MANAGEMENT OF TRAUMATIC SKIN WOUNDS IN PROFESSIONAL ROAD CYCLISTS

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Professional road cyclists not only ride at speeds of up to 80 km/hr, they often do so in a peloton of up to 200 riders. They also have to contend with narrow roads, tortuous descents and 'road furniture' (such as traffic islands, roundabouts and bollards). More recently, there have been a number of significant injuries caused by collisions with motorcycle outriders carrying photographers or TV cameramen, eager to obtain close up images of the riders during the key moments of the race. In addition, the supporting team cars travel in very close proximity to the riders and frequently move through the peloton at great speed in order to attend to mechanical issues or wheel changes, so it's perhaps not so surprising that crashes are fairly frequent occurrences.

Skin wounds are the most frequent traumatic cycling injury and the commonest of these are skin abrasions ('road rash') and skin contusions. Other types of skin wounds are also occasionally seen (lacerations, incisions and puncture wounds). The injury mechanism is usually a combination of shear and compression forces, with the association between the two determined partly by the speed at the time of impact, the nature of the road surface and the trajectory as the rider hits the ground. Injuries can also be caused by contact with other riders, their bikes, cars/motorcycles and a variety of 'road furniture', as alluded to previously. The commonest sites for skin trauma are over the greater trochanter, shoulder, upper back, knees and elbows. Less frequent sites include the medial and lateral malleoli at the ankle, which can be very difficult to manage due to the minimal overlying skin thickness, occasionally requiring skin grafting.

While skin wounds may appear to be only a minor issue, they can impact heavily on the performance of an individual, as their presence in the typical locations will often impair sleeping and thereby recovery. Recovery is a key performance determinant in a 3-week stage race such as the Tour de France and several nights of interrupted sleep are likely to have a gradual attritional effect on the rider

Clothing worn during cycling races/training typically offers very little protection from skin injury, though that is beginning to change with the development of specialised fabrics incorporated into the garments (see below). Lightweight Lycra garments are the norm, particularly when competing in hot or humid conditions.

With this in mind, there is clearly potential for riders to sustain much more

significant injuries, including fractures, head injuries and damage to internal organs and this should always be considered first when assessing a rider, not only during the race, but also immediately following when they seek medical attention.

SKIN STRUCTURE

Before discussing the different types of skin wounds, it is worth briefly reviewing the structure of skin; it is composed of three distinct layers – the epidermis, the dermis and the hypodermis (or subcutaneous layer).

- **Epidermis:** refers to the outer layer of the skin. It is avascular and just a few cells thick. It provides a barrier to infection and other injurious agents and also regulates water loss through the skin. It's the first layer to be damaged in traumatic skin injuries, such as abrasions.
- **Dermis:** the layer below, consisting of connective tissue, nerves, blood vessels and specialised cells, including fibroblasts. This is the main site of inflammation when the skin is subject to trauma. It's numerous nerve endings makes it highly pain-sensitive when injured.
- **Subcutaneous layer (hypodermis):** the deepest layer, which is very variable in thickness, depending on location and the person's degree of adiposity. It consists of fat tissue, connective tissue and blood vessels.

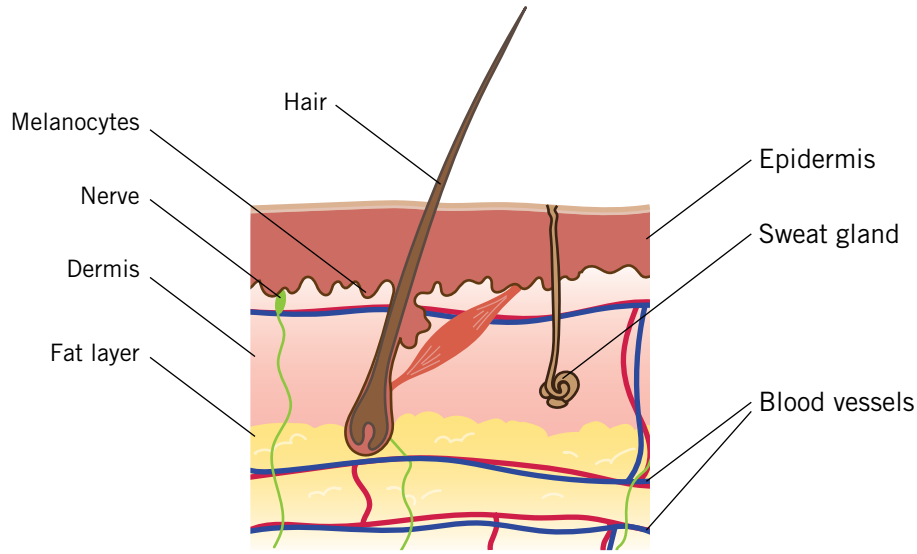


Figure 1: Normal skin structure.

CLASSIFICATION OF SKIN WOUNDS

Five different types of skin wounds are usually described; abrasions, contusions, lacerations, incisions and puncture wounds.

Abrasions occur where the skin is scraped or rubbed off, usually due to friction. This is the commonest type of skin injury seen in cyclists, often accompanied by a contusion. They are sometimes further classified into

- 1st degree (involving only the epidermis)
- 2nd degree (extending into the dermis)
- 3rd degree (extending into the hypodermis).

Second and 3rd degree are the most painful since numerous nerve endings are exposed, particularly when a large area of skin is involved. They also tend to heal with a degree of scarring[1].

Contusions are closed wounds, caused by blunt trauma, resulting in damage to the tissues beneath the skin, but with the skin surface still intact.

Lacerations occur when the skin is torn or cut, resulting in an irregular wound edge. They are caused by blunt trauma and are sometimes seen in association with severe abrasions.

Incisions are cuts caused by sharp surfaces or implements. There is a concern that these may be more frequently seen if disc brakes are introduced into the peloton, as is currently under consideration.

Puncture wounds occur when a sharp object penetrates the skin – these are tetanus-prone wounds, so it's important to assess the rider's tetanus status. They are sometimes seen when a rider comes into forceful contact with the bike during a crash, in particular the front chainring, which has numerous pointed teeth around its circumference.

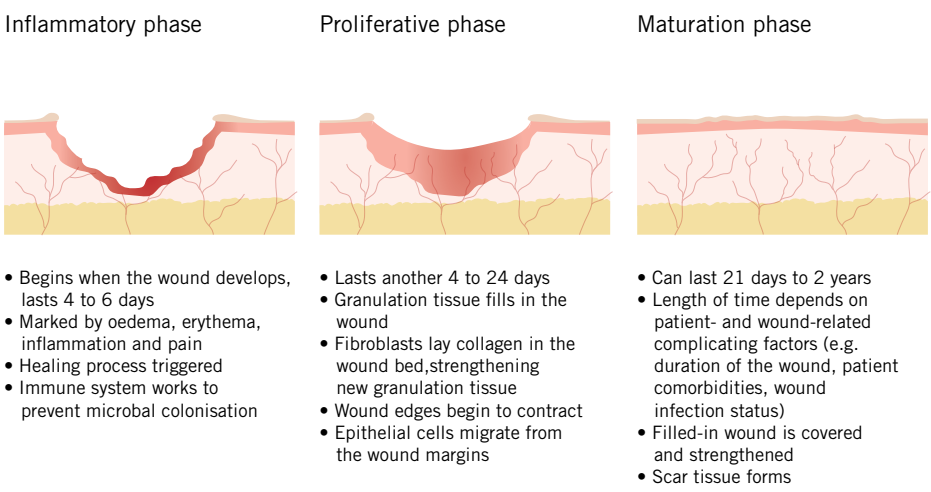


Figure 2: The phases of wound healing.

THREE PHASES OF WOUND HEALING

There are three phases of wound healing that need to be considered in the management of traumatic skin lesions, the first two of these being the most important from a cyclist's perspective.

The first phase is the **inflammatory phase**, which starts immediately after skin injury, with haemostasis and continues for around 5 to 6 days. It's characterised firstly by an influx of neutrophils in response to chemotactic factors released by damaged tissue. Their function is to cleanse the injured area of cell debris, their activity peaking over 1 to 2 days. Following this, there is an influx of monocytes, which transform to macrophages once they leave the microcirculation – these produce numerous growth factors (such as transforming growth factors, interleukin-1, interleukin-6, tumour necrosis factor-alpha, platelet-derived growth factor), which prepare the way for fibroblast proliferation in the following stage, as well as promote the initial stages of angiogenesis (growth of new blood vessels).

The next stage is the **proliferative/granulation phase**, beginning around day 4 and usually lasting a further 1 to 3 weeks, depending on the type of wound. It's characterised by an in influx of fibroblasts and subsequent production of collagen types 1 and 3, as well as glycosaminoglycans and proteoglycans, constituents of the matrix. Angiogenesis becomes more prominent at this time and there is also evidence of re-epithelialisation, where epithelial cells migrate from the periphery of the wound to leave a thin layer covering the wound surface.

Image: Treatment from the team car.

Finally, there is the **maturation/remodelling phase**, which commences towards the end of the preceding granulation process and can last for months or even longer. There is continuous collagen turnover and remodelling, and potential for wound contraction via the action of specialised cells called myofibroblasts, especially if the wound has healed by secondary intention. The maximal tensile strength of the resulting scar is typically reached after around 3 months.

Two different scenarios present to the team or race doctor. Management of skin wounds during the race and definitive management in the following period.

MANAGEMENT OF SKIN WOUNDS DURING THE RACE

Once a rider has been involved in a crash during the race there are three possible immediate outcomes:

- They get up straight away and attempt to rejoin the race.
- They get up more slowly with the potential to continue, often after a quick check by the race doctor or team doctor by the roadside.
- They don't get up and most likely abandon the race, needing more involved medical assessment.

It is very common for riders to get straight back on the bike if at all possible. Any delay

makes it less likely that they will regain their position in the race. If they don't get up, it suggest more serious injury, in which case management of skin trauma is rarely the priority

If a rider gets back onto their bike after the crash, they will often come over to their team car or race doctor for medical assistance while they continue in the race, usually as they hold onto the side of the moving car. Ideally, the injured side should be closest to the car, which may mean some careful manoeuvring on the part of those inside, including switching from front to back seat if room permits. The first priority is to ensure that the rider is safe to continue and, in this regard, a rapid screen for concussive symptoms using modified Maddocks questions should be performed prior to evaluating any injuries. The doctor should also ask if there is any pain not related to sites of skin wounds riders with clavicular fractures usually aren't able to continue, but it's not unusual for riders with wrist, elbow or shoulder fractures to carry on riding, albeit in severe discomfort.

Control any bleeding by applying firm pressure with a sterile gauze pad. Consider cleaning the wound if it appears badly contaminated, in which case use a sterile gauze pad and copious amounts of water, which doesn't need to be sterile – drinking water in a race bottle is fine for this purpose and it also allows for a jet of water to be squirted onto the skin to assist in wound irrigation. The main aim of in-race management is to cover the wound and prevent any further contamination by road debris – it is not possible to provide definitive wound cleaning and dressing.

Abrasions of the upper limbs are most easily managed by the use of appropriately-sized tubular bandage (usually netting type), cut to an appropriate length. This is quickly applied to the limb and a non-adherent dry dressing slid underneath to cover the wound, held in place by the elasticated bandaging. Wounds over the shoulder area, trochanteric area or knee are most easily treated in a different manner, by using a non-adherent dressing, held in place by a secondary adhesive tape, such as Hypafix. In order to promote skin adhesion, first quickly clean the skin of any road grime and sweat, then swab the surrounding skin with Friar's Balsam or plaster spray. Cut adhesive tape to size and then apply a non-adherent dressing to the tape before applying them to the wound site. This is not always easy, particularly if occurs while negotiating sections of downhill or corners!

Image: Use of tubular bandage for upper limb abrasions during the race.

If there is a delay in getting up or the rider is on his feet but not attempting to get back on his bike, assess for other injuries first at the roadside. Consider the possibility of a spinal injury, fracture or internal injury prior to a concussion screen, which, in this case, should also include a quick balance test. If the rider is deemed fit to carry on riding any skin wounds can subsequently be managed at the car.

If the rider remains on the ground, skin is not a priority. A significant injury is a real possibility and a more detailed medical evaluation is warranted, which is beyond the scope of this article.

DEFINITIVE MANAGEMENT OF SKIN WOUNDS (POST-RACE)

Once the day's racing has finished, definitive wound care can take place. It is best to advise the rider to take his usual post-race shower and at the same time, clean his wounds thoroughly and then present for definite wound management. Most professional riders are used to this procedure and will clean wounds in the shower on the team bus immediately after riding and, while this does potentially raise issues regarding the transmission of blood-borne infections, it is highly effective. If cleaning hasn't taken place by the time the rider is assessed, an alternative method is to place the rider on a large incontinence blanket and employ this to soak up the water used in the process. The key thing is to use copious amounts of water to clean the wound. In general, this procedure can be quite uncomfortable and is made much easier by anaesthetising the wound using local anaesthetic (Lidocaine) gel or spray.

Cleaning of contaminated wounds can be facilitated by use of a sterile plain surgical scrub brush. If this isn't available, a new bath sponge (taken directly out of its packaging) is an alternative. However, it's important not to traumatise the wound any more than is necessary for adequate cleaning.

Don't forget to check the rider's tetanus status, though this is usually up-to-date and not requiring further immunisation unless it's a tetanus-prone wound, in which case tetanus immunoglobulin may be advocated.

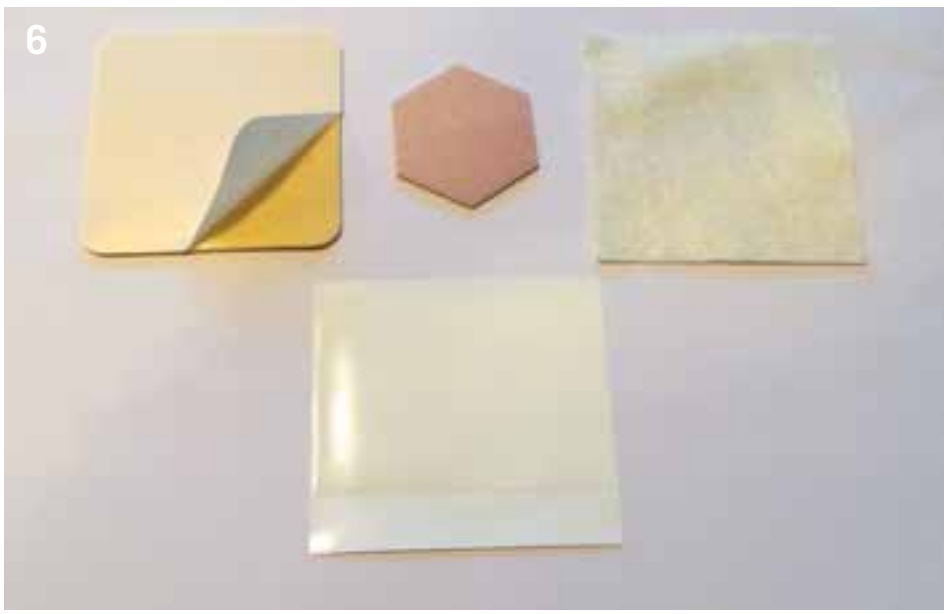
Medical advice should be sought for wounds that appear deep (affecting the subcutaneous tissues and/or underlying structures) and for lacerations, incised wounds and puncture wounds. Many lacerations can be closed with sutures or steristrips, depending on the skin site and the degree of tension placed on it. Others are best left to heal by secondary intention, where the wound is kept open, due to the likely difficulties posed by skin closure when there is significant tissue loss. Highly

Figure 3: The sponge side can be used for lightly contaminated wounds, while the brush side is reserved for those needing more rigorous cleaning.

Figure 4: Hydroploymer dressing with overlying secondary dressing.

Figure 5: Skin laceration healing by secondary intention.

Figure 6: From left to right – hydropolymer dressing with backing sheet partly removed, matrix dressing, alginate dressing, silicon dressing below.



contaminated wounds may need surgical assessment.

Once the wound has been thoroughly cleaned, it and the surrounding skin can be dried using a piece of sterile gauze. If the rider will be training or racing again the following day, it's essential to prepare the skin to promote dressing adhesion, otherwise it's likely that sweat, rain or the mechanical stress of joint movement will cause the dressing to loosen and eventually detach while riding. There are several different ways to do this, including the use of spray plaster onto the skin prior to dressing application. However, possibly the most effective is to use Friar's Balsam (tincture of Benzoin), which makes the skin very tacky and markedly improves the adherence of the secondary dressing. Alternatively, a length of tubular bandage can be used to cover the dressing and hold it in place.

Once the skin is prepped, the primary dressing (in contact with the wound) can be applied and then covered with a secondary dressing (adhesive dressing tape, 10 cm width) to hold it in place. The exact choice of primary dressing depends on the nature of the wound, but the most appropriate one is usually a hydropolymer (or foam) dressing, due to its capacity to handle the high exudate levels typically seen in cycling-related skin trauma. Hydropolymer dressings also help maintain a moist wound environment, which is thought to promote skin healing and reduce pain relative to dry dressings[2-4]. Other dressing types that are sometimes used are:

- Hydrocolloid/hydrogel – these contain gel-forming agents (a gelatin or sodium carboxymethylcellulose) held within an adhesive compound, often laminated to a waterproof outer layer. This results in a pre-formed dressing that is waterproof and can be used in its own right without the need for a secondary dressing to hold it in place. As with hydropolymer/foam products, they protect the wound from infection while maintaining a moist environment. Their main disadvantages are that they don't cope well with heavily exudating wounds, nor can they be easily adapted to cope with abrasions of different sizes and shapes. They may be used several days following the initial injury, at which time exudate levels are not so high, but only on suitably-sized skin lesions, as they are usually preformed.
- Hydropolymer – packing/alginates (derived from seaweed) – useful for deep cavity wounds, but only after specialist assessment. They would usually be placed underneath a standard hydropolymer dressing, which is then covered with a secondary dressing. They are used to absorb the exudate

that would otherwise form within the wound cavity.
- Silicon dressings – can be used to prevent wound adherence[5], especially when the wound is granulating and producing less exudate. It's important to minimise any dressing adhesion, since it disrupts the re-epitheliasation process and ultimately delays healing.

Matrix dressings – protease-modulating matrix (collagen/oxidised regenerated cellulose) may be beneficial in situations where healing is likely to take longer, such as deeper, cavity-type wounds. They are usually placed underneath the primary dressing. There is evidence to suggest they may provide a better environment for the formation of granulation tissue[6,7].

The primary dressing is cut to size and applied to the wound. The secondary dressing is also cut to size, with a generous amount of overlap, so that a reasonable amount remains in contact with the prepped skin.

For wounds over joints (e.g. the knee) it is usually best to apply the dressing when the joint is partially flexed, to reduce mechanical tension on the dressing while riding.

Hydropolymer/foam dressings can be left in place for up to 7 days. This is not always possible or practical, particularly if the dressing becomes soiled by subsequent days of racing. However, it's best to leave it in place for as long as possible, only removing it when it has reached its capacity to absorb exudate or when it's visibly dirty. The dressing can be protected when showering by the application of several wraps of Clingfilm, secured at its edges by adhesive tape.

If a dressing needs to be reapplied, use of another hydropolymer/foam dressing is advised. If the wound is no longer producing much exudate, a silicon dressing can be applied underneath to minimise the risk of wound adherence.

It is unusual for skin abrasions treated in the above manner to become infected. Signs of infection would include spreading redness of surrounding skin, increasing pain, offensive wound discharge, malaise or fever.

MINIMISE INFLAMMATION

Tissue inflammation results in pain and stiffness. It is quite common for a rider's performance to be impaired for several days following a crash resulting in injury. This may simply reflect pain inhibition, reflected in altered movement patterns and reduced force production. However, direct effects from a systemic inflammatory response remain a possibility, as C-reactive protein levels are often elevated in the days following injury. In order to reduce the degree of inflammation, the rider should be advised to apply an ice bag to the dressed wound (approximately 30 minutes every 2 hours) and a compressive bandage at all other times – a cohesive bandage is ideal for this purpose. This should be done for the remainder of the day and for the following day prior to riding, at the very least. It is also beneficial to elevate the injured body part, if feasible. Pneumatic devices combining compression and cooling are available and are popular with some teams for their injury management. It would also seem prudent to take a short course of non-steroidal anti-inflammatory drugs for several days, to further minimise the inflammatory response.

STRATEGIES TO PREVENT OR REDUCE THE SEVERITY OF SKIN INJURIES

Recently, there have been some new developments in materials used for cycling clothing. Foremost among these is the use of a special fabric made from Ultra High Molecular Weight Polyethylene fibres (UHMWPE). The fibres are 15 times stronger than steel and offer maximum strength with minimum weight. The fibres are woven into a fabric which is used to reinforce the areas on the body most commonly affected by abrasive skin injury elbows shoulders, upper back and lateral thigh/trochanteric region. While such technology can't prevent all skin injuries, it likely offers significant protection from shear forces and, to a lesser extent, compressive forces.

SUMMARY POINTS

- Skin injuries are very common in professional road cyclists. The ensuing pain and inflammation often leads to a reduction in performance over the following days.
- Definitive wound care can only take place after the end of the day's racing.
- The commonest types of injuries are abrasions and contusions.
- The initial stage of management is to thoroughly clean the wound with copious amounts of water and a sterile scrub brush/sponge. Use of local anaesthetic gels and sprays can facilitate this process.
- Foam/hydropolymer dressings, when used with a secondary dressing, provide the best combination of optimal healing environment and ability to cope with wounds of different shapes and sizes and at different locations on the body.
- Promote dressing adhesion by the application of Friar's Balsam to surrounding skin.
- Take steps to minimise the inflammatory response
- Most dressings can be left in place for several days, providing they are not contaminated or have exceeded their capacity to absorb exudate.
- New fabric technologies are now available that show promise in reducing the severity of skin trauma.

References
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