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ORIGINAL CONTRIBUTIONS

Physical and Mental Impact of Laparoscopic Sleeve Gastrectomy on the Surgeon: French vs. American Positions. A Randomized and Controlled Study

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Abstract

Purpose To determine the physical and mental impact on the primary surgeon, by the patient's and surgical staff's dispositions at the operating table, during laparoscopic vertical sleeve gastrectomy.

Materials and Methods This is a randomized and controlled study that included 18 laparoscopic sleeve gastrectomy procedures performed by two surgeons in a private and academic hospital. The cases were randomized for the American or French position. After surgery, the National Aeronautics and Space Administration - Task Load Index (NASA-TLX) and the Body Part Discomfort (BPD) scales were applied to the primary surgeon.

Results An increased workload and more discomfort were reported when using the French position. The NASA-TLX was 28 ± 8 vs. 57 ± 18 ($p = 0.001$), and the BPD was 2 vs. 8 ($p = 0.001$).

Conclusions The American position resulted in a lower physical and mental impact on the surgeon when performing a laparoscopic sleeve gastrectomy.

Keywords Gastrectomy · Bariatric surgery · Ergonomics · Workload · Discomfort

Introduction

Bariatric surgery has increased in popularity over the last decade, mainly due to positive long-term results, low complication rates, and low mortality risk [1, 2].

In general, surgeons that devote themselves to perform bariatric surgeries work almost exclusively in this area and with high volumes, due to the high demand of this surgery. Approximately 70% of the surgeons present osteoarticular symptoms, such as neck, back, shoulder, or hand pain following laparoscopic procedures. Some surgeons also experience potential disability symptoms, such as hand and finger paresthesia, which correlates with a higher number of surgeries performed [3–5].

Among all bariatric procedures, sleeve gastrectomy is the most commonly performed in many countries [6], probably including Venezuela. It can be performed with the surgeon positioned on the right side of the patient (American position) or between the patient's legs (French position). Both positions result in different workloads and different types of discomfort for the surgeon, which have not been previously studied regarding this surgical technique.

Determining which position generates a lesser workload and results in less physical discomfort could promote changes leading to an improved quality of life for surgeons and less stress, discomfort, and pain. It could even prevent osteoarticular manifestations that may force the surgeon to retire early.

The objective of this study is to determine the physical and mental impact that these surgical procedures produce on the primary surgeon, according to the disposition of the patient

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and the surgical team at the operating table. The hypothesis presented by the authors is that, for the surgeon, the American position would result in a lesser workload and decreased physical discomfort than the French position.

For this purpose, the National Aeronautics and Space Administration - Task Load Index (NASA-TLX) and Body Part Discomfort (BPD) scale were used. The NASA-TLX is a multidimensional scale, designed to obtain workload estimates from one or more operators during or after the execution of the task. It is based on the weighted average of six subscales: mental, physical, and temporal demand; performance; effort; and frustration. This has been used in several studies related to laparoscopic surgery and has been translated in different languages, including Spanish [7–9].

The BPD scale is a subjective questionnaire that evaluates the direct experience of the subjects with pain or discomfort in different parts of the body. The surgeon identifies the area of discomfort on an image of the human body, scoring the intensity on a scale from 1 to 5, where 1 means no discomfort and 5 indicates severe pain [10, 11].

Comparisons between the American and French positions during laparoscopic cholecystectomy have favored the latter [12, 13]. However, the authors considered that this result could not be extrapolated to laparoscopic sleeve gastrectomy, since the working axis, surgical tasks, and position of the target organs are different.

Materials and Methods

This is a prospective, randomized, and controlled study to compare the surgeons' workload and discomfort during laparoscopic sleeve gastrectomy performed in the American and French positions. The study was carried out in a private and academic hospital in Caracas, Venezuela, between January and June 2017.

Population

Scheduled cases for laparoscopic sleeve gastrectomy due to morbid obesity or metabolic diseases were included. All patients were informed about the potential risks and benefits of each position and signed the informed consent. Revisions and conversions were excluded.

Interventions

The cases included in the study were randomly assigned to be performed in either the American (group A) or French (group B) position. All procedures were performed by two surgeons, whose prior experience included almost 400 laparoscopic sleeve gastrectomy procedures each, with half carried out in the French and half in the American positions.

Laparoscopic sleeve gastrectomy is performed through five ports: subxiphoid to separate the left lobe of the liver, one port in each hypochondrium, another in the midline above the umbilical scar, and the other on the left flank for the assistant. The distance between trocars is set around 10 cm. Once the ports are placed, the patient is moved to an anti-Trendelenburg position, at surgeon's discretion level. No lateral rotation is added. The surgery begins by releasing the gastric greater curvature and posterior wall of the stomach until exposing the left diaphragmatic crura. The gastric resection is performed by following a 36-French bougie as a calibrator, leaving a 4–6-cm distance from the pylorus. Once the stomach is sectioned, the entire stapling line is reinforced with absorbable and continuous 2-0 polyglactin sutures.

For the American position, the patient is lying supine, with both arms extended. The surgeon is positioned at the right side of the table; meanwhile, a single assistant stand to the left. The camera is placed through the left hypochondrium port during all dissections and sutures on the stapling line, so the surgeon works through the ports of the right hypochondrium and the midline during most of the intervention.

In the French position, the patient is placed in the modified lithotomy position with the legs supported on adjustable stirrups. The chief surgeon is located between the legs of the patient, with the first assistant on the left and the camera on the right. The surgeon works through hypochondrium ports during the entire intervention.

In all cases, intermittent pneumatic compression sleeves were used to prevent venous thrombosis.

Randomization

The patients were randomly distributed into group A (American position) or group B (French position), in a 1:1 ratio and using random numbers generated by a computer. The allocation was indicated on envelopes that were sequentially numerated. After anesthesia induction, the surgeon opened the envelop that indicated the assigned position to the rest of the team.

Study Variables

The main variable was the surgeon's workload, measured by the NASA-TLX. Secondary variables included the surgeon's physical discomfort, measured by the BPD scale, preparation time (measured from the intubation to the first incision), the surgical time (measured from the first incision to the removal of the trocars), total operative time (measured from intubation to removal of the trocars), complications, and blood loss. Following this procedure, the surgeons answered both scales.

Before the beginning of the study, both surgeons were instructed about the scales. As required for applying the NASA-TLX, dimensions were weighted by surgeons before the first patient inclusion.

Sample Size

The sample size was calculated according to previous studies of laparoscopic gastric bypasses, which reported a NASA-TLX of 50, performed in the American position [8]. The authors considered a difference of 20 points as significant. A 5% significance level and 80% power were used, and 18 cases were required for a minimum sample.

Statistical Measurements

The mean and standard deviation of continuous variables were calculated. For nominal variables, the frequency and percentages were determined. Whether continuous variables followed a normal distribution was assessed by the Shapiro-Wilk test. The Student's *t* test was applied for independent samples for continuous variables following a normal distribution. In case of continuous variables that did not follow a normal distribution, the non-parametric Mann-Whitney *U* test was applied. The nominal variables among groups were compared using the Pearson's chi-square test. A p value < 0.05 was considered statistically significant. The R-studio 1.1.422 software for Windows was used.

Results

Eighteen patients were included in the study, nine for each group. No differences were found regarding age, sex, weight, size, BMI, presence of hepatic steatosis, and postoperative body-weight loss (Table 1).

From all measured variables during the surgery, preparation time was highest for French position. However, this difference did not influence the overall surgical time (Table 2). There were no complications.

The American position showed better results than the French position in mostly all dimensions of the NASA-TLX (Table 3). The difference in the total weighted result that favored the American position was at the expense of less mental, physical, and effort demand and less frustration level.

The surgeons reported some discomfort after the intervention in 88% of the cases (7 for American position vs. 9 for French position). These discomforts were greater in the French position according to the results of the BPD scale (Table 4).

Table 1 Comparison of baseline indicators according to position

Variables	American position		French position		*p*
n	9		9		–
Age (years)*	42 ± 7		35 ± 8		0.106
BMI (kg/mt^2)*	38.7 ± 3.8		37.2 ± 3.8		0.413
Height (mt)*	1.69 ± 0.13		1.71 ± 0.1		0.783
Sex					1.000
Male	5	55.6%	4	44.4%	
Female	4	44.4%	5	55.6%	
Hepatic steatosis	5	55.6%	5	55.6%	1.000
Preop weight loss achieved	2	22.2%	2	22.2%	1.000

*Average ± standard deviation

Discussion

The results of this study indicate that the American position led to a lesser workload and decreased physical discomfort to the surgeon during the laparoscopic sleeve gastrectomy. Both the NASA-TLX and the BPD scale showed better results for this position.

It is possible that these results were related to the ergonomics of the procedure, which is different in both positions. Releasing the greater gastric curvature and staple line reinforcement are the most time-consuming steps, at least for the surgeons involved in this study. The work axis of a gastric sleeve is located to the left of the column and goes from bottom to the top and slightly from right to left. In the American position, when the surgeon uses the ports of the right hypochondrium and the midline to work, he/she aligns the axis of the forearms with the working axis of the sleeve, without requiring any major changes in range of motion. Therefore, the surgeon can work with great comfort and, subsequently, with less workload.

When the camera is located in the port of the left hypochondrium, the axis of vision is placed between 30 and 45° in relation to the instrument of the surgeon. Previous simulating studies have reported that the performance could be greater when this is at 0°, which is achieved when the camera is between the two working ports of the surgeon. In experts, as

Table 2 Comparison of bleeding means, preparation time, surgical time, and total time according to type of position

Variables	American position	French position	*p*
n	9	9	–
Bleeding (cc)	44 ± 15	74 ± 26	0.334
Preparation (min)	13 ± 6	19 ± 5	0.036
Surgical time (min)	75 ± 22	72 ± 8	0.705
Entire time (min)	88 ± 22	91 ± 11	0.714

Table 3 Comparison of NASA-TXL component averages according to the type of position

Variables	American position	French position	*p*
Mental demand	4 ± 2	10 ± 5	0.007
Physical demand	5 ± 4	13 ± 4	0.001
Time demand	4 ± 3	7 ± 5	0.117
Performance	19 ± 1	19 ± 1	0.375
Efforts	4 ± 3	14 ± 3	0.001
Frustration	2 ± 1	9 ± 6	0.010
Weighted total	28 ± 8	57 ± 18	0.001

in the case of the surgeons included in this study, the performance is not affected until 90° [14].

One of the described disadvantages of the American position during laparoscopic surgery is deltoid and trapezium fatigue (12), which is due to the abducted position of the surgeon's right arm (in case of a gastric sleeve), between 60 and 90° in relation to the axis of the body for extended periods of time. However, during the surgeries performed in our study, this factor was minimized by changing the position of the working port of the right hand of the surgeon towards the midline.

Following this analysis, we considered that the American position, with the optics positioned in the left hypochondrium for most of the procedure, determines a better ergonomic position during the gastric sleeve when compared to the French position. This meant less mental, physical efforts and frustration in our study.

Studies performed with virtual simulators contradict our results. Yousef et al. [12] reported better ergonomic results, with a lesser workload in the French position using the Rapid Upper Limb Assessment (RULA) and the NASA-TLX. However, the monitor in this study was placed above the simulator's head. This is important, since in the operating room, the monitor is placed in front of the surgeon, regardless of the selected position. This frontal localization guarantees less rotation of the cervical and dorsal spine, improving the performance, as shown in other studies [15, 16].

The surgeons complained about feeling some discomfort in 88% of procedures. This agrees with other publications where a prevalence of 73% or 88% was found [17]. These discomforts mostly manifested when using the French position.

There are several theories that could explain these findings. In the French position, the surgeon tends to flex the body upwards, as suggested by Kramp et al. [18] when using motion-tracking devices attached to the head, back, and sacrum of the subjects. This could influence the discomfort in the lumbar region. This factor can be minimized, but not completely eliminated, placing the patient in Fowler's position. This table movement brings ports closer to the surgeon, but can be limited by the surgeon or patient height and the size of the patient's abdomen.

Some surgeons use a flat stool to stand on, allowing more comfortable positions for their shoulders. Nevertheless, these devices are usually not wide enough and make it difficult to reach pedals like the harmonic or monopolar cautery. On the other hand, the most ergonomic position for the surgeon is to stand with both legs sufficiently separated. As this can not be achieved with short stools, the surgeon is forced to acquire uncomfortable positions, balancing all their weight towards one the hips and knees, which can lead to discomfort and potentially future disabilities.

Similarly, having the working axis at a greater angle in relation to the one of the surgical instruments of the right upper limb requires the surgeon to bend the wrist and abduct the shoulder to accomplish the required task, or change position by rotating the column or lower limbs. This results in joint discomfort and can be felt in the hands, fingers, and lower limbs [19]. These changes in the upper limb position occur fundamentally when working at the antrum. The authors experienced that in the American position, even at this level, there are no conflicts between surgeon's instruments, and both arms and shoulders remain in acceptable and relaxed positions (Fig. 1).

Although it was not evaluated in this study, the impact of the position in the assistant deserves some considerations. In the American position, a single assistant can hold the camera with the left hand and other instruments with the right and stay

Table 4 Comparison of medians of the BPD scale according to type of position

	American position			French position			
Indicators	Mn	Min	Max	Mn	Min	Max	*p*
Neck	0	0	4	2	0	3	0.190
Right shoulder	0	0	0	0	0	3	0.258
Left shoulder	0	0	0	0	0	4	0.258
Right elbow	0	0	0	0	0	3	0.436
Right elbow	0	0	0	0	0	4	0.113
Right wrist	0	0	0	0	0	3	0.258
Left wrist	0	0	0	0	0	3	0.436
Right hand	0	0	0	0	0	3	0.436
Left hand	0	0	2	0	0	4	0.730
Back	0	0	0	0	0	4	0.258
Lumbar	0	0	3	2	0	4	0.113
Right knee	0	0	3	0	0	2	0.222
Left knee	0	0	0	0	0	4	0.436
Right ankle	0	0	0	0	0	0	1.000
Left ankle	0	0	0	0	0	4	0.730
Right foot	0	0	0	0	0	4	1.000
Left foot	0	0	0	0	0	0	1.000
Total	2	0	7	8	3	32	0.001

Mn median

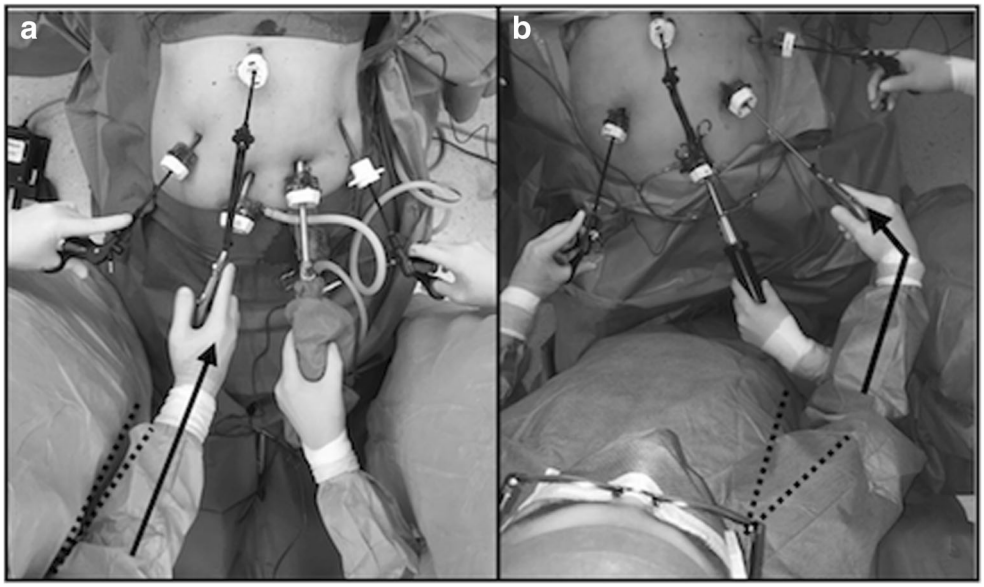

Fig. 1 Upper limb angles according to surgical positions. **a** American position. **b** French position. Interrupted black line: upper limb abduction angle. Black line with arrow: wrist angles

relatively comfortable (Fig. 1). This factor can not be reproduced in French position, in which two assistants are needed, one for each side. The camera holder in this position often has to abduct the shoulder for long periods of time, leading to pain and discomfort. In fact, the authors always perform the laparoscopic gastric bypass in American position, and the assistant takes the same role, as explained before.

Safety concerns may arise for having only one assistant as limitation for proper control of intraoperative complications like spleen bleeding. Authors have found that unless you need an additional port, two experienced surgeons can deal with this kind of problem. In fact, our appreciation is that the angle of vision achieved with the American position improves visualization of the short vessels of the gastric fundus and the spleen.

Awareness of operating room ergonomics could be protective for laparoscopic surgeons [20]; hence, consulting an ergonomist and then applying ergonomic concepts into the operating room performance seem a reasonable strategy in order to prevent work-related injuries [21].

In others activities, a tailored work place exercise protocol showed clinically meaningful reductions of pain symptoms and disability on upper limb and neck regions [22]. Any exercise plan must strengthen the muscles involved in the regular surgeon movements and positions, such as deltoids, rotator cuff, biceps, forearm prono/supinator, and spine erector. This objective can be achieved by making adapted functional exercises, using rubber bands or cufflinks that emulate all the movements that surgeons routinely do. Also, some stretching routine done before the surgery could be helpful. Authors recommend the reader to consult a rehabilitation therapist technician to deepen the topic.

Among the limitations of the study is the fact that the surgeons' positions and angles were not measured during the procedure; thus, there is no direct ergonomic data. Likewise, it is well known that the difference between surgeons' and patients' heights could modify the surgical environment and influence changes in a less ergonomic position. A taller surgeon does not have to flex the body upwards in the French position, but must if he is short or has short arms. The same occurs with the position of the monitor, in case it cannot be adapted to the level of the surgeon's eyes.

Another limitation, that could be a source of bias, is that both surgeons are experts of this procedure. Other studies have reported that expert surgeons are less susceptible to lower ergonomic changes [23].

Improving the workload, in addition to caring for the surgeon, can become a protective factor for the patients. Yurko et al. [24] showed that a greater workload relates to a greater chance of making mistakes and generating unnoticed lesions.

Conclusions

Laparoscopic surgery offers indisputable benefits to patients, but not many for the surgeons. Among many factors that could lead to a high workload, discomfort, or pain in the doctors performing routine gastric sleeve surgeries, we could include patient position. By adapting the selection of the working trocars, in the American position, gastric sleeve surgery can be performed with less physical and mental impact.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval Statement 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.

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

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