Chapter 4
Vertebral Morphometry in Forensics

Giuseppe Guglielmi
University of Foggia, Italy & Scientific Institute Hospital, Italy

Stefano D'Errico
University of Foggia, Italy

Cristoforo Pomara
University of Foggia, Italy

Vittorio Fineschi
University of Foggia, Italy

ABSTRACT

Imaging techniques (plain radiographs, multi slice computed tomography (MSCT), and magnetic resonance (MRI)) are being increasingly implemented in forensic pathology. These methods may serve as an adjuvant to classic forensic medical diagnosis and as support to forensic autopsies. It is well noted that various post-processing techniques can provide strong forensic evidence for use in legal proceedings. This chapter reviews vertebral morphometry application in forensic, expressly used in the case of semi-automatic digital recognition of vertebral heights in fractures, by means of vertebral shape analysis which relies on six or more points positioned over the margins of each vertebrae T5 to L4 used to calculate anterior, medial, and posterior heights and statistical shape models. This approach is quantitative, more reproducible, and more feasible for large-scale data analysis, as in drug trials, where assessment may be performed by a variety of clinicians with different levels of experience. As a result, a number of morphometric methodologies for characterisation of osteoporosis have been developed. Current morphometric methodologies have the drawback of relying upon manual annotations. The manual placement of morphometric points on the vertebrae is time consuming, requiring more than 10 min per radiograph and can be quite subjective. Several semi-automated software have been produced to overcome this problem, but they are mainly applicable to dual X-ray absorptiometry (DXA) scans. Furthermore, this chapter aims to verify by an experimental model if the technique could contribute, in present or in future, to investigate the modality of traumatic vertebral injuries which may explain the manner of death.

DOI: 10.4018/978-1-60960-483-7.ch004

FORENSIC APPLICATION OF RADIOLOGY

The improvement and evolution of radiological sciences toward a broader definition of the technical parameters meant to study the details of the human body and its components, both in an anatomical–structural and physiological–physiopathological sense, brought radiology and forensic medicine closer together. In fact, the study and interpretation of anatomical reports is the principal aim in both.

The methodological and operational approach between the two disciplines has roots dating to the first uses of traditional radiology for the study and report of foreign bodies retained in the corpse. Back in the 1970s in the United States, the American College of Pathologists signaled the importance of the correct use of a preventive radiographic inquiry in some deaths and, concurrent with its introduction, studied the use of ecoguided techniques of anatomical sampling. In 1982 in Italy, Pierucci edited a handbook for the correct use of radiography in the study of deaths by firearms, which immediately gained credibility for the discipline. The prior identification of bullets held undamaged or in fragments was considered essential for a correct cross-sectional experiment. It was as essential as their consequential removal and report. In the 20 years and more since and especially in the last few years, the increasing availability—practically and economically—of eidologic exams has allowed the two disciplines to work in close collaboration, refining methods and gaining experience.

Postmortem radiography is an important part of a complete forensic examination. A radiology table or a portable x-ray machine should be always present in a modern autopsy service. The three-dimensional object is projected on a two dimensional plane and information about the position of an object that lies in the direction of the ray is lost unless a second projection, orthogonal to the first, is also obtained. Wide availability makes radiography a useful application in forensic pathology. A complete Rx examination (total body) is extremely useful for locating bullets or other metallic foreign objects, and its use is well known in forensic pathology for firearms-related fatalities or in cases of unknown or burned cadavers.

A routine anteroposterior and laterolateral radiograph is an acceptable approach to fetus autopsies also for the diagnosis of skeletal abnormalities. Lytic, inflammatory, degenerative, and developmental lesions of bones and joints are particularly best revealed by radiographs.

Computed tomography (CT) uses x-rays to obtain transverse (axial) images of body sections. The tube rotates around the longitudinal (z) axis of the cadaver lying on the CT table, transmitting radiation through the body from many angles. X-rays are absorbed according to the different radiographic density of tissues; those not absorbed reach the detector system beyond the cadaver, contributing to the absorption profile of one specific tube angle. The many profiles measured during one rotation are used by the computer to calculate a density map of the body section with discrete absolute density values of all image elements (voxels). Modern multidetector row scanners (multislice scanner, [MSCT]) are able to acquire information for several slices during one rotation, which can be used to improve z-axis, volume coverage, or speed.

Images of the slice thickness requested will then be calculated from those data at any selected z-axis position within the volume, according to the reconstruction interval chosen. This gives a resolution that is equivalent to isotropic imaging; voxels have similar dimensions in all three axes, for example, 1 mm. Isotropic voxels are ideal for image post-processing using multiplanar reformation to obtain images in sagittal, frontal, or oblique planes, or even three-dimensional presentation methods.

CT application on the postmortem examination allows forensic pathologists an excellent *in situ* reconstruction of injuries (i.e., traffic fatalities,