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TECHNICAL NOTE

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Old Dogs Can Learn New Tricks—A New Application of the ABFO #2 Scale

ABSTRACT: In 1984 at its first Bitemark Workshop, the American Board of Forensic Odontology (ABFO) developed guidelines for the analysis of bitemark evidence. Prior to this, no standards had been established for the evaluation of bitemarks. The development of the ABFO #2 scale in 1987 gave the forensic odontologist a reproducible way to rectify and measure bitemarks that had been documented photographically. Primarily developed for the analysis of bitemark evidence, its use has expanded to encompass myriad forms of evidence. While the ABFO #2 scale can depict horizontal and vertical measurements, it is unable to depict depth accurately. The purpose of this paper is to show its successful application to three dimensions.

KEYWORDS: forensic science, bitemark analysis, scale, evaluation of evidence, three-dimensions

There has been seen an evolutionary progression in the collection and analysis of forensic evidence. Early on, it was believed that simple photographic documentation alone was acceptable and ample for the evidentiary process.

All systems undergo change. This change is often a direct result of the influence of knowledge and advances in technology. These factors can alone, and in tandem, stimulate change in a formerly static system. Systems that do not adapt are replaced by newer or better models. A basic tenet of zoology is "Ontogeny recapitulates phylogeny." Form follows function. This tenet can be related to forensic evidence, in that function necessitates a change in the evaluation of three-dimensional objects.

Man and his associated crimes exist in three dimensions or planes. However, the forensic community continually compares evidence in only two dimensions, the horizontal and vertical. These entities have depth but are treated as if they are devoid of this property.

Since its acceptance by the American Board of Forensic Odontology in 1987, the ABFO #2 scale has been acknowledged as the "gold standard" for the evaluation of forensic evidence. Developed by Hyzer and Krauss (1), the scale is the measurement tool for photographic documentation and analysis of bitemarks and wound patterns.

The ABFO #2 scale was conceived in an effort to rectify distortion due to incorrect camera position and angulation. The scale was designed to allow for life-size reproduction with a known degree of accuracy in its vertical and horizontal dimension (2). Additionally, its three circles can allow for the correction of an oblique camera angle and prevent distortion in the enlargement process.

Accepted case development dictates that the ABFO #2 (3) scale is to be placed in the same plane as the documented item to nullify distortion. In actuality, the scale is only in the same plane at one point in space. While the scale accurately depicts the horizontal (length) and vertical (height) dimensions, it is deficient in its representation of depth, thereby limiting its use in representing a three-dimensional object in the two dimensions of a photograph (4). Hence, the next step in the evolution of forensic documentation would be the three-dimensional analysis of evidence.

The x-axis (vertical component) and the y-axis (horizontal component) of the scale document two coordinates in three-dimensional space. It is now necessary to be able to determine the depth component, or z-axis. This advancement would give the required third coordinate the ability to analyze and give accurate life-size reproduction in three-dimensional space and facilitate forensic analysis.

Materials and Methods

A new imaging guide or evidence marker would be able to broaden the application of the ABFO #2 scale. This plural part evidence marker is described in its entirety in the United States Patent application #US 2004/0020089 A (5). Its design is similar in appearance to a six-legged child's toy jack or star (Fig. 1). This "star" is comprised of six identical and orthogonally placed legs: each leg being manufactured of a rigid plastic or polymer. The four sides of each leg are square in cross-section and grooved to accept two ABFO #2 scales or their equivalent. The purpose of these grooves is to allow the scales to be friction-set into the legs at a 90° angle to each other (Fig. 2). The guide and the attached scales are then positioned adjacent to the evidence, (i.e., bitemark or wound) and then photographed (Fig. 3).

The plastic or polymer used in the manufacturing process should have a low modulus of elasticity to avoid dimensional change. The rigidity of the material and its design maintain the perpendicular arrangement of the scales. Additionally, the legs not involved in the support of the scales are used to stabilize the entire assembly. The

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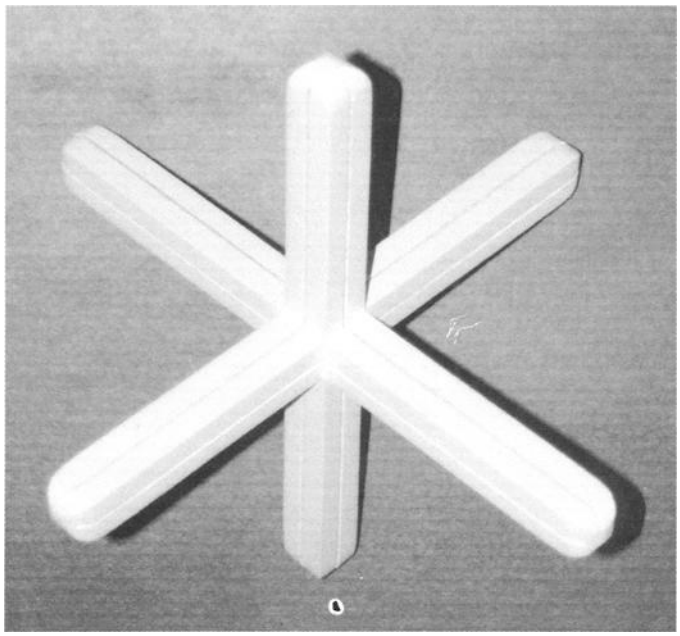

FIG. 1—*Plural part evidence marker or "STAR."*

"hands-free" design aids in the reduction of irrelevant shadowing and eliminates artifacts from the photographic field.

Other advantages of this device are as follows: the plastic or polymer material can support identifying marks such as (but not limited to) scale markings, case identification name or number, or pre-printed bar coding. Because the scales can be removed and retained with the guide in standard evidence packaging, there is ease in storage and a decreased probability of deformation.

Global positioning satellite (GPS) technology allows for the spatial mapping of geographic locations. Actual geographic coordinates may be determined with the use of these sensors on the imaging guide. Location of victims, evidence, and their spatial relationships can be then mapped with the use of standard GPS devices.

Improvements in the offset amount of GPS readings have steadily resulted in an increase in accuracy of mapping. Used in conjunction with the evidence marker, the amount of distortion would be limited to this offset amount and the accuracy of the manufacturing process. Both amounts would be quantifiable and therefore known constants.

Discussion

Hyzer established the correlation of the two major axes (x, y) to the elliptical shape of the circular reference marks on the ABFO #2 scale to determine mathematically the camera viewing angle (6). The z-axis coordinate can be determined by the perpendicular relationship of the scales in the imaging guide. The importance here is that the three-dimensional relationship of two or more items of evidence can be documented accurately while not lying in the same photographic plane.

Photographic documentation of curved surfaces such as the human body shows the greatest amount of distortion at the periphery

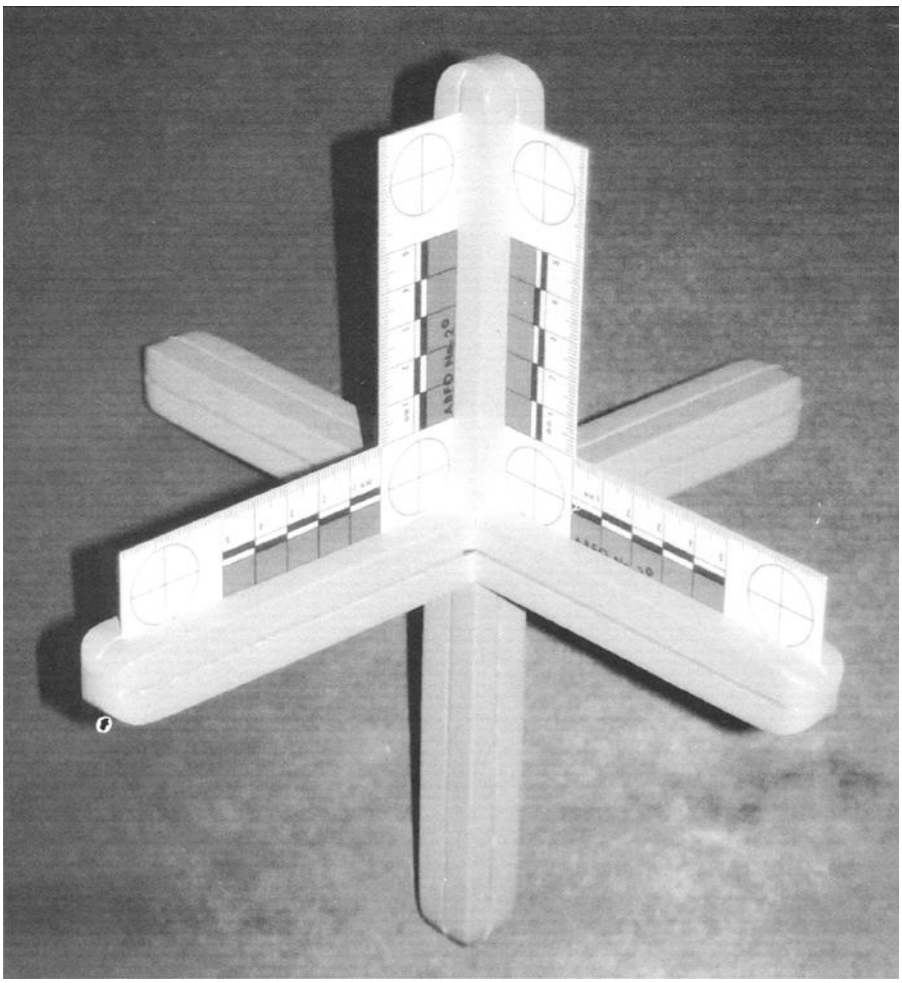

FIG. 2—*Evidence marker with ABFO #2 scales positioned correctly.*

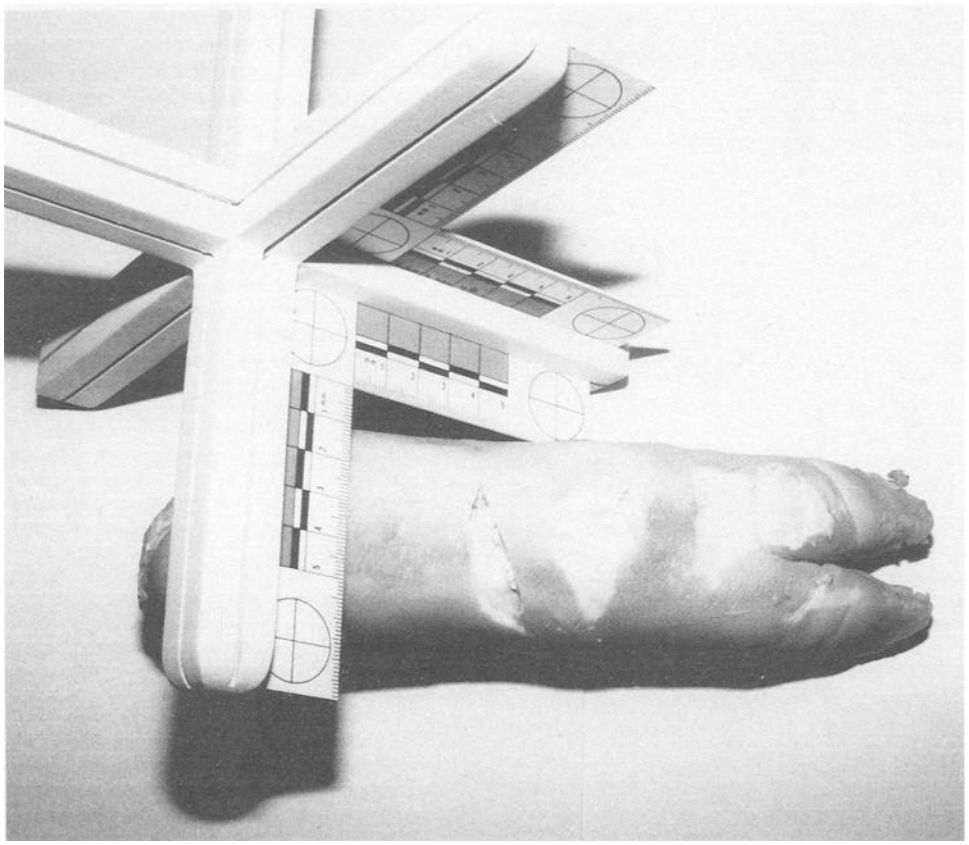

FIG. 3—*Photograph taken of "patterned injury" with evidence marker assembly in place.*

of the image. The imaging guide gives one the ability to depict the spatial relationship of the scales to the evidence. The display of this relationship allows the photographic overlapping of images taken from multiple angles.

The three-dimensional imaging guide does have known disadvantages compared to the standard use of the ABFO #2 scale. There is an increased cost associated with the need to purchase the additional scale and imaging guide. The greater problem, however, is the more complex mathematical model necessary to determine the spatial coordinates (when not used in conjunction with GPS).

This guide or evidence marker offers a cost-effective and technically feasible method to evaluate accurately three-dimensional evidence beyond the two-dimensional constraints of a photograph. The main advantage of this device is that there is no alteration of the universally accepted ABFO #2 scale, only its application.

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