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ROBOTIC BARIATRIC SURGERY IN THE MANAGEMENT OF MORBID OBESITY: BENEFITS, LIMITATIONS AND LONG-TERM PROSPECTS

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Abstract: Objective: To evaluate the efficacy, safety and complications associated with robotic bariatric surgery in the treatment of morbid obesity, as well as to identify the factors that influence long-term results. **Method:** This is a narrative literature review, developed according to the criteria of the PVO strategy, using the PubMed/MEDLINE database including terms such as "robot", "robotics", "bariatric surgery" and "obesity"**. Discussion:** Robotic bariatric surgery has significant technical advantages, especially in complex and revision cases. Short-term weight loss outcomes are comparable to those of laparoscopic surgery, but the robotic approach stands out for lower conversion rates to open surgery and a reduction in specific complications. However, high costs and technological limitations, such as the absence of tactile feedback, restrict its widespread adoption. Even so, the safety offered by the robotic technique is an important differentiator. **Final considerations:** Although the initial results are promising, it is essential to carry out more research focused on late outcomes, patient quality of life and cost-benefit analysis, especially for high-risk groups such as patients with morbid obesity associated with comorbidities.
Keywords: Robotic surgery, bariatric surgery, morbid obesity, long-term results.

INTRODUCTION

Morbid obesity has become a global epidemic, affecting millions of individuals and burdening health systems around the world. This multifactorial condition significantly compromises quality of life and is associated with a series of serious comorbidities, such as cardiovascular disease, type 2 diabetes and hypertension. Faced with the continuous increase in the prevalence of obesity, bariatric surgery has emerged as the most effective and long-lasting intervention for the management of morbid obesity, especially for patients with poor adherence to conventional treatment methods (Iranmanesh *et al.*, 2020; Elettra *et al.*, 2023).

Among the available surgical techniques, Roux-en-Y gastric bypass and sleeve gastrectomy stand out as the most widely used, being predominantly performed laparoscopically due to their efficacy, safety and shorter recovery time (Velardi *et al.*, 2024; Iranmanesh *et al.*, 2020). However, the introduction of robotic bariatric surgery has brought a new perspective, offering significant benefits such as greater precision, three-dimensional vision and ergonomics for the surgeon.

According to Fantola *et al.* (2022), comparative studies between bariatric techniques such as sleeve gastrectomy, gastric bypass, SADI-S and robotic surgeries have highlighted the advantages of the robotic approach, especially in complex and revision procedures. Pavone *et al.* (2024) point out that robotic surgery surpasses laparoscopy in aspects such as depth perception, three-dimensionality and field of vision, factors that optimize ergonomics during the procedure and contribute to more accurate results.

Despite the obvious advantages, robotic surgery faces significant challenges to its widespread adoption. Rafaelli *et al.* (2024) emphasize that high cost and longer operative time, when compared to laparoscopy, are major barriers. In addition, tactile feedback, a crucial element for surgeons in tissue identification, is still limited in the robotic approach, although technological improvements are being implemented (Pavone *et al.*, 2024).

Although promising, robotic bariatric surgery still lacks a solid base of scientific evidence to support its superiority over laparoscopy. Most of the available studies focus on short-term results, while research evaluating long-term outcomes such as sustained efficacy, complications and cost-effectiveness remains scarce (Velardi *et al.*, 2024; Fantola *et al.*, 2022).

This study aims to investigate the efficacy, safety and complications associated with robotic bariatric surgery in the treatment of morbid obesity, as well as to identify the factors that impact long-term results. The review also seeks to explore the main barriers to the adoption of this technology and discuss whether its benefits justify the high costs in different clinical scenarios.

METHODS

A literature review using the PVO strategy (Population or research problem, Variables and Outcome) based on the following guiding question: "What are the efficacy, safety and main complications of robotic bariatric surgery in the treatment of morbid obesity, and what factors influence long-term clinical outcomes?". The search was carried out in the PubMed/MEDLINE database, using search terms combined with the Boolean operators "AND" and "OR". The search strategy included terms such as "robot", "robotics", "bariatric surgery" and "obesity". Initially, 284 articles were identified, which passed previously established selection criteria. The inclusion criteria considered publications in English, between 2019 and 2024, which directly addressed the research objectives, and studies such as reviews, meta-analyses, observational and experimental studies. The exclusion criteria included duplicate articles, articles available only as

abstracts or articles that did not meet the proposed criteria. After applying these criteria, 16 articles were selected and made up the body of evidence for this review, which analyzed the efficacy, safety, complications and factors that impact the long-term results of CBR in the management of morbid obesity.

DISCUSSION

TECHNICAL BENEFITS OF ROBOTIC BARIATRIC SURGERY (CBR)

According to Morrell *et al.* (2021), one of the main conclusions of the studies is the ability of robotic systems to overcome common technical limitations of laparoscopy, especially in cases of extreme obesity. This is due to better ergonomics, three-dimensional visualization and the ability to operate in restricted spaces, provided by compact and articulated instruments. Although CBR often requires a longer operative time, the results indicate a significant reduction in specific post-operative complications, such as bleeding and ulcers.

Research such as that by Zhang *et al.* (2021) corroborates these findings, showing that there are no significant differences in weight loss or body mass index (BMI) between the robotic and laparoscopic approaches over 12 months. This confirms that both strategies are effective in controlling weight in the short and medium term. However, the lower incidence of serious complications in CBR, such as infections, especially in patients with previous comorbidities, highlights the potential for greater safety in this technique. At the same time, studies such as that by Marincola *et al.* (2024) show that the comfort provided to the surgeon and the reduction in technical challenges in complex procedures, such as the Roux-en-Y gastric bypass (RYGB), are significant advantages of the robotic approach.

Another important technical benefit was pointed out by Awad *et al.* (2015), who showed the superiority of manual sutures in end-to-side gastrojejunostomy during CBR. Although no significant differences were observed between the mechanical and manual techniques, hand-sewn anastomoses showed a lower incidence of bleeding. This benefit is attributed to the greater flexibility of manual stitching, which allows for better adaptation and precision during complex reconstructions.

COMPARISON WITH LAPAROSCOPIC TECHNIQUES AND COSTS

In clinical practice, these advances are particularly applicable in specialized centers that have trained teams and adequate infrastructure. The shorter learning curve associated with CBR, compared to laparoscopy, represents an important advantage for the dissemination of this technique. In addition, standardizing the use of robotics could improve the outcomes of complex surgeries, such as revision procedures and cases of severe obesity. Beckmann *et al.* (2020) argue that these benefits may justify the higher initial costs of CBR, especially in health systems that prioritize reducing complications and hospital readmissions.

In a comprehensive analysis, Makkar *et al.* showed that patients undergoing the robotic approach have reduced hospitalization times compared to laparoscopic techniques. This reduction in hospitalization time was corroborated by Economopoulos et al. who also pointed out the safety of robotic surgery, especially in more challenging contexts. However, the high cost remains a significant barrier, restricting the widespread adoption of this technology in many healthcare systems.

In addition, Pennestrì *et al.* (2024) compared the Hugo™-RAS and DaVinci®-SS platforms, analyzing complication rates and operative times in Roux-en-Y gastric bypass (RYGB). Although the results are comparable between the systems, the widespread adoption of robotic-assisted surgery (RA) faces challenges such

as limited accessibility and high costs. While DaVinci®-SS shows greater clinical consolidation due to the experience accumulated since 2013, the viability of Hugo™-RAS depends on a reduction in costs and greater clinical use.

PERSPECTIVES AND LIMITATIONS IN THE USE OF ROBOTIC BARIATRIC SURGERY (CBR)

However, some gaps remain. The lack of randomized controlled studies limits the generalizability of the available results. Issues related to the cost-effectiveness of CBR require more detailed investigations, taking into account economic and regional disparities. In addition, the long-term impacts of the robotic technique on obesity complications and relapses are still poorly explored, since most studies focus on short- and medium-term outcomes (Morrell *et al.*, 2021).

After a comparative analysis of a total of 355,278 morbidly obese and overweight patients who underwent robotic or laparoscopic surgery, Pastrana *et al.* (2020) evaluated post-operative outcomes to see if one of the techniques provided significant advantages for patients. The study concluded that there were no relevant differences associated with the surgical technique used, although there was a higher rate of post-operative complications in overweight patients, regardless of the method adopted.

Similarly, Moon *et al.* (2020) analyzed 94 patients who underwent robotic and laparoscopic approaches over a two-year period, with surgeries performed by two experienced professionals. After 30 days of follow-up, the data did not show statistically significant results that favored robotic surgery over laparoscopic surgery. However, the authors stressed the need to follow up patients for longer periods in order to identify possible advantages or late post-operative outcomes of both techniques.

In a meta-analysis conducted by Ataya *et al.* (2023), 11 studies involving more than 60,000 patients were reviewed, 55,889 in the laparoscopic group and 5,809 in the robotic group. The parameters analyzed included average operative time, length of hospital stay, conversion to open surgery and complications. Of all the factors evaluated, the only one with a statistically significant difference was the conversion rate to open surgery, which was lower in the robotic approach, indicating a possible advantage of the technique in more challenging procedures.

On the other hand, Dimou *et al.* (2021) observed a significant increase in the adoption of robotic surgery in recent years, compared to laparoscopy. The study emphasized the need to establish formal indications for performing robotic procedures, with the aim of optimizing postoperative results and ensuring patient safety.

CONSIDERATIONS

CBR has significant technical benefits, such as greater surgical precision and a lower rate of specific complications, especially in complex cases of severe obesity. Although the results related to short-term weight loss are comparable to those of the laparoscopic approach, the robotic technique stands out for reducing conversions to open surgery. The advances made possible by this technology include a significant reduction in the learning curve for surgeons and increased safety in challenging procedures. However, high costs and the scarcity of long-term studies limit its widespread adoption in clinical practice. Future research should focus on evaluating late outcomes, patients' quality of life and cost-effectiveness. In addition, it is essential to investigate the possible psychological impacts associated with this technological approach. In this way, high-risk groups, such as patients with morbid obesity and significant comorbidities, will be able to benefit more effectively and safely.

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