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REVIEW ARTICLE

ORTHOPEDIC RELATED COMORBIDITIES IN SPINAL CORD-INJURED INDIVIDUALS

ASPECTOS ORTOPÉDICOS NO PACIENTE LESADO MEDULAR

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ABSTRACT

Objective: This study aims to review, identify and study the determinations of the main orthopedic aspects in SCI patients. Methods: A total of 80 articles from PUBMED and three theses (MSc. /DSc.) were examined. Results: The results refer to the most essential joints. There is a chronic overload on the shoulder girdle due to the use of the upper limb as a supporting joint. The elbow presents osteoarthritis, subclinical, acute and chronic pain, mainly in quadriplegic patients. In the hand and wrist joints there are cases of paralysis, osteoporosis and osteoarthritis. Hips are the main weight-bearing joints while sitting which leads to a substantial degenerative process of this joint. Lastly, on the knee, feet and ankles, spasticity, contractures, osteoporosis and deformities can arise. Conclusion: Along with the increase in cases and research that analyze the alterations that spinal cord-injured individuals suffer, it is necessary to recognize the orthopedic changes to understand their limits and identify the relevance of the rehabilitation program to improve the muscle performance. ***Level of Evidence II, Prognostic Studies – Investigating the Effect of a Patient Characteristic on the Outcome of Disease.***

Keywords: Quadriplegia. Spinal Cord Injuries. Chronic Pain.

RESUMO

Objetivo: O objetivo do estudo foi identificar, através de uma revisão sistemática, os aspectos ortopédicos e suas determinações nos pacientes lesados medulares. Métodos: Foram examinados 80 artigos na base Pubmed e três teses de mestrado e doutorado. Resultados: Os resultados obtidos referem-se às principais articulações. No ombro há uma sobrecarga crônica na cintura escapular devido ao uso como articulação de suporte. O cotovelo apresenta alterações osteocartilaginosas e dores subaguda, aguda e crônica principalmente no paciente tetraplégico. Nas articulações da mão e punho, a lesão leva à perda da capacidade de compressão por paralisia, osteoporose e osteoartrite. O quadril constitui a principal articulação de sustentação de peso quando sentado, ocorrendo um processo degenerativo importante nesses pacientes. Nos joelhos, pés e tornozelos surgem espasticidade, contraturas e osteoporose levando a deformidades. Conclusão: Devido ao aumento de casos e de pesquisas que analisam as alterações que os lesados medulares sofrem, se faz necessário o conhecimento das alterações ortopédicas do lesado medular para compreendermos a sua limitação e identificar a relevância do programa de reabilitação para melhora da performance muscular. ***Nível de Evidência II, Estudos Prognósticos – Investigação do efeito de característica de um paciente sobre o desfecho da doença.***

Descritores: *Quadriplegia. Traumatismos da Medula Espinal. Dor Crônica.*

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INTRODUCTION

Spinal cord injuries (SCI) cause the loss of motor, sensory and autonomic functions below the injured level, damaging social, physical and psychological functions. Trauma is the most common cause of this condition. In Brazil, it mainly occurs due to car accidents, gunshot injuries and falls; the most affected group are males, aged 15 to 40 years. Morbidity characteristics of the disease further aggravate the patient's psychological condition,[1] as they frequently are younger and have an active lifestyle.

Spinal injuries lead to disuse of the affected limbs, which may generate spasticity, osteoarthritis, muscle hypotrophy, venous thrombosis, osteoporosis etc.

The number of cases of such injuries has been increasing, reaching almost 10,000 new cases per year in Brazil, a very high incidence

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The study was conducted at Universidade Estadual de Campinas, School of Medical Sciences, Campinas, SP, Brazil.
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when compared to other countries using WHO standards. The longer survival of victims of traumatic spinal cord injury is related to the training of multidisciplinary teams from first care to restructuring of the patient in society.[2] Due to this increase in cases, its study and treatment has been undergoing great technological and medical advances, with alternatives that improve quality of life. This study aimed to conduct a systematic review of the literature of the Laboratory of Biomechanics and Rehabilitation of the Locomotor Apparatus of the Universidade Estadual de Campinas (Unicamp) to identify the main orthopedic aspects in spinal cord injuries. The identification of such aspects in choice of treatment improves the quality of life of these patients.

MATERIALS AND METHODS

Between October and December 2018, we carried out a systematic review that included master's and doctoral theses defended in the Graduate Program in Surgery at FCM/Unicamp as well as articles available in the Pubmed databases on quadriplegic and paraplegic patients of the Spinal Rehabilitation Outpatient Clinic - HC. This type of review allows the study, evaluation and synthesis of the evidence already available on the subject. The indexing terms used were 'SCI'; 'pain'; 'tetraplegic'.

We raised 80 articles and 3 theses. Of these, we selected only those that contained orthopedic aspects of spinal cord injuries in their titles and abstracts. The articles and theses selected were fully read. Inclusion criteria were allusion to the spine, shoulders, elbows, wrists, hands, hips, knees, ankles and feet of those with spinal injuries. We excluded those that did not address the causes, consequences and repercussions of a spinal cord injury on the axial and appendicular skeleton as well as therapeutic proposals for these impacts.

RESULTS

Shoulder

Spinal cord injury patients are strictly dependent on their upper limbs to perform daily activities. Whether for wheelchair propulsion, body support or weight transfer. These patients use their upper limbs as supporting joints; as such, this daily requirement causes a chronic overload on the shoulder girdle, aggravated by the muscular weakness due to spinal injury itself, high body-mass index, prolonged injury time, and injury level.[3]

The main complaint of these patients is shoulder pain, whose etiology is multifactorial. The most affected structures are the supraspinatus tendon, bursae and the acromioclavicular joint (Figure 1).[3] Main pathologies of the shoulder include bursitis, rotator cuff rupture, tendinopathies, anterior instability, osteoarthrosis, osteonecrosis and osteoporosis of the acromioclavicular joint.[4] Tendinopathies and decreased acromioclavicular space are caused by mechanisms that have not yet been explained of change in blood supply in these areas.[4]

There is a distinction regarding the etiology of pain in the shoulders of patients with spinal injuries. Among the recently injured, pain is possibly related to the attempt of mobilization of the upper limbs unfit to their conditioning. Complaints in patients with longer injury time are usually related to overload of the osteoarticular system of the shoulder girdle.[5]

Pain may be present in subclinical, acute and chronic forms. All of them can be evidenced by radiography, a low-cost and efficient noninvasive method. If necessary, magnetic resonance imaging (MRI) can be performed to complement analysis.[5,6] Detection of lesions in early stages is essential for good prognosis of the upper limbs in patients with spinal injuries. On the other hand, shoulder strengthening, and stabilization of the scapula are important as preventive factors for major injuries. Sport is a very effective therapeutic proposal in developed scenarios.[6]

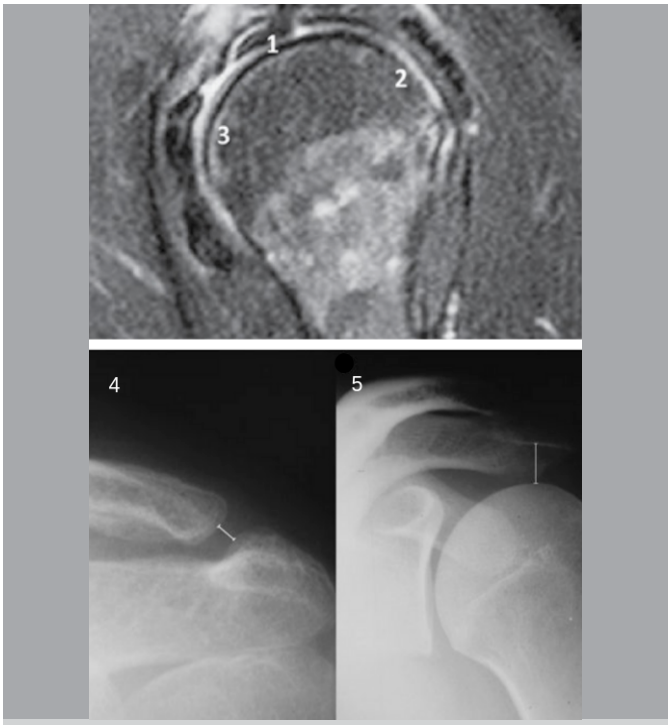

Figure 1. T2 sagittal section of the left shoulder. (1) Peritendinous hypersignal in the supraspinatus and liquid in the subacromial and subdeltoid bursa; (2) Infraspinatus ligament. X-ray of the left shoulder. Hypersignal of the rotator cuff, between the insertion of the supraspinatus; (3) and subscapular ligaments; (4) ACJ space: distance between the medial tip of the acromion and the lateral edge of the clavicle; (5) Acromio-umeral space.[5,6]

Elbow

The elbow is a relevant joint as it is responsible for the movement of the forearm and hand. Patients with spinal injuries with clinical and physical alterations in this joint become totally dependent on third parties.[7]

The prevalence of pain and injury to the elbows is reported in 5% to 16% of the literature. Many factors are capable of triggering elbow pain, among them ulnar mononeuropathy by nerve compression resulting in cubital tunnel syndrome – prevalent in 22%-45% of spinal cord injuries – osteoarthritis, lateral epicondylitis and olecranon bursitis.[8] The etiology of pain in these cases is described as a compilation of inflammatory, degenerative and hypertrophied processes resulting from the manifestation of the organism to protect against joint injuries by increasing its load.

Overload during transfers and in wheelchair use is the cause of the main clinical and anatomical changes, similarly to the shoulder. In one of the reviewed studies, we found that alterations commonly present as decreased active range of motion (ROM) and muscle and osteocartilaginous alterations (Figure 2b and 2c).

Quadriplegic patients have a significant loss of control and motor strength, besides presenting a lower range of motion than paraplegics.[7] A study shows that muscle function (dynamometry) of elbow extensors is better correlated with functional tests than elbow flexors. Thus, we can affirm that there is a predominance of independence of elbow extension. However, the extensor muscles of the forearm still have less strength than the flexors, especially in patients with high quadriplegic (C5-C6) (Figure 2a).[9]

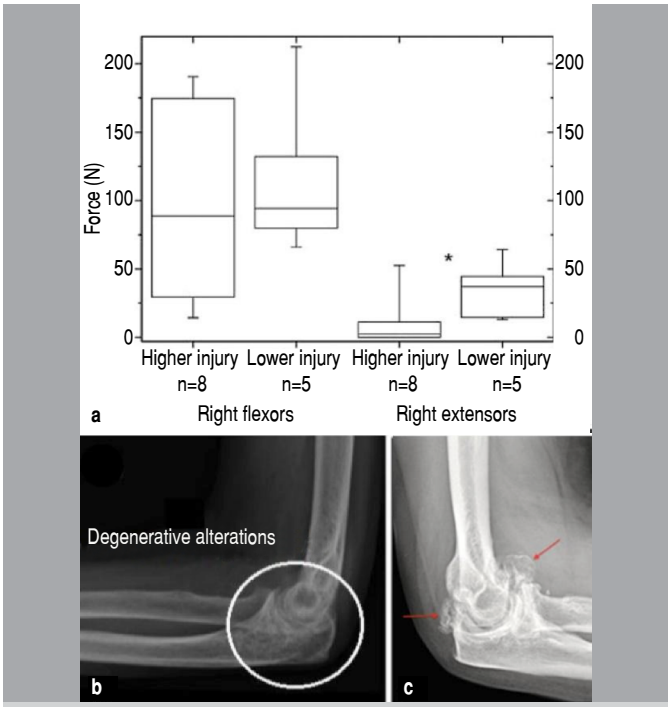

Figure 2. a: Strength measurements of the flexor and extensor muscles of the right upper limb in quadriplegic patients with high and low lesion; b: Presence of changes in the articular surface of the left elbow; c: Joint destruction and presence of free bodies (see red arrow).[7,9]

Hand and wrist

Hands are essential elements in planning, coordinating and executing daily activities with objects. After spinal cord injury there are ruptures and reorganizations of neuronal circuits in cervical vertebrae that lead to impairment of the upper extremities.[10] That is, the connection between the supraspinal centers and the muscles is lost, leading to paralysis of the upper limb and loss of movement, which results in the loss of independence. Lesions between C1-C4 result in loss of complete motor function of the upper limbs, while in C5 there is loss of function from the elbow to the distal end and in C6 only paralysis of the hands.[11]

In most cases, the patient has a certain degree of muscle strength that allows the positioning of the hand in space through shoulder and arm movements, but the hand grip function is compromised. Neuromuscular Electrical Stimulation (NMES) acts on the paralyzed muscles of the spinal cord injury and promotes rapid muscle fatigue, favoring joint movements and preventing joint stiffness.[12] This procedure can be used as a rehabilitation tool, enabling the return of movements such as holding and releasing objects. This can provide the return of the individual's activities and their independence. A research was carried out that evaluated the capacity of NMES with surface electrodes and concluded that it is possible to understand the muscles affected by fixed stimulation of an open circuit, in addition to demonstrating positive feedback from patients when exercising simple activities.[13]

Hips

In paraplegic or quadriplegic patients with spinal injuries, the hip is the main weight-bearing joint since these patients begin to use the wheelchair as the main mean of accommodation and locomotion. Therefore, the mechanical requirement, due to the axial load, is immense. At the same time, patients face the immobility inherent to the sitting position, which determines marked disuse of this joint, accelerating the degeneration and hindering rehabilitation.

Osteoarticular alterations observed are heterotopic ossification, which is the most prevalent, narrowing of the hip joint space, ectopic calcifications and morphological changes in the femoral head and acetabulum.[14]

An effective and low-cost method to monitor the wear on hips of a patient with spinal injuries is X-ray imaging.[4,15]

Early detection of symptoms can help a good prognosis and improve the quality of life of these patients in their daily activities and rehabilitation processes. For this reason, radiological monitoring of the hips of people who have suffered spinal injuries is suggested.[4]

Knee

In about 70% of spinal cord injuries there is a motor disorder due to involvement of the upper motor neuron, known as spasticity. Increased muscle tonus, stretch reflex and resistance to passive movement are debilitating consequences that worsen the quality of life of patients.[16] In contrast, spasticity delays atrophy when compared to other muscle groups.[17] Unfortunately, spastic symptoms are not adequately treated and diagnosed in the population with spinal cord injury, since they are diverse and their etiology uncertain. Knowledge of spastic alterations was approached in a study with patients with spinal injuries in order to evaluate how much the Pendular Test is influenced by posture, concluding that positions in which the rectus femoral muscle is more relaxed there is less spasticity. Meanwhile, supine and semi-supine postures increase blood pressure and pain in patients with injury above T6 (autonomic dysreflexia).[17] Another related study was prepared to evaluate the effect of neuromuscular electrical stimulation on spasticity in patients with spinal cord injury and concluded that it is effective by reducing spasticity, but with short duration. Figure 3a – before NMES, there are disorganized movements and less wave amplitude, explained by the absence of muscle control. While, in Figure 3b – after NMES, we can observe more coordinated movements and larger amplitudes, defined as decreased spasticity. The long-term effects of neuromuscular electrical stimulation have not been evaluated.

Considering the increase in life expectancy of patients with spinal injuries simultaneous to the advance of technological developments in therapy, researchers investigated whether the locomotor training program, capable of promoting gait, causes moderate and severe knee injuries. Since there are no complaints of pain in this joint in spinal cord injuries due to lack of sensitivity, it is necessary to use imaging tests to know probable changes. In this study, magnetic resonance imaging was the examination of choice. The authors concluded that patients undergoing training should be monitored in order to prevent future injuries. And that despite presenting abnormalities in MRI (Figure 3c and 3d), there was not enough pathological information to support the interruption of the training program.[14]

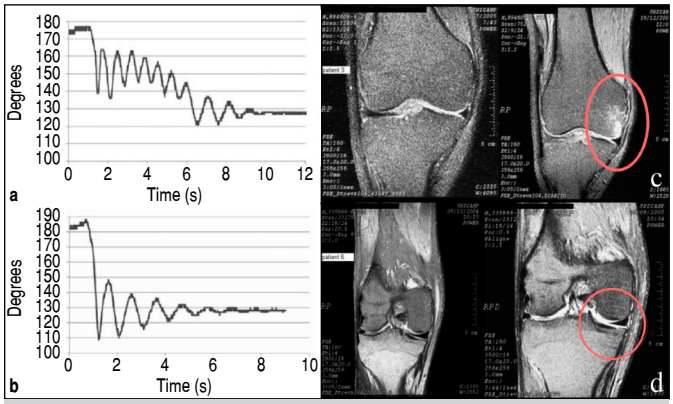

Figure 3. a: Graph representing the variation in degrees of spasticity in the pendular test before the NMES; b: Similar graph in 'a', but after NMES; c: MRI scan with contusion of the medial bone (red circle); d: MRI points to medial meniscus injury with internal decrease.[17,18]

Foot and ankle

The ankle is a joint formed by the distal articular surface of the tibia and foot. The heel bone is articulated with the foot and tarsal bones and its contact with the ground constitutes the posterior support of the foot. The tarsal bone is articulated anterior to the fourth and fifth metatarsals. The five metatarsal bones connect the tarsal bones to the phalanges, located distally. The articulation between the bases of the proximal phalanges and the metatarsal heads brings static and dynamic stability, along with muscular balance of the foot.[18]
The ankle is a fundamental joint for gait. Gait is the displacement of the body from one place to another. The foot also participates, since the friction between it and the ground modifies acceleration and deceleration, affecting gait.

There are few studies describing the changes in the feet and ankle of spinal injury patients. Spasticities, contractures and osteoporosis arise due to spinal cord injury and disuse of the limbs, which can lead to deformities.
The feet and ankles of spinal injury patients still have normal anatomical aspects, although there are alterations (Figure 4a and 4b). These are a consequence of the absence of tactile, proprioceptive and pain sensitivity. An example are overload ulcers, Charcot arthropathy (consequent of repetitive microtraumas), the accentuation of deformities due to muscle imbalances and fractures due to low bone density. The latter, known as osteoporosis, occurs due to the absence of mechanical stress and neurological and hormonal alterations. In the feet, mainly, this hinders the possibility of returning to walking.

A

	Normal angle (degrees)	Wider angle with tendency to the following deformities:	Narrower angle with tendency to the following deformities:
Hallux valgus	15	Hallux valgus	Hallux varus
Foot joints	9	Metatarsus varus	Metatarsus valgus
Anteroposterior Kite angle	30	Adduction	Abduction
Calcanean angle	30	Cavus/supine	Plane/prone
Lateral Kite angle	30	Cavus	Plane
Moreau-Costa-Bertani's angle	4 a -4	Cavus/supine	Plane/prone
Tibiocalcaneal angle	90	Calcaneous foot	Equine

B

Figure 4. A: deformities found in the feet and their relationship of angles with deviations; B: Bilateral flat feet.[12]

The use of NMES as a treatment allows patients to remain in an orthostatic position and thus perform movements, helping to keep the feet and ankles of spinal injuries planted and in an appropriate position for walking, which may lead to the reacquisition of autonomous gait.[12]

DISCUSSION

Due to the high medical and technological development, the life of these patients has changed profoundly in recent decades.[19] However, sequelae after spinal injuries bring several comorbidities that influence lifestyle.
Therefore, the understanding of the orthopedic aspects of each patient is fundamental for adaptation within the training and rehabilitation of the locomotor system. In this review, most of the anatomical and functional characteristics, as well as their alterations, were presented in order to discuss the relationship of the structure with the condition of the patient and all the main repercussions of a spinal cord injury.
Many pertinent aspects about the main structures of these conditions have not yet been fully explored, such as limb disuse of a quadriplegic or paraplegic patient and the mechanism of this impairment, as well as the most effective diagnostic methods and therapeutic proposals with lower associated cost. Considering that spinal cord injury is a delicate clinical condition and its traumatic expression is a public health problem in Brazil, greater scientific production on this subject is essential.

CONCLUSION

The correct and early diagnosis of possible malfunctions and subsequent intervention, whether with Neuromuscular Electrical Stimulation, physical therapy exercises and the practice of physical activity, are essential for the good prognosis of the patient.

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