

Impact of Less Invasive Technologies versus Coronary Bypass in the Treatment of Acute Coronary Syndrome: Efficiency Assessment

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Abstract:

➤ Introduction

Coronary artery bypass surgery is a crucial procedure for treating coronary artery disease, especially in patients with severely blocked arteries. This procedure improves blood flow to the heart by rerouting blocked arteries using healthy blood vessels. With the advancement of less invasive technologies, this surgery has evolved, offering potential benefits in terms of cost, recovery, and healthcare efficiency.

➤ Objective

To analyze the efficacy, safety, and costs of these technologies to provide a comprehensive and up-to-date view that can inform clinical practice and health administration.

➤ Method

A literature review was conducted using PubMed, Bireme, and Infomed. Studies on the costs, efficacy, and safety of less invasive CABG technologies, published in the last 5 years in English and Spanish, were selected.

➤ Conclusion

In conclusion, these technologies offer promising options for optimizing clinical practice, although their adoption must balance benefits, costs, and patient profile to maximize outcomes and sustainability in healthcare.

Keywords: *Technology, Coronary Artery Bypass, Management.*

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I. INTRODUCTION

Coronary artery bypass graft (CABG) surgery has been the gold standard for the treatment of severe coronary artery disease since its introduction in the 1960s. (1)

This procedure improves blood flow to the heart by rerouting blocked arteries using healthy blood vessels. (2)

However, CABG has traditionally been an invasive surgery with a prolonged recovery and high associated costs. (3) With the advancement of less invasive technologies, CABG has evolved, offering potential benefits in terms of cost, recovery, and efficiency in healthcare management. (1)

The scientific problem that prompted this review is the need to evaluate the impact of less invasive technologies in coronary artery bypass graft surgery, specifically in terms of

efficiency and resource management in Intensive Care Units (ICUs). As healthcare systems seek to optimize resources and improve the quality of care, it is crucial to understand how these technologies can influence costs and clinical outcomes. (2)

This review is based on the increasing adoption of less invasive technologies in CABG and the need to assess their impact on clinical practice and health administration. (3)

Less invasive technologies promise to reduce recovery times, decrease postoperative complications, and optimize the use of resources in ICUs. (1)

However, a thorough analysis is needed to confirm these benefits and provide evidence-based recommendations. (2)

Previous studies have demonstrated its effectiveness in improving patient survival and quality of life. (2)

Over time, less invasive techniques have been developed, such as robot-assisted surgery and minimally invasive direct coronary bypass surgery (MIDCAB), which have shown promising results in terms of reducing complications and recovery times. (3)

Recent research has compared the costs and efficiency of less invasive techniques with conventional techniques. (1)

For example, a study conducted in the United States found that minimally invasive surgery can reduce hospital costs by 20% compared to traditional CABG. (2)

Another study in Europe reported a significant decrease in days spent in the ICU and a reduction in postoperative complication rates. (3)

This literature review aims to evaluate the impact of less invasive technologies in coronary artery bypass graft (CABG) surgery from the perspective of efficiency and resource management in Intensive Care Units (ICUs). It seeks to analyze the efficacy, safety, and costs of these technologies to provide a comprehensive and up-to-date overview that can inform clinical practice and healthcare administration.

II. METHODS

A literature review based on scientific studies was conducted to gather all possible information on the impact of less invasive technologies on coronary artery bypass graft (CABG) surgery. The literature review follows the recommendations for the publication of systematic reviews of the 2020 PRISMA Statement (flow) diagram for new systematic reviews which included searches of databases and registers only), which contains a proposal to improve the publication of systematic and bibliographic reviews and is used as a guide.

To formulate the research question, the PICO strategy (Patient , Intervention , Comparison , Outcome) was used: How do less invasive technologies in CABG affect the efficiency and management of resources in Intensive Care Units (ICUs)?

To begin the literature review process, keywords were chosen that define the study topic and allow for the search of results through the selected strategy and databases. The keywords used were: "CABG", "less invasive technologies", "health efficiency", "resource management", "hospital costs", "patient safety", and "postoperative recovery".

For the translation and standardization of terms, health sciences descriptors (DeCS) were obtained and combined using the Boolean operator "AND" to establish search combinations. The Mendeley bibliographic manager and Microsoft Office Professional Plus 2019 Word 64-bit software were used for citing the bibliography in Vancouver format, once the most relevant articles were found.

- Inclusion criteria: Full-text articles that analyze, study, or describe the impact of less invasive technologies on CABG, in Spanish or English, with a time interval of 5 years, indexed in electronic databases, and with a publication date from 2020 to 2024.
- Exclusion criteria: those that are repeated in several databases, articles that are not carried out on humans and articles of weak scientific quality, those whose time interval is more than 5 years ago.

The search for studies was conducted through electronic searches in various national and international health databases. The main databases used were Medline (PubMed), BIREME, Infomed , Google Scholar , and ScienceDirect . These databases were chosen because they are international resources, with the aim of including more countries.

To carry out the selection of the final articles that will make up the literature review, a process consisting of the following phases was followed:

- First phase: Articles were selected using the Rayyan tool based on their titles, provided they were related to the impact of less invasive technologies on CABG. In this phase, all articles unrelated to this topic and those overlapping or repeated in multiple databases were excluded.
- Second phase: All articles whose reading and analysis of the abstract did not correspond to the topic of interest for this bibliographic review were excluded.
- Third phase: They were screened based on their relationship to the research topic after full reading and based on

compliance with the inclusion and exclusion criteria for the acceptance or rejection of articles.

- Fourth phase: The methodological quality of the selected articles was evaluated using the Critical method Appraisal Skills Spanish Programme (CASP), finally obtaining the articles with which the study is carried out.

It is important to note that studies can be subject to bias, which compromises the validity and applicability of the findings. To avoid this, high-quality documents are selected

using the Critical Method. Appraisal Skills Spanish Programme (CASP). This implies selecting those that present clear objectives, with an adequate description of the population, intervention, and comparison. They must have appropriate inclusion and exclusion criteria, a comprehensive methodology, randomization, an adequate sample size, and results that are extrapolatable, reproducible, accurate at least at 95%, and useful for drawing conclusions.

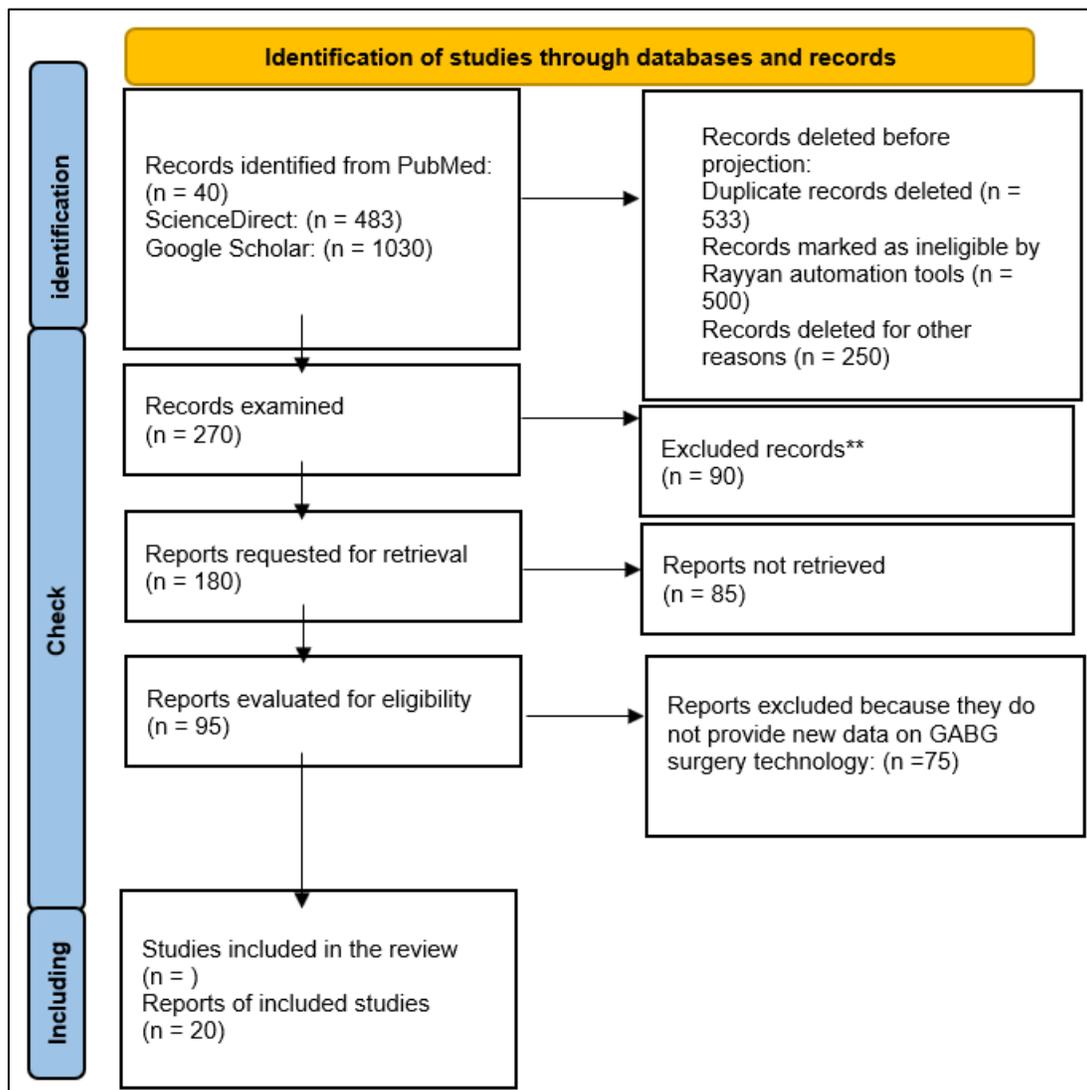


Fig 1 Diagrama De Flujo Prisma

The main findings from the review of the selected articles are then written in chronological order according to publication date.

➤ *Brief Evolutionary Description of Cardiology*

In their 2023 article, Claudia et al. emphasize the ongoing evolution of cardiology, driven by technological advancements

and collaborative research. She highlights the crucial roles played by many individuals in shaping the field, from early physicians to modern medical pioneers.

➤ *Less Invasive Technologies*

Coronary Angioplasty (1977): Andreas Grüntzig performed the first successful coronary angioplasty, a

procedure that uses a small inflated balloon to open blocked arteries.

➤ *Coronary Artery Bypass Graft (CABG)*

René Favalaro: He developed the coronary artery bypass graft (CABG) technique, which involves using blood vessels from other parts of the body to divert blood flow around blocked arteries, thus improving the supply of blood and oxygen to the heart.

Cardiac Surgery and Modern Interventional Procedures: Modern cardiology includes minimally invasive surgical procedures and catheter-based interventions, including fetal interventions, significantly reducing recovery times and surgical risks. (4)

➤ *The Evolution of Cardiac Surgery: From Traditional Bypass to Percutaneous Intervention*

In their 2024 study, Lacerda de Oliveira et al. describe the evolution of cardiac surgery from coronary artery bypass grafting (CABG), introduced in the 1960s as the standard for myocardial revascularization, to percutaneous coronary intervention (PCI), which began to be developed in the 1970s. The bypass technique, using arterial or venous grafts, allows for the restoration of blood flow in obstructed coronary arteries. However, the search for less invasive methods spurred the development of percutaneous coronary angioplasty, in which blocked arteries are dilated with an inflatable balloon inserted through a catheter.

Advances in percutaneous interventions included the introduction of stents, particularly drug-eluting stents, which reduced restenosis rates and the need for additional surgeries. These advances facilitated less invasive procedures, faster recovery, and shorter hospital stays compared to bypass surgery in selected cases. The review also highlights the importance of ongoing innovation in techniques and devices, such as bioresorbable stents, and the use of advanced imaging technologies to improve outcomes and personalize cardiovascular treatment. (5)

➤ *Impact of Coronary Artery Bypass Surgery on Survival and Quality of Life in Patients with Coronary Artery Disease*

The article by Grimanesa del Rocío Figueroa García and others, conducted in Guayaquil, Ecuador, reviews the impact of coronary artery bypass graft (CABG) surgery on the survival and quality of life of patients with coronary artery disease. This surgical intervention, used primarily in cases of multivessel disease or left coronary artery disease, has been shown to significantly improve outcomes compared to conventional medical treatments and percutaneous coronary angioplasty.

CABG not only prolongs survival by reducing mortality related to major cardiovascular events, but it also improves quality of life. Patients experience relief from symptoms such as angina and dyspnea, allowing them to lead more active lives. Although the choice between CABG and other options depends

on the individual patient's profile, CABG remains essential in the management of coronary artery disease due to its long-term clinical and functional benefits. (6)

The paper prepared by Victoria Villalta del Olmo at Barcelona 2022 addresses minimally invasive therapies for treating aortic stenosis (AS), one of the most common valvular diseases in older adults. It focuses on two innovative options: sutureless bioprostheses (SU-SAVR) and transcatheter aortic valve implantation (TAVI), comparing their outcomes in patients with severe AS and low surgical risk.

Studies show that both techniques have similar outcomes in terms of mortality and stroke at two years. However, SU-SAVR is associated with a higher risk of readmission for heart failure and the development of conduction disorders, such as persistent left bundle branch block (PLBBB), which increases the need for a pacemaker. On the other hand, TAVI has a lower impact on readmissions and a better valvular gradient profile, but is associated with a higher incidence of vascular complications.

SU-SAVR and TAVI are valid alternatives for selected patients, highlighting the need to personalize treatment according to the patient's profile and anatomy. Furthermore, the importance of conducting further studies is emphasized. (7)

➤ *Myocardial Revascularization of the Left Anterior Descending Artery with the Left Internal Mammary Artery: A Long-Term Comparison of Two Techniques*

In the article by Dr. Juan Carlos Bahamondes S. and others in Temuco, Chile, the impact of using the left internal mammary artery (LIMA) as a graft to the left anterior descending artery (LAD) using surgical techniques with and without cardiopulmonary bypass (CPB) in patients with isolated LAD lesions was analyzed. The study compared 85 patients operated on between 1992 and 2004, of whom 40 were operated on with a cardiopulmonary bypass pump and 45 without.

The results showed that the group without a pump had shorter operative and mechanical ventilation times. No operative deaths, myocardial infarctions, strokes, or reoperations were reported in the group with a pump. In long-term follow-up, two late deaths were recorded in the group with a pump and none in the group without a pump. Survival probabilities were 96% at 139 months for the group with a pump and 98% at 64 months for the group without a pump.

The use of LIMA as a graft in coronary artery bypass grafting is safe and provides a prolonged period free of cardiac events, regardless of whether the technique is used with or without a pump. (8)

➤ *Official Journal of the Mexican Society of Cardiac Surgery, Mexican College of Cardiovascular and Thoracic Surgery.*

The research by Halil Ibrahim Bulut et al. in Mexico 2024 addresses the potential of minimally invasive surgical

revascularization procedures to become the standard of care for ischemic heart disease. Ischemic heart disease, a leading cause of death, is traditionally treated with coronary artery bypass graft (CABG) surgery, which, while effective in the medium and long term, is highly invasive and carries a risk of complications. Recent advances in minimally invasive techniques, such as off-pump coronary artery bypass grafting (OPCAB), minimally invasive direct bypass (MIDCAB), and minimally invasive coronary artery bypass grafting (MICSCABG), offer benefits in terms of less pain, faster recovery, and fewer complications. However, questions remain about their durability and long-term survival efficacy. Further research is needed to evaluate these methods compared to traditional techniques and determine whether they could become the preferred treatment for the disease. (9)

➤ *The Da Vinci System: Technology and robot-Assisted Surgery (CAR)*

Paula Melgar's study in Spain 2024 focuses on robotic surgery, particularly the Da Vinci system, which has transformed modern surgical practice. This system combines advanced technology with the surgeon's skill, offering greater precision, less invasiveness, and improved patient outcomes. It describes the system's evolution, advantages, limitations, clinical applications, and the role of the surgical team, including nursing staff.

The benefits include reduced postoperative pain, a lower risk of complications, and faster recovery. However, challenges such as high cost, a steep learning curve, and prolonged surgical time are noted. Furthermore, the importance of specialized training for the entire surgical team is emphasized.

Although robotic surgery offers significant advantages, further research and development is needed to overcome its limitations and expand its use. (10)

III. ANALYSIS OF THE RESULTS

A review of advances in cardiology and cardiac surgery shows that minimally invasive technologies, such as coronary angioplasty, drug-eluting stents, minimally invasive coronary artery bypass grafting (MICS-CABG), and robotic surgery (Da Vinci system), have proven to be effective and safe in most cases. These innovations significantly reduce recovery times, postoperative pain, and complications, improving patients' quality of life.

In terms of cost, although modern technologies such as robotic surgery have a high initial cost and require specialized training, their lower impact on prolonged hospital stays and reoperations could justify their implementation in specialized centers. However, the long-term durability of these minimally invasive procedures, compared to traditional techniques such as CABG, is still a subject of debate and requires further research for a comprehensive evaluation.

IV. CONCLUSIONS

In conclusion, these technologies offer promising options for optimizing clinical practice, although their adoption must balance benefits, costs, and patient profile to maximize outcomes and sustainability in healthcare.

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