EDUCATIONAL TRACK: BASIC INDICES PHYSICIANS SHOULD KNOW ABOUT —REVIEW ARTICLE

^{123}I-*meta*-iodobenzylguanidine Sympathetic Nerve Function Indices Derived from Planar Images

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Abstract

Innervation imaging using ^{123}I-*meta*-iodobenzylguanidine (MIBG) has been applied mainly to imaging heart failure in nuclear cardiology. The most popular quantitation tools comprise the heart-to-mediastinum (H/M) ratio and the washout rate (WR) derived from anterior planar images. Although the method of calculation is simple, some cautions are essential for region-of-interest setting. In addition, camera-collimator differences should be considered for the H/M ratio, and background and time-decay correction is needed to precisely determine the WR. Since the H/M ratio and WR have been applied to most diagnostic and prognostic studies of heart failure, understanding these parameters is important for clinical applications of ^{123}I-MIBG.
Keywords: Heart-to-mediastinum ratio, Innervation imaging, Quantitation, Washout rate
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The noradrenaline (norepinephrine) analogue ^{123}I-*meta*-iodobenzylguanidine (MIBG), has unique characteristics that reflect neuronal functional activity and was initially applied to innervation imaging during the late 1980s. The Japanese Ministry of Health and Welfare approved healthcare insurance coverage of MIBG in 1992 and it has since become applied particularly to imaging ischemic heart disease and heart failure. The major indication described in the Nuclear Cardiology Guidelines of the Japanese Circulation Society (1) is evaluation related to the diagnosis and prognosis of heart failure. The American Society of Nuclear Cardiology has also proposed imaging guidelines (2). A basic understanding of how to quantify planar ^{123}I-MIBG images is an essential first step towards informative clinical and research applications.

Heart-to-mediastinum ratio

The heart-to-mediastinum (H/M) ratio reflects the integrity and activity of the cardiac sympathetic nervous system. Early and late images are acquired at 15-30 minutes and 3-4 hours after an intravenous administration of 111, 185 and 370 MBq of ^{123}I-MIBG in Japan, Europe and the USA, respectively. Anterior planar images are obtained using a matrix of 256 pixels for 3-10 minutes. A circular or heart-shaped region of interest (ROI) is set over the heart (Fig. 1). Several proposed methods for setting ROI include semi-automated algorithms, such as smartMIBG software (3).

The H/M ratios vary depending on the choice of cameras and low- (LE) or medium- (ME) energy collimators that are quite different. The calculated H/M ratio is higher for ME, than for LE collimators. This is mainly due to a higher fraction of septal penetration using LE collimators. Low-medium energy collimators are also popular. Conversion coefficients derived from phantom-based experiments are a practical way to standardize H/M ratios (4, 5). As consistent H/M ratios are obtained from ME collimators, our recommendation is to standardize all H/M ratios to a condition equivalent to that of ME collimators (Table 1), although LE high-resolution collimators are popular for ^{123}I-MIBG imaging in the USA.

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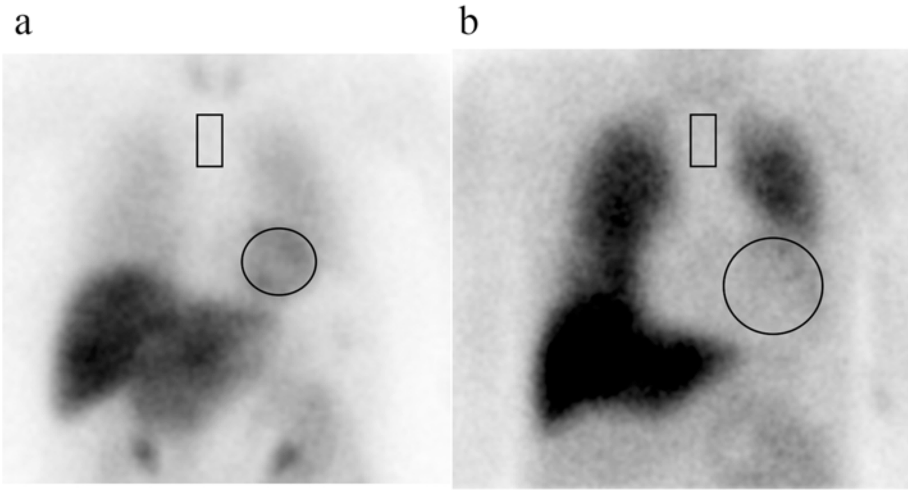

Fig. 1 Typical regions of interest (ROI) settings for ^{123}I-MIBG studies in images of normal (a) and low (b) cardiac ^{123}I-MIBG activity.
Cardiac and mediastinal ROI are circular and rectangular, respectively.

Table 1 Normal ^{123}I-MIBG values derived from normal databases of the Japanese Society of Nuclear Medicine (7).

	Average	Range
Early HMR	3.1	2.2-4.0
Late HMR	3.3	2.2-4.4
Washout rate (decay and background corrected)	13	0-34%

Washout rate

The washout rate (WR) reflects sympathetic drive or turnover and it is used to calculate the early heart count (H_{early}) minus the late heart count (H_{late}) divided by H_{early}. However, background subtraction (or a mediastinal count, M) is required because background activity overlaps heart counts. Since the half-life of ^{123}I is 13 hours, decay corrections can be applied to determine the physiological decrease in cardiac MIBG activity. Therefore, WR can be calculated as follows:

WR=[(H_{early} - M_{early}]) - (H_{late} - M_{late})/decay correction factor]/(H_{early} - M_{early}), and the decay correction factor is calculated using the equation, 0.5^(elapsed time between early and late image acquisition/13 h), where M_{early} and M_{late} are early and late mediastinal counts, respectively.

Calculation methods including background subtraction and decay correction have not been uniform across ^{123}I-MIBG studies. The methods should be carefully confirmed when WR results are applied to results from individual institutional and multicenter studies (6).

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Conflicts of interest

KN has a collaborative research work with FUJIFILM RI Pharma, Co. Ltd, Tokyo, Japan

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