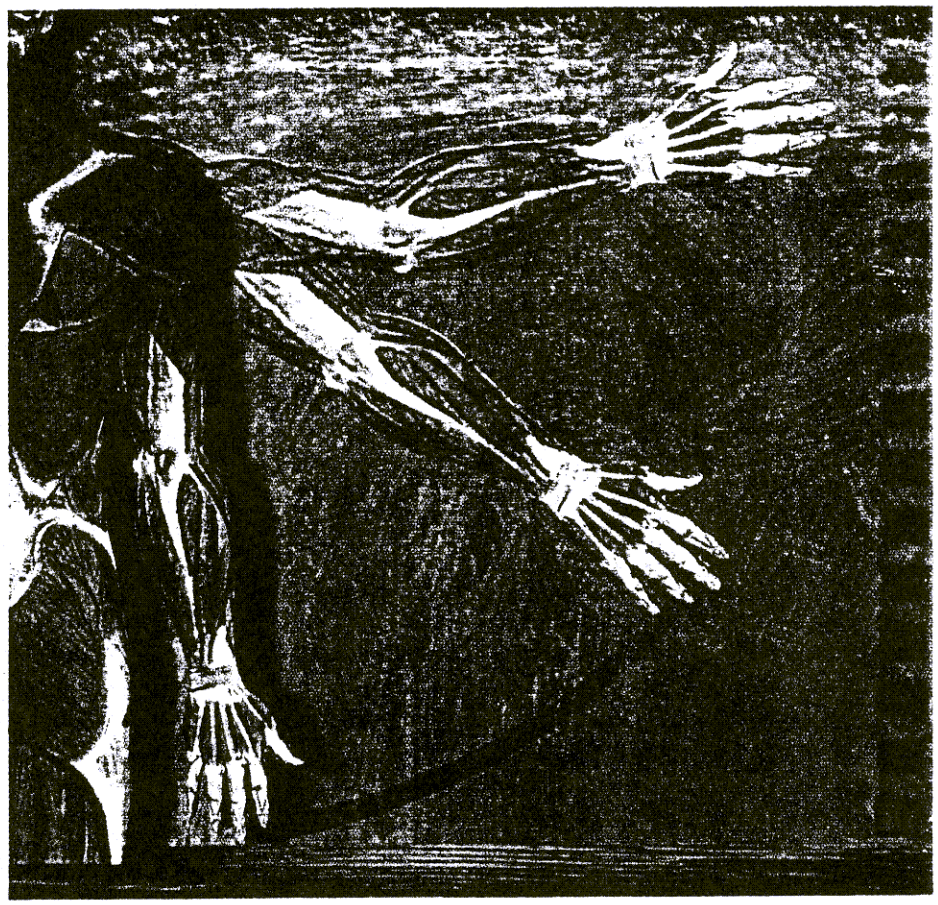
Clinical Management Options for Soft Tissue Stiffness and Loss of Joint Motion

The article presents an overview of treatment options for soft tissue stiffness and loss of joint motion. Manual therapy, serial casting, serial splinting, manipulation, dynamic tension splinting and the JAS technique are compared for cost, length and frequency of treatment, side effects, home use, and patient compliance issues.



by Michael Hotz, LPT

Many patients develop joint stiffness and loss of motion as a secondary complication of disease or injury. Joint stiffness is a very difficult, time consuming and costly problem to correct. The most common conditions leading to the development of stiff joints are immobilization, fracture, neurologic injury and trauma. When loss of joint range of motion (ROM) occurs, the joint capsule, ligaments, tendons and skin are usually involved. These structures are considered to be connective, or soft tissue; the most prevalent tissue in the body. Connective tissue is made up of collagen and elastic fibers within a fluid matrix or ground substance. The fibers are organized in a mesh-like pattern and are aligned according to the tissue's function. Connective tissue that makes up the structures around a joint is unique. It is able to stretch or change shape to allow flexibility, but can return to its original shape to offer stability to the joint. Connective tissue is also capable of remodeling or reorganizing, depending on the forces placed on it. Form follows function for all connective tissue structures, which tend to shorten slowly and progressively if not subject- ▶

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ed to the regular forces involved with movement and function. As the tissue contracts and reorganizes, it becomes denser. This can lead to a loss of ROM within a short period of time. When trauma, edema, impaired circulation or inflammations accompany immobilization, new collagen can form in as early as three days. This process results in creating an even greater loss of ROM.

Therapeutic Approaches: Analysis

What can be done to restore ROM? Fortunately, connective, or soft tissue, is capable of being stretched after it shortens. It is viscoelastic in nature, meaning that when a stretching force is applied and then removed, the tissue will respond by reaching either the elastic or plastic deformation state. Elastic deformation can be compared to a coiled spring. It can be stretched or uncoiled but will return to its original state once the force or load is removed. Plastic deformation can be compared to therapy putty. If stretched, it will reach a newly elongated state and remain at the new length once the force is removed. The goal of therapeutic stretch is to achieve permanent length changes in tissues that have stiffened or shortened. The scientific definition for this permanent length change is plastic deformation. When the state of plastic deformation is achieved, the tissues are permanently elongated and allow the joint to move through its full or functional ROM. When a therapist is treating a patient who has lost motion due to soft tissue limitations, the stretch applied must be sufficient enough for the tissue to reach the plastic deformation state. This should be the goal of any treatment program or mechanical stretching device.

Research Results: The Therapeutic Stretch

What is happening when tissues change length? Does additional tissue grow or does it stretch? This has been a subject of debate among scientists and clinicians. It is generally agreed that existing tissue is remodeled when therapeutic stretch is applied. The stretch must be sufficient for the tissue to reach the plastic deformation state and a newly-elongated length. The tissue does not necessarily grow new cells to increase its length. This stretch-versus-growth consensus is supported by a published scientific research study performed on rabbit ligaments.[1]

Types of Stretch Techniques

The goal of any ROM rehabilitation program is to achieve plastic deformation of tissue.How is this accomplished? There are two types of loading conditions that can be applied to soft tissue: creep and stress relaxation. With a creep-based loading condition, constant force is applied to tissue and the displacement varies; with a stress-relaxation loading condition, displacement is constant and the force varies. Another difference is that in a creep-based loading condition, the same amount of force is applied over a long period of time, whereas in a stress-relaxation loading condition, the force applied changes throughout the period of stretch.

Therapists employ a stress-relaxation loading condition with manual therapy. (Stress-relaxation is also used with serial casting, serial splinting and turnbuckle splinting, described later in this article.) When a therapist stretches a patient's joint, he or she will apply force and hold the joint at that end point. During this "holding phase," the properties within the tissue change and elongation occurs. This is manually achieved stress relaxation, which can be simulated with therapy putty. If you apply a force at both ends of the putty, it will stretch. As you maintain this position, the forces within the putty start to change (relax) and the putty starts to sag. Once it sags, if you stretch it again, the process reoccurs. If you do this several times and then put the putty down on the table, it will be longer than the piece you started with. This is also stress relaxation. Applying a stress-relaxation loading condition to a material with viscoelastic properties will cause the material to reach the permanent plastic deformation state more quickly than by applying a creep-based loading condition.

Static Progressive Stretch

Another important technique to employ when attempting to elongate soft tissue is static progressive stretch. Static progressive stretch is a therapeutic technique that incorporates stress relaxation, and, in fact can best be described as incremental, periodic application of stress relaxation. When stretching a patient's joint, the therapist will elongate the tissue and hold that displacement (stress relaxation). After a period of time, another, stronger force is applied. The therapist will then hold the now elongated tissue at the new length until the tissue relaxes again. When another relaxation occurs, a still stronger force is applied. Static progressive stretch is the application of progressively stronger force over a period of time. Static progressive stretch is utilized with serial casting, serial splinting and the JAS system.

How do therapists decide which type of loading condition (creep or stress-relaxation) to use when treating a patient? Also, how long should a force be applied to get the best response? These questions have been poorly addressed over the years, therefore clinical protocols varied widely.

Review of Treatment Techniques

Treatment techniques include manual therapy, serial casting and serial splinting, manipulation, dynamic tension splinting, and the JAS technique. With the exception of dynamic tension splinting, all of these techniques utilize a combination of a stress-relaxation loading condition and static progressive stretch.

A number of factors must be considered when choosing an adjunctive splinting device for a patient. Biomechanical considerations are joint integrity, skin and soft tissue integrity, the ability to apply a therapeutic stretch to the endpoint of range and the adjustability of the device throughout the ROM. Patient considerations include comfort, ease of application, wearing time and compliance. Cost considerations are rental versus purchase cost, ROM capability, outcomes and Physical Therapist (PT)/ Occupational Therapist (OT) fitting

time. Each of these areas affects patient use and results.

Manual therapy is performed in a clinical setting by a licensed professional (usually a PT or an OT) and is clearly the most effective treatment available. It is hands-on, and the most efficient for restoring ROM. The therapist applies a therapeutic stretch and adjusts the force according to each individual patient's need. Manual therapy incorporates a stress-relaxation loading condition, static progressive stretch, soft tissue distraction and application of individualized force. The goal of any of the adjunctive devices discussed would be to closely simulate the treatment technique and carry over its benefits to the home setting. Unfortunately, manual treatments are costly, fatiguing for the therapist, and usually performed in a clinical setting 2-3 times a week for sessions lasting 15-20 minutes. Costs associated with manual therapy include office visits to the therapist and the referring physician. Outcomes may vary, depending on the tolerance of the patient and skill and endurance of the therapist.

Serial casting is another common treatment technique. The patient's joint is stretched to the end range and a cast is applied. The extremity is essentially immobilized for a period of time. The cast is then removed and the extremity is stretched to a new length. The cast is then reapplied and the extremity is immobilized again. During this time, the limb is nonfunctional and the effects of immobilization begin to affect the tissue, joint, capsule and ligaments. Casting can continue for several weeks at a time. Serial casting changes the arc of motion rather than increasing overall mobility. Patients gain motion in one direction, but often lose motion in the opposite direction.

Serial splinting is the same treatment concept as serial casting, except that the splint is removable. Each time the patient returns to the clinic, the therapist will remold the splint to a new stretch position. This option is more functional but still requires prolonged wearing time. Costs associated with serial casting include the time and materials to apply the cast, office visits to the therapist and office visits to the referring physician.

Manipulation is usually a last resort. When conservative therapy is not successful and patients are significantly limited in function, orthopedic surgeons may opt for manipulation under anesthesia. Manipulation gives patients immediate, short-term results, however, there are major risks and disadvantages. Patients do not maintain the motion that was initially gained by the manipulation, and many times the problem reoccurs. Manipulation is the most costly intervention, because it requires a hospital admission and placing the patient under general anesthesia.

Dynamic tension splinting has been used for decades and, for a long time, was the only treatment available home use. Dynamic tension splinting utilizes a creep- based loading condition. The belief regarding dynamic tension is that prolonged constant force on stiff tissue will achieve permanent elongation of soft tissue.

In the early 1980s, commercially available, removable devices came to market. These were based on the principles of low-load, prolonged stretch, and it was assumed that the longer the stretch was applied, the greater the gains in ROM. We then learned that using creep is not the most efficient loading condition to address soft tissue problems. The concept is effective and does work, but the disadvantages outweigh the advantages. The dynamic tension splints are lightweight, removable and used in the home. However, patient compliance is a problem; the splints compress the joint surfaces, are difficult to apply, can cause skin irritation, need to be worn for long periods of time (8-12 hours per day), and most work in only one direction. Additionally, the splints need to be worn for weeks to months at a time, and outcome studies do not support lasting results. Thus far, I know of no in-depth study on the efficacy of dynamic tension splinting published in a peer-reviewed journal that addresses such issues as tissue response, wearing time or cost.

Although *The JAS System* employs a device, it simulates some of the manual treatment techniques used in the clinical setting. Wearing time is only 30 minutes per session, and the patient's goal is to work up to three 30-minute sessions per day. The JAS allows patients to use a device in their own homes and yet still benefit from clinical treatment techniques. Skin problems and skin irritation are nonexistent because of the short wearing time. The force applied with the JAS unit is patient-directed and therefore, patients are in control and tend to be more aggressive in their rehabilitation efforts. Patients are less likely to lose motion once they stop using the device. Costs consist of rental costs for the device. The average rental period is 2 months, as opposed to 6 to 8 months with a dynamic tension splitting system. There is no need for the patient to purchase the JAS because of the short rental period and rehab time.

Conclusion

Certified case managers need to make informed decisions when reviewing patient referrals for adjunctive therapeutic devices relating to rehab effectiveness, cost effectiveness and appropriateness as part of their patients' overall rehabilitation program.

Both creep and stress-relaxation loading conditions are effective at accomplishing an increase in range of motion. However, devices that utilize a stress-relaxation are more efficient with regards to wearing time, length of treatment and outcomes. Cost of the device, and associated treatments, are important factors in determining your selection. All the devices discussed have distinct advantages and disadvantages. Treatment decision should be based on sound clinical, biomechanical and financial considerations. CM

References

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