constantly subjected to stress, adapting to mechanical stimuli through atrophy and hypertrophy, which determine skeletal architecture. Bones are optimised to withstand physiological loads, considering both their material properties and structural geometry (DINIZ, 2006).

The main injuries that affect the upper bone structure are humeral fractures and shoulder bursitis, which is nothing more than an inflammation of the synovial bursa, a tissue that acts as a small cushion located inside a joint, preventing friction between the tendon and the bone (SANTOS, 2017).

The rotator cuff injury, which is quite common, affects 20% of people and its incidence increases with age. Shoulder dislocation is defined as the loss of joint contact, i.e. the separation of two bones that are usually in close and continuous contact by means of a smooth, sliding area called cartilage (SANTOS, 2017).

On the other hand, one of the main injuries to the lower bone structure is fractures of the leg, ankle or foot, which can occur as a result of falls, direct trauma or excessive forces. In orthopaedics, diaphyseal fractures of the femur are among the most common. They are serious injuries resulting from violent forces and most often come from motor vehicle accidents, generally involving young people and adults (POLO, 2021).

Another injury that directly affects the bone structure is osteoporosis, i.e. a decrease in bone mass per unit volume compared to what is considered normal for a given age, sex or race. The loss of bone mass causes the progressive weakening of the bone and increases the possibility of fractures, which is why osteoporosis can be a silent process that becomes evident when it causes a fracture (CARVALHO, 2001).

The pathology discussed above has emerged as a public health problem, mainly attributed to increased life expectancy. Spinal cord injury causes alterations in numerous organic systems, including calcium metabolism and the bone system, leading

to a loss of motor function, which is generally irreversible. Although part of the pathophysiology of osteoporosis in spinal cord injured people is attributed to simple disuse, it differs from traditional osteoporosis in that the neuromuscular system, related to other body systems, is modified (CARVALHO, 2001).

Injuries are classified as acute, subacute, chronic, acute superimposed on chronic injury or subclinical adaptation, the duration and timescale used for each stage of healing are arbitrary, it must be understood that these time periods often vary. There is little objective basis for deciding when an injury passes from one stage to another, this determination is usually based on the physiotherapist's experience (DALMOLIN, 2013).

Bone regeneration involves the formation of a bone callus to stabilise the fracture and the remodelling of the damaged bone. Treatment can include immobilisation, surgery and physiotherapy to restore bone function and strength (PAULINO, 2020).

STAGES OF THE INFLAMMATORY RESPONSE TO INJURY

In this context, Martins *et al.* (2021) conceptually defined musculoskeletal injury as a set of pathologies that affect structures such as muscles, tendons, ligaments, joints, nerves, spinal discs, cartilage and associated soft tissues. It emphasises that there are possibilities that they can be caused or intensified by physical activity.

The inflammatory process is a consequence of the body suffering an injury and can be triggered by various stimuli, such as biological agents, chemical substances, physical agents and tissue malformations. It involves the production of mediators that trigger biochemical, cellular and vascular changes to restore homeostasis (VARUSSA, 2022).

Inflammation has the potential to progress from an acute phase, defined by increased blood flow and leukocyte migration, to a chronic phase, with specific immunological responses. The clinical indicators of inflammation include oedema, redness, heat and pain, the implications of the action of mediators in local tissues. Inflammatory pain is caused by a decrease in the excitatory threshold of neurotransmitters. In cases of systemic and chronic evolution of inflammation, loss of function can occur as an additional sign of the inflammatory process (MONSANTO, 2019).

According to Varussa 2022, the inflammatory response arises as the body's defence mechanism against both exogenous and endogenous aggressors.

Inflammation helps to eliminate the offending agent by stimulating the removal of damaged tissue and the regeneration of new tissue.

At the time of injury, biochemical and chemotactic mediators are released during the tissue repair phases, in which each phase prepares the tissue for the removal of damaged cellular components, activates the proliferation of satellite cells and forms new fibres for cell fusion. Tissue repair is comprised of 4 phases that often overlap: homeostasis, inflammatory phase, proliferative phase and finally, remodelling phase (VARUSSA, 2022).

Acute injuries are generally caused by macrotraumas and indicate the initial phase of injury and healing. Described as the inflammatory phase, this lasts around 7 to 10 days and is characterised by the response to the injury such as cell death and vascular involvement. Clinically it is described by symptoms such as the formation of oedema, erythema, heat and pain. The inflammatory stage can last from 24 hours to 72 hours after the injury, and its response is generated through the release of chemical mediators, which initiates tissue cleansing, with the removal of debris and dead tissue and the fight against possible infections, followed by vasoconstriction by noradrenaline, and the proportional migration of leucocytes and macrophages that will carry out the phagocytic task and release biochemical mediators such as histamine, prostaglandins and bradykinins to free up blood flow and permeability again, thus forming oedema (VARUSSA, 2022).

As the inflammatory process begins, symptoms manifest from 8 hours after the event. The symptoms of intense pain, muscle spasms, reduced range of motion and functional impairment gradually subside as the inflammation subsides (ZWEIFACH, 2014).

The inflammatory response is an important process for tissue regeneration, however, the formation of oedema can cause the condition to worsen and promote cell death if the inflammation phase does not last a considerable minimum time in order to prioritise tissue recovery time. Although non-surgical treatment results in a good prognosis in the majority of athletes with muscle injuries, the consequences of treatment failure can be dramatic, delaying the return to physical activity for weeks or even months (ZWEIFACH, 2014).

In children, many acute injuries result in growth plate fractures or avulsions in the physeal region, as these areas are weaker than the bone itself, whereas injuries suffered by adults are more concentrated in the lower limb areas, so that the knee, ankle and lumbar spine are the anatomical regions most often involved. In sports

involving the upper limb, the shoulder, due to its extensive mobility and minimal inherent stability, is the main focus of injuries (MAGEE, ZACHAZEWSKI & QUILLEN, 2013).

A subacute injury is one that has passed through the acute phase and is now in the healing (proliferation) phase, or regeneration and repair. It typically lasts 5 to 10 days after the acute phase (12 to 20 days after the injury). This so-called proliferative phase occurs after the third day of the injury, starting the process of tissue repair, with the production of granulated connective tissue through fibroplasia, where fibroblasts will begin a synthesis of secretion of extracellular matrix components such as glycosaminoglycans, type I and type III collagen fibres (MAGEE, ZACHAZEWSKI & QUILLEN, 2013).

Moving on, the final phase, called remodelling, usually begins nine days after the injury, with no specific end date. It is characterised by the maturing of the scar tissue, a gain in tensile strength and a reduction in the size of the scar. The fibroblasts are replaced by type I and III collagen fibres, causing a reduction in cellular activity at the site and blood vessels. When fully healed, the tissue acquires 70% more strength than uninjured tissue, becomes avascular, pink or white in colour (VARUSSA, 2022).

The term chronic lesion has several meanings. It can indicate the final stage of healing, in which the injury has reached the maturation phase and is moving towards resolution in order to complete the healing cycle. The final stage of healing occurs 26 to 34 days after the injury and is usually complete in about two weeks, although it can take up to two years to achieve the strength that existed before the injury and the resolution of the tissue to near-normal strength. The term chronic injury can apply to an injury that lasts more than 1 month and does not seem to be getting better (injury or state of illness). This is called chronicity (ZWEIFACH, 2014).

Chronicity is a persistent inflammatory state that promotes extensive fibroplasia and lipogenesis. With chronicity, healing is much slower because of the accumulation of repetitive scar adhesions, degenerative changes and other detrimental effects. This type of chronic injury demonstrates subclinical adaptation, which is associated with pathophysiological changes. Subclinical adaptation is seen in repetitive strain injuries when the tissue does not have time to adapt to the stresses imposed (ZWEIFACH, 2014).

Thus, there is a constant struggle to balance the amplification of the inflammatory response, with a view to resolving the aggression, and the tissue damage resulting from its uncontrolled exacerbation. At the same time, the aim is to maintain the functionality

and integrity of the entire system so as not to jeopardise the body's protective responses (ZWEIFACH, 2014).

THERAPEUTIC RESOURCES APPLIED

Muscle damage is a pathological development that harms the individual, and is more common in athletes due to training routines that require great effort, however, anyone, whether due to sudden movements, blows or accidents, can acquire these injuries. According to Fernandes (2011 p. 247), muscle injuries are the most common cause of physical disability in sports. It is estimated that between 30 and 50 per cent of all sports-related injuries are caused by soft tissue injuries. Early diagnosis and precise management leads to an integrated recovery and minimises downtime.

In order to help patients with their rehabilitation, therapeutic resources have been incorporated, such as activities, equipment, techniques and methods that can help repair these structures after injuries. These include thermotherapy, cryotherapy, electrophototherapy, ultrasound and manual therapy.

Thermotherapy, defined as the therapeutic application of heat, can be achieved in various ways with the aim of raising the temperature of local body tissue. One of the means of heating applied to biological tissue is the infrared light lamp. In general, the penetration of infrared radiation is a maximum of 3mm from the skin, defining it as a superficial heat resource (SANTOS *et al.* 2019).

Cryotherapy consists of the therapeutic application of any substance to the body in order to reduce the temperature in a certain area of the body. It is also known as subtraction thermotherapy, due to the use of a thermal stimulus with a temperature below body temperature to remove body heat. Heat is always transferred unidirectionally from the most heated body to the least heated (FURLAN 2015 p. 10).

Electrothermophototherapy includes transcutaneous electrical neurostimulation (TENS), interferential current, radiofrequency diathermy, ultrasound, low-power laser, surface electromyography, among many others. There are countless possible applications, aimed at reducing pain, muscle spasms, returning neuromuscular activity, preventing atrophy as a result of disuse, gaining joint mobility, tissue repair, increasing local blood flow, reducing oedema, preventing post-operative thrombosis, among many other beneficial factors.

Ultrasound is one of the most sought-after therapeutic techniques in physiotherapy and is defined as an inaudible high-frequency sound wave (above 20 kHz) that can cause a rise in temperature and thus various physiological effects, such as increased blood flow, reduced pain and muscle spasm, and increased collagen extensibility (BRUNING, 2016 p. 4).

Manual therapy corresponds to the application and handling of technical movements that recover and improve the mobility of soft tissues, in other words, they are known as massages with the aim of reducing pain and increasing the quality of movement. However different the treatable mechanisms may seem, they have the same purpose of promoting recovery, relieving pain, reducing inflammation and improving the function of musculoskeletal structures (SANTANA *et al.* 2022).

Determining the appropriate treatment depends on the degree of severity of the injury, the stage of the healing process, the symptoms manifested and a careful consideration of the therapeutic methods available. The combination of different therapeutic mechanisms can subsidise and hasten recovery, enabling muscle regeneration in the inflammatory phase. In summary, the treatment of musculoskeletal injuries requires a singularised and comprehensive approach, with the aim of enabling appropriate healing, rehabilitating muscle function and preventing long-term complications.

RESULTS

The results of this literature review allude to an in-depth exploration of musculoskeletal structures in the face of possible injuries and treatment methods during the recovery process. A bibliographic survey was carried out in the databases of Latin American and Caribbean Literature in Health Sciences, PublicMedline, Medical Literature Analysis and Retrieval System on Line, Scientific Electronic Library Online, Google Schoolar and in books. Next, articles whose objectives and content were aligned with the aims of this research were carefully selected.

The article provides a tangible and brief overview of the anatomical and physiological properties of muscles, tendons and joints, together with a discussion of feasible recovery and prevention methods, emphasising the importance of personalised and multidisciplinary care. The works used as a basis address the anatomical and physiological characteristics of the properties mentioned, exposing the mechanisms of

injury and the impacts on the recovery process. They also explore different therapeutic approaches, including conservative and surgical interventions, physiotherapy, rehabilitation and complementary therapies.

The information found provides a comprehensive overview of research carried out in the field of musculoskeletal injuries, highlighting different approaches and contributions to knowledge and clinical practice in this area. Analysing these studies allows for a broader and more grounded understanding of the treatment and rehabilitation strategies used, aiding clinical decision-making and promoting better outcomes for affected patients.

Table 1 below summarises the relevant scientific publications on the subject, including authors, years of publication, journals, methodological approaches and main findings.

Table 1 - Presentations of scientific publications on injuries, recovery and treatments applicable to musculoskeletal structures with authors' names, years of publication, journal names, methodological approaches and main findings.

AUTHOR	YEAR	SOURCE	TYPE OF PUBLICATION	STUDY SITE	RELATIONSHIP WITH THE RESEARCH OBJECTIVES	METHODOLOGICAL APPROACH	MAIN FINDINGS
TORTORA & DERRICKSON	2013	Federal University of Rio de Janeiro	Book	Rio de Janeiro - RJ	Yes	Technical Review	It covered the fundamentals of anatomy and physiology, presenting the concepts and processes by which structures function.
SERRA *et al.*	2001	Santa Creu Hospital	Book	Benito Valez - Salvador	Yes	Systematic Review	He presented the physiotherapist's intervention and, above all, the examination of physical parameters in a systematic way.
RUARO	2004	Federal University of Paraná	Book	Umuarama - Paraná	Yes	Case Studies	He has made a modest contribution due to the experience he has accumulated over the years, the effects on the Orthopaedics and Traumatology specialities.
MAGEE *et al.*	2013	University of Alberta	Book	Alberta - Canada	Yes	Systematic Review	It covers all the scientific aspects associated with the

							structures of the musculoskeletal system and brings together the necessary content for collaborating and implementing treatments.
PAULINO	2020	Faculty of Science and Technology, University of Coimbra	Thesis	Coimbra - Portugal	Yes	Scientific Research	To develop an electromechanical system, to be attached to an external fixator, which allows the automation of micro-movements, guaranteeing daily stretching in multiple steps.
RAMOS *et al.*	2016	Department of Orthopaedics and Traumatology	Article	São Paulo - SP	Yes	Case Studies	It demonstrated the athlete's recovery to sport at the same functional level as before the injury and return the athlete with minimal risk of recurrence.
XAVIER	2017	Interdisciplinary journal of medical sciences	Article	Belo Horizonte - Minas Gerais	Yes	Case Studies	It sought to identify the most common crossfit injuries and their prevention.
MARTINS *et al.*	2021	Cuidarte Magazine	Article	Viseu - Portugal	Yes	Case Studies	It showed that intense and prolonged sports

							training in athletes can cause pathologies in the musculoskeletal system.
PINHO *et al.*	2013	University of Porto	Article	Porto - Portugal	Yes	Case Studies	A review of the main aspects related to musculoskeletal injuries associated with sports practices in children and adolescents.
MARTINS *et al.*	2020	Federal University of Pará	Article	Belém - Pará	Yes	Case Studies	The aim is to analyse the incidence of pain and musculoskeletal injuries in military police officers, as well as the authoritative health regulatory strategies and their preventive contributions in this context.
SILVA	2023	Faculty of Sport, University of Porto	Article	Porto - Portugal	Yes	Report	It improves physical and functional fitness, both in healthy populations and in those with some kind of pathology.
SANTOS *et al.*	2021	Educational Institute	Article	Santa Catarina	Yes	Case Studies	Deepen and analyse the skeletal

							muscle changes of ageing.
VERRAL	2016	Sports medicine department	Article	Adelaide - Australia	Yes	Case Studies	This research applies elastic movement principles to the anatomy and movement patterns of MSK structures.
NOGUEIRA	2016	Brazilian journal of functional health	Article	Cachoeira - Bahia	Yes	Systematic Review	The aim is to find out about the main types of MSDs that affect nursing professionals.
DINIZ ET AL.	2006	Vale da Paraíba University - Institute for Research and Movement	ARTICLE	Paraíba Valley - São Paulo	YES	Case Studies	Initially understand the description of the necessary biomechanical concepts.
FREITAS et al.	2019	Leão Sampaio University Centre	Article	Juazeiro do Norte - Ceará	Yes	Case Studies	This study consists of a literature review on therapeutic approaches to inflammatory diseases.
SILVA	2021	Doctum education network	Article	Serra - Espírito Santo	Yes	Case Studies	The aim is to identify whether physical education teachers who work in bodybuilding have the necessary skills

							to prescribe and guide rehabilitation training for musculoskeletal injuries.
SILVA *et al.*	2016	Maringá Metropolitan College	Article	Maringá - Paraná	Yes	Case Studies	To analyse the characteristics of musculoskeletal injuries suffered by professional VP athletes.
VARUSSA	2022	Institute of Biosciences	ARTICLE	Rio Claro - São Paulo	YES	Case Studies	To evaluate the action of thermotherapy in the treatment of severe acute muscle injuries.
SANTANNA *et al.*	2022	FIFA Medical Centre of Excellence	Article	São Paulo - SP	Yes	Case Studies	It separates mild, moderate and severe injuries and gives a diagnosis for each depending on the degree.

Source: Prepared by the authors (2024).

The plurality of content in the studies used as a reference, enhances the assimilation of musculoskeletal injuries and co-operates with the enhancement of instructional knowledge in the area, adding valuable subsidies for the improvement of professionals in clinical practice.

DISCUSSION

With regard to the objectives presented in this research, the discussion sought to conceptually portray the relevance of knowledge of musculoskeletal structures for an approach to injuries, recovery, as well as treatments aimed at physiotherapy patients. It also highlights the multidisciplinary approach and the importance of an individualised assessment for each injury, taking into account its severity and specific characteristics, in order to determine the best rehabilitation plan for the most efficient and specialised treatments.

Conceptualisation and Characteristics of Musculoskeletal Structures

Among the authors cited, Martins *et al.* (2021) defined the components of the musculoskeletal system as the muscles, joints and bones of the human body. These structures perform essential functions for the movement, support and protection of the body and are exposed to a variety of injuries that can affect their function and body mobility.

Martins *et al.* (2021) also argued that musculoskeletal injury is a set of pathologies that affect structures such as muscles, tendons, ligaments, joints, nerves, vertebral discs, cartilage, blood vessels or associated soft tissues, and can be caused or aggravated by physical activity.

Therefore, according to Santanna *et al.* (2022 p. 2) the cause of muscle damage can be considered indirect or direct. In view of this, indirect injury is related to the absence of contact and can be functional, due to mechanical overload, neurological or structural injury, which occurs when there is partial or complete muscle rupture. On the other hand, direct injury occurs at the site of contact and can cause laceration or contusion. Thus, more than 90 per cent of all sports-related injuries are contusions or strains. Muscle tears, on the other hand, are the least frequent injuries in sport.

Structures such as tendons, which are closely linked to bone and muscle, are

also affected by injury. As such, tendon injuries are quite common and can range from mild to severe. Some examples of injuries include tendonitis, which is an inflammation of the tendon due to overuse or acute injury, which can occur in any tendon in the body, but is commonly seen in the tendons of the shoulder, elbow, knee and ankle. Another is tendon rupture, which occurs when the tendon structure ruptures completely or partially, for example Achilles tendon rupture, biceps tendon rupture, patellar tendon rupture (GREENER, 2006).

Joints play a fundamental role in the human body, being essential structures that allow movement, stability and protection of bones, muscles and connective tissues. They can be defined as a point where two bones articulate or come into contact, enabling a wide range of movements that are essential for daily activities and physical exercise. The structure of joints is complex and involves the presence of cartilage, ligaments, tendons and synovial fluid, which act together to ensure their functionality and integrity, they can be classified into different types, each with specific characteristics that determine their function and mobility (TORTORA & DERRICKSON, 2016).

In addition, Magee *et al.* (2013) corroborated that the functionality of cartilage includes structural support, absorbing impacts and sliding between bones, lining articular surfaces and facilitating movement in joints. In addition to these functions, another important function of cartilage is to maintain the opening of the various holes and tubes that are present in our bodies, as well as taking part in the process of endochondral ossification.

The importance of bone structure as an essential component of the musculoskeletal system was also emphasised. Since bone tissue provides support and structure to the body, it is considered an anatomical structure and a physiological organ. Bone tissue is rigid and provides the region in which it is located with: support for the thorax and extremities; leverage for the locomotor function of skeletal muscles; protection for vulnerable viscera (SALTER, 1985).

Ratifying this sentence, Paulino (2020) argued that bone tissue is made up of cells and calcified extracellular material, these cells being composed of: osteocytes, mature bone cells; osteoblasts, cells that produce the organic part of the bone matrix and osteoclasts, larger cells that are mobile and responsible for regenerating bone tissue.

This highlights the importance of preventing these structures as a whole, so that

they can perform their functions satisfactorily. When injured, the relevant treatment is determined based on the degree of severity of the injury, the stage of the healing process, the symptoms manifested and a cohesive consideration of the therapeutic methods available.

Main Treatments Approached Based on the Particularities of Each Injury Respecting the Principle of Individuality Based on a Multidisciplinary Approach

In order to provide excellent treatment for patients suffering from musculoskeletal injuries during rehabilitation, various therapeutic resources have been added, such as equipment, techniques, methods and surgical interventions when necessary, which can contribute to the repair of these structures after injuries.

In an acute phase, the immediate treatment for injury to musculoskeletal tissue or any soft tissue is known as the principle of Protection, Rest, Ice or Ice, Compression and Elevation (PRICE). After this initial care, depending on the characteristics of the injuries, other resources can be incorporated. Thermotherapy, defined as the therapeutic application of heat, can be achieved in various ways with the aim of raising the temperature of local body tissue. In addition to hot pack compresses, one of the means of heating applied to biological tissue is the infrared light lamp. For a safe protocol, the penetration of infrared radiation is a maximum of 3mm from the skin, defining it as a superficial heat resource (SANTOS *et al*. 2019).

Cryotherapy is the therapeutic application of any substance to the body in order to reduce the temperature in a certain area of the body. It is also known as subtraction thermotherapy, due to the use of a thermal stimulus with a temperature below body temperature to remove body heat. Heat is always transferred unidirectionally from the most heated body to the least heated (FURLAN 2015 p. 10).

Based on electrotherapy methods, treatments involving electrothermophototherapy include numerous modalities, such as Transcutaneous Electrical Neurostimulation (TENS), interferential current, radiofrequency diathermy, ultrasound, low-power laser, surface electromyography, among others. Representing a diversity of applications aimed at: reducing pain and muscle spasms; returning neuromuscular activity, preventing and delaying atrophy due to disuse; gaining joint mobility; tissue repair, including skin lesions; increasing local blood flow; reducing acute and chronic oedema; preventing post-operative thrombosis, among others1, although

there are controversies about their results (GOULART, 2018).

Alongside this, ultrasound is one of the most sought-after therapeutic techniques in physiotherapy, which is defined as an inaudible high-frequency sound wave (above 20 kHz) that can cause a rise in temperature and thus various physiological effects, such as increased blood flow, reduced pain and muscle spasm, and increased collagen extensibility (BRUNING 2016 p. 4).

Another resource discussed was manual therapy, which is the application and handling of technical movements that recover and improve the mobility of soft tissues, i.e. what are known as massages, which, among other things, aim to reduce pain and increase the quality of movement. That said, all treatment procedures, however disparate they may be, have the aim of promoting recovery, relieving pain, reducing inflammation and improving the function of musculoskeletal structures.

CONCLUSION

The results of this specialised review highlight the complexity and importance of the musculoskeletal structures that play a crucial role in injuries, recovery and applicable treatments. Several studies have highlighted the importance of the integrity of these structures, and have attempted to emphasise that understanding the different tissues involved, biomechanical aspects and the appropriate choice of therapeutic resources are fundamental to promoting effective and functional recovery for patients.

This explains the urgency of a multidisciplinary and singularised intervention, taking into account the particularities of the injuries and the importance of a specific rehabilitation plan for the patient's recovery. Emphasising the importance of a broad and congruent intercession aimed at preventing complications and promoting a full recovery, the period from procedures to recovery depends on the severity of the injury and the patient's condition.

It is mentioned that although there are several recovery strategies available, the assertive advice of the professional regarding the appropriate treatment for the patient is essential. It is also recognised that preventing injuries to musculoskeletal structures is fundamental to maintaining good health. Regular physical activity, the use of appropriate protective equipment and the adoption of healthy habits are examples of significant precautionary measures to prevent injuries and preserve the completeness of structures.

Concisely, the distinguished review highlights the substantial proficiency of knowledge about the behaviour of musculoskeletal structures in the processes of injury, recovery and applicable treatments. Knowledge of the specificities of these structures and the application of preventive parameters are essential to guaranteeing the health and quality of life of individuals. It is assumed that the corollaries can contribute to an increase in knowledge by explaining the aspects reviewed, with the aim of expanding knowledge in this area and instituting improvements in the care provided to patients with musculoskeletal injuries.

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