

# Injury, tissue damage, healing-return to function

*In this article Russell Thomas presents a review of generally accepted processes occurring following tissue damage - caused by trauma or over-use.*

The injured area undergoes a healing process, which, for convenience, is divided into three broad but over-lapping phases:

- **Inflammation**
- **Repair**
- **Remodelling.**

It is important that the therapist, in assisting the injured person to regain full function, understands these stages. It is also important that the therapist is aware of the particular stage the person being treated is currently undergoing. Each stage requires treatment, and an approach to treatment, which differs from other stages.

## **Injury and tissue damage**

Soft tissue damage comes about through a traumatic event such as a kick, a knock, a sudden forceful action, over-stretching, or through over-use. 'An overuse injury develops over a period of hours, days or weeks, as a result of unaccustomed or excessive, repetitive activities.'<sup>1</sup>

In any case, some level of disruption is caused to muscle, tendon or ligament fibres and to surrounding blood vessels. Fibres will be torn, blood vessels ruptured. This leaves the way open for bacterial invasion at the injury site.

## **Inflammatory phase**

The instant the damage occurs, the body swings into action, marshalling all its significant defences against the invading army of bacteria. Potent inflammatory chemicals are released, to neutralise the bacteria and to stop it from spreading. Specialised cells, neutrophils, form the front line and, within an hour of injury occurring are 'actively devouring bacteria, toxins and dead tissue cells.'<sup>2</sup>

The author of the textbook from which this quote is taken, goes on to say '...the battle takes a considerable toll on both sides...'<sup>3</sup> No wonder, then, that pain is experienced!

A blood clot temporarily seals off the damaged area and stems the blood flow into surrounding tissue. But the injured person is left with a painful, swollen area.

The acute inflammatory phase lasts for three to five days. Treatment in this phase consists of protecting the injured part from further damage and R.I.C.E. (rest, ice, comprehension and elevation). However, complete immobilisation is not advised. Gentle exercises can begin soon after the injury.

'Two days following the injury careful exercising may be commenced. At this stage your injury will be stabilising. Gentle, controlled movement that *does not produce or increase pain* at your injury site stimulates the healing process, without causing further damage.'<sup>5</sup> The emphasis is on *gentle*.

Massage is not advisable within the first 48 hours or so of the injury, but will be beneficial once inflammation has subsided.

### Repair phase

'Two to three days after the injury, while the inflammatory response is still taking place, the repair process begins with the formation of new blood vessels and nerve tissue around the edge of the injury site. After a further three to five days new tissue is produced to fill the gap caused by disruption as a result of trauma or over-use.'<sup>4</sup> Newly forming blood vessels and nerve fibres infiltrate this tissue.

The terms 'regeneration' and 'replacement' are used to describe processes occurring during this phase. Regeneration refers to the formation of new cells of the same type as the damaged or dead cells. Replacement refers to the replacement of dead or damaged cells by cells of a different type. These replacement cells lead to the formation of a scar, consisting mainly of collagen fibres.

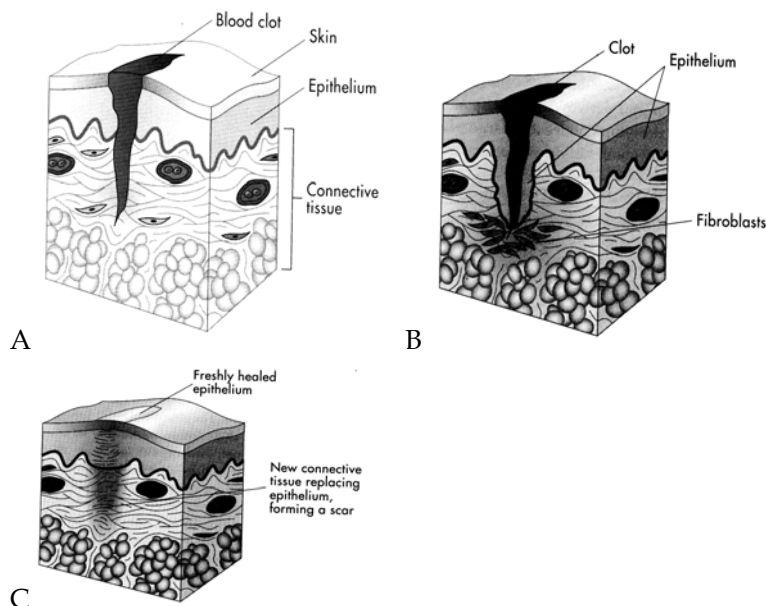
The two parallel processes are illustrated in the following diagrams. We can see that the outer layer of tissue is healed via regeneration, whereas the underlying layer of tissue heals through the process of replacement by cells of another type, largely collagen, and a scar forms.

### Captions

A - Tissue damage from acute injury.

B - Tissue repair underway.

C - Surface tissue 'healed over'. Underlying tissue healed with a scar.



Scar tissue presents a problem. 'Scar tissue is very strong...but it lacks the flexibility and elasticity of most normal tissues. Also, it cannot carry out the normal functions of the tissue it has replaced.'<sup>6</sup> The diagrams illustrate healing of a skin wound. The layer of epithelium (skin) *regenerates*. The layer under the skin, connective tissue, however, heals, to a greater or lesser extent, through *replacement* of damaged cells.

Unfortunately, while epithelial (skin) tissue has a significant capacity to regenerate, 'skeletal muscle and cartilage regenerate poorly, if at all.'<sup>7</sup> This means that these particular tissues heal largely through replacement, leaving permanent scar tissue behind.

At this stage, the replacement or collagen fibres are immature and structurally weak. Therefore, care still has to be taken and activity should not be too vigorous. This phase lasts for approximately three weeks, commencing about three days after injury.

As long as inflammation has subsided, massage can assist in the healing process and also in aligning the new fibres forming the scar tissue. Frances Tappan, retired Associate Dean, School of Allied Health Professionals, University of Connecticut, believes that: 'Massage can prevent scarring *to some degree* by not allowing stagnation of tissue oedema following injury, thus preventing fibrosis.'<sup>8</sup> Fibrosis is the: 'Proliferation of fibrous connective tissue, called scar tissue.'<sup>9</sup>

Tappan's statement is ambiguous, but, to some degree provides a clue. 'Scarring' cannot be prevented but, perhaps, the extent and amount of scar tissue laid down can be limited.

As far as exercise goes, and exercise is all-important for recovery and return to full function, 'four days following the injury, the exercises are increased in strength and duration...' 'By the fourth day the healing process will have started. Controlled movement that produces *a gentle stretch* but no pain at your injury site exercises the newly developed scar tissue.'<sup>10</sup> Exercise can be further progressed during this phase, to the point where *controlled* exercise or movement will produce, '*a firm stretch* but *no pain*.'<sup>11</sup>

This takes us up to the third week after the injury, but keep in mind, the time lines presented here are only approximations.

We will have progressed from gentle movements/stretching exercises, to more vigorous, firm exercises. Massage should be included in treatment, with stroking and pressure directed longitudinally.

### **Remodelling phase**

'The remodelling phase follows the repair phase and can last for up to a year. It involves maturation of collagen tissue from Type 3 (immature) to Type 1 (mature) and realignment of collagen tissue.'<sup>12</sup>

The authors of the article this quote is taken from go on to say: 'When it is first laid down, the collagen tissue is haphazard and does not possess a lot of tensile strength.'

The first illustration (A) shows normal tissue alignment. The second (B) shows the random and disorderly arrangement of fibres in the early stages of repair after an injury.

Controlled, precise and carefully progressed exercises are necessary to realign the cross-woven, random fibres in diagram B.

It is crucial that the injured person understands the need for and benefits of exercise. The person may be disinclined to use the injured part, for fear of causing pain or further injury, or in the mistaken belief that a health care practitioner can 'fix' the problem for them.

Robin McKenzie, a New Zealand physiotherapist well known for his 'McKenzie Method' for treating back and neck problems, is adamant on this point. 'Only through exposure to mechanical loading can remodelling occur, de-conditioned structures be made functional, and sensitised tissue be made normal. This is only achieved with regular exercise that challenges the unfit tissue.'<sup>13</sup>

McKenzie goes on to say, of individuals recovering from injury and in the repair phase, 'It is at this stage, however, when individuals learn the habit of avoiding activities because they hurt. If this habit is prolonged and individuals develop the habit of avoidance of painful movements then the repair process will be retarded, remodelling will not occur, normal function will not be restored and persistent symptoms are likely.'<sup>14</sup>

How many times have you seen clients who exhibit this kind of avoidance behaviour, who hold the injured part or are over-careful in their movements, long after the injury and well past what would normally be the repair period? How many times have you seen clients who complain of pain and who, on palpation, have lumpy scar tissue and adhesions at the site of the injury? Remodelling has not been complete!

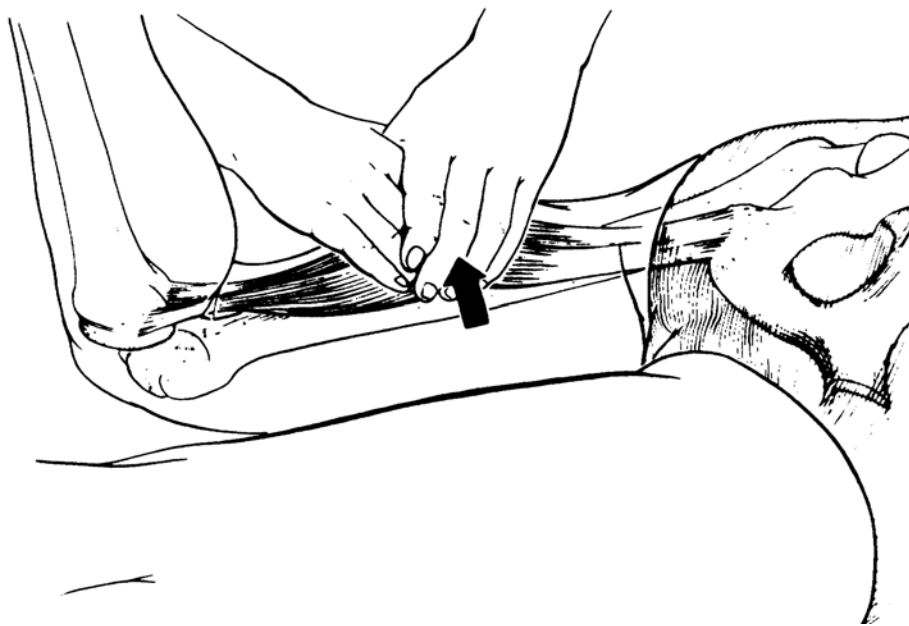
McKenzie accepts that some pain will be felt during exercising, *but it should not be long lasting.*

Appropriate exercises for this phase are functionally orientated and resistance can be offered using body weight, weights or an elastic exercise band. The exercises need to be carefully progressed.

Massage is beneficial and can promote further healing, increase blood flow and help align new fibres. Firm pressure can be used at this stage. Some practitioners advocate the use of friction massage to assist in the breakdown of excess scar tissue and to prevent adhesions.

Dr Robert Wertz, who has a background in massage therapy, physiotherapy and chiropractic, in his article, *Transverse Friction Massage Technique*, writes, 'The goal must be to prevent the continued adherence of unwanted young fibrous tissue in recent cases, or to rupture adherent scar tissue in longstanding cases.'<sup>15</sup>

He goes on to say that stretching does not widen the distance between fibres, rather, the opposite occurs. Forceful movement is required to broaden out and separate fibres, thus, breaking down adhesions, and this is precisely what transverse friction massage provides. The direction of friction is perpendicular to the fibres, 'across the grain,' thus separating individual fibres from each other, freeing them up, restoring movement and mobility.



Caption: Cross-function massage to belly of hamstring muscle

### **Transverse Friction Massage (TFM) to the hamstring belly.**

TFM is usually associated with the musculotendinous junction, but as the diagram above illustrates, it can be used in any part of the muscle. It is also useful on tendons and ligaments.

The person with the (healing) injury may protest that they work or play sport – they are using the injured part constantly. Isn't that enough? Well, yes and no. They might be abusing or misusing the injured part. In fact, it might be just that kind of use that caused the injury in the first place. They may be causing further damage. At this point assessment skills come into play.

What is required for the optimal resolution of tissue damage, caused by trauma or over-use, is an exercise protocol that is specific to the soft tissue which has been damaged, the phase of recovery, controlled and carefully progressed.

In this respect it is worth citing Wolff's Law. In essence, Wolff's Law states, 'that bone is laid down along lines of stress.'<sup>16</sup> However, this law can also be applied to soft tissue: 'It (Wolff's Law) reflects the truism that anatomical tissues and structures will tend to reflect the functional stresses demanded of them. Progressively increased loads will strengthen tissues and enhance function; stress deprivation will cause atrophy and dysfunction.'<sup>17</sup>

### **Conclusion**

The three phases outlined in this article present approximations of what happens to individuals as a result of injury. There will be overlapping of phases and the progress of a particular injury will depend very much on the type of injury, the soft tissue that has been injured and the person who is injured.

'Injuries cannot be made to heal faster than their natural speed. Without completion of any of the three phases the scar tissue will not be adequate for normal function. Failure in any phase of the repair process may result in ineffectual healing, leading to chronic degenerative changes, repeated structural failure, or less than optimal tissue.'<sup>18</sup>

The key point is, the body has evolved ways and means for dealing with injuries and insults to tissue. As therapists, we should not be trying to subvert the body's own processes, but, instead, attempting to work with and complement these processes to ensure the optimal outcome.

The phases and treatment protocols are summarised in the table below.

<p><b>Inflammatory Phase</b>            Inflammatory chemicals flood area            Blood vessels dilate/contract            Clot formation            Dead and damaged cells disposed of</p>	<p><b>Repair Phase</b>            Noxious chemicals and debris removed            'Budding' of (new) blood vessels and nerve tissue            Collagen (type 3) 'repair mesh' formed to bridge the gap between the torn ends of damaged tissue            Fragile, easily injured repair (<b>scar</b>) tissue</p>	<p><b>Remodelling Phase</b>            From immature to mature connective (type 1 collagen/scar) tissue            Contraction of scar tissue            Re-aligning of scar tissue fibres – along lines of stress or tension            Increasing strength of scar tissue via loading/mechanical stress</p>
<p><b>Protection Phase</b>            Manage effects of inflammation – <b>RICE</b>            Relative rest – <b>gentle</b> movement and stretching            Isometric exercises (muscle setting) commenced            Massage (in later stages), gentle to moderate pressure</p>	<p><b>Controlled Motion Phase</b>            Promote healing and develop mobile scar            Carefully progressed isometric and resistance exercises            Massage, using moderate pressure, especially longitudinal stroking. May introduce Transverse Friction Massage</p>	<p><b>Return to Function Phase</b>            Increase strength and alignment of scar            Develop functional independence            Carefully progressed strengthening, endurance and stretching exercises            Massage, using firm pressure, especially transverse friction massage</p>

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#### References

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- <sup>2</sup> Marieb E.N., *Human Anatomy and Physiology*, (4<sup>th</sup> edition, 1998), Adison Wesley Longman, Inc., page 763
- <sup>3</sup> Marieb, page 764
- <sup>4</sup> Lindsay R., et al, page 8
- <sup>5</sup> Lindsay R., et al, page 15
- <sup>6</sup> Marieb, page 137
- <sup>7</sup> Marieb, page 137
- <sup>8</sup> Tappan F.M., *Healing Massage Techniques*, (2<sup>nd</sup> edition, 1988), Appleton and Lange, page 24
- <sup>9</sup> Marieb, glossary, page 1148
- <sup>10</sup> Lindsay R., page 15
- <sup>11</sup> Lindsay R., page 15
- <sup>12</sup> Physioroom, Chartered Society of Physiotherapists, U.K., *Ligament Damage and Repair* www.physioroom.com
- <sup>13</sup> McKenzie R., May S., *The Human Extremities, Mechanical Diagnosis and Therapy*, (2000) Spinal Publications, page 36. A different approach of assessment of musculoskeletal problems
- <sup>14</sup> McKenzie R., May S., page 65
- <sup>15</sup> Wertz Dr. R., *Transverse Friction Massage Technique* (30/9/02), page 1, www.drwertzseminars.com
- <sup>16</sup> Hendrickson Thomas, *Massage for Orthopedic Conditions*, (2003), Lippincot Williams & Wilkins, page 8
- <sup>17</sup> McKenzie R., May S., page 29
- <sup>18</sup> McKenzie R., May S., page 30

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