Detection of Acute Myocardial Ischemia using High-Frequency QRS Analysis

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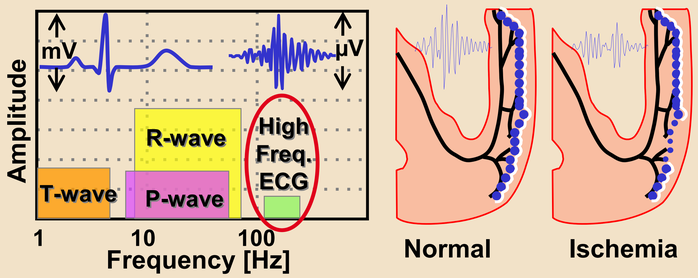
BACKGROUND

Myocardial ischemia causes changes in the depolarization phase of the ECG.

High-frequency mid-QRS components (HFQRS) are reliable markers of myocardial ischemia.



Frequency band of standard ECG components is typically 0.05-100Hz. HFQRS represents subtle changes in the 150-250Hz band, resulting from the fragmented waveform of electrical myocardium activation.

OBJECTIVES

- **To test the HFQRS analysis technique in detecting supply ischemia caused by prolonged intra-coronary balloon occlusions.**
- **To assess the feasibility of HFQRS-based detection of acute ischemia using a single, unreferenced measurement.**

METHODS

High resolution 12-lead ECG was recorded prior to and during prolonged intra-coronary balloon occlusion in 104 patients (60±11 yo, 65 men) undergoing elective PTCA (STAFF-III database).

The HyperQ™ System (BSP Ltd, Israel) was used to derive HFQRS indices based on i) relative intensity reduction and ii) ischemia-specific signal morphology without a reference measurement.

HyperQ™ System

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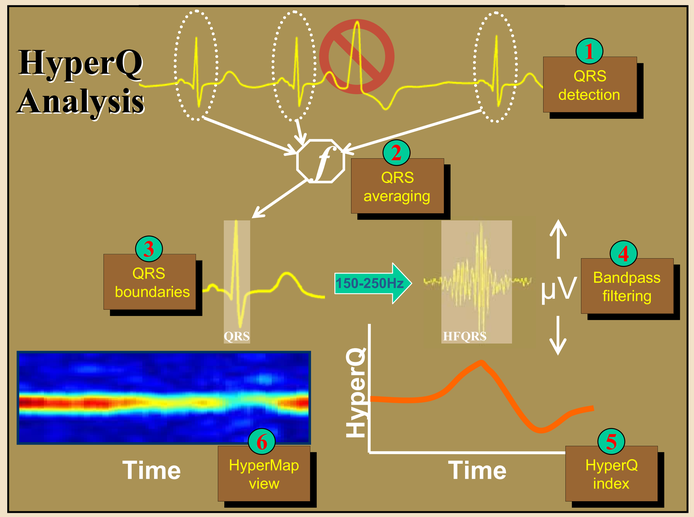
The area under the receiver operating characteristics (AUROC) curve was used to assess the diagnostic value of each index and to derive optimal cutoff values.

ST changes were examined according to ESC/ACCF/AHA/WHF guidelines.



HFQRS analysis by the HyperQ™ algorithm: (1) QRS detection identifies valid QRS complexes, (2) QRS alignment and averaging to improve SNR, (3) Detection of QRS boundaries, (4) Band-pass filtering (150-250Hz) to obtain HFQRS. Intensity and morphology indices are extracted from HFQRS to produce a trend line (5), or a color-coded HFQRS map (6).

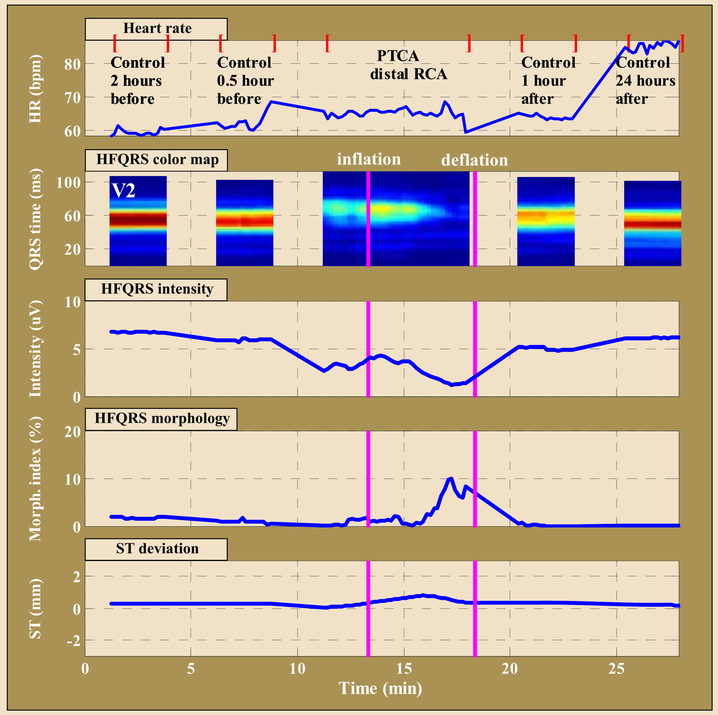
RESULTS

Balloon occlusions lasted 4.4±1.3 min.

Both HFQRS indices were significantly more sensitive than ST analysis (Table), with similar specificity for the HFQRS intensity index and ST analysis.

Index	Sens.	Spec.	Accuracy	AUROC
HFQRS intensity (N=87)	95%*	96%	96%*	0.99
HFQRS morphology (N=64)	84%*	80%	82%*	0.88
ST deviation (N=99)	55%	95%	75%	-

*** p<0.001 vs. ST analysis**



A representative example of HFQRS indices (lead V2) before, during and following a 5-minute balloon occlusion of the distal RCA in a 59 yo male. During occlusion: a marked reduction in the intensity of HFQRS and a significant increase in the index of HFQRS morphology. Following balloon deflation: both indices returned to baseline values.
ST elevation during occlusion was 1.1 mm (below the threshold of the guidelines).

CONCLUSIONS

- **HFQRS analysis provided high diagnostic performance in detecting acute supply ischemia.**
- **HFQRS morphology index achieved high accuracy without using a baseline measurement.**
- **HFQRS analysis may aid in detecting both transient ischemic episodes and conditions of acute myocardial ischemia/infarction.**

REFERENCES

[1] Abboud S. et al., Circulation 1987;76:585-96.
[2] Pettersson J. et al., JACC 2000; 36(6): 1827-34