Understanding scars and adhesions: Implications for manual therapy.

Willem J Fourie PT MSc.

Private practice, Johannesburg, South Africa.

School of Anatomical Sciences, University of the Witwatersrand, Johannesburg, South Africa.

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Introduction

For normal day-to-day use of the body, sensation, mobility, stability and freedom from disabling pain and anxiety are all prerequisites for quality of life. Our soft tissues, particularly in its relationship to musculoskeletal and motor function play an important part in this quality. A failure within or breakdown of any of the above will affect normal functioning, not only of the affected part, but may even influence function globally. The body is a functional unit and for coordinated and economical musculoskeletal function, soft tissue have to stretch, shift and glide smoothly in harmony with every movement of the body. If one part is injured or damaged, the entire unit suffers.

Maintenance of our well-being depends on the body's anatomical and physiological integrity. Whenever this integrity is disturbed, symptomatic dysfunction may occur and repair is needed. In guiding any injury through an appropriate sequence of repair without complications, nature has given us a highly effective survival tool by restoring tissue integrity via granulation scar tissue in response to damage. While non-surgical tissue trauma such as infection, chemotherapy, radiation and cancer may damage tissue and initiate the healing cascade, a common trigger to tissue healing and scarring is still injury and surgery. All wounds pass through the same mechanism of repair towards full recovery, the final cosmetic and functional result however may differ considerably.

The ideal is for a scar to first close the wound and establish tissue stability; and, secondly, to blend cosmetically with surrounding tissue, allowing for pre-injury function and movement. For open wounds (including surgical wounds) and severe internal tears (ruptured tendon or ligament), wound closure and tissue strength are critical and a certain amount of scarring is necessary and inevitable. When scar tissue fills defects in loose, flexible tissue, it will change to duplicate the same tissue characteristics as far as possible in the final stages of healing (Bouffard et al. 2008). Impaired soft tissue mobility can contribute to chronic pain and tissue stiffness as well as abnormal movement patterns within the musculoskeletal and motor systems.

What is the problem?

After an injury or surgery, successful healing of the part does not necessarily correlate with a return to full pre-injury/intervention function. A repaired tendon may develop normal tensile

strength after surgery, but will be a functional failure if it does not glide within its tendon sheath. Similarly, a healed surgical incision on the surface with compromised movement between muscles, contracture of a joint capsule or adhesions between visceral organs may also be classified as functional failures – often ending in a dysfunctional unit. An important requirement for any post-injury or post-surgical management strategy is the maximization of ***function*** without disruption of the wound healing and tissue repair processes.

The extent of the problem

Post-surgical scarring and adhesions result from injured tissue (following incision, cauterization, suturing or other means of trauma) fusing together to create abnormal connections between two normally separate surfaces of the body (Ergul & Korukluogla 2008). Outcomes differ depending on the injured tissue, type of injury, genetic factors and the presence of systemic disease, and the impact on function may range on a continuum from inconsequential to debilitating with considerable clinical consequences. For example:

- After a laparotomy, almost 95% of patients are shown to have adhesions at later surgery (Ellis 2007). Intestinal obstruction, chronic abdominal and pelvic pain and female infertility are also reported.
- Previous abdominal surgery has been shown to be a factor in lower backache, myofascial pain syndromes (Lewit & Olsanska 2004).
- Minimally invasive surgical procedures (e.g. arthroscopy) are reported as contributing to increased risk of developing knee osteoarthritis (Ogilvie-Harris & Choi 2000).
- Previous surgical scars can be associated with surgical difficulties and postoperative complications in primary total knee arthroplasty (Piedade et al. 2009).
- Adhesions, tissue fibrosis and loss of tissue glide between structures can be identified as the source of pain and restriction of movement and function in up to 72% of patients after surgery for breast cancer (Lee et al. 2009).

Not only do severe injury, aggressive surgery (e.g. cancer surgery) and burns potentially lead to a poor cosmetic outcome or disfigurement, but there is also a heavy economic burden on the medical care system. This could be as direct costs of care, or as future re-admissions and surgery as a result of the original procedure or injury. In the US, adhesion-related health costs exceed one billion dollars annually (ASRM Committee 2013).

A key problem is how to define and develop a sensible postoperative programme to optimise final functional outcomes after injury or surgery. The development of such programmes start with an understanding of what a scar is, how it is formed, and its possible involvement in dysfunction.

What do we need to know?

To develop a scar and adhesion treatment strategy the following needs to be understood:

- The entire healing process and its phases
- The way tissue responds to injury and knowledge of healing outcomes

- Factors influencing the repair process at different stages
- An anatomic understanding of the tissue layers between the surface and the deeper layers of the body
- A good working knowledge of massage and manual tissue techniques.

Need to know 1: Phases of wound healing

Scar formation is our primary method of restoring tissue integrity. All wounds, whether the result of surgery or trauma, progress through the same sequence and repair process, but may, however, vary markedly in the final cosmetic and functional result. Normal, uncomplicated healing and its time frames will be discussed.

Superficial wounds heal without scar tissue formation by simply regenerating the damaged epithelium. The healing of deeper wounds is an organized and predictable process consisting of three overlapping phases: **inflammation, proliferation and maturation/remodelling** (Myers 2012).

- The first response to injury is **inflammation,** allowing the body to control blood loss and fend off bacterial invasion. It also recruits the cells needed to restore the injured area. This phase usually lasts from 48 hours to 6 days, depending on the extent of the damage. During this phase, the wound has no tensile strength and has a poor response to mechanical stress.
- During the **proliferative phase**, new tissues are built to fill the gap left by damaged and debrided tissues. As a result, epithelial integrity is restored, and the wound is considered **closed.** This is an active healing phase starting from about day 5, reaching a peak around day 14 and lasting up to several weeks. There is now a slow increase in tensile strength with fibroblasts and collagen aligning along lines of stress.
- **Maturation and remodelling** starts at around day 21 and may last up to 2 years after wound closure. During this time scar tissue is reorganized from haphazard fiber arrangement to being oriented along the lines of tissue stress, until reaching maximum strength and function. During this phase tensile strength and mechanical behaviour of the scar continue to improve (Lederman 1997). Unfortunately, even after remodeling, scar tissue is less elastic than the original tissue and may only achieve a maximum of approximately 80% of the original tissue strength (Myers 2012). A wound is considered **healed** after it is resurfaced, and has achieved maximal attainable tissue strength.

Need to know 2: Different healing outcomes

'Friendly' scars close the wound, create stability, blend cosmetically with the surrounding tissue and allow structures to resume their pre-injury function. Problem or 'unfriendly' scars fall into two categories:

- Failure to heal within the expected time frame due to the absence of inflammation, reduced inflammation (delayed healing) or chronic inflammation due to foreign bodies, malnutrition, infection, repetitive mechanical trauma or insufficient scar formation (dehiscence)
- Excessive repair including hypertrophic scarring (overproduction of immature collagen), keloids, or contractures (pathological shortening of scar tissue resulting in deformity; Myers 2012).

A **scar** is the fibrous tissue that replaces normal tissues which a burn, wound, surgery, radiation, or disease has destroyed (Andrade & Clifford 2008). Scar tissue is never as strong as normal, uninjured skin or tissue.

Hypertrophic scarring is due to the overproduction of immature collagen during the proliferative and remodeling phases of wound healing. This is more likely to occur in wounds that cross the lines of tension in the skin, in wounds with a prolonged inflammatory phase (large or infected wounds) or in burns because of their lengthy proliferative phase (Myers 2012).

A **contracture** is the pathological shortening of scar tissue resulting in deformity (Myers 2012). The term 'contracture' is usually used to indicate a loss of joint range of movement as a result of connective tissue and muscle shortening. Underlying contracture formation are adhesions or excessive cross-links.

Adhesions/fixations are related to the scarring process and develop secondary to the normal healing process. It is the process of adhering or uniting two surfaces or parts, especially the union of the opposing surfaces of a wound (*Stedman's Medical Dictionary* 1972). Unlike scarring, adhesions are characterized by a loss of mobility of tissues that normally glide or move in relation to each other and once matured, may even be stronger than the tissue to which they adhere (Lederman 1997). Adhesions can contribute to impaired muscle, joint, and connective tissue integrity (Andrade & Clifford 2008). Secondary to an adhesion, a continuous state of mechanical irritation can affect many systems that are far removed from the involved site. The impact of the adhesion of normally sliding surfaces on normal organ or musculoskeletal function could range on a continuum from inconsequential to debilitating.

Fibrosis is defined as the thickening and scarring of connective tissue. Fibrosis, as a process, is less linear than scarring, which typically occurs step by step in sequence. Fibrosis usually involves the connective tissues and structures of an entire region.

Need to know 3: Factors influencing outcomes

Examples of factors that may influence the rate of wound healing or change the outcomes of certain stages include:

- **Wound characteristics** such as the mechanism of onset, location, dimensions, temperature, wound hydration, necrotic tissue and infection
- **Local factors** include local blood circulation, sensation and mechanical stress in the wound area

- **Systemic factors** include age, inadequate nutrition, comorbidities, medication and behavioural risk taking like smoking and alcohol abuse
- **Inappropriate wound management.**

Management protocols must be flexible enough to promptly recognize complications and risks in order to adjust the timing and application of therapeutic intervention.

Need to know 4: The anatomy of tissue layers

When palpating tissues, therapists will encounter a succession of tissue layers. Using the different characteristics of these layers such as hardness, density, texture, and mobility, the therapist can distinguish between layers summarized below.

The body is arranged in several layers:

- The **skin** formed by the epidermis and dermis
- The **superficial fascia** consisting of two or more adipose, loose connective tissue layers separated by a membranous layer(s) of collagen and elastic fibers
- The **deep fascia** that envelops the large muscles of the trunk and forms fascial sleeves in the limbs
- The **muscle** and its **epimysial fascia** beneath the deep fascia of the limbs
- The **peritoneum** is a thin layer of irregular connective tissue that lines the abdominal cavity. It further consist of two layers:
    - The **patietal peritoneum** as the outer lining of the abdominal cavity
    - **Visceral peritoneum** covering the viscera and organs contained therein.

Need to know 5: Connective Tissue – the interface between tissue layers

There are no ”empty spaces” in the body. Every part or structure relates to every other surrounding part or structure. This is largely a function of the connective tissue system where dense connective tissue forms part of the force transfer and tissue layer system, and areolar (loose) connective tissue forming filler tissue of the interfaces where movement takes place.

Connective tissue structure: Connective tissue consists of three components:

- Extra-cellular matrix
    - Structural proteins – collagen, elastin
    - Non-collagenous/crosslink proteins
    - Ground substance (gel-like component)
    - Ionized water (viscoelasticity)
    - Glucosaminoglicans (hyaloronan – viscous lubricant for sliding)

- Cells
    - Mast cells and macrophages (wound repair and immune system)
    - Adipocytes (heat, protection, energy)
    - Fibroblasts (synthesize the components of the ECM)
- Fibrous proteins
    - Collagen
    - elastin

Connective tissue functions: It has a diversity of roles

- Is a highly specialized tissue.
- It maintains form in the body.
- Provides mechanical support,
- Movement quality,
- Tissue fluid transport,
- Cell migration,
- Wound healing,
- Control of metabolic processes in other tissues.

Connective tissue and fluid dynamics:

- Loose/areolar connective tissue harbours the vast majority of the 15 litres of interstitial fluid in the body
- This flows through an extracellular matrix of loose areolar connective tissue which contains cells (e.g. fibroblasts, tumour cells, immune cells, adipocytes.)
- This fluid/cell environment has an important effect on tissue morphogenesis, function, cell migration, cell differentiation, remodeling, wound healing and tissue repair.

Variations of the ***content and volume*** of water, ions, and other substances can alter the ***biomechanical properties*** of the loose areolar connective tissue. This is of particular importance after trauma as inflammatory cytokines change collagen tension influencing fluid dynamics (Meert 2012).

Need to know 6: How do we evaluate and treat?

Guidelines

The practitioner needs to keep two basic guidelines in mind during the evaluation and treatment of scars and adhesions. Touch needs to be graded and it should be understood where and how tissue stops under one's palpating fingers or hands.

Depth and grading of touch

An advantage of manual techniques is that the hand is a sensitive instrument which establishes a feedback relationship with the manipulated tissue. When treating wounds and scarring, the therapist should be clear of how deep and firmly to work. A grading scale of 1–10 could be used (Fourie & Robb 2009).

- **Grade 1 to 3:** Very light, mild and non-irritating. It can be compared to moving the eyelid on the eyeball without irritating the eye. No discomfort.
- **Grade 4 to 6:** Moderate to firm. This is where most massage techniques are performed. There may be mild discomfort, but with no irritation or damage to tissue.
- **Grade 7 and 8:** Firm, deep and uncomfortable pressure with discomfort, but is tolerable. Potential exists for tissue bruising. Trigger point work would be performed at this level.
- **Grade 9 and 10:** Deep, very uncomfortable or painful with a strong potential for tissue damage. It is often described as 'surgery without anaesthesia'. An example of this grade would be deep transverse friction.

The barrier phenomenon

Similar to joints, soft tissue has a specified range of available movement. Within this range of movement, normal soft tissue has three barriers, or resistances, that can limit movement – the physiological barrier, the elastic barrier, and the anatomical barrier (Andrade & Clifford 2008).

- Physiological range is necessary for smooth, unrestricted movement of underlying structures during normal movement – it determines the available active range of movement
- The elastic barrier is the resistance one feels at the end of the passive range of movement when taking the slack out of the tissue (engaging the tissue)
- The anatomical range (barrier) refers to where tissue can be stretched beyond the physiological range before coming to a stop without discomfort or pain (the final passive range of movement)
- The distance between physiological and anatomical limits constitutes a 'safety' zone protecting the body from damage should external forces be applied.

At the physiological barrier minimal resistance to stretch or shift is encountered. When resistance is met with no further tissue movement possible, the anatomical barrier is reached. Under normal conditions this barrier has a soft, elastic end-feel and can be moved easily accompanied by a sensation that no unnecessary tension or pain is present in the target tissue.

In a ***pathological*** barrier, the anatomical (passive) tissue range is reached prematurely and occurs when soft tissue dysfunction is present. This barrier characteristically has a tense, restrictive feel, with an abrupt, hard or leathery end-feel. Normal physiological movement may still be present with no apparent movement restriction, but there will be reduced protection when the tissue is strained. Restrictive barriers may occur in skin, fascia, muscle, ligament, joint capsule, or a combination of these tissues (Andrade & Clifford 2008). Pathological barriers can

limit available range of motion in tissue or alter the position of the mid-range, thereby changing the quality of available movement in joints or between structures.

Evaluation

Scar evaluation aims to determine the **quality, extent and depth** of the 'premature or pathological' tissue barrier.

- **Quality** refers to the perceived **end-feel –** a normal soft, elastic or an abnormal solid, abrupt end-feel.
- The **extent** of the barrier refers to **where** in the available range resistance is encountered, and the size of the involved area
- The **depth** of the tissue barrier may be subjective but an attempt should be made to distinguish between **which tissue layers** restrictions are felt: superficial between dermis and deep fascia, deep restrictions between muscles, organs or between a tendon and its sheath.

Assessment of fascial glide:

- **Skin and superficial fascia** – manually glide the skin **over** the deep fascia. Move hand and skin as a unit to the end of available tissue glide using a pressure grading of 2–4.
- **Deep fascia and myofascial interfaces** – move one deep structure **over** another. Change hand or finger position accordingly and glide tissue at a firm pressure grading of 4–6.
- **Deep muscle and soft tissue on bone interfaces** – modify hand and/or finger position to test for specific directional restrictions with fingertip or thumb pressure at a pressure grade of 6–8. Discomfort may be experienced by the patient and should therefore be done with care.

This is an assessment of tissue **movement**, not of painful areas within the soft tissue. Palpation is for tissue mobility, flexibility and freedom of tissue glide. The position and direction of tight, hypomobile or inflexible tissue should be documented.

Assessment of scar movement:

- **Longitudinal** along the length of the scar
- **Transverse** across the long axis of the scar
- **Rotation** clockwise and anti-clockwise
- **Lifting** the scar vertically away from deeper layers.

Need to know 7: Basic techniques

Manual techniques used on scars and adhesions mostly have no prescribed style or sequence, but are based on the principles outlined above. The goal of treatment is to loosen the collagen fibre linkages that have developed within the scar and the adherences between it and its surrounding tissues. Effective treatment applies direct pressure to specific points and directions of resistance i.e. **concentrating effective force on local areas**. For effective, concentrated force application,

the therapist's fingers or hand should not glide over the skin's surface. No, or very little, lubrication should therefore be used.

Need to know 8: Cautions

Therapists must use their training and best judgment when deciding whether or not to proceed with scar massage. While treatment is most effective when a scar is still in its immature phase, it is also a wise time to seek physician permission. It is always good practice to monitor the response of scar tissue to determine the appropriateness and effectiveness of massage intervention. Warning signs of potential scar problems include limited range of motion, new onset of joint restrictions, banding of scar tissue with movement, or blanching with stretching of the scar tissue

A few additional cautions for immature scars include:

- Take extreme care with radiated tissues, as the skin is delicate and can break easily
- Aside from friction massage, do not continue if your actions cause pain or increase tissue redness
- Never perform massage on any open lesions.

In many cases the problem may be irreversible with scars becoming so fixed and strong that only surgery will release the adhesion. In established fixed scars, where no tissue gliding is possible by manual means, treatment is aimed at creating more soft tissue space and flexibility in the surrounding tissue. In many cases adhesive scarring may affect quality of life adversely; however, open, positive discussion with adequate explanation and intervention may vastly diminish the patient's anxiety, suffering and disability, making scar work a rewarding field in manual therapy.

REFERENCES

Andrade C-K, Clifford P 2008 Outcome-based massage, from evidence to practice, 2nd edn. Wolters Kluwer, Philadelphia

ASRM Committee 2013 Pathogenesis, consequences, and control of peritoneal adhesions in gynecologic surgery: a committee opinion. Fertil Steril 99:1550-1555, doi:10.1016/j.fertnstert.2013.02.031

Bouffard N A et al 2008 Tissue stretch decreases soluble TGF-β and type-1 procollagen in mouse subcutaneous connective tissue: evidence from ex vivo and in vivo models. J Cell Physiol 214:389-395

Ellis H 2007 Postoperative intra-abdominal adhesions: a personal view. Colorectal Dis 9 (Suppl 2):3-8

Ergul E, Korukluoglu B 2008 Peritoneal adhesions: facing the enemy. Int J Surg 6:253-260 doi:10.1016/j.ijsu.2007.05.010

Fourie WJ, Robb K 2009 Physiotherapy management of axillary web syndrome following breast cancer treatment: discussing the use of soft tissue techniques. Physiotherapy 95:314–320 doi:10.1016/j.physio.2009.05.001

Lederman E 1997 Fundamentals of manual therapy. Churchill Livingstone, Edinburgh

Lee T S et al 2009 Prognosis of the upper limb following surgery and radiation for breast cancer. Breast Cancer Res Treat 110:19-37

Lewit K, Olsanska S 2004 Clinical importance of active scars: abnormal scars as a cause of myofascial pain. J Manipulative Physiol Ther 27:399-402

Meert GF 2012 Fluid dynamics in fascial tissyes. In: Scleip R et al. (Ed). Fascia: The Tensional Network of the Human Body. The science and clinical applications in manual and movement therapy. Churchill Livingstone, Elsevier, Ediburgh

Myers BA 2012 Wound management: principles and practice, 3rd edn. Pearson Education, New Jersey

Ogilvie-Harris DJ, Choi CH 2000 Arthroscopic management of degenerative joint disease. In: Grifka J, Ogilvie-Harris DJ (ed) Osteoarthritis: fundamentals and strategies for joint-preserving strategies. Springer-Verlag, Berlin

Piedade SR, Pinaroli A, Servien E, Neyret P 2009 Is previous knee arthroscopy related to worse results in primary total knee arthroplasty? Knee Surg Sports Traumatol Arthrosc 17:328–333 doi 10.1007/s00167-008-0669-9

Stedman's Medical Dictionary, 22nd edn 1972 Williams & Wilkins, Baltimore