LAWN MOWER INJURIES TO THE FOOT

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Injury to the lower extremity resulting from lawn mower trauma has been treated at our Institution frequently throughout the summer months. Nationwide, over 100,000 injuries due to lawn mower accidents are reported annually and are steadily increasing. A large percentage of these injuries involve the adult and pediatric foot. According to statistics from the Consumer Product Safety Commission, children under the age of fourteen and adults over the age of forty-four are at the greatest risk of injury. With these statistics in mind, it is appropriate that podiatrists be familiar with the injury pattern, initial evaluation, and treatment of this traumatic injury.

A power lawn mower is capable of tremendous wounding potential. The tip of a rotary mower blade has been estimated to travel at 232 miles an hour. When this velocity is calculated in the equation for kinetic energy, $KE=mv^2$, it can be determined that a 26 inch rotary power mower rotating at 3,000 rpm generates the kinetic energy of approximately 2848 J, or 2100 ft/lbs. This force is three times the muzzle velocity of a 0.357 magnum, or equivalent to the energy of a 20 lb weight dropped from a height of 100 feet.

The mechanism of injury specific to lawn mower trauma differs between populations of adults and children studied in the reports reviewed for this paper. Adults are most likely injured by pulling a lawn mower over the top of their foot and leg, especially when working on inclines and embankments. Children are usually injured by either falling into the path of a mower while playing near the operating machinery, or by falling off the mower while riding as a passenger. While the mechanisms of injury in this particular subset are not usually crucial to wound management or treatment, it is of anecdotal interest to some. Love, et al. points out that only consumer education regarding the proper usage and safety of this machinery will lower the staggering incidence of injuries sustained by lawn mower accidents. Podiatrists should adequately inform patients as to the proper shoegear to be worn when operating a power lawn mower, as many of the injuries were probably made worse by lack of proper shoewear. Indirect injury secondary to debris being discharged from the mower blades is another mechanism of injury to the foot and leg, however, it is less common than direct contact with rotating blades.

INITIAL MANAGEMENT

The patient injured by a lawn mower will probably initially present to the local emergency room or office practice, especially if in close proximity to the site of injury. These trauma patients should be triaged as would any patient involved in a similar type of injury. General supportive care should be instituted, and attention given to the primary and secondary survey for associated injuries such as head, neck, lower back, wrist and clavicle injuries which may have occurred secondary to a fall during the injury. Most of these patients are quite apprehensive and fearful, thus reassurance will undoubtedly yield a clearer understanding and evaluation of the injury.

Once the initial assessment has been complete, and appropriate physical examination pursued, identification of the wound is initiated and many considerations must be properly addressed in sequence to assure satisfactory management.

The step-wise approach to the injury can be identified as:

1. Initial Management
2. Definitive Treatment (intraoperatively, or at "bedside")
3. Follow-up evaluation and treatment plans.

Most injuries sustained by a power mower involve a break in the skin, and may include damage to various tissues including tendon, muscle, nerve, vessel, and bone.

Any break in the integument must be considered a significant risk for potential infection, thus proper tetanus prophylaxis should be administered based upon the patient's immunization status. In the initial management, radiographs should be taken if any suspicion of osseous injury is present. Simple lacerations and minor avulsion type injuries are generally treated in the office or emergency room setting with adequate lavage under sterile conditions.

More extensive soft tissue injury will probably benefit from copious irrigation under pressure. This is often too painful to be performed outside of the operating room. An initial consideration is to aggressively cleanse the wound, as soon as possible without significant discomfort to the patient. Any injuries other than a simple uncomplicated soft tissue injury should be thoroughly evaluated under appropriate anesthesia as will be discussed in the lecture. In so far as the initial treatment protocol, active bleeding is usually resolved by the time the patient arrives, however, control of bleeding is obviously a priority. Ice can be used with direct pressure and elevation to control hemorrhage and reduce the amount of edema to the wound site.

Once an injury pattern has been identified which warrants surgical exploration and debridement, such as those injuries with associated soft tissue loss, (muscle, tendon, nerve or vessel pathology, and open fracture), several considerations are addressed. First, it is important to receive an adequate medico-legal consent to surgery, thus any narcotics or medications should be avoided until informed consent can be achieved if possible. We will generally start broad spectrum antibiotic coverage as soon as possible, especially with radiographic evidence of fracture or dislocation. Gustilo, et al. have identified parameters for management of open fractures graded on a classification system which should be well known to the treating physician. It has also been established that cultures taken superficially at the injury site are highly erroneous, therefore we generally refrain from obtaining a culture series until deeper cultures can be obtained in the surgical suite. These wounds are usually highly contaminated with debris, grass, dirt, grease, metal filings, and other foreign bodies from socks and shoegear. It is obvious then that proper antibiotic coverage must be instituted as soon as possible and directed at aerobic and anaerobic Gram positive and Gram negative organisms. We have also witnessed fungal growth in a patient with a lawn mower injury with significant dorsal soft tissue injury to the foot. This growth was presumably from retained grass particles which breed fungus in their natural environment.

The keystone of treatment of these injuries hinges upon the judicious, expedient use of irrigation and inspection of the entire wound. Many studies have shown that the most beneficial method of cleansing a contaminated wound is with highly pressurized, copious (10,000 cc or more) irrigation with adequate exposure to the involved site. Antibiotics in solution with the irrigation have proven no more successful in preventing infection in several controlled studies. Care should be taken to preserve viable tissue while flushing the wound. Gentle tissue handling is imperative. Forceps can be used simultaneously while irrigation is taking place, to "pick" small portions of debris from the wound site. It is at this time that adequate cultures are taken to ensure a reliable result.

Wounds properly managed and treated within 6-8 hours from the time of injury generally stand a better prognosis in terms of infection than wounds treated beyond 6-8 hours. This time frame may be used as a determining factor in the decision to close a wound primarily or to keep the wound open with packing for delayed primary closure. Regardless of the treatment plan, all non-viable tissue should be sharply dissected from the wound site to prevent poor healing and a potential infectious process from occurring.

Steps should then be undertaken to evaluate the extent of other possible associated injuries, including damage to tendon muscle, nerve, vessel and bone. Tendon and muscle should be salvaged if possible, being certain to primarily repair these structures with minimal suture bulk to

ensure adequate healing and function. Devitalized tendon or muscle fragments need to be removed entirely at the time of surgical debridement. Attention to blood supply is imperative at this time as well, and palpable pulses should be verified. As the majority of these injuries involve the digits, blood supply can be tenuous. A sterile Doppler transducer is helpful intraoperatively to assess the quality of blood flow to the digits, and with a more proximal injury, the remaining lower extremity. Dusky, cyanotic tissue is more difficult to evaluate since contusion may appear similar to devitalized tissue.

Nerve injury to small cutaneous branches may be present, resulting in small regions of denervation and subsequent numbness or paresthesia. Combined motor-sensory and purely motor branches can be injured with a more significant wound. Repair of digital nerves is technically very difficult and is usually not indicated as a primary therapy. Larger nerves of the foot, especially those which supply muscle function, should be identified and primary anastomosis may be attempted, provided that the instrumentation and technical skill are available.

Fracture management of lawn mower injuries represents a specific criteria which must be appreciated so that morbidity can be minimized. Stabilization of all fractures must be attempted diligently at the time of initial debridement for several reasons. It has been proven that rigid internal fixation allows the most desirable physiologic effect to occur, thus returning the fracture site to "normal" in a timely manner. The AO group lead this revolutionary movement and scientifically refined techniques to support these statements over the past 40 years. An important concept to understand is that stability of the fracture site has a profound effect on the surrounding soft tissue and will promote the body's ability to mount a defense against infection. Primary fixation of bone fragments should be a prime consideration, and various techniques have been described in detail in the literature. Failure to adequately reduce and fixate these injuries will undoubtedly result in a less than desirable result. A wound which is considered clean with an associated fracture can often be treated with primary closure and should be rigidly fixated if possible. Wounds which will remain open, packed and subsequently covered will benefit from primary fixation at a date concurrent with final closure.

Bony fragments which are too small to fixate internally should be removed from the wound as they will serve as a nidus for complication. With respect to cartilaginous defects, some debate remains. With an exposed joint surface, usually significantly contaminated, two choices are presented. Removal or salvageable repair of the remaining viable cartilage may be performed or resection of cartilaginous tissue can be executed. Some authors feel that by retaining articular surface, even if sub-optimal in a functional sense, will aid in prevention of bone (medullary) infection by providing a biologic cap. Others feel that when articular cartilage is damaged and contaminated, it needs to be resected to ensure less likelihood of an infectious process. No specific comparative studies are available to evaluate this description, and ultimately clinical judgement on an individual basis will prevail. However, converting the wound to "as tidy as possible" with adequate resection of devitalized bone and/or articular surface is clearly indicated.

When the appropriate criteria have been met for closure of a lawn mower type wound, inert suture materials such as prolene or nylon are utilized. Minimal tension should be placed on the skin and subcutaneous tissues to promote adequate healing. Therefore, proper closure techniques are invaluable. If a wound is to be left open, it should be dry, clean, and have adequate packing of dead spaces around vital tissues. A dry, soft compressive dressing should then be applied followed by immobilization casting or splinting as indicated. Dressing changes should be performed with adequate sterility, and anesthesia. Cultures should also be taken to monitor the status of the wound. Repeat debridements are usually necessary prior to delayed closure. Specific techniques including split thickness skin grafts, biologic dressings, and delayed closure considerations also need to be appreciated in this injury pattern.

In conclusion, this brief narrative is a general outline to some of the many considerations when confronted with this traumatic injury. The podiatrist will encounter this injury at some time in his or her professional practice, and should be well-versed with regard to all of its considerations.

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