POST-OPERATIVE REHABILITATION FOLLOWING PANCARPAL ARTHODESIS

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Pancarpal arthrodesis is defined as surgically induced osseous union of the carpus.[16] Factors leading to the necessitation of a pancarpal arthrodesis are generally a severe palmar carpal sprain secondary to a hyperextension injury to that joint or a disease process.[16] More than 80% of the hyperextension injuries involve the middle carpal joint, the carpometacarpal joint of both, while often there is no detectable injury to the antebrachiocarpal joint.[16] However, when the antebrachiocarpal joint is involved, a complete arthrodesis is necessitated. Some disease processes however (i.e. immune-mediated joint diseases or septic arthritis) that will also affect the carpus and may necessitate a pancarpal arthrodesis.[16, 29]

The procedure involves complete removal of all articular cartilage from the three joints (antebrachiocarpal, carpometacarpal and antebrachiocapral) as well as the vertical intercarpal joints. Bone grafting and plating is required, and the joint is usually placed in 5 – 15 degrees of extension.[16, 25] It is also recommended that an external coaptation support be applied to the limb for 4 – 8 weeks following surgery.[25]

The Effects of Immobilization on the Musculoskeletal System

Firstly, it is important to understand what happens to soft tissues and articular structures after a period of immobilization or disuse. It is well known that muscle atrophy is caused by disuse, such as bed rest or unilateral lower limb immobilization.[1] Twenty days of bed rest has been shown to induce up to 10% atrophy in the lower limb muscles of health men and women.[1] Total hind limb immobilization has been shown to cause as much as 40% loss of muscle mass to the soleus muscle in rats within seven days.[2, 5, 6] The antigravity muscles are the ones most affected.[5] The disuse effects to muscles include a loss of lean tissue mass, an atrophy of type I slow-twitch (oxidative) muscle fibres and their associated tendons (generally the extensor muscle groups), and a biochemical conversion of subtype IIa skeletal muscle fibres into type IIb, thus further debilitating the oxidative (aerobic) capacity of the muscles. [2, 5, 12, 28, 31, 34] When muscles are immobilized in a shortened position, this causes a loss of serial sarcomere number along the length of the muscle fibres with a consequent shortening of muscle length and loss of strength.[6,12, 31, 34] As well, immobility results in a loss of muscle protein due to an early decrease in protein synthesis rate which leads to an increase in protein degradation and hence a loss of muscle volume.[4]

Immobilization can also lead to ligament atrophy, with a decrease in maximum load to failure and a decreased biochemical, structural and mechanical properties.[31, 34] Cartilage can also be affected by immobilization: Degenerative joint changes occur and there is a gradual reduction in proteoglycan content and production, a thinning or loss of articular cartilage, a decrease in cartilage matrix and cellular components and a decrease in synovial fluid which then reduces cartilage nutrition.[31, 34] A loss of subchondral bone, osteoporosis, osteopenia, osteophytes, and periarticular fibrosis are problems with immobilization that affect bone.[12, 31, 34] Additionally, in situations of non-use, bone exhibits demineralization (specifically, a loss of calcium) and protein wastage due to loss of gravitational forces and movement.[5, 20]

Therapeutic Interventions

As compared to other articular surgical interventions where the rehabilitation targets the affected joint and its most proximal soft tissue structures, physiotherapy for a post operative pancarpal arthrodesis primarily targets the adjacent joints and their corresponding soft tissue structures as well as bone demineralization / osteoporosis. Additionally, focus on overall function is of great importance.

Stretching of soft tissue structures

In the case of pancarpal arthrodesis, full flexion and extension of the shoulder joint (including the scapulothoracic synsarcosis), the elbow joint and each digit should be administered regularly to stretch the 1-joint muscles surrounding these joints. As well, specific stretching of 2-joint muscles (i.e. biceps brachii, long head of triceps, the superficial and deep digital flexors, the common digital extensor and the lateral digital extensor) and muscles that are not generally put in a lengthened position when a forelimb is immobilized (latissimus dorsi, teres major, rhomboids, and brachiocephalicus) should be addressed with stretching. Stretching has been shown to be effective in increasing joint and muscle flexibility.[8, 9, 19, 21, 27, 32] Regular stretching can improve eccentric and concentric force production, velocity of contractions, maximal volitional contractions, counter-movement jump height, 50 yard dash and athletic performance.[15, 30] One study even found that regular stretching can induce hypertrophy in immobilized muscles and another speculated that this effect may improve performance in the long term.[6,30] It is, in fact, recognized as a very powerful stimulant of muscle growth and protein synthesis and has been demonstrated to reduce the amount of muscle fibre atrophy following immobilization or deconditioning.[6, 13, 28] Stretching can achieve these effects in the soft tissues of the joints proximal and distal to the carpus in this scenario following application of an external coaptation and convalescence.

Joint mobilizations and passive range of motion

The health of the adjacent joints should be addressed as soon as possible. Joint mobilizations (passive articular movements and/or accessory movements) have been reported to aid in cartilage nutrition, restore voluntary movement and enhance periarticular soft tissue metabolism.[3, 35] Note that the repetitive passive joint movements (oscillations) need to be carried out at the limit of the joint's available range in order to achieve these mechanical effects (i.e. tissues need to be stretched).[35]

Electrical muscle stimulation

Electrical muscle stimulation (e-stim) may also have some value in treating muscle atrophy. E-stim at 2.5 Hz has been shown to create muscles that are faster and stronger and possess a better capability to fatigue resistance than normal muscles.[10]

Exercising with e-stim may also aid in healing or strengthening deconditioned muscles.[18] For dogs following a pancarpal arthrodesis, the use of e-stim on the triceps or common digital extensor muscles while encouraging weight shifting or static balancing on the affected limb may speed muscle recovery, strengthening or encourage function and limb use.

Weight bearing and therapeutic exercise

A study of the effects of weight-bearing on healing of cortical defects was conducted on the canine tibia.[26] This study found that significantly less woven bone formed in the defects in the non-weight bearing tibiae than in the weight-bearing tibiae. This was determined to be due to the disuse response in the under-loaded tibiae, in which less bone formed, rather than to the formation of more bone in the weight-bearing tibiae. Weight bearing has the potential to result in earlier recovery of mobility and strength, and facilitation of an earlier return to activities.[7, 17, 23, 26] The canine patient should be encourage to weight bear on the affected limb in a gradual manner. Utilization of water walking may aid in gradually loading the affected limb, and therapeutic exercises that safely encourage partial weight bearing may also be used and progressed.[11, 33] Muscular strengthening of the affected limb will be accomplished in the same manner with many of the same techniques. As well, swimming and hill walking may enhance both forelimb strength and range of motion (of the shoulder, elbow and possibly digits).[11, 22]

Summary

Post-operative physiotherapy should be contemplated not only in cases where the joint itself requires therapy but also in cases where the entire limb and health of adjacent joints will have been compromised due to a period of deconditioning or immobilization. Physiotherapy can provide a scientific basis for therapeutic reconditioning.

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