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5-lead 3D-vectorcardiography differentiates between high and low cardiovascular risk profiles in patients with suspected or known coronary heart disease

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CHD: Coronary Heart Disease (koronare Herzerkrankung, KHK)
CSG: Cardisiographie
CVRF: Cardiovascular risk factors

Zusammenfassung und Interpretation

- Modified PROCAM-Score (CVRF-Score)
  - Klassischer Risiko-Score zur Ermittlung der Vortestwahrscheinlichkeit einer koronaren Herzerkrankung
- Aktuelle Analyse: 407 Patienten
  - 225 Patienten HDZ, Bad Oeynhausen
  - 182 Patienten einer hausärztlichen Praxis, Berlin
- Verglichen wurde der CSG-Index (Parameter der CSG) mit dem CVRF-Score in Bezug auf die Vorhersagekraft auf das Vorhandensein einer KHK

Ergebnis

„The CSG Index differentiated those with no signs and symptoms of CHD and patients with CHD and is a better predictor for cardiovascular risk than the classical risk factors"

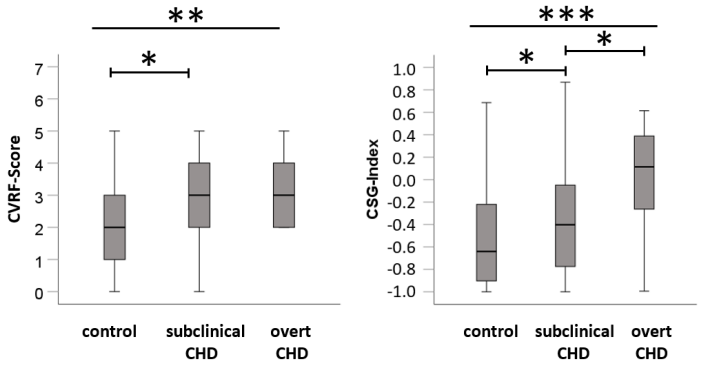
- Zur nicht-invasiven Beurteilung einer KHK ist die CSG dem CVRF-Score **überlegen**
- CSG-Index korreliert signifikant (p < 0,001) mit klinisch bestätigtem KHK-Status
- NPV (negativer prädiktiver Wert) der CSG lag bei 91%

Interdependency of CVRF-score, CSG-Index and clinical status of CHD

variable	r^2	significance
CSG-Index vs. CVRF-Score	0.26	< 0.001
CSG-Index vs. clinical status CHD	0.71	< 0.001
CVRF-Score vs. clinical status CHD	0.18	< 0.001

CSG-Index correlates stronger with cardiovascular risk (r^2=0.71, p<0.001) compared to CVRF-Score (r^2=0.18, p<0.001)

Correlation of CVRF-Score, CSG-Index and clinical status of CHD



Strong correlation of CVRF-Score, CSG-Index and clinical status of coronary heart disease (CHD) (p=0.016)

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Purpose of the study

- 5-lead 3D-vectorcardiography (5L3DVCG-AI) offers additional information over standard 12-lead electrocardiography (ECG) in the detection of cardiac ischaemia.
- Artificial Intelligence (AI) and access to a massive global clinical data repository have the potential to boost the performance of VCG beyond conventional techniques [1,2].
- Quantifying cardiovascular risk (CVR) according to SCORE2, QRISK3 or ASCVD is not always feasible especially in hard to reach populations. The modified PROCAM-Score (CVRF-Score) offers a validated alternative [3].
- Thus, it would be interesting to assess a low cost, easy to use, easily accessible tool to quantify individual CVR.
- **Hypothesis**:

  5L3DVCG-AI is able to differentiate between patients with low and high risk of coronary heart diseases (CHD) and can identify patients requiring coronary interventions.

References: [1] Meier, Clinical cardiology, 1987; [2] Braun, J Electrocardiology, 2020; [3] Schmidt-Lucke, Circulation, 2005

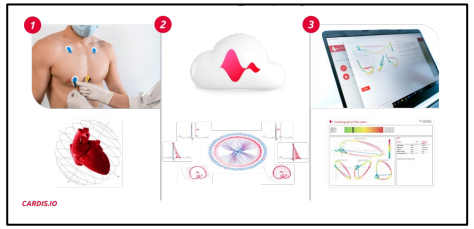
Methods

Inclusion criteria: Clinical indication for further diagnostics to confirm or exclude CHD in two centres

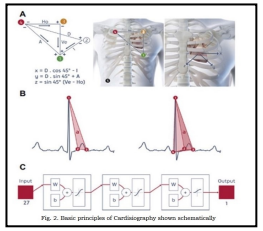
Predefined primary endpoint: Suitability of 5L3DVCG-AI in predicting clinical relevant CHD

Design: multicentric, retro- and prospective design with prespecified primary endpoint

- 5L3DVCG-AI with calculation of CSG-Index (including 731 parameters, e.g., QRS-T angle and in-house features calculated in time and frequency domains, such as beat moments)
- Patient classification as high or low CHD risk, based on CSG-Index [-1 to 1] (CSG-Index cut-off: -0.27)
- Quantification of CVRF-Score as number of risk factors according to mod. PROCAM-Score [3]
- Confirmation of CHD was performed according to the practitioners' discretion blinded to the CSG-Index
- Definition of clinical status of CHD: control (exclusion of any signs or symptoms of CHD), minimal subclinical findings of CHD, overt clinical signs and / or symptoms of CHD



(1) Five electrodes are attached to the body for signal recording. (2) The collected data is transmitted to the manufacturer's web service and processed using an AI algorithm. (3) After a few minutes, the result is available in the form of a report.



(A) Positioning of the electrodes in a geometrically predefined position. (B) Extract of characteristic parameters recorded by 5L3DVCG-AI. (C) Neural network architecture: Ensemble of five feedforward neural networks.

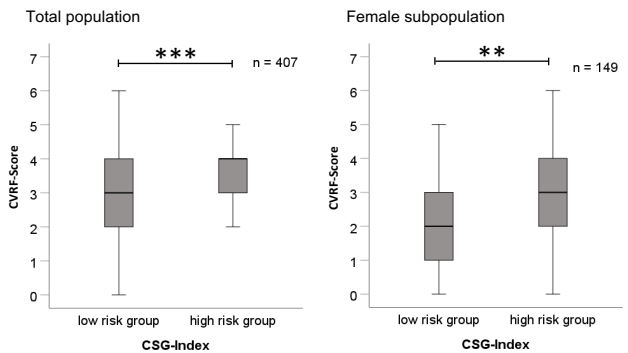
Results

Demographic Data

Patient characteristic	Total population	Female subpopulation
n	407	149
Gender [m:f]	258:149	-
Age [years]	62.9 ± 13.8	62.2 ± 14.1
Body Mass Index [kg m^{-2}]	26.4 ± 5.6	25.4 ± 6.1
No. of CVRF [3] [CVRF-Score; 0 - 7]	3.1 ± 1.4	2.6 ± 1.4
Smoking	32.0%	26.2%
Diabetes	18.9%	16.1%
Hypertension	64.9%	62.4%
HLP	54.6%	52.4%
Family history	21.4%	23.0%

Inclusion of 468 patients, 407 patients with complete data for analyses. 16% had arrhythmias or conduction disturbances (AF, PM, BBB), 15% had consecutive PCI or CABG

Cardiovascular risk classification with CSG-Index



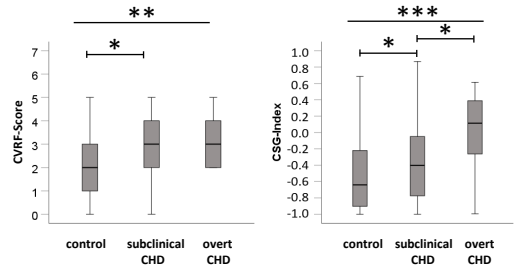
62% were classified as low while 38% were classified as high risk for CHD by the CSG-Index
CVRF-Score was significantly higher in patients with high risk for CHD, including the female subpopulation

Risk estimation with 5L3DVCG-AI in mixed population

CSG-Index reliably identified healthy controls (negative predictive value = 0.91) without signs or symptoms of CHD.

Results

Correlation of CVRF-Score, CSG-Index and clinical status of CHD



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Variables influencing clinical status of CHD

variable	β	T	significance
CSG-Index	0.24	3.34	0.001
CVRF-Score	0.19	2.57	0.011

CSG-Index is better predictor for cardiovascular risk than CVRF-Score

Conclusions

- AI-based 3D-VCG is an innovative diagnostic tool that can help determine a patient's cardiovascular risk in resting condition for clinical and research purposes
- The CSG-Index differentiated those with no signs and symptoms of CHD and patients with CHD and is a better predictor for cardiovascular risk than the classical risk factors
- These preliminary data will have to be confirmed in the ongoing prospective, large-scale performance trial to verify the diagnostic accuracy

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