Canadian Journal of Cardiology 32 (2016) 378–383

Clinical Research

Left Ventricular Dilatation Assessed on the Lateral Chest Radiograph: The Classic Hoffman and Rigler Sign Falls Short in a Modern-Day Population

Marco Spaziano, MD,[a,b,c,*] Guillaume Marquis-Gravel, MD, MSc,[a,b,*] Isabelle Ramsay, TMI,[b] Giovanni Romanelli, MD,[a,b] Émilie Marchand, MD,[a,b] and François Tournoux, MD[a,b,d]

[a] Faculty of Medicine, Université de Montréal, Québec, Canada

[b] Centre Hospitalier de l'Université de Montréal (CHUM), Montréal, Québec, Canada

[c] McGill University Health Center (MUHC), Montréal, Québec, Canada

[d] Centre de Recherche du CHUM, Montréal, Québec, Canada

ABSTRACT

Background: The classic Hoffman and Rigler (H&R) sign, originally described in 1965, suggests that left ventricular (LV) dilatation is present if the left ventricle extends more than 18 mm posterior to the inferior vena cava at a level 2 cm above their crossing on a lateral chest radiograph. This sign is still widely used by radiologists but has not been well evaluated against modern methods of noninvasive assessment. This study investigated the sensitivity and specificity of the H&R sign in a modern population.

Methods: A sample of 145 patients with LV dilatation based on current echocardiographic criteria was matched for age and sex with 145 patients without LV dilatation. Patients were required to have undergone a lateral chest radiograph in the 3 months before or after undergoing echocardiography; the H&R sign and the cardiothoracic index were assessed on the radiograph independently by 2 blinded physicians.

RÉSUMÉ

Introduction : Le modèle classique d'Hoffman et Rigler (H & R), publié à l'origine en 1965, suggère qu'une dilatation ventriculaire gauche est présente si le ventricule gauche (VG) dépasse postérieurement de plus de 18 mm la veine cave inférieure à un niveau de 2 cm au-dessus de leur intersection sur une radiographie thoracique latérale. Ce modèle est encore largement utilisé par les radiologues mais n'a pas été bien confronté aux méthodes modernes d'évaluation non invasive. Cette étude a examiné la sensibilité et la spécificité du modèle H & R dans une population contemporaine.

Méthodes : Un échantillon de 145 patients avec une dilatation du VG sur la base de critères échocardiographiques actuels a été apparié pour l'âge et le sexe avec 145 patients sans dilatation du VG. Les patients devaient avoir subi une radiographie thoracique latérale dans les trois mois avant ou après avoir subi une échocardiographie; le modèle H & R et l'index cardiothoracique ont été évalués sur la

Dyspnea is commonly encountered as a chief complaint in emergency departments.[1] Although the majority of patients diagnosed with heart failure (HF) complain of dyspnea on presentation,[2] it is not a specific symptom.[3] Rather, the suspicion of HF is based on global assessment integrating not only clinical symptoms and signs but also biochemical analyses, electrocardiographic analysis, and more often chest radiography results. The Bayesian probability of diagnosing HF correctly is modified as the available data accumulate,[4] which allows the clinicians to avoid ordering unnecessary additional tests in the quest to improve cost-effectiveness in health care. Echocardiographic examination provides key information on left ventricular (LV) dimensions and function and can help rule in or out the diagnosis of HF if suspected on initial evaluation. It also allows prognostication given that LV dimensions and function are independently associated with increased morbidity and mortality.[5] Although echocardiography is widely available today, it is not always immediately feasible, and this can prolong hospitalization time. In that regard, multiple radiographic signs can potentially be used to exclude the diagnosis of HF. Furthermore, the presence of these signs often raises the suspicion of LV enlargement, thereby driving referrals for imaging. Whether this practice is appropriate deserves to be studied.

The presence of interstitial edema and pulmonary venous congestion on the chest radiograph are the best radiographic clues of congestive HF as the cause of dyspnea, whereas the absence of cardiomegaly excludes HF with a relatively high

Received for publication April 6, 2015. Accepted June 13, 2015.

*These authors contributed equally to this work.

Corresponding author: Dr François Tournoux, Centre Hospitalier de l'Université de Montréal, 3840 Saint-Urbain, Montréal, Québec, H2W 1T8, Canada. Tel.: +1-514-890-8000 ×15438.

E-mail: francois.tournoux@umontreal.ca

See page 383 for disclosure information.

http://dx.doi.org/10.1016/j.cjca.2015.06.018

Results: Using the threshold value of 18 mm, sensitivity, specificity, and positive and negative likelihood ratios of the H&R sign were 54.9%, 59.2%, 1.34, and 0.76, respectively (area under the curve [AUC], 0.58). In comparison, the cardiothoracic index provided better prediction of LV dilatation (sensitivity, 87.9%; specificity, 47.5%; AUC, 0.72).

Conclusions: The H&R sign is a poor marker of LV enlargement when compared with echocardiography and should not be used as a radiologic index of LV enlargement.

Résultats : L'utilisation de la valeur seuil de 18 mm, la sensibilité, la spécificité et les rapports de vraisemblance positifs et négatifs du modèle H & R étaient de 54,9 %, 59,2 %, 1,34 et 0,76, respectivement (aire sous la courbe, 0,58). En comparaison, l'index cardiothoracique fourni une meilleure prédiction de la dilatation du VG (sensibilité, 87,9 %; spécificité, 47,5 %; aire sous la courbe, 0,72).

Conclusions : Le modèle H & R est un marqueur faible de l'élargissement du VG en comparaison à une échocardiographie et ne devrait pas être utilisé comme un indice radiologique de l'élargissement du VG.

certainty.[6] The Hoffman and Rigler (H&R) sign is a marker of LV enlargement on the lateral chest radiograph that was initially described in 1965.[7] It is assessed by tracing a line (measurement A) from the posterior border of the inferior vena cava to the posterior border of the left ventricle, parallel to the horizontal vertebral body plates line, starting 2 cm cephalad to the crossing of the inferior vena cava and left ventricle (Fig. 1). According to the original article, the H&R sign is positive if measurement A is $\geq$ 18 mm.[7] Although this sign is an accepted marker of LV enlargement, it was originally validated against surrogate non-validated markers of LV enlargement, such as systemic hypertension, aortic stenosis/regurgitation, and mitral regurgitation. Since their initial report, numerous technologies have emerged to objectively assess LV mass and dimensions. Whether the H&R sign is accurate for diagnosing LV enlargement using contemporary methods of evaluation of LV dimensions as gold standards has scarcely been studied.[8,9] The objective of this study was to assess, in a contemporary population, the diagnostic performance of the H&R sign using echocardiography as a gold standard.

Methods

A retrospective case-control study was performed in adult patients at the Centre Hospitalier de l'Université de Montréal (CHUM). Cases were included if they had increased LV internal diastolic diameter (LVIDd) by echocardiographic measurement according to the American Society of Echocardiography guidelines ($\geq$ 53 mm for women and $\geq$ 59 mm for men).[10] Controls had normal LVIDd and were matched with cases for sex and age in a 1:1 ratio, with a difference of $\pm$ 3 years being tolerated. To be included, all patients needed to have had a lateral chest radiograph within 4 months of the echocardiographic examination. All chest radiography was performed on the same platform.

Consecutive echocardiographic examinations performed between January 2012 and December 2012 at the CHUM were screened for eligibility until the desired sample size was reached. Demographic and radiologic data were extracted from the electronic medical charts, echocardiographic reports, and chest radiographs. The H&R sign and the cardiothoracic index were assessed by a blinded investigator. A second investigator evaluated the H&R sign in 20 patients to assess interobserver variability. Intraobserver variability was assessed similarly. In the present article, the terms "H&R index" and "measurement A" are used interchangeably. A positive H&R sign was defined as an H&R index $\geq$ 18 mm.

The primary outcome was the degree of agreement between the H&R sign and LV enlargement as determined by echocardiography (LVIDd), using sensitivity, specificity, and positive and negative likelihood ratios (LRs). Secondary

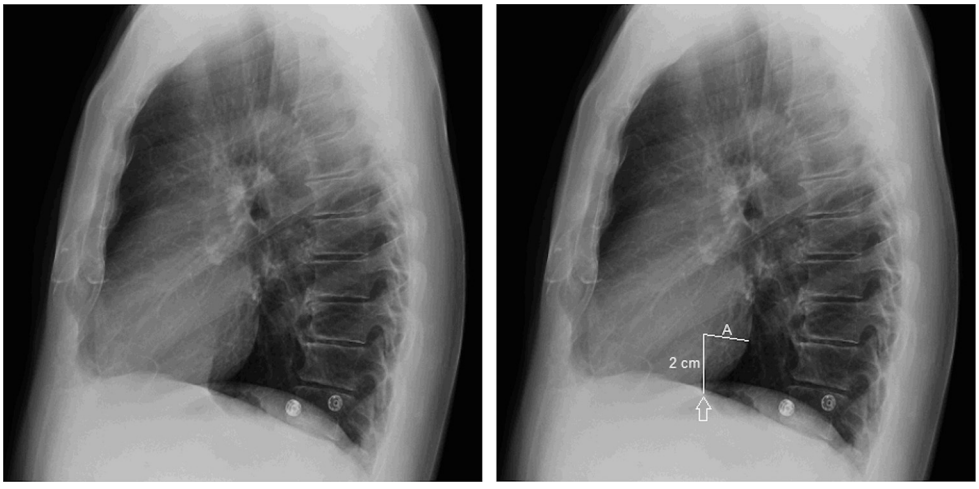

Figure 1. Example of Hoffman and Rigler index measurement. **Arrow** denotes crossing of inferior vena cava and posterior border of heart. Note that measurement A orientation should be parallel to the vertebral bodies.