

# Pelvic floor rehabilitation in patients with levator ani muscle avulsion

J.A. García-Mejido<sup>1,2,\*</sup>, C. Suarez-Serrano<sup>3</sup>, E.M. Medrano-Sanchez<sup>3</sup>, M.J. Bonomi Barby<sup>1</sup>,

A. Armijo Sánchez<sup>1</sup>, J.A. Sainz<sup>1,2</sup>

<sup>1</sup>Department of Obstetrics and Gynecology, Valme University Hospital, Seville (Spain)

<sup>2</sup>Department of Obstetrics and Gynecology, University of Seville (Spain)

<sup>3</sup>Department of Physiotherapy, University of Seville (Spain)

## Summary

**Objective:** To determine if physiotherapy treatment applied to patients with levator ani muscle (LAM) avulsion identified after a vaginal delivery, reduces the LAM hiatus area. **Material and Methods:** A prospective observational study of 52 nulliparous (26 in the experimental and 26 in the control group). We included patients with LAM avulsion, diagnosed by 3-4D/transperineal ultrasound performed 3 months after delivery. Patients in the experimental group underwent a program of pelvic floor exercises, assisted by biofeedback and lumbopelvic stabilization exercises. Assessment of LAM was carried out at 6 and 9 months postpartum, using 3-4D/transperineal ultrasound, and taking the following measurements: levator hiatus area at rest, during Valsalva and at maximum contraction; LAM area, and thickness of right and left LAM. **Results:** Patients in the experimental group presented a reduction in the levator hiatus area at rest (17.0, 15.7, 15.9 cm<sup>2</sup>), during Valsalva (23.0, 20.8, 19.9 cm<sup>2</sup>) and at maximum contraction (15.6, 14.4 and 13.5 cm<sup>2</sup>), in comparison with patients in the control group, who presented a levator hiatus area at rest of 17.4, 17.2 and 16.8 cm<sup>2</sup>, during Valsalva of 21.0, 20.8 and 20.3 cm<sup>2</sup>, and at maximum contraction of 16.6, 16.1 and 15.6 cm<sup>2</sup>, at 1, 6 and 9 months postpartum respectively ( $P < 0.05$ ). However, no changes were appreciated in the successive examinations regarding LAM area between study groups: experimental 9.5, 8.9, 9.6 cm<sup>2</sup> versus 8.9, 9.0, 9.2 cm<sup>2</sup> in the control group. **Conclusions:** Physiotherapy treatment based on pelvic floor exercises with lumbopelvic stabilization exercises in patients with LAM avulsion reduces the levator hiatus area at rest, during Valsalva and at maximum contraction.

**Key words:** Pelvic floor muscle training; Levator ani muscle avulsion; Postpartum physiotherapy.

## Introduction

There are changes taking place during pregnancy that cause a remodeling of the connective tissue and pelvic floor muscles [1]. Nonetheless, vaginal delivery is the most important risk factor for the appearance of levator ani muscle (LAM) avulsion, which is defined as the discontinuity of the hyperechogenic puborectalis muscle fibers at their pubic insertion [2]. This injury is produced by the changes that occur in the hiatus of the levator muscle to allow the passage of the fetal head during delivery [3].

LAM avulsion occurs in 10-36% of deliveries [4]. A prolonged second stage of labor, large fetal head circumference and a high fetal weight have been described as risk factors for the occurrence of LAM avulsion [4, 5]. It has been established that the most important risk factor for this type of injury is the use of forceps in an operative vaginal delivery. The avulsion rate for a forceps delivery ranges from 35 to 64% [1, 6, 7]. To date, the use of vacuum has not been considered a risk factor for LAM avulsion, although this has been challenged by a recent publication [8].

The importance of LAM avulsion lies in the increase of the hiatus area it causes [9], leading to a reduction of its strength [10, 11]. This strength reduction favors the appear-

ance of pelvic organs prolapse [12], concerning especially the anterior and central compartments, although it bears no relation to urinary stress incontinence [13].

To date, neither the application of mechanical methods for the prevention of LAM avulsion [14] nor the attempts of postpartum repair [15] have proven to be effective. In addition, the prediction of LAM trauma before delivery can be difficult or even impossible [16]. As currently we cannot prevent or repair LAM avulsion, pelvic floor rehabilitation could be a useful alternative in patients with this sort of injury. Therefore, the objective of our study is to determine if a specific physiotherapy treatment for the rehabilitation of pelvic floor dysfunction in patients with LAM avulsion after a vaginal delivery reduces the levator hiatus area.

## Methods

A prospective observational study was conducted, including 52 nulliparous women (26 in the experimental group and 26 in the control group) who were recruited in our maternity unit, between January 2016 and September 2016. The recruitment process was carried out as shown in figure 1. The study was approved by Andalusia's Board of Biomedicine Ethics Committee.

Recruitment was performed consecutively during the

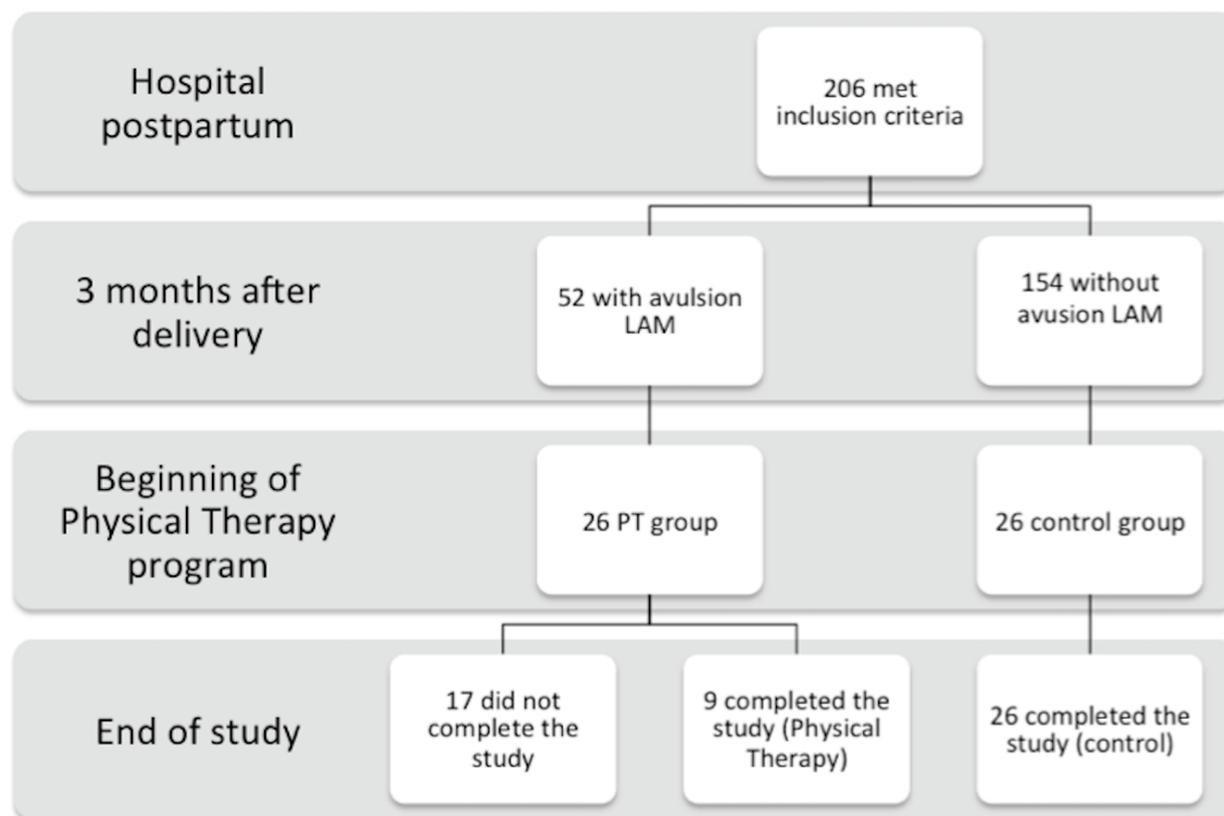


Figure 1. — Recruitment process (flow diagram).

postpartum period, including patients with a single-term gestation (37-42 weeks of gestation), with an operative vaginal delivery in cephalic presentation. Patients with previous history of previous pregnancies or pelvic floor corrective surgery were excluded. All patients agreed to participate in the study and written informed consent was obtained prior to their enrollment.

An initial evaluation of patients was performed by 3D transperineal ultrasound at 3 months postpartum, identifying those with LAM avulsion. Subsequently, patients with LAM avulsion were randomly assigned to one of the two study groups: the experimental group and the control group.

Once included in the study, the following obstetric parameters were evaluated: maternal age, gestational age, induction of labor, epidural status, duration of the second stage of labor, type of delivery, episiotomy, perineal tears and fetal weight at birth.

Deliveries were assisted by obstetricians belonging to our maternity unit with extensive experience in the use of vacuum and forceps. All deliveries were performed without the Kristeller maneuver and with protection of maternal perineum at the moment of exit of the fetal head. Selective episiotomy (mediolateral) was carried out, following Valme's University Hospital clinical practice guideline for operative vaginal deliveries.

Initial ultrasound evaluation was performed 3 months

after delivery, by a single examiner with specific training in 3D pelvic floor ultrasound. Prior to, and throughout the ultrasound assessment, the examiner was blinded to obstetric data regarding the delivery and randomization. A 500® Toshiba Aplio (Toshiba Medical Systems Corp., Tokyo, Japan) ultrasound with PVT-675MV 3D abdominal probe was used. The technique of image acquisition and offline analysis of the volumes captured was carried out as described in previous studies [8]. Three volumes were captured for each patient: at rest, during Valsalva and at maximum contraction. LAM avulsion was defined in the multiscreen ultrasound as an abnormal insertion of LAM in the inferior pubic ramus identified in all three central slices, i.e. in the plane of minimal hiatal dimensions (PMD) and the two cranial slices at 2.5 and 5.0 mm [12].

Ultrasonographic measurements of LAM and levator hiatus area were assessed in the PMD, as described in previous studies [12].

Ultrasound evaluations for both groups were performed at 3 months (at the moment of randomization, after establishing the diagnosis of LAM avulsion), 6 months and 9 months after delivery. In each examination, the following LAM characteristics were evaluated: presence of LAM avulsion, levator hiatus area (at rest, during Valsalva and at maximum contraction), LAM area and thickness of the right and left LAM [17].

Table 1. — Obstetric data of study population

	Mean ( ± DT) or %		P
	Experimental (n = 9)	Control (n = 26)	
Maternal Age	30.4 ( ± 4.2)	30.0 ( ± 4.6 )	NS
Gestational age	40.3 ( ± 1.2)	40.1 ( ± 1.3 )	NS
Epidural	9/9 (100 %)	26/26 (100 %)	
2nd stage of labour (min)	97.5 ( ± 67.3 )	79.4 ( ± 35.1 )	NS
Episiotomy	7/9 (77.8%)	20/26 (76.9%)	NS
Perineal tear			
No	0/9 (0.0%)	17/26 (65.4%)	< 0.0005
Grade I	0/9 (0.0%)	3/26 (11.5%)	
Grade II	8/9 (88.9%)	1/26 (3.8%)	
Grade III	1/9 (11.1%)	5/26 (19.2%)	
Grade IV	0/9 (0.0%)	0/26 (0.0%)	
Type of delivery			
Vacuum	7/9 (77.8%)	12/26 (46.2%)	0.019
Forceps	1/9 (11.1%)	14/26 (53.8%)	
Spatulas	1/9 (11.1%)	0/26 (0.0%)	
Birth weight	3335.9 ( ± 489.7 )	3588.3 ( ± 401.5 )	NS
Type of avulsion			
Unilateral	5/9 (55.6%)	14/26 (53.8%)	NS
Bilateral	4/9 (44.4%)	12/26 (46.2%)	

NS: Not statistically significant

Physiotherapy treatment was applied to the experimental group by a physiotherapist specializing in pelvic floor dysfunctions, with more than 15 years of experience in this area. Pelvic floor function was evaluated by the physiotherapist before the beginning of the therapy and once the patients were able to perform the exercises correctly on their own.

The therapy lasted two months, at a rate of two 45-minute sessions per week. The program consisted of pelvic floor exercises assisted by manometric biofeedback, which were performed in supine position for 20 minutes. In addition, active lumbopelvic stabilization exercises, including the contraction of pelvic floor muscles, was performed in the supine, plank and quadruped position.

Together with the treatment at the clinic, patients were asked to perform a series of exercises at home, consisting in: 8-12 sustained contractions of 6 seconds, with a rest period of double the exercise time, followed by 3-5 fast contractions of 2 seconds at maximum intensity, again followed by resting double the exercise time. Domiciliary exercises were performed in supine, sitting and standing position.

The control group received an information brochure with recommendations, including the same program of pelvic floor exercises taught to the patients in the experimental group, but without any kind of supervision by the physiotherapist.

To detect a difference of 10% in the reduction of the size of the levator hiatus area between the study groups at 6 months after the beginning of the intervention and considering a common standard deviation of 10% (based on a

pilot study), an alpha error of 5 % and a power of 90%, we needed 23 women per study group. Assuming a loss of 10% in the follow-up, the final size should be 52 women, 26 per study group.

We used means and standard deviations to describe numeric variables, while qualitative variables were written as percentages. Comparisons of numeric variables between study groups were performed using Student's *t*-test if the data were normally distributed, and the Mann-Whitney U-test was performed for nonnormally distributed data. Comparisons of qualitative variables between study groups were performed using contingency tables and the chi-squared test or Fisher's exact test. Significance level was set at 95% ( $P < 0.05$ ). The data analysis was performed with the statistical package IBM SPSS statistics 22 (IBM, Armonk, NY).

## Results

52 patients who met the inclusion criteria and were diagnosed with LAM avulsion were invited to participate in the study.

Of the 52 patients included in the study, 26 were randomized into the control group and 26 into the experimental group. There were no patient losses in the control group, while 17 patients in the experimental group drop out of the study (Figure 1).

35 patients completed the study (26 in the control group and 9 in the experimental group). General and obstetric characteristics of the study population are listed in Table 1. In the group that received physiotherapy treatment, 77.8%

Table 2. — Levator hiatus area and LAM measurements in the experimental group ( $n = 9$ )

	Mean ( $\pm$ SD) or %			P
	3 month postpartum	6 months postpartum	9 months postpartum	
Levator hiatus area at rest ( $\text{cm}^2$ )	17.0 ( $\pm$ 2.1)	15.7 ( $\pm$ 2.9)	15.9 ( $\pm$ 2.4)	NS
Levator hiatus area during Valsalva ( $\text{cm}^2$ )	23.0 ( $\pm$ 3.8)	20.8 ( $\pm$ 5.9)	19.9 ( $\pm$ 3.2)	0.032
Levator hiatus area at maximum contraction ( $\text{cm}^2$ )	15.6 ( $\pm$ 3.7)	14.4 ( $\pm$ 2.9)	13.5 ( $\pm$ 2.4)	NS
LAM area ( $\text{cm}^2$ )	9.5 ( $\pm$ 1.6)	8.9 ( $\pm$ 1.7)	9.6 ( $\pm$ 2.3)	NS
Right puborectal muscle thickness (mm)	10.6 ( $\pm$ 1.7)	10.9 ( $\pm$ 1.7)	12.2 ( $\pm$ 0.8)	0.01
Left puborectal muscle thickness (mm)	9.2 ( $\pm$ 1.4)	9.6 ( $\pm$ 1.6)	11.0 ( $\pm$ 1.1)	0.003

NS: Not statistically significant

of patients had a vacuum delivery, 11.1% a forceps delivery and 11.1% a spatulas delivery, while in the control group vacuum and forceps deliveries were 46.2% and 53.8%, respectively. There were 5/9 (55.6%) cases of unilateral avulsions in the experimental group and 14/26 (53.8%) in the control group. Bilateral avulsions were present in 4/9 (44.4%) cases in the experimental group and 12/26 (46.2%) in the control group. In both study groups, all the avulsions were identified in every ultrasound assessment performed throughout the study.

Levator hiatus and LAM measurements taken from patients in the experimental group are listed in table 2. As can be seen, levator hiatus area progressively reduces throughout the treatment period (at 3, 6 and 9 months postpartum) at rest, during Valsalva and at maximum contraction. No difference was identified in the LAM area between the ultrasound examinations performed to the patients in the experimental group ( $9.5 \pm 1.6 \text{ cm}^2$ ,  $8.9 \pm 1.7 \text{ cm}^2$ ,  $9.6 \pm 2.3 \text{ cm}^2$ ). However, an increase in the muscle thickness of both puborectal muscles was appreciated throughout the treatment period.

Levator hiatus and LAM measurements taken from patients in the control group are presented in Table 3. There were no statistically significant differences in the measurements taken throughout the study for the patients in the control group.

In comparison with the control group, patients in the experimental group presented a reduction of the levator hiatus area at rest (Figure 2-A), during Valsalva (Figure 2-B) and at maximum contraction (Figure 2-C). However, no changes in the LAM area was identified in any of the study groups throughout the study (Figure 2-D).

## Discussion

The importance of the vaginal delivery and its impact on the pelvic floor muscles comes from the increase it causes in the levator hiatus. This increase is particularly relevant when an avulsion of the levator ani muscle occurs (level of evidence II) [1]. During the postpartum period, women suffering from LAM avulsion present changes in LAM function, altering its passive properties, such as its strength, contraction speed and resistance [18]. These alterations have

also been described in women with urinary incontinence and pelvic organs prolapse [19-21]. In order to manage this sort of injuries after delivery, there have been attempts at postnatal surgical repair, which have proven uneffective [15]. Hence, some authors determine that pelvic floor physiotherapy should be the first-line of non-invasive treatment in patients with LAM avulsion, focusing the research efforts on describing whether or not women affected could improve by LAM training [18]. Our data revealed that intensive postpartum physiotherapy treatment, when directed and supervised by an expert physiotherapist, reduces the levator hiatus area at rest, during Valsalva and at maximum contraction, in patients diagnosed with LAM avulsion.

Training the pelvic floor muscles is an effective method to increase their contractibility in pregnant women and after childbirth, improving urinary symptoms [22]. When physiotherapy is applied during the postpartum period, it contributes to improving pelvic floor function, muscle strength and global quality of life, leading to higher patient satisfaction rates [23, 24]. These changes can be attributed to the hypertrophy of the LAM, which causes a readjustment of pelvic floor structures, elevating the bladder and rectum at rest, and the shrinking of the hiatus during maximum Valsalva [25].

These modifications could be due to changes in collagen, muscle tissue, and other morphological adaptations achieved by muscle training [26]. In our work, intensive physiotherapy has led to an increase in the thickness of both puborectal muscles in comparison with women who did not receive this treatment. However, and despite the increase appreciated in the thickness of both puborectal muscles in the rehabilitated patients (Table 2), no changes were identified in the LAM area throughout the study (Figure 2D, Figure 3).

This can be explained by understanding the shortening effect of physiotherapy on the musculature, thus, the muscle area remains constant despite the increase in thickness. However, the effectiveness of the different rehabilitation protocols is variable [27]. Therefore, future research should focus on evaluating the different physiotherapy protocols available for the improvement of pelvic floor muscles after LAM avulsion.

Studies on the effectiveness of physiotherapy treatment

Table 3. — Levator hiatus area and LAM measurements in the control group (n:26).

	Media ( ± DT) or %			P
	3 month postpartum	6 months postpartum	9 months postpartum	
Levator hiatus area at rest (cm <sup>2</sup> )	17.4 ( ± 4.5 )	17.2 ( ± 4.3)	16.8 ( ± 4.2)	NS
Levator hiatus area during Valsalva (cm <sup>2</sup> )	21.0 ( ± 5.2)	20.8 ( ± 5.2)	20.3 ( ± 4.9)	< 0.0005
Levator hiatus area at maximum contraction (cm <sup>2</sup> )	16.6 ( ± 4.9)	16.1 ( ± 4.8)	15.6 ( ± 4.7)	< 0.0005
LAM area (cm <sup>2</sup> )	8.9 ( ± 2.8 )	9.0 ( ± 2.7)	9.2 ( ± 2.7)	< 0.0005
Right puborectal muscle thickness (mm)	11.1 ( ± 2.2)	11.2 ( ± 2.2)	11.3 ( ± 2.2)	0.004
Left puborectal muscle thickness (mm)	9.3 ( ± 2.4 )	9.6 ( ± 2.3)	9.9 ( ± 2.1)	< 0.0005

NS: Not statistically significant

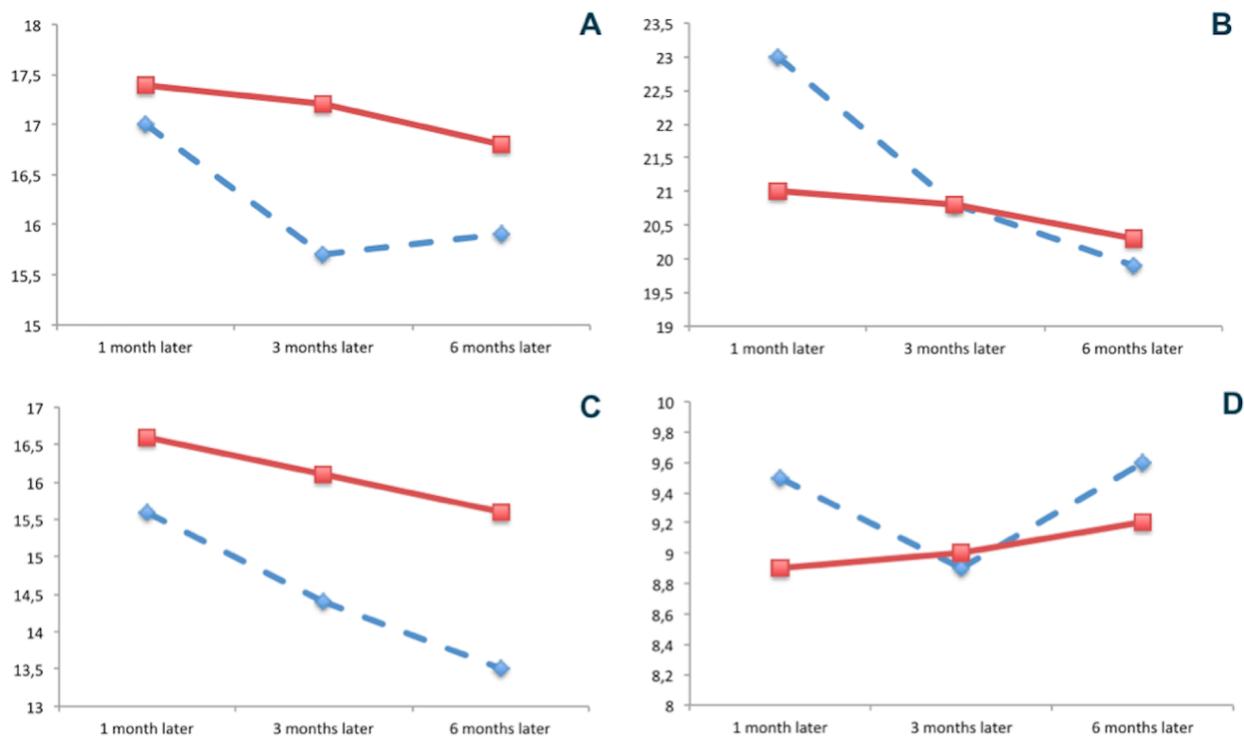


Figure 2. — The continuous lines represent the non-rehabilitated patients while the discontinuous lines represent the rehabilitated patients. The figure shows the levator hiatus area at rest (cm<sup>2</sup>) (A), levator hiatus area during Valsalva (cm<sup>2</sup>) (B), levator hiatus area at maximum contraction (cm<sup>2</sup>) (C) and LAM area (cm<sup>2</sup>) (D).

in cases of pelvic floor dysfunction are highly variable. Some authors suggest that rehabilitation programs are not effective in patients with pelvic organs prolapse, with or without postpartum LAM injuries [28]. However, other authors describe a significant improvement in symptoms after LAM training [29]. Brækken *et al.* [25] found that supervised pelvic floor rehabilitation can increase muscle volume, closing the levator hiatus and shortening the muscle length, thereby achieving an elevation of the bladder and rectum at rest (level of evidence: I). The findings of Brækken *et al.* [25] are consistent with those described in our work in patients with LAM avulsion.

One of the main strengths of our study is the fact that the sonographer performing the assessments, was blinded to the

study group (experimental versus control) that the patient belonged to. In addition, the physiotherapy protocol was applied very strictly, therefore only the patients who had completed the entire rehabilitation cycle were included in the study. The main limitation of our study is its small sample size, since there were a high number of patients in the experimental group that did not complete the physiotherapy treatment. The reasons for dropping out of the study were: lack of access to childcare during the physiotherapy sessions (9 patients), difficulties to attend rehabilitation sessions (5 patients), need to return to work (1 patient) and the patient's lack of faith in the usefulness of the treatment (2 patients). We recommend increasing the sample size for future works in order to accurately determine the level of im-

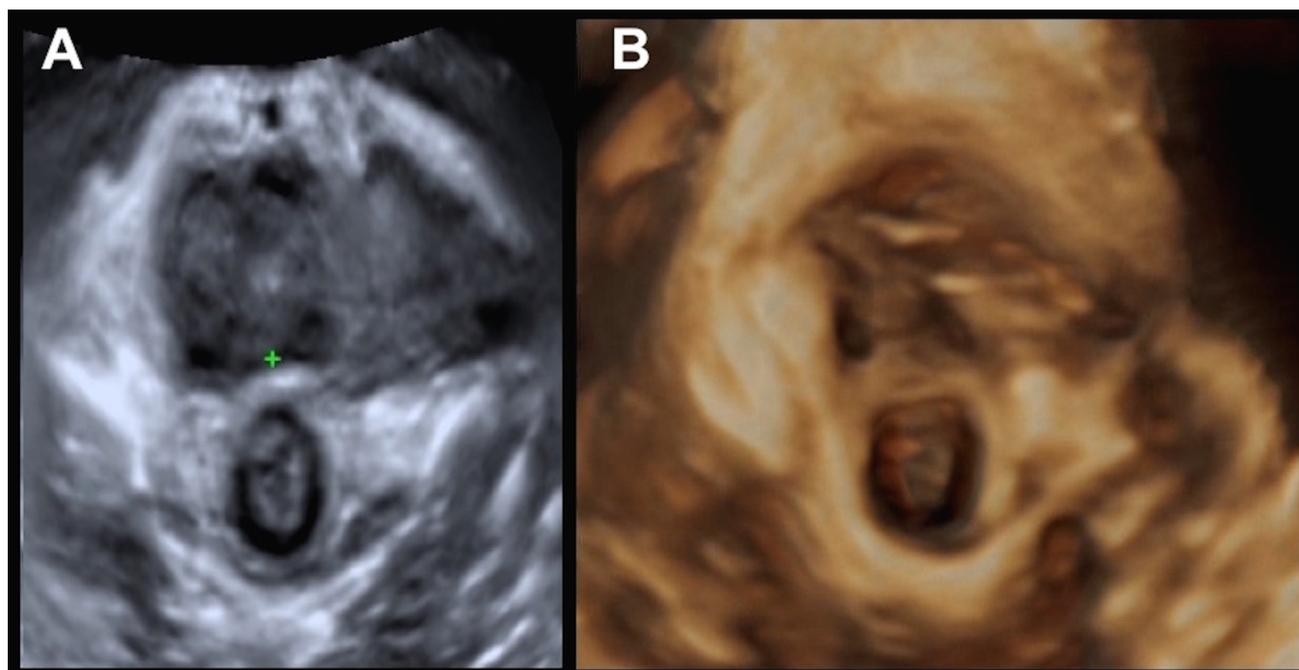


Figure 3. — The levator ani muscle area. (A). The levator ani muscle area of the non-rehabilitated patients. (B). The levator ani muscle area of the rehabilitated patients.

provement accomplished with physiotherapy treatment after delivery in women with LAM avulsion. Therefore, we believe that future research on the effectiveness of pelvic floor rehabilitation programs should be carried out, taking into account women's personal circumstances after delivery.

We conclude that intensive pelvic floor physiotherapy treatment applied to patients with levator ani muscle avulsion reduces the levator hiatus area at rest, during Valsalva and at maximum contraction.

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#### Conflict of Interest

The authors declare no competing interests.

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## Corresponding Author:

JOSÉ ANTONIO GARCÍA MEJIDO, M.D.

Department of Obstetrics and Gynaecology

Valme University Hospital, Seville

Carretera de Cádiz S/N.

Hospital Universitario Valme. Sevilla (Spain)

e-mail: jagmejido@hotmail.com