



## Breast Surgery

# Influence of the Pectoralis Major Muscle Sling in Chest Wall-Based Flap Suspension After Vertical Mammoplasty: Ten-Year Follow-Up

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## Abstract

**Background:** The pectoralis muscle sling has proven to be a suitable alternative technique for long-term results in breast parenchyma suspension. Although the pectoralis muscle sling has been subjectively observed to reduce the bottoming-out effect with a bipedicle muscle flap (muscular loop), there has not been a study to objectively or numerically prove it.

**Objectives:** This study aimed to radiologically evaluate the influence of a pectoralis muscle sling in supporting the chest wall-based flap after a vertical breast-reduction technique.

**Methods:** Twenty-one female patients underwent a vertical breast reduction with the chest wall-based flap and were randomly divided into two subgroups. Ten patients were in subgroup (S), which consisted of patients with a muscle sling. Eleven patients without the muscle sling technique were assigned as a control group (C). Periodic radiological examinations were performed at 1, 3, 6, and 12 months and then at 10 years postoperatively to analyze the breast flap and any migration with respect to three titanium clips placed intraoperatively on the chest wall parenchyma flap.

**Results:** Patients in subgroup S had a significantly higher difference in migration of the chest wall-based flaps between the first day and 10 years postoperatively when compared with patients in subgroup C ( $P < .001$ ), as shown by the distances measured between titanium clip locations.

**Conclusions:** After 10 years of follow-up, there were changes in chest wall-based flap bottoming-out in patients in whom a pectoralis major muscle sling was utilized compared with those patients without it. Thus, a pectoralis major muscle sling seems to provide greater and longer-lasting support to the flap position on the patient's chest.

## Level of Evidence: 2



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Successful mammoplasty techniques aim to provide safe repositioning of the nipple-areola complex (NAC), to correct breast ptosis and hypertrophy, to remodel the breast parenchyma to provide a natural and firming aspect to the breast, to reduce skin scars, and to provide low rates of morbidity and complications to the patients.

The constant search for the ideal breast has led to the development and improvement of numerous techniques.<sup>1–6</sup> A new technique was accomplished by following a Wise pattern technique,<sup>7</sup> and later achieved by Pitanguy,<sup>8</sup> which left scars in an inverted T-pattern with a short vertical segment and a

long transverse segment. Unfortunately, the use of these techniques over time has developed a phenomenon commonly

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referred to as bottoming out, that is, a heavy lower pole and a loss of projection in the upper pole of the breast.<sup>9-11</sup>

In recent years, one of the primary goals of modifying these standard techniques is to reduce scar morbidity and maintain upper-pole projection while maintaining the longevity of these results.<sup>12-18</sup> With this primary goal in mind, Ribeiro et al<sup>9</sup> proposed the dermolipoglandular flap, fashioned from the central and lower parenchyma of the breast, often reported as an inferior pedicle flap.

Fashioning of the dermolipoglandular flap requires the lateral and medial release with fixation superiorly, thereby redistributing the breast parenchyma up into the upper pole. This provides comparable breast shape and upper-pole projection to an implantable prosthesis with less comorbidity to the patient.<sup>19,20</sup>

As initially described by Daniel<sup>21</sup> and then later extensively modified by the primary author (R.G.), the modification of adding the pectoralis major muscle to address the bottoming-out phenomenon through fashioning a bipediced flap has proven to be successful.<sup>22</sup>

The “sling” of muscle flap is fashioned parallel and from the fibers of the pectoralis major muscle. This loop uses the superficial two-thirds of the pectoralis major muscle fibers which avoids costal exposure and injury to lymphatic drainage. The chest wall-based flap is then released from all four sides (superior, inferior, medial, and lateral) and then passed under this muscle sling.

This approach has provided subjective observations of significant reduction of the bottoming-out phenomenon over time. However, there has not been any studies to prove either objectively or numerically and to evaluate the static and dynamic outcomes that utilization of this flap has had in breast-reduction patients over time.

The aim of this study is to radiologically evaluate the influence of the bipediced pectoralis major flap (muscle sling) in the support of the chest wall-based flap (breast flap) to provide the ideal breast shape after a vertical breast-reduction technique and to analyze the pattern of flap movement over time.

## METHODS

A longitudinal, interventional, and randomized controlled study was carried out to investigate the efficacy of the muscle loop in decreasing the weight-bridge phenomenon, and therefore the maintenance of upper-pole fullness in the vertical breast-reduction patient. Approval was obtained from the Ethics Committee of the Universidade Federal do Paraná. All patients received both written and verbal information pertaining to the aims and design of the study.

Twenty-two female patients underwent vertical breast reduction during the period of August 2003 to April 2005. Randomization involved 22 sealed opaque envelopes, 50% of which contained the phrase “with sling” or “without sling.” During the surgery, a research nurse picked an envelope from

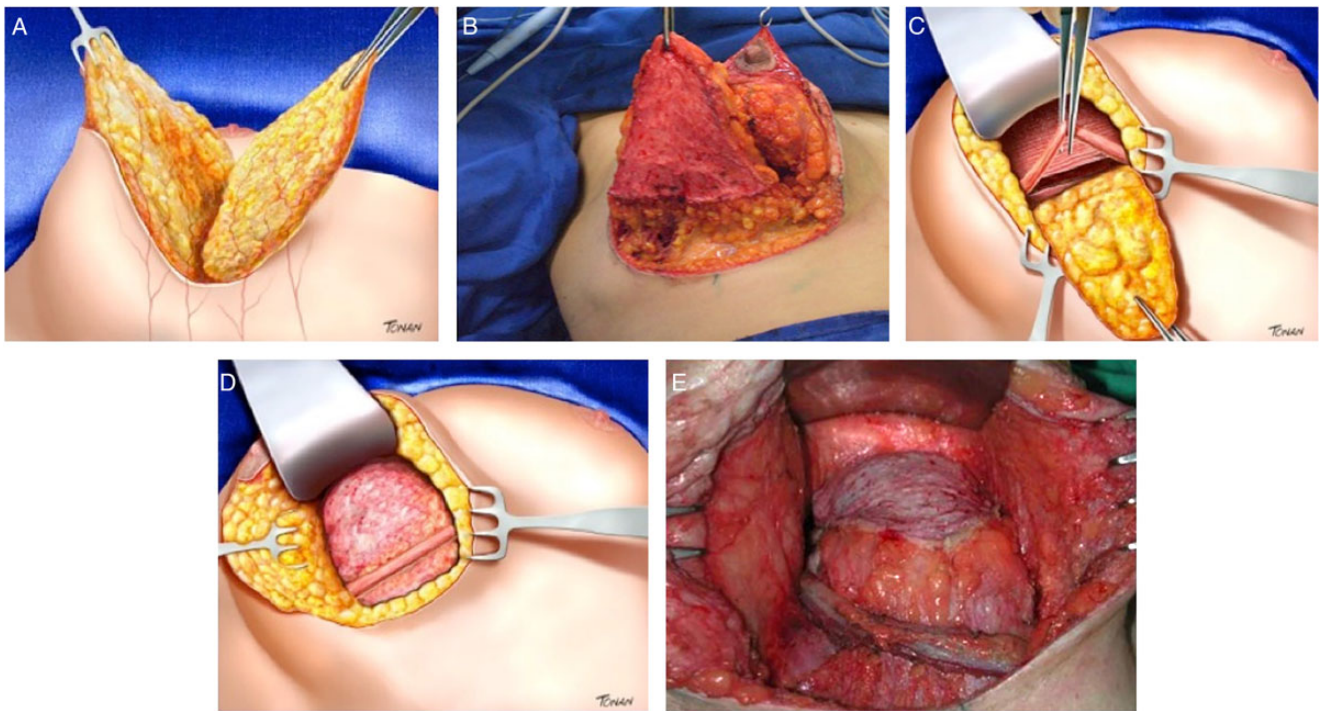
the top of the shuffled pile and announced which technique would be performed. Patients were blinded to which surgical technique was performed. One of the patients in the study group lost follow-up and was excluded. Therefore, 10 patients were randomly selected into the study group (S) in which a muscle loop strip was utilized, and 11 patients were placed into the control group (C) in which no muscle loop strip was fashioned during breast-reduction surgery.

All of the patients were clinically evaluated for baseline breast characteristics, previous and current comorbidities, and previous breast surgeries. Baseline mammography was carried out during the preoperative assessment. All of the patients in the study were initially presented with some degree of breast hypertrophy. Preoperative grading of breast ptosis was not carried out in all of the patients enrolled in the study. Benign preoperative mammographic findings (BIRADS category 1 or 2) were included in the study. Patients that manifested any of the following at the preoperative assessment were excluded from the study: (1) congenital breast malformations (Poland syndrome, tuberous breasts, or others); (2) acquired deformities (trauma, previous burns, or others); (3) previous breast surgery; or (4) any serious associated medical comorbidity or those with an American Society of Anesthesiology (ASA) score of III or above.

The senior author (R.G.) marked all of the patients in the standing position. Chest midline, inframammary crease, and breast meridians were marked on all patients. Four points (A, B, C, and D) delineated an area of skin resection utilizing the Lejour maneuver to obtain the vertical lines finishing 2 cm above the inframammary fold.<sup>23</sup>

At the start of every procedure, liposuction was performed at the lateral aspect of the breasts. The entire marked areas were then de-epithelialized, maintaining areolar diameter of 4 cm. The dermis was incised horizontally approximately 1 to 2 cm below the areola, perpendicular to the plane of the thoracic wall, until the incision meets the fourth intercostal space (Figure 1A). An incision was then made obliquely in the upper portion of the flap, leaving the tissue intact for the breast pillars (laterally and medially). Dissection of the chest wall-based flap was designed by following the dimensions of 8 to 10 cm wide to include the fifth and sixth intercostal vessels as a perforator flap and as long as 10 to 12 cm (Figure 1B). The breast tissue was undermined to the second intercostal space, detaching the gland from the pectoralis major muscle fascia. The lower portion of the flap was then meticulously dissected down to the original inframammary crease, while widening its base.

In the study subgroup (S), a bipediced flap of pectoralis major muscle was fashioned with dimensions of 3 cm wide and 10 cm long just above the base of the chest wall-based flap. Dissection followed the direction of the muscle fibers, which is approximately two-thirds of the muscle thickness, without exposing the underlying chest wall (Figure 1C). The defect in the donor muscle fascia was closed with



**Figure 1.** (A) The breast is divided at the level of Würinger ligaments. (B) The chest wall-based flap is released superiorly, laterally, inferiorly, and medially to the level of the pectoralis major fascia, as shown on this 38-year-old woman. (C) A muscle sling is created just superiorly to the chest wall-based flap. (D) A chest wall-based flap is passed through the muscle sling. (E) The final view of the flap, as shown on a 38-year-old woman.

simple interrupted sutures to maintain the integrity of the muscle fascia. The chest wall-based flap was then passed under the muscle loop and secured to the pectoralis major muscle at the second intercostal space utilizing running 3-0 nylon sutures (Figures 1D-E). Fixation commenced laterally and finished medially, moving upward on the flap to maintain the superior part of the flap free from any tension.

After fixation of the chest wall-based flap, three titanium clips 10 × 1 mm LT-300® (Ethicon Endo-Surgery, Inc., Blue Ash, OH, USA) were used as radiological markers. The first clip was affixed to the apex of the chest wall-based flap, and two additional clips were placed on the medial and lateral aspect of the flaps.

Upper-pole projection and a conical breast shape were achieved with the initial-fixation suture placement from the central parenchyma deeply into the pectoralis major muscle above the chest wall-based flap. The NAC was elevated and affixed into the new desired position, and the medial and lateral breast pillars were stitched together to narrow the new breast base width. A closed-vacuum drainage system was utilized in six patients from the study group and seven patients from the control group, with its use following individualized clinical indication criteria.

A postoperative follow-up was carried out with a clinical evaluation and a radiological examination starting on the first postoperative day and then at 1, 3, 6, and 12 months,

and 10 years, to objectively measure the migration of the chest wall-based flaps. A blind analysis of all radiological images was undertaken, and the following measurements were recorded on each radiological film for each patient:

- Fixed measurements: landmarks of the anterior chest
  - A point located between the medial one-third and two-thirds lateral to the edge of each clavicle
- Variable measurements: from surgical clips to fixed reference points.
  - Vertical distance: distance from the midpoint of each clip to the clavicular reference point
    - SUP-v R: vertical distance from the superior right clip;
    - MED-v R: vertical distance from the medial right clip;
    - LAT-v R: vertical distance from the lateral right clip;
    - SUP-v L: vertical distance from the superior left clip;
    - MED-v L: vertical distance from the medial left clip;
    - LAT-v L: vertical distance from the lateral left clip.

Statistical analysis was carried out utilizing the IBM SPSS v.20 software (SPSS, Inc., Chicago, IL, USA). The *t* test was utilized to compare the various measurements from a fixed reference point over a period of 10 years. Further analyses of these points were compared between subgroup S (patients with muscle sling) and subgroup C (patients without muscle sling suspension) utilizing means, standard deviation, and

variance. The *t* test was considered for independent and paired samples. Variables with a value of  $P < .05$  were considered statistically significant.

## RESULTS

A total of 22 patients underwent breast-reduction surgery. On the day of surgery, the mean age in subgroup S was 46 years (range, 29-73 years), and the mean age in subgroup C was 40 years (range, 20-52 years). BMI showed a variation of 1.47 to 7.14 kg/m<sup>2</sup> during follow-up (mean variation, 4.38 kg/m<sup>2</sup> in the study group; 2.09 kg/m<sup>2</sup> in the control group).

The average amount of breast tissue resected in subgroup S was 210 g (range, 20-600 g) and in subgroup C was 151 g (range, 40-390 g). The average amount of liposuction at the lateral aspect of the breast was 275 mL from each side from both groups.

One control-group patient had breast cancer and underwent a unilateral mastectomy, and one study-group patient lost follow-up and was excluded.

Ten patients in the study group and 11 patients in the control group were subjected to X-rays on day 1 and 10 years postoperatively (Figure 2). Photographs were taken at the preoperative visit and then 1 year and 10 years postoperatively (Figures 3-4).

Analysis of the results has not been conducted individually but rather as group. For example, for the variable "SUP-V" in the study, group 10 cases were considered. For each case, measurements were made on the right and left breasts. Initially, we tested the null hypothesis of mean SUP-V measurement in the left breast being equal to the measurement of the right breast vs the alternative hypothesis of the difference in means. Table 1 shows the summary statistics of these variables in each of the breasts and both breasts, and the *P* value of the statistical test. Because the initial evaluation did not show a significant difference between the breasts in both groups, the results were considered globally.

### Superior Vertical Distance from Fixed Reference Point (SUP-V)

In all of the patients, vertical measurements were evaluated in both breasts of the patient, between the same breast over the different review periods, and finally between the two subgroups (with and without a muscle sling).

In each subgroup, we tested the null hypothesis of the mean SUP-V measurement being equal in the two periods evaluated (Day 1 and 10 years follow-up) vs the alternative hypothesis of the difference in means (Table 2).

In both groups, a difference was seen when measurements were compared with the 10-year measurements on the first day showing a descent of breast parenchyma, as may be expected (Table 2).

Patients who have undergone breast reduction without the muscle sling (subgroup C) had a significant difference between the first day and a 10-year postoperative breast measurements when compared with patients in subgroup S ( $P < .001$ ). This demonstrates the superiority of the muscle sling flap in maintaining upper-pole projection over a 10-year period (Table 3 and Figure 5).

### Medial Vertical Distance from Fixed Reference Point (MED-V)

Vertical measurements were evaluated in both breasts in all of the patients. Measurements were then compared in the same breast over the two time periods (Day 1 and 10 years postoperatively), and subsequent analyses of these measurements were undertaken between both study groups (in patients with and without a muscle sling).

Table 2 tabulates the descriptive analysis of this variable for each moment, as well as the difference between the results for the late assessment and evaluation at the time D1.

The difference between the first-day and 10-year postoperative measurements from the radiological studies were calculated and compared within both subgroups. There was a statistically significant difference between both time periods in the control subgroup compared with the study group ( $P < .001$ ) (Table 3 and Figure 6).

### Lateral Vertical Distance from Fixed Reference Point (LAT-V)

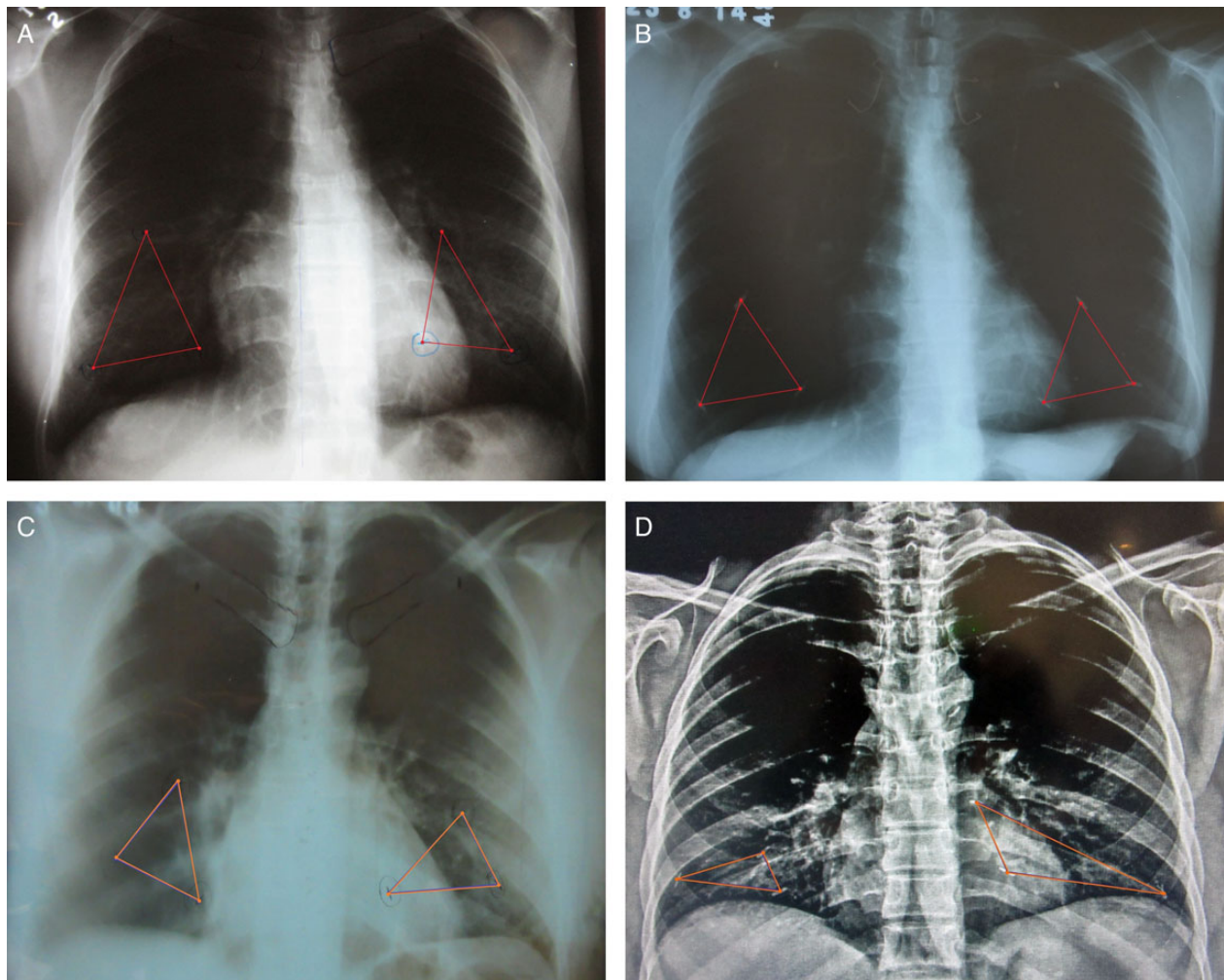
Vertical measurements were evaluated in both breasts in all of the patients. The measurements were then compared in the same breast over the two time periods (Day 1 and 10 years), and subsequent analyses of these measurements were undertaken between both study groups (those with and without muscle sling).

In each subgroup, we tested the null hypothesis that the mean LAT-V remained equal during the two periods evaluated (D1 and 10y) and the alternative hypothesis of the difference in means.

Differences between the two subgroups were compared. Thus, we tested the null hypothesis of an equal mean decrease in both groups and the alternative hypothesis of different means of descent. Table 2 depicts a summary of the statistics in each group and the statistical *P* value.

Patients undergoing breast reduction without a muscle sling (subgroup C) had a significant difference in lateral vertical-height measurement between the first-day radiological study and the 10 year postoperative evaluation compared with patients in subgroup S ( $P < .001$ ) (Table 3 and Figure 7). This also demonstrates the superiority of utilizing the muscle flap sling in maintaining upper-pole projection over the course of 10 years.





**Figure 2.** (A) Radiography on the first postoperative day of this 42-year-old woman with a muscle sling (group S) and (B) at the tenth postoperative year of this same patient (now 52 years old). The red triangles are the projections of the clips positioned in the chest wall-based flap. (C) Radiography on the first postoperative day of this 40-year-old woman with no muscle sling (group C) and (D) at the tenth postoperative year of this same patient (now 50 years old). The orange triangles are the projections of the clips positioned in the chest wall-based flap.

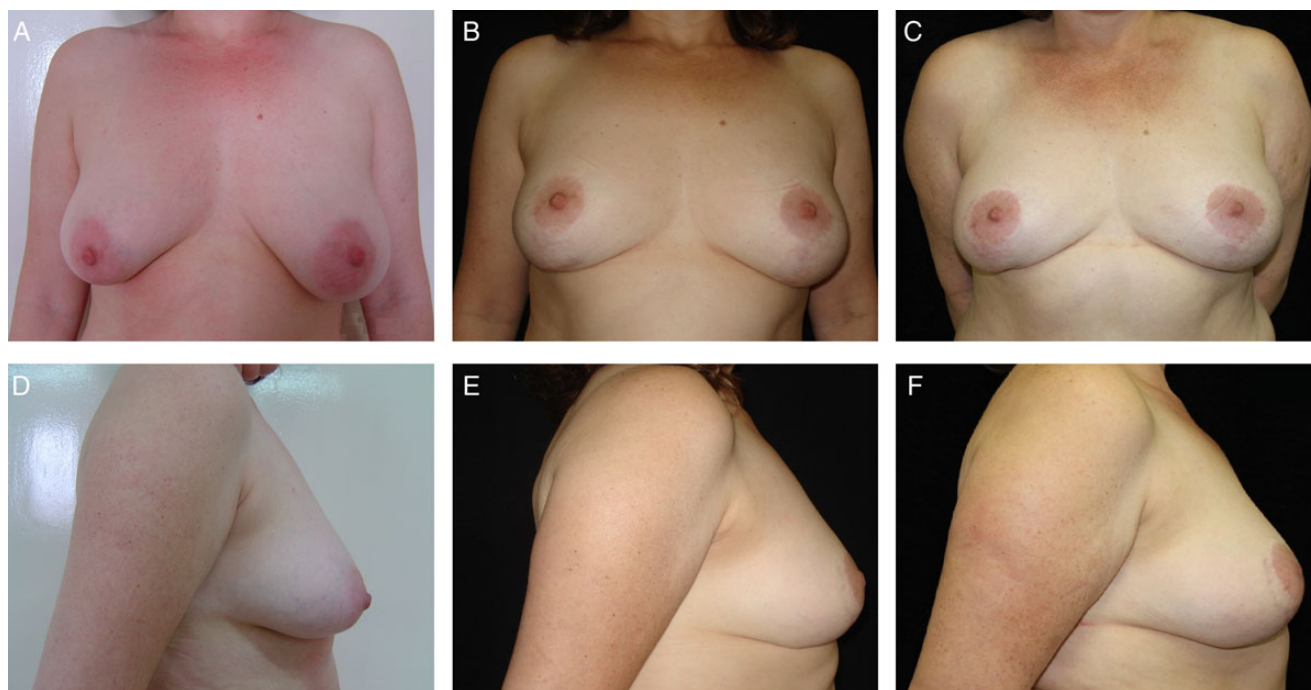
## DISCUSSION

A pectoralis major muscle sling seems to provide greater and longer-lasting support to the chest wall-based flap, filling the breast upper pole and maintaining long-term projection of the breast. After extensive review of the indexed literature, there were no studies that numerically quantified the anatomical position of the chest wall-based flap on the chest wall after breast reduction, with or without pectoralis muscle flap.

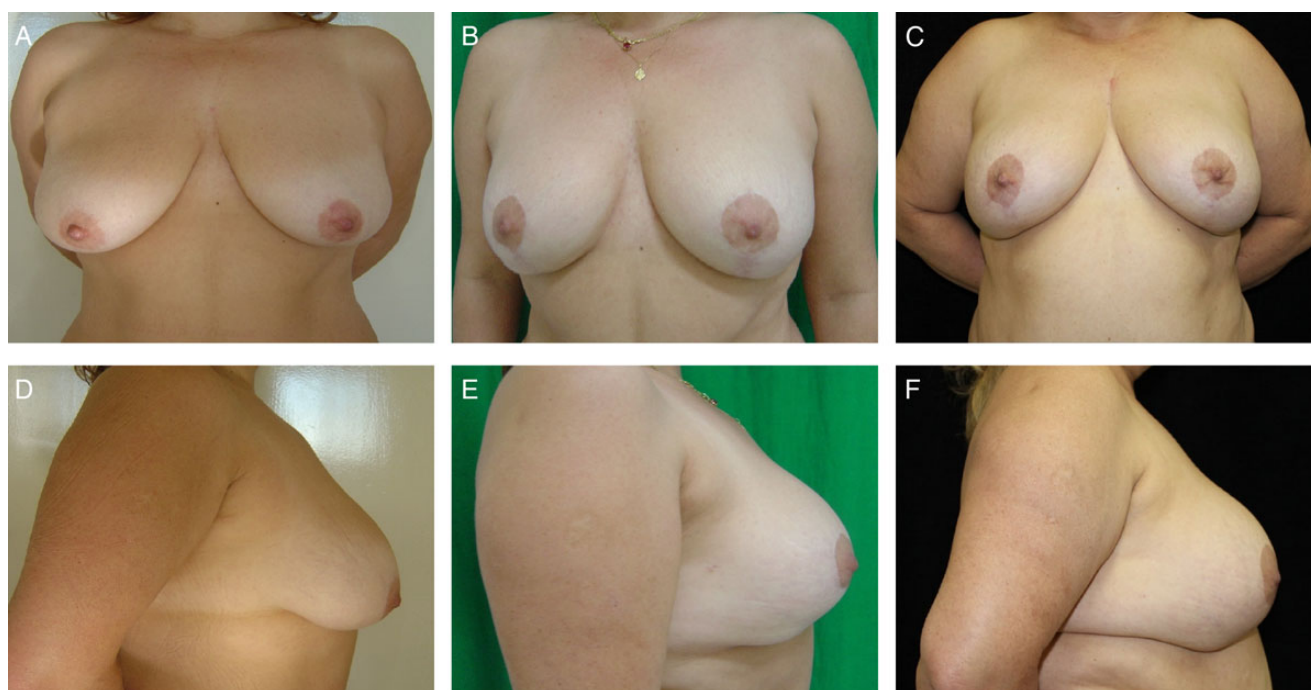
This study utilized a low-cost method to analyze this technique with minimal morbidity to the breast-reduction patients. Sequential chest x-rays were taken to analyze the movement of the chest wall-based flap, marked with three titanium clips intraoperatively, and to evaluate the influence of a pectoral muscle sling to support the breast flap in the early and late postoperative periods.

Standard measures were performed from the midpoint of each clip, which had dimensions of  $10 \times 1$  mm. This prevented bias caused by clip rotation. Fixed landmarks were measured on the anterior thorax, such as the medial-third and two-thirds lateral clavicle transitions as a site to vertical mobile reference points. These landmarks were chosen because of their constancy on the anterior chest, which are located in vertical projection in relation to the marked flap. In each radiographic film, the anterior thoracic midline was identified between mid-clavicle epiphyses, which often do not coincide with vertebral column midline.

Analysis of the results of this study (Figures 5-7 and Table 3) show the evolution of the vertical (down) clips over time in both subgroups. There was a statistical difference between the two subgroups, with maintenance of chest wall-based flap position over time in the study subgroup.



**Figure 3.** (A, D) Preoperative, (B, E) 1-year postoperative, and (C, F) 10-year postoperative photographs of a woman in the muscle sling group (group S). This woman was 46 years old at the time she underwent the operation.



**Figure 4.** (A, D) Preoperative, (B, E) 1-year postoperative, and (C, F) 10-year postoperative photographs of a woman in the control group (group C). This woman was 42 years old when she underwent the operation.

**Table 1.** Distance from the SUP-V Clip to the Clavicular Reference Point in the Study Group on the Right, Left, and Both Breasts, and the *P* value of the Statistical Test

Breast(s)	No.	Mean	Minimum	Maximum	SD	<i>P</i> value
Right	10	9.63	8.00	11.10	1.19	
Left	10	10.32	8.20	13.00	1.47	
Right and Left	10	−0.69	−4.80	1.10	1.74	.241

SD, standard deviation.

**Table 2.** Ten-Year Evaluation in Each Group

Group		No. of Breasts	Mean	Minimum	Maximum	SD	<i>P</i> value
SUP-V with Sling (S)	First day (D1)	20	9.98	8.00	13.00	1.35	
	Ten years (10y)	20	11.12	8.50	15.00	1.79	
	(10y) - (D1)	20	1.14	0.60	4.20	1.20	< .001
SUP-V without Sling (C)	First day (D1)	21	9.40	6.20	12.30	1.89	
	Ten years (10y)	21	12.63	9.00	20.60	2.81	
	(10y) - (D1)	21	3.23	1.00	11.70	2.43	< .001
MED-V with Sling (S)	First day (D1)	20	16.92	13.40	22.00	2.02	
	Ten years (10y)	20	17.21	13.90	22.20	2.00	
	(10y) - (D1)	20	0.29	0.00	0.80	0.20	< .001
MED-V without Sling (C)	First day (D1)	21	16.20	11.40	18.30	1.74	
	Ten years (10y)	21	18.22	13.60	20.40	1.58	
	(10y) - (D1)	21	2.02	1.30	2.90	0.45	< .001
LAT-V with Sling (S)	First day (D1)	20	16.93	13.00	21.10	2.27	
	Ten years (10y)	20	17.40	13.50	21.50	2.26	
	(10y) - (D1)	20	0.47	0.30	0.80	0.14	< .001
LAT-V without Sling (C)	First day (D1)	21	16.81	13.60	19.00	1.45	
	Ten years (10y)	21	18.60	15.50	20.50	1.42	
	(10y) - (D1)	21	1.78	1.10	3.20	0.50	< .001

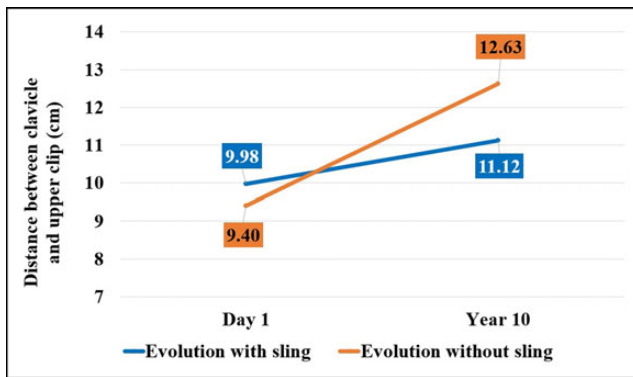
SD, standard deviation.

**Table 3.** Difference Between the Groups on Day 1 and at 10 Years Postoperatively

Group	No. of Breasts	Mean	Minimum	Maximum	SD	<i>P</i> value
SUP-V with sling (S)	20	1.14	−0.60	4.20	1.20	< .001
SUP-V without sling (C)	21	3.23	1.00	11.70	2.43	
MED-V with sling (S)	20	0.29	0.00	0.80	0.20	< .001
MED-V without sling (C)	21	2.02	1.30	2.90	0.45	
LAT-V with sling (S)	20	0.47	0.30	0.80	0.14	< .001
LAT-V without sling (C)	21	1.78	1.10	3.20	0.50	

SD, standard deviation.





**Figure 5.** Flap evolution of the SUP-V clip.

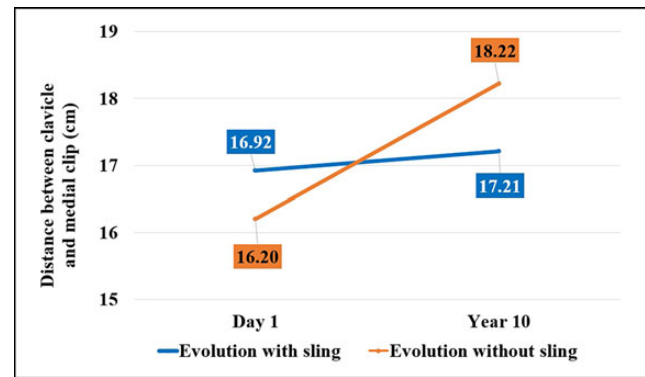
Downward vertical movements were recorded in both subgroups. Greater retardation of the bottoming-out phenomenon was noted in the breast-reduction patient cohort with a muscle sling. A statistically significant difference between the two groups in all measurements strengthens the idea of a longer-lasting result as already observed in clinical follow-up. It is therefore noticed in medical imaging with titanium clips placed at the time of surgery remaining in similar positions at Day 1 (D1) and 10 years in patients who underwent breast reduction with a muscle sling (Figures 2A-B).

Fluctuation in weight was also noted in all patients from both subgroups. The weight gains in both subgroups ranged from 4 to 18 kilograms (average, 7.68 kilograms) during the period of 10 years. However, weight gain during the follow-up period is a normal event for women in these age groups and hence not deemed to be influential, because these gains were experienced in both subgroups.

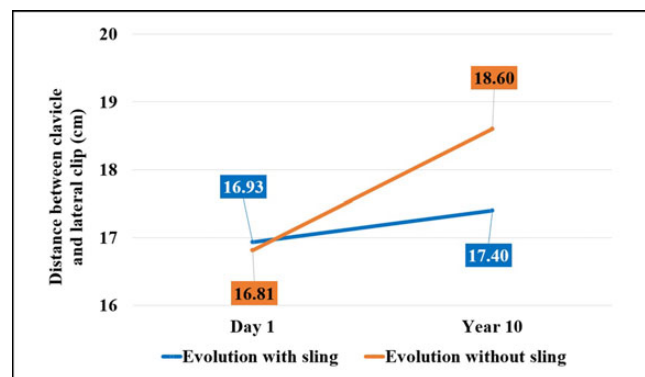
The breast shape of both subgroups may have increased and presented some degree of ptosis over time. However, the chest wall based flap remained supported by the sling, and therefore, less variation is expected with weight gain and breast enlargement to influence ptosis. Similarly, gravity is a factor that interferes with the breast ptosis. However, the muscle sling provides less tissue at the lower pole leading to less bottoming out effect which was confirmed by this study where the muscle sling study group kept the chest flap position longer.<sup>24</sup>

With respect to age and the possible influence on the results, the technique can be utilized for patients of all ages. Ages of all of the patients ranged from 20 to 73 years (median, 41.5 years) and were similar in both subgroups (average, 46 years in the study group and 40 years in the control group). The eldest patient from the control group had little to no influence over the statistical results.

The chest wall flap was constructed in a similar manner in both groups (same technical design), and the amount of resected breast tissue in each breast was proportional to the preoperative breast volume. The flaps were created below the Würinger septum in both the control and study groups.



**Figure 6.** Flap evolution of the MED-V clip.



**Figure 7.** Flap evolution of the LAT-V clip.

We know that asymmetric breasts often have similar mammary volumes below this septum.<sup>24</sup> Therefore, the chest wall-based flap volume was similar in both groups and thus did not feature as a biased variable.

In our study, complications (early or late) relating to the chest wall-based flap were not identified. Neto et al<sup>22</sup> refers to a similar technique for secondary breast-reduction patients, who may present with complications such as fat necrosis of the distal part of the flap. Because the study was conducted only in primary breast reduction, patients were not considered for the flap size or its vascular supply.

Considering that the main objective of the chest wall-based flap and the bipedicle, major pectoralis flap is to provide greater and longer-lasting projection of the breast upper pole, the upper clips assume singular and greater importance relative to other clips, especially in vertical movement.

Future directions include randomizing patients measuring both surgeon and patient reported outcomes.

The chest wall-based flap contributes to greater and longer-lasting breast projection after mammoplasty surgery, reducing the ptotic bottoming-out phenomenon observed after amputation of the lower pole of the breast with the classic techniques of mammoplasty.



## CONCLUSIONS

After a 10-year follow-up, this study confirms the superiority of long term results in the patients with a pectoralis major muscle sling compared with patients without it. This result supports the hypothesis that the muscle flap is effective to suspend the upper portion of the breast flap, thus achieving upper-breast pole fullness and maintaining this aesthetic result for a longer period of time.

## Disclosures

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