The Process of Inflammation and Repair at Cellular Level and Implications for Sports massage Practitioners.

The healing of an injury is a complicated process, it starts as soon as the injury occurs and can take up to 9 months or more to complete. Injured tissue can include skin, muscles, ligaments or tendons. There are 3 phases to the healing process, the inflammatory, proliferation and re-modelling phase.

The healing process

The first stage is the inflammatory phase[figure 1]. There is a great deal of activity in the tissues. Where there is bleeding, a blood clot forms to join tissue back together, at the same time vascular and cellular activity starts dealing with microbes, foreign bodies and dying tissue[1][figure 1 c].

![Figure 1](image)

**Figure 1** Inflammation (a) normal tissue (b) immediately after injury (c) 12-24hrs post injury [2]

First the arterioles temporarily contract, then vasodilate which opens up capillaries causing hyperaemia[2] "an excessive amount of blood in an organ or part"[3]. This causes capillaries to become very permeable to fluid and large molecules[3][figure 1 c]. A protein rich inflammatory exudate enters damaged areas
causing swelling as it pushes tissues apart[2]. This contains Fibrinogen[2] “A protein in the blood plasma that is essential for the coagulation of blood and is converted to fibrin by the action of thrombin.”[3]. The fibrinogen is converted into a network of fibrin[2][figure 1 c]. An insoluble protein that creates long threads that entangle platelets, forms clots[4].

White blood cells[figure 1 c] (mainly polymorphonuclear leucocytes[2]) migrate through capillary walls to the injury. These cells deal with the debris of cells, damaged tissue, other foreign bodies and micro-organisms with a process called phagocytose[2] (they envelope). The cells do their job more effectively when they are not free floating so they attach themselves to the network of fibrin that has been formed[2].

At the 24 to 48 hour stage the tissues are distended with cells, fibrin and fluid. Torn blood vessels are plugged. Blood that escaped from damaged vessels is in the tissues and the lymph bed is dilated[2]. The inflammation process is instigated and controlled by chemical mediators released from blood, cells and tissues[2]. This includes histamine, hageman factor and bradykinin.[figure 2][2].

![Figure 2 chemical mediators][2]

Next in the inflammatory process, the worn out polymorphonuclear leucocytes are replaced by macrophage cells. These do a similar job but slower. They phagocytose the depleted polymorphonuclear leucocytes cells, tissue debris and
debris of blood cells[2], they are like cleaners getting rid of the used up and damaged cells and tissues. If there is an infection the healing process is slowed and a second wave of polymorphonuclear leucocytes are released before macrophage cells start their task. The inflammatory phase normally takes between 24 and 72 hours, depending on the severity of damage. The phases are not set in stone so one phase may start before the previous one has finished [figure3]. The desired effect from this stage is wound cleansing[5].

![Figure 3 time scale of healing process](image)

The proliferation phase is next [figure 3], and can take up to 21 days. While the macrophage cells are busy cleaning up they also instigate the proliferation stage by secreting active mediators[figure 2] which include chemotactic and growth factors[figure 2], these mediators propagate granulation tissue[2].

Granulation tissue consists of fibroblasts[2][figure 4 a and b]. (fibroblasts are large, flat, elongated cells. Fibroblasts produce tropocollagen, which is the forerunner of collagen, and ground substance)[4]. The fibroblasts undergo a change and become myofibroblasts[2]. The myofibroblasts act like smooth muscle and contract the wounds edges together[5]. This along with fibronectin molecules, contract and can reduce the wound area by up to 30%[2].

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At the same time neovascularization is taking place[2][figure 4 a and b]. This is the regeneration of blood capillaries in the damaged tissue. This happens 3 different ways. Firstly the generation of new vascular networks in the wound[6], secondly pre-existing vessels naturally graft[6] and thirdly the coupling and re-coupling of vessels[6]. The newly forming scar tissue is sensitive as the capillaries innervated[2] “To supply (an organ or a body part) with nerves.”[3]

After the wound has finished contracting there is a change in the fibroblasts to a secretory mode[2], they start to lay down collagen and a fibronectin matrix[2]. They are fed oxygen and nutrients from the newly formed capillary supply[2]. The desired effect of this stage is wound healing[5].

Lastly is the re-modelling stage[figure 4 c] also known as the maturation stage[5][figure 3]. This stage can take up to and beyond 9 months. The fibronectin matrix that has been laid down allows the fibroblasts to move around easily as they attach and detach themselves from the matrix, it is felt that the fibronectin is essential to the organisation of the collagen I and III fibres into bundles and may act as a template[2]. The fibroblasts firstly produce fibrils of collagen III this is degraded and eventually replaced by collagen I[2]. The collagen eventually polymerizes and becomes mature structural collagen[2]. There is some realignment or re-modelling of the collagen at this point so that the bundles of fibres become aligned along the stress of the tissue[2]. The desired outcome for this stage is wound strengthening[5].
When the process is finally complete the capillaries in the area are reduced and the collagen bundles increase in size[2]. Scar tissue is never the same as the original tissue, there can be some loss of function and it can be more prone to injury. The mature scar tissue is less sensitive than healthy tissue and is avascular[2]. There can also be deformation in the scar tissue such as keloid or hypertrophic scars[6].

**The treatment process**

**The inflammatory stage**

Giving an exact time scale of when specific hand skills can be used is difficult and will vary according to the severity, size and type of injury. If a bone is broken or skin damaged you would not be able to treat until it has healed. All this needs to be taken into consideration when treating an injury. The time scales below are for a moderate injury and I would adjust the time scale depending on the severity and also bearing in mind the client and how they feel. The hand skills available are effleurage, petrissage, tapotment, friction, dermal rolling, compressions, vibrations and stretching. They have a variety of physiological and mechanical benefits and these can cross over from one hand skill to another.

Due to the risk of further damage or restarting bleeding it is contra indicated to massage in the first 24 to 72 hours of injury or until bleeding has stopped. This is the inflammatory phase, normally characterized by redness, heat, swelling and pain which subside as the inflammatory process finishes. At this stage PRICE should have been applied. Protect, Rest, Ice, Compression and Elevation. This will have an impact on the injury and make the difference to how well the injury repairs. By controlling the inflammation process by reducing swelling which would mainly be achieved by compression, you can prevent the swelling from becoming excessive and impinging blood and lymph vessels which would slow the healing process.

**Treatment in the proliferation phase**

The proliferation phase is where the massage therapist would start to treat. During the first 3 and 7 days care is required, work above the injury site would
benefit using effleurage, choosing flat hand, rotary, opposing glide, forearm glide, V and cam and spindle. These are all broad techniques and will give me flexibility in depth of pressure. The mechanical effect of effleurage improves lymph and venous flow; this helps to encourage movement of fluids above the area, allowing easier passage of excess fluids out of the injury area and fresh blood in. This would also alleviate any retaining swelling in the injury site.

If possible careful massage can be applied over the injury using flat hand and V to aid lymph and venous flow which would further reduce swelling. Other benefits include, increased cell permeability and increased cell metabolism. This increases oxygen and nutrients to the injury site feeding the tissues and cells, and increased removal of waste, allowing the process to be more effective. Warming of tissues would accrue which may help alleviate stiffness in the muscle.

Between 8 to 12 days. The same treatment can be continued and if possible introduce further effleurage hand skills over the injury site. This would include cam and spindle, forearm glide and opposing glide, still all broad techniques. The benefit to the injury is as before but hopefully more effective, penetrating further into the tissues. The aim is to get the most effective healing by helping to supply the tissues with the high demand of oxygen and nutrients required to aid the cells and provide better waste removal.

Between 13 to 17 days. Building on the existing plan and introducing more specific effleurage hand skills like butterfly, encourages the collagen to lay down in the line of stress and prevent it sticking to other structures. Where it has stuck to other structures and is starting to cause adhesions loosen it off and reduce the adhesions. Petrissage could be introduced it has the same benefits as effleurage so helping to support them, but also helps to stretch the muscle in specific areas helping to encourage the movement and elasticity in the muscle, which will help to keep length in it and prevent too much shortening when the myofibroblasts start to draw the damaged tissue together.

Between 18 to 21 days. This is the last few days of the proliferation stage. Following the same plan as before for the same reasons, but with more focus on the butterfly and petrissage to prevent and reduce adhesions and keep muscle
length as myofibroblasts will be coming to the end of their shortening stage. Vibrations would be introduced, this helps to reduce any excessive muscle tone in the muscle and have a calming effect on the athlete. By reducing the muscle tension it would help to keep the muscle functioning more effectively allowing better blood and lymph flow through the muscle. Maintenance stretching (very much within the pain tolerances of the client) would be introduced to elongate the tissues, improve joint ROM and decrease muscle tension. Compressions can be used either at the golgi tendon organ to encourage lengthening, or direct to any specific area of tension in the tissues. This helps prevent too much shortening of the area by the myofibroblasts and fibronectin molecules helping to keep a better functional length of the muscle.

**Treatment in the re-modelling stage**

Moving into the re-modelling stage attention should be focused on the direction the collagen is laying down, muscle length and flexibility. Continuing on with the existing treatment plan but focusing on moves like butterfly, petriissage and maintenance stretching will aid with this. At about 30 days dermal rolling can be introduced to reduce adhesions between skin and other structures, improving circulation in the capillaries encouraging the scar tissue to stay vascularised and therefore improving its function. At about 45 days maintenance stretching can be replaced by developmental stretching to increase the length of the muscle. Tapotment can be introduced to draw circulation to the capillaries to encourage the tissues to stay more vascularised. At all times the client and their pain threshold should be considered and the injury should also be monitored for any signs of slowing from possible infection or a negative reaction to the treatment plan.

The only technique to avoid would be fictions. This technique should be saved for when all other avenues are exhausted. This is used when the tissue is healing badly and there is a lot of functional loss. It is a very aggressive technique and takes the tissues back to the inflammatory stage so you can effectively start again and encourage effective rehabilitation. It is very painful and is not usually necessary if good rehabilitation procedures have been followed. The physiological effects of frictions are damage to immature scar tissue, trauma to soft tissue, damage to blood vessels and pain.
Understanding the healing process enables the massage practitioner to provide a thorough and comprehensive treatment which will aid in a faster more effective rehabilitation, allowing the best performance possible from the injured area. This in turn allows the athlete to get back to their training as quickly as possible in the best possible shape. Any practitioner not understanding this process could potentially make the injury worse, slow the healing process or encourage poor healing which could have an impact on an athlete’s performance and career.

List of references

7. http://www.clinimed.co.uk/Portals/10/images/Wound%20Healing%20Graph%202.jpg