

VIDEODENSITOMETRIC TECHNIQUES IN DIGITAL SUBTRACTION VIDEOANGIOGRAPHY

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Techniques of extracting quantitative information from x-ray images have been extensively studied and applied since the first quantitative angiographic method for determining cardiac volume was reported. Among these techniques is videodensitometry which relates the video signals from an image-intensifier video-fluoroscopy system to the thickness dimension of the x-rayed structure. The applicability of x-ray videodensitometry has been limited by the present angiographic techniques which require catheterization. The recently developed digital subtraction videoangiography provides a powerful tool for non-invasive intravenous studies. The use of logarithmic video processing and mask-mode subtraction in this technique cancels out structural background and enhances the contrast signal. For these reasons, digital videoangiography lends itself to the implementation of videodensitometry. However, the presence of radiation scatter and the veiling glare in the video-signal from the image intensifier produce a non-uniform black level for the logarithmic amplification. This bias in the logarithmic amplification suppresses the signal size of the mask-mode subtraction images. Such effects have been demonstrated with phantom measurements.

A technique using a digital convolution algorithm to approximate and correct for the scatter and glare components in the video signal has been developed. The feasibility of this correction technique has been demonstrated with phantom measurements. The convolution implemented for the scatter and glare correction employs a simple rectangular kernel function. The distribution of scatter produced in a water phantom and its dependence on the air gap and the water thickness has been studied by a simplified calculation considering only single Compton scattering processes. The results depend mostly on the air gap. The shape of these distributions are roughly independent of the water thickness. Therefore, the choice of an optimal kernel function for the scatter and glare correction may vary according to the air gap used in imaging.

Another intrinsic characteristic with the image intensifiers is pincushion distortion. This results in the representation of area by a false number of digital picture elements and therefore erroneous videodensitometric values. However, pincushion distortion has been found to be of no consequence in ratio measurements such as that used for determining cardiac ejection fractions.

The scatter and glare correction technique has been applied to the videodensitometric measurement of canine left ventricular ejection fractions. The effect of such correction on the calculated ejection fractions has been demonstrated. The motion artifacts involved with breathing or patient motion have been found to contribute considerable inaccuracy in the ejection fraction calculation. Intrinsic to intravenous injections is the overlapping of left ventricle with a considerable amount of opacified structures. Backgrounds due to these structures have been studied. A two window technique has been developed to measure ejection fractions over 15 heart beats with a 3-4% consistency. Refined background corrections have been attempted by using background values measured in adjacent regions. However, the results are nearly identical to those obtained with the two window technique.

