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Clinical Outcomes of Robotic vs Conventional CABG and Alternative Revascularization in CAD Patients: A Systematic Review of Current Evidence

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Abstract: Robot-assisted coronary artery bypass grafting (RA-CABG) has gained recognition as a less invasive substitute for traditional CABG, offering potential benefits in patient recovery and lower complication rates. This systematic review examines the safety, effectiveness, and postoperative results of RA-CABG in comparison to standard CABG and alternative revascularization methods.

Keywords: *Robotically Assisted CABG, Coronary Artery Bypass Grafting, Minimally Invasive Surgery, Systematic Review, Outcomes Assessment.*

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I. INTRODUCTION

Cardiovascular diseases (CVD), particularly conditions such as heart attacks and strokes, continue to be among the foremost causes of death globally【1】. Coronary artery bypass grafting (CABG) remains the preferred intervention for individuals with complex coronary artery disease, widely regarded as the gold standard in surgical treatment【2】. Nevertheless, the traditional CABG method, which involves a sternotomy—or a large incision through the breastbone—has been linked to elevated complication risks, especially within certain patient demographics【2】. For example, individuals who are diabetic, obese, or require bilateral internal mammary artery (IMA) grafts are more likely to experience extended hospitalizations and a higher likelihood of deep sternal wound infections (DSWI)【3】.

Over time, CABG procedures have seen multiple innovations intended to enhance outcomes and mitigate risks. One notable development is the off-pump CABG technique, performed without the use of cardiopulmonary bypass (CPB)【3】. By eliminating CPB, this method helps reduce the systemic inflammation typically caused by extracorporeal circulation. Clinical studies suggest that off-pump CABG may lower the incidence of complications such as strokes, kidney dysfunction, and the need for transfusions【4】. The use of alternative arterial grafts—like the radial artery and the right gastroepiploic artery—has further improved procedural success, offering better graft durability and improved long-term results when compared to traditional saphenous vein grafts【5】. In addition, innovations in minimally invasive approaches, such as mini-thoracotomy, have allowed for less traumatic surgeries and quicker patient recovery【6】.

More recently, robotic-assisted coronary artery bypass grafting (RA-CABG) has emerged as a noteworthy advancement. This method encompasses a variety of procedures, including robot-assisted minimally invasive direct coronary artery bypass (MIDCAB) and totally endoscopic coronary artery bypass (TECAB)【7】. These robotic techniques aim to overcome the drawbacks of conventional CABG by offering minimally invasive options that may reduce the need for rib spreading, decrease postoperative discomfort, and promote faster recovery, thereby enhancing overall patient quality of life【8】.

A key benefit of robotic surgical systems is the provision of high-definition, three-dimensional (3D) visualization. In contrast to traditional endoscopic methods that rely on flat, two-dimensional (2D) imagery, robotic systems allow surgeons to operate using advanced tools with greater dexterity and depth perception【9,10】. The robotic console precisely translates the surgeon's hand movements, offering tremor-free control and refined manipulation, thus increasing both the safety and accuracy of procedures【1】.

Beyond cardiac surgery, robotic-assisted techniques have found growing application across several medical specialties, including gynecology, urology, and gastrointestinal surgery【12,13】. The increasing prevalence of robotic platforms, such as the da Vinci system, reflects this broader trend. Between 2007 and 2009, the installation of da Vinci systems in the United States rose by roughly 75%, with comparable growth recorded across Europe【14】.

Despite the growing enthusiasm and adoption of RA-CABG, there remains ongoing debate regarding its comparative effectiveness and safety relative to traditional, non-robotic surgical methods for cardiac revascularization. The primary goal of this systematic review is to critically assess the existing research on the outcomes of robotically assisted CABG. By analyzing the current body of evidence, this review aims to offer a well-rounded evaluation of the benefits and challenges associated with RA-CABG, helping to inform clinical decisions and future studies in cardiac surgery.

II. METHODS

This systematic review was conducted in accordance with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) standards, employing an extensive search protocol across several electronic databases. The selection criteria encompassed randomized controlled trials, cohort studies, case-control analyses, and observational research, all published in English within the last 20 years. Data collection and evaluation of potential bias were performed following the detailed procedures recommended in the Cochrane Handbook for Systematic Reviews of Interventions, ensuring methodological rigor and consistency.

III. RESULTS

In total, 15 studies fulfilled the eligibility requirements, involving a combined sample of 2,442 patients who underwent either RA-CABG or traditional CABG procedures. The findings suggest that RA-CABG may be linked to lower mortality rates, fewer occurrences of stroke and surgical site infections, shorter durations of hospitalization, and a reduced necessity for blood transfusions when compared to conventional CABG. Nonetheless, discrepancies in results and reported complications among the studies highlight the necessity for additional research to validate these observations.

IV. DISCUSSION

The emergence of robot-assisted coronary artery bypass grafting (RA-CABG) has introduced new possibilities in the realm of minimally invasive heart surgery, offering the potential for lower complication rates and enhanced patient recovery. This systematic review compiles and analyzes data from 14 studies, including a total of 2,442 patients, to assess the effectiveness, safety, and clinical outcomes of RA-CABG

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in comparison with traditional CABG and other revascularization strategies.

V. CONCLUSION

This systematic review synthesizes evidence from 14 studies to evaluate the safety, efficacy, and outcomes of robotically assisted coronary artery bypass grafting (RA-CABG) compared to conventional CABG and other revascularization techniques. The review highlights several advantages of RA-CABG, including potentially lower mortality rates, fewer complications such as stroke and wound infections, shorter hospital stays, and reduced need for blood transfusions. However, the studies also underscore variations in outcomes and complications, emphasizing the need for further research, particularly randomized controlled trials with standardized methodologies and longer-term follow-ups.

RA-CABG demonstrates promising advantages over conventional CABG, including improved postoperative outcomes and reduced morbidity. The findings support its clinical utility but emphasize the necessity for more randomized controlled trials with standardized methodologies and longer-term follow-ups to establish definitive evidence.

REFERENCES

[1]. Kolkailah AA, Alreshq RS, Muhammed AM, Zahran ME, Anas El-Wegoud M, Nabhan AF. Transradial versus transfemoral approach for diagnostic coronary angiography and percutaneous coronary intervention in people with coronary artery disease. Cochrane Database Syst Rev. 2018;4(4): CD012318.

[2]. Nisivaco S, Kitahara H, Abutaleb A, Nathan S, Balkhy HH. Robotic Endoscopic Coronary Bypass to the Left Anterior Descending Artery: Left Versus Right Internal Thoracic Artery Grafts. J Surg Res. 2023;291:139-150.

[3]. Dokollari A, Sicouri S, Prendergast G, et al. Robotic-Assisted Versus Traditional Full-Sternotomy Coronary Artery Bypass Grafting Procedures: A Propensity-Matched Analysis of Hospital Costs. Am J Cardiol. 2024;213:12-19.

[4]. Tasoudis PT, Caranasos TG, Doulamis IP. Robotic applications for intracardiac and endovascular procedures. Trends Cardiovasc Med. 2024;34(2):110-117.

[5]. Wu NH, Hsieh TH, Chang CY, Lin HY. Impact of the intra-aortic balloon pump on the reliability of the fourth-generation FloTrac/EV1000 system in patients undergoing robotic-assisted off-pump coronary artery bypass surgery. Heart Vessels. 2024;39(3):275-276.

[6]. Ravikumar N, George V, Shirke MM, Ashry A, Harky A. Robotic coronary artery surgery: Outcomes and pitfalls. J Card Surg. 2020;35(11):3108-3115.

[7]. Kitahara H, Wehman B, Balkhy HH. Can Robotic-Assisted Surgery Overcome the Risk of Mortality in Cardiac Reoperation? Innovations (Phila). 2018 Nov/Dec;13(6):438-444.

[8]. Guenther TM, Chen SA, Balkhy HH, Kiaii B. Robotic Coronary Artery Bypass Grafting: The Whole 9 Yards. Innovations (Phila). 2020;15(3):204-210.

[9]. Balkhy HH, Nisivaco S, Kitahara H, Torregrossa G, Patel B, Grady K, Coleman C. Robotic off-pump endoscopic coronary artery bypass in the current era: report of 544 patients. Eur J Cardiothorac Surg. 2022 Jan 24;61(2):439-446.

[10]. Amabile A, Torregrossa G, Balkhy HH. Robotic-assisted coronary artery bypass grafting: current knowledge and future perspectives. Minerva Cardioangiol. 2020;68(5):497-510.

[11]. Moscarelli M, Harling L, Ashrafian H, Athanasiou T, Casula R. Challenges facing endoscopic robotic coronary artery bypass grafting. Int J Med Robot. 2015;11(1):18-29.

[12]. Buehler AM, Ferri C, Flato UA, Fernandes JG. Robotically assisted coronary artery bypass grafting: a systematic review and meta-analysis. Int J Med Robot. 2015;11(2):150-158.

[13]. Giambruno V, Chu MW, Fox S, et al. Robotic-assisted coronary artery bypass surgery: an 18-year single-centre experience. Int J Med Robot. 2018;14(3):e1891.

[14]. Hemli JM, Patel NC. Robotic Cardiac Surgery. Surg Clin North Am. 2020;100(2):219-236.