

The Three Stages of Traumatic Injury

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The focus of the present discussion is to increase understanding of the mechanisms in play during the various stages of injury and to help bridge the gap between Western and Eastern models. TCM treatment strategies are informed by and explained with biomedical insights. A special emphasis is given to the internal treatments, since the distinctions are more subtle. In TCM, the external treatment of injury is governed by clinical manifestation, while internal treatment is governed by particular stages of trauma. In order to appreciate the value of timing in one's strategy, it is helpful to be familiar with what exactly is happening in the tissues at the site of injury. There are three distinct stages of traumatic injury, which are expressed by a limited number of clinical manifestations. Bleeding is a special manifestation of traumatic injury, and is a pattern unto itself. In most injuries where there is bleeding, it must be stopped before further assessment is made. In this sense bleeding can be considered pre-first stage trauma.

The First Stage of Trauma

This is the most critical stage for treatment. It is distinguished by the three chief manifestations of pain, heat and swelling. Toxin and blood stasis begin to form. Heat usually manifests as localized redness, but in the absence of redness, it might be experienced by the patient as the sensation of heat at the site of the injury. In minor injuries, the heat may not be detectable, but it is always present. This stage can last anywhere from three days to several weeks, depending on the type and severity of injury. The treatment strategy is to clear heat and resolve toxin, dispel stasis and relieve pain. The formulas used to treat stage-one trauma are the coldest formulas of the three stages; they emphasize eliminating heat toxin while helping the body move out damaged tissue.

The biomedical understanding of the body's response to traumatic injury is discussed as a subset of its understanding of inflammatory response in general. In other words, though inflammation can occur without injury, no injury has occurred where the inflammatory response has not been engaged. More than 180 chemicals have been identified as playing a role in acute inflammation.¹ Since the targets of the chemical inflammatory mediators are the local vessels, and the vessels respond by creating the environment and supplying all the material for inflammation, these responses are collectively referred to as the "[vascular reaction](#)" to injury.²

Vasodilation actually occurs as the result of two types of contraction. First, the smooth muscle around the larger vessels contract, which slows the flow of blood in the capillaries at the injured site to prevent blood loss. Then, endothelial cells, which line the inner wall in the smaller vessels, contract. The contraction makes the vessel more permeable by increasing the space between cells that line the inner wall of the vessel. The vessel as a whole does not actually become larger in vasodilation. The result is increased permeability. Vasodilation allows both red and white blood cells to leak out into the injured site. The presence of red blood cells outside the vessel is responsible for the color and heat associated with inflammation. The movement of plasma fluids out of the vessel and into the surrounding tissue creates localized swelling.

In addition to vasodilation, the chemical inflammatory mediators cause the interior wall of the blood vessel to become sticky. Under normal circumstances, the leukocytes do not adhere to each other or to the walls of the blood vessels as they are too diffuse in the blood to collect in any one place. Increased adhesion caused by the chemical release at the site of injury changes all that. Red blood cells do not adhere to the affected walls of the vessel, but leukocytes do. This accumulation, along with the localized thickening of the blood from the loss of plasma fluid, slows down the flow of the blood through the vessels considerably, contributing to what TCM calls "blood stasis." When the leukocytes become stuck and accumulate in the endothelium, the inside layer of leukocytes are able to migrate out of the vessel and into the injured tissue.

Two main leukocytes play a predominant role in the injured tissue: neutrophils and macrophages. If the skin has been breached, neutrophils can help destroy invading bacteria. The macrophages specialize in clearing out the area to make way for new cells by literally digesting bacteria and dead cells, but they are not formed inside the blood vessels. One of the predominant leukocytes that accumulates on the endothelium is a monocyte. These are semi-differentiated white blood cells that further differentiate into macrophages when exposed to an inflamed environment. Whereas the primary chemical inflammatory mediators appear on the injury scene immediately, it typically takes monocytes **eight to 12 hours** to accumulate in the endothelium and pass through into the injured tissue.³ It can take an additional **eight to 72 hours** before the monocytes differentiate into macrophages.⁴

The period in which the macrophages are in peak activity is determined mainly by the severity of the damage. In the cases of bone fracture or major surgery, the macrophages can be at peak activity for a few weeks. In mild to moderate trauma, such as a banged knee, the macrophagic activity may only last from two to four days.

Due to a short half-life of the chemical inflammatory mediators, the acute inflammatory response requires constant stimulation to be sustained. In addition, granulocytes (a special type of leukocyte) make their way into the injured tissue from the bloodstream in the same manner as the monocytes. These granulocytes act upon some of the mediators (the prostaglandins) to initiate a termination sequence. Inflammatory mediators are quickly degraded in the tissue. Hence, new inflammation ceases to generate once the **stimulus has been removed**.⁵ This is why temporary immobility can hasten the termination of the inflammation stage. Stress to an injured site from improper movement can re-stimulate the release of the inflammation mediators. The inflammation cessation program **ends** when the macrophages exit the site of injury by getting absorbed into the lymphatics.⁶

In TCM, the vast majority of all toxin is heat type. The common quality of all toxin in TCM is that its presence causes harm to the body. Usually, this harm connotes either pathological tissue changes or violent *qi* rebellion. Heat toxin causes pathological, though not necessarily permanent, tissue changes. In the case of traumatic injury, heat toxin does not enter the body from the outside if the skin is not broken. Given that TCM does not accept the notion that the body attacks itself, why do we consider the inflammatory response of traumatic injury to be "toxin"?

The TCM perspective is that heat toxin causes the signs of inflammation, and inflammation is the result of heat toxin accumulating and obstructing the normal flow of *qi*. Heat toxin is created immediately following an external impact. The compression from the blow forces blood out of the vessel and forces the turbid *wei qi* to combine with the errant blood. When warm, turbid *qi* combines with clear, nourishing blood, the warmth cooks the blood. The product is a toxin because the *wei qi* and blood are not in their proper places and do not have the right relationship to each

other. *Zhèng* (right, righteous, correct) is in opposition to *xiè* (evil, pathogenic).⁷ Therefore, though the body is not attacking itself, the impact of the injury causes a *xiè* relationship between *qi* and blood. This relationship results in tissue changes in the form of redness, swelling and necrosis, hence toxin.

The main focus of first-stage trauma treatment in both biomedicine and TCM can be summarized as an attempt to reduce or eliminate secondary injury so that healing can begin. Secondary injury is any further damage to the tissue peripheral to the locus of injury that occurs as a result of improper movement by the patient or aggravation from the inflammatory response itself. The former can be reduced through stabilization, but the latter must be controlled through topical applications of ice, herbs or both, in conjunction with the appropriate internal treatments.

The pathophysiology of secondary injury is chiefly related to the swelling factor. Swelling creates pressure, which decreases blood flow by compressing blood vessels to the point where they can no longer transport enough oxygen to the injured area, so the healthy peripheral tissue begins to suffocate from lack of oxygen, thereby causing secondary tissue death. Swelling also restricts fluid flow between cells; more fluid will attempt to enter tissue surrounding the injury, causing these cells to burst and die. Chinese herbs are very effective at controlling secondary injury by invigorating blood flow, accelerating the removal of toxin, and promoting vessel repair.

The Second Stage of Trauma

The second stage of trauma starts when the initial inflammation first subsides. What remains is blood stagnation combined with congestion of *qi* and fluids in the local area. This congestion causes stiffness and pain. The damaged tissue weakens the defense against the invasion of external pathogens such as wind and damp. Swelling may remain a factor, especially if treatment during the first stage was neglected or insufficient, or if the damage was severe. The treatment strategy for the second stage of trauma is similar to the first stage, but clearing heat becomes secondary to moving blood and dispelling stasis. Herbs are added to dispel wind and damp so that these pathogenic factors do not become lodged in the area as chronic *bi* syndrome.

Blood stasis is always present in traumatic injury. It begins to form in the first stage, but remains a secondary concern until the second stage, when eliminating heat toxin becomes secondary to dispersing stasis. The goal of dispersing stasis is to decrease pain and to clear the way for the tissue regeneration that characterizes stage three. Blood stasis is the result of four causes: primary vessel damage, extravasation, pressure from swelling and increased adhesion.

Primary vessel damage occurs at the moment of impact. Some extravasation occurs at impact, but also comes from the vascular reaction to injury. That is, the increased permeability of the vascular reaction allows for blood (both red and white cells) to leak out of the vessel into the surrounding tissue. Pressure from swelling decreases blood flow to the injured area by compressing blood vessels.⁸ Previously, I described how chemical stimulators cause increased adhesion as part of the vascular reaction to injury. In TCM, we say that blood cooked by *wei qi* becomes sticky. The resulting toxin, therefore, has a tendency to accumulate, which complicates the blood stasis situation both by increasing pressure via swelling and by restricting flow within the vessels themselves.

Damaged and weakened tissue is always highly susceptible to invasion from external evils. Once the heat toxin is mostly eliminated, treatment strategies should include some action to dispel wind, cold and damp, as well as protect the area from further penetration by these pathogens. In second-stage treatment, expelling external pathogens is secondary to eliminating stasis, but must be

addressed.

The Third Stage of Trauma

The third stage of trauma, according to the biomedical model, is tissue healing. This is also the case in TCM, but we are additionally concerned with the expulsion of, and protection from, invading pathogens such as wind, cold and damp. The third stage is traditionally marked by the need to rebuild tissue and dispel exogenous pathogens that may have transformed into wind-cold-damp *bi* syndrome. There is often some residual blood stasis that is contributing to the lingering pain. As a result, there is inevitable overlap between the second and third stage of trauma herbal formulas. Both should move blood, dispel stasis and relieve pain, but in the second stage, heat may still be a minor factor so and the formulas are cooling or neutral. Third-stage herbal formulas are the warmest of the formulas that treat trauma. They often contain kidney-supplementing herbs to stimulate the regeneration of ligaments, bones and cartilage. Lingering heat in the injured area should be cleared before employing a warm-property formula.

All of the body's responses to injury are part of its healing process. The vascular reaction initiates the inflammatory response. In TCM, we tend to think of inflammation as pathogenic, even calling the substance of inflammation *du*, "toxin." But all of these are part of healing. [Biomedicine describes the function of inflammation](#) as fighting off possible infectious agents, removing debris such as broken cells, and preparing the area for reconstruction.⁹

These functions are neatly arranged to suggest that inflammation initiates all three stages of trauma. Fighting off possible infection is most closely associated with the heat signs of the first stage of trauma. Once debris removal is noticeable, swelling and heat begin to decline and the patient is in the second stage. The third function of inflammation is to prepare for the healing and regeneration characteristic of the third stage.

Tissue healing begins as the inflammatory process starts to slow down, but the two processes overlap. Macrophages clear out debris and prepare the area for the regeneration of new tissue. After a few days, fibroblasts (collagen-producing cells) begin to construct a new matrix, upon which new cells will generate. Once inflammation is sufficiently restrained and there is enough space, new capillaries begin to sprout, bringing fresh blood to the region. This is known as angiogenesis or revascularization. When blood flow has been reestablished, specific tissue cells begin to generate around the collagen matrices (such as muscle or bone tissue). If the injury is severe enough to involve several types of tissue, there may also be non-specific cells. If these are not removed, they can evolve into scar tissue. Chinese herbs can help reduce the formation of scar tissue by use of blood-nourishing and invigorating substances, such as angelica root (*dang gui*) and spatholobus (*ji xue teng*).

New blood bathes the nascent cells, which begin to proliferate as they mature. The proliferation phase lasts up to four weeks. After there are enough new cells, the remodeling stage takes over. The new cells knit together to produce functioning tissue. Depending on the severity of the initial damage, remodeling can take from [a few weeks to a few years](#).¹⁰ During remodeling, the new tissue orients according to the stresses imposed upon it. It is therefore important to gently stretch in the correct direction so to optimize the strength of the new tissue.

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