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An Analysis of the Use of Ultrasonography in the Assessment of the Effects of Rectus Abdominis Muscle Separation and Rehabilitation Therapy in Postpartum Women

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Abstract: *Objective:* To explore the effect of ultrasonography in assessing the effect of rectus abdominis muscle separation and rehabilitation in postpartum women. *Methods:* 254 cases of postpartum women admitted to the hospital from January 2022 to July 2023 were selected as the study group, and 63 cases of women with rectus abdominis muscle not separated during the same period were selected as the control group, and all of them used GEDiscoveryE9 ultrasonic diagnostic instrument to compare the separation distance of rectus abdominis muscle of 3 cm above the umbilicus of the women in the two groups; and to compare the separation distance of rectus abdominis muscle of the women in the study group after treatment. *Results:* The rectus abdominis muscle separation distance of 3 cm above the umbilicus was (4.36 ± 0.87) cm in the study group and (1.88 ± 0.07) cm in the control group, and the difference between the study group and the control group was significant ($P < 0.05$); the rectus abdominis muscle separation of the study group was (3.78 ± 0.69) cm, (3.01 ± 0.69) cm and (3.01 ± 0.69) cm respectively in the 1st, 2nd, 3rd, 4th, 5th, and 6th post treatment; and the rectus abdominis muscle separation of the study group was (3.78 ± 0.69) cm, (3.01 ± 0.58) cm, (2.75 ± 0.57) cm, (2.31 ± 0.48) cm, (1.97 ± 0.36) cm, and (1.95 ± 0.44) cm, respectively, with a significant difference compared to the pre-treatment ($P < 0.05$). *Conclusion:* The optimal section for ultrasonographic detection of rectus abdominis muscle separation in the postpartum period was 3.5 cm below the umbilicus, and this section was able to effectively assess the degree of rectus abdominis muscle separation in patients.

Keywords: Ultrasonography; Rectus abdominis separation; Rehabilitation

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1. Introduction

During pregnancy, the pressure on the abdominal wall gradually increases as the foetus grows and the size of the uterus increases. In order to maintain the stability of the body's centre of gravity and protect the internal organs, muscle groups such as the abdominal muscles and diaphragm relax and decrease in contractility during pregnancy,

resulting in the abdominal organs protruding from the anterior superior part of the abdomen into the pelvic cavity; coupled with hormonal effects, adaptive changes occur in the muscles, the white line of the abdomen is stretched and thinned, and the rectus abdominis muscle spacing is increased. After caesarean section, the above phenomena can be rapidly relieved due to faster tissue repair [1]. However, some women still have diastasis recti abdominis separation 3–6 months or more after delivery, causing a series of problems such as low back pain, pelvic organ prolapse, scoliosis, and changes in physiological curvature in patients [2]. At present, the diagnostic criteria for rectus abdominis muscle separation at home and abroad are mainly to segment the midline of the abdomen with the index and middle fingers, and the distance between the two sides is ≥ 2 cm to confirm the diagnosis, which is easily affected by the subjective judgement of the doctor, and the operation is cumbersome and time-consuming, so it is difficult to promote the use of this method. In addition, the commonly used clinical ultrasonography cannot directly show the separation status and can only be used as an auxiliary means. With the development of ultrasound technology, in recent years, scholars at home and abroad have mostly used two-dimensional ultrasound, three-dimensional ultrasound or colour Doppler ultrasound to assess and diagnose maternal rectus abdominis muscle separation, and have achieved good results [3]. In this paper, a combined treatment of ultrasound with pelvic floor muscle trainer was used to evaluate 254 cases of postpartum rectus abdominis muscle separation and analyze the treatment effect, aiming at exploring the feasibility and accuracy of ultrasound evaluation of rectus abdominis muscle separation, and providing reference for clinical diagnosis and treatment.

2. Information and methodology

2.1. General information

254 cases of postpartum women admitted to the hospital from January 2022 to July 2023 were selected as the study group, and all the women were eligible for natural delivery. The ages ranged from 23 to 40 years old, with a mean of 31.24 ± 1.36 years old; the gestational weeks were 37 to 40 weeks, with a mean of 39.51 ± 1.09 weeks; 110 cases had a bodymass index (BMI) ≥ 25 kg/m^2, and 144 cases had a body mass index (BMI) < 25 kg/m^2. In the same period, 63 cases of women with an undivided rectus abdominis muscle were used as the control group, with ages ranging from 22 to 40 years old, with a mean of 31.14 ± 1.44 years old, and gestational weeks ranging from 37 to 40 weeks, with a mean of 39.21 ± 1.01 weeks.

Inclusion criteria: (1) age between 20–40 years old; (2) singleton, full-term, vaginal delivery or cesarean section; (3) rectus abdominis muscle separation diagnosed by ultrasound with a separation distance of ≥ 2 cm; (4) subjects were aware of the purpose of the study, the methodology, and the possible risks; and (5) signed an informed consent form.

Exclusion criteria: (1) patients with pregnancy complications and co-morbidities; (2) patients with psychiatric diseases and mental disorders such as mental retardation; (3) patients who have recently undergone abdominal surgery or abdominoplasty; and (4) those suffering from severe organic lesions of the heart, liver, kidneys and lungs.

2.2. Methodology

(1) Ultrasound detection method

The GEDiscoveryE9 ultrasound diagnostic instrument was used, with a probe frequency of 3.5 MHz. Before the detection, the patient was asked to relax the muscles of the abdominal wall and lie on the examination bed in a supine position; the inspector held the probe in his right hand on the abdominal

wall and lifted it immediately after a few seconds of pressure, and at the same time, the patient was asked to cooperate with the head-up and abdominal movements to ensure that the abdomen was filled up and full. Observe whether the rectus abdominis muscle is separated, record the separation distance if there is obvious separation, and mark the location and size of the separation in the two-dimensional image, which is divided into six levels: no separation; type I separation (1 cm ≤ separation < 3 cm); type II separation (3 cm ≤ separation < 6 cm); type III separation (6 cm ≤ separation < 8 cm); type IV separation (8 cm ≤ separation ≥ 10 cm); Type V separation (≥ 10 cm). Starting from the 10^{th} postpartum day to the end of the 6^{th} postpartum month, a total of 6 times, each with an interval of more than 7 days. All ultrasound results were done by the same doctor in the same time period to ensure data consistency.

(2) Treatment

Firstly, maintain correct standing, sitting and lying postures, avoid bending and increasing abdominal pressure; if an umbilical hernia occurs, you can use air mattress bed or lumbar support. Secondly, eat more high-quality protein food, reduce high-calorie food intake, eat more vegetables and fruits and coarse grains to increase intestinal peristalsis to promote defecation; it is recommended to take the principle of eating less and more frequent meals, while paying attention to nutritional balance, eating less and more frequent meals, and supplementing high-quality protein, vitamins, dietary fibre and other nutrients appropriately, on top of ensuring the energy required by the body, to promote wound healing and recovery. Then, sufficient rest, especially 1 week after delivery, should be bed rest. Then, start walking exercise till the next day, when there is no obvious pain in the abdomen can carry out some simple abdominal muscle exercise, step by step.

(A) Pelvic floor muscle training: Take the supine position, legs bent at the knees and separated from the hip the same width, hands behind the head to support the trunk and buttocks, eyes flat at the ceiling, slowly contract the buttocks and inner thigh muscles upward to lift the anus, lasting 5–6 seconds, and then relax for 5 to 6 seconds. Do 10 times in a row for a group, do 3–5 groups per day, and the interval between each group is not less than 2 minutes.

(B) Abdominal breathing: Inhalation when the abdomen is inflated, exhalation of the abdominal wall ring jump point down to the pubic bone joint, each time to adhere to 15–30 seconds, every day to practice 2–3 times.

(3) Herbal medicine external treatment

Chinese medicines (astragalus, angelica, chuanxiong) with the effect of activating blood circulation and removing blood stasis, tonifying the liver and kidney can be selected and made into medicinal powder, and cotton swabs dipped in the medicinal powder can be applied to the umbilicus and the painful parts of the abdomen twice a day.

2.3. Observation indicators

To compare the rectus abdominis muscle separation distance of 3 cm above the umbilicus between the two groups, and to compare the rectus abdominis muscle separation distance after treatment in the study group.

2.4. Statistical methods

SPSS 23.0 software was applied for statistical analysis, the measurement information was expressed as mean ± standard deviation (SD), and *t*-test was used for comparison, and the count information was expressed as rate (%), and χ^2 test was used for comparison, and $P < 0.05$ was considered as statistically significant difference.

3. Results

3.1. Distance of rectus abdominis muscle separation 3 cm above the umbilicus in both groups

The separation distance of rectus abdominis muscle 3 cm above the umbilicus was (4.36 ± 0.87) cm in the study group of women and (1.88 ± 0.07) cm in the control group of women, and the difference between the study group and the control group was significant ($P < 0.05$), as shown in **Table 1**.

Table 1. The separation distance of the rectus abdominis muscle 3 cm above the umbilicus in both groups of women

Groups	Number of examples	Rectus abdominis muscle separation distance (cm)
Study group	254	4.36 ± 0.87
Control group	63	1.88 ± 0.07
t		22.581
P		0.000

3.2. Distance of rectus abdominis muscle separation in the study group after maternal treatment

The 1st, 2nd, 3rd, 4th, 5th and 6th rectus abdominis muscle separations of the study mothers after treatment were (3.78 ± 0.69) cm, (3.01 ± 0.58) cm, (2.75 ± 0.57) cm, (2.31 ± 0.48) cm, (1.97 ± 0.36) cm, (1.95 ± 0.44) cm, respectively, which were compared with those before treatment. The difference was significant ($P < 0.05$), as shown in **Table 2**.

Table 2. Distance of rectus abdominis muscle separation in the study group after maternal treatment

Groups	1st	2nd	3rd	4th	5th	6th
Before treatment (*n* = 254)	4.36 ± 0.87	4.36 ± 0.87	4.36 ± 0.87	4.36 ± 0.87	4.36 ± 0.87	4.36 ± 0.87
Post-treatment (*n* = 254)	3.78 ± 0.69	3.01 ± 0.58	2.75 ± 0.57	2.31 ± 0.48	1.97 ± 0.36	1.95 ± 0.44
t	8.325	20.577	24.670	32.881	40.455	39.397
P	0.000	0.000	0.000	0.000	0.000	0.000

4. Discussion

Separation of the rectus abdominis muscle refers to the separation of the rectus abdominis muscle due to the gradual enlargement of the uterus during pregnancy, which forces the rectus abdominis muscle on both sides of the abdominal wall to shift towards the midline. In recent years, with the improvement of social living standards and the influence of factors such as the delay in the age of women's childbearing, the phenomenon of rectus abdominis muscle separation after childbirth has been increasing. Relevant studies have shown that the incidence of rectus abdominis muscle separation in postpartum women is 45–80% and increases with the number of deliveries (9.6%), and one-third of these separated patients require surgical treatment [4]. In addition, some scholars have found that the degree of rectus abdominis muscle separation is closely related to low back pain and fatigue symptoms, which can affect daily activities and even induce psychological problems such as depression and anxiety in severe cases in Chinese mothers [5]. At present, clinicians' diagnosis of postpartum rectus abdominis separation is mainly judged by asking about medical history, physical examination and imaging examination. Before the popularity of

ultrasound instruments, there was a "gold standard" in traditional medicine-rectal manometry to assess the degree of diastasis recti, which calculates the change in the volume of abdominal organs by measuring the difference in abdominal pressure to estimate the degree of diastasis recti. However, this method is complicated and prone to errors, which is not conducive to the timely judgment of maternal condition. Ultrasound, as a non-invasive, rapid and accurate medical imaging technology, has been widely used in the diagnosis of abdominal diseases. Studies have shown that ultrasonography can not only accurately display the contours of abdominal organs and their movements, but also observe the dynamic changes of the uterus, ovaries and other pelvic organs in real time [5]. Therefore, ultrasound technology also plays an important role in the diagnosis of postpartum rectus abdominis separation. Rectus abdominis muscle separation refers to the phenomenon in which the tissue between the rectus abdominis muscles separates from the abdominal white line to the sides. Normally, women will gradually recover on their own within 6 months after delivery, but some women still have diastasis recti abdominis separation 3 years or even more than 10 years after delivery, which has a greater impact on the patient's daily life [6,7].

The results of the study showed that the separation distance of the rectus abdominis muscle at 3 cm above the umbilicus was significantly greater in the study group than in the control group ($P < 0.05$), which is consistent with the results of related studies at home and abroad [8,9]. Ultrasonography can clearly show the morphology, thickness and separation distance of the rectus abdominis muscle, providing an objective and accurate basis for clinical diagnosis. Secondly, this study confirms the effectiveness of rehabilitation therapy on postpartum rectus abdominis muscle separation. In the study group, the separation distance of the rectus abdominis muscle was gradually reduced after the rehabilitation treatment, and the difference was significant compared with that before the treatment ($P < 0.05$), which indicated that the rehabilitation treatment could effectively improve the symptoms of the separation of the rectus abdominis muscle, and promote the recovery of the function of the abdominal wall.

Separation of the rectus abdominis muscle refers to an increase in the distance between the anterior sheath of the rectus abdominis muscle and the white line of the abdomen, which can cause changes in the morphology of the abdominal muscles and result in some degree of dysfunction. The occurrence of rectus abdominis muscle separation is mainly related to the gestational week, the size of the foetus and the mother's factors. In late pregnancy, as the uterus gradually increases in size, the abdominal muscles are stretched and lengthened; in late pregnancy, under the pressure of the uterus, the abdominal muscles show passive relaxation. When a woman gives birth, the abdominal muscles have not yet returned to their original position, which leads to widening of the rectus abdominis muscle, increasing the distance between the rectus abdominis muscles. In addition, due to the heavier weight of the newborn, it also puts pressure on the abdomen, which leads to separation of the rectus abdominis muscles. Studies have shown that 25–40% of women develop diastasis recti abdominis separation postpartum and the prevalence increases with age [10]. Most scholars believe that rehabilitation within 6 weeks postpartum can help prevent or reduce the degree of diastasis recti separation [11]. In addition, the degree of diastasis recti abdominis separation may be exacerbated if the mother suffers from diabetes mellitus or hypertension.

Currently, the commonly used clinical diagnostic criteria is the method developed by the American College of Obstetricians and Gynecologists: place a finger on the navel, move it along the midline of the rectus abdominis muscle from left to right, and then observe the maximum distance between the finger and the skin surface, with a measurement interval of about 2.5 cm; if it is less than this range, it indicates the presence of rectus abdominis muscle separation; if it is greater than 2.5 cm, a further CT scan is required to confirm the diagnosis [12]. This method is simple to perform, but it cannot distinguish whether it is a separation of the external abdominal oblique muscle or not, and is prone to misdiagnosis.

Some scholars suggested other diagnostic methods. For example, the thickness of the abdominal wall is calculated based on maternal height, body fat percentage and abdominal circumference, and then the degree of rectus abdominis muscle separation is deduced based on the above formula [12]. In addition, other scholars have found by comparing the ultrasound images that there is a large difference in rectus abdominis muscle separation in mothers of different ages, and the older the woman is, the more serious the degree of rectus abdominis muscle separation is [13], both methods can effectively distinguish the type of rectus abdominis muscle separation, but the Due to the more complicated calculation process, it is not favourable for generalization.

In recent years, ultrasound technology has been widely used in the diagnosis of rectus abdominis separation. Among them, the three-point, five-point, and seven-point methods are currently the most common clinical measurements [14,15]. The three-point method uses the hand placed on the upper edge of the umbilicus, the index and middle fingers placed on the lower edge of the umbilicus, and the two fingers separated horizontally around the umbilicus for one week, obtaining three intersections, and then measuring the vertical distances of these three intersections, respectively, and calculating the degree of rectus abdominis separation according to the formula. The five-point method is to take the navel as the centre, respectively, 3 cm above and below the navel by touching with the fingers, looking for five checkpoints, measuring the vertical distance between these points, and calculating the degree of rectus abdominis separation according to the formula [16].

5. Conclusion

In conclusion, the optimal view for ultrasound detection of rectus abdominis muscle separation in the postpartum period is 3.5 cm below the umbilicus, and this view is effective in assessing the degree of rectus abdominis muscle separation in patients. When self-testing the presence of abdominal wall muscle separation, it should be noted that the thumb is placed above the umbilicus (about 2–3 cm above the pubic symphysis), and the index, middle and ring fingers are pressed below the umbilicus and pushed in the direction of the spine, and the width of their contact with the skin surface is observed, which is the degree of abdominal wall muscle separation. After delivery, due to pelvic congestion, uterine contraction, and breastfeeding, some mothers will experience different degrees of rectus abdominis muscle separation, but with the extension of time, most of the mothers can gradually recover. If the separation of the rectus abdominis muscle is still obvious within 6 months after delivery, it is recommended to go to the hospital for timely consultation and professional and systematic rehabilitation treatment to reduce or avoid the adverse consequences. For the multilayer spiral CT and MRI examination methods commonly used in clinical work, there are certain limitations due to the need for multiple scans. Ultrasound, as a simple and easy non-invasive means of examination, has the advantages of easy operation and low cost, and is of great significance to clinical diagnosis and treatment.

Disclosure statement

The authors declare no conflict of interest.

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