

This is an author produced version of a paper published in Journal of Electrocardiology. This paper has been peer-reviewed but does not include the final publisher proof-corrections or journal pagination.

Citation for the published paper:

Trägårdh, Elin

"High-frequency electrocardiogram in acute myocardial ischemia."

J Electrocardiol. 2006 Jan;39(1):87.

<http://dx.doi.org/10.1016/j.jelectrocard.2005.08.002>.

Access to the published version may require journal subscription.

Published with permission from: Elsevier

Editorial comment: High-frequency ECG in acute myocardial ischemia

Elin Trägårdh, MD
Department of Clinical Physiology
Lund University Hospital
221 85 Lund, Sweden

By convention, the standard 12-lead electrocardiogram (ECG) contains frequencies below 100 Hz, but it is well known that the ECG signal, particularly the QRS complex, also contains higher frequencies. Different techniques to extract the high-frequency QRS components (HF-QRS) have been used in previous studies, as well as different frequency ranges.

It has previously been shown that changes in HF-QRS, in the 150-250 Hz range, are more sensitive than is standard ECG for detecting myocardial ischemia, both during exercise tests and during angioplasty-related coronary artery occlusion [1-3]. In this issue of the *Journal of Electrocardiology*, Rahman et al investigate changes in HF-QRS during adenosine myocardial perfusion imaging (MPI) stress tests. They conclude that analysis of HF-QRS is highly sensitive and specific for detecting reversible perfusion defects, and significantly more sensitive than conventional ST-segment analysis. The results are promising for the future of HF-QRS.

It is very interesting that the authors find a high sensitivity when using adenosine MPI as gold standard. It has been debated whether administration of adenosine causes "true myocardial ischemia" (oxygen deficit) or only reflects the impairment of flow reserve caused by the atherosclerotic stenosis. One study has shown that cardiac output doubles in healthy individuals during adenosine infusion [4], thus causing a real workload on the heart, whereas others argue that "true ischemia" during adenosine administration only occurs in the presence of coronary steal [5]. It is not possible to know whether "true ischemia" occurred or not in the present study. The findings of highly sensitive and specific changes in HF-QRS could therefore occur be due to "true ischemia" or due to other factors.

The mechanisms underlying HF-QRS are not fully understood. Studies suggest that HF-QRS depend on the local conduction in the heart [6]. The phenomenon has been simulated in a computerised heart model, and one possible explanation for the decrease in HF-QRS during acute ischemia is slowing of conduction velocity in the region of ischemia. There is also some evidence that the autonomic nervous system affects HF-QRS, but so far no basic studies have been performed.

The article by Rahman et al is an important contribution to the studies on high-frequency ECG. The article uses software, recently developed by the authors at NASA, that allows HF-QRS to be analysed and displayed in real-time [7]. This new method has shown promising results in detecting various cardiac conditions and could be an important future contributor to the clinical electrocardiography.

References

1. Abboud S, Cohen RJ, Selwyn A, Ganz P, Sadeh D, Friedman PL. Detection of transient myocardial ischemia by computer analysis of standard and signal-averaged high-frequency electrocardiograms in patients undergoing percutaneous transluminal coronary angioplasty. *Circulation* 1987;76:585-96.
2. Pettersson J, Pahlm O, Carro E, Edenbrandt L, Ringborn M, Sömmo L, Warren SG, Wagner GS. Changes in high-frequency QRS components are more sensitive than ST-segment deviation for detecting acute coronary artery occlusion. *J Am Coll Cardiol* 2000;36:1827-34.
3. Beker A, Pinchas A, Erel J, Abboud S. Analysis of high frequency QRS potential during exercise testing in patients with coronary artery disease and in healthy subjects. *PACE* 1996;19:2040-50.
4. Edlund A, Sollevi A, Linde B. Haemodynamic and metabolic effects of infused adenosine in man. 1990;79:131-8.
5. Travin MI, Wexler JP. Pharmacological stress testing. *Semin Nucl Med* 1999;29:298-318.
6. Abboud S, Berenfeld O, Sadeh D. Simulation of high-resolution QRS complex using a ventricular model with a fractal conduction system. Effects of ischemia on high-frequency QRS potentials. *Circ Res* 1991;68:1751-60.
7. Schlegel TT, Kulecz WB, De Palma JL, Feiveson AH, Wilson JS, Rahman MA, Bungo MW. Real-time 12-lead high frequency QRS electrocardiography for enhanced detection of myocardial ischemia and coronary artery disease. *Mayo Clin Proc* 2004;30:285-91.

Elin Trägårdh, MD
Department of Clinical Physiology
Lund University Hospital
221 85 Lund, Sweden
E-mail address: elin.tragardh@med.lu.se