

Injuries to Extremities

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It would be well in discussing injuries to the extremities to have as a basis some knowledge of the anatomy of the structures involved, as well as a fair knowledge of the terminology used in describing these structures. The framework is the skeleton, which consists of bones, ligaments, and joints. The upper extremity consists of the arm from shoulder to elbow, the forearm from elbow to wrist, and the hand. The lower extremity consists of the thigh from hip to knee, the leg from knee to ankle, and the foot. The bones involved in these areas are the humerus in the arm, radius and ulna in the forearm, and multiple smaller bones in the hand and wrist. The femur is the bone in the thigh; the tibia and fibula in the leg; and again multiple smaller bones are present in the foot. The bones are classed as long bones or flat bones. Long bones, of course, make up the length of the extremity and consist of a hard cortical layer surrounding a medullary canal. The proximal and distal ends of the long bones usually contain spongy bone known as cancellous bone. The flat bones are the other type of bone, and these bones are characterized by a flat or irregular shape; the bones of the ribs, the skull and the pelvis are included in this classification. Ligaments are fibrous structures extending from one bone to another helping to form joint capsules, and these maintain stability of the joints. They are, therefore, quite complex in their directions and relationships in order to maintain stability of some of the joints in any position. Joints are of several types, the main types being the hinge joint, ball and socket joint, and sliding joints. Examples of these are the knee, a hinge joint; the hip, a ball and socket joint; and the wrist joints could be considered as sliding joints. Joints generally are lined with synovial membrane which is a smooth glistening membrane, usually quite thin, which is responsible for secreting the joint fluid. Hyalin cartilage covers the ends of the bones within the joints and is smooth and thus provides a smooth, gliding surface that is lubricated by the joint fluid, which, in turn, is secreted by the synovial membrane. The joint fluid also furnishes nutrition for the cartilage. In some joints there are special cartilages which tend to deepen and help stabilize the joint. This is particularly true in the knee, these cartilages being known as the semi-lunar cartilages. All of the tissues involved are, of course, living tissues and the bone is subject to constant

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change from muscle pull. Muscles consist of the muscle belly and the tendon. The action of a muscle is to pull. There is never any pushing involved with a muscle. The muscle is activated by a nerve impulse and the muscle is maintained in a state of constant tone. This is essentially a taking up of the slack of the muscles so that when the muscles start to contract, there is not a jerk.

Nerves to the extremities, consist of motor and sensory fibers. The motor fibers receive impulses from the central nervous system; each main trunk supplies several muscles usually with the same general function. That is, a nerve will supply the muscles which caused the wrist to flex and the fingers to flex while a different nerve will usually supply the muscles which cause the wrist to extend and the fingers to extend. The sensory nerves supply the skin and the deeper tissues with sensation. There is frequently an over-lap of several motor and sensory areas and one nerve root can be completely removed without appreciable loss of sensation or muscle power in some areas.

Blood supply to the extremities consists of arteries, veins and capillaries. The function of these structures is to supply nourishment and oxygen to the muscles and tissues in the extremity and to remove waste products from them. Usually there is one main artery with several accessory arteries available to establish what is known as collateral circulation. In case the main artery is damaged, these collateral arteries will dilate and take over the function formerly performed by the main artery and supply enough blood to the extremity so that gangrene does not set in. The remaining tissue is the skin which is a cover for the entire extremity and is so constructed that there is relaxation of the skin over the joints; in this way, flexion of the joints is permitted due to the elasticity of the skin in these regions.

EFFECTS OF INJURIES — BONES

The commonest type of injury to the bone is a fracture, and this may be of several types. These may be complete, which means that the structure of the bone has been completely disrupted, or incomplete, which means that some of the bony cortex is still intact. They may be comminuted, which means that in addition to the two main pieces, there are one or more smaller pieces of bone at the fracture site. The "greenstick fracture" is an incomplete fracture in which the fracture line resembles a green twig that has been bent but not completely separated. In addition to this, there is a type of fracture known as a compression fracture which is usually applied to the flat bones and is, as the name states, simply a compression of the spongy bone so that the height of the involved bone is not as great as normal. Another classification of fractures is simple and compound. The simple fracture does

not communicate with the outside, the skin being intact at the fracture site. The compound fracture has an opening in the skin that communicates with the outside. Fractures may also extend into the joint and the growth center or the epiphyseal line may be fractured and cause what is called an epiphyseal separation. The epiphyseal lines occur at the ends of the long bones in growing children. Usually in the normal adult, epiphyseal lines have completely solidified and are not visible on x-ray examination.

Treatment of a fracture varies with the age of a patient, the general condition of the patient, and the type of fracture. Fractures in the younger age groups of children heal much more rapidly than those in adults, and the older adult age groups have a greater tendency to have the joints become stiff following immobilization. The usual method of treating fractures is by closed reduction and immobilization. Immobilization is customarily done by means of a plaster cast. Some fractures, however, are not amenable to closed treatment and immobilization, and it is necessary in some severely comminuted fractures to apply traction either by means of a metal pin passed through the bone or adhesive tape applied to the skin for a period of several weeks in order to give the fracture satisfactory alignment and then a cast can be applied. Some fractures cannot be reduced by means of closed manipulations or traction and, in that case, open operation is resorted to with reduction of the fracture and fixation by means of screws or plates or intramedullary pins, the intramedullary pin passing down through the central canal of the long bones and immobilizing the fracture in that manner. A few fractures involving some of the growth lines or some of the joints nearly always require open operation in order to give satisfactory function at a future date.

Complications involved in the treatment of fractures are many, and delayed union, non-union or weak union may occur. The causes of delayed and non-union are multiple. Some of them are the site of the fracture at the point where the nutritive artery enters the bone causing a loss of blood supply and consequent loss of satisfactory new bone elements being transported to the fracture site. Excessive motion at the fracture site is sometimes considered to be a cause of delayed union. For example, a cast may be applied, and following the application of the cast, swelling in the extremity would subside leaving the cast quite loose which would permit undue motion at the fracture site. The interposition of soft tissue between the ends of the fracture, as a piece of muscle tissue which was torn at the time of fracture and is not visible on x-ray, being between the ends of the bone, would prevent satisfactory union from occurring. Another complication is excessive callous formation. The callous is the name applied to the healing tissue around

the site of the fracture and excessive callous can cause pressure upon a nerve or blood vessel and, if close to the joint, can cause an interference with joint motion. Malposition is another complication in which there may be angulation at the fracture site, or shortening due to overriding or to angulation. Stiffness of the joints adjacent to the fracture frequently occurs, because of the time necessary for the fracture to have sufficient healing and the necessary immobilization of the joints above and below the fracture line in order to satisfactorily hold the fracture in position. Muscle atrophy occurs and this, of course, is the result again of prolonged immobilization. Other complications are infections, myositis ossificans, which is a calcification in the muscle tissue, and laceration of the blood vessel or nerve. Laceration of the blood vessel may result in amputation and laceration of the nerve may result in a paralysis of the extremity either entire or in part, depending on how much of the nerve is damaged and the site of the damage.

The average healing time of fractures is increased by nearly all of the above mentioned complications. The average healing time of fractures varies from approximately 8 weeks to as much as 52 weeks. This depends on the age of the patient and the bone involved as well as on the type of fracture; the longer times being in older people with fractures of weight bearing bones, usually the neck of the femur, and the shorter times being in younger adults in the bones of the upper extremity.

LIGAMENTS AND JOINTS

Sprains are one of the commonest injuries involving the skeletal system. These consist of partial or complete tears of the ligaments around a joint and these may be extremely disabling, the patient being incapacitated for many weeks. There is also an entity known as a sprain fracture in which a small flake of bone is pulled off by the ligament at its attachment to the bone, showing on x-ray, a very small calcified chip in the region of the injury.

Dislocations usually involve complete tear of the ligaments around the joint which make up the capsule of the joint, and the two bones making up the joint have lost their normal relationship. Cartilage tears are familiar injuries occurring frequently in young athletes, particularly in football players. This is a condition where the semi-lunar cartilages, the accessory cartilage mentioned previously, sustain a tear or displacement within the knee joint and thus cause a locking or catching of the knee. Loose bodies also occur within the knee joint. The symptoms of these may follow injuries or there may be no injury involved in the history.

The healing time for the above ligament and joint disorders varies, the sprain taking anywhere from two to three weeks for the

customary sprain, although a severe sprain may take as long as three months. It is, at times, necessary to surgically repair the ruptured ligaments around a joint. Usually this is not necessary unless the joint is completely dislocated. Dislocations that may be reduced by simple manipulation under anesthesia will take at least two weeks to heal, usually longer to establish freedom of motion following removal of the restrictive bandage. Cartilage tears in the knee may not heal without surgery and may be recurrent, requiring surgical removal at a later date.

EFFECTS OF INJURIES TO MUSCLES AND TENDONS

Injury in this area may result in complete rupture of the muscle due to sudden strain. There may be hemorrhage into the muscle tissue which may eventually cause calcification and a large mass may be felt within the muscle. Lacerations of the muscle are by direct injury. In order to secure satisfactory function after the laceration or severance of a tendon, surgical repair of the tendon must be performed. The earlier this is performed, the better, because of the better healing in the recently severed tendon as well as the fact that the tendon retracts as the muscle contracts and makes it much more difficult to approximate the ends of the severed tendon.

The healing time for a severed tendon is three weeks minimum and may extend up to five weeks. Here again, age is a slight factor, the older person having a longer healing time. In the case of a muscle belly that is ruptured, the surgical repair is necessary, but that portion of the muscle that is separated from the entrance of the nerve to the muscle will probably not recover muscular function but will become scarred and fibrosed and there will be a permanent partial loss of function of that muscle. Dupuytren's contracture is a condition that is generally considered not to be the result of injury to the part but is a change in the fibrous tissue of the palmar fascia in the hand that results in a drawing down into a flexed position of the fingers, usually the little and ring finger are the fingers involved but any of the fingers may be involved.

EFFECTS OF INJURIES ON BLOOD VESSELS

Laceration in the case of small vessels is treated by simply clamping the vessel and tying it to prevent further bleeding. In the case of an extremely large vessel, if the patient is seen soon after the injury, suture of the large vessel may be attempted with very gratifying results. Contusion of the muscle wall may result in thrombosis, which is a blood clot within the lumen of the vessel. The danger of this type of injury is that small pieces of the thrombus may break off and find their way through the heart to the lung

and may cause the patient's death. Ecchymosis is simply a black and blue mark as a result of hemorrhage beneath the skin.

Volkman's contracture is a condition resulting from disturbance of circulation to the flexor muscles of the forearm. This frequently follows injuries around the elbow with resultant severe swelling in this area and interference with blood supply. The muscles of the forearm secondarily develop hemorrhage into the muscle belly followed by fibrous scar formation and contracture of the scar tissue developing a claw-like hand which is practically functionless. Surgical procedures may improve the function of a Volkman's contracture slightly, but there is usually no completely satisfactory recovery once this condition has developed.

EFFECTS OF INJURIES ON NERVES

A nerve may be divided by direct laceration or tearing, may be contused, stretched or compressed. It may be complete or incomplete. Its onset may be early or late. In the case of the early onset, the history is usually obtained of a laceration or a severe blow or stretching or compression which is responsible for the symptoms. In the case of symptoms appearing late following an injury, this may be due to scar around the nerve, compression of the nerve by callous formation at the fracture site, pressure from a splint or cast or a bone fragment at the site of the fracture. Pressure from a crutch in the arm pit can also cause a complete paralysis of the hand. The complete division of the nerve results in a sudden and complete paralysis of both the motor and sensory function of that nerve and there is no pain present at the site of the sensory area supplied by that nerve.

The treatment is to relieve the condition. In the case of a severed nerve, the nerve can be sutured, and if it grows back, it is considered that the nerve grows at the approximate rate of 1" per month so that if a nerve is cut in the upper arm, it can be as long as 18 months before the nerve function returns to the muscles of the forearm. If the condition is one of late onset, apparently due to excessive callous formation or scar tissue around the nerve, surgical relief of this condition usually gives satisfactory results.

Sudeck's atrophy is a condition involving an extremity, often following a relatively minor injury, in which the hand or foot is extremely cold, painful, and swollen, and glossy in appearance. X-ray shows a patchy osteo-porosis, which is a condition associated with loss of minerals from the bone and usually is quite painful. This condition seriously prolongs the patient's disability although eventual full recovery occurs. This is generally considered to be the result of some change in the sympathetic nerve supply to the extremity from the apparently minor injury.