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Foot And Ankle Forensic Implications

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ABSTRACT

Clinicians may not see much of a connection between forensic medicine and the foot and ankle complex. The foot and ankle, however, can offer details assisting in identification and incident analysis if decomposed, charred, fragmented, or skeletonized human remains are discovered. Analysis of the information gathered from incidents might also result in safety changes. In order to verify a person's identity positively utilising radiographic comparisons and to examine aviation incidents, this article discusses common forensic medicine principles that are applied to the foot and ankle. Clinicians' awareness of the potential forensic importance of the foot and ankle will be improved by knowledge of these cases. (2003, The Journal of Foot & Ankle Surgery, 42(4), 221-225)

Keywords: forensic science, forensic pathology, human identification, ankle, foot

INTRODUCTION

It is frequently necessary to use a multidisciplinary approach when examining human remains in suspicious, unanticipated, violent, and unattended deaths. These professionals include forensic pathologists, radiologists, anthropologists, and odontologists (1). Medical and forensic literature has discussed the use of the foot and ankle complex in forensic investigations (2–14). In the notorious Ruxton case of 1935, dismembered feet were matched to footwear in an attempt to boost the likelihood that two mutilated murderers could be identified (14,15). Anthropometric approaches from extensive skeleton collections have been used to quantitatively assess the use of foot and ankle bones in forensic medicine (2,3,6,9). In some circumstances, radiographs taken before and after surgery on the foot and ankle can help establish a presumptive or definitive diagnosis . Additionally, even if the sole antemortem radiographs are those taken prior to surgery, surgical intervention with subsequent soft tissue and bone healing does not prevent positive identification.

The examination of aviation events and establishing positive identification through radiographic comparisons are the two forensic investigations involving the foot and ankle that are covered in this article. Clinicians' awareness of the potential forensic importance of the foot and ankle will be improved by knowledge of these cases.

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Foot and Ankle Identification of Human Remains

Identification of a decedent could be a component of a forensic inquiry. When human remains are recovered that have been decayed, fractured, or otherwise altered, identification can be exceedingly challenging. The skull, teeth, chest, lumbar spine, and pelvis are the anatomical structures that are most helpful for identifying an individual. The foot and ankle can be helpful when these components aren't available because they were damaged, aren't conclusive, or aren't complete. The feet typically avoid the trauma that is sustained by the rest of the body because of their protective nature in footwear. Wearing shoes not only delays the disarticulation process but also helps to keep the foot and ankle bones in place (17). In watery conditions, high-top boots may delay the disarticulation sequence between the leg and the foot (17). Additionally, the metatarsals' short and strong architecture provides an extra layer of protection (9).

Remains of Animals or Humans?

Bear paws are an exception, despite the fact that morphologic differences between human and animal remains shouldn't fool a skilled forensic specialist. The difference between a human foot and a bear's hind paw is particularly subtle at first appearance. When the fur, claws, and hide are stripped away, the paws frequently resemble human hands and feet (18,19). When paired with an examination of the osseous traits, the circumstances surrounding the recovery, such as the disposal site, method of skinning, and time of year discovered, can assist determine whether the remains are in fact human (19).

It is possible to identify significant skeletal variations between the human foot and the hind bear paw using radiographs or defleshing methods. The paw calcanei taper from the proximal to proximal. The talus of the bear paw features a noticeably deep trochlea. The phalanges and metatarsals are also more sculpted, devoid of distal tufts, and rich in metatarsal sesamoid tissue. The robusticity of the metatarsals is likewise inverted. Humans have the largest and longest first metatarsal, whereas the fourth metatarsal on a bear's hind paw is the strongest.

Identifying Patients Using Radiographic Comparisons

In order to positively identify human remains, postmortem radiographs and antemortem films might be compared (10-17). Positive identification can be aided by radiographic examination of foreign bodies, congenital defects, disease processes, and previous surgical intervention (17). Unique properties inside and between the soft tissues and bones may be present even if the area is physically complete. Exostoses and trabecular bone patterns are examples of these characteristics. Nevertheless, radiographic comparisons call for the acquisition of the victim's medical records following a presumed identification. Usually, this is done by using the accessible personal effects or the scene of the death.

Possibility of Identification

A precise identification cannot be achieved when all that is available are postmortem radiographs. However, assuming identity based on comparisons between postmortem radiographs and previous medical records can be helpful. In a wooded region, a burning automobile with charred and calcined human remains was found. Right foot proximal bones and distal right tibia were fused to the victim's socks. Unfortunately, the left foot's bones were too broken up to be of much value in

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a forensic investigation. The owner of the car had a right ankle injury 15 years prior to his departure, according to his medical history (14). Postmortem radiographs of the right ankle revealed a distal fibulectomy and a medically induced tibiotalar fusion. On the basis of the patient's prior medical history and postmortem radiographs, a preliminary identification was achieved.

Surgical Intervention and Positive Identification

A single burned human foot was found in a farmyard (7). A middle-aged woman had been reported missing by her husband before the foot was found. An antemortem medical treatment was consistent with postmortem radiographs of the left foot, which revealed surgically fused proximal and distal interphalangeal joints. A surgical procedure was performed on the missing person's left foot, including an arthrodesis of the interphalangeal joints. To compare, antemortem radiographs were acquired. Along with the phalanges that had undergone surgery, the trabecular patterns matched perfectly and provided positive identification (7).

Surgical plates, screws, and pins are also very helpful for establishing identification (18,19). The use of surgically implanted devices in the foot and ankle may provide important identifying information if antemortem data is available. By comparing the device with the available medical records, radiographic comparisons of a first metatarsophalangeal joint implant, for instance, were able to positively identify a deceased person (Boyd G. Stephens, MD, personal communication, February 1998).

Abnormal growth and successful identification

Positive identification from decomposed human remains can also be established by abnormal foot and ankle development combined with surgical intervention. For instance, a 79-inch male who was noticeably decayed was discovered in a cramped, locked apartment (20). The flat was undisturbed, and there were no signs of forced entry, thus the death appeared to be a natural one at first glance. The deceased was photographed by police wearing orthopaedic shoes. Bilateral talipes equinovarus was discovered during the decedent's physical examination in the coroner's office.

Several methods were tried, but none of them were successful in establishing definitive identification. Only 3 fingerprints could be collected due to the degraded state of the bones. Although the probable dead had been detained for vagrancy, neither the municipal nor the national databases included any fingerprints.

The decedent's family did not report him missing, and no medical or dental records were accessible. Investigators contacted local providers of specialised orthopaedic footwear because the decedent's foot abnormalities were a distinguishing anatomical trait. A merchant had made shoes for a customer who matched the decedent's physical characteristics. Noteworthy is the description of a clinical diagnosis of bilateral talipes equinovarus.

The client's name, social security number, and date of birth were also provided, along with the most recent radiographs of each foot, to the coroner's office. After defleshing, radiographic examinations of the feet revealed bilateral talipes equinovarus abnormalities (19). Skeletal characteristics visible in the radiographs were used to confirm the identity. With antemortem surgical intervention, including cal- caneal osteotomies to repair the bone deformities of talipes equinovarus, the skeletal characteristics of both feet were consistent.

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Mass Fatality Incidents

The Valujet Flight 592 disaster and the Oklahoma City bombing are two mass death occurrences where foot and ankle radiographs were used for identification (15,16). The infamous Noronic accident serves as a historical illustration of the use of foot and ankle radiographic comparisons for identification in many fatalities (31,32). 119 of the 527 passengers on the Toronto Great Lakes ship Noronic perished in a fire that broke out on September 17, 1949. (11,12). Antemortem radiographs of the passengers were obtained due to the severe distortion and mutilation of the human remains.

One tragedy victim's body and extremities were virtually obliterated . The left foot was largely unharmed but had a planar flexion at the ankle joint and an arched midtarsal joint, both of which were most likely the result of perimortem alterations. For postmortem comparison, a passenger's left foot's antemortem radiograph was collected. There were numerous places of agreement without any discrepancy offered by posterior bone spurs and articulations (tarsal and intertarsal). Additionally, the antemortem radiographs and the medial sesamoid bone beneath the first metatarsal matched exactly (21). As a result, radiographic comparison allowed for the establishment of positive identification.

Foot and Ankle Analysis of Aviation Incidents

The documentation of foot and ankle injuries sustained after an aviation disaster can give safety improvements and significant forensic data (13–19). These facts can help with aircraft design and stop similar accidents from happening again. An investigation into a DC-9 aeroplane incident in Toronto serves as one illustration . The aircraft reached the end of the runway and crashed 50 feet into a ravine in an unsuccessful attempt to abort takeoff. The surviving passengers had fractures of the tibia, fibula, talus, calcaneus, and cuboid as well as other foot and ankle injuries (16).Improvements in aircraft design were made as a result of clinical radiological analysis of these injuries and their implications. For instance, the seats of the wrecked plane were fixed to longitudinal floor rails. Each seat had a transverse bar underneath it that was fastened to the floor rail. Further inspection showed that the transverse bars remained firmly fastened to the floor rails despite the fact that many seats had separated from the mounting rails. The feet of the passengers were caught underneath these bars when they were propelled forward on impact, which resulted in several foot and ankle injuries. These injuries might have been prevented if the bars had been fastened to the seats rather than the floor (16). Aircraft seat design recommendations were made, and adjustments to seat construction got under way.

Flail-Type Injury Patterns

As a result of the 1985 bombing of Air India Flight 182, which caused severe dislocations and flail-type injuries to the foot and ankle, Brogdon reviewed the radiographs of 131 victims (B. G. Brogdon, MD, personal communication, March 2001). Comminuted fractures at the distal extremities of the tibia and fibula are comparable to a flail injury, where a significant amount of force applied dorsally from the plantar position causes the foot and ankle to flail outward due to the resulting dorsiflexory pressures. Occasionally, despite repeated metatarsal and midtarsal fractures, the calcaneus remains undamaged (14,15). This fracture pattern is consistent with high-intensity plantar stresses being imparted to the midfoot before the leg and foot start flailing during contact,

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as seen in aviation incidents. These fractures may have occurred as a result of the body colliding with the seatback in front and being thrown upward and through the seat belt on an aeroplane. Additionally, serious casualties could result from a collision with an aeroplane part.

Who was the aircraft's pilot?

Forensic investigators must pay particular attention to the injury patterns of fatally hurt aircraft pilots in order to determine who was in charge of the aircraft at the time the fatal incident occurred (15). This question is particularly important when there are several passengers on board and they are all removed from the cabin during impact. Due to the mismatched body parts in these situations, it is challenging to distinguish between the bodies and replicate the episodes. In cases involving training missions, the question of who was in charge of the aircraft at the moment of the crash can be extremely important.

During a crash, if the pilot's feet were on the cockpit structures, there may be noticeable soft tissue and skeletal damage. Significant dorsiflexory strains are placed on the calcaneus as a result of the angulated design of the rudder pedals. impact.[20] Tarsal bone comminuted fractures are also experienced. The pilot's foot resting on the cockpit controls can result in soft tissue tears, hematomas with stripes, and flail-type injuries.

The most frequent talus fracture site in aviation accidents is in the neck (18). "Aviator's astragulus" is the name Anderson gave to this fracture pattern. When pilots are fully plantarflexed during an aeroplane crash, their feet's soles resting on the rudder bar, causing a fracture (14,15). Additionally, motorcycle accidents and falls from great heights have both been linked to aviator's astragulus (19).

The astragulus of the aviator can be used in conjunction with other forensic evidence to identify one person as the pilot more strongly than another. Sometimes, forensic professionals are asked to make a distinction between two individuals-one alive and the other dead—who both had blood alcohol levels that were above the legal limit for driving. [21-22]The living individual may be exonerated if it is possible to identify and forensically assess the aviator's astragulus.

CONCLUSION

The lower extremity may have a lot of forensic importance. For medical professionals, the relationship between damage pattern and clinical history is intriguing and merits more research to stop insurance fraud and understand the mechanism of trauma. The foot and ankle have significant forensic implications that will almost surely help with human identification, incident reconstruction, and safety improvements.

Acknowledgment

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