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RESEARCH ARTICLE

ATHEROSCLEROTIC CORONARY PLAQUE REGRESSION: MECHANISMS, INTERVENTIONS, AND CLINICAL OUTCOMES

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ABSTRACT

Background and objectives: Controlling coronary artery plaque regression is essential for the treatment of cardiovascular diseases, as it directly influences patient outcomes. Although advancements have been made in imaging and pharmacotherapy, significant challenges remain in accurately assessing plaque changes and managing associated treatment side effects. This article aimed to explore the current state of coronary artery plaque regression management, including the limitations of existing imaging technologies and the side effects of lipid-lowering treatments, as well as potential future approaches. ***Methods:*** A comprehensive review of the literature was conducted, focusing on advancements in imaging modalities, pharmacological treatments, and patient management strategies for coronary artery disease (CAD). Special attention was paid to the challenges of assessing plaque dynamics and the clinical implications of long-term treatment strategies. ***Results:*** Imaging modalities for plaque assessment continue to face limitations, particularly in providing comprehensive examinations of plaque changes. Although lipid-lowering therapies are effective in reducing plaque burden, they are associated with side effects that affect patient adherence. Long-term lifestyle changes are difficult to maintain, further hindering plaque regression. Despite these challenges, novel medications and an enhanced understanding of plaque biology offer promise for improving treatment outcomes. ***Conclusion:*** Effective management of coronary artery plaque regression remains a critical factor in reducing the global burden of cardiovascular disease. Future treatment strategies should focus on optimizing patient adherence, minimizing the adverse effects of therapy, and leveraging innovative imaging technologies for the more accurate detection and treatment of atherosclerosis. Addressing these challenges will significantly enhance preventive efforts and patient care [1].

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INTRODUCTION

Atherosclerosis, traditionally a degenerative disease that develops with age, involves plaque accumulation in the arterial walls and obstructions of blood flow. This process includes lipid, inflammatory cell, and connective tissue build-up, forming plaques (1). Over time, these plaques can significantly obstruct the arteries, increasing the risk of coronary artery disease and stroke (2) and affect the healthcare system and patient quality of life. We need to deeply understand the mechanisms of plaque formation and regression to develop effective prevention and treatment approaches to reduce the worldwide effects of cardiovascular disease.

Importance of plaque regression in clinical practice

Simplify to Cardiovascular outcomes improve significantly with coronary plaque regression with a reduction in adverse events, such as myocardial infarction and sudden cardiac death (3). Plaque regression is characterized by reduced plaque volume and increased stabilization, making it less prone to rupture and thrombotic complications. Achieving plaque regression with lipid-lowering medications, lifestyle modifications, and evolving treatments has considerably improved patient prognoses.

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Understanding and promoting plaque regression is a key objective in managing coronary artery disease, with the aim of increasing longevity and quality of life. Studies have shown the clinical benefits and potential of therapies aimed at plaque regression, emphasizing the critical role of plaque regression in modern cardiology (4) (5). This paper discusses atheromatous coronary plaque regression, its mechanisms, treatment options, and its clinical consequences. The efficacy of several therapies, including statins, PCSK9 inhibitors, and non-pharmaceutical interventions, such as diet and exercise, in promoting atheroma have been carefully reviewed. It also explains the consequences of plaque regression on patient outcomes, such as decreased rates of myocardial infarction (MI) and improved prognosis. Additionally, the review studies emerging treatments and prospects, including new pharmacological agents and advanced imaging techniques, to enhance patient management approaches and to identify areas that require further research.

Overview of atherosclerotic plaque development: Atheromatous plaques begin with endothelial dysfunction. Low-density lipoprotein (LDL) enters the intima due to disturbed blood flow, and perpetual inflammation activates the endothelium, increasing its permeability. Monocytes and macrophages are attracted by oxidized LDL, which accumulate in the intima. They then convert to lipid-laden foam cells, which constitute the fatty atheroma core of the lesion (6)(7). Plaques grow as cells multiply, and the extracellular matrix is deposited around them, creating fibrous caps, whereas smooth muscle cells migrate from the media into the intima through the atheroma, where

they proliferate, thus contributing to their enlargement. These vulnerable plaques have thin caps of connective tissue covering large quantities of lipid material, making them prone to rupture, initiating thrombus formation and leading to acute ischemic events.

Cellular and molecular mechanisms involved in plaque regression: Plaque regression involves mechanisms such as reversal of lipid accumulation, inflammation, and fibrosis in atherosclerotic plaques. Evidence suggests that reducing inflammation, as indicated by C-reactive protein levels, is linked to plaque stabilization and regression (8). Effective lipid-lowering treatments can decrease the plaque lipid content and reduce the risk of rupture. Studies have indicated that PCSK9 inhibitors reduce atheromatous plaque content by 17% over six months. (9) Macrophages and foam cells play crucial roles. They initially remove lipids but can contribute to plaque growth and become foam cells if overloaded. Promoting macrophage clearance and limiting foam cell formation are essential for reversing plaque build-up (10). Endothelial function is vital for maintaining vessel wall integrity. Impaired cells increase permeability and leukocyte adhesion, thereby worsening plaque formation. Thus, promoting endothelial repair can aid in plaque regression and improve vascular health (11).

Imaging Techniques and Biomarkers for Assessing Plaque Regression Non-invasive imaging modalities: Coronary angiography uses quantitative plaque analysis and fractional flow reserve derived from coronary computed tomography angiography to evaluate plaque regression. Investigations suggest that plaque characteristics, including diameter stenosis, plaque volume, minimum lumen area, and remodeling index, are crucial for assessing plaque progression (12). The accuracy of coronary angiography in identifying and measuring plaque size over time remains questionable, owing to its limitations in plaque visualization and the possibility of unpredictable results. Compared to coronary angiography, intravascular ultrasound (IVUS) provides better imaging of the vessel walls, allowing for more accurate measurements of the vessel lumen and plaque area. These measurements are useful in assessing the effectiveness of lipid-lowering therapies for atherosclerosis (13). IVUS parameters, such as total atheroma volume, percent atheroma volume, and fibrous cap thickness, have been extensively used in clinical studies to assess plaque regression (14). Optical coherence tomography (OCT) is a sophisticated imaging method that can create detailed images of the coronary arteries. This allowed us to study atherosclerotic plaques closely, especially their fibrous cap thickness and lipid content, and whether they had started to ulcerate, as these are all known markers of instability in these deposits. Additionally, this technique may identify features that predict major cardiac events, such as an area on top of cholesterol crystals within fibrous caps, which are also assessed by it, showing whether any change has occurred during regression (15). Coronary computed tomography angiography (CCTA) allows visualization of arterial walls while providing information about plaque development or regression. Radionics analysis applied to CCTA images has demonstrated the capability to identify high-risk plaques with potential risks and could help monitor plaque regression (16). The detection of plaque progression by CCTA, however, still requires improvements and reliability testing before considering it a reliable method for detecting plaque regression (17).

Biomarkers for plaque activity and regression: The blood lipid levels indicate the type and progression of atheromatous plaques in coronary artery disease. Reducing these lipids with statins and ezetimibe significantly reduces plaque formations (18). Elevated High-density lipoproteins (HDLs) are protective against atherosclerosis and may aid in plaque regression, although recent studies have reported mixed results (19). Combining advanced imaging and computational techniques with lipid markers provides a comprehensive method for identifying and monitoring plaque regression in coronary artery disease patients with CAD.

Inflammatory markers: Inflammatory markers are crucial for identifying coronary plaque progression; however, their predictive value for plaque regression is complex and requires further investigation. High-sensitivity C-reactive protein levels are linked to cardiovascular events or plaque development but do not affect plaque regression in patients undergoing intensive lipid-lowering treatments, such as PCSK9 inhibitors (20). These findings suggest that, although inflammatory markers can identify unstable plaques and predict complications, they may not reliably indicate plaque regression. Despite their association with cardiovascular risk, inflammatory markers for predicting plaque regression require further investigation.

Pharmacological Interventions

Statins and their role in plaque regression: Statins have been highly effective in reducing plaque owing to their reduced blood cholesterol and anti-inflammatory effects. It has been shown that high-dose statin treatment lowers peri-coronary adipose tissue reduction, a sign of coronary inflammation. Furthermore, statins reduce the amount of non-calcified plaque while increasing the amount of calcified part of the mixed plaques, indicating that the plaque is stabilized (21). Meta-analyses have shown that statin treatment significantly reduces the total and percentage atheroma volumes. This is likely due to the anti-inflammatory effects of statins, as demonstrated by a reduction in CRP/hsCRP levels (8). Studies have shown that statins can decrease the annual growth in plaque volume by 37% in individuals with high-risk plaque quality. High-intensity statin treatment has been shown to lower low-density lipoprotein (LDL) by more than 50%, which can reduce coronary atheroma (22). These results showed that statins could potentially reduce plaque progression. Statins transform coronary atherosclerosis by increasing high-density calcium levels. This shows that the risk of atherosclerosis decreases because a higher plaque density is linked to slower total plaque progression (23). People treated with statins and PCSK9 inhibitors continue to experience plaque reduction, even if they still have systemic inflammation. This is shown by the fact that this occurred regardless of the initial hs-CRP levels (20). These results show that long-term statin use can help lower the risk of major cardiovascular diseases, inhibit plaque formation, and maintain existing plaque stability. It can also improve general heart health by lowering inflammation. In clinical studies, ezetimibe lowered the fibro-fatty plaque volume more than that in the control group, regressing coronary atheroma. However, plaque components such as fibrous plaque, necrotic core, and dense calcification volumes were not significantly reduced between the treatment and control groups (24). The PRECISE-IVUS study showed that the combination of statins and ezetimibe reduced atheroma volume more than statin monotherapy.

LDL-C reduction and regression of coronary atherosclerosis in intermediate lesions are similar when ezetimibe is combined with moderate-intensity statins compared with high-intensity statins alone (25). This showed that the effect of this combination regimen was comparable to that of high-intensity statin dosage. However, the percentage of atheroma volume reduction with dual lipid-lowering treatment with ezetimibe and atorvastatin was lower in individuals with acute coronary syndrome and diabetes mellitus (26). These results suggest that high-risk patients require more intensive lipid-lowering treatment. Studies, such as ASTEROID, REVERSAL, and SATURN, have shown that high-intensity statins can significantly reduce the volume of coronary atherosclerotic plaques. PCSK9 inhibitors such as evolocumab and alirocumab are monoclonal antibodies that significantly reduce LDL cholesterol levels and stabilize coronary atheroma. Studies such as GLAGOV, HUYGENS, and PACMAN-AMI have shown that these drugs significantly reduce LDL-C levels by 60%. This decrease in LDL-C levels reduces atherosclerotic plaques and cardiovascular events (27). PCSK9 inhibitors work differently than statins and ezetimibe do. They reduce LDL receptor degradation and increase blood LDL particle removal (28). This method lowers LDL cholesterol in the blood and stops monocyte-endothelial cell attachment through the NF-κB and eNOS pathways. These pathways are crucial to plaque formation (29).

The increasing use of PCSK9 inhibitors is expected to play a prominent role in preventing major adverse cardiac events and potentially regressing coronary thrombosis (27). Icosapentyl ether is a purified form of eicosapentaenoic acid (EPA), an omega-3 fatty acid,

that has shown promise in reducing cardiovascular risk. In high-risk patients, such as those with cardiovascular disease, EPA reduces cardiovascular mortality, non-fatal myocardial infarction, stroke, coronary revascularization, and unstable angina. The EVAPORATE study showed that EPA reduced the size of low-attenuation plaques, a sign of high-risk features (30). A recent meta-analysis showed that pure eicosapentaenoic acid (EPA) combined with low-intensity statins reduced the percent atheroma volume (PAV), probably by an anti-inflammatory effect, suggesting that it contributes to plaque formation (29).

Peroxisome proliferator-activated receptor (PPAR) γ agonists, such as pioglitazone, are another group of drugs that have demonstrated the potential to cause coronary plaque regression, although the specific dose-dependent nature of their effects has not been clearly described in previous studies. A study on (PPAR) γ agonists in non-diabetic patients with acute coronary syndrome showed that pioglitazone 30 mg daily reduced the amount of necrotic core in coronary plaques and the overall plaque volume (31). PPAR-gamma agonists have anti-inflammatory and antithrombotic effects, and inhibit vascular smooth muscle cell production. These properties may prevent atherosclerosis and promote plaque regression (32). Although PPAR-γ agonists have the potential to reverse coronary atherosclerosis, further research is needed to understand the mechanisms and establish the best dosages. Colchicine has the potential to reduce coronary plaques in patients with heart disease, likely through multiple mechanisms. Studies suggest that colchicine directly affects cholesterol crystal formation and structure, reducing their volume and altering their shape, leading to the stabilization and regression of atherosclerotic plaques (32). Colchicine is known to reduce plaque inflammation and size by reducing the number of neutrophils and monocytes in atherosclerotic plaques (33). Low-dose colchicine prevents heart attacks, stroke, and cardiac deaths in patients with chronic coronary artery disease (CAD) (34)(35). Angiotensin II receptor blockers (ARB) can reduce the formation of coronary atherosclerotic plaques. Studies have shown that olmesartan reduces plaque accumulation in patients with stable angina. Intravascular ultrasound (IVUS) studies have shown a significant reduction in coronary plaque volume in hypertensive patients treated with olmesartan or valsartan for six months (36). These effects are likely to be due to their anti-inflammatory and anti-proliferative effects. A small multicenter study showed that ARBs reduced plaque volume by 10.2% after six months and improved serum adiponectin levels (37). Therefore, a multidimensional therapeutic approach involving LDL- cholesterol reduction, reduced inflammation, and altered plaque composition is important. Optimizing lipid-lowering therapies, searching for novel agents, such as PCSK9 inhibitors and PPAR-gamma agonists, and using antihypertensive drugs, such as ARBs, could reduce or reverse coronary atherosclerosis.

Lifestyle Modifications and Dietary Interventions Impact of diet on plaque regression: The regression of coronary atheroma, in conjunction with lipid-lowering medications, is significantly affected by our dietary choices. The Mediterranean diet has a substantial effect on coronary atheromas. It decreases inflammation and endothelial dysfunction, coronary artery disease (CAD) and all-cause mortality (38). Evidence shows that switching from high- cholesterolto reduced- cholesterol diets in animal models leads to the regression of coronary plaques. While the cardiovascular advantages of the Mediterranean diet are well -established, these trials did not investigate its direct impact on reversing coronary artery plaque regression. However, there may be a mutually beneficial interaction between statin medication and the Mediterranean diet in reducing the incidence of coronary atheroma.

Low-carb and ketogenic diets: The Low-carbohydrate and ketogenic diets improve cardiovascular health and promote regression of coronary plaques in patients with coronary artery disease. For instance, studies have shown that among obese or overweight people suffering from type 2 diabetes, a low-carbohydrate and keto diet decreases blood sugar levels as well as hemoglobin A1c and triglycerides while increasing HDL cholesterol levels (39). In animal studies, high-fat diets caused greater systemic inflammation and plaque burden than ketogenic diets (40). These findings suggest that, although such diets indirectly affect atheroma progression, such as weight loss and better metabolic indicators, their direct impact on this condition remains unknown.

Plant-based diets: Plant-based diets improve cardiovascular disease risk variables, such as plasma lipid concentrations, body mass index, and blood pressure, thereby contributing to atherosclerosis (41). Studies have shown that low-fat plant-based diets reduce weight, blood pressure, lipid profiles, and glycemic control (42). Furthermore, CT angiography studies have shown that a plant-based diet may slow the development of atherosclerosis and lower non-calcified plaque volume in patients with non-obstructive coronary artery disease (43). These dietary habits lead to coronary atheroma regression, although further studies are required to determine the mechanisms of long-term plaque reversal. Plant-based diets and statins should be considered when effectively managing patients.

Physical activity and exercise: Physical activity and exercise are crucial lifestyle modifications that can enhance cardiovascular health and potentially reverse coronary atheroma in patients with coronary artery disease. Regular exercise can reduce atherosclerosis progression, alleviate angina symptoms, and decrease cardiovascular events, positively affecting atheroma progression (44). Research emphasizes the significance of lifestyle changes, such as regular exercise, and standard treatments, such as statins, in promoting plaque reduction and improving heart health outcomes (45). Supervised high-intensity interval training (HIIT) has been shown to reduce atheroma volume in patients with stable coronary disease following PCI after six months, compared to patients adhering to standard preventive guidelines (46). This finding suggests that HIIT can counteract and reverse atheroma progression of atheroma. Regular aerobic exercise and optimal medical treatment for 12 weeks induced moderate regression of the necrotic core and plaque burden in IVUS-defined coronary lesions (47). Long-term lifestyle modifications, including exercise, can reduce coronary atherosclerotic plaque size (48)(49). However, intense, high-volume exercise in middle-aged and older athletes may increase the severity of coronary artery disease despite plaques being more stable (49). Further research is needed to evaluate the direct impact of exercise on coronary atheroma regression in patients with coronary artery disease. Nevertheless, moderate and, long-term exercise training effectively promotes the regression of existing coronary atherosclerotic plaques through beneficial effects on lipids, inflammation, and vascular function.

Smoking cessation: Smoking accelerates coronary artery disease (50). Quitting smoking can reduce or even reverse atheroma. A study of > 1,000 patients showed that smoking cessation prevented the progression of coronary artery atheroma by reducing coronary lesion diameter stenosis more effectively than smoking cessation (50). For CHD patients, smoking cessation can lower MI risks by 30-50% within 3-7 years (51). The Atherosclerosis Risk in Communities (ARIC) study indicates that the risk of heart disease decreases with longer abstinence from smoking. Although the risk remains elevated after 20 years, significant improvements suggest gradual repair of the coronary arteries (52).

Emerging Therapies and Future Directions Novel pharmacological agents: Emerging lipid management strategies extend beyond LDL-C reduction, focusing on alternative pathways, and providing new insights into the pathophysiology of atherosclerosis. One strategy involves using biocompatible HA-guided cerasomes to target CD44-positive cells in atherosclerotic plaques. Recent studies in animal models, such as Apoe−/− mice, have provided insights into have shown that cerasomes can deliver drugs such as rosuvastatin (RST) to enhance plaque regression and improve imaging by loading gadodiamide (53). Additionally, senolytic drugs selectively remove senescent cells from atherosclerotic plaques and can stabilize plaques and fibrous caps, thereby enhancing the effects of statins and other lipid-lowering treatments. Another novel approach involves targeting macrophage epsins, which are endocytic adaptors that regulate lipid

metabolism and transport. Researchers have reduced the plaque size by delivering small interfering RNAs (siRNAs) into lesional macrophages using lipid nanoparticles (NPs). They promote regression by inhibiting epsin, thereby increasing cholesterol efflux and decreasing lipid uptake in animal models (54). These advances have offered new strategies for reversing atheromas and improving cardiovascular outcomes.

Clinical Outcomes and Prognostic Implications

Impact of plaque regression on clinical outcomes: Plaque regression reduces and stabilizes atherosclerosis-related plaques in arteries, thereby enhancing the clinical outcomes. Statins lower cholesterol and inflammation, stabilizing or reversing lesions through their antioxidant properties, thus reducing rupture risks, such as thrombosis. This method decreases the incidence of heart attacks and stroke fatalities in patients with heart disease. A meta-analysis indicated that a 1% reduction in atherosclerotic plaque volume reduces the risk of severe adverse cardiovascular events by 25%. Researchers have shown that plaque volume strongly correlates with MACE rates, increasing with volume and decreasing when the volume drops (55). Reducing inflammation and lipids at necrotic sites limits plaque development (56). Studies using CT-FFR and IVUS have demonstrated that plaque regression improves the clinical outcomes. Patients with acute coronary syndrome who experience plaque regression over six months are more likely to remain incident-free (57). Reversal of atherosclerosis may predict cardiac events. High-intensity lipid-lowering medications such as alirocumab have caused "triple" atherosclerotic plaque regression, reducing the size, content, and fibrous cap thickness (58). These changes reduce unfavorable cardiovascular events, such as myocardial infarction mortality or hospitalization for revascularization (58). Currently, atherosclerosis therapy focused on stabilizing and reducing plaques. Accurate volume measurements using CIMT ultrasonography or IVUS guide management to stabilize or diminish the volume (59). In conclusion, aggressive lipid-lowering therapy and improved diagnostic imaging can enhance ASCVD patient outcomes. Research using imaging techniques, such as intravascular ultrasound and computed tomography-fractional flow reserve, has shown that plaque regression is associated with better clinical outcomes.

Challenges and Limitations

Variation in treatment response: Complete coronary artery atheroma reversal signifies ultimate treatment success. However, several factors influence therapeutic outcomes. Genetic differences in lipid metabolism and inflammatory responses may increase the efficacy of statins in some individuals. Medication metabolism also varies with age and sex, leading to different effects on young men and older women. Disease heterogeneity results in plaques differing by body system, some in late stages and others in early stages with specific components. Diabetes and hypertension complicate management by slowing the atheroma regression. Additionally, lifestyle behaviors such as smoking cessation, exercise, and diet significantly affect health outcomes, and should be considered in therapeutic approaches. Finally, patient adherence is crucial, and regression is unlikely without following treatment plans.

Limitations of current imaging techniques: Coronary angiography, intravascular ultrasonography (IVUS), and optical coherence tomography (OCT) have limitations for assessing coronary atheromas. Angiography may miss plaque burden by only observing the lumen, whereas IVUS and OCT provide detailed plaque images, but have limited penetration depth. However, these invasive and expensive procedures restrict their clinical use. Lipid-lowering medications, such as statins and PCSK9 inhibitors, reduce plaque load but cause side effects, such as muscle pain, liver function abnormalities, increased diabetes risk, injection site reactions, and flu-like symptoms, which may decrease patient adherence and treatment efficacy. Lifestyle changes should continue until a significant atheroma reduction is achieved; however, poor motivation, lack of support, and health issues can hinder long-term compliance. Dissatisfaction with the slow regression process may also reduce compliance and effectiveness.

Clinical implications

Reduction in Cardiovascular Events: Regression of the coronary atheroma is related to a decrease in cardiovascular events. Lipid-lowering therapies, especially statins, can regress plaques, ultimately preventing conditions such as heart attacks and strokes.

Improvement in Plaque Characteristics: Apart from reducing the volume of atheroma, lipid-lowering treatments have also been found to improve various aspects of plaques, including thickening of the fibrous cap and shrinking of core lipids, which are related to lower vulnerability and the likelihood of rupture (59). Use of Advanced Imaging: Modern techniques such as intravascular ultrasound (IVUS) and non-invasive imaging directly assess plaque volume changes and their composition. This may help monitor the effectiveness of treatment and even guide the type(s) of therapy that should be implemented.

Recommendations

For cardiovascular disease prevention, intensive lipid-lowering treatment with high-dose statins and, if necessary, additional ezetimibe is recommended. This method stops, and sometimes reverses, atherosclerosis.

Lifestyle changes: In addition to utilizing medicines, patients should eat less saturated fat and exercise regularly to reduce plaque and improve heart health. Monitoring and customizing treatment: Advanced imaging can be used to monitor lipid levels and plaque characteristics to assist in crafting patient-specific therapies. This method limits cardiovascular risks as much as possible while recognizing individual circumstances. New medicines targeting the atherogenesis pathways are being developed. These medications may stabilize or regress plaques, thereby reducing cardiovascular risk.

Future research directions: Breakthroughs have been made in lipid-lowering therapies and imaging technologies to attain atheroma regression in coronary artery disease. In the future, personalized treatment approaches should focus on the individual plaque characteristics and risk profiles. Novel lipid-lowering agents, such as PCSK9 inhibitors and RNA interference therapies targeting PCSK9 production, may yield more potent and sustained reductions in LDL-C levels, leading to larger plaque regression. Furthermore, emerging non-invasive imaging modalities, such as automated plaque quantification in CT with advanced plaque analysis tools using AI-driven software validated against histology, have the potential to guide therapeutic interventions and improve clinical outcomes for patients with atherosclerotic cardiovascular disease, which is expected to enhance the accuracy and efficiency of monitoring plaque changes over time. This might provide a method for wider screening, thus making it possible to intervene in the subclinical stages of diseases much earlier. Moreover, targeting non-LDL risk factors, such as inflammation and lipoprotein (a), is gaining interest, which could add to current lipid-lowering strategies to improve plaque regression. As we deepen our understanding of plaque biology, future research should also explore combination therapies that simultaneously target multiple pathways involved in atherogenesis, potentially resulting in more comprehensive and effective plaque regression strategies.

Summary of key findings: Controlling coronary artery plaque regression is crucial for treating cardiovascular disease and improving patient outcomes. Despite advancements in imaging and medication, the assessment of plaque changes and management of side effects remain challenging. Current imaging technologies have limitations that impede comprehensive examinations. The adverse effects of lipid-lowering treatments and challenges associated with long-term lifestyle changes hinder plaque regression. Nevertheless, novel medications and an increased understanding of plaque dynamics may enhance coronary artery disease treatment. Future approaches should

focus on optimizing patient adherence, minimizing therapeutic side effects, and employing innovative technologies for accurate detection and treatment of atherosclerosis. Addressing these challenges can enhance healthcare prevention and decrease the global burden of cardiovascular disease.

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