

04. Stem cell therapy for post-myocardial infarction myocardial regeneration

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Background: Myocardial infarction (MI) remains one of the leading causes of mortality and long-term cardiac disability worldwide. According to the World Health Organization, ischemic heart disease accounts for nearly 9 million deaths annually, contributing to approximately 16% of total global deaths. Studies suggest that nearly 20–30% of post-MI survivors eventually develop chronic heart failure due to irreversible myocardial damage and progressive ventricular remodeling. Although current therapies such as thrombolysis, percutaneous Coronary intervention, and pharmacological management have significantly reduced acute mortality rates, they do not adequately regenerate necrotic myocardial tissue. The limited regenerative capacity of adult cardiomyocytes has therefore shifted scientific interest towards stem cell-based regenerative therapy. **Objective:** To evaluate the therapeutic efficacy of stem cell therapy in myocardial regeneration following myocardial infarction and assess its effects on ventricular remodeling, myocardial function, infarct scar reduction, and overall cardiac recovery. **Methodology:** A systematic review and meta-analysis was conducted according to PRISMA 2020 guidelines. A comprehensive literature search of PubMed, Scopus, Embase, and Cochrane Library databases was performed for studies published between January 2016 and March 2026. Eligible studies included randomized controlled trials and observational studies evaluating stem cell therapy in adult post-myocardial infarction patients. The PICO framework included patients with myocardial infarction receiving stem cell-based therapy compared with placebo or standard medical therapy. Primary outcomes included improvement in left ventricular ejection fraction (LVEF), infarct scar reduction, myocardial perfusion, angiogenesis, and ventricular remodeling. Studies involving animal models, in vitro experiments, review articles, editorials, conference abstracts without sufficient data, and duplicate publications were excluded. Pooled effect estimates were analyzed using a random-effects model. Heterogeneity was assessed using the I^2 statistic, and results were reported with 95% confidence intervals (CI). **Results:** A total of 16 randomized clinical trials involving 1,641 patients met the inclusion criteria. Meta-analysis demonstrated a significant improvement in left ventricular ejection fraction following stem cell therapy compared with conventional medical therapy (mean difference: +2.55%; 95% CI: 1.62–3.48; $I^2 = 58\%$). Significant reduction in infarct scar size was observed, with pooled analysis demonstrating a mean reduction of 7.8% (95% CI: 4.1–11.5; $I^2 = 52\%$). Improvement in myocardial perfusion and angiogenesis was

consistently reported across several studies. Mesenchymal stem cell-based therapies demonstrated comparatively greater improvement in ventricular remodeling and myocardial recovery than bone marrow mononuclear cell therapy. Moderate heterogeneity among studies was attributed to differences in stem cell type, administration route, dosage, and duration of follow-up. No statistically significant increase in mortality or major arrhythmogenic adverse events was observed. **Conclusion:** Stem cell therapy demonstrates promising potential in promoting myocardial regeneration and improving cardiac function following myocardial infarction. Significant improvements in ventricular performance, scar reduction, and myocardial repair were observed across included studies. However, variability in study protocols and moderate heterogeneity continue to limit definitive clinical application. Larger multicenter randomized trials with longer follow-up periods are necessary to establish standardized treatment protocols, long-term safety, and clinical efficacy in regenerative cardiology.

Key Words: Myocardial Infarction; Stem Cell Therapy; Cardiac Regeneration; Ventricular Remodeling; Mesenchymal Stem Cells; Left Ventricular Ejection Fraction (LVEF); Regenerative Cardiology; Angiogenesis

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