Sequelae in soft tissues after beating, suspension, and fixation

By Karen Prip

From scientific studies of biomechanical reactions of the collagenous and connective tissues that are found in almost all parts of our body, it is known that these tissues react in a specific way when they are subjected to certain stresses and strains over shorter or longer periods. It is also known that changes occur when tissues are damaged by *direct trauma* (such as beating) and by *indirect trauma* (overloading, for example when a person is suspended and tied up and fixated in awkward positions.)

Injuries to muscles, such as contusions and atraumatic conditions (e.g. mechanical strain), include muscle fibre damage, connective tissue disruption or complete rupture of the muscle, blood vessel damage, and nerve injury.

Collagenous and connective tissue

The collagenous and connective tissues which surround the skeletal system form the *ligaments, joint capsules, tendons, fasciae, aponeuroses, and skin.* Connective tissue also "fills in" the spaces between the muscles and organs and in the nervous system (peripheral and central).

The structural orientation of fibres differs from tissue to tissue. The fibres are almost completely parallel in *tendons.*

Fibre orientation is less constant in the *ligaments and capsules*; it depends on the function of the ligament. Examples are the collateral ligament of the knee and the Y-shaped ligament of the shoulder. They have different functions, so the fibres run in different directions.

By contrast the fibres in the *skin* have no predominant direction – they are all intermeshed, which gives the skin an extensibility in all directions. The differences in alignment of the fibres produce differences in mechanical properties.

When *tendons* are loaded, all the fibres straighten out because of their parallel alignment. Since this is in the direction of loading, they are able to bear the highest tensile loads.

When *ligaments* are loaded, the fibres not being aligned so much, only the fibres that are orientated in the direction of the principal load straighten out completely and sustain loads; the fibres that are not orientated in the direction of loads will only bear lower loads before they have all been straightened out. This means that some fibres will rupture earlier than others.

In the *skin* only few fibres are orientated in the direction of loading. Thus, the skin is weaker in tension than tendons and ligaments. The main components of tendons, ligaments, and capsules are collagenous fibres *and* elastic fibres.

At rest, collagenous fibres are usually buckled, and the wavy shape they assume is called *crimp* (fig. 1). When stress is applied to a collagenous fibre the first to happen is that crimp is removed (1st phase = Toe phase). When removed, the collagen fibres start to resist strongly any further elongation. Consequently, more force is required to produce further elongation. In the linear phase (2nd phase) at 3-4% elongation, microfailure of the fibres begins. When the fibres reach an elongation of 6-7% they have reached the complete failure – total rupture. *Elastic fibres* elongate to almost *twice* their normal length with low loads. With increased loads, however, they suddenly become stiff and rupture abruptly without deformation. Examples are the ligamenta flava and the ligamentum nuchae. In a way, the physiotherapy examination and treatment of soft tissues and joints involve a stress and strain curve for consideration. When passive movement is induced in mobilizing joints, a stress is applied, and strain is reflected both in terms of the range of movement (quantity) and in the form of the palpated resistance to movement (the quality of movement) (fig. 2). It is important to realize that physical examination should not enter the second phase, so as not to induce micro-failure of the structure.

When a constant force is left applied to a collagenous structure for a longer period, the result is the phenomenon that further movement can be detected. This movement is small in amplitude and occurs slowly – and is therefore known as *creep* (fig. 3). Graphically, creep is seen as continued displacement when a constant force is maintained at some point on a stress-strain curve.

This knowledge is highly interesting because many torture survivors have been suspended and left in fixated positions for hours, maybe days and months, unable to move and change to another position. It must be expected, and indeed it is true, that the torture survivors have massive changes in their supportive and stabilizing tissues after suspension and fixations.

It can be assumed that a possible significance of this creep phenomenon can be explained by another characteristic behaviour of the collagenous tissue.

When a structure is unloaded from a loaded position, it regains another shape, different from the initial shape. This difference in behaviour, referred to as *hysteresis* (fig. 4), reflects the amount of energy lost when the structure was initially stressed. The difference between the initial and final shape is referred to as *set.* A set often occurs after creep. When the applied force is released, the structure does not immediately return to its original shape, although it may do so in time.

This phenomenon is important in the interpretation of trauma to ligaments or capsules. The energy lost in breaking the tissue may not be recoverable, and the original structure is not fully reformed.

Healing may occur in a set position, and this may compromise the mechanical function of the structure. Healing in a set position effectively lengthens the ligament, and it will therefore permit a greater range of movement than normal. This may in some cases not be desirable. The "joint play" will change, and may result in wear and tear of the joint, with early arthrotic changes as a result. Torture survivors have an impaired afferent input from the mechanoreceptor system because of pathological "joint play" resulting from impairment of the collagenous and connective tissues. Almost all torture survivors have been subjected to sustained positions and ex-

treme loading of joints. The tissue damage, which is inevitable, will result in dysfunction in various joints, e.g. the spine and shoulder, wrist, knee, ankle, sacroiliac joints, etc.

Management of traumatic conditions in muscles, tendons, and ligaments after beatings

Before any rational plan of management of traumatic conditions can be initiated, it is essential to understand the sequence of events that follow partial or complete rupture of soft tissues, and their duration of repair. The 3 phases that follow soft tissue injury are:

1. Acute inflammatory phase (up to 72 hours): vascular rupture and cellular infiltration.
2. Repair phase (72 hours to 4-6 weeks): collagen deposition.
3. Remodelling phase (3-6 weeks to 3-6 months): collagen and muscle remodelling.

Acute inflammatory phase

In the acute inflammatory phase, caused by vascular disruption, red cell extravasation and fibrin clot formation are the predominant features. The condition will be: *Rubor – Tumor – Dolor – Functio Laesa – Calor.*

General management

In the acute phase the aim is to minimize bleeding and to minimise oedema formation from post-capillary vascular "leakage". The phase can be summarized by the now commonly recognized **RICE**.

R Rest of the injured soft tissues.

I Ice or cold application. Cold can control pain and oedema and prevent further tissue damage at the site of the damage. Cold should be applied at least in the first 48 hours after injury. Acute musculo-skeletal injuries lead to bleeding, with resultant inflammation, oedema, muscle spasm, and pain. Without appropriate therapy, these effects can cause loss of motion, disuse, and decreased return of function. Cold treatment is extremely important in the interruption of this cycle.

C The early use of compression can support an injured area while decreasing oedema. Once the injury has been evaluated, the involved area can be bandaged, which can decrease oedema and pain by allowing the tissues to stabilize and coagulation to develop in injured vessels. Compression bandaging should be applied continuously for at least 48 hours.

E Together with ice and compression, elevation of an injured extremity is useful; it can decrease swelling by decreasing blood flow, thereby increasing drainage of the soft tissue oedema. Elevation enhances venous return and increases vascular "suck" of extravascular fluid.

ATTENTION: Do not use heat. Heat increases bleeding and vascular "leakage" and thus also increases oedema formation. Alcohol is a potent vasodilator and should not be taken during the first 48 hours.

Repair phase

This is a difficult phase to manage because it requires a balance between setting optimal conditions for collagenous repair and recovery of injured muscle or ligaments. For a muscle injury the important objective is a pain free muscle with full strength, power, and extensibility. For a ligament injury the important objective is a pain free ligament with full return to pre-trauma tensile strength and full range of movement since ligaments act as stabilizers under muscle contraction and joint movement. These are of course the optimal objectives.

Remodelling phase

The repair and remodelling phases blend into each other. The important thing is to graduate the rehabilitation programme.

Already 3 days after a trauma, passive stretching and later active stretching should be initiated. This should be done daily during the whole rehabilitation period.

After a week, active exercises and load-bearing, i.e. walking, and resistance exercises with little load, should be initiated. All within the pain limit. Ultrasound, if available

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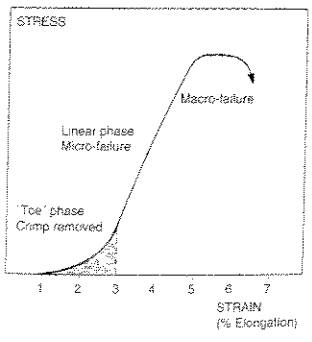

Fig. 1. *Stress-strain curve of collagen.*

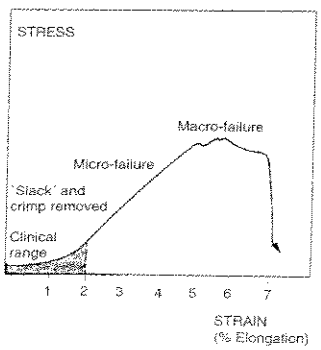

Fig. 2. *Stress-strain curve for a ligament.*

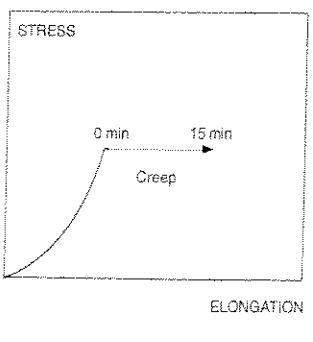

Fig. 3. *Stress-strain curve illustrating creep. Despite maintenance of a constant load, elongation occurs with the passage of time.*

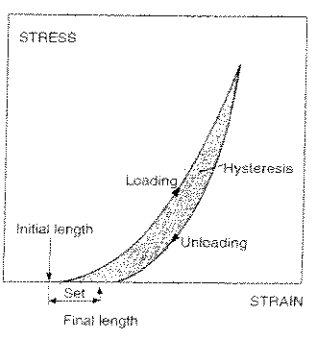

Fig. 4. *Stress-strain curve illustrating hysteresis. When unloaded, a structure regains shape at a rate different to that at which it deformed. Any difference between the initial and final shape is the 'set'.*

2. Poor tactile discrimination
   a. Poor two-point discrimination
   b. Impaired ability to recognize the shape of an object through manipulation.

How to treat these conditions:

1. Stimulation by firm touch, e.g. deep touch pressure. The following method can be recommended: with a soft surgical brush, brush the arms of the client from the elbows and downwards, including the hands, and brush the legs from the knees downwards, including the dorsi of the feet; use fast brushing movements and follow with rapid compression of all the joints in the arms and legs, 10 times each. The whole procedure within 2 minutes.

2. Proprioceptive and linear vestibular stimulation. (Bobath-ball, trampoline, tilt-board). Running, imitating different positions ("mirror exercises").

3. Increase self-initiated tactile stimuli (e.g. swimming, bicycling, different kinds of sports activities).

Summary

The ideas of Margaret Rood and Jean Ayres are helpful tools in the treatment of torture survivors. Many of the clients tell that their movements during imprisonment and torture were not free and functional, and that they were placed in fixed positions for long periods, unable to change position though their pain told them to do so.

This means that the natural flow in the chain of human movements had missing links. Following the pattern of normal motor development it is important to pay attention to the possible missing links. When observing the client while he changes position, it has to be cleared up whether he uses his righting reactions (i.e. rotates the head in the direction of the movement), and, if it is difficult to come from one position to another, whether it is a problem of mobility or stability. Then give exercises to his specific problem. The sensory and motor areas of the cortex are placed close to each other on either side of the sulcus centralis of the cortex. Because of this close connection, augmented tactile proprioceptive and vestibular stimuli will flow to the motor areas and thus make an influence. This means that adequate sensory afference gives more coordinated output, according to the theory of Jean Ayres. With adequate stimuli there will be no sympathetic reactions. Furthermore, following the normal motor development gives the client as normal afferent input as he is able to transfer.

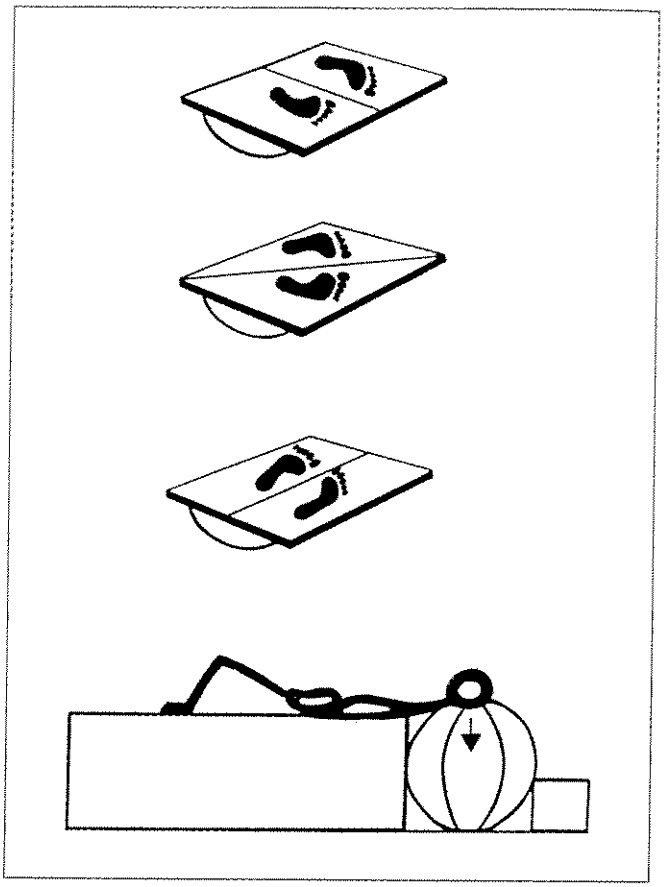

Fig. 2. *Equipment used at RCT.*

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should be applied after a few days. More active exercises should begin 3-6 weeks after muscle and tendon injury.

§The above mentioned programme in rehabilitation of soft tissue damage is an ideal model. In the treatment of torture survivors in their home country, an adaptation and the necessary precautions may be possible and thus help to initiate better function of the whole body.

In the treatment of torture survivors with late sequelae, it is individual how the body adapts to damaged tissue, and so it is at the physical examination by the physiotherapist, when dysfunction and tissue damage are revealed. All physiotherapy methods and special techniques can be used. It is not necessary to stress that special adaptations and gentle handling are important for this very traumatized group. Among the concepts used are manual therapy and a psychosomatic approach, as well as sensory integration management.

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RCT IRCT

Borgergade 13
DK-1300 Copenhagen K
Denmark
Phone: +45 33 76 06 00
Telefax: +45 33 76 05 00