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RESEARCH ARTICLE

# Role of Virtual Histology Intravascular Ultrasound in Detecting Subclinical High-Risk Plaques in Acute Coronary Syndrome

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## ABSTRACT

**Background:** Vulnerable plaques that may not be angiographically noteworthy can rupture and cause acute coronary syndrome (ACS). High-risk characteristics can be identified and the composition of plaque can be thoroughly characterized using Virtual Histology Intravascular Ultrasound (VH-IVUS).

**Objective:** To evaluate the role of VH-IVUS in detecting subclinical high-risk plaques in ACS patients.

**Methods:** A prospective observational study was conducted over one year involving 50 ACS patients. VH-IVUS was used to assess plaque composition and identify features of vulnerability such as thin-cap fibroatheroma (TCFA).

**Results:** VH-IVUS detected high-risk plaques in 72% of patients, including non-culprit lesions. No significant correlation was observed between traditional risk factors and presence of high-risk plaques ($p > 0.05$).

**Conclusion:** VH-IVUS is a valuable tool in identifying subclinical high-risk plaques in ACS patients, potentially improving risk stratification beyond conventional methods.

**Keywords:** VH-IVUS, high-risk plaques, risk stratification, conventional methods, thin-cap fibroatheroma

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## Introduction

A variety of clinical symptoms brought on by acute myocardial ischemia, such as unstable angina, NSTEMI, and STEMI, are collectively referred to as acute coronary syndrome (ACS). Most of the time, thrombus development and subsequent coronary artery obstruction are caused by the rupture or erosion of susceptible atherosclerotic plaques[1]. Coronary angiography has long been the gold standard for diagnosing coronary artery disease, although it mainly assesses luminal constriction and offers little insight into the composition of plaque. Recent developments in intracoronary imaging have improved our knowledge of the susceptibility and shape of plaque. Virtual Histology Intravascular Ultrasound (VH-IVUS) is one of these modalities that enables precise identification of the components of plaque, such as thick calcium, fibrous tissue, fibrofatty tissue, and necrotic core[2].

High-risk plaques like thin-cap fibroatheromas (TCFA), which are prone to rupture even when they do not produce severe luminal stenosis, can be identified thanks to this technology. There is growing evidence that angiographically mild or moderate lesions with high-risk characteristics are the source of many acute coronary events. Consequently, the actual load of susceptible plaques may be underestimated if traditional imaging methods are the only ones used. Additionally, even though they play a significant role in the formation of atherosclerosis, traditional cardiovascular risk factors like smoking, diabetes, hypertension, and dyslipidemia may not accurately predict plaque instability[3]. By offering insights into plaque biology rather than merely anatomy, VH-IVUS has emerged as a promising method to close this gap. It makes

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it possible to identify asymptomatic high-risk plaques that could otherwise go undetected, providing a chance for better risk assessment and early management. Better diagnostic techniques are required to detect high-risk individuals in the Indian population, where the prevalence of cardiovascular disease is rising quickly. Nevertheless, there is still a dearth of information about VH-IVUS use in ACS patients. The goal of the current study is to determine how well VH-IVUS detects subclinical high-risk plaques in individuals with ACS and how well it correlates with conventional cardiovascular risk variables[4].

## Methods

- Study Design: Prospective observational study
- Duration: 1 year
- Sample Size: 50 patients
- Setting: SMS Medical College and Hospital

## Inclusion Criteria

- Patients diagnosed with ACS
- Age ≥ 18 years
- Undergoing coronary angiography with VH-IVUS

## Exclusion Criteria

- Previous CABG
- Severe renal dysfunction
- Hemodynamic instability

## Procedure

- Coronary angiography followed by VH-IVUS
- Assessment of plaque composition
- Identification of TCFA and high-risk plaques

## Statistical Analysis

- Chi-square test
- p-value < 0.05 considered significant

# Results

**Table 1:** Baseline Characteristics

| *Variable* | *Value* |
|---|---|
| Mean Age | 58 ± 9 years |
| Male | 36 (72%) |
| Female | 14 (28%) |

**Table 2:** Risk Factor Distribution

| *Risk factor* | *Frequency (%)* |
|---|---|
| Hypertension | 28 (56%) |
| Diabetes Mellitus | 22 (44%) |
| Smoking | 32 (64%) |
| Dyslipidemia | 24 (48%) |

**Table 3:** VH-IVUS Findings

| *Parameter* | *Value (%)* |
|---|---|
| High-risk plaques | 36 (72%) |
| TCFA | 30 (60%) |
| Necrotic core-rich plaques | 34 (68%) |
| Non-culprit vulnerable plaques | 26 (52%) |

**Table 4:** Association with High-Risk Plaques

| *Risk factor* | *p-value* |
|---|---|
| Hypertension | 0.58 |
| Diabetes Mellitus | 0.46 |
| Smoking | 0.63 |
| Dyslipidemia | 0.51 |

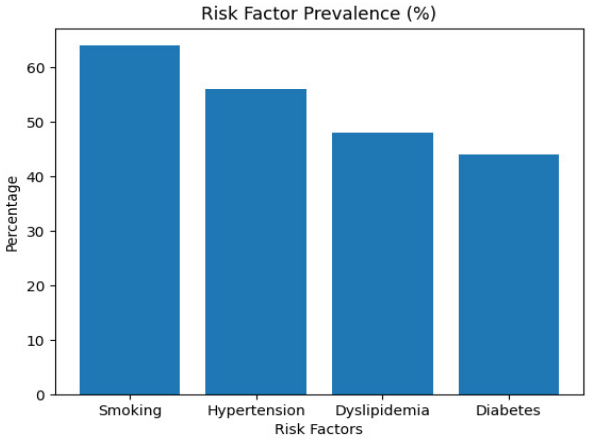


**Figure 1:** Risk factors prevalence

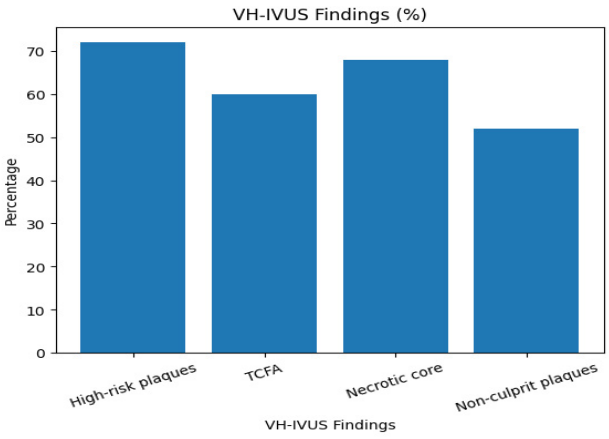


**Figure 2:** VH-IVUS findings

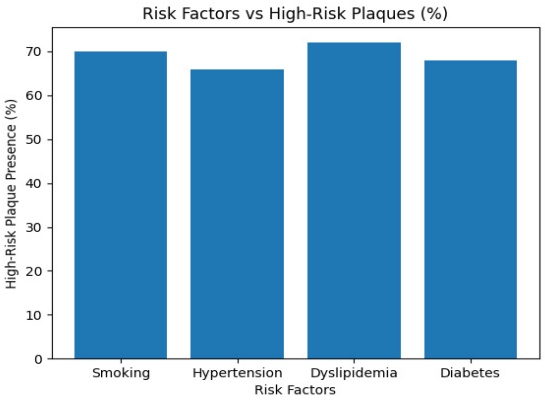


**Figure 3:** Risk factors Vs high risk plaques

## Discussion

The effectiveness of Virtual Histology Intravascular Ultrasound (VH-IVUS) in identifying subclinical high-risk plaques in individuals with acute coronary syndrome was assessed in this study. The results show that vulnerable plaque features, including lesions that are not angiographically severe, can be detected by VH-IVUS in a considerable percentage of patients. One important finding in this study was that 60% of patients had thin-cap fibroatheromas (TCFA), which are known to be precursors of plaque rupture, and 72% of patients had high-risk plaques. Significantly, several of these high-risk plaques were found in non-culprit segments, underscoring the widespread nature of atherosclerosis and the limits of traditional angiography in identifying susceptible lesions. It is noteworthy that high-risk plaque characteristics do not significantly correlate with established cardiovascular risk factors[5].

Despite being known causes of atherosclerosis, risk variables such dyslipidemia, diabetes mellitus, smoking, and hypertension did not substantially correlate with plaque vulnerability in this group. The idea that local biological processes, including as inflammation, endothelial dysfunction, and extracellular matrix degradation, have a greater impact on plaque instability than systemic risk factors alone is supported by this finding. Despite being the most common risk factor in the study population, smoking did not exhibit a statistically significant correlation with the identification of high-risk plaque[6]. This implies that although smoking speeds up atherosclerosis, its impact on plaque composition and vulnerability may be mediated via intricate inflammatory pathways that were not specifically examined in this study.Similarly, the existence of susceptible plaques was not predicted by diabetes mellitus or dyslipidemia, which are known to encourage lipid accumulation and plaque formation[7].

This may suggest that rather than instability, metabolic risk factors are the main cause of plaque accumulation. VH-IVUS has a major advantage over conventional imaging methods due to its capacity to identify TCFA and necrotic core-rich plaques. Before clinical events occur, VH-IVUS enables clinicians to identify lesions at high risk of rupture by seeing the composition of the plaque. This has significant ramifications for preventive measures, such as more intensive medical treatment and vigilant observation[8]. The study does have several drawbacks, though. The study was carried out at a single location and had a rather small sample size, which may restrict generalizability. Furthermore, although while VH-IVUS is quite informative, its resolution is lower than that of more recent modalities like optical coherence tomography (OCT). The findings highlight the therapeutic value of VH-IVUS in detecting asymptomatic high-risk plaques despite these drawbacks. In order to create more thorough risk prediction models, future studies should concentrate on combining VH-IVUS results with biomarkers and genetic profiles[9].

## Conclusion

The importance of Virtual Histology Intravascular Ultrasound in identifying subclinical high-risk plaques in patients with acute coronary syndrome is demonstrated by this prospective observational study. In most patients, VH-IVUS was able to detect susceptible plaque features, such as thin-cap fibroatheromas and necrotic core-rich lesions, many of which were not visible on traditional angiography. The lack of a strong correlation between plaque vulnerability and conventional cardiovascular risk variables raises the possibility that the risk assessment algorithms used today are inadequate for forecasting acute coronary events.

These results highlight how crucial it is to integrate cutting-edge imaging modalities into standard clinical practice in order to enhance the identification of high-risk lesions. VH-IVUS offers the ability to direct focused therapy interventions and enhance patient outcomes by facilitating the early detection of susceptible plaques. Larger multicentre investigations are yet required to confirm these results and create uniform procedures for their use. To sum up, VH-IVUS is a useful supplement to traditional diagnostic methods, providing a deeper understanding of plaque biology and improving the capacity to identify individuals who are more susceptible to unfavourable cardiovascular events.

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