# Robotic-assisted bariatric surgery: case series analysis and comparison with the laparoscopic approach.

## *Cirurgia bariátrica robótico-assistida: análise de série de casos e comparação com via laparoscópica.*

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A B S T R A C T

**Objective:** *to report a series of cases of robotic bariatric surgery in the treatment of obesity in Brazil.* **Methods:** *we evaluated patients undergoing robotic bariatric surgery at the Garrido Institute and compared them with a group submitted to conventional laparoscopic surgery.* **Results:** *we analyzed 45 patients, with a mean age of 39.44 years, of which 34 were female, with an initial mean BMI of 41.26kg/m². Among the procedures performed, 91.11% were Roux-en-Y gastric bypass, while 8.89% were sleeve gastrectomy. The mean total surgery time was 158 (±56.54) minutes, with mean docking time of 7.93 (±3.9) minutes, and console time 113.0 (±41.4) minutes. The average pain presented in the post anesthetic recovery was 2.61 (±3.30) points on a scale of 0 to 10; four patients presented with mild signs of nausea, responding well to drug treatment. Only one patient needed ICU admission for a period of two days after surgery due to previous cardiopathy. In two cases, there was an incisional hernia at the trocar site, which were surgically treated without further complications. In the comparison between roboticversus laparoscopic surgery groups, 45 patients were selected for each group. Operative time was significantly longer in the robotic surgery group, with most other variables being equivalent, including postoperative control of comorbidities.* **Conclusion:** *robotic bariatric surgery is a safe procedure, with results comparable to laparoscopic surgery.*

**Keywords:** *Obesity. Bariatric Surgery. Gastric Bypass. Robotics.*

## INTRODUCTION

The overweight and obesity pandemic that affects the world surpasses two billion people[1]. In Brazil, more than 51% of the population is overweight, with about 22 million obese, corresponding to 17% of the population, and approximately six million morbidly obese[2,3]. Bariatric surgery is recognized as the most effective treatment for morbid obesity, maintaining a stable weight reduction in the long term and reducing comorbidities, with a favorable impact on mortality[4-6].

Bariatric surgery performed by laparoscopy became a preferential technique because it was minimally invasive, leading to less surgical trauma, decreased morbidity and postoperative recovery time[7-9]. On the other hand, laparoscopic access limits vision to two dimensions, being technically not ergonomic, especially in super-obese patients, requiring great physical effort of the surgeon. In addition, the instruments need to be better adapted to the fine and intuitive dexterity required to perform the procedure[8].

Robotic surgery has the potential to minimize such difficulties, with superior image quality in three dimensions and more ergonomic instruments, fully flexible and better adapted to the precision of surgical movements[10]. A recent study with 36,158 participants showed that the robotic assisted procedure is compared to the conventional laparoscopic approach. However, robotic bariatric surgery is associated with longer surgical time at the beginning of the learning curve and is likely to be costly, due to the high price of the equipment,

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but with shorter hospitalization time and incidence of complications[11,12]. However, more studies are needed tobetter delineate the role of robotic platforms in digestive surgery.

Robotic surgery has been implemented in Brazil in recent years, also in bariatric surgery. The objective of this study was to evaluate a series of cases submitted to Robotic-assisted Roux-en-Y Gastric Bypass (RA-RYGB) or Sleeve Gastrectomy (RA-SG), and to compare them with a conventional laparoscopic group.

## METHODS

We evaluated all patients submitted to robotic bariatric surgery at the Garrido Institute, in São Paulo, from November 2015 to December 2017. A single surgeon trained for such procedure performed all surgeries. In addition, in a secondary analysis, we selected a group submitted to laparoscopic surgery with similar characteristics to the robotic surgery group for comparison purposes. The criterion for performing robotic-assisted surgery was the patient's desire, and there were no specific indication factors for this procedure. The present study was approved by the Local Research Ethics Committee under CAAE nº 55925916.0.0000.0087. All participants signed an Informed ConsentForm.

We included in the study patients aged 18-65 years and eligible for bariatric surgery according to NIH criteria[13]. We excluded cases of surgery considered to be revisional or concurrent with other abdominal surgeries, such as cholecystectomy, hiatal hernia repair, among others.

In the first analysis, we assessed 54 patients undergoing robotic-assisted bariatric surgery. In a second comparative analysis, we evaluated 45 patients operated by the robotic route between September 2015 and November 2017. We then selected a group of patients operated by conventional laparoscopy on the same day or in the period of 24 hours before or after the robotic cases, with similar characteristics of gender, age and weight. These patients formed the "Conventional" group, being compared with the robotic group. The postoperative follow-up ranged from four to six months.

### Surgical technique

Robotic-assisted RYGB was performed with the patient in a lithotomy position. Pneumoperitoneum was instilled with a Veress needle, with placement of the trocar to introduce the 30-degree robotic optics 12 to 15 cm below the xiphoid appendix and 2cm to the left of the midline. From the introduction of optics in the abdominal cavity, all other trocars were introduced under direct vision.

The gastric pouch preparation initiated with the dissection of the His angle and gastric wall release in the small curvature, thus obtaining access to the gastric retrocavity. Once the retrocavity was exposed, we performed the first firing with a linear mechanical stapler of 45mm purple load, transversely. The dissection of the gastric retrocavity then initiated until the complete visualization of the left diaphragmatic pillar. We then completed the gastric pouch with the vertical stapling with a purple load of 60mm. Since we used a conventional stapler, all stapling was performed by an assistant in the surgical field, guided by the surgeon on the robotic console.

We set the biliopancreatic loop at 80cm. We performed the gastrojejunal anastomosis with a linear mechanical stapler with a white load of 45 mm, but using only 20mm as a calibration measure. We sutured the openings in the gastric pouch and the jejunal loop continuously in two planes, with a 32Fr Fouchet catheter as a guide.

Based on the gastrojejunal anastomosis, we measured the food loop, set at 100cm. We performed

the entero-enteric anastomosis in a lateral-lateral manner, with a linear stapler, with a white load of 45mm, but using only 20mm of the load as a form of calibration of the anastomosis, and we sutured the stapler orifice with absorbable suture. We closed the space between the mesenteries of the biliopancreatic loop and the common loop with continuous, unabsorbable suture. We routinely performed a leak test of the anastomoses and stapling lines with saline solution and methylene blue.

We performed the robotic-assisted sleeve gastrectomy in a similar way with respect to the surgical position and trochar sites, using a 60mm linear stapler (black and purple load) for complete gastric section, carrying out no routine suture over the staple line. We performed conventional laparoscopic surgeries in a technically similar manner, differing only in the absence of the robotic platform.

We present the qualitative variables by absolute and relative frequency, and the quantitative ones, as measures of central tendency and dispersion. The confidence level adopted was 95%. We performed statistical analysis with statistical software Stata version 11.0.

## RESULTS

### Robotic Surgery

In the initial analysis group, 54 patients underwent robotic-assisted bariatric surgery. However, we excluded nine due to insufficient data. The group consisted of 45 patients with mean age of 39.44 (±12.16) years, of whom 22 were female, and 23, male. Among the surgeries performed 91.11%, were RYGB, and 8.89%, sleeve gastrectomies (SG). The mean initial BMI was 41.26 (±3.64) kg/m$^2$.

The total surgery time was 158 (±56.54) minutes, with mean docking time of 7.93 (±3.9) minutes, and console time of 113.0 (±41.4) minutes. The stay in the operating room was of a mean of 207.31 (±45.90) minutes, while the average stay in the post-anesthetic recovery room (PAR) was 107.04 (±48.48) minutes (Table 1).

During the PAR stay, the mean pain presented by the patients was 2.61 (±3.30) points on a scale of 0 to 10. Only four patients presented slight signs of nausea, responding well to drug treatment. Only one case required ICU

***Table 1.*** *Description of variables.*

| Variable | Median (p.25-p.75#) | Mean (SD##) | Minimum | Maximum |
|---|---|---|---|---|
| Age | 38 (34-46) | 39.44 (12.16) | 18 | 72 |
| BMI | 41.31 (38.50-43.70) | 41.26 (3.64) | 35.16 | 51.6 |
| Hospital (time in hours) | 51 (44-55) | 48.86 (10.76) | 19 | 77 |
| OR* (time in minutes) | 195 (175-230) | 207.31 (45.90) | 135 | 370 |
| Docking (time in minutes) | 8 (5-10) | 7.93 (3.87) | 3 | 15 |
| Console (time in minutes) | 103 (87-137) | 113.04 (41.45) | 57 | 265 |
| Operative (time in minutes) | 146 (115-190) | 158 (56.54) | 90 | 380 |
| PAR** (time in minutes) | 90 (65-132.5) | 107.04 (48.48) | 55 | 245 |
| Pain at PAR | 0 (0-6) | 2.61 (3.30) | 0 | 8 |

*# p. 25-p. 75: 25 and 75 percentiles; ## SD: standard deviation; * OR: operating room; ** PAR: post-anesthetic recovery room.*

admission for a period of two days after surgery because of previous cardiopathy. There were two cases of intestinal subocclusion, caused by trochar site incisional hernia, diagnosed by computed tomography, after three and seven days of surgery. In one case, the hernia site was the trocar used for optic placement, and in the other, the trocar was used by the assistant. Both required reoperation, one undergoing enterectomy of a 20cm jejunum segment, and reduction of the hernia content in the other, without major complications. It is important to note that the two cases occurred at the beginning of the curve, which lead us to decide to close the sites of the wider trocars, and there were no similar complications in the rest of the series. There were no deaths. The mean hospital stay was 48.86 (±10.76) hours. During follow-up, late complications occurred in 24.07% of the cases, all of which considered mild (Table 2).

There was an excess weight loss of 70.69% after nine months (n=21), and an average loss of 84.14% after 12 months (n=21) (Figure 1).

***Table 2.*** *Postoperative complications.*

| Variable | n | % |
|---|---|---|
| Calculous cholecystopathy | 7 | 15.55% |
| Late complications | | |
| Yes | 12 | 24.07 |
| Types of late complications | | |
| Epigastric pain | 2 | 4.44 |
| Reflux | 0 | 0 |
| Vomiting | 2 | 4.44 |
| Daytime hypoglycemia | 1 | 2.22 |
| Trocar site hernia | 2 | 4.44 |
| Diarrhea | 1 | 2.22 |
| Dyspepsia | 1 | 2.22 |
| Vertigo | 1 | 2.22 |
| Melena | 1 | 2.22 |
| Mortality | 0 | 0 |
| Rehospitalization in 30 days | 0 | 0 |

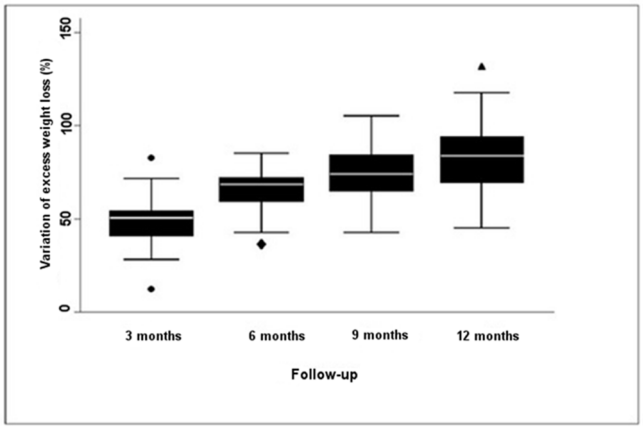


***Figure 1.*** *Box plot of the variation of the excess weight loss percentage in the 12-month follow-up*

**Robotic vs. Laparoscopic Surgery**

In the second phase of the study, we compared patients undergoing robotic-assisted surgery with a group undergoing conventional laparoscopy. For the comparative analysis, 90 patients participated, of whom 45 were operated with robotic assistance and 45 by laparoscopy, on the same day, or in a period of 24 hours before or after, with similar characteristics of gender, age and weight. Patients operated by laparoscopy formed the "conventional" group. The postoperative follow-up ranged from four to six months.

Of the total number of participants, 54 were female and 36 were male, with a median age of 37 years. The analysis had medians of 155 minutes of stay in the operating room, 90 minutes in the PAR and 105 minutes operative time. The mean length of hospital stay was 52 hours, as shown in table 3. The median initial BMI was 40.7 and the final BMI 32.9 kg/m$^2$ for conventional surgery, and 41.7 and 32.5 kg/m$^2$, respectively, for the robotic group. The median excess weight loss percentage was 66% for conventional surgery and 50% for robotics (Table 3).

Robotic surgeries had considerably longer operation room times, as well as operative times. The PAR time, although not statistically significant, was higher for patients undergoing conventional

surgery. There was no difference for the pain variable, which we evaluated by the Analog Pain Scale, nor for the presence of nausea / vomiting during PAR (Table 3).

There were no transoperative complications. Among the 90 patients, six patients presented some type of complication in the immediate postoperative period, such as excessive drowsiness, wound bleeding, excessive pain that did not stop until the discharge to the ward and one patient who required admission to the ICU due to cardiopathy. The presence of complications in the immediate postoperative period showed no difference between groups. Both presented 42 patients with no complications and three patients with some type of complication already described.

Only two patients had a late postoperative complication, characterized by intestinal obstruction due to hernia at the trocar insertion site, one of such cases being from the robotic-assisted group. Among the non-surgical complications, one case of feeding difficulty occurred in a patient submitted to robotic-assisted surgery, one case of diarrhea/ vomiting (robotic-assisted) and one patient presented convulsions due to a lupus crisis, without major complications (conventional laparoscopy). The percentage of excess weight loss presented a median of 0.66 (0.53; 1.09) for the conventional group and 0.50 (0.40; 0.58) for the robotic group, without statistical significance (p=0.013).

With regard to baseline comorbidities, 23 patients had systemic arterial hypertension and 44 were diabetic. Table 4 presents the association between comorbidities according to the type of surgery performed. None of the studied variables presented statistically significant results in the

***Table 3.*** *Excess weight loss percentage, length of stay, surgical times, nausea/vomiting in PAR and postoperative pain according to the type of surgery performed.*

| Variable | Type of surgery | | p * |
|---|---|---|---|
| | Conventional | Robotics | |
| | Median (95% CI) | | |
| Excess weight loss percentage | 0.66 (0.53;1.09) | 0.50 (0.40;0.58) | 0,013 |
| Hospitalization (hours) | 54 | 52 | 0,752 |
| OR time (min) | 116.94 | 195 | < 0.001 |
| PAR time (min) | 95 | 90.0 | 0.192 |
| Operative time (min) | 85 | 90 | 0.192 |
| Variable | Conventional | Robotics | p ** |
| | n (%) | | |
| Pain | | | |
| Absent | 26 (57.78) | 28 (62.22) | 0.519 |
| Mild | 0 (0) | 1 (2.22) | |
| Moderate | 10 (22.22) | 11 (24.44) | |
| Intense | 9 (20.00) | 5 (11.11) | |
| Nausea/Vomiting | | | |
| Absent | 40 (88.89) | 41 (91.11) | 0.725 |
| Mild | 5 (11.11) | 4 (8.89) | |

** Mann-Whitney test. 95.0% CI: 95.0% confidence interval; ** Chi-square test.*

comparison between robotic and laparoscopic surgery.

## DISCUSSION

Robotic surgery has as one of its advantages a more adequate and comfortable ergonomics, facilitating procedures in obese patients, and especially super-obese ones[14]. The use of minimally invasive surgical technique offers less aggression to organs and systems, reducing morbidity and recovery time[8]. This study presents cases of robotic-assisted bariatric surgery. The most important complications related to the procedure were the two cases of trocar site incisional hernia, occurring in the beginning of the learning curve, without reoccurrence after the standardization of the trocar sites closure. The other significant complication was a postoperative stay in ICU in a cardiac patient, not directly related to the procedure.

Artuso *et al*. state that the robotic technique offers greater accuracy in certain procedures, which could be related to a lower rate of complication and pain onset[14]. In our series, most cases presented mild degree or absence of pain during the first recovery hours. The results also show that the time of hospitalization, operation room and anesthetic recovery are within expected parameters and that they do not differ much from bariatric surgeries performed in the conventional laparoscopic manner. Similar results were reported by Ramos *et al*.[15].

***Table 4.*** *Comorbidities according to the type of surgery performed.*

| Comorbidity | Conventional surgery | | | Robotic surgery | | |
|---|---|---|---|---|---|---|
| | Before | After | p * | Before | After | p * |
| | n (%) | | | n (%) | | |
| Systemic hypertension | | | | | | |
| Yes | 12 (26.67) | 4 (8.89) | 0.004 | 11 (24.44) | 9 (20.00) | 0.157 |
| No | 33 (73.33) | 41 (91.11) | | 34 (75.56) | 36 (80.00) | |
| Diabetes *mellitus* | | | | | | |
| Yes | 22 (48.89) | 5 (11.11) | <0.001 | 22 (48.89) | 14 (31.11) | 0.004 |
| No | 23 (51.11) | 40 (88.89) | | 23 (51.11) | 31 (68.89) | |
| Dyslipidemia | | | | | | |
| Yes | 26 (57.78) | 8 (17.78) | <0.001 | 23 (51.11) | 10 (22.22) | 0.004 |
| No | 19 (42.22) | 37 (82.22) | | 22 (48.89) | 35 (77.78) | |
| Hepatic steatosis | | | | | | |
| Yes | 27 (60.00) | 4 (8.89) | <0.001 | 30 (66.67) | 10 (22.22) | <0.001 |
| No | 18 (40.00) | 41 (91.11) | | 15 (33.33) | 35 (77.78) | |
| Hiatal hernia | | | | | | |
| Yes | 3 (6.67) | 1 (2.22) | 0.317 | 3 (6.67) | 2 (4.44) | 0.563 |
| No | 42 (93.33) | 44 (97.78) | | 42 (93.33) | 43 (95.56) | |
| Vomiting | | | | | | |
| Yes | 1 (2.22) | 1 (2.22) | 1.000 | 4 (8.89) | 0 (0) | 0.045 |
| No | 44 (97.78) | 44 (97.78) | | 41 (91.11) | 45 (100) | |

* *McNemar's test.*

With the learning curve progression, a reduction in operative time is expected. This condition, coupled with ergonomic benefits and low complication rates, may make the use of fully robotic surgery more and more feasible. In this context, clinical studies have shown comparison of robotic surgery with laparoscopic surgery, with promising results. In a study of 2660 participants who performed RA-RYGB (7.4%) *versus* 21,280 with laparoscopic RYGB (L-RYGB), RA-RYGB was associated with longer operative time (136 vs 107 min; p<0.001) and with a higher readmission rate in 30 days, with 7.3% vs. 6.2%. In addition, there was no statistical difference regarding morbidity, mortality, unplanned admission to an intensive care unit, reoperation or reintervention within 30 days after surgery. Therefore, RA-RYGB is safe compared with the conventional laparoscopic approach[12].

Another work evaluated 137,455 patients submitted to RA-RYGB (n=2415) or L-RYGB (n=135,040). There were significant differences for operative time (150.2±72.5 vs 111.8±47.6, p<0.001), reoperation in 30 days (4.8% vs 3.1%, p=0.002), reoperation in 90 days (8.8% vs 5.3%, p<0.001), complications (15.8% vs 12.5%, p=0.001), readmission (8.5% vs. 6.4%, p=0.005), stenosis (3.5% vs 2.0%, p=0.001), ulceration (1.2% vs 6%, p=0.034), nausea or emesis (6.4% vs. %, p=0.001) and anastomotic leakage (1.6% vs 2.0%, p<0.001). After including surgical time in propensity matching, there was no significant difference in readmission in 30 days, ulceration or readmission in 90 days. All other differences remained significant. Despite controlling the patient's characteristics, the RA-RYGB group developed higher rates of early morbidity compared with the L-RYGB, suggesting that L-RYGB may provide better postoperative results[16].

In 2018, in a comparative study of 246 patients, 125 were submitted to robotic surgery and 121 to L-RYGB. The robotic group was older and had higher weight, but showed a similar loss of weight compared with the laparoscopic group. In addition, laparoscopic operative time was shorter, but the mean weight loss was greater in the robotic group. There were no leaks or mortality. Based on the Clavien-Dindo classification, there were fewer global and less severe complications in the robotic approach compared with the laparoscopic one. Therefore, the use of robotic technology for the creation of gastric bypass occurred in longer operative time, with similar weight loss, and a lower number and severity of complications compared with the laparoscopic approach[11].

There was a statistically significant difference in weight loss in the groups studied, favoring the laparoscopic group. This was probably due to the short segment and insufficient number of patients, which can lead to statistical difference when a patient lies outside the curve in the analysis. We expect that the results will become comparable with the increase in the series and follow-up. The results of the present study confirm the findings described in the literature regarding total weight loss, excess weight loss, operative time. However, it is imperative to perform controlled and randomized studies to be able to know the efficiency and effectiveness of robotic bariatric surgery in a reliable way.

Robotic bariatric surgery proved to be a safe procedure, presenting satisfactory postoperative results. Longer and larger studies are needed for a better comparative evaluation.

R E S U M O

**Objetivo:** relatar uma série de casos de cirurgia bariátrica robótica no tratamento da obesidade no Brasil. **Métodos:** foram avaliados pacientes submetidos à cirurgia bariátrica robótica no Instituto Garrido, e realizada comparação com grupo submetido à cirurgia laparoscópica convencional. **Resultados:** foram analisados 45 pacientes, com média de idade de 39,44 anos, sendo 34 do sexo feminino, com média de IMC inicial de 41,26Kg/m$^2$. Dentre as cirurgias realizadas, 91,11% foram bypass gástrico em Y de Roux, enquanto 8,89% foram do tipo gastrectomia vertical. A média de tempo total de cirurgia foi de 158 (±56,54) minutos, com tempo médio de docking de 7,93 (±3,9) minutos e tempo de console 113,0 (±41,4) minutos. A média de dor apresentada na recuperação pós-anestésica foi de 2,61 (±3,30) pontos, em escala de 0 a 10, com quatro pacientes apresentando sinais leves de náusea, respondendo bem ao tratamento medicamentoso. Somente um paciente necessitou internação em UTI por um período de dois dias após a cirurgia, devido à cardiopatia prévia. Em dois casos ocorreram hérnia incisional em sítio de trocater, tratados cirurgicamente, sem posteriores complicações. Na comparação entre os grupos de cirurgia robótica versus laparoscópica, foram selecionados 45 pacientes para cada grupo. O tempo operatório foi significativamente mais longo na via robótica, sendo a maior parte das outras variáveis equivalentes, inclusive controle pós-operatório de comorbidades. **Conclusão:** a cirurgia bariátrica robótica é um procedimento seguro, com resultados comparáveis à cirurgia laparoscópica.

**Descritores:** Obesidade. Gastroplastia. Robótica. Cirurgia Bariátrica.

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