Comparative analysis of clinical, electrocardiographic, angiographic and echocardiographic data of indigenous and non-indigenous residents of Yakutia with coronary artery atherosclerosis

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Aim. The aim of the study is to compare clinical, angiographic, electrocardiographic, echocardiographic data between indigenous and non-indigenous residents of Yakutia.

Study design. We performed cross-sectional analysis of the Registry of Selective Coronary Angiography (SCAG) of the Yakutsk Republican Hospital for the period from 2004 to 2007. All patients (n = 1,233) were admitted to hospital from all 35 regions of the Sakha Republic (Yakutia). Initially, 12 (1%) patients, who had abnormal coronary arteries and 259 (21%) patients with normal coronary arteries were excluded from this study. From the remaining 962 (78%) patients with detected coronary artery atherosclerosis 394 (41%) patients were excluded for having congenital heart malformations due to possible influence on the outcomes of examination for myocardial hypertrophy. Finally, only 568 patients were selected for further examinations.

Methods. We analyzed clinical data, and the findings of selective angiography, multi-detector computed tomography (CT), electrocardiography (ECG), 24-hour Holter ECG monitoring and echocardiography.

Results. (a) In the Sakha Republic (Yakutia) single-vessel coronary disease, coronary stenosis with 50–75% and 75–90% of constriction were detected more often among indigenous males, while multiple-vessel coronary stenosis was detected more often among non-indigenous males as well as stenosis with more than 90% of constriction. Lower calcium score mean (349.1 ± 129.8 vs. 621.8 ± 115.2) was observed among indigenous patients compared to non-indigenous patients; (b) Painless myocardial infarction, painless ischaemia, arterial hypertension and atrial fibrillation were detected more often among indigenous male compared to non-indigenous participants; (c) Based on the results of ECG and echocardiographic examinations, left ventricular (LV) hypertrophy, particular eccentric type of hypertrophy, was found more commonly among indigenous than non-indigenous males; and (d) By laboratory findings, indigenous males had significantly lower triglyceride levels, while platelet counts were higher compared to non-indigenous patients. Obesity was observed less frequently among indigenous men compared to non-indigenous men.

Conclusion. The differences observed in this study are disputable and call for further studies. Collection of reliable data for women should be the aim of future studies.

Keywords: atherosclerosis; eccentric hypertrophy; indigenous population; non-indigenous population; Yakutia

Until now, quite a lot of epidemiological studies exploring region-specific risk factors for cardiovascular disease have been conducted in the Sakha Republic (Yakutia). Similar to morphological symptoms of atherosclerosis (1), risk factors for cardiovascular disease have been shown to be more prevalent among non-indigenous population of Yakutia (2–5).

Materials and methods
We performed cross-sectional analysis of the Registry of Selective Coronary Angiography (SCAG) of the Yakutsk Republican Hospital for the period from 2004 to 2007. All patients (n = 1,233) were admitted to hospital from all 35 regions of the Sakha Republic (Yakutia). Initially, 12 (1%) patients who had abnormal coronary arteries and 259
(21%) patients with normal coronary arteries were excluded from this study. From the remaining 962 (78%) patients with detected coronary artery atherosclerosis, 394 (41%) patients were excluded for having congenital heart malformations due to possible influence on the outcomes of examination for myocardial hypertrophy. Finally, only 568 patients were selected for further examinations. All subjects gave informed consent.

For the purpose of comparative study, patients with coronary artery atherosclerosis were divided into 2 groups (N = 568):

Group 1 included representatives of indigenous population (n = 286), 266 of them were men (mean age: 54.2 ± 0.5 years) and 20 were women (mean age: 55.0 ± 1.6 years);

Group 2 included representatives of non-indigenous population (n = 282), 234 of them were men (mean age: 52.6 ± 0.6 years) and 48 were women (mean age: 55.3 ± 1.1 years).

Indigenous population included Yakuts, Evenks, Evens and Dolgans; non-indigenous population included Russians, Ukrainians, Byelorussians and others. Ethnicity of the patients was determined based on passport information (Table I).

**Clinical examination**

Clinical diagnosis of angina pectoris, arterial hypertension and chronic heart failure were established using angiographic, electrocardiographic, echocardiographic, laboratory examination methods in compliance with the Russian Society of Cardiology (RSC) guidelines.

Atrial fibrillation (AF) was determined based on documented clinical spontaneous AF episodes, findings of electrocardiography (ECG) and 24-hour Holter ECG monitoring. We used transoesophageal echocardiography (TEE) to detect left atrial appendage thrombi in patients with AF.

Type 2 diabetes mellitus was established based on documented regular medical records of the patients, who were followed-up on a regular basis in the Endocrinology Clinic (Dispensary).

**Functional examination methods**

SCAG was performed using conventional Judkins method, and Axiom Artis BA angiography system (Siemens, Germany). We visually assessed types of coronary circulation (right coronary, left coronary or general) and number of diseased arteries (1-vessel, 2-vessel or 3-vessel involvement). Severity of stenosis was determined by means of quantitative coronary angiography, using following coronary angiographic classification: stage 1 – <50% stenosis; stage 2 – 50–75% stenosis; stage 3 – 75–90% stenosis; stage 4 – >90% stenosis.

Multi-detector CT was performed by using Somatom Sensation-4 scanner (Siemens) and included calculation of total calcium score. We used integrated software for automated quantitative analysis and employed conventional Agatston method (1990), which defined coronary calcification as an area with maximum density greater than 130 Hounsfield units (HU). Each calcified plaque in every slice was marked. Individual calcium scores for major coronary arteries and patient’s total calcium score (expressed as the sum of calcium scores in all CT slices) were quantified automatically. Degree of calcification was expressed as total calcium score.

Standard 12-lead ECG was performed with the speed of 25 mm/s, using EK 512 equipment (Hellige). ECG results showing the presence of blocks, pacemaker, or Wolff-Parkinson-White syndrome (WPW) were excluded from the analysis.

**Table I. Patient examination: methods and number of procedures**

| Patient examination methods | Indigenous |   | Non-indigenous |   |
|----------------------------|------------|---|----------------|---|
|                            | M          | F |                |   |
| Clinical examination, smoking, body mass index | 266        | 20 | 234            | 48 |
| Total cholesterol, LDL, HDL, triglyceride levels | 266        | 20 | 234            | 48 |
| Haemostatic parameters (platelets, fibrinogens) | 234        | 20 | 213            | 48 |
| Selective coronary angiography (SCAG) | 266        | 20 | 234            | 48 |
| Multi-detector CT | 26         | 10 | 37             | 12 |
| Electrocardiography | 266        | 20 | 234            | 48 |
| Holter monitoring (ECG) | 125        | 16 | 127            | 23 |
| Echocardiography | 202        | 20 | 189            | 48 |
| Transoesophageal echocardiography (TEE) | 80         | 50 | 10             | 8  |

LDL, low-density lipoprotein; HDL, high-density lipoprotein; CT, computed tomography; ECG, electrocardiography.
The following voltage criteria for left ventricular (LV) hypertrophy were calculated: Sokolow-Lyon index ($S_{VL} + R_{V5(V6)}$), Gubner-Ungerleider criterion ($R_1 + S_{NI}$), Cornell voltage ($R_{V5(V6)} + S_{V3}$), Cornell product $[(R_{V5(V6)} + S_{V3} + 6 \text{ in females})] \times QRS$ duration. The following were the signs of LV hypertrophy: $R_{V5(V6)} > 11 \text{ mm}$, $R_{V5(V6)} \geq 27 \text{ mm}$, Sokolow-Lyon $\geq 35 \text{ mm}$, Gubner-Ungerleider $> 25 \text{ mm}$, Cornell voltage $> 28 \text{ mm}$ in males and $> 20 \text{ mm}$ in females, Cornell product $> 2,440 \text{ mm/ms}$ (6,7).

For 24-hour Holter ECG monitoring, patients were thoroughly instructed to accurately comply with the recommended monitoring protocol. Patients kept detailed record of activities and symptoms in their diaries throughout Holter monitoring period. Depression specific for ischaemia (horizontal or downsloping depression of ST segment for $\geq 0.08 \text{ s}$ after the J point) or ST segment elevation of $1 \text{ mm}$ persisting for $\geq 1 \text{ min}$ with return to baseline for at least $1 \text{ min}$ between the episodes was considered as an episode of ischaemia.

Echocardiography was performed using a conventional method. We used the following formula to calculate myocardial mass, as recommended by the American Society of Echocardiography (ASE): LV mass = $0.8 \times (1.04(LVIDd + PWTd + SWTd)^2 - (LVIDd)^3) + 0.6 \text{ g}$. All values were indexed to body surface area.

**Laboratory tests**

Laboratory tests included analysis of platelet counts, levels of fibrinogen, glucose, total cholesterol and cholesterol fractions.

**Table II.** Clinical characteristics of patients with coronary atherosclerosis, Yakutia

| Clinical parameters               | Males n = 266 (%) | Females n = 234 (%) | p     | Males n = 20 (%) | Females n = 48 (%) | p     |
|----------------------------------|-------------------|---------------------|-------|------------------|-------------------|-------|
| Age                              | 54.2 ± 0.5        | 52.6 ± 0.6          | 0.777 | 55.0 ± 1.6       | 55.3 ± 1.1        | 0.412 |
| Smoking (%)                      | 109 (41.0)        | 98 (41.9)           | 0.777 | 10 (50.0)        | 18 (37.5)         | 0.412 |
| Obesity, BMI ≥30 kg/m² (%)       | 82 (30.8)         | 92 (39.3)           | 0.047 | 4 (20.0)         | 32 (66.7)         | 0.001 |
| Myocardial infarction (%)        | 167 (62.8)        | 145 (62.0)          | 0.851 | 14 (70.0)        | 34 (70.8)         | 0.945 |
| Painless myocardial infarction (%)| 141 (53.0)       | 99 (42.3)           | 0.024 | 4 (20.0)         | 11 (22.9)         | 0.846 |
| Age at the time of myocardial infarction, M ± m | 51.2 ± 0.6     | 50.6 ± 0.6          | 0.269 | 48.3 ± 1.6       | 52.9 ± 0.8        | 0.010 |
| Arterial hypertension (%)        | 245 (82.1)        | 187 (79.9)          | 0.001 | 20 (100.0)       | 48 (100.0)        | 0.743 |
| Atrial fibrillation (%)          | 75 (28.2)         | 48 (20.5)           | 0.047 | 5 (25.0)         | 4 (8.3)           | 0.069 |
| Type 2 diabetes mellitus (%)     | 51 (19.2)         | 53 (22.6)           | 0.360 | 5 (25.0)         | 13 (27.1)         | 0.860 |
| Left atrial appendage thrombi (%)| 25 (10.5)         | 10 (4.7)            | 0.025 | –                | –                | –     |
| Post-infarction aneurysm (%)     | 45 (16.9)         | 30 (12.8)           | 0.187 | 4 (20.0)         | 8 (16.7)          | 0.743 |
| Heart failure (New York Heart Association) | 84 (31.6)  | 70 (29.9)           | 0.687 | 6 (30.0)         | 9 (18.8)          | 0.308 |
| Class I                          | 129 (48.5)        | 111 (47.4)          | 0.813 | 10 (50.0)        | 26 (54.2)         | 0.754 |
| Class III                        | 53 (19.9)         | 53 (22.6)           | 0.457 | 4 (20.0)         | 13 (27.1)         | 0.539 |
| Class IV                         | –                 | –                   | –     | –                | –                | –     |

BMI, body mass index.

**Statistical analysis**

Statistical analysis was done using standard SPSS software package (Version 11.5). The results were presented as $M \pm m$ (M denotes arithmetic mean, m denotes standard deviation; 95% CI denotes 95% confidence interval). Normality of distribution of the quantitative variables was tested by Kolmogorov-Smirnov test. As the variables had mostly non-normal distribution, we employed non-parametric Mann-Whitney test to test statistical significance of the differences in median quantitative variables between 2 ethnic groups; qualitative variables were tested by Pearson’s $\chi^2$-test for independent samples. Hypotheses were tested for 95% CI ($p < 0.05$).

**Results**

Clinical analysis showed that arterial hypertension ($p = 0.001$), AF ($p = 0.047$), left atrial appendage thrombi ($p = 0.025$) and myocardial infarction without a previous history of angina pectoris ($p = 0.024$) were found more often among indigenous males than non-indigenous. Patients had no differences in occurrence of myocardial infarction in previous histories, age at the time of past myocardial infarction, or in rates of type 2 diabetes mellitus (Table II).

Analysis of SCAG results had shown that single-vessel coronary disease was detected more often among indigenous males, as well as coronary stenosis with 50–75% and 75–90% of constriction; while multiple-vessel coronary stenosis was detected more often among non-indigenous males as well as stenosis with more than 90%
constriction. Average number of diseased arteries was 2.1 ± 0.1 vs. 2.4 ± 0.1; p < 0.001, respectively (Table III).

Total calcium scores based on multi-detector CT results were found to be significantly lower among indigenous males than among non-indigenous males: 349.1 ± 129.8 vs. 621.8 ± 115.2 units, respectively (p < 0.011).

All voltage signs of LV hypertrophy among males were detected more often among indigenous patients (Table IV). LV hypertrophy with the presence of one or more voltage signs was found in 55% of indigenous males and in 29% of non-indigenous males (p < 0.001).

Based on the results of Holter ECG monitoring, episodes of painless ischaemia occurred more often among indigenous males compared to painful ischaemia episodes (63 vs. 38%; p < 0.028).

Among males all cardiac structure–function indicators were found to be significantly higher among indigenous patients than among non-indigenous (Table V). Eccentric type LV hypertrophy was detected more commonly among indigenous versus non-indigenous males (64% vs. 47%; p = 0.001).

Laboratory results showed that triglyceride levels were significantly lower among indigenous males, however, platelet count was significantly higher among indigenous patients, both men and women, compared to non-indigenous patients (Table VI).

### Table III. Incidence and stages of stenosis (coronary artery disease) among Yakutia residents (n in %)

| Stages of coronary stenosis | Males | | Females | |
|-----------------------------|-------|------------------|---------|------------------|
|                             | I     | NI n = 266 (%)   | p       | NI n = 234 (%)   | p       |
| <50%                        | 33 (12.5) | 28 (12)         | 0.880  | 2 (10.0)         | 0.771  |
| 50–75%                      | 48 (18.0) | 27 (11.5)       | 0.042  | 7 (35.0)         | 0.101  |
| 75–90%                      | 76 (28.6) | 52 (22.2)       | 0.105  | 4 (20.0)         | 0.437  |
| >90%                        | 109 (40.9) | 127 (54.3)     | 0.003  | 7 (35.0)         | 0.610  |

### Table IV. Incidence of left ventricular hypertrophy in patients with coronary atherosclerosis residing in Yakutia (by echocardiographic findings)

| Voltage signs of LV hypertrophy | Males, n (%): I n = 200 (%) vs. NI n = 174 (%) | Females, n (%): I n = 16 (%) vs. NI n = 42 (%) |
|---------------------------------|-----------------------------------------------|-----------------------------------------------|
| R<sub>AVL</sub> >11 mm          | 54 (27.0) vs. 16 (9.2) p = 0.001              | 3 (18.8) vs. 6 (14.3) p = 0.675               |
| Cornell voltage                 | 38 (19.0) vs. 14 (8.0) p = 0.002              | 5 (31.3) vs. 10 (23.8) p = 0.563              |
| Cornell product                 | 76 (38.0) vs. 34 (19.5) p = 0.001             | 7 (43.8) vs. 12 (28.6) p = 0.271              |
| Sokolow-Lyon index              | 36 (18.0) vs. 18 (10.3) p = 0.036             | 3 (18.8) vs. 8 (19.0) p = 0.979               |
| R<sub>VSVR</sub> ≥27 mm         | 28 (14.0) vs. 14 (8.0) p = 0.069              | 2 (12.5) vs. 2 (4.8) p = 0.299                |
| Gubner-Ungerleider index (R<sub>l</sub> + S<sub>III</sub>) | 26 (13.0) vs. 6 (3.4) p = 0.001              | 2 (12.5) vs. 2 (4.8) p = 0.299                |

### Discussion

Less severe coronary artery disease among indigenous population correlated with the previous epidemiological studies conducted among healthy population in Yakutia. Possible explanation of similar frequencies of myocardial infarctions among indigenous and non-indigenous patients with presence of less severe atherosclerosis among the indigenous population could be the following: acute coronary events among the indigenous population were associated with thrombi (clot) and with high platelet count rather than with the severity of coronary stenosis. Predisposition to thrombi development among the indigenous population may be suggested, but this must be further investigated.

High incidences of painless ischaemia and of myocardial infarctions without angina pectoris in the indigenous population had been noted by other researchers from Yakutia, but reasons for this had remained incompletely understood (8). Personal characteristics, social status and cultural characteristics had an important role to play.

The observed high incidence of LV hypertrophy and relatively enlarged heart chambers in indigenous patients correlated with population studies conducted in Chukotka. Based on echocardiographic findings in those studies, LV hypertrophy had been detected 2–2.5 times more
often in a group of indigenous population of coastal villages than among indigenous population of an urban area, Novosibirsk city (9). High incidence of arterial hypertension among indigenous males can be named as one of the reasons for LV hypertrophy (10). It should be noted, that arterial hypertension was also thought to be a typical “adaptation disease”. And the patterns, in which such diseases progress, depended on many factors: climatic, ecological, heliophysical and psychosocial factors (9–12).

Conclusions

a. In the Sakha Republic (Yakutia) single-vessel coronary disease, coronary stenosis with 50–75% and 75–90% of constriction were detected more often among indigenous males, while multiple-vessel coronary stenosis was detected more often among non-indigenous males as well as stenosis with more than 90% of constriction. Lower calcium score mean (349.1 ± 129.8 vs. 621.8 ± 115.2) was observed among indigenous patients compared to non-indigenous patients;

b. Painless myocardial infarction, painless ischaemia, arterial hypertension, AF were detected more often among indigenous male compared to non-indigenous males;

c. Based on the results of ECG and echocardiographic examinations, LV hypertrophy, particular eccentric type of hypertrophy, was found more commonly

Table V. Mean echocardiographic values in patients with coronary atherosclerosis resining in Yakutia, M ± m

| Indicator                        | Indigenous   | Non-indigenous | p    |
|----------------------------------|--------------|----------------|------|
|                                 | M ± m        | 95% CI         | M ± m| 95% CI |     |
| Males                            | n = 236      | 1.99–2.09      | 1.89–1.97| 0.002   |
| LAD index (sm/m²)                | 2.05 ± 0.03  | 1.93 ± 0.02    | 1.89–1.97| 0.002   |
| SWT index (sm/m²)                | 0.62 ± 0.01  | 0.57 ± 0.01    | 0.56–0.59| 0.002   |
| LVPWT index (sm/m²)              | 0.64 ± 0.01  | 0.59 ± 0.01    | 0.58–0.61| 0.001   |
| IDd index (sm/m²)                | 2.03 ± 0.03  | 1.88 ± 0.29    | 1.82–1.94| 0.001   |
| LVMM index (g/m²)                | 141.0 ± 2.4  | 132.6 ± 2.8    | 127.1–138.0| 0.003   |
| EDV index (mL/m²)                | 82.2 ± 1.7   | 76.7 ± 1.7     | 73.3–80.1| 0.015   |
| ESV index (mL/m²)                | 34.2 ± 1.3   | 31.8 ± 1.2     | 29.4–34.2| 0.113   |
| SI (mL/m²)                       | 47.1 ± 0.8   | 43.8 ± 0.6     | 42.6–44.9| 0.002   |
| CI (L/min/m²)                    | 3.0 ± 0.1    | 3.0 ± 0.1      | 2.9–3.2  | 0.147   |
| LV hypertrophy, eccentric        | 70 (34.7)    | 40 (21.2)      |       | 0.003   |
| LV hypertrophy, concentric       | 60 (29.7)    | 48 (25.4)      |       | 0.342   |
| Normal geometry                  | 62 (30.6)    | 75 (39.6)      |       | 0.063   |
| Concentric remodeling            | 10 (5.0)     | 26 (13.8)      |       | 0.003   |
| EF%                              | 59.7 ± 0.7   | 59.4 ± 0.8     | 57.8–61.1| 0.723   |

LAD, left atrial dimension; SWT, interventricular septal thickness; LVPWT, left ventricular posterior wall thickness; IDd, internal end-diastolic dimension; LVMM, left-ventricular myocardial mass; ESV, end-systolic volume; EDV, end-diastolic volume; SI, stroke index; CI, cardiac index; EF, ejection fraction.

Citation: Int J Circumpolar Health 2013, 72: 21219 - http://dx.doi.org/10.3402/ijch.v72i0.21219
Table VI. Mean laboratory findings in patients, who had ischaemic heart disease with coronary atherosclerosis, residing in Yakutia

| Indicator                  | Males, M±m       | Females, M±m       |
|----------------------------|------------------|--------------------|
|                            | (n = 266)        | (n = 234)          | (n = 20)          | (n = 48)          | p      |
| Leucocytes (10^9/L)        | 6.1±0.2          | 6.4±0.2            | 5.8±0.6          | 5.7±0.4          | 0.884  |
| Platelets (10^9/L)         | 216.4±5.8        | 185.8±4.7          | 275.1±43.6       | 200.3±12.5       | 0.050  |
| ESR (mmHg)                 | 13.2±0.9         | 12.3±1.0           | 23.6±3.0         | 20.3±3.5         | 0.403  |
| Glucose level (mmol/L)     | 5.82±0.14        | 5.81±0.13          | 5.6±0.4          | 6.4±0.5          | 0.575  |
| Fibrinogen level (g/L)     | 3.45±0.09        | 3.56±0.11          | 4.02±0.52        | 3.9±0.29         | 0.770  |
| Total cholesterol (mmol/L) | 4.8±0.1          | 4.9±0.1            | 5.2±0.3          | 5.5±0.2          | 0.169  |
| HDL (mmol/L)               | 0.97±0.03        | 0.90±0.03          | 0.90±0.02        | 0.95±0.01        | 0.358  |
| LDL (mmol/L)               | 3.12±0.06        | 3.22±0.09          | 3.32±0.26        | 3.55±0.12        | 0.178  |
| Triglycerides (mmol/L)     | 1.45±0.03        | 1.56±0.04          | 1.53±0.08        | 1.64±0.06        | 0.106  |

ESR, erythrocyte sedimentation rate; HDL, high-density lipoprotein; LDL, low-density lipoprotein.

among indigenous than non-indigenous participants; and
d. By laboratory findings, indigenous men had significantly lower triglyceride levels, while platelet counts were higher compared to non-indigenous patients. Obesity was observed less frequent among indigenous men compared to non-indigenous men.

Limitations
This study was conducted without regard to patient compliance, alcohol consumption and physical activity. It must be noted, that indigenous patients were mostly from regions with highly unfavorable access to medical services. The study results regarding women were not very reliable due to small sample size. The differences observed in this study are disputable and call for further studies as well as the collection of reliable data for women. No multivariate analysis was done. All these limitations could have influence on the results.

Acknowledgements
The authors express their sincere gratitude to Nikitin Yu. P., Academician of RAMS, for the discussion of results. The authors are sincerely grateful to the team of the Yakut Scientific Center for Complex Medical Problems (YSC CMP SB RAMS), and to all the doctors, who participated in this study.

Conflict of interest and funding
The authors have not received any funding or benefits from industry or elsewhere to conduct this study.

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