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ORIGINAL ARTICLE

Cosmetic

Ribs with Anterior Protrusion (Winged Ribs) Treated Using Percutaneous Chondroplasty

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Background: Thoracic features play a significant role in determining various plastic surgery techniques. Particularly, the thorax has potential for excessive anterior projection, commonly referred to as winged ribs. This study aimed to describe a treatment method for addressing winged ribs for aesthetic purposes using percutaneous chondral management.

Methods: Thirty-two female patients underwent FrontXribs from February to March 2023. Two angular measurements were obtained: (1) the angle formed by lines intersecting tangentially to the shoulder and the lower gluteal border; and (2) the angle formed by a line tangential to the greatest anterior projection, intersected by a vertical line on the standing axis. Length measurements were obtained using a tape measure at the position of the greatest thoracic projection. Pulmonary function studies were conducted. All variables were measured before surgery and 6 months postoperatively.

Results: On average, patients were 25 years old. The average operative time was 51.1 minutes, and all patients underwent general anesthesia. The average increase for angular measurement 1 was 26.1 degrees, whereas that for angular measurement 2 was 3.43 degrees. The average decrease in anterior chest length during the postoperative period was 9.66 cm ($P < 0.001$). Spirometric tests showed no significant changes 6 months postoperatively.

Conclusions: The FrontXribs technique for treating winged ribs effectively reduces anterior costal protrusion, as evidenced by the angular variation of projections and the reduction in thoracic length at this level. No adverse effects on respiratory function were observed 6 months postoperatively. *(Plast Reconstr Surg Glob Open 2024; 12:e6178; doi: 10.1097/GOX.0000000000006178; Published online 24 September 2024.)*

INTRODUCTION

The ribcage holds significant importance in all body contouring procedures, particularly when achieving a contoured and aesthetically pleasing waistline is desired.[1–4] The thorax serves as a structural support for muscles, tendons, and fascia while protecting vital organs such as the heart, lungs, and major blood vessels, including the aorta and vena cava.[5] When considering rib procedures for aesthetic enhancement, we must bear in mind that the thoracic shape serves as a pivotal factor that influences treatment decisions. The conformation of a wide chest combined with a short waist often necessitates reduction procedures involving costal monocorticotomy.[4] Similarly, in procedures such as augmentation mammoplasties using breast implants, the shape of the thorax plays a critical role in determining projection and aesthetics. In this context, Andrades et al presented a detailed study on the management of winged ribs, a thoracic deformity, through rib resection performed through an incision in the inframammary fold. This approach, combined with concurrent breast implant placement during the surgical procedure, aims at enhancing the aesthetic outcomes of breast surgery by correcting thoracic deformities.[6]

In our clinical practice, we regularly encounter cases of winged ribs, a condition that often leads to issues with self-esteem and dissatisfaction among patients. As a result, this deformity causes many individuals to feel insecure about wearing swimwear or exposing their chest. The management approach proposed by Andrades et al, involving rib resection, may be negatively perceived by patients

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concerned about the concept of rib removal and the potential for wide scars, especially when breast implants are not desired.[6]

To address these concerns, the FrontXribs technique is proposed. This technique seeks to reduce the anterior projection associated with winged ribs by means of chondroplasty using a percutaneous needle or piezotome. The aim of this study was to describe the FrontXribs technique and evaluate its effectiveness in correcting winged ribs 6 months after the procedure was performed.

MATERIALS AND METHODOLOGY

A total of 32 female patients, aged between 19 and 30 years (mean age, 25.0 years), were recruited. These patients sought medical evaluation for body contouring surgery, expressing aesthetic dissatisfaction with the anterior protrusion of the thorax, commonly referred to as winged ribs. After considering various treatment options, the decision was made to treat the anterior thorax using the proposed technique known as FrontXribs. The inclusion criteria required that patients be between 18 and 40 years of age and present with discomfort related to thoracic deformity. Diagnosis of the deformity was confirmed through three-dimensional rib cage and cartilaginous window tomographic evaluation, identifying it as type I according to Acastello classification, that is, involving the joint (Fig. 1). Patients with a history of uncontrolled chronic diseases (including types II, III, and IV deformities, defined according to Acastello classification); a history of thoracic surgery; or pulmonary, cardiovascular, osteomyoarticular, or autoimmune diseases affecting postoperative outcomes were excluded.[7] Patients with abnormal spirometric results prior to the procedure and those requiring rib girdle reduction through resection or monocortical fracture were also excluded from the study.

All patients received regular follow-up care from a specialized nurse, who collaborated with the surgeon to ensure adherence to respiratory physiotherapy and medical indications. Demographic data were collected by reviewing medical records; the data were recorded in a Microsoft Excel (version 19.00) database. Statistical analysis was performed using SPSS software, version 25.

The patients agreed to sign an informed consent where they provide authorization for the use of their information and image for the purposes of this study. Approval was obtained from a local ethics committee, and the principles outlined in the Declaration of Helsinki were adhered to.

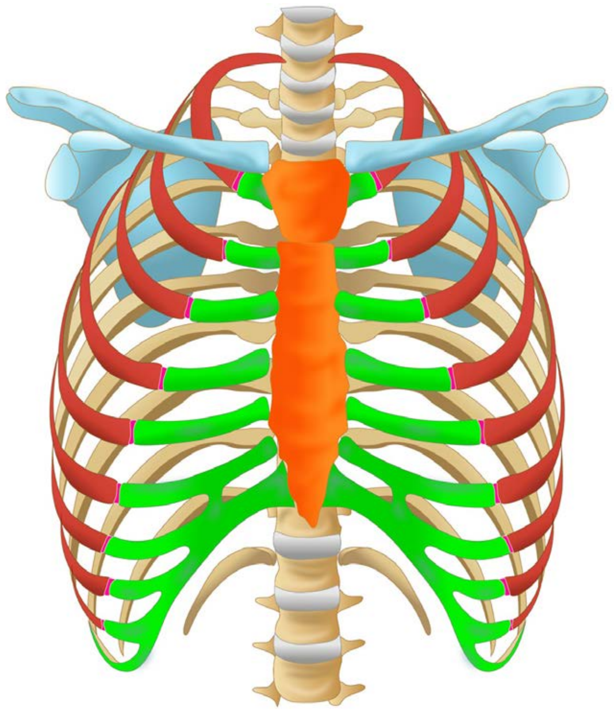

Fig. 1. Acastello classification in relation to the structure affected. I: cartilaginous (pink). II: costal (red). III: chondro-costal (green). IV: sternal (orange). V: clavicle-scapular (sky blue).

Takeaways

Question: Can the complementary FrontXribs technique enhance aesthetic outcomes and correct anterior projection of a thorax with winged rib features?

Findings: Average increases of 26.1 degrees and decrease 3.43 degrees were observed for angular measurements 1 and 2, respectively. The mean decrease in the length of the anterior thorax in the postoperative period was 9.66 cm ($P < 0.001$).

Meaning: In treating winged ribs, the FrontXrib technique is effective in reducing the anterior costal protrusion as assessed using angular variations in projections and decreased thoracic length. No resultant respiratory function changes were observed 6 months postoperatively.

PHOTOGRAPHIC TECHNIQUE

Photographs were captured with the patient standing and positioned laterally to the right. A Canon EOS 90D camera with 18–135 mm IS USM lens was used, placed at a distance of 2 m from the patient. All photographs were captured by the same photographer, both before surgery and 6 months after surgery. The JPEG image format was used for photographic analysis.

TECHNIQUES USED TO MEASURE ANGLES

Two angular measurements were obtained using standardized photographs of the patient in a lateral position. Angular measurement 1 was defined as the angle formed by lines tangential to the greatest anterior projection of the thorax and to the lower gluteal border (Fig. 2). Angular measurement 2 was defined as the angle determined by a line tangential to the greatest anterior projection, intersected by a vertical line on the axis of the patient's stance (Fig. 3). The length measurement at the position of the most pronounced thoracic projection was obtained using a tape measure.

These measurements were determined using Adobe Systems, San Jose, California. The measurements were subsequently stored in a Microsoft Excel (version 19.00) database.

Fig. 2. A 30-year-old female patient during evaluation and measurement of angle 1 before (A) and 6 months after (B) the FrontXribs procedure.

WAIST MEASUREMENTS

With the patient standing laterally to the evaluator, we located the point of greatest projection of the anterior thorax, and proceeded to measure the length at that level. The thoracic contours were measured with measuring tapes (Fith brand). The tapes were placed on the identified point and projected laterally so that the measurement could be read. The measurements were obtained at the same position 6 months after surgery.

SPIROMETRY

Spirometry was performed as part of the preoperative evaluations, as well as 6 months postoperatively at the same pulmonological center. Standard procedures and instrument calibration were conducted. Forced expiratory volume per second (FEV1), forced vital capacity (FVC) and the FEV1 to FVC ratio were assessed to identify patterns consistent with lung disease or pulmonary function limitation. All spirometric data were recorded and stored in a Microsoft Excel (version 19.00) database.

TECHNIQUE DESIGN

With the patient standing, the costal rim is palpated bilaterally, and ultrasound is used to pinpoint the costochondral and chondral joints of the false ribs at the anterior level. Subsequently, a line is drawn tracing the path from the last rib to the sternum region, after which the costochondral points and chondrocostal junctions are marked for puncture sites. [**See Video (online),** which shows the FrontXribs percutaneous chondroplasty technique.]

SURGICAL PROCEDURE: TREATMENT OF RIBS WITH ANTERIOR PROTRUSION (WINGED RIBS), BY PERCUTANEOUS CHONDROPLASTY—FRONTXRIBS

The patient is placed in a right lateral decubitus position. This position enables the costochondral joints of the false ribs and the chondrosternal joints to be located, as well as the previously marked points.

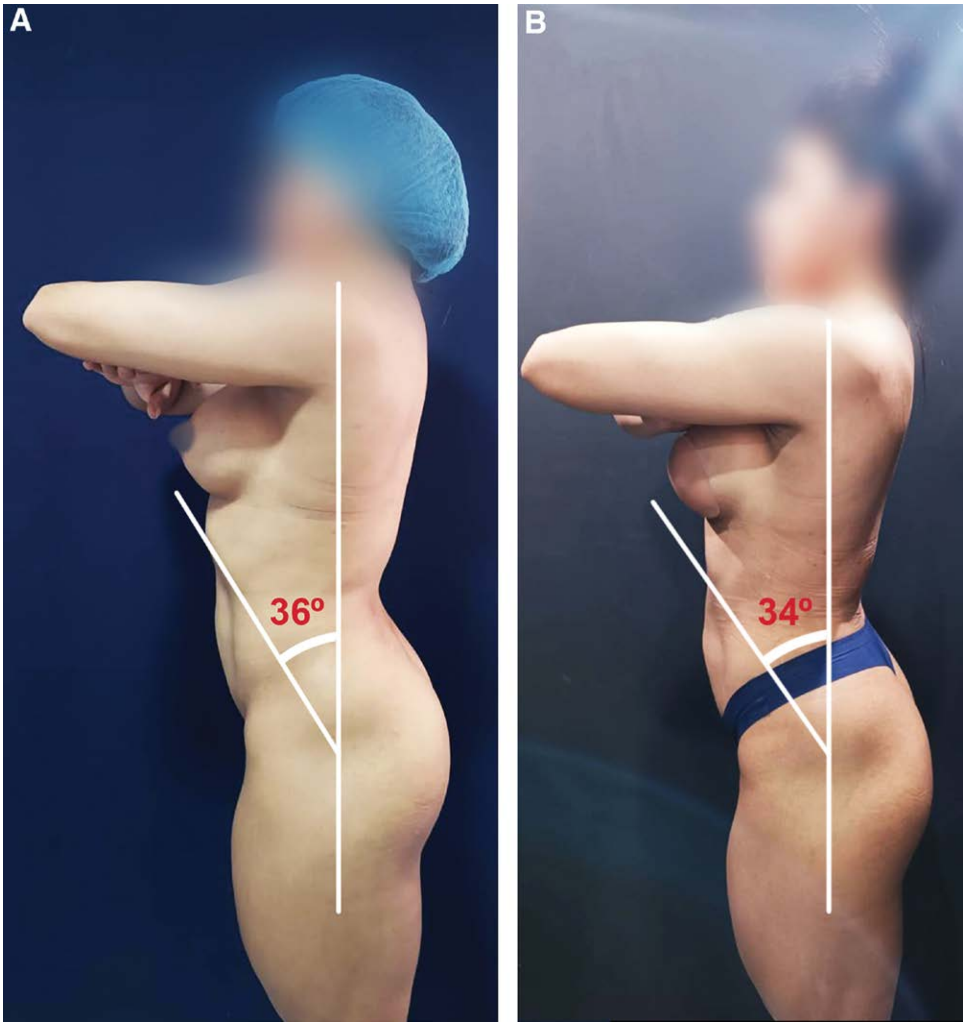

Fig. 3. A 30-year-old female patient during evaluation and measurement of angle 2 before (A) and 6 months after (B) the FrontXribs procedure.

Table 1. Descriptive Data on Age and Operative Time

Variable	N	Average	SD	Minimum	Maximum
Age (y)	32	25.0	3.9	19	30
Operative time (min)	32	51.1	5.8	40	60

Details regarding sex and cardiovascular risk (CR) are not possible because all patients were female or CR and no complications were observed.

COSTOCHONDRAL CHONDROPLASTY

Using an N22 needle, sustained punctures are made with moderate pressure at the level of the costochondral joints. Similarly, a piezotome can be used at the puncture sites, inducing an internal deformation that is verified using ultrasonography to ensure joint mobility without any rupture or complete separation. Likewise, punctures are performed at the costal bone level at the junction of the joint to promote internal angulation of the cartilage. Finally, we place the compression waistband at the level of the upper chest [**See Video (online)**].

RESULTS

We assessed 32 female patients who underwent anterior costal protrusion reduction surgery (FrontXrib), aged between 19 and 30 years. All patients were classified as having a grade I surgical risk according to Goldman (100%). The mean operative time was 51.1 minutes. All patients received postoperative care, and no complications, such as infections at the operative site, pneumothorax, hemothorax, visceral injury, or other respiratory complications, were observed (Table 1).

With regard to angular measurement 1, before surgery the maximum angle determined was 144 degrees and the minimum was 141 degrees (mean, 142.41 degrees). At 6 months postoperatively, the maximum angle was 171.50 degrees and the minimum was 164.50 degrees (mean, 168.56 degrees; Table 2). For angular measurement 2, before surgery the maximum angle was 35 degrees and the minimum was 33 degrees (mean, 33.6 degrees).

Table 2. Comparison of Angular Measurement and Anterior Thorax Length Values before and 6 Months after Surgery

Variable	N	Average	Stand Deviation	Median	RIC	Z	P
Angular measurement 1 (postoperative)		168.56	4.43	168.50	164.50–171.50		
	32					−4.94	<0.001
Angular measurement 1 (preoperative)		142.41	1.83	142.00	141.00–144.00		
Angular measurement 2 (postoperative)		37.09	0.78	37.00	36.50–38.00		
	32					−4.97	<0.001
Angular measurement 2 (preoperative)		33.66	1.18	34.00	33.00–35.00		
Anterior thoracic length (preoperative)		77.22	1.66	77.00	76.00–79.00		
	32					−4.95	<0.001
Anterior thoracic length (postoperative)		67.56	1.79	67.00	66.00–69.50		

The data showed no normality, applying Wilcoxon T.
RIC: interquartile range

Table 3. Comparison of Forced Expiratory Volume, Forced Vital Capacity, and the Forced Expiratory Volume to Forced Vital Capacity Ratio *100 Values

Variable	N	Average	SD	Median	RIC	Z	P
FEV1(l)		3.263	0.131	3.262	3.172–3.367		
	32					−5.660	<0.001
FEV1(l) (postoperative)		3.283	0.131	3.282	3.192–3.387		
FVC(l)		3.488	0.181	3.453	3.371–3.587		
	32					−4.900	<0.001
FVC(l) (postoperative)		3.487	0.174	3.445	3.381–3.577		
(FEV1/FVC)*100		93.68	3.95	93.93	90.85–95.65		
	32					−4.34	<0.001
(FEV1/FVC)*100 (postoperative)		94.24	3.27	94.79	91.69–96.54		

The data showed no normality, applying Wilcoxon T.

At 6 months postoperatively, the maximum and minimum angles were 38 degrees and 36.5 degrees, respectively (mean, 37.09 degrees; Table 2).

Prior to surgery and at 6 months postoperatively, the mean measurements of the anterior thorax at the level of the anterior protrusion were 77.22 cm and 67 cm, respectively (Table 2). The mean values of FEV1 and FVC before surgery were 3.263 L and 3.488 L, respectively. The value of the FEV1/FVC coefficient was 93.68. Six months postoperatively, the values obtained for FEV1, FVC and FEV1/FVC were 3.283 L, FVC 3.483 L, and 94.24, respectively (Table 3; Figs. 4–6).

DISCUSSION

The thoracic structure significantly influences the outcomes of aesthetic procedures performed in this part of the body. A notable example is the approach proposed by Andrades et al,[6] who outlined a surgical intervention for winged ribs aimed at enhancing the aesthetic outcomes of breast augmentation.

Ribs with the characteristics of winged ribs often cause discomfort in patients, as they find it challenging to manage, and feel restricted when wearing clothing that exposes the anterior thorax. Thus, the resection technique described by Andrades et al has significance because it offers immediate correction and promising outcomes. However, this technique relies on making an incision of 6–7 cm below the breast rim to facilitate placement of the implant. This raises the question: What if the goal is to enhance the thoracic area without placing breast implants or scarring? The approach proposed in the present study was developed to address this issue.[6]

The FrontXribs technique of chondroplasty by percutaneous puncture arises from our analysis. We observed that winged ribs manifest visibly in the skin through the costal cartilages, especially those forming the joint arch of the false ribs that connect to the sternum via a synchondrosis joint. Based on this, we decided to target the treatment of these ribs at the costochondral level. This was achieved through anatomical localization ultrasonography and an N22 needle and/or piezotome set on the cartilage function at a low frequency.

The functionality of this procedure is based on the internalization of cartilage, as proposed by Gibson and Davis,[8] where the cartilage possesses a memory due to fibroelastic forces that confer stability. When a scraping or puncture is performed on the cartilage, the resulting forces are disrupted, causing the opposite region to bend due to the action of the healthy perichondrium.

During this procedure, each rib undergoes chondral work at the chondral region at the level of the chondrocostal junction, where the puncture and use of the piezotome have the function of breaking the fibrocartilaginous union forces, producing a weakening, having as a secondary effect the inward curve of the cartilaginous portion that joins towards the sternum.

Of note is that this technique necessitates the use of a compression waistband to keep the anterior fixation. The goal is to eliminate cartilaginous memory, creating an internal bending that results in a new cartilaginous arrangement. This new arrangement is sustained over time by the stability provided by the waistband, as the fibrocartilaginous tension is restructured and stabilizes in the new position, generating a new cartilaginous memory.

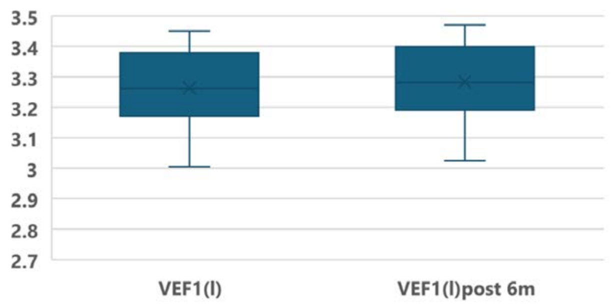

Fig. 4. Comparison of forced expiratory volume per second values.

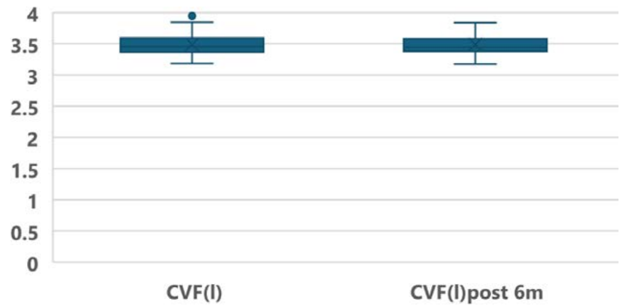

Fig. 5. Comparison of FVC values.

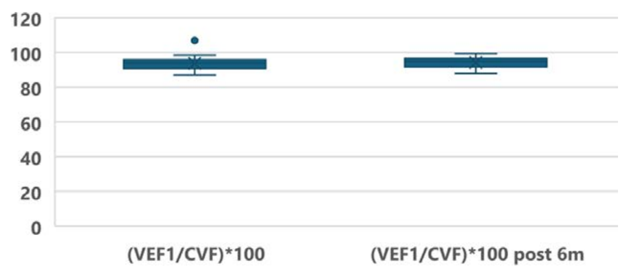

Fig. 6. Comparison of the forced expiratory volume to FVC ratio values.

The procedure takes into account the capacity of the cartilage for endochondral ossification, as well as the capacity of the perichondrium to regenerate, particularly in the costochondral joints. This provides greater stability in the newly shaped thorax and contributes to the stabilization of the waist.[9,10]

When we perform the punctures, our aim is not to disarticulate the cartilage from the bone; rather, we seek to induce weakening of the cartilage that generates an inward effect (Fig. 7). We capitalize on this new deformation to stabilize the area and promote the formation of a new memory in the cartilage through the external pressure applied by the waistband. Furthermore, we prioritize preservation of the perichondrium during the procedure, as it plays a vital role in harboring chondrogenic progenitor cells; these cells enable adequate chondral repair and contribute to perichondral thickening. This thickening aids in new chondral stabilization and the establishment of a new cartilaginous memory. Likewise, we can use the piezotome to puncture the bone edge of the osteochondral joint. This generates a small bone hematoma that favors inward angulation and promotes the stimulation of progenitor cells that will stabilize the chondrocostal joint.

The vascularization of the cartilage arises primarily from the intercostal arteries and internal thoracic arteries. Preserving this vascularization during chondral treatment is crucial to maintain the regenerative properties of the perichondrium. The perichondrium is rich in matrices of type II collagen, which offer robust support and promote chondral regeneration, making it essential for forming a durable cartilaginous memory.[9–13] A technique that eliminates the need for scarring or rib resection can significantly enhance patient acceptance, especially when breast augmentation with implants is not recommended. However, emphasizing the importance of committing to the consistent use of a waistband to ensure firm maintenance of the costal–cartilaginous arrangement is crucial (Figs. 8 and 9).

When we performed the angular measurements during the postoperative follow-up, we identified two crucial points for measurement. Firstly, angular measurement 1 was obtained from the intersection of a line tangential to the shoulder and another line originating from the lower gluteal border towards the anterior thoracic projection. Secondly, angular measurement 2 was determined by the intersection of a vertical line formed through the standing axis and a tangential line to the anterior thoracic projection. In the case of angular measurement 1, we observed a considerable increase in angle, which was attributed to the reduction of the anterior projection, resulting in a decrease in the angular vertex. Similarly, 6 months postoperatively, angular measurement 2 showed a significant decrease, evidencing effectiveness in reducing the projection caused by the winged rib formation (Fig. 10).

Our analgesic protocol involved administering acetaminophen 1 g every 8 hours for 5 days. A model of the waistband was designed by the author. The waistband has a high anterior compression and was used continuously for 3 months postoperatively, beginning immediately after surgery. In the same way, as a preventive measure, patients underwent physical and respiratory therapy, along with the use of an incentive spirometer. The spirometer was used three times a day for 1 week prior to surgery and every 4 hours for 15 days after surgery.

Another critical aspect is the assessment of the pulmonary function before and 6 months after surgery. Our follow-up indicated that the FEV1, FVC, and FEV1/FVC values remained unaffected, with no evidence of obstructive or restrictive patterns. At 6 months after surgery, controls did not present with signs of pain, and the tests were performed without the use of a waistband or any other factor that may have affected the accuracy of the spirometry examinations.

Throughout the follow-up, no complications such as puncture site infection, thoracic instability, pneumothorax, visceral injury, or alterations in respiratory functions were observed. In particular, this technique demands

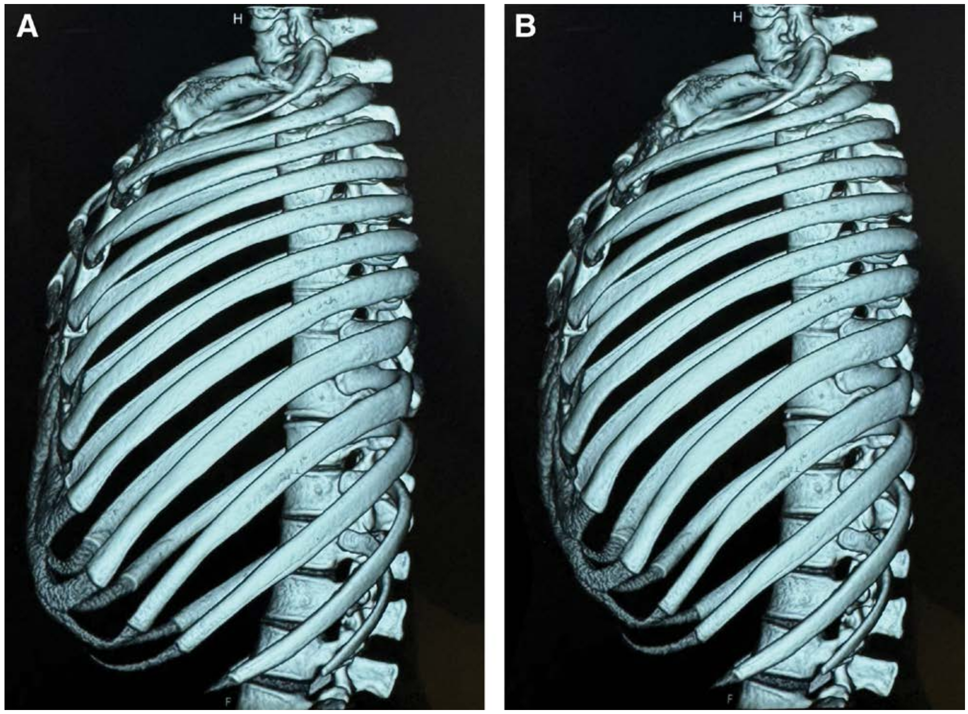

Fig. 7. Lateral view of preoperative ribcage CT study of a 30-year-old female patient. A, Preoperative image. B, Six-month postoperative FrontXribs image.

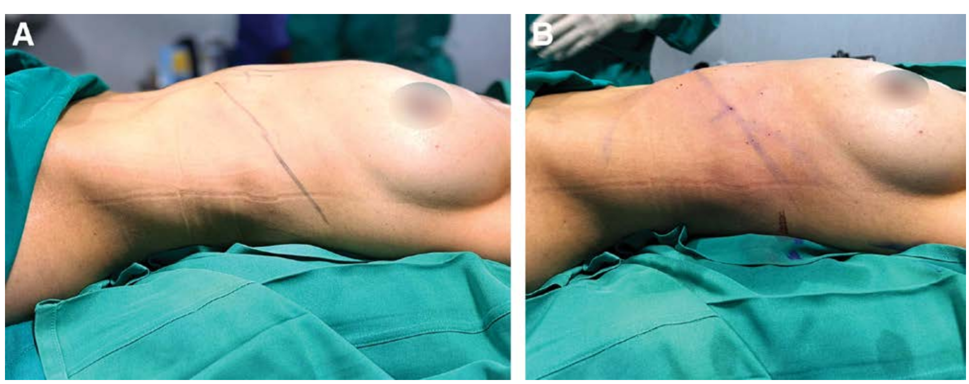

Fig. 8. Lateral view of a 26-year-old female patient. A, Preoperative view. B, Immediately after FrontXribs procedure.

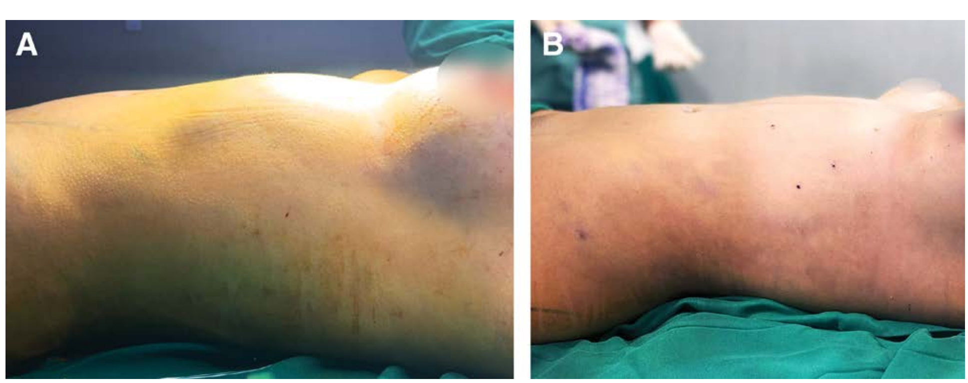

Fig. 9. Lateral view of a 24-year-old female patient. A, Preoperative view. B, Immediately after FrontXribs procedure.

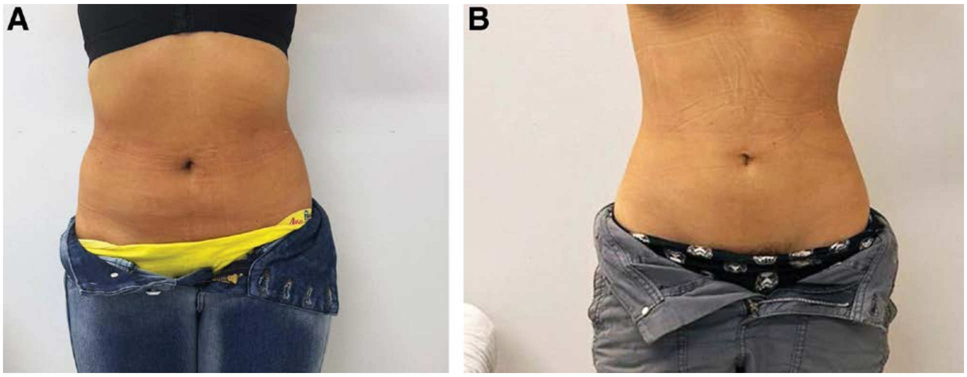

Fig. 10. Comparison of the FrontXribs surgical procedure in a 23-year-old female patient. A, Preoperative frontal view. B, Six-month postoperative frontal view.

skilled proprioception, which is acquired through a lengthy learning curve.

CONCLUSIONS

The anterior thoracic chondroplasty technique, FrontXribs, has been demonstrated to be effective in reducing the anterior projection associated with winged ribs, as evidenced by significant angular variation and decrease in length measurements at the level of the anterior thorax's greatest projection. Notably, no alterations in lung function or development of obstructive or restrictive patterns were observed 6 months postprocedure.

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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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