CORELAȚII ÎNTRE ASPECTELE IMAGISTICE, EVALUAREA FFR A PLĂCILOR ATEROSCLEROTICE ȘI EVOLUȚIA PACIENȚILOR CU SINDROAME CORONARIENE ACUTE

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Introduction

Cardiovascular diseases (CVD) remain the leading cause of death globally (≈17.9 million/year), most commonly due to acute myocardial infarction (AMI) and stroke, with an economic impact exceeding USD 1 trillion per year. The "classic" risk factors—hypertension, dyslipidemia, diabetes, smoking, obesity, and physical inactivity—account for over 80–90% of coronary events, and the INTERHEART study confirmed their universality. The main substrate is atherosclerosis, a chronic inflammatory–metabolic disease whose plaque instability leads to acute thrombosis. In Eastern Europe (including Romania), a disproportionate burden persists compared with Western Europe, driven by poor risk-factor control and unequal access to prevention and revascularization. Added to these determinants is the "residual risk" (low-grade inflammation, lipoprotein(a), genetic susceptibility, dysbiosis). Sex differences are striking: men experience earlier onset; in women, incidence rises after menopause, with more atypical presentations and higher post-STEMI mortality.

Thesis Hypothesis and Objectives

The thesis starts from the hypothesis that acute coronary syndromes (ACS) require an integrated evaluation—clinical, intracoronary imaging, and demographic—to enable finer risk stratification and personalized therapeutic decision-making, with impact on short- and long-term prognosis. Three sub-studies operationalize this hypothesis:

1. The combined value of fractional flow reserve (FFR) and optical coherence tomography (OCT) in multivessel disease and their influence on revascularization decisions;
2. Differences between STEMI and NSTEMI regarding acute complications and anatomic patterns;
3. The role of sex in the occurrence of de novo atrial fibrillation (NOAF) in STEMI and the associated risk profile.

Cohorts, Criteria, and Analysis

Populations were drawn from a university interventional center. Consecutive patients with ACS (STEMI/NSTEMI) confirmed clinically, by ECG, and by biomarkers, and treated with coronary angiography/percutaneous coronary intervention (PCI) per ESC/AHA–ACC guidelines were included. Collected variables comprised demographics, risk factors, biomarkers (troponin, CK-MB, lipid profile, NT-proBNP), renal function, and echocardiographic parameters (LVEF). Study designs were: prospective randomized (FFR vs. FFR+OCT) in multivessel disease; retrospective comparative (STEMI vs. NSTEMI; sex-specific in STEMI). Statistical analyses used parametric/non-parametric tests, χ^2, and multivariable logistic regression ($p<0.05$).

Sub-study 1 – FFR + OCT in Multivessel Disease

Design: prospective, randomized, single-center; 36 patients with ACS and bi/tri-vessel disease allocated 1:1 to FFR-guided vs. FFR+OCT guidance for non-culprit lesions.

Procedures: FFR with PressureWire X; intracoronary adenosine; decision algorithm: revascularize for FFR<0.80; in the FFR+OCT arm, plaque morphology (vulnerability) could change the decision even with FFR≥0.80.

Key results: Baseline characteristics, lesion counts, and territorial distribution were comparable. OCT significantly increased the need for post-implant stent optimization (44.4% vs. a single case in FFR-only; p=0.0178) and changed management in 11 cases with FFR≥0.80 due to vulnerable plaques; overall, decision changes (implant vs. no implant) were significantly more frequent with FFR+OCT (p=0.0153; implant-only p=0.0006). Lesions with OCT-driven decision changes involved the RCA, LAD, and LCx in similar proportions.

Interpretation: FFR remains the standard for ischemic relevance but may "miss" plaque vulnerability. OCT adds critical morphological information (thin fibrous cap, rupture/erosion, large lipid core), refining PCI decisions and optimizing procedural outcomes. **Limitations:** potential risk of "over-stenting," single-center, no long-term follow-up, no cost-effectiveness assessment.

Sub-study 2 – Complications in STEMI vs. NSTEMI

Design: retrospective; 172 patients (STEMI n=108; NSTEMI n=64), April–July 2021; objective: ventricular arrhythmias and hemodynamic instability.

Key results:

- **Demographics/comorbidities:** slightly higher age in NSTEMI; similar sex distribution; prior ACS more frequent in NSTEMI (p=0.011); chronic smoking more frequent in STEMI; hypertension prevalent in both.
- **Biomarkers/function:** numerically higher hscTnI and NT-proBNP in STEMI, not significant; LVEF comparable.
- **Culprit anatomy:** LAD most frequent in both; **RCA** more involved in STEMI; **left main (LM)** far more frequent in NSTEMI (≈47% vs. ≈2%; p<0.0001).
- **Complications: hemodynamic instability** significantly more common in NSTEMI (≈10.9% vs. ≈0.18%; p=0.005); **ventricular arrhythmias** overall similar, with an **LCx–arrhythmia** association in NSTEMI (p=0.0001). **Interpretation:** Although STEMI has a dramatic acute profile, NSTEMI patients often have complex multivessel/LM disease and comorbidities, explaining more frequent hemodynamic instability and worse long-term risk. Findings support differentiated strategies: STEMI—rapid revascularization and prevention of immediate complications; NSTEMI—complex management focused on extensive anatomy and comorbidities.

Sub-study 3 – Sex and NOAF in STEMI

Design: retrospective, single-center; 109 STEMI patients treated by PCI (April–July 2022); women (n=28) vs. men (n=81). **Key results:**

- **Age:** women older (66.5 vs. 59.6 years; p=0.0148).
- **Risk/biomarkers:** smoking more frequent in men (47% vs. 21%; p=0.0002); dyslipidemia more frequent in men, but mean total cholesterol higher in women; **NT-proBNP** significantly higher in women (p=0.0045); LVEF similar.
- **Culprit anatomy: LCx** involvement significantly more frequent in women (25% vs. 8%; p=0.002); RCA more frequent in men (trend).
- **NOAF:** overall ≈18%; **women nearly double vs. men** (29% vs. 15%; p=0.02). In multivariable regression, **age**, **smoking**, and **higher total cholesterol** independently predicted AF; sex remained significant (negative coefficient for male), indicating higher risk in women.

Interpretation: The NOAF risk profile in STEMI is sex-dependent; women—older, higher NT-proBNP, more frequent LCx culprit—require intensified rhythm surveillance acutely and post-discharge. Results support integrating sex-specific factors into risk scores and monitoring protocols.

General Conclusions and Originality

The thesis demonstrates the utility of an **integrated model** (clinical + imaging + demographic) in ACS:

- **FFR+OCT** changes decisions and optimizes PCI by identifying vulnerable plaque beyond ischemia (FFR), with meaningful procedural impact.
- **NSTEMI** is not a "milder" entity: LM disease and hemodynamic instability are more common, requiring individualized management focused on anatomic complexity and comorbidities.
- **Sex** influences NOAF in STEMI: women are at higher risk, with implications for monitoring and prevention.

Originality lies in the **integrative approach** across three axes—functional–anatomic morphology (OCT+FFR), clinical phenotype (STEMI vs. NSTEMI), and demographic biology (sex)—converging toward **precision medicine** in interventional cardiology. Practical implications include systematic incorporation of OCT for selected non-culprit lesions, more aggressive triage of NSTEMI with complex/LM disease, and sex-specific protocols for NOAF detection. Multicenter validation, long-term follow-up, and cost-effectiveness analyses are warranted to support broad implementation.