OPEN

PRS GLOBAL OPEN

ORIGINAL ARTICLE
Cosmetic

Waist Remodeling without Incision, with Ultrasound-guided Monocortical Fracture

Raúl M. Manzaneda Cipriani, MD*†‡
Héctor Duran Vega, MD‡§
Laura Cala Uribe, MD‡¶‖
Mauricio Viaro, MD‡**
Gerardo A. Adrianzen, MD*††‡‡
Daniel L. Botelho, MD‡‡

Background: Rib remodeling is a surgical technique for waist shaping in women and men. However, one of the main patient complaints is the scar. We aimed to describe a scarless, ultrasound-guided rib remodeling (RibXcar) technique that assessed the degree of angular variation of the fracture by ultrasound and the variation in waist measurement and patient satisfaction through a survey.

Methods: The RibXcar technique was performed in 30 women aged 18–35 years in Peru, Colombia, and Mexico between October and December 2022 by three board-certified plastic surgeons trained in ultrasound and in this technique. The plastic surgeons measured costal angles before and immediately, 1 month, and 3 months after the surgery by ultrasound, as well as the waist in the same site and at these time points. Similarly, patient satisfaction was surveyed 3 months after the surgery, in which questions were asked about body aesthetics and the puncture site.

Results: Ultrasound angular measurements before and immediately, 1 month, and 3 months after the surgical procedure were 168.00, 158.00, 160.00, and 160.43 degrees in the 10th rib, 170.50, 160.50, 152.50, and 163.50 degrees in the 11th rib, and 172.00, 162.00, 154.00, and 165.00 degrees in the 12th rib, respectively. The satisfaction survey showed that patients were satisfied with the aesthetic results of both the shape of the waist and the puncture site.

Conclusions: RibXcar surgery maintains the angular variation over time. Similarly, waist measurements show a sustained reduction. Three months postoperatively, the patients were satisfied with the aesthetic results of the waist and the puncture site.
(Plast Reconstr Surg Glob Open 2023; 11:e5499; doi: 10.1097/GOX.0000000000005499; Published online 19 December 2023.)

INTRODUCTION

Body contouring surgery is part of the global trend to enhance physical appearance and body beauty. However, because current techniques based on liposuction and its variations may have limitations, waist-narrowing surgery, such as rib procedures, could allow for improved results initially achieved by traditional procedures.[1,2]

In some cases, the desired results cannot be achieved even though various techniques are used in body contouring. In this regard, the transition from the chest to the hip plays a key role. In our opinion, rib surgery allows this transition to improve by considering the anatomical characteristics of each patient. Rib remodeling can be performed by rib removal or rib fracture.[3–5]

Among rib procedures, rib remodeling by fracture is an alternative with a straightforward procedure, possibly with lower risks than rib removal, and highly favorable aesthetic results when performed by a skilled surgeon.[5] Similarly, in our experience, ultrasound-guided rib remodeling by fracture increases safety.

Many of our patients have expressed their concerns about the scar that may result from rib surgery. Therefore, developing a procedure that overcomes this disadvantage is crucial for achieving satisfactory aesthetic results.

This study aimed to describe a monocortical technique of scarless, ultrasound-guided rib remodeling by fracture by assessing the angular variation of the fracture

*From *Private Practice, Lima, Peru; †Manzaneda Academy, Lima, Perú; ‡Plastic and Reconstructive Surgeon; §Private Practice, Merida, Yucatán, México; ¶Sabana University, Bogotá, Colombia; ‖Dhara Clinic, Bogotá, Colombia; **Private Practice, Santa Maria, RS, Brasil; ††Cayetano Heredia University, Lima, Peru; and ‡‡Private Practice, Londrina, Paraná, Brasil.*

Received for publication August 7, 2023; accepted November 3, 2023.

DOI: 10.1097/GOX.0000000000005499

Disclosure statements are at the end of this article, following the correspondence information.

Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

Table 1. Descriptive Data of the Age, Weight, Height, BMI, and Surgery Time Variables

Variables	N	Minimum	Maximum	Mean	SD
Age (y)	30	19	35	26.3	3.95
Weight (kg)	30	55	70	63.3	4.59
Height (cm)	30	160	170	165.6	3.15
BMI	30	19	26	23.1	1.74
Surgery time (min)	30	21	40	31.0	4.80

BMI, body mass index.

with ultrasound measurements (before, immediately after, 1, and 3 months after the surgery) and patient satisfaction with the aesthetic results of the waist and puncture site.

MATERIALS AND METHODS

This is a case series in which all patients completed a medical evaluation for body contouring surgery and, based on the treatment possibilities, agreed to undergo rib remodeling by monocortical fracture after consensus with the surgeon. These surgical procedures were performed in three private clinics in Lima-Peru (Santa Julia Clinic), Bogota-Colombia (Dhara Clinic), and Merida-Mexico (Eme Red Hospitalaria) between October and December 2022. The inclusion criteria were female patients aged 18–35 years, and the exclusion criteria were complementary liposuction, a history of rib surgery (in plastic surgery or other medical specialties), a surgical risk score of Goldman Risk Index class II or more, a body mass index more than 28 kg per m^2, and flaccid skin in the abdomen and/or in the thoracolumbar region with a Matarasso score of 2 or more. All patients signed an informed consent form before the surgery and authorized the use of their image in the present study in accordance with the guidelines of the Declaration of Helsinki. The research protocol was approved by the institutional research ethics committee in each institution (Table 1).

Waist Measurements

With the patients standing upright, the midpoint between the 11th and 12th ribs was located before measuring the waist circumference, using a Fith flexible tape measure placed on this point and projected toward the abdominal midline. The measurement was taken in the same place at all time points (before and immediately, 1 month, and 3 months after the surgery). Statistical analysis was performed in SPSS (v.25), using Friedman nonparametric test.

Rib Remodeling Design

With patients standing upright with their backs to the plastic surgeon, the posterior axillary line was marked bilaterally by drawing an oblique line ("M" line) from the upper edge to the lower edge of the vertebral line, intersecting the intergluteal space. In the operating room, with patients in the left lateral decubitus position on the operating table and flexed at the 11th and 12th ribs, the 10th, 11th, and 12th ribs were palpated at the oblique line ("M" line). Ultrasound was performed to identify each rib, locating the linear transducer parallel to them to highlight the trajectory of each rib and the fracture point, considering the staggered pattern shown through the "M" line (Fig. 1). (**See Video 1 [online],** which demonstrates the presurgical planning method.)

Takeaways

Question: Is the RibXcar technique effective in reducing waist width and 10th, 11th, and 12th costal angulations, and is the fixture maintained over time?

Findings: The RibXcar technique produced a significant angular decrease in all the ribs analyzed. Patient satisfaction scales indicated adequate postprocedure satisfaction ($P < 0.0001$).

Meaning: The RibXcar is a safe and reproducible technique that can model the waist and control rib fractures. Patients were satisfied with the outcome because this technique did not scar.

Fig. 1. A photograph demonstrating presurgical planning. 1, Posterior axillary line; 2, vertebral line; 3, "M" line.

Fig. 2. A photograph demonstrating a patient in the lateral decubitus position on an operating table with flexion at the level of the 11th and 12th ribs.

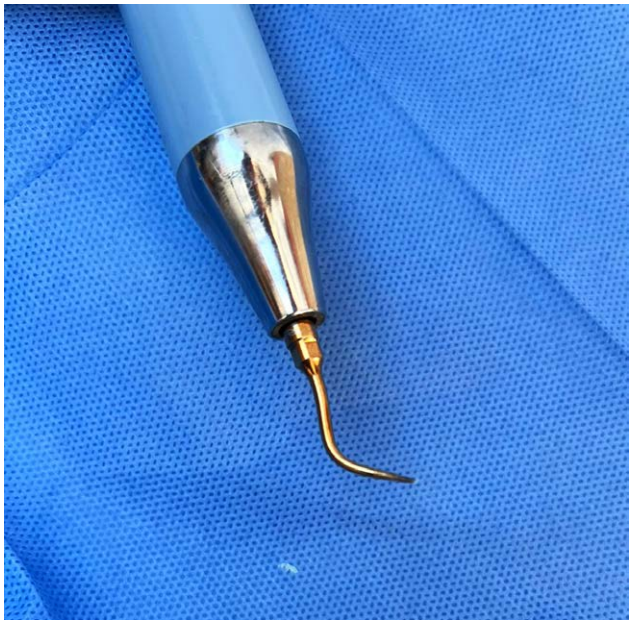

Fig. 3. A photograph of the piezotome thin head, used for rib fracture.

Ultrasound Measurements

With the patient in the right lateral decubitus position on the operating table, flexed at the level of the 11th and 12th ribs, the trajectories of the 10th, 11th, and 12th ribs were palpated (Fig. 2). Subsequently, an ultrasound was performed on a Clarius L7 ultrasound scanner to identify the trajectory of each rib. The previously marked point on each rib was located before taking the angular measurement before the surgery. Postoperatively, the immediate postoperative angular variation was measured by placing the transducer on the fracture site made in each rib (locating the fracture line). Similarly, this ultrasound measurement was performed 1 and 3 months postoperatively, by each surgeon by identifying the fracture line and recording the values in a Microsoft Excel (v.19; Microsoft Corp., Redmond, Wash.) database. Statistical analysis was performed in SPSS, v.25 (IBM Corp., Armonk, N.Y.) using Friedman nonparametric test. This procedure was performed bilaterally. All surgeons used the same brand and model of ultrasound scanner connected to an iPad Pro-12.9. (**See Video 2 [online],** which demonstrates how angular variation was measured by ultrasound before and after the surgical procedure.)

Patient Satisfaction Survey

All patients completed an online (Google Forms; Google Inc, Mountain View, Calif.) satisfaction survey 3 months postoperatively. The survey included questions about their satisfaction with the aesthetic created in Microsoft Excel (v.19). Statistical analysis was performed in SPSS software (v.25.9). (**See appendix, Supplemental Digital Content 1,** which shows the postoperative satisfaction survey. **http://links.lww.com/PRSGO/C993**.) (**See table, Supplemental Digital Content 2,** which shows the postoperative satisfaction with aesthetic results. **http://links.lww.com/PRSGO/C994**.) (**See table, Supplemental Digital Content 3**, which shows postoperative scar satisfaction results. **http://links.lww.com/PRSGO/C995**.)

Waist Narrowing by Rib Remodeling Without Incision *(RibXcar)*

Anesthesia: Posterior Intercostal Block

Ultrasound-guided infiltration with 1% lidocaine at a dose of 0.5 mg per kg in a total volume of 6 mL was performed into the subperiosteal and deep and superficial subcutaneous spaces, completing the infiltration at the intercostal levels of the target ribs[6]. (**See Video 3 [online]**, which demonstrates the RibXcar technique and the puncture site after 15 days of RibXcar technique.)

Surgical Procedure

With patients in the right lateral decubitus position on the operating table and flexed at the level of the 11th and 12th ribs, the staggered designed points were located. With ultrasound guidance, anatomical structures were identified before puncturing the skin with an N18 needle at the designated point perpendicular to the surface and locating the rib. Desperiostization was then performed using a needle and a piezotome tip (Fig. 3; **Video 3 [online]**).

Two N21 intravenous catheters were inserted at an approximately 45-degree angle, each of which was 2 cm from the puncture site. Using ultrasound guidance, the catheters were positioned next to the piezotome head (intersection of three points). The fracture was performed using the piezotome at 80% power and with the water jet turned off by applying multiple 6-second

pulses, with continuous infiltration of a 0.9% NaCl solution at 10°C from both equidistantly placed catheters, and with a drip of 0.9% NaCl solution at 10°C from an external syringe applied over the site of piezotome entry.

Once the fracture line was assessed by ultrasound, manual deformation was performed by applying gentle and continuous pressure with the first finger of the dominant hand. The same procedure was then performed on the left side. Angulation and monocortical fracture were assessed by ultrasound (**Video 3 [online]**).

POSTOPERATIVE CARE

All the patients used a special corset for 6 months. They did not perform physical effort for at least 1 month. The follow-up was carried out by telephone calls and medical appointment controls.

RESULTS

In total, 30 female patients aged 18–35 years (26.3) who were subjected to rib remodeling surgery were evaluated in this study. The body mass index ranged from 19 to 26 (23.1). All (100%) patients had grade I Goldman Risk Index class. The average operating time was 31 minutes. All (100%) patients received optimal postoperative care, during which there were no complications, such as surgical site infection, pneumothorax, hemothorax, or other respiratory complications. However, there were two cases of skin burns, which were promptly treated (Table 1).

Median waist measurements was 69 cm preoperatively and 60 cm, 59 cm, and 58.70 cm immediately, 1 month, and 3 months postoperatively, respectively (Table 2). The median angular measurements of the 10th rib were 168 degrees preoperatively and 158, 160, and 160.43 degrees immediately, 1 month, and 3 months postoperatively, respectively (Table 3). The median angular measurements of the 11th rib were 170.50 degrees preoperatively and 160.50, 152.50, and 163.50 degrees immediately, 1 month, and 3 months postoperatively, respectively (Table 4). The median angular measurements of the 12th rib were 172.00 degrees before the surgery and 162.00,154.00 and 165.00 immediately, 1 month, and 3 months postoperatively, respectively (Table 5).

Table 2. Variations in Waist Measurements

Variable	Measurement	Median	IR	Chi Square	*P*
Waist measurements (cm)	Presurgery	69.00	(72–66)	90.0	0.0001
	Im postsurgery	60.00	(62–60)		
	1 month postsurgery	59.00	(61–59)		
	3 month postsurgery	58.70	(60–58)		

Friedman nonparametric test.
IR, interquartile range.
Im, immediate postoperative moment.

Table 3. Changes in Costal Angular Measurements (10th Rib)

Variable	Measurement	Median	IR	Chi Square	*P*
Angular measurements (degrees)	Presurgery	168.00	(171–162)	90.0	0.0001
10th rib	Im postsurgery	158.00	(161–152)		
	1 month postsurgery	160.00	(163–154)		
	3 months postsurgery	160.43	(164–155)		

Friedman nonparametric test.
IR, interquartile range.
Im, immediate postoperative moment.

Table 4. Changes in Costal Angular Measurements (11th Rib)

Variable	Measurement	Median	IR	Chi Square	*P*
Angular measurements (degrees)	Presurgery	170.50	(175–165)	90.0	0.0001
11th rib	Im postsurgery	160.50	(165–155)		
	1month postsurgery	152.50	(157–147)		
	3 month postsurgery	163.50	(168–158)		

Friedman nonparametric test.
IR, interquartile range.
Im, immediate postoperative moment.

Table 5. Variations in Costal Angular Measurements (12th Rib)

Variable	Measurement	Median	IR	Chi Square	*P*
Angular measurements (degrees)	Presurgery	172.00	(175–165)	90.0	0.000
12th rib	Im postsurgery	162.00	(165–155)		
	1 month postsurgery	154.00	(157–147)		
	3 months postsurgery	165.00	(168–158)		

Friedman nonparametric test.
IR, interquartile range.
Im, immediate postoperative moment.

Table 6. Satisfaction Level

Level	N	%
Satisfactory	30	100.00
Indifferent	0	0.00
Unsatisfactory	0	0.00
Total	30	100.00

The results of satisfaction with the aesthetic outcome and surgical scar from the survey conducted during the third postoperative month were divided into three groups: satisfactory (containing very satisfied and satisfied answers), indifferent (containing neither satisfied nor dissatisfied answers), and unsatisfactory (containing dissatisfied or very dissatisfied answers), showing 100% satisfactory results (Table 6).

DISCUSSION

The skeletal system of the thoracic region is important for protecting the thoracic organs, such as the heart and lungs, and serves as a support for the thoracic musculature and the upper limbs. This region consists of vertebral, sternal, and costal components, which, when perfectly articulated, enable the proper physiological functioning of all its systems.[7]

The human body has 12 pairs of ribs. Ribs 1 to 7 are considered true ribs because they are directly connected to the sternal manubrium through cartilage in a synarthrosis joint. Ribs 8, 9, and 10 are considered false ribs because they are not directly connected to the sternal manubrium, and ribs 11 and 12 are known as floating ribs because they do not have any connection to the sternum and are shorter and less curved than the aforementioned ribs.[7,8]

In the pursuit of female beauty and body harmony, the waist plays a key role because it helps to highlight the buttocks, lower back, hips, and leg muscles. Thus, having a narrow waist creates a visual effect of beauty and femininity, which is sought after by many patients.

The approach is one of the most critical aspects. Accordingly, having clear anatomical references helps ensure the success of the surgery. Similarly, the location and position of the patient are fundamental when identifying anatomical landmarks, facilitating the procedure, and reducing the risk of complications (Fig. 2).[8–10]

When considering rib surgery, questions may arise as to which procedure is better or provides better results, or whether some type of surgery has a specific indication when compared with others. In our experience, the decision depends on the training of each surgeon and on the risk–benefit analysis conducted in conjunction with the patient.[3,5]

The piezotome with a thin head is introduced through the puncture with the irrigation turned off because this function is not adapted to the small orifice (Fig. 3). To avoid burns or necrosis caused by heat generation, the lateral punctures should be irrigated with 0.9% NaCl solution at 10°C because using a single port could deform the working plane (**Video 3 [online]**).

We used two internal ports, placed equidistantly through the puncture, continuously infusing 0.9% NaCl to maintain a cool temperature of the body of the ultrasound tip (thus avoiding burns), while the distal part (the effector) remained warm to perform the fracture line. Additionally, external infusion on the puncture site with a continuous drip kept the entry point at a low temperature and prevented skin burns.

The fracture line was achieved by applying 6-second pulsatile vibrations between cooling periods of the ultrasound tip (**Video 4 [online]**), which was placed in a 0.9% NaCl solution at 10°C to prevent soft tissue burns (**Video 3 [online]**). (**See Video 4 [online]**, which demonstrates the fracture technique with piezotome in animal model.) We also avoided burns by using a thin ultrasound tip. Most

Fig. 4. RiXcar surgery in a female patient. A photograph of a patient before (A) and 1 month after the surgery (B).

Fig. 5. RiXcar surgery in a female patient. A photograph of a patient before (A) and 3 months after the surgery (B).

piezotome tips are broad, which may cause burns, whereas a thin ultrasound tip allows for a more accurate introduction of the tip (**see Video 4 [online]**).

The fracture line was completed when the ultrasound image showed that the ultrasound tip had penetrated 80% of the rib thickness, which enables manual osteoclasis. Because this is likely a monocortical fracture, the click may not be heard or felt on the rib, unlike in bicortical fractures. For this reason, ultrasound plays a key role in visualizing the fracture line (**Video 3 [online]**).

Notwithstanding the good angulation and fracture line, the long-term result can be achieved by maintaining a compression force that stabilizes the fracture. For this purpose, patients used an elastic waistband for at least 3–6 months.

We decided to perform a staggered fracture from the 10th to the 12th ribs, following the oblique ("M") line, to achieve a harmonious transition, thus avoiding a choppy effect that could deform and create asymmetry in the hips. The expected complications included skin burns, asymmetries, and deformations, due to the use of vibrational technology (piezotome) and to fracture consolidation problems.[11,12]

Our results showed that the degree of angulation significantly ($P < 0.0001$) changed postoperatively and remained within the ranges of variation that were obtained through rib remodeling, as measured by ultrasound 3 months postoperatively. Therefore, rib remodeling was effective, which was corroborated by the degree of aesthetic satisfaction of the waist as surveyed 1 month postoperatively ($P < 0.0001$).

Unlike others, this procedure involves considerable manipulation, such as detachment, to free the rib. As such, this procedure may be safer than others.

The surgical scar often determines the final degree of patient satisfaction. In our survey, 95% of respondents did not notice the puncture site, which may promote high satisfaction (100%) (**Video 3 [online]**). Only 5% of respondents mentioned being able to notice the puncture site, but none were dissatisfied with the outcome (0%). Although there were two cases of burns at the puncture site, they were less than 0.5 cm in diameter and were promptly treated without causing further complications, such as infections or larger scars that could have resulted from an incision (Figs. 4–6).

Regarding limitations, this research is a follow-up study involving ultrasound, so operator variability may have affected the measurements. For this reason, the procedure was standardized with properly calibrated ultrasound equipment, and the operators received instruction on the use of these devices in the same training program.

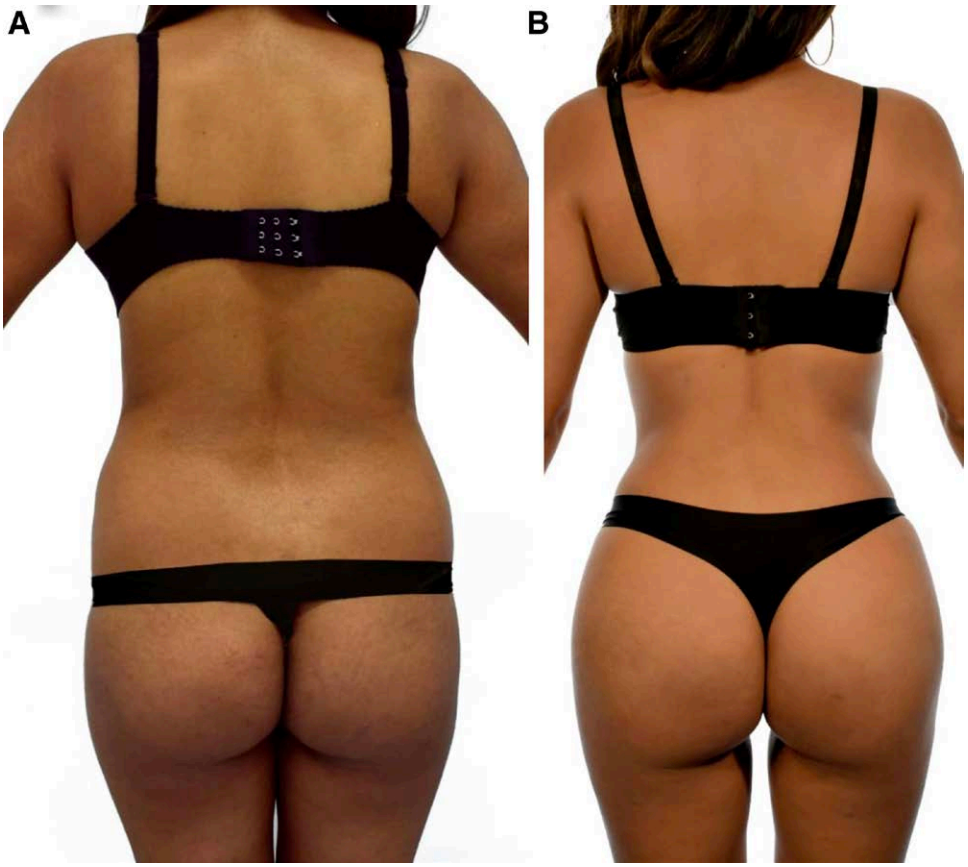

Fig. 6. RiXcar surgery in a female patient. A photograph of a patient before (A) and 6 months after the surgery (B).

Another point to consider is that the survey used in this study was not validated and solely assessed patients' levels of satisfaction with the procedure.

CONCLUSIONS

The RibXcar technique effectively reduces the waist diameter and improves the aesthetic appearance at the third postoperative month, as measured in the postoperative follow-up and in the ultrasound assessment of angular variation. The degree of postoperative satisfaction showed a significantly ($P < 0.0001$) high acceptance level, with a good confidence level.

Raúl Martín Manzaneda Cipriani, MD
Av Circunvalación del Golf los Inkas 208
Lima, Peru
E-mail: rmanzanedacipriani@hotmail.com
Instagram: @manzaneda_academy

DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

REFERENCES

1. Friedman T, Wiser I. Abdominal contouring and combining procedures. *Clin Plast Surg.* 2019;46:41–48.
2. Klassen AF, Cano SJ, Scott A, et al. Satisfaction and quality-of-life issues in body contouring surgery patients: a qualitative study. *Obes Surg.* 2012;22:1527–1534.
3. Verdugo JP. Rib removal in body contouring surgery and its influence on the waist. *Sci Art Plast Surg J.* 2022;3.
4. Ferreira LM, Ferreira PEN, Bernardes ABS, et al. Aesthetic contouring of the chest wall with rib resection. *Aesthetic Plast Surg.* 2021;45:1099–1104.
5. Kudzaev KU, Kraiushkin IA. Waist narrowing without removal of ribs. *Plast Reconstr Surg Global Open.* 2021;9:e3680.
6. Tsai J, Moon T, Vachhani S, et al. Anesthesia for thoracic surgical procedures. In: Firstenberg MS, ed. *Principles and Practice of Cardiothoracic Surgery.* London: InTech; 2013.
7. Graeber GM, Nazim M. The anatomy of the ribs and the sternum and their relationship to chest wall structure and function. *Thorac Surg Clin.* 2007;17:473–489, vi.
8. Hussain A, Burns B. Anatomy, thorax, wall [updated July 30, 2023]. In: *StatPearls.* Treasure Island, Fla.: StatPearls Publishing; 2023. Available at https://www.ncbi.nlm.nih.gov/books/NBK535414/.
9. Watkins RG, Watkins RG. *Surgical Approaches to the Spine.* New York, N.Y.: Springer; 2015.
10. Lee SJ, Damon A, Pichelmann MA, et al. An anatomical method for rib disconnection during posterior costotransversectomy for paravertebral access to the ventral thoracic spine. *World Neurosurg.* 2022;164:367–373.
11. Psillakis JM. Plastic surgery of the abdomen with improvement in the body contour physiopathology and treatment of the aponeurotic musculature. *Clin Plast Surg.* 1984;11:465–477.
12. Hurwitz D. *Comprehensive Body Contouring: Theory and Practice.* Berlin/Heidelberg: Springer; 2015.