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Long-term outcomes of Indocyanine Green (ICG) fluorescence imaging-guided lymphadenectomy for gastric cancer: A systematic review and meta-analysis

Abstract:

Background: Indocyanine Green (ICG) fluorescence has emerged as a transformative imaging-guided lymphadenectomy for enhancing lymph node (LN) dissection in gastric cancer patients undergoing laparoscopic or robotic gastrectomy. However, its long-term oncological outcomes remain inadequately explored.

Objective: This meta-analysis aimed to evaluate the long-term survival outcomes of ICG fluorescence-guided lymphadenectomy compared to conventional lymphadenectomy in gastric cancer patients who underwent minimally invasive gastrectomy.

Methods: A comprehensive literature search of PubMed, Embase, Cochrane, and Scopus from December 2024 to March 2025 was performed to identify studies directly comparing ICG fluorescence-guided lymphadenectomy with conventional procedures. Hazard ratios (HR) based on Kaplan-Meier curves were extracted using WebPlotDigitizer and the Tierney method while the Risk Ratio (RR) with 95% confidence intervals (CIs) was pooled with a random-effects model. Key outcomes assessed included overall survival (OS), disease-free survival (DFS), and recurrence rates.

Results: Eight studies (1 Randomized Controlled Trial and 7 Observational Studies) with a total of 6,837 patients were included, of whom 2,880 (42%) used ICG fluorescence guided-imaging lymphadenectomy. Average follow-up is within 2-5 years period post-surgical. Pooled analysis revealed that ICG fluorescence-guided lymphadenectomy significantly improved OS (HR 0.70 ; 95% CI 0.56-0.87; p = 0.002; I2 = 0%) and DFS (HR 0.82; 95% CI 0.68-0.98; p = 0.03; I2 = 0%) compared to conventional lymphadenectomy for gastric cancer patients who underwent gastrectomy. Additionally, recurrence rates were significantly lower in the ICG group (12% vs 22%; RR 0.59; 95% CI 0.43-0.82; p = 0.002; I2 = 0%) in comparison to patients who used non-ICG fluorescence in minimally invasive lymphadenectomy.

Conclusion: ICG fluorescence-guided lymphadenectomy significantly improved long-term survival and reduced recurrence rates in gastric cancer patients. These findings provide robust evidence supporting the clinical utility of ICG fluorescence in enhancing oncological outcomes for patients who underwent minimally invasive gastrectomy. However, further randomized controlled trials are needed to confirm these benefits and refine our understanding of ICG's long-term impact in gastric cancer surgery.