

Three-dimensional vs two-dimensional laparoscopic gastric bypass for manual gastrojejunal anastomosis: A prospective and randomized trial

Reducción del tiempo quirúrgico al realizar la gastroyeyunoanastomosis utilizando sistemas de imagen en tercera dimensión en bypass gástrico laparoscópico: estudio prospectivo aleatorizado

Martín Rojano-Rodríguez^{1*}, María Torres-Ruiz¹, Adolfo Cuendis-Velazquez¹, Luz S. Romero-Loera¹, Monserrat Reséndiz-Barragán², Enrique Rentería-Palomo³, Paola Vazquez-Cárdenas² y Mucio Moreno-Portillo¹

¹Departamento de Endoscopia, Invasión Mínima Gastrointestinal y Cirugía; ²Obesidad y Clínica Metabólica; ³Departamento de Cirugía Endoscópica General. Hospital General "Dr. Manuel Gea González," Ciudad de México, México

Abstract

Objective: The objective of this study was to compare the total procedure time and task-specific execution time in gastric bypass using a three-dimensional (3D) versus two-dimensional (2D) imaging system. **Materials and methods:** This study was a prospective and randomized clinical trial. Forty obese patients were randomized into two groups: gastric bypass with 3D imaging system or with conventional 2D system. The primary endpoint was operative time during manual gastrojejunal anastomosis. Data collection was carried out on demographics, comorbidities, operative time in three stages, and complications. The same surgeon performed all surgeries. Two patients were excluded because technical issues were encountered for viewing their videos during the trial. **Results:** A total of 20 patients in the Laparoscopic Gastric Bypass (LGB) 3D group and 18 in the LGB 2D group were analyzed. There were no significant differences in the pre-operative data. The average procedure time was 16.5 min lower in the 3D group versus the 2D group. Execution time for specific tasks was not statistically significant, except for the gastrojejunal anastomosis, which is routinely performed as a manual anastomosis in our surgery group. There was no complication intra- or post-operative. **Conclusions:** The use of a 3D imaging system for laparoscopic gastric bypass was associated with a shorter total operative time, especially for the hand-sewn gastrojejunal anastomosis, compared with the 2D imaging system.

Key Words: Gastrojejunal anastomosis. Metabolic surgery. Three-dimensional and two-dimensional imaging system. Laparoscopy.

Resumen

Objetivo: Comparar el tiempo total del procedimiento y de tareas específicas en bypass gástrico laparoscópico (BGL) utilizando sistemas de imagen 3D y 2D. **Método:** Estudio prospectivo, aleatorizado, con 40 pacientes obesos divididos en dos

Correspondencia:

*Martín Rojano-Rodríguez

Calzada de Tlalpan, 4800

Col. Sección XVI, Del. Tlalpan

C.P. 14050, Ciudad de México, México

E-mail: drojano@icloud.com

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grupos: BGL 2D o 3D. El objetivo principal fue medir el tiempo al realizar la gastroyeyunoanastomosis manual. La recolección de datos incluyó comorbilidad, demografía, tiempo operatorio en tres fases (formación de reservorio, gastroyeyunoanastomosis y yeyunoyeyunoanastomosis) y complicaciones posoperatorias. El mismo cirujano realizó los procedimientos. Se excluyeron dos pacientes por incapacidad para abrir el video. **Resultados:** Se analizaron 20 pacientes en el grupo 3D y 18 en el grupo 2D. No hubo diferencias significativas en los datos preoperatorios. El tiempo promedio del procedimiento fue menor en el grupo 3D que en el 2D en 16,5 minutos. El tiempo de ejecución para realizar tareas solo fue significativo al realizar la gastroyeyunoanastomosis. No hubo ninguna complicación intraoperatoria ni posoperatoria. **Conclusiones:** El uso de un sistema de imagen 3D se asoció con un menor tiempo quirúrgico total, en especial para la gastroyeyunoanastomosis manual, en comparación con el sistema de imagen 2D.

Palabras Clave: Gastroyeyunoanastomosis. Cirugía metabólica. Sistemas de imagen 3D y 2D. Cirugía laparoscópica.

Introduction

The efficacy and safety of laparoscopic Roux-en-Y gastric bypass for treating morbid obesity has been widely demonstrated in the literature. The laparoscopic approach for gastric bypass has reported minor bleeding, lower admission rate to the intensive care unit, and a reduced overall hospital stay compared with conventional surgery¹⁻⁴. One of the most important challenges for a gastric bypass is the gastrojejunal anastomosis. This surgical step is crucial for the postsurgical prognosis and can be achieved by different techniques, mainly hand-sewn and mechanical anastomosis, which could be made with a circular or linear stapler. There is no consensus on which is the optimal technique, therefore, the technique is chosen based on surgeon's preference or practice. Jiang et al. revealed in their meta-analysis no significant differences between mechanical and hand-sewn anastomosis except for greater incidence rates of post-operative bleeding and wound infection with the use of circular staplers⁵.

High-definition cameras have been used in laparoscopic bariatric procedures during the past two decades. The conventional laparoscopic imaging system of two-dimensional (2D) vision that functions by alternating between both eyes to produce a quick sequence of images separated by milliseconds; afterward, these images are combined into one that is magnified at a lower resolution than the human eye to produce a visual interface between the surgical field and the surgeon, who must operate based on a mental and perceptual process using a three-dimensional (3D) image that is indispensable for adjusting the range and speed of its movements⁶. In this way, it leads to the loss of depth perception and consequently a more cognitive workload for surgeons.

Using conventional equipment, the human brain must process 2D stimuli to create a perception of depth that differs from the perceived through natural stereoscopic vision. We, therefore, have evaluated whether a 3D imaging system can improve the surgeon's performance, especially in procedures involving multiplane interactions, such as manual anastomosis⁷. In a recent meta-analysis, Casanovas et al. revealed that the 3D display system is superior to the 2D system in clinical settings with significantly shorter operating time, less blood loss, and shorter hospital stay⁸.

Materials and methods

We conducted a prospective, randomized, and single-center controlled trial to compare the operative time for laparoscopic gastric bypass using a 3D versus a 2D imaging system.

The Ethics and Research Committee of the Hospital General "Dr. Manuel Gea González" approved the study. Inclusion criteria consisted of patients with morbid obesity with an indication for gastric bypass according to the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) guidelines scheduled for a laparoscopic Roux-en-Y gastric bypass who agreed by signing the informed consent.

The sample size calculated was 17 in each group, it was considered using the difference between two independent means formula (two groups), with the following parameters: two tails hypothesis, α error probability of 0.05, statistical power ($1-\beta$ err. prob.) of 0.8, allocation ratio $N_2/N_1 = 1$, for the estimated effect size, we utilized data from the article 3D versus 2D laparoscopic bariatric surgery: a single-surgeon prospective randomized comparative study published by obesity surgery considering the gastrojejunal anastomosis time⁹.

Patients were randomized on surgery day by a computer-generated allocation list. The first group underwent laparoscopic gastric bypass using a 2D imaging system (Storz Image HD®), and a 3D imaging system (Viking 3D®) was used in the other group.

The laparoscopic gastric bypass surgical technique was identical in all patients and was performed by the same surgeon. After the insertion of the five access ports, the surgical procedure was divided into three different stages. The first consisted of the gastric section, the second was the performance of the hand-sewn gastrojejunal anastomosis, and the third was the jejunojunal anastomosis.

The jejunojunal anastomosis and the gastric pouch were created with a linear stapler. The gastrojejunal anastomosis was carried out manually with a running absorbable monofilament suture in a single plane for the posterior aspect of the anastomosis, and the anterior aspect was carried out with interrupted non-absorbable suture using Gea extracorporeal knotting technique, which is preferred in our hospital, for it can be easily performed by a left-handed surgeon and only one hand is used for tying¹⁰.

All surgeries were recorded and analyzed in a single blind method by a researcher who unknowledge which group each video belong.

The time for each stage and complete procedure was measured. The time count started from the insertion of the last trocar until the last stitch during jejunojunal anastomosis.

The statistical analysis was performed with the software Stata/IC 13.1 for Mac median and 25th and 75th percentile values of operative times were calculated in each group. Comparisons between them were carried out using Wilcoxon rank-sum test, considering $p < 0.05$ as statistically significant.

Results

The 2D group included 18 patients, 3 men and 15 women. The 3D group included 20 patients, 3 men and 17 women. From the analyzed patients, the average age was 35.9 years for the 2D group and 37.2 years for the 3D group, the mean body mass index (BMI) was 48 kg/m² (37-66), 48.4 kg/m², and 47.7 kg/m² for the 2D and 3D group, respectively; there were no significant differences in age, gender, comorbidities, weight, or BMI between both groups. The comorbidities were: systemic hypertension in 50% for 2D group and 35% for 3D, type 2 diabetes mellitus in 2D group was 33% and 40% in 3D group, obstructive

Table 1. Demographics and pre-operative comorbidities

Parameter	Data
Total patients, n	38
2D	18
3D	20
Age (years)	
2D	35.9 (18-56)
3D	37.2 (23-58)
Sex, n (%)	
Female	32 (84%)
2D	15 (39.4%)
3D	17 (44.7%)
Male	6 (15.7%)
2D	3 (7.8%)
3D	3 (7.8%)
BMI (kg/m ²)	
2D	48.4 (36-66)
3D	47.7 (37-58)
Comorbidity, n (%)	
Hypertension	
2D	9 (50%)
3D	7 (35%)
Type 2 diabetes	
2D	6 (33%)
3D	8 (40%)
OSA	
2D	5 (27%)
3D	2 (10%)
Others (hypothyroidism and dyslipidemia)	
2D	3 (16%)
3D	4 (20%)

BMI: body mass index; OSA: obstructive sleep apnea; 2D: two-dimensional vision, 3D: three-dimensional vision.

sleep apnea in 2D was 27% and 10% in 3D and other comorbidities (hypothyroidism and dyslipidemia) for 2D was 16% and for 3D was 20% (Table 1).

The operative time difference between the groups using 2D and 3D imaging systems for the laparoscopic gastric bypass was statistically significant ($p = 0.015$) being 16.5 min lower in the 3D group than in the 2D group (Table 2). Moreover, the manual gastrojejunal anastomosis time was significantly lower in the 3D group than in the 2D group (42.7 vs. 53.1 min, $p = 0.001$, Table 2). It is important to mention that this step is made by a non-mechanical technique in our surgery group.

In contrast, the mechanically performed tasks, the gastric section and jejunojunal anastomosis, did not differ from using 3D or 2D imaging systems ($p = 0.208$ and $p = 0.588$, respectively). Neither intraoperative (bleeding and perforation) nor post-operative (leaks, fistula, and surgical site infection) complications were reported in any group.

Table 2. Operative times of component tasks and complete laparoscopic gastric bypass using 2D and 3D imaging systems

	Operative time		p*
	2D group (n = 18)	3D group (n = 20)	
Complete procedure (min)	136.5 (117-171)	120 (112.5-129)	0.015
Gastric section (min)	18.5 (16.4-25)	17.2 (9.8-24.3)	0.208
Gastrojejunal anastomosis (min)	53.1 (50.3-63)	42.7 (35.5-50.4)	0.001
Jejunojejunal anastomosis (min)	25.7 (19.3-32.3)	24.2 (17.1-30.15)	0.588

(*) Using the Wilcoxon rank-sum test. Median (25th-75th percentiles) values of operative times are shown.

2D: two-dimensional vision; 3D: three-dimensional vision; min: minutes.

Discussion

The choice of laparoscopic tools should be based on the best evidence available. The use of 3D vision laparoscopic equipment must be supported by trials that demonstrate its theoretical benefit to resemble stereoscopic vision and improve the surgeon's performance, resulting in shorter procedure time without increasing intraoperative complications.

In the present study, the total time for gastric bypass with 3D vision was lower than using 2D vision, with a statistically significant difference. In the analysis of each surgery task, it is particularly noteworthy that the hand-sewn gastrojejunal anastomosis, which demands great skill and involves multiplane interaction, involved less time using 3D vision equipment ($p = 0.04$).

At the step of the gastric bypass, in which mechanical instruments are used, we infer that there is no significant difference in time; this supports the idea that 3D vision improves the surgeon's skills, especially in complex procedures, reducing execution time.

In our literature review, we found only two randomized studies and one meta-analysis comparing the use between 2D and 3D laparoscopic techniques in surgical patients.

Hanna et al. published the first study in 1998; it included 60 patients who were divided into two randomized groups. The first consisted of 30 elective cholecystectomies with 2D vision and the second in 30 elective cholecystectomies with 3D vision. The main variables were the operative time and surgeon's transoperative mistakes. The study results are as follows: median operative time, 3160 s versus 3100 s intervals (between 2735-4335 and 2379-3710, respectively, $p = 0.20$), and a measure of six versus six

errors. Therefore, there were no statistically significant differences between the two vision systems⁶.

Curro et al. compared the 3D versus 2D vision in two laparoscopic bariatric surgeries: mini-gastric bypass and sleeve gastrectomy. They concluded that the surgery time in 3D was < 70 min in sleeve gastrectomy and < 90 min in mini-gastric bypass, while all procedures were above these times with 2D imaging system. This report also includes variables related to surgical parameters registered by the surgeon, who experienced better depth perception with 3D system rather than the 2D system, particularly during mini-gastric bypass, a procedure with similar duration as the Roux-en-Y gastric bypass⁹.

A meta-analysis by Cochrane in 2010 concluded that additional blind and randomized clinical trials to evaluate the advantages of 3D imaging are needed and that the surgeon's comfort is a major factor¹¹.

Conclusions

The use of a 3D vision system to perform gastric bypass in patients with morbid obesity reduces the total surgical time, and more specifically, the required for the manual gastrojejunal anastomosis compared to the 2D vision system.

Conflicts of interest

The authors have no conflicts of interest or financial ties to disclose.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

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