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Waist Reduction through Conversion from False to Floating Ribs

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Background: Waist reduction by ultrasound-guided monocortical fracture (RibXcar), usually performed on floating ribs, may show limitations when performed on false ribs (9 and 10) because of the stress force exerted on the anterior fixation point (cartilage union to sternum). Hence, we introduced a procedure for conversion from false to floating ribs to improve the final result of the treatment of false ribs through a rib treatment scheme.
Methods: Forty-nine female patients undergoing rib surgery were recruited. Waist measurements and angular variations were compared between two groups of patients, the first (26 patients) consisting of patients who underwent RibXcar with conversion surgery (ribs 9 and 10) and the second (23 patients) consisting of patients who underwent RibXcar without conversion surgery (ribs 9 and 10).
Results: The waist measurements taken after 6 months showed a mean decrease of 8.70 cm in the group where only RibXcar was performed, whereas a statistically significant mean reduction of 17.04 cm was observed in the group where RibXcar was performed with rib conversion surgery.
Conclusions: The false-to-floating-rib conversion technique combined with RibXcar demonstrated more reduction in waist circumference and a more efficient rib angulation compared with RibXcar alone. *(Plast Reconstr Surg Glob Open 2024; 12:e5900; doi: 10.1097/GOX.0000000000005900; Published online 13 June 2024.)*

INTRODUCTION

Waist reduction through rib surgery, as part of a body harmonization treatment, provides many benefits that cannot be achieved with other conventional techniques. Waist reduction relies on alteration of the bone structure at the lower region of the rib cage, which is precisely what shapes the waist.[1,2]

Waist reduction techniques aimed at rib treatment generally target the floating ribs (11th and 12th), and in some cases the false ribs (ninth and 10th), by performing monocortical resection and/or fracture and even using osteosynthesis with a fixator in some cases.[3–5]

In the treatment by monocortical fracture, the factors to be considered are the support and stress forces that fix the ribs to the surrounding tissues. Therefore, when performing this fracture, compensatory forces may alter the result, especially when the targets are the false ribs, which, by having a cartilage union that joins them to the sternal manubrium, have a central force that limits the effect of costal deformation toward the interior.[6–8] This is why costochondral disarticulation is required to improve the direction of the monocortical fracture. In this study, this was performed using ultrasonographic guidance and piezotome entry, through the technique known as RibXcar.[5] The objective of this study is to describe a surgical technique for converting false to floating ribs (Xonversion Ribs) combined with RibXcar (monocortical fracture without scarring), compared with RibXcar alone, which is performed in patients whose ribs 9, 10, 11, and 12 are treated according to a rib treatment scheme. One of the authors (R.M.M) performed the procedure using ultrasound guidance, as well as the comparison of the angular variation of the fracture in both cases using ultrasound and waist measurements 6 months after surgery.

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MATERIALS AND METHODS

Forty-nine female patients, aged 18–35 years, requesting medical assessment for body contouring surgery were recruited; the decision to remodel the rib through

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monocortical fracture was made in consensus and based on the likelihood of treatments. All patients whose three-dimensional (3D) tomographic assessment of the rib cage and cartilage did not show floating rib abnormalities, and patients with all false ribs (8, 9, and 10) showing a common cartilage attachment to the sternal manubrium were included in the study. The exclusion criteria were complementary liposuction in the surgical plan, having a history of previous rib surgery (aesthetic or other specialties), Goldman surgical risk greater than II, body mass index above 28, and skin flaccidity in the abdomen and/or dorsolumbar region with a Matarasso index greater than or equal to 2.

The surgical decision scheme for rib treatment is shown in Table 1 and was devised by one of the authors (R.M.M.; Fig. 1).

A comparative study of the two groups of patients who received rib treatment based on the scheme proposed by the author was performed as follows:

1. Group 1: patients undergoing ultrasound-guided monocortical fracture (RibXcar) in floating (11 and 12) and false (9 and 10) ribs with conversion surgery (26 patients)
2. Group 2: patients undergoing ultrasound-guided monocortical fracture (RibXcar) in floating (11 and 12) and false (9 and 10) ribs without conversion surgery in false ribs (9 and 10) (23 patients)

The procedures in group 2 were performed between January and June, 2022, whereas those in group 1 were performed between August and December, 2022. All patients signed an informed consent for surgery in addition to providing authorization for image use in this study. The guidelines of the Declaration of Helsinki were followed (Table 2).

Waist Measurements

With the patient standing, the equidistant point between ribs 9 and 10 was located. Next, the waist circumference was measured using Fith measuring tapes, which were placed at this point and projected toward the abdominal midline where the measurement reading was made. Measurements were performed at the same location immediately, 1 month, and 6 months after surgery.

Takeaways

Question: Does the complementary Xonversion Ribs technique improve RibXcar results by reducing the angulations of the ninth and 10th ribs, as well as reducing the waist?

Findings: The group of patients in whom RibXcar associated with Xonversion Ribs was performed showed a reduction in angulations for ribs 9 and 10, as well as in waist diameter with greater effectiveness, compared with those in whom only RibXcar was performed ($P < 0.05$).

Meaning: Xonversion Ribs is an effective and safe technique as a complement to RibXcar in ribs 9 and 10, and allows improvement in postsurgery results after 6 months.

Ultrasound Findings

With the patient in the right lateral decubitus position and the flexion of the stretcher at ribs 11 and 12, the trajectories of ribs 8, 9, 10, 11, and 12 were palpated; ultrasound was performed using the Clarius L7 ultrasound equipment to identify the trajectory of each rib. Each rib had a previously designed point, and the ultrasound angular measurement was made before surgery. Immediately after the procedure, the postsurgery angular variation was measured by placing the transducer at the site of the fracture made in each rib (locating the fracture trace). Similarly, ultrasonographic measurement was performed 1 and 6 months after surgery by identifying the fracture trace, thus obtaining values that were recorded in a Microsoft Excel v19.00 database. Statistical analysis was performed using the SPSS, v.25 software.

Technique Design

With the patient in the dorsal decubitus position, false ribs 9 and 10 were located by palpation, the trajectory was verified by ultrasound, the chondral junction site was located, and the sites where the disarticulation was to be performed with needles or piezotome were drawn. Likewise, the patient was placed in the lateral decubitus position to locate the trajectories of ribs 9 and 10 and draw the fracture points on the M line (RibXcar technique) (Fig. 2). [**See Video 1 (online),** which demonstrates the conversion technique from false ribs to floating ribs.] [**See Video 2 (online),** which demonstrates the RibXcar technique.]

Table 1. Therapeutic Decision for Costal Treatment

	RibXcar Indication	Xonvertion Ribs Indication
Ninth rib*	• Ratio carried out between ninth rib and the largest thoracic diameter is ≥ 0.75	• 3D tomography indicates cartilaginous junction between ribs (8–9)
10th rib*	• Ratio carried out between 10th rib and the largest thoracic diameter is ≥ 0.75 • Higher iliac crests and short waist: this is determined by the distance between the iliac crests and the 10th rib (<10 cm)	• 3D tomography indicates cartilaginous junction between ribs (9–10)
11th rib	• Pass the scapular line	• Not needed
12th rib	• Pass the outer edge of the longissimus muscle	• Not needed

*If RibXcar treatment is required, Xonvertion Ribs will be done if 3D reconstruction tomography with cartilaginous window shows cartilaginous junction between them.

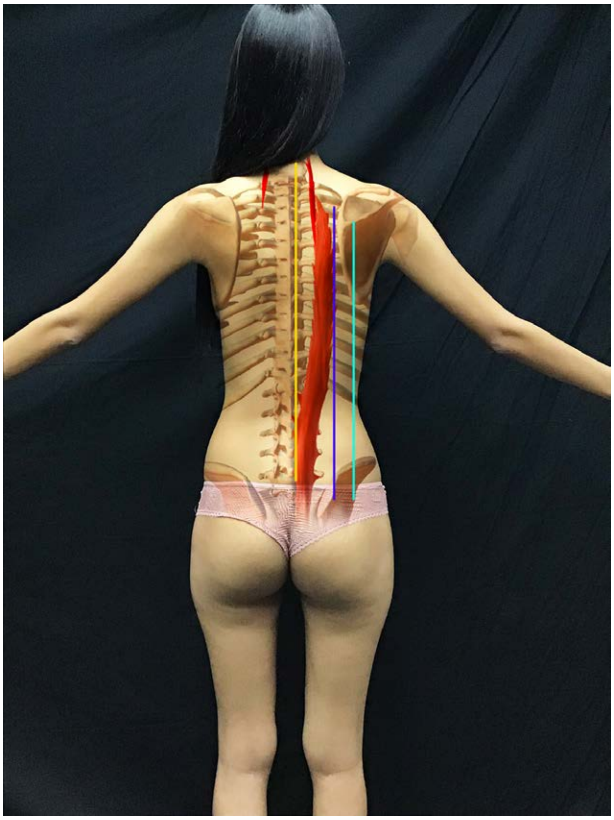

Fig. 1. Anatomical repairs in rib surgery. Yellow: vertebral line. Blue: outer border of longissimus muscle. Sky blue: scapula line.

Surgical Procedure

Conversion from False to Floating Ribs

With the patient in the dorsal decubitus position, the previously designed points were located. Next, a size 18 needle was introduced at the costochondral joints of ribs 8–10, applying a sustained acupressure on the area surrounding the puncture to feel the disarticulation of the rib; this can also be done by a piezotome. This process was performed bilaterally, palpating for mobility and resistance loss. Thereafter, the patient was placed in the lateral decubitus position to continue with RibXcar (Fig. 3). [**See Video 1 (online),** which demonstrates the conversion technique from false ribs to floating ribs.] [**See Video 3 (online),** which demonstrates ultrasound assessment.]

RibXcar

With the patient in the left lateral decubitus position and the stretcher in flexion at ribs 11 and 12, the designed staggered points were located. Ultrasonography was performed to identify anatomical structures, and a puncture was performed perpendicularly with a size 18 needle at the design point, locating the ribs to be operated through ultrasound. De-epithelialization was performed with a needle and complemented with a piezotome tip (not in operation). Next, two size 21 intravenous catheters were introduced at approximately 45 degrees, each at 2-cm equidistant points from the puncture site and located close to the piezotome head (three-point sign), using ultrasonography. Fracture was performed by piezotome at 80% power and with the water release function disabled. This was achieved by multiple 6-second pulses with continuous infiltration of 0.9% NaCl solution at 10°C from both previously placed equidistant catheters, as well as dripping of 0.9% NaCl at 10°C with an external syringe at the site of piezotome insertion[5] (**Video 2**).

Once the fracture trace was verified by ultrasound, manual deformation was performed using the first finger of the dominant hand and by applying gentle and continuous pressure. The same procedure was repeated on the left side. Ultrasound was performed to detect angulation and monocortical fracture (**Video 2**).

RESULTS

Forty-nine female patients (26 in group 1 and 23 in group 2), aged 18–35 years (mean age, 26.54 years in group 1 and 26.48 years in group 2), who underwent rib re-shaping surgery with or without conversion from false to floating ribs (Xonversion Ribs) were assessed. The mean body mass index in groups 1 and 2 was 24.82 and 23.84, respectively. All patients showed Goldman surgical risk grade I (100%); the mean surgery time in groups 1 and 2 was 54.31 min and 42.74 min, respectively. All patients underwent postoperative care without complications, such as surgical site infections, pneumothorax, hemothorax, or other respiratory complications. Two cases of neuropathic pain in group 2 showed favorable evolution (Table 2). With respect to rib 9, in group 1

Table 2. Characteristics of the Study Groups

	Groups					
	Group 1: RibXcar (9, 10, 11, 12) with Conversion of Ribs 9 and 10			Group 2: RibXcar (9, 10, 11, 12) without Conversion of Ribs 9 and 10		
	n	Mean	SD	n	Mean	SD
Age (y)	26	26.54	4.29	23	26.48	5.69
Duration (min)*	26	54.31	2.87	23	42.74	8.02
Weight (kg)	26	68.15	4.49	23	66.22	4.71
Size (cm)	26	165.92	5.07	23	166.74	4.09
BMI	26	24.82	2.27	23	23.84	1.83
Complications	26	0	—	23	2†	—

*$P < 0.001$.

†Neuropathic pain was found in two cases in group 2.

Fig. 2. Presurgical design. Brown: chondral junction. Purple: ribs anterior projection.

(with conversion: Xonversion Ribs), a 10.96 degree reduction in angularity was observed immediately after surgery, a 12.42 degree reduction 1 month after surgery, and a 14.04 degree reduction 6 months after surgery. In group 2 (without conversion surgery), a 5.13 degree reduction in angularity was observed immediately after surgery, a 5.09 degree reduction 1 month after surgery, and a 7.22 degree reduction 6 months after surgery (Table 3).

As for rib 10, in group 1 (with conversion: Xonversion Ribs), an 11.96 degree reduction in angularity was observed immediately after surgery, a 12.81 degree reduction 1 month after surgery, and a 14.27 degree reduction 6 months after surgery. In group 2 (without conversion surgery), a 3.30 degree reduction in angularity was observed immediately after surgery, a 3.30 degree reduction 1 month after surgery, and a 4.87 degree reduction 6 months after surgery (Table 4).

Waist reduction in group 1 (with conversion: Xonversion Ribs) was as follows: 12.42 cm immediately after surgery, 15.50 cm 1 month after surgery, and 17.04 cm 6 months after surgery. In group 2, waist reduction was as follows: 7.48 cm immediately after surgery, 8.30 cm 1 month after surgery, and 8.70 cm 6 months after surgery (Table 5).

DISCUSSION

The development of concepts in rib surgery allows the success of many of the techniques devised to perform an effective reduction. The body has 12 pairs of ribs, which, from number 1 to number 7, are considered as true because they articulate with the sternal

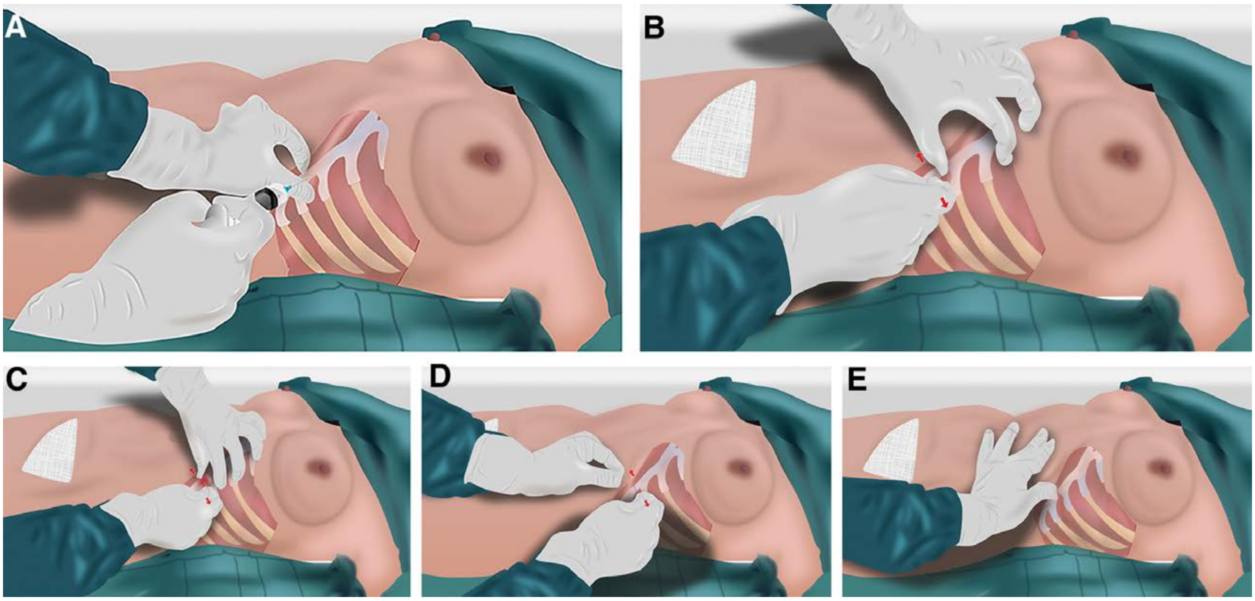

Fig. 3. Xonversion Ribs procedure. A, Chondral anesthetic block. B, Palpation and location of chondral joint. C, Chondral disarticulation with size 18 needle. D, Manual pressure and disarticulation of chondral joint. E, Loss of strength at disarticulation site.

Table 3. Assessment of Angular Variation of the Ninth Rib

Difference from Presurgery Angulation (Degrees)	Group	n	Mean	SD	t	P
Angulation immediately after surgery (degrees)	Group 1	52	−10.96	0.824		
					−8.77	<0.001
	Group 2	46	−5.13	3.279		
Postsurgery angulation after 1 month (degrees)	Group 1	52	−12.42	1.027		
					−10.46	<0.001
	Group 2	46	−5.09	3.410		
Postsurgery angulation after 6 months (degrees)	Group 1	52	−14.04	1.038		
					−9.48	<0.001
	Group 2	46	−7.22	3.503		

Table 4. Assessment of Angular Variation of the 10th Rib

Difference from Presurgery Angulation (Degrees)	Group	n	Mean	SD	t	P
Angulation immediately after surgery (degrees)	Group 1	52	−11.96	1.183		
					−14.59	<0.001
	Group 2	46	−3.30	2.754		
Postsurgery angulation after 1 month (degrees)	Group 1	52	−12.81	1.096		
					−18.53	<0.001
	Group 2	46	−3.30	2.344		
Postsurgery angulation after 6 months (degrees)	Group 1	52	−14.27	1.218		
					−18.65	<0.001
	Group 2	46	−4.87	2.222		

Table 5. Waist Reduction Assessment (cm)

Difference from Presurgery Waist Measurement (cm)	Group	n	Mean	SD	t	P
Postsurgery waist measurement (immediate) (cm)	Group 1	26	−12.42	1.815		
					−10.23	<0.001
	Group 2	23	−7.48	1.534		
Postsurgery waist measurement (1 month) (cm)	Group 1	26	−15.50	2.387		
					−11.38	<0.001
	Group 2	23	−8.30	1.987		
Postsurgery waist measurement (6 months) (cm)	Group 1	26	−17.04	2.441		
					−13.54	<0.001
	Group 2	23	−8.70	1.769		

manubrium via a cartilage in a synarthrosis joint; ribs 8–10 are considered as false because they do not have a direct articulation with the sternal manubrium. Ribs 11 and 12, which are the floating ribs, are also considered false because these do not articulate with the sternal manubrium and are shorter in length and curvature than those mentioned above.[6–8]

Waist treatment through ultrasound-guided (RibXcar)[5] monocortical fracture is usually performed in floating and false ribs; however, in the latter, the stress force exerted toward the sternal manubrium may limit inward angulation, producing an unsatisfactory result usually directed toward the ninth and 10th ribs. Although no frequency data regarding chondral joints in ribs 8, 9, and 10 exist, based on our surgical experience, rib 10 behaves as floating in most cases.[6–10]

The RibXcar procedure has allowed us to satisfactorily achieve waist reduction through ultrasound monitoring. Although the main treatment is directed toward the floating ribs, occasionally, treatment of ribs 9 and 10 is needed. These ribs, which are joined by a costochondral joint to the sternal manubrium, show a stress force that does not allow inward deformation, the main basis of RibXcar's success. In this regard, the proposed alternative is the conversion of false ribs to floating ones to release this stress force, thereby allowing inward deformation and enabling RibXcar to work effectively.[5]

Accordingly, who is the ideal patient eligible to undergo this procedure (Xonversion Ribs)? The answer to this question might cause confusion, because this will depend greatly on the type of approach and required results. If we treat the floating ribs, which have a single posterior anchor point at the vertebral level, monocortical fracture will be enough to alter the angulation of the ribs, generating an inward deformation, which allows the waist to be modulated and its diameter to be reduced. However, when the ribs are false (having an anterior fixation point), the deformation that occurs has the risk of becoming bicortical due to the stress force the anterior point exerts; complications may also arise, such as pseudoarthrosis,

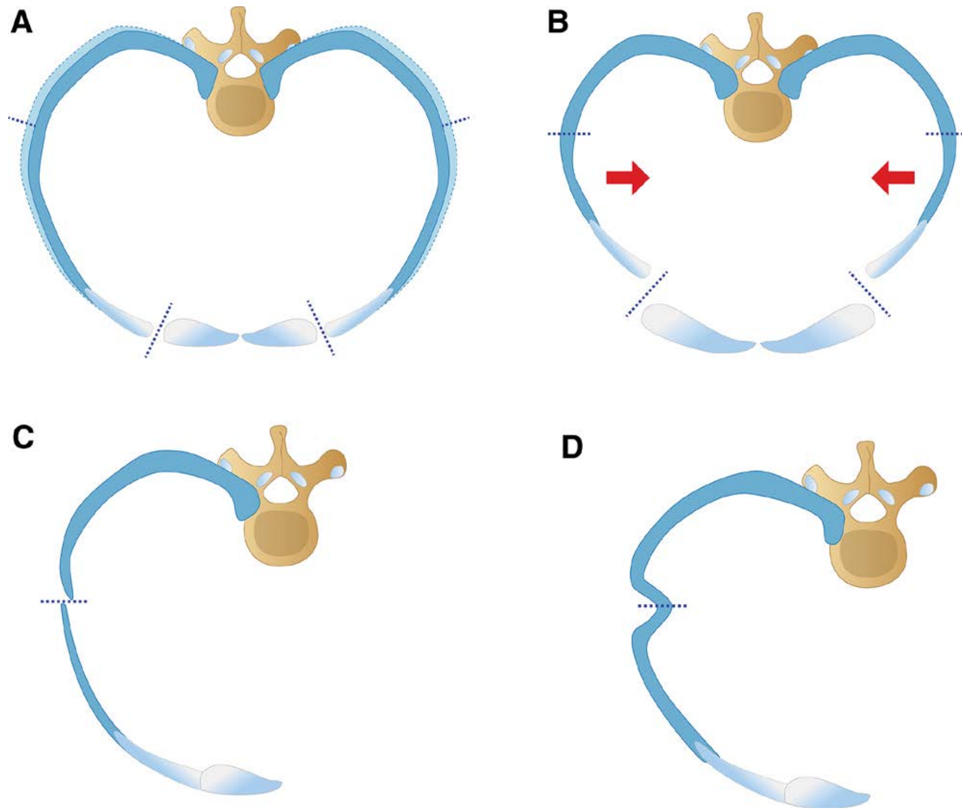

Fig. 4. False rib conversion concept. A, Remodeling and disarticulation of chondral sites. B, Interior angulation in false ribs after Xonversion Ribs and RibXcar procedure. C, Complete fracture complication. D, Deformity complication.

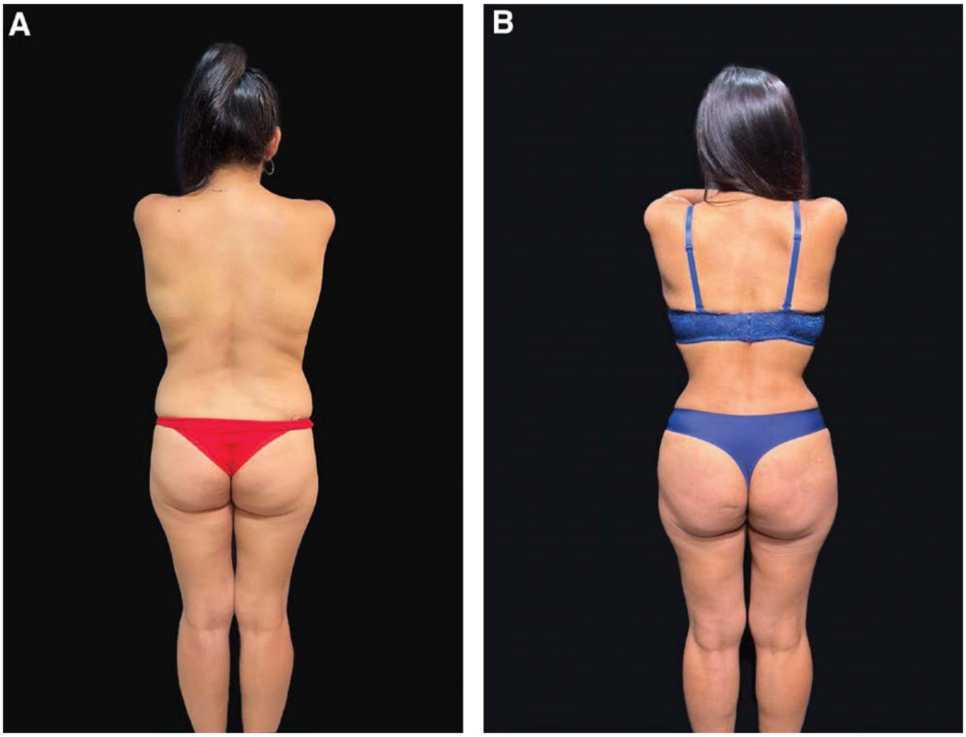

Fig. 5. Patient outcomes: Before (A) and at 6-month postoperative follow-up (B) in posterior view.

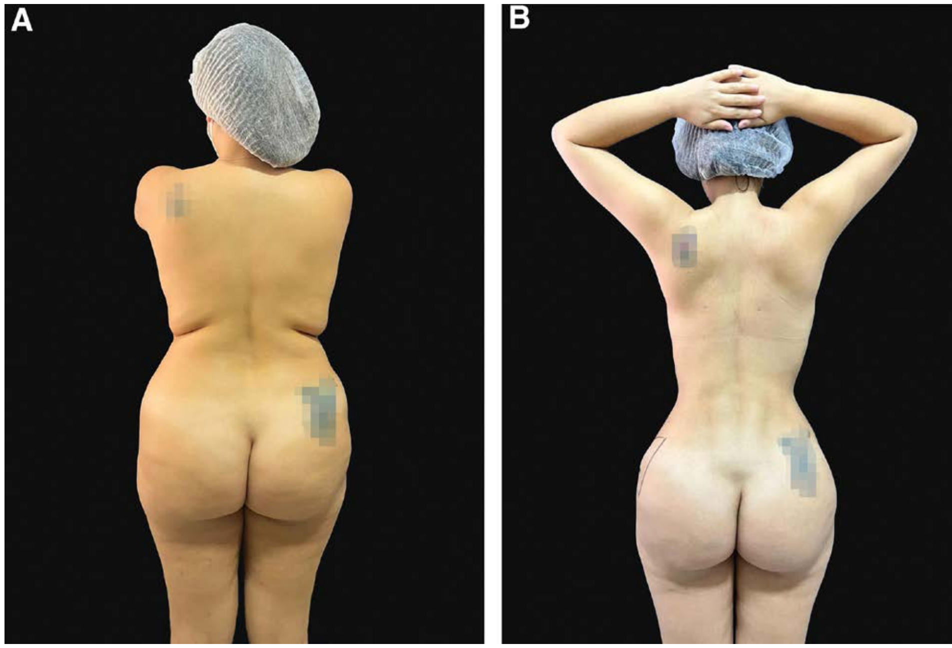

Fig. 6. Patient outcomes: Before (A) and at 1-year postoperative follow-up (B) in posterior view.

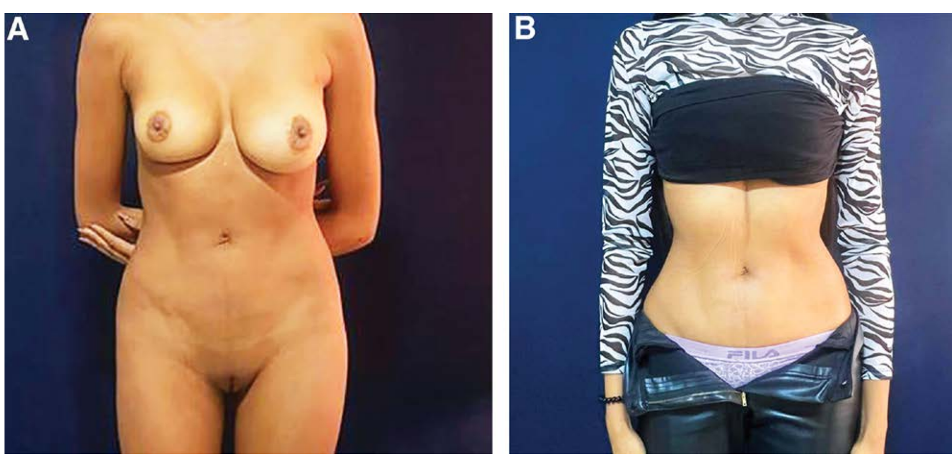

Fig. 7. Patient outcomes: Before (A) and at 6-month postoperative follow-up (B) in frontal view.

dextroposition, and pain, in addition to limiting angulation (Fig. 4).

Once the patient whose ninth and 10th ribs need to be treated has been determined, the next step is to assess the location of the floating ribs. For this, the ideal procedure is to request a computed tomography scan with 3D reconstruction alongside a cartilage window; this will allow assessment of the situation of the costochondral joint to adequately plan for the conversion of false ribs to floating ribs.

It is important to emphasize that the use of ultrasound is essential to ensure a good fracture trace when RibXcar is performed; this allows us to evaluate the effectiveness and subsequent costal angulation produced by this monocortical fracture (**Video 3**).

Costochondral disarticulation is achieved using size 18 needles or a piezotome with digital pressure applied on the joint; this allows for better manipulation for disarticulation. This must be verified using ultrasound to ensure its effectiveness.[5]

In RibXcar, the fracture trace is achieved when the ultrasonic tip enters up to 70%–80% of the rib thickness, thus allowing a controlled fracture (**Video 2**).

Notably, despite showing a good angulation and a good fracture trace, long-term results may be achieved by maintaining the compressive force that stabilizes the fracture and angulation. This is achieved by maintaining a fixative waistband for at least 3 to 6 months.[11,12]

The anatomical characteristics of ethnic groups from different regions of high altitudes, especially in South

America with countries such as Colombia, Ecuador, Peru, Bolivia, Chile, and Argentina, undergo an anatomical adaptation of the rib cage to improve the respiratory capacity, to prevent hypoxia in these places with high altitude. The main anatomical adaptations include the greater anterolateral width of the thorax and the greater surface area and greater angulation of the ribs. Therefore, rib treatment in patients with these characteristics implies work on higher (false) ribs, as well as improving the angulation of these ribs to generate a more harmonious effect toward the waist (Xonversion Ribs + RibXcar).[13–15]

Complications are unlikely in Xonversion Ribs. This is because no structures, such as the lung, are present at the site of disarticulation in the anterior thoracic region, although the site is close to the diaphragm, pleura, or hepatic region. However, ultrasound allows these structures to be located and provides safe entry for the needle. It also allows disarticulation to be performed safely with acupressure. As this procedure is associated with RibXcar, the complications to be considered are asymmetries and deformities, as well as irregular consolidations or neuropathic pain due to intercostal nerve injuries. In some cases, if the pleura is perforated, a pneumothorax could occur; in these cases, the management of complications is aimed at addressing these events (ie, placement of a drainage tube if necessary and correction of deformations and/or secondary asymmetries). In our procedures, we did not face any severe complications, such as pneumothorax, bleeding, or alterations in consolidation. However, we experienced two cases of neuropathic pain, which were successfully treated with 75 mg of pregabalin twice daily for 7 days. These complications were associated with the RibXcar procedure and not the Xonversion Ribs procedure.[11,12]

At the 6-month follow-up, we observed that the group in which rib conversion surgery was performed (group 1) had a greater angular decrease in ribs 9 and 10, as well as a statistically significant reduction in waist diameters, compared with the group in which conversion surgery was not performed (group 2) (Figs. 5–7).

CONCLUSIONS

The technique of conversion from false to floating ribs (9 and 10) associated with RibXcar proved to be effective in reducing waist diameter and in improving the aesthetic appearance six months after surgery, as measured in the postoperative follow-up on angular variability and waist diameter ($P < 0.05$).

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DISCLOSURE

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

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