G31 Fractalyse Software — The Analysis of the Trabecular Bone in Identification

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After attending this presentation, attendees will possess new information regarding the use of mandibular trabecular bone patterns to establish positive identification.

This presentation will impact the forensic science community by demonstrating a method of calculating the significance of mandibular trabecular bone patterns in arriving at a positive identification.

According to University of California, Berkeley's orthopedic biomechanics research, the trabecular bone can be classified as a porous cellular solid, consisting of an irregular 3D array of bony rods and plates, called trabeculae, which are composed of a calcified matrix. Bone marrow fills the spaces of the pores. In addition, because all free bone surfaces are covered with bone cells, bone is a living tissue that is self-healing and has the ability to adjust its morphology in response to changes in its mechanical environment, the so-called but poorly understood phenomenon of bone remodeling. As such, the mechanical complexity of this two-phase biological tissue surpasses any engineering material making it a fascinating subject of study, regardless of clinical applications.

The process of dental identification compares postmortem to antemortem data. It involves the analysis of different factors such as: the presence and absence of teeth; crown and root morphology and their interrelationships; the evaluation of the periodontal status; the type and extent of restorative, endodontic, fixed, removable, and implanted materials; tori and sinus configuration; anomalies and pathologies of teeth and bone; and trabecular pattern morphology.

Few studies have been conducted on the statistical reliability of trabecular bone patterns for identification purposes. Some deal with algorithms, a mathematical expression that produces the answer to a question or the solution to a problem in a finite number of steps. Others deal with fractal analysis, consisting of assigning a fractal dimension or other fractal characteristic to a dataset. The theoretical dataset, pattern, or signal extracted from a phenomenon can include natural geometric objects, sound, market fluctuations, heart rates, digital images, molecular motion, networks, etc.

Some of the studies apply fractal geometric techniques: (1) to the study of trabecular bone; (2) to fractal analysis of radiographs by the assessment of trabecular bone structure and prediction of elastic modulus and strength; (3) to methodological principles for fractal analysis of trabecular bone; (4) to digital image analysis of cadaver mandibular trabecular bone patterns; (5) to fractal dimension and lacunarity analysis of dental radiographs; (6) to technical factors in fractal analysis of periapical radiographs; (7) to the morphodigital study of the mandibular trabecular bone in panoramic radiographs; (8) to fractal analysis of mandibular trabecular bone using the tile counting method; (9) to the anatomical variations of trabecular bone structure in intraoral radiographs using fractal and particles count analyses; (10) to the analysis of trabecular bone using site-specific fractal values calculated from cone beam Computed Tomography (CT) images; and, finally, (11) to the fractal dimension of the mandibular trabecular bone measured on digital and digitized images.[1-11]

As a continuation of previous research projects, the current research focused on the multifunctional uses of Fractalyse software, a free open source software, as an aid and noteworthy tool for trabecular bone pattern

morphometric analysis and comparison.[12-15] For that purpose, 20 digital panoramic radiographs from ten patients treated in implantology and orthodontics were analyzed and compared. For each panorex, 12 designated squared areas were selected on the mandible, of which 11 were adjoining and shifted by the equal distance. The resulting 240 radiographic areas were analyzed and compared with one another, taking into account various factors. This process was also conducted independently by a second researcher and the results compared. Outcomes suggest that the development of a new software with a revolutionary approach to handling human trabecular jaw bone patterns for identification purposes could be possible. This approach would be especially practical in mass disaster situations involving large numbers of edentulous victims and/or with fragmented remains.

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