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REVIEW ARTICLE

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Major approaches to endoscopic treatment of gastrojejunal anastomosis post gastric bypass with argon plasma and dietary monitoring: a systematic review

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Abstract

Introduction: Obesity is a serious chronic non-communicable disease (NCD) that has several consequences for public health. In this scenario, there are more than 2.2 billion people who are overweight or obese in the world, and the latest census showed that Brazil is in fifth place in the world ranking with 18.0 million obese individuals, tending to reach 70.0 million patients. Roux-en-Y Gastric Bypass (RYGB) is one of the most performed surgeries in the world, however, approximately 20% of patients undergoing this surgery do not lose the desired weight in the first year and 15% of patients regain weight after 18 to 24 months. Anastomotic diameters above 15.0 mm have been associated with a recurrence of obesity and may be associated with complaints of decreased satiety. Thus, the application of argon plasma in gastrojejunal anastomosis has been proposed to reduce weight in patients undergoing RYGB who presented recurrent obesity. **Objective:** It was to develop current scientific approaches through a systematic review of the main approaches and application of argon plasma and dietary monitoring in the reduction of dilated gastrojejunal anastomosis and the consequent reduction of recurrent weight after gastric bypass. **Methods:** The research and development of the work were carried out from May to July 2024 in the Scopus, PubMed, Science Direct, and Scielo databases, using the main scientific articles on nutrigenomics, and following the PRISMA rules. The quality of the studies was based on the GRADE and AMSTAR-2 instruments, and the risk of bias by the Cochrane instrument (Funnel Plot). **Results and Conclusion:** Twentyone studies were included out of a total of 125. According to the GRADE instrument, most studies presented homogeneity in their results, with X^2=88.6%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 37 studies

with a high risk of bias and 25 studies that did not meet the GRADE and AMSTAR-2 criteria. The application of argon plasma in the treatment of dilated gastrojejunal anastomosis and dietary monitoring have been highlighted as effective and safe methods in the treatment of recurrent obesity. The application of argon plasma via an endoscopic approach is very effective in its indications, technically easy to perform, and has numerous advantages over conventional electrocoagulation. Complications are rare. The limit of tissue penetration depth of 2 to 3 mm associated with excellent coagulation allows its application in critical areas such as the duodenum and colon.

Keywords: Obesity. Weight regained. Gastrojejunal anastomosis. Argon plasma. Diet. Endoscopy.

Introduction

In contemporary society, obesity is a serious chronic non-communicable disease (NCD) that has several consequences for public health **[1]**. In this scenario, there are more than 2.2 billion people who are overweight or obese in the world **[1]**, and the latest census showed that Brazil is in fifth place in the world ranking with 18.0 million obese individuals, with a trend towards reaching 70.0 million patients **[2]**.

Statistical data also indicate that by the year 2050, there will be 15.4 million deaths worldwide due to NCDs and the Brazilian population will contribute significantly to this scenario **[1,2]**. Therefore, it is necessary to expand and improve knowledge about the main predictors of its cause, in an attempt to expand society's education and health professionals' tools to mitigate this scenario **[3-5]**.

In this context, there is currently no more efficient treatment for morbid obesity than bariatric surgery **[6]**. Roux-en-Y Gastric Bypass (RYGB) is one of the most commonly performed surgeries in the world, along with sleeve gastrectomy. However, approximately 20% of patients undergoing this surgery do not lose the desired weight in the first year and 15% of patients regain weight after 18 to 24 months **[3-6]**.

In super-obese patients, the rate of obesity recurrence can reach 35% **[7]**. Although weight recurrence is expected after two years, or insufficient weight loss in the first year, these conditions cannot be overlooked since obesity (BMI >30 kg/m^2) is a disease **[8]**. The negative consequences of obesity recurrence on health and quality of life can be significant **[9]**. Previous studies correlate obesity recurrence with type 2 diabetes recurrence, worsening the resolution of this disease **[10]**. Thus, to date, several studies regarding RYGB have demonstrated timid results concerning weight loss, with surgical complication rates 3 to 5 times higher than those of primary surgery **[6,11-13]**. These results call into question the justification for reintervention in this patient population **[14]**.

Bariatric surgery, however, can lead to postoperative complications **[15]**. The most feared complications in the postoperative period, responsible for mortality rates between 0.1 and 0.5%, include sepsis of abdominal origin, caused by dehiscence of the sutures or anastomosis, and pulmonary thromboembolism **[16,17]**. The most common late complication is the recurrence of obesity, in which the main associated factors are poor eating habits and poor lifestyle habits associated with a sedentary lifestyle, resulting in an increased gastric reservoir and consequent dilation of the anastomosis **[18,19]**.

It is known that obesity recurrence is directly correlated with factors such as BMI before surgery, eating habits, psychiatric disorders, self-esteem problems, and socioeconomic conditions **[21]**. Thus, anastomotic diameters above 15.0 mm have been associated with obesity recurrence and may be associated with complaints of decreased satiety **[22]**. As a consequence of weight gain recurrence, abnormal anatomical findings are found in 71.2% of patients, with 58.9% having dilation of the gastrojejunal anastomosis (GJA) **[22]**.

Therefore, numerous endoscopic techniques have been proposed to treat the problem. In 2009, Ahmad Aly published for the first time the proposal to cause a narrowing of the GJA through the application of argon plasma (APA). The objective was to reduce the speed of emptying of the gastric reservoir, giving the patient a feeling of satiety and promoting weight loss **[23]**. What is currently under discussion is the efficacy and safety of GJA narrowing through the APA by endoscopic application in the recurrence of obesity in patients undergoing RYGB. Thus, APA in GJA has been proposed to reduce weight in patients undergoing RYGB who presented a recurrence of obesity **[3-5]**.

Therefore, the present study developed current scientific approaches through a systematic review of the main approaches and application of argon plasma and dietary monitoring in the reduction of dilated gastrojejunal anastomosis and the consequent reduction of recurrent weight after gastric bypass.

Methods

Study Design

This study followed the international systematic review model, following the PRISMA (preferred reporting items for systematic reviews and meta-analysis) rules. Available at: http://www.prisma-

statement.org/?AspxAutoDetectCookieSupport=1. It was accessed on: 06/14/2024. The AMSTAR-2 (Assessing the methodological quality of systematic reviews) methodological quality standards were also followed. Available at: https://amstar.ca/. It was accessed on: 06/14/2024. Table 1 shows the main variables of this study that were addressed, according to the designation of the PICOS (Patients; Intervention; Control; Outcomes, and Study Design) literary search strategy.

Table 1. Literary search strategy - PICOS.

PATIENTS	Patients with recurrent obesity and dilated gastrojejunal anastomosis
INTERVENTIONS	Argon plasma and diet
CONTROL	Conventional treatments
OUTCOMES	Recurrent weight loss and improvement of comorbidities.
TYPE OF STUDIES	Randomized, prospective and retrospective observational clinical studies.

Source: Own Authorship.

Instruments and Professionals for Study Eligibility

Studies that rigorously presented the results of the search process in Table 1 and that presented scientific quality according to the GRADE classification, and that did not present a significant risk of bias, that is, that could compromise the safety of the results, according to the Cochrane instrument, were selected.

Data Sources, Search Strategy, and Study Time

The search strategies for this study were based on the descriptors of the DeCS platform (available at: https://decs.bvsalud.org/) with the descriptors (MeSH Terms): "Obesity. Weight regained. Gastrojejunal anastomosis. Argon plasma. Diet. Endoscopy". Search filters designated as clinical studies were used. The research and development of the work were carried out from May to July 2024 in the Scopus, PubMed, OVID, Science Direct, LILACS, and EBSCO databases, using previous articles to the present. In addition, a combination of keywords with the Boolean operators "OR", AND, and "NOT" operator was used to target the scientific articles of interest. The title and abstracts were examined in all conditions. Table 2 presents an example of the search structure in PubMed. The same search strategy was used in the other databases.

Table 2. For example, in the search structure in PubMed, the same search strategy was used in the other databases.

PubMed	*Obesity* ***OR*** *Weight gain* ***OR*** *Weight regained* ***OR*** *Gastric bypass*
	AND
PubMed	*Obesity treatment* ***OR*** *Gastrojejunal anastomosis* ***OR*** *Argon plasma* ***OR*** *Diet*
	AND
PubMed	*Prospective Clinical studies* ***OR*** *Retrospective Clinical studies* ***OR*** *Randomized clinical trials* ***OR*** *Clinical case series* ***OR*** *Review studies*
	NOT
PubMed	*Editorials* ***OR*** *Short communications* ***OR*** *Case Report*

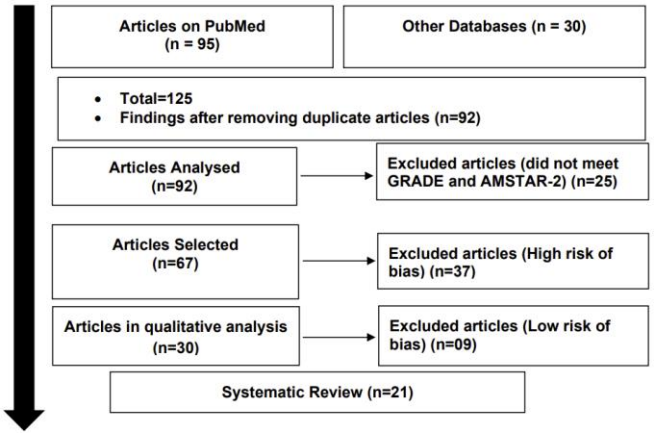
Source: Own Authorship.

Results and Discussion

Summary of Findings

As a corollary of the literature search system, a total of 125 articles were found that were submitted to eligibility analysis and, subsequently, 21 of the 30 final studies were selected to compose the results of this systematic review. The listed studies presented medium to high quality (Figure 1), considering in the first instance the level of scientific evidence of studies in study types such as meta-analysis, consensus, randomized clinical, prospective, and observational. Biases did not compromise the scientific basis of the studies. According to the GRADE instrument, most studies presented homogeneity in their results, with X^2=88.6%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 37 studies with a high risk of bias and 25 studies that did not meet GRADE and AMSTAR-2.

Figure 1. Flowchart showing the article selection process.

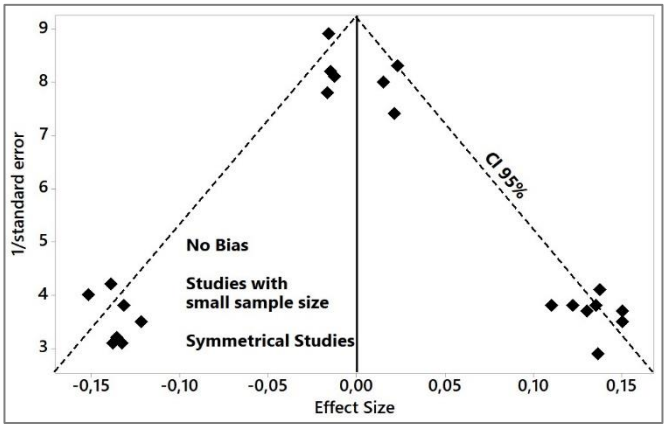


Source: Own Authorship.

Figure 2 presents the results of the risk of bias of the studies using the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using Cohen's Test (d). Precision (sample size) was determined indirectly by the inverse of the

standard error (1/Standard Error). This graph had a symmetrical behavior, not suggesting a significant risk of bias, both among studies with small sample sizes (lower precision) at the bottom of the graph and in studies with large sample sizes at the top.

Figure 2. The symmetrical funnel plot suggests no risk of bias among the studies with small sample sizes, which are shown at the bottom of the graph. High confidence and high recommendation studies are shown above the graph (n=21 studies).



Source: Own Authorship.

Major Clinical Outcomes

Weight regain after RYGB may occur due to treatment failure, which leads to an increase in the gastrojejunal anastomotic diameter (GAD), contributing to a failure in the restriction and the patient begins to eat more food, thus hindering the desired weight loss. However, the most recent scientific studies do not confirm this thesis **[3-5]**.

In the current scenario of treatment of gastrojejunal anastomotic widening, there is discussion about the efficacy and safety of using argon plasma (APA) by endoscopic application in the recurrence of obesity in patients undergoing RYGB **[12]**. As a consequence of the recurrence of weight gain, abnormal anatomical findings are found in most patients, with more than half of the cases presenting dilation of the GAD **[13-16]**. Thus, APA in the GAD has been proposed to reduce weight in patients undergoing RYGB who have relapsed obesity **[17]**.

It is admitted that the subject is controversial and there are two sides to the argument. One believes that the restriction on the size of the gastroplasty is due to the diameter of the anastomosis, and the other believes that these are not important factors in weight loss **[18]**. In this sense, the argon method for reducing the anastomotic diameter does not aim to influence post-surgical weight loss, but rather the weight regained after the initial loss when this is significant **[19-21]**. In this sense, endoscopy has stood out as an effective and safe method for treating recurrent obesity, and APA is effective in its indications, technically easy to perform, and has numerous advantages over conventional electrocoagulation **[20]**. The limit of tissue penetration depth of 2.0 to 3.0 mm is associated with excellent coagulation, which allows its application in critical areas such as the duodenum and colon. Regarding treating gastrojejunal application with APA, it is important to emphasize first that argon is an odorless, inert, non-toxic, cheap, and easily ionized gas. It has been used in conventional surgeries since the 1980s and, in the field of endoscopy, it was introduced in 1991 **[14]**.

Unlike most endoscopy equipment for anastomotic suturing, argon is approved by the National Health Surveillance Agency (ANVISA) of Brazil and is low cost, easy to perform, does not require extensive training of endoscopists, not to mention its safety, speed, and minimal side effects and complications. APA has also shown a higher percentage of recurrent weight loss than other endoscopic methods and drastically reduces the need for revision surgery in post-gastric bypass patients with weight regain **[14]**.

In addition, endoscopy should provide information such as the diameter of the anastomosis and complications after bariatric surgery. Monitoring by a specialized team and physical activity contribute to a better indication criterion to be adopted in patients who have regained weight after RYGB **[3,4]**.

Reducing the diameter of a dilated anastomosis can lead to a 23% reduction in excess weight on average, as well as a significant improvement in the clinical picture **[10]**. APA has promoted a reduction in its diameter and consequent delay in gastric emptying, early satiety, and weight reduction **[14]**. Thus, the relevance of studies on the effect of argon on weight reduction in patients undergoing RYGB envisions the increasing continuity of its use **[19]**.

Thus, a study with follow-up of 3 and 6 months after APA, as a therapy for anastomotic reduction after RYGB, showed that 53 patients (age 49.0 ± 1.3 years, 195F / 28M) had a pre-RYGB BMI of 52.1 ± 10.7 kg m-2. The postoperative weight was 29.6 ± 1.1 kg m-2. APA was performed 8.6 ± 3.4 years after RYGB, with weight regain resulting in a BMI of 35.4 ± 1.1 kg m-2. The anastomotic reduction was 16.1 ± 3.7 mm to 13.5.

The mean number of sessions was 1.3 **[16]**.

Of note, Baretta et al (2015) **[14]** studied 30 patients undergoing APA treatment after gastric bypass and observed 3 endoscopic sessions (on average) of APA with an intensity of 70 W at 2.0 L/min, spaced between each other for 8 weeks. In their results, they described a mean weight loss of 15.0 kg.

A retrospective study was also performed by De

Souza et al (2015) **[17]** with 37 participants. In this study, the use of APA obtained a success rate of 50% and a 24.0% reduction in relapsed weight. In addition, a prospective controlled longitudinal study with PA carried out by Cambi et al (2015) **[20]** showed a success rate of 90.0% and a reduction of up to 41% in weight with recidive.

In 2018, data from a retrospective analysis of 558 patient records from eight bariatric centers in the United States and Brazil who underwent PAC between July 31, 2009, and March 29, 2017, were published **[12]**. This therapy was performed in patients who regained weight after RYGB. The mean weight was 94.5 ± 18.6 kg and the mean BMI was 34.0 kg/m2 at PAC. When data were available, the mean lowest weight was 67.0 ± 23.0 kg and the mean lowest BMI was 24.1 kg/m2 after RYGB. Mean weight loss was 6.5, 7.7, and 8.3 kg at 6, 12, and 24 months, respectively, and changes in weight over time were statistically significant ($p < 0.0001$). Of the 333 patients in four centers who provided information on complications, complications after PCA included stricture (n = 9), GJ ulcer (n = 3), vomiting (n = 3), GJ leak (n = 2), and melena (n = 1). Therefore, PCA was shown to be useful in reducing weight regain after RYGB, and patients had a total weight loss of 6.0–10.0% at 12 months.

The work published by Thompson et al. (2012) **[15]**, however, showed that revision weight regain surgery that is practiced at the clinical level could even be considered experimental. Even without strong scientific evidence, these are the procedures that are growing the most in the United States, according to data provided by the American Society for Metabolic and Bariatric Surgery published in the article "Systematic Review on preoperative bariatric surgery American Society for Metabolic and Bariatric Surgery Revision Task Force" from 2014 in the journal "Surgery for Obesity and Related Diseases", which in its conclusion highlights the lack of scientific evidence to support their use despite clinical practice.

In addition, the authors Ramos et al. (2017) **[21]** evaluated the size of gastrojejunal anastomoses and their influence on weight loss, where an anastomosis calibrated to 15.0 mm presents better results (with statistical significance) when compared to an anastomosis of 45.0 mm in a 2-year follow-up. It is no coincidence that between 10 and 15.0 mm is the diameter that is targeted for endoscopic treatment.

In addition to these studies, it is important to emphasize that the method is used in clinical practice in several countries such as the United States, Spain, France, and Germany without the need to submit it to experimental clinical research protocols. In Brazil, the method has been used at a clinical level and in research protocols, and its results have been published **[12,14,20]**.

Also, after analyzing 5 published studies using APA to reduce AGJ, the case series ranges for each procedure were respectively 10 to 49. Most of the studies followed longitudinal prospective studies. An average weight regain reduction (kg) of 24.5% was also observed after using PA. The success rate was 82.5%. In a subsequent non-parametric correlation analysis between the results of weight loss and PA regain, the result was $p = 0.580$, considering $p>0.05$ **[12,14,16,17]**.

Recurrence of obesity is associated with decreased quality of life and recurrence of comorbidities in these patients **[17]**. Thus, endoscopic techniques have been developed in an attempt to effectively reduce the anastomotic diameter and consequent weight loss **[23-27]**. Abnormal anatomical findings are found in 71.2% of patients, 58.9% with AGJ dilation, 28.8% with pouch dilation, and 12.3% with alterations in both **[28]**. Thus, several methods such as endoluminal reduction of AGJ with suture, surgery, and APA in AGJ have been proposed to reduce weight regain in patients undergoing RYGB. In this scenario, surgical treatments are the most commonly performed; however, they are associated with a higher incidence of complications morbidity, and mortality when compared to the other treatments proposed above **[29,30]**.

Conclusion

The application of argon plasma in the treatment of dilated gastrojejunal anastomosis and dietary monitoring have been highlighted as effective and safe methods in the treatment of recurrent obesity. The application of argon plasma via an endoscopic approach is very effective in its indications, technically easy to perform, and has numerous advantages over conventional electrocoagulation. Complications are rare. The limit of tissue penetration depth of 2 to 3 mm is associated with excellent coagulation, which allows its application in critical areas such as the duodenum and colon.

CRediT

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Santos; **Formal Analysis -**Leonardo Honório de Andrade Mélo Neto, Vitor Bezerra de Medeiros, Hugo Menezes Lopes, Jeffeson Alexandre Azevedo de Araujo, Diego Pereira Netto, Brysa Freitas Dall'orto, Nicole Velasco Campos; **Investigation-**Kennya Medeiros Lopes de Barros Lima, Ana Gabriela de Magalhães, Laís Martins Borges; **Methodology -**Karlla Gabrielly Claudino Santos, Leonardo Honório de Andrade Mélo Neto, Vitor Bezerra de Medeiros, Hugo Menezes Lopes, Jeffeson Alexandre Azevedo de Araujo, Diego Pereira Netto, Brysa Freitas Dall'orto, Nicole Velasco Campos; **Project administration -** Kennya Medeiros Lopes de Barros Lima; **Supervision -**Kennya Medeiros Lopes de Barros Lima, Ana Gabriela de Magalhães; **Writing - original draft -** Kennya Medeiros Lopes de Barros Lima, Ana Gabriela de Magalhães, Laís Martins Borges, Karlla Gabrielly Claudino Santos, Leonardo Honório de Andrade Mélo Neto, Vitor Bezerra de Medeiros, Hugo Menezes Lopes, Jeffeson Alexandre Azevedo de Araujo, Diego Pereira Netto, Brysa Freitas Dall'orto, Nicole Velasco Campos; **Writing-review & editing-** Kennya Medeiros Lopes de Barros Lima, Ana Gabriela de Magalhães, Laís Martins Borges, Karlla Gabrielly Claudino Santos, Leonardo Honório de Andrade Mélo Neto, Vitor Bezerra de Medeiros, Hugo Menezes Lopes, Jeffeson Alexandre Azevedo de Araujo, Diego Pereira Netto, Brysa Freitas Dall'orto, Nicole Velasco Campos.

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No additional data are available.

Conflict of Interest

The authors declare no conflict of interest.

Similarity Check

It was applied by Ithenticate®.

Peer Review Process

It was performed.

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