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## Ocena czynników wpływających na skuteczność terapii integracji sensorycznej u dzieci w wieku przedszkolnym i wczesnoszkolnym

## Assessment of factors influencing the effectiveness of sensory integration therapy in preschool and early school-aged children

**Praca fizjoterapeuty z osobami niepełnosprawnymi intelektualnie**

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- BIOMATERIAŁY WE WSPÓŁCZESNEJ MEDYCYNIE I STOMATOLOGII;
- ZABURZENIA CZYNNOŚCIOWE UKŁADU RUCHOWEGO NARZĄDU ŻUCIA;
- BIOMECHANIKA UKŁADU RUCHOWEGO I STOMATOGNATYCZNEGO;ORTOPODOLOGIA;
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# Stretching of the anterior fascial tape in women after a caesarean section

*Rozciąganie przedniej taśmy powięziowej u kobiet po cesarskim cięciu*

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## Abstract

Introduction. The cesarean section rate in the 21st century has significantly increased compared to the previous century. Consequences related to the existence of a scar after a cesarean section may contribute to various discomforts in the abdominal, back, or pelvic regions.

Aim of the study. The research hypothesis posited that the application of stretching therapy of the anterior fascial band has an impact on and is associated with the scar texture after a cesarean section.

Study materials and methodology. Eight women, 3-4 months postpartum, with an average age of 27.5 ± 4.17 years, participated in the study. The MyotonPro device was utilized to assess the biomechanical properties of the tissue around the scar. The women performed stretching exercises for 2 months, twice a week. One session per week was supervised by the researcher, and during the other session, participants performed the assigned exercises independently. Measurements with the MyotonPro device were repeated after 8 weeks.

Results. A strong and positive correlation was observed between: cs_2 and cs_1 r = 0.88, cs_2 and ls_1 r = 0.96, cs_2 and rs_1 r = 0.82, ls_2 and ls_1 r = 0.97, rs_2 and rs_1 r = 0.96.

Conclusions. Engaging in stretching exercises has a positive impact on improving the texture of scar tissue.

## Keywords

cesarean section, stretching exercises, anterior fascial tape, MyotonPro

## Streszczenie

Wstęp. W XXI wieku odsetek porodów przez cesarskie cięcie znacznie wzrósł w porównaniu z poprzednim stuleciem. Konsekwencje związane z obecnością blizny po cesarskim cięciu mogą przyczyniać się do różnych dolegliwości w obrębie brzucha, pleców lub miednicy.

Cel badania. Hipoteza badawcza zakładała, że zastosowanie terapii rozciągającej przednią taśmę powięziową ma wpływ i jest związane z teksturą blizny po cesarskim cięciu.

Materiały i metodyka badania. W badaniu wzięło udział osiem kobiet, 3-4 miesiące po porodzie, ze średnią wieku 27,5 ± 4,17 lat. Urządzenie MyotonPro zostało wykorzystane do oceny biomechanicznych właściwości tkanki wokół blizny. Kobiety wykonywały ćwiczenia rozciągające przez 2 miesiące, dwa razy w tygodniu. Jedna sesja w tygodniu była nadzorowana przez badacza, a podczas drugiej sesji uczestniczki wykonywały przydzielone ćwiczenia samodzielnie. Pomiar za pomocą urządzenia MyotonPro został powtórzony po 8 tygodniach.

Wyniki. Zaobserwowano silną i pozytywną korelację między: cs_2 a cs_1 r = 0,88, cs_2 a ls_1 r = 0,96, cs_2 a rs_1 r = 0,82, ls_2 a ls_1 r = 0,97, rs_2 a rs_1 r = 0,96.

Wnioski. Angażowanie się w ćwiczenia rozciągające ma pozytywny wpływ na poprawę tekstury tkanki bliznowatej.

## Słowa kluczowe

cesarskie cięcie, ćwiczenia rozciągające, przednia taśma powięziowa, MyotonPro


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## Introduction

The rate of performed cesarean sections is continuously increasing in Poland and other European countries [1]. The procedure involves sequentially cutting through all layers of the body, starting with the skin, then the fascia, followed by muscles, and finally, the uterus is incised. As a result of this procedure, damage occurs to the anterior fascial band, which plays a crucial role in daily activities. This band stabilizes the spine, aids maintaining proper posture and balance, and ensures physiological functions such as breathing and coughing [2]. Proper fascial function provides protection to internal organs and enables the effective functioning of abdominal muscles [2]. Patients who give birth through cesarean section show significant changes in abdominal muscle thickness and fascia compared to those who give birth naturally. Fascial damage leads to disturbances in fascial gliding and muscle deficits [3]. An inherent symptom is the sharp pain experienced by women after a cesarean section [4]. After a complete wound healing, adhesions may form [5], which can cause chronic pain following a cesarean section [6]. Other unpleasant experiences may include abdominal and pelvic adhesions, bowel obstruction, and even future infertility [1,4]. It has already been proven that effective soft tissue mobilization is a good way to manage adhesions within the scar area [7].

## Aim of the study

Before commencing the study, a research hypothesis was formulated: the applied therapy of stretching the anterior fascial band has an impact on and is related to the texture of the scar after a cesarean section.

## Material and methodology

The study involved 8 women aged 27.5 ± 4.17 years, who had undergone their first pregnancy delivered by transverse cesarean section, 3-4 months postpartum. MyotonPRO device was employed to measure the scar tissue, allowing for the assessment of biomechanical and viscoelastic properties of the skin [8], such as: resting tone, elasticity, stiffness, creep, and mechanical relaxation time [9].

Measurements were conducted both before the initiation of the prescribed, originally designed exercises for the muscle-fascial band and after ten weeks, i.e., upon completion of the exercises. Inclusion criteria for the study comprised of the post-cesarean section status and the absence of any physiotherapeutic intervention. Exclusion criteria included non-healed cesarean section incisions and previous scar therapies.

Scar tissue measurements were consistently performed by the same researcher. Prior to each measurement, the procedure was explained, and a demonstration was conducted. Measurements were taken at three locations: right edge, left edge, and the center of the scar. Over ten weeks, the women engaged in proprietary stretching exercises for the anterior muscle-fascial band. The exercises were conducted twice a week, and the women performed the following exercises:

**1. Trunk Rotation Reach**

Starting position: lying on the back, lower limbs slightly abducted, and upper limbs tilted away from torso to over 90 degrees.
Movement: reaching with one hand towards the other while lying on the side with legs apart in a lunge position and retracting the pelvis (performing posterior depression). Stretching occurs on the side of the body facing the ceiling.
Number of repetitions: 8 per side.

**2. Open and Closed Book**

Starting position: lying on the side, the lower limb closer to the floor extended, and the other lower limb bent to 90 degrees at the hip and knee.
Movement: holding the bent lower limb with one hand, rotate the torso, transferring the arm to the other side, and the head follows the hand.
Number of repetitions: 8 per side.

**3. Stretching of Abdominal and Groin Fascia in Prone Position**

Starting position: lying face down, feet together, pressed to the floor, and upper limbs abducted to 90 degrees, palms facing down.
Movement: reaching with the foot towards the opposite hand, holding for 8-10 seconds in position.
Number of repetitions: 8 per side.

**4. Rocking in Prone Position**

Starting position: lying face down, buttocks tight, upper limbs grabbing the lower limbs at ankle height, chin on the ground.
Movement: lifting head slightly and rocking chest to knees.
Number of repetitions: dependent on a patient's condition.

**5. Trunk Twist in Prone Position**

Starting position: lying face down, feet pressed to the floor, buttocks tight, support on forearms, stable torso with the head raised.
Movement: shifting the hand closer to the hip and incomplete extension of the elbow, causing a twist of the chest, pulling the abdominal fascia.
Number of repetitions: 8-10 repetitions per side.

**6. Cobra Pose with Front Support**

Starting position: Front support/lying face down.
Movement: Bringing the front pelvic spikes as close as possible to the ground, tightening the buttocks, resting the tops of both feet on the ground with eyes directed towards the ceiling.
Number of repetitions: 8.

**7. Side Bend Kneeling**

Starting position: Kneeling on both knees, upper limbs hanging loosely by the torso.
Movement: Alternating torso bends to the side, while one hand rests on the heel of the same side of the body.
Number of repetitions: 8 per side.

**8. Trunk Rotation in Side-Lying Position**

Starting position: Lying on the side, the lower limb closer to the ground is bent and held by the hand on the same side of the body. The other lower limb lies bent to 90 degrees at the hip and knee, also held by the hand on the same side of the body.
Movement: Trunk rotations with simultaneous turning of the head.
Number of repetitions: 8 per side.


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**9. Simplified Warrior I Pose**
Starting position: Kneeling on one knee, hands resting on hips.
Movement: Deepening the knee bend with simultaneously tightened buttocks.
Number of repetitions: 8 per side.

**10. Simplified Triangle Pose**
Starting position: Standing with legs apart, a chair or box is placed on the side of one leg for support. Hands are placed on the chair to keep the spine in a neutral position.
Movement: Lifting the upper arm, twisting the pelvis, chest, and abdomen.
Number of repetitions: 8 per side.

**11. Supine Ball Rolling**
Starting position: Lower limbs bent at the knees, feet set wider than hip-width, back resting on a ball, buttocks tightened.
Movement: Sliding the body on the ball while reaching far back with the arms.
Number of repetitions: 5.

**12. Relaxation on Rolled Mat**
Starting position: Lying on the back on a rolled mat placed across the lower back, lower limbs extended, feet in a pointed position.
Movement: Gentle breathing and relaxing the body.
Exercise duration: 1-2 minutes.

Upon the completion of exercises by the females, another measurement of scar tissue was conducted. The collected results were subjected to statistical analysis using the StatSoft 13.1 software package. The research was carried out with the approval of the Bioethics Committee at the University of Medical Sciences in Poznan, protocol number 308/22, and after obtaining a written consent from the study participants.

## Results

At the beginning of the statistical analysis, it was verified whether the obtained data followed a normal distribution, and such distribution was confirmed. The women were examined before and after scar therapy. Characteristics of the scar on the sides (right edge – rs and left edge - ls) as well as in the center (center scar – cs) were analyzed. Initially, the statistical analysis used the t-Student test to compare two dependent features. The Pearson correlation test was also applied to check for a linear correlation between the parameters center scar, left scar, and right scar. The results were also presented in the form of graphs. The significance level was set at 0.05.

**Abbreviations**
The scar in the center – center scar = cs_1 (before therapy) and cs_2 (after therapy).
The scar on the left – left scar = ls_1 (before therapy) and ls_2 (after therapy).
The scar on the right – right scar = rs_1 (before therapy) and rs_2 (after therapy).

The analysis was initially conducted for the values of the center scar (cs_1 – center scar before therapy and cs_2 – center scar after therapy). No statistical significance was observed before and after therapy with a p-value of 0.6134 (Figure 1).

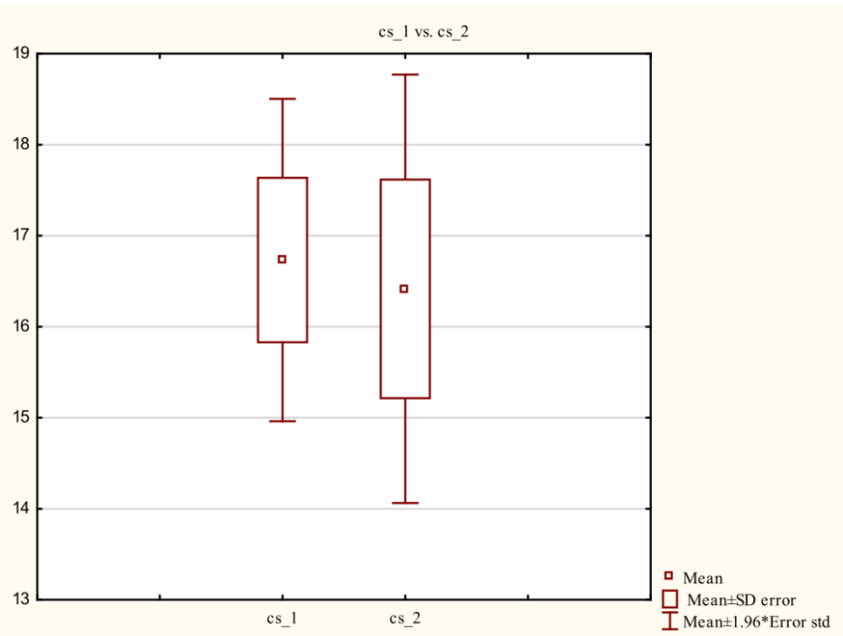


**Figure 1. Impact of therapy on center scar before and after therapy (cs_1 – center scar before therapy, cs_2 – center scar after therapy).**

Subsequently, an examination was conducted to determine whether the performed therapy has an impact on the left scar (ls_1 – left scar before therapy and ls_2 – left scar after therapy). Again, no statistical significance was observed, with a p-value of 0.0846 (Figure 2).


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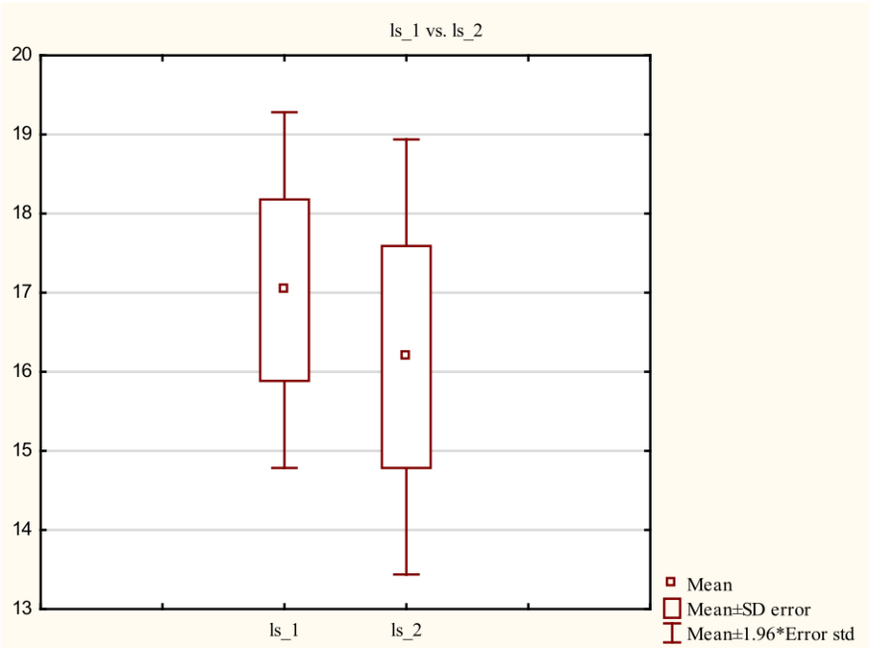


**Figure 2. Impact of therapy on left scar before and after therapy (ls_1 – left scar before therapy, ls_2 – left scar after therapy)**

In the next stage, an analysis was conducted for right scar (rs_1 – right scar before therapy and rs_2 – right scar after therapy). Similarly, no statistical significance was observed with a p-value of 0.2414 (Figure 3).

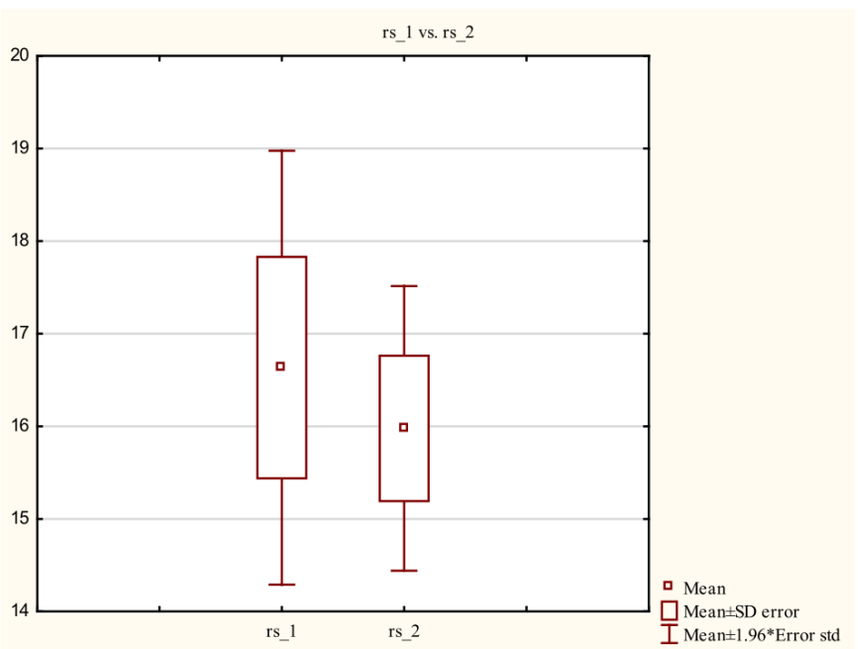


**Figure 3. Impact of therapy on right scar before and after therapy (rs_1 – right scar before therapy, rs_2 – right scar after therapy)**

Next stage of the statistical analysis involved determining the level of linear dependence. The strength of the dependence is strong, and the direction of the dependence is positive for the following values:cs_1 (center scar_1 – before therapy) i cs_2 (center scar_2 – after therapy) p-value = 0.020, r = 0.88 (Table 1, Figure 4), ls_1 (left scar_1 – before therapy) i cs_2 (center scar_2 after therapy) p-value = 0.001, r = 0.96 (Table 1, Figure 5), rs_1 (right scar_1 – before therapy) i cs_2 (center scar_2 – after therapy) p-value = 0.044, r = 0.82 (Table 1, Figure 6), ls_1 (left scar_1 – before therapy) i ls_2 (left scar_2 – after therapy) p-value = 0.001, r = 0.97 (Table 1, Figure 7), rs_1 (right scar_1 – before therapy) i rs_2 (right therapy_2 – after therapy) p-value = 0.002, r = 0.96 (Table 1, Figure 8).


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**Table.1 Linear dependence values for obtained data center scar, right scar, and left scar (center scar = cs_1 – before therapy, center scar = cs_2 – after therapy, left scar = ls_1 before therapy, left scar = ls_2 - after therapy, right scar = rs_1 - before therapy, right scar = rs_2 - after therapy)**

| Variable | Correlations indicated correlation coefficients that are statistically significant at p < , 05000 N = 6 | | |
|---|---|---|---|
| | cs_2 | ls_1 | rs_1 |
| cs_1 | **0.88** | 0.78 | 0.67 |
| ls_1 | **0.96** | **0.97** | 0.80 |
| rs_1 | **0.82** | 0.65 | **0.96** |

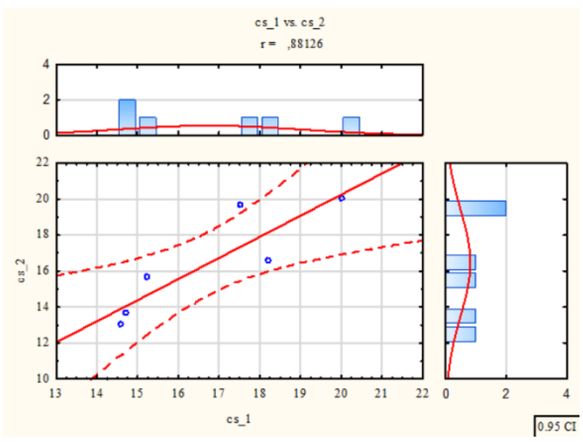


**Figure 4. Linear dependence cs_1 i cs_2 (center scar_1 – before therapy; center scar_2 – after therapy)**

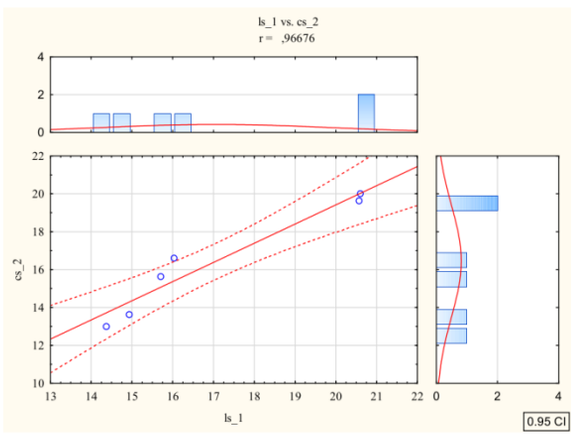


**Figure 5. Linear dependence ls_1 i cs_2 (left scar_1 – before therapy; center scar_2 – after therapy)**

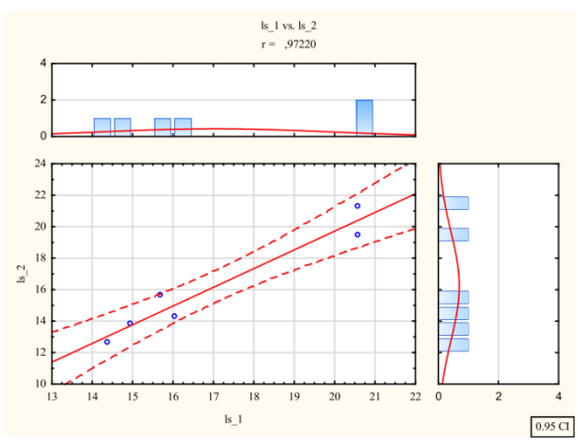


**Figure 6. Linear dependence between ls_1 i ls_2 (left scar_1 – before therapy; ls_2 – after therapy)**

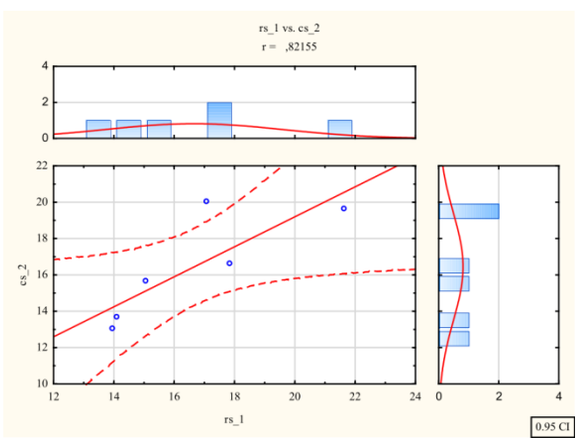


**Figure 7. Linear dependence between rs_1 i cs_2 (right scar_1 – before therapy; center scar_2 – after therapy)**

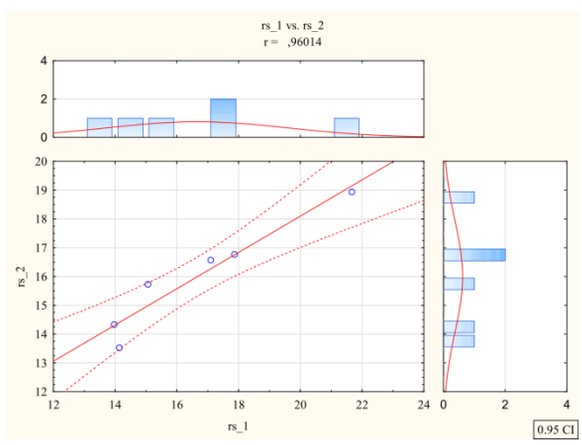


**Figure 8. Linear dependence between rs_1 i rs_2 (right scar_1 – before therapy; right scar_2 – after therapy)**


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## Discussion

The cesarean section procedure is performed in cases of anatomical pelvic defects in women, life-threatening situations for the mother or child, and depressive disorders. However, cesarean section is associated with the occurrence of complications, with the most common being discomfort related to the scar [9]. Despite the introduced perinatal care, women are not fully aware of the impact of cesarean section on their overall health and the autonomic nervous system [10]. Currently, physiotherapeutic care after a cesarean section aims to prevent the formation of adhesions, scar hypertrophy, and is focused on reducing the discomfort and pain experienced by women, primarily improving the appearance of the tissue [11]. In studies conducted by Lubczyńska et al., the impact of manual therapy on the scar was assessed using the POSAS scale (from 1 to 10, where 1 indicates no discomfort, and 10 indicates very intense discomfort) [11]. Olszewska et al. also demonstrated that the use of manual therapy in scar treatment has a positive effect on the viscoelasticity of scar tissue and the usefulness of the POSAS scale [12].

The POSAS scale can also be used to assess: itching, color, stiffness, regularity, as well as vascularity and elasticity of scar tissue. Similarly, therapeutic massage, dry needling, and kinesiotaping have a positive impact on patient's experiences and the appearance of the scar [11]. Gilbert et al. emphasized in their study that a cesarean section scar requires osteopathic mobilization due to its stiffness and pain sensations [13]. These researchers observed that performing a short osteopathic therapy once a week for only two weeks resulted in a reduction of pain and an improvement in scar elasticity [13]. The use of the MyotonPRO device indicates its reliability in the objective measurement of the viscoelastic properties of a cesarean section scar and undamaged skin [14]. In women with endometriosis after a cesarean section, a rare complication may be scarring endometriosis [15]. In a meta-analysis conducted by Liu et al., the positive impact of therapeutic massage in reducing the feeling of pain after surgical procedures was demonstrated [16]. Treatments in the field of balneoclimatology may also have a positive effect on scar tissue by improving skin blood circulation [17]. Women after a cesarean section often experience lower back pain [18].

In this situation, in addition to scar mobilization, it is important to introduce exercises to reduce lower back pain in females [19], as well as visceral therapy, which has a positive impact on reproductive organs [20]. Maintaining the mobility and movement of internal organs through visceral techniques can regulate anatomical relationships and physiological processes within the urogenital system [20].

## Conclusions

The conducted study confirmed that performing stretching exercises has a positive impact on improving the viscoelasticity of scar tissue. The limitation of the study is the small number of participants.

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