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CASE REPORT

Hypopressive abdominal gymnastics protocol in postpartum women after cesarean section in the remote period: Preliminary case series

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Abstract

Background: The postpartum period is pronounced by important changes to return to the pre-pregnancy situation. During pregnancy, the recumbent muscles of the abdomen suffer withdrawal, characterizing diastasis of the rectus abdominis muscles (DRAM), and this condition may remain pathological postpartum. Hypopressive abdominal gymnastics (HAG) has a beneficial role in activating the abdominal muscles, presenting positive results in reducing DRAM. **Objective:** To describe the effect of a HAG protocol in postpartum women undergoing cesarean section in the remote period, comparing the inter-rectum distance (IRD) and abdominal circumference before and after applying the protocol. **Methods:** Case series quasi-experimental character involving participants had their IRD assessed using a portable ultrasound machine with a linear transducer and abdominal circumference measured using a flexible measuring tape. They received a HAG protocol, with nine postures, for three weeks, twice a week, totaling six sessions lasting 45 to 60 minutes each. After intervention, all participants were reevaluated using the same methods. **Results:** Four postpartum women participated. The largest point before intervention was the umbilical at rest. Both supraumbilical points analyzed obtained greater results in reducing IRD. Participant 001 achieved the greatest reduction in IRD after the protocol, as she had higher IRD values during evaluation, in addition to a high body mass index (BMI) and a largest measurement of abdominal circumference. The measurement of abdominal circumference showed a change after HAG, reaching a reduction of 10 cm in one of the participants. **Conclusion:** This case series demonstrated positive results from the practice of HAG in reducing RAD, mainly supra-umbilical, and also in reducing abdominal circumference. Participants with higher BMI and waist circumference showed greater reductions in IRD.

Keywords: Postpartum period; rectus abdominis; cesarean section; waist circumference.

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BACKGROUND

The puerperal period begins after the expulsion of the placenta and its post-pregnancy annexes, being marked by important bodily and psychological changes to return to the pre-pregnancy situation. This period is divided into three stages, the immediate postpartum, which begins on the 1st day after birth and continues to the 10th day; the late postpartum period, from the 11th to the 45th postpartum period; and remote postpartum, which continues beyond the 45th day[1].

With the constant growth of the fetus during the gestational period, added to the displacement of abdominal organs and hormonal changes (relaxin, progesterone, and estrogen) that modify the elasticity of the connective tissue, the abdominal wall suffers stretching of its muscles, which may result in the separation of the bundles of the rectus abdominis muscles, characterizing a condition of diastasis of the rectus abdominis muscles (DRAM)[2]. Varying estimates of the incidence of DRAM have been reported from 66% to 100% during the third trimester of pregnancy, up to 53% immediately after delivery, and 36% in the remote period[3].

DRAM is relatively common, and its natural resolution occurs between one and eight days after birth. However, this condition may persist in a pathological form, and one of the factors that predisposes it is the cesarean section[3]. Although there is still no consensus regarding the cutoff point to diagnose this condition, it is considered that a separation of both medial borders of the muscles greater than two centimeters should be considered pathological[4]. This increase in inter-rectus distance (IRD) can weaken the muscles of the abdominal wall, influencing the effectiveness of its functions[5]. Looking for exercises for the treatment of DRAM, a systematic review with meta-analysis published by Gluppe, Engh, and Bø (2021) concludes that the results are still contradictory, with there not being enough evidence to recommend any specific physiotherapeutic exercise program for this purpose[6].

There is also a correlation between pelvic floor dysfunctions and DRAM; the higher the IRD, the greater the reduction in strength of the pelvic floor muscles (PFM)[7]. The reduction in the effectiveness of PFM associated with changes in the abdominal wall occurs due to the synergism and co-contraction of these muscle groups[8]. Therefore, DRAM may be a risk factor for the development of fecal incontinence, urinary incontinence strain, and pelvic organ prolapse[7].

In the early 1980s, hypopressive abdominal gymnastics (HAG) became popular in Europe; created by Marcel Caufriez with the intention of toning the abdominal muscles in the postpartum period, taking into account the damage that kinesiotherapy and intense physical exercise cause to the female pelvic floor (PF)[9]. This is a postural and systemic method that, through the activation of different muscle groups and respiratory control, promotes relaxation of the diaphragm and a decrease in intra-abdominal pressure (IAP), which, by reflex, tones the abdominal muscles and AP without overload[10]. Studies suggest that a HAG program has a beneficial role in improving postural control[11] and activation of the transversus abdominis, internal oblique, external oblique, rectus abdominis, and PFM in different postures[12], thus presenting positive results for the reduction of DRAM, mainly supra-umbilical, and these changes can remain for a period of up to two months[13].

In view of the above, in view of the scarcity of studies relating HAG with the remote postpartum period, added to the fact that DRAM brings physical and emotional impacts to women who have undergone pregnancy, the need to search for new interventions is revealed. in this area. The present study, therefore, aimed to describe the effect of a HAG protocol in postpartum women undergoing cesarean delivery in the remote period, comparing IRD and abdominal circumference before and after the application of the protocol.

METHODS

This is a series of cases with a quasi-experimental character, bringing preliminary data from a larger study entitled "Hypopressive abdominal gymnastics protocol for reducing diastasis of the rectus abdominis muscles in postpartum women undergoing cesarean section in the remote period". The study was approved by the Human Research Ethics Committee (CEP) of the State University of Santa Catarina (UDESC), under opinion no. 5.830.512 (CAAE 65609322.1.0000.0118). The study was submitted and included in the Brazilian Clinical Trials Registry (ReBEC) under number RBR-4vhnyr9. The inclusion criteria were women aged eighteen years or over, with a cesarean section, primiparous, between 45 days and 12 months postpartum with a single pregnancy, and who performed the hypopressive maneuver effectively. Women who were undergoing pregnancy, who had neurological or autoimmune tissue disorders, contraindications for HAG (cardiorespiratory disease, systemic arterial hypertension, cancer, vasovagal disorders), who had performed HAG in the last two years, who were undergoing any intense physical exercise during the data collection period, and who were undergoing physiotherapeutic treatment for postpartum monitoring of abdominal dysfunction.

For recruitment, publicity was carried out through social media, and from then on, women who were interested in participating in the study contacted the project team to schedule a time based on availability. Data collection took place in the Biomechanics Laboratory of the Center for Health and Sports Sciences (CEFID) at UDESC. In the first contact with the participant, all the procedures and stages of the research were explained, and the Informed Consent Form was then handed over, read, and signed for consent to participate. Afterward, the participants were evaluated individually, using the evaluation form (FIGURE 1), containing questions regarding sociodemographic, obstetric, and gynecological information and fields for recording the physical examination. A flexible measuring tape, 150 centimeters long x 2 centimeters wide[14], with an accuracy of 0.1 cm, was used to measure abdominal circumference and was positioned halfway between the lower rib and the upper edge of the ridge. The Iliac was measured after exhalation in tidal volume[15].

Puerperium Physiotherapeutic Assessment Form

Assessment Date:_____/ _____/ _____ ID:_____

PERSONAL DATA

Full name:_____

Age: _____ Years Birth: _____/ _____/ _____

Addres:_____Nº:_____

Complement:_____Neighborhood:_____City:_____

Telefone: ( ) _____

Email:_____

Skin color: ( ) White ( ) Black ( ) Brown

Marital status: ( ) Married ( ) Divorced or legally separated ( ) Divorced ( ) Single ( ) Widow

Education: ( ) incomplete primary education ( ) complete primary education ( ) incomplete secondary education ( ) complete secondary education ( ) incomplete higher education ( ) complete higher education

Occupation: ( ) With a signed work permit ( ) Military and statutory civil servants ( ) Other without a signed work permit

Postpartum time:_____months Place of birth:_

CLINICAL HISTORY - HISTORY

Pregnancy History:

Medications during pregnancy:_____

Did you undergo prenatal care and when did you start:_____

Complications during pregnancy:_____

Obstetric and Gynecological History:

Previous abortion:_____

Gestational age:_____

Delivery route:_____

Active labor time: _____

Birth complications:_____

Postpartum complications (bleeding, puerperal infection, abdominal pain caused by cesarean section or episiotomy pain, deep vein thrombosis, embolisms, cesarean scar)? _____

Breastfeeding: ( )Yes ( )No

How much time:_____

Lactation problems: ( )Yes ( ) No Which:_____

Do you use hormonal contraceptives? ( )Yes No

If yes, which type? ( ) Oral ( ) Injectable

PHYSICAL EXAM:

Body mass: _____Kg Height:_____cm BMI: _____Kg/m2

Waist circumference: _____cm

Figure 1. Puerperium Physiotherapeutic Assessment Form

Subsequently, using a portable ultrasound machine with a linear transducer LOGIQTM Ultrasound V2 (General Electric Company - GE HEALTHCARE®, USA), the IRD was assessed by an experienced physiotherapist, demarcating four measurement locations: at the upperumbilical edge, ¼ and ½ of the distance from the upper umbilical edge to the xiphoid process; and ¼ of the distance from the umbilical edge to the pubis. To do this, the participant was laid on the stretcher in a prone position, with her head elevated 15°, with knees flexed at 90°, feet supported, and arms at her sides[16]. The conductive gel used during IRD measurements and the transducer were placed transversally at each marked point. An image was captured at each measurement point in three situations: rest, when flexing the trunk during exhalation until the lower edges of the scapula donot touch the stretcher[17,18], and during PF contraction (FIGURE 2).

Diastasis of the rectus abdominis muscles by ultra sound measurements	Rest	Forward trunk flexion	Pelvic floor contraction
AU1 half the superior umbilical edge-xiphoid distance	_____ cm	_____ cm	_____ cm
AU2 a quarter of the superior umbilical edge-xiphoid distance (most proximal to the umbilicus)	_____ cm	_____ cm	_____ cm
U upper umbilical edge	_____ cm	_____ cm	_____ cm
BU a quarter of the superior umbilical edge-pubis distance (most proximal to the navel	_____ cm	_____ cm	_____ cm
Pelvic floor ultra sound measurements			
	Rest	Contraction	
Anteroposterior diameter	_____ cm	_____ cm	

Figure 2. Diastasis of the rectus abdominis muscles by ultra sound measurements

Prior to commencing the protocol, a crucial step was the assessment of the diaphragmatic muscles through palpation, categorizing them as normotonic, hypotonic, or hypertonic. Additionally, a postural assessment was conducted, utilizing the AI Posture Evaluation and Correction System (APECS) software. This comprehensive evaluation, including the participant's stance in anterior, posterior, lateral views, and trunk flexion, was essential due to the regulations set by the hypopressive method adopted.

The intervention was conducted by a physiotherapist with experience implementing the hypopressive method and applied in a group at the CEFID/UDESC Biomechanics Laboratory. The protocol used was adapted from the Hypopressive Methodology (HM) by Janaína Cintas (2022) for the study. The participants underwent the intervention lasting three weeks, twice a week, totaling six sessions lasting 45 to 60 minutes each. The first session was for assessments and familiarization with the technique, focused on learning breathing techniques and oriented on the positioning and activations necessary for the proper execution of the postures, including keeping the eyes open, distance between the feet, activated feet moved forward , anteriorization of the body, neutral neck and spine, arms along the body and activation of the serratus and rhomboids. The complete progression from hypopressive postures (standing to supine) was carried out in the last sessions. Before the start of each session, the muscle series were released (if the following muscles were tense, manual release was performed: internal and external intercostals, scalenes, upper fibers of the trapezius and sternocleidomastoid).

The intervention involved a total of nine postures, each serving a specific purpose. These included exercises in orthostatic posture with support, orthostatic posture without support, squatting, kneeling, four supports, three supports, sitting, and supine position (SP) (FIGURE 3). Each session consisted of three postures, maintained for a total of 20

minutes. The physiotherapist facilitated the sessions, adjusting body positioning and use of upper limbs (UL) as needed (FIGURE 4). For each posture, three series were performed (3 x 3 respiratory cycles with expiratory apnea at the end of each cycle + abdominal suction after the third apnea). Then, during the third suction, the posture was changed (FIGURE 5). Through the diaphragmatic assessment, the participants were instructed whether they would need to perform suction or not during the passages of respiratory cycles, since only hypertonic diaphragms should do so, according to the regulations of the method adopted, and it was explained that they would all perform this maneuver during the change of posture. The breathing rhythm and exercises were constantly guided by the responsible physiotherapist, who supervised the correct execution. It should be noted that if the participant had any symptoms of fatigue or wanted to stop the exercise, she could notify the physiotherapist who was conducting it. In the last session, right after the intervention, the reassessment used the same procedures as the initial assessment.

HYPOPRESSIVE ABDOMINAL GYMNASTICS PROTOCOL

Positioning and activations

Before beginning hypopressive abdominal gymnastics (HAG) practice, some technical fundamentals must be followed:

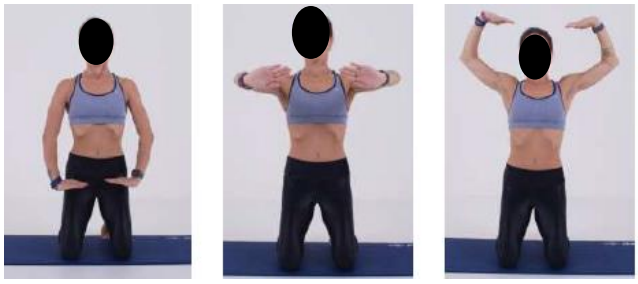
- Eyes open
- Distance between feet (barefoot and without socks): one hand flat or one foot across
- Activated feet always moved forward in order to reduce the tibial tarsal angle
- Forward movement of the body without removing the heels from the floor
- Neutral neck and spine, respecting normal curvatures
- Arms along the body
- Activation of rhomboids and serratus

Execution:

The participant will be instructed to inhale in two strokes and exhale in four strokes in a fluid manner without lip brakes, respecting the pauses between the inspiratory and expiratory breaths. Apnea will occur upon exhalation and will be requested after 3 complete breathing cycles, starting with 6 to 8 seconds and progressing throughout the sessions up to 10 seconds. The progression of postures and increase in difficulty follows Figure 4.

Figure 3. Hypopressive abdominal gymnastics protocol

DEFINITION	DISPLAY
Posture 1 – Standing against the wall	

Posture 2 – Standing	
Posture 3 – Crouching	
Posture 4 - Kneeling	
Posture 5 – On all fours	
Posture 6 – On three points of contact	
Posture 7 - Sitting	

Posture 8 - Sitting	
Posture 9 – Supine	  

Figure 4. Progression of postures and increase in difficulty through the use of upper limbs

The evaluation and reevaluation data were organized in a Microsoft Excel spreadsheet, with the tabulated data kept on the researchers' computers. The analyses were carried out in a descriptive manner, presenting each participant's information regarding sociodemographic and clinical data and the variables waist circumference and IRD (in different locations and conditions), with the variables presented with values from the evaluation and after the intervention (reevaluation).

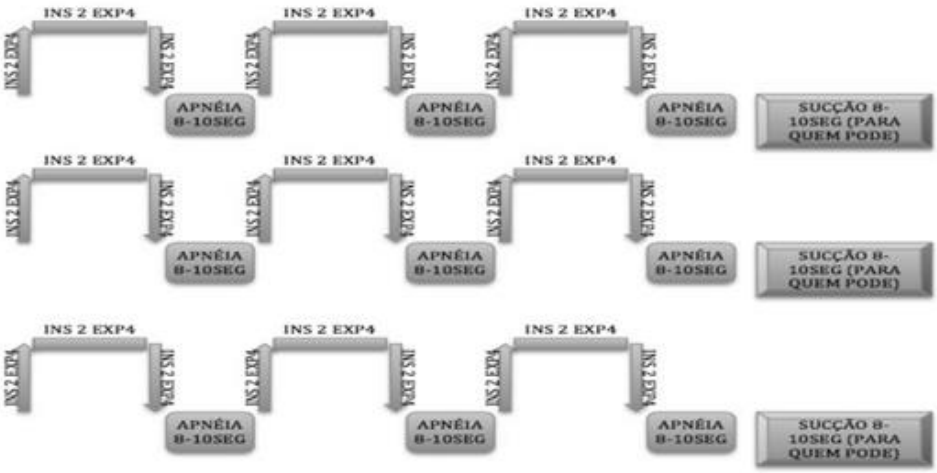


Figure 5. Execution of the MH in a posture

Source: Janaína Cintas (2022)

RESULTS

Four postpartum women participated in the study, with an average age of 29 years, aged between 23 and 35 years. The average postpartum period was five months, with postpartum women lasting three to six months. Regarding the physical examination, they presented an average mass of 72 kg and an average height of 1.65 m. In terms of activation of the diaphragm muscles, two women presented hypotonic on the right side, one hypertonic and one normotonic, and in relation to the left side, there were two participants with hypotonic condition and two with normotonic condition.

The characterization of the sample in terms of sociodemographic characteristics is described in Table 1 and in terms of clinical characteristics in Table 2, according to data obtained from the evaluation.

Table 1. Sociodemographic characteristics of the participants

Variables	01	02	03	04
Age	23	35	28	30
Skin color				
White	x	x		x
Brown			x	
Marital status				
Single	x	x		x
Married			x	
Education				
Complete high school	x			
Graduated		x	x	x
Ocupation				
With signed work card			x	x
Another without a signed work permit	x	x		

Table 2. Clinical characteristics of the participants

Variables	01	02	03	04
Mass (kg)	83	63	53	89
Height (cm)	1,60	1,69	1,60	1,72
BMI (kg/m2)	32,4	22,1	20,7	30,44
Waist circumference (cm)	106	74	75	102
Postpartum time (months)	3	6	5	6
Baby weight at birth (kg)	3,550	2,665	3,360	3,800
Right diaphragm characterization	Hypertonic	Normotonic	Hypotonic	Hypotonic
Left diaphragm characterization	Hypotonic	Hypotonic	Normotonic	Normotonic

Notes*: Kg: kilograms; cm: centimeters; BMI: body mass index.

IRD was measured at four points along the linea alba according to the images captured from the ultrasound. The point of greatest pre-intervention distance was the umbilical cord at rest, with an average of 2.43 cm. Both supra-umbilical points analyzed obtained greater results in reducing IRD, highlighting points AU1 and AU2 at rest, in which all participants obtained a reduction in the measurement. Participant 001 presented higher IRD values before the intervention, with an average of 2.88 cm, highlighting the umbilical and infra-umbilical points at the moment of trunk flexion, with 3.26 cm. This same participant was the only one in the sample to have a reduction in IRD in all points evaluated, highlighting the infra-umbilical point in trunk flexion, where there was a reduction of 1.88 cm. The IIR measurements found before and after applying the protocol are presented in Table 3.

Table 3. Characteristics of ultrasound measurements of IRD before and after application of the protocol

US measurements (cm)	01	02	03	04
IRD in AU1				
Av home	2,55	1,49	1,66	1,10
Reav rest	1,87	1,26	1,37	0,95
Diference	0,68	0,23	0,29	0,15
Fxstem av	2,59	1,42	1,90	0,93
Fxstem reav	2,33	0,85	1,09	0,93
Diference	0,26	0,57	0,81	0
AP av	2,10	1,35	1,68	0,80
AP reav	1,64	1,23	1,23	0,94
Diference	0,46	0,12	0,45	-0,14
IRD in AU2				
Rest av	2,73	2,37	2,59	1,56
Reav rest	2,34	2,13	2,36	1,49
Diference	0,39	0,24	0,23	0,07
Fxstem av	2,95	2,22	2,17	1,62
Fxstem reav	2,32	1,81	2,17	1,21
Diference	0,63	0,41	0	0,41
AP av	3,03	2,66	2,30	1,60
AP reav	2,18	1,57	2,59	1,38
Diference	0,85	1,09	-0,29	0,22
IRD in U				
Av rest	2,90	1,66	2,09	3,09
Reav rest	2,58	1,98	2,74	1,86
Diference	0,32	-0,32	-0,65	1,23
Fxstemav	3,26	1,07	2,33	2,02
Fxstem reav	2,39	1,21	2,10	1,66
Diference	0,87	-0,14	0,23	0,36
AP av	3,17	1,74	1,93	2,60
AP reav	2,52	1,83	2,32	1,43
Diference	0,65	-0,09	-0,39	1,17
IRD in BU				
Rest av	2,90	1,54	1,25	2,06
Rest reav	1,55	1,62	1,42	0,67
Diference	1,35	-0,08	-0,17	1,39
Fxstem av	3,26	1,91	1,50	1,74
Fxstem reav	1,38	1,67	1,54	1,22
Diference	1,88	0,24	-0,04	0,52
AP av	3,21	1,73	1,38	1,40
AP reav	1,44	1,76	1,62	0,97
Diference	1,77	-0,03	-0,24	0,43

Note*: AU1: half the distance between the upper umbilical edge and the xiphoid process; AU2: one quarter of the distance between the upper umbilical edge and the xiphoid process; U: upper umbilical edge; BU: one quarter of the distance between the upper umbilical edge and the pubic symphysis; IRD: inter-rectus distance; Fxtronco: trunk flexion; AP: pelvic floor; av: evaluation; reav: reevaluation

Regarding the measurement of abdominal circumference, on the day of the initial assessment, there was an average of 89.25 cm. After applying the protocol, there was a change in these measurements (average of 82.75 cm), with participant identification 004 having the greatest difference in pre- and post-intervention measurements, which was 10 cm. These data are represented in Table 4.

Table 4. Characteristics of abdominal circumference measurements before and after applying the protocol

Measurements AC (cm)	01	02	03	04
AC av	106	74	75	102
AC reav	99	70,5	69,5	92
Difference	7	3,5	5,5	10

Notes*: AC: abdominal circumference; av: evaluation; reav: reevaluation.

DISCUSION

This study's main premise was to describe the effect of a HAG protocol on postpartum women undergoing cesarean delivery in the remote period, comparing IRD and abdominal circumference before and after application of the protocol, identifying that, in general, there was a reduction IRD and abdominal circumference after the adopted protocol. According to the findings, there were higher IRD values at the umbilical (U) and supra-umbilical (SU2) levels, corroborating other studies[13], being explained by the fact that the rectus abdominis have more than one muscular belly, separated by three tendinous insertions above the umbilical scar[2]. Cesarean delivery is one of the risk factors for the development of DRAM in postpartum women, as this procedure damages the fascia and abdominal muscles, making the recovery process difficult[19]. Furthermore, the baby's higher birth weight and obesity are factors that predispose postpartum women to this condition[20].

The study by Liaw et al. (2011) brings as one of its main findings that six months after birth, the IRD and abdominal muscle function did not return to normal, reducing the force production capacity of these muscles[21], being However, the time taken for the rectus abdominis to return to its pre-pregnancy state is still a controversial issue[22]. Another study[22] also shows that twelve months after birth the incidence of DRAM is above 30%. This explains one of the reasons why umbilical and supra-umbilical points did not obtain such positive results. On the other hand, all participants showed a significant reduction in their abdominal circumference measurement after the protocol, reaching a 10 cm difference in one participant (004). Caufriez[23] states that there is a direct relationship between reducing waist circumference and abdominal muscle tone. In the study conducted by Rial et al. (2014)[24], a protocol of hypopressive exercises was performed for 20 minutes, showing immediate effects of the practice on the reduction of this measure.

Authors describe that changes in IAP lead to changes in abdominal wall tension[25], and considering that HAG reduces intra-abdominal pressures[9], they hypothesize that abdominal wall tension is reduced after the practice . These data may also be related to an improvement in the effectiveness of activating the deep abdominal muscles[26].

Participants 01 and 04 presented, in their clinical characteristics, in comparison to the other study participants, greater risk factors for the development of DRAM, including obesity and higher birth weight, in addition to cesarean delivery. Participant 001, through the initial assessment, presented a greater measurement of abdominal circumference, and, at the end of the protocol, large reductions in IRD were observed at all points and in abdominal circumference. Participant 004, in US assessment, measured lower IRD values (average of 1.71 cm) despite presenting points where there is pathological DRAM. And, at the end of the practice, the participant achieved a reduction in most points, with the exception only of the SU1 line in PF contraction, being the participant who presented the greatest reduction in abdominal circumference. In this way, the results of participants 01 and 04 can be articulated. IAP and intra-abdominal volume are increased chronically by obesity and temporarily by pregnancy[27]. With this in mind, both had a chronically altered IAP, which was corrected by the practice of HM. In this way, it may be the justification for the fact that the participants showed greater reductions in IRD at all points, in addition to important reductions in abdominal circumference. As limitations of the study, a lack of control group and an intervention group, the small sample size, and the short duration of the protocol were found, as with a greater number of sessions, better results would possibly be obtained. Therefore, further studies are suggested to prove the effectiveness of the technique for this population, in addition to correlating IRD and its reduction with the application of HAG with characteristics such as BMI and waist circumference.

CONCLUSION

This series of cases demonstrated positive results from the application of the HAG protocol to reduce DRAM, mainly supra-umbilical, and to reduce abdominal circumference in the remote postpartum period. Participants who had higher BMI and waist circumference at the beginning of the protocol showed greater reductions in IRD. In view of this, further studies are suggested to evaluate the effects of HAG on IRD with greater quality, also exploring more variables such as BMI and waist circumference, in order to scientifically support the effectiveness of this practice during the postpartum period.

Author Contributions: N.A. and M.M. contributed to the design and development of the study and data acquisition. C.K., E.P.D.M.G., J.C. and S.C.T.L. contributed to the critical review, correction and ap-proval of the final version. G.J.S.H. contributed to the elaboration of the design, development of the study, data analysis and approval of the final version.

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