H38 Burning Extremities: Patterns of Arms, Legs, and Preexisting Trauma

O' Brian C. Smith, MD, Regional Forensic Center of the University of Tennessee, 1060 Madison Ave, Memphis, TN; and Elayne J. Pope, MA, University of Arkansas, 330 Old Main, Fayetteville, AR*

After viewing this presentation, the attendee will be able to: 1) recognize soft tissue changes of fleshed arms and legs, 2) understand of the dynamics of pugilistic posture, 3) observe the progression of burning evidenced by color and heat-induced fractures in bone, and 4) identify effects of preexisting trauma.

Analysis of burned victims begins long after dramatic events of burning occur to soft and hard tissues of the body. What is seen at the medical examiner's office is an arrested phase of extremely dynamic processes involving heat, combustion, organic degradation and alteration of the body position. Little attention has been given to understanding processes creating burned trauma simply because it has not been directly observed. There are many clinically based theories about what happens to a burning body, and these misconceptions even make their way into well accepted forensic texts until disproved experimentally

A sample of 16 fully fleshed unembalmed human arms, legs, and torsos from anatomical gift donations were used in order to document changes during burning events. Several limbs were completely disarticulated at the humeral and femoral mid shafts while others remained anatomically intact. Conditions and activities of each experiment were documented with written notes, digital pyrometer, 35mm slide film, and digital camera based on timed intervals. These methods identified predictable sequences of burning for unobstructed extremities of the body, delineated phases of the pugilistic posture and established burning patterns for soft and skeletal tissue through all stages of burning events illustrated below.

Once placed in the context of heat, skin becomes waxy, glossy, tightens, blackens from charring, and begins to split into transverse, longitudinal, and stellate patterns. These windows expose underlying musculature, tendons, and finally bone. Shortening of tissues causes curling and abduction of fingers and toes, sequentially followed by gradual flexion of the wrist and ankles, contraction of elbow and knee, and finally localized tightening of the hip and shoulder. Bones become predictably exposed on the distal phalanxes, metacarpals, ulna, and radius as skin splits and burns away. Muscles and tendons from the proximal wrist quickly burn, disarticulate, mushroom at the margin, and recede distally to join the collective mass of tissue around the anterior surface of the elbow, while posterior effects expose the ulna, radius, and humerus. This is followed by gradual antero-medial rotation of the shoulder positioning the arm over the chest. Toes mimic fingers, splay and curl around the ball of the foot, while the ankle rotates medially, followed by a slow contraction of the knee and finally hip into the pugilistic posture. Superficial soft tissue protection around the knee and shin quickly expose bone followed by gradual destruction of musculature along the shaft. Unconfined arms and legs react in a sequential fashion as heat increases the severity of damage in direct proportion to time and temperature.

Prior to burning, several of the long bones were subjects of surgical practices and exhibited a variety of artifacts such as screws, plates, steel rod implants, and surgical cuts to skin and bone. All were easily identifiable during the post burn analysis, but observation revealed their influence in soft tissue and bone during the burning process. Superficial incisions in the skin were instantly affected by heat, tightening skin, with additional tensile forces from contracting muscle. Cut or traumatized soft tissues bulge and mushroom initially through surgical openings, resulting in premature exposure of underlying bone as soft tissue contracts and burns away. In a forensic setting, these results may indicate perimortem trauma to soft tissue or bone.

After bone is exposed, direct application of heat destroys the organic composition, expressed through progressive color changes of buff (exposure margin of initial organic degradation), black (charred bone undergoing organic destruction), and white/gray (calcined inorganic structure). Interpretation of these colors accurately reconstructs location, direction and extent of burning activity. Absence of color in advanced stages of incineration indicates complete loss of organic material, leaving stress signatures of longitudinal, transverse, curved transverse, and crazing heat-induced fractures in calcined bone. A variety of these may be present and by aiding interpretation of how and where soft tissue reduction occurred, help reconstruct events. One unique heat fracture identifies tissue regression as muscle tightens and pulls away, leaving a curving transverse defect as a watermark of gradual burning. Correlation of soft tissue burning and post fire fracture analysis further illustrates how tissue regression fractures are indicative of orientation and progression of burning in fleshed remains. The same is true for articular surfaces protected by soft tissue and cartilage, where stacked arcs of curved transverse fractures permanently illustrate the progression in burning and soft tissue reduction.

Fractured, cut, or compromised bone exhibits interesting patterns during the burning phases of soft and hard tissues. For example, one of the fleshed lower legs had been transected across the proximal mid shaft of the tibia and fibula with minimal surgical invasion in the overlying soft tissue on the posterior surface. Early in the firing, the powerful contraction of the leg muscles shortened and pulled the bone wide apart like a hinge; splitting skin, exposing muscle, and finally bone along the anterior surface, long before the knee drew up into the pugilistic posture. Post burn analysis of this specimen demonstrated the prolonged thermal effects due to the early exposure and even the calcined bone retained tool marks at sectioned surfaces and drill holes. These characteristics should be considered indicative of preexisting trauma since the mid shaft is an abnormal site for early burning to occur in most long bones. All features described above will be illustrated during this

 ** Presenting Author*

presentation.

Skeletal Trauma, Burned Bone, Fire Investigation

 ** Presenting Author*