HİTİT MEDICAL JOURNAL
HİTİT ÜNİVERSİTESİ TIP FAKÜLTESİ DERGİSİ

e-ISSN: 2687-4717 Cilt|Volume: 8 • Sayı|Issue: 1 - Şubat|February 2026

The Effectiveness of Shear Wave Elastosonography for the Evaluation of Cesarean Scar and Its Contribution to Delivery Planning

Sezaryen Skarına Yönelik Yapılan Shear Wave Elastosonografinin Etkinliği ve Doğum Planlamasına Katkısı

Oghuz Abdullayev[1] | **Ersen Ertekin**[2]

[1]Tekirdağ Dr. İsmail Fehmi Cumalıoğlu City Hospital, Department of Radiology, Tekirdağ, Türkiye
[2]Hitit University, Faculty of Medicine, Department of Radiology, Çorum, Türkiye

ORCID: OA: 0000-0002-2292-1906, **EE:** 0000-0001-7182-0725

Sorumlu Yazar | Correspondence Author
Oghuz Abdullayev
aboguz@gmail.com
Address for Correspondence: Hürriyet Mh. Şehit Serkan Tuban Cd. No:18. Rodosto Konakları A. Blok D:1, Süleymanpaşa, Tekirdağ, Türkiye

Makale Bilgisi | Article Information
Makale Türü | Article Type: Araştırma Makalesi | Research Article
Doi: https://doi.org/10.52827/hititmedj.1694935
Geliş Tarihi | Received: 08.05.2025
Kabul Tarihi | Accepted: 08.12.2025
Yayım Tarihi | Published: 27.02.2026

Atıf | Cite As
Abdullayev O, Ertekin E. The Effectiveness of Shear Wave Elastosonography for the Evaluation of Cesarean Scar and Its Contribution to Delivery Planning. Hitit Medical Journal 2026;8(1):9-17. https://doi.org/10.52827/hititmedj.1694935

Hakem Değerlendirmesi: Alan editörü tarafından atanan en az iki farklı kurumda çalışan bağımsız hakemler tarafından değerlendirilmiştir.

Etik Beyanı: Çalışma için 28/01/2021 tarihinde Aydın Adnan Menderes Üniversitesi Klinik Araştırmalar Etik Kurulu'ndan onay alınmıştır. Karar no: 2.

İntihal Kontrolleri: Evet (iThenticate)

Çıkar Çatışması: Yazarlar çalışma ile ilgili çıkar çatışması beyan etmemiştir.

Şikayetler: hmj@hitit.edu.tr

Katkı Beyanı: Fikir/Hipotez: EE; Tasarım: OA, EE; Data Collection/Data Processing: OA; Veri Analizi: OA; Makalenin Hazırlanması: OA, EE.

Hasta Onamı: Tüm hastalardan yazılı bilgilendirilmiş onam ve yayın için izin alınmıştır.

Finansal Destek: Çalışma için finansal destek alınmamıştır.

Peer Review: Evaluated by independent reviewers working in at least two different institutions appointed by the field editor.

Ethical Statement: Approval for the study was obtained from the Aydın Adnan Menderes University Clinical Research Ethics Committee on 28/01/2021. Decision no: 2.

Plagiarism Check: Yes (iThenticate)

Conflict of Interest: The authors declared that they have no conflict of interest.

Complaints: hmj@hitit.edu.tr

Authorship Contribution: Idea/Hypothesis: EE; Design: OA, EE; Data Collection/Data Processing: OA; Data Analysis: OA; Manuscript Preparation: OA, EE.

Informed Consent: Written informed consent and consent for publication was obtained from the patients.

Financial Disclosure: No financial support was received for the conduct of this study.

The Effectiveness of Shear Wave Elastosonography for the Evaluation of Cesarean Scar and Its Contribution to Delivery Planning

ABSTRACT

Objective: This study aims to evaluate the impact of cesarean section on the myometrium using gray-scale ultrasonography and shear wave elastography techniques, and to contribute to the decision-making process regarding the mode of delivery in pregnant women with a history of cesarean delivery.

Material and Method: This prospective study included 120 pregnant women between 28 and 32 weeks of gestation. Of these, 60 had a history of cesarean delivery and 60 had a history of vaginal delivery. In both groups, half of the cases had a history of one birth, and the other half had a history of two births. Ultrasonography and shear wave elastography measurements were used to evaluate cesarean scars. Additionally, the cesarean delivery group was divided into three subgroups based on the time since the previous birth: less than two years, between two and five years, and more than five years.

Results: The mean myometrial elasticity value was 9.6 ± 3.22 kPa in pregnant women with a history of vaginal delivery and 21.33 ± 9.18 kPa in those with a history of cesarean delivery, showing a statistically significant difference between groups ($p<0.001$). The difference in myometrial stiffness was also statistically significant between women with one cesarean and those with one vaginal delivery (21.86 ± 10.54 kPa vs. 10.07 ± 3.24 kPa, $p<0.001$), as well as between women with two cesareans and those with two vaginal deliveries (20.80 ± 7.74 kPa vs. 9.14 ± 3.19 kPa, $p<0.001$). According to the time elapsed after cesarean delivery, the mean elasticity values were 28.9 ± 10.42 kPa in women less than two years post-cesarean, 24.01 ± 6.98 kPa in those 2–5 years post-cesarean, and 14.45 ± 5.46 kPa in those more than five years post-cesarean. The differences among all groups were statistically significant ($p<0.001$).

Conclusion: Myometrial elasticity values were higher in women whose previous cesarean section had occurred less than two years earlier, whereas in those with a cesarean history of five years or more, elasticity values approached those of women who had vaginal deliveries. This finding suggests that elastosonography may serve as an important parameter in guiding pregnant women with a history of cesarean section toward vaginal delivery.

Keywords: Cesarean Scar, Shear wave elastography, Ultrasonography, Vaginal delivery.

Sezaryen Skarına Yönelik Yapılan Shear Wave Elastosonografinin Etkinliği ve Doğum Planlamasına Katkısı

ÖZ

Amaç: Bu çalışmanın amacı, sezaryen doğumun myometriyum üzerindeki etkisini gri skala ultrasonografi ve shear wave elastografi tekniklerini kullanarak değerlendirmek ve sezaryen öyküsü bulunan gebelerde doğum şeklinin belirlenmesine yönelik karar sürecine katkı sağlamaktır.

Gereç ve Yöntem: Bu prospektif çalışmaya, 28-32. gebelik haftaları arasında olan toplam 120 gebe dahil edildi. Gebelerin 60'ı geçirilmiş sezaryen, 60'ı vajinal doğum öyküsüne sahipti. Her iki grupta da olguların yarısının bir doğum, diğer yarısının ise iki doğum öyküsü mevcuttu. Sezaryen doğum yapmış gebeler, önceki doğumundan elastografi ölçümlerine kadar geçen zamana göre iki yıldan az, iki-beş yıl arası ve beş yıldan fazla olmak üzere üç gruba ayrıldı. Sezaryen skarlarının değerlendirilmesinde ultrasonografi ve shear wave elastografi ölçümleri kullanıldı.

Bulgular: Vajinal doğum yapmış gebelerde ortalama myometrium elastisite değerleri 9,6 ± 3,22 kPa, sezaryen doğum yapmış gebelerde ise 21,33 ± 9,18 kPa ölçülmüş olup iki grup arasında istatistiksel olarak anlamlı fark mevcuttu (p<0,001). 1 sezaryen ile 1 vajinal doğum öyküsü bulunan gebeler arasında miyometriyal sertlik farkı (sırasıyla 21,86 ± 10,54 kPa, 10,07 ± 3,24 kPa, $p<0,001$) ve 2 sezaryen ile 2 vajinal doğum öyküsü bulunan gebeler arasında myometriyal sertlik farkı istatistiksel olarak anlamlıydı (sırasıyla 20,80 ± 7,74 kPa, 9,14 ± 3,19 kPa, $p<0,001$). Sezaryen sonrası geçen süreye göre elastisite değerleri iki yıldan az olan grupta 28,9 ± 10,42 kPa, 2-5 yıl arası olan grupta 24,01 ± 6,98 kPa ve 5 yıldan fazla olan grupta 14,45 ± 5,46 kPa olarak ölçüldü. Tüm gruplar arasındaki fark istatistiksel olarak anlamlı bulundu ($p<0,001$).

Sonuç: Önceki sezaryen öyküsü 2 yıldan az olan grupta myometriyal elastisite değeri daha yüksek bulunurken, sezaryen öyküsü 5 yıl ve daha fazla olan grupta gebelerin myometriyal elastisite değerleri normal doğum yapmış gebelerin değerlerine yaklaşmaktadır. Bu bulgu, sezaryen geçirmiş gebeleri normal doğuma yönlendirmek için elastosonografinin önemli bir parametre olarak kullanılabileceğini göstermektedir.

Anahtar Sözcükler: Sezaryen skarı, Shear wave elastografi, Ultrasonografi, Vajinal doğum.

Introduction

As the risks associated with cesarean delivery (CD) for both mothers and infants have become better understood over time, the perception of CD as an alternative to vaginal delivery (VD) and the rising CD rates have sparked significant debate (1). CD is fundamentally a method of delivery reserved for cases where VD poses a risk to maternal or fetal health (2). The World Health Organization recommends that the ideal CD rate should remain below 10–15% (3). However, in parallel with global trends, CD rates have distinctly increased in our country in recent years (4). One key factor driving this increase is the reluctance to recommend VD for women with a prior cesarean section scar (CSS) due to the associated risk of uterine rupture.

Although the factors influencing CSS formation remain unclear, serious complications such as uterine rupture, placental insertion anomalies, and scar pregnancies are frequently observed in women with a history of CD. These risks are further amplified in cases of repeated CDs (5,6). Evidence suggests that conditions such as multiple pregnancies, advanced maternal age, labor induction, premature rupture of membranes, and preeclampsia contribute to higher incidences of CSS defects (7).

The morphology of CSS can be effectively visualized with transvaginal ultrasonography (US), alongside other diagnostic methods such as hysterosalpingography, saline infusion sonohysterography, magnetic resonance imaging (MRI), and hysteroscopy in non-pregnant women (8,9). For pregnant women, transabdominal US and MRI are considered appropriate for evaluating the CSS (10). Although previous studies have suggested that MRI is the best method for evaluating CSS, no parameter other than scar thickness and length has been evaluated in these studies (11,12).

Among the latest advancements, US elastography is a technique designed to measure tissue stiffness, providing valuable additional information about pathological processes such as fibrosis, inflammation, and malignancy (13,14). Tissue elasticity, a mechanical property defined as the resistance of tissue to applied pressure and deformation, can now be assessed using dynamic methods such as shear wave elastography (SWE), which offers more reliable data compared to earlier techniques like strain elastography (15). We did not encounter any study in the literature that used elastosonography for the evaluation of CSS in myometrium.

This study aims to evaluate the effects of CD on the myometrium using US and SWE techniques, to provide new quantitative data to the literature regarding the assessment of CSS, and to contribute to delivery planning by comparing measurements between pregnant women with a history of CD and those with a history of VD.

Material and Method

This prospective study was conducted on pregnant women who were followed at the Aydin Adnan Menderes University Obstetrics and Gynecology Clinic and referred to the Radiology Department between February 2021 and May 2022. Ethical approval was obtained from the Clinical Research Ethics Committee of our faculty (Decision No. 2, dated 28.01.2021). The procedure was explained in detail to all participants, and informed consent forms were collected.

A total of 120 pregnant women were enrolled in the study, comprising 60 with a history of CD and 60 with a history of VD. Each group was further stratified into two subgroups based on the number of prior deliveries—either one or two. Consequently, four subgroups were established: 30 women with one prior CD (CD1), 30 with two prior CDs (CD2), 30 with one prior VD (VD1), and 30 with two prior VDs (VD2). To minimize the potential influence of fetal engagement on SWE measurements and to assist in birth planning, radiological evaluations were conducted between the 28th and 32nd weeks of pregnancy.

To maintain consistency within the study, specific exclusion criteria were applied. Women in their first pregnancy or with a history of three or more pregnancies were excluded. The study also

excluded pregnancies outside the 28th–32nd gestational weeks, CDs performed using non-low transverse uterine incisions, prior uterine surgeries, multiple pregnancies, placental invasion anomalies, placenta previa, polyhydramnios, oligohydramnios, fetal anomalies, preeclampsia, vertex presentations, and cases where the placenta was anteriorly and inferiorly located.

Radiological evaluation

Radiological assessments were conducted using the Medison RS80A Prestige US system (Samsung Medison Co. Ltd., Seoul, Korea). Pregnant participants were positioned in the supine position on the examination couch. A high-resolution linear probe operating within a frequency range of 3–12 MHz was utilized for gray-scale imaging of the myometrium. SWE measurements were carried out using the point shear wave technique, based on the acoustic radiation force impulse (ARFI) elastography method, employing a linear probe with a frequency range of 2–9 MHz. All US and elastography examinations were performed by a single radiologist with 10 years of experience in the field of obstetric imaging.

Myometrial thickness was measured using gray-scale US, and myometrial stiffness was assessed using SWE at the site of the CSS in pregnant women with a history of CD. In cases where the scar was not visible or in women with a history of VD, the measurements were performed approximately 2 cm above the upper border of the bladder, corresponding to the typical location of the cesarean incision line (Figure Ia).

In gray-scale US, the US probe was positioned perpendicular to the abdominal wall, and the thickness of the anterior myometrium was measured at the specified location (Figure Ib).

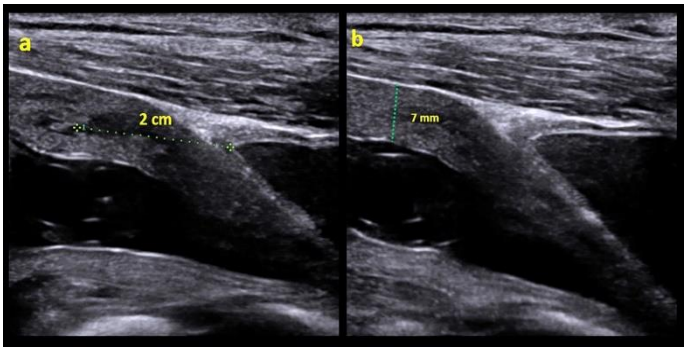
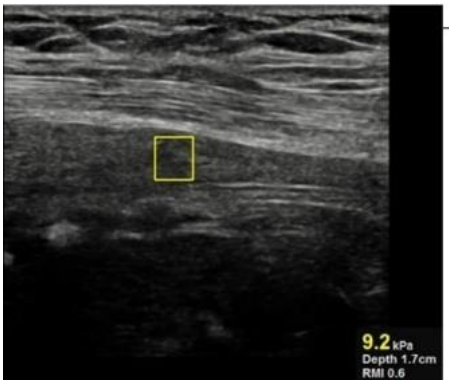


Figure I. Example of Myometrium Examination
a) Determination of the myometrium area to be examined
b) Measurement of myometrial thickness

During the SWE examination, a sufficient amount of gel was applied to prevent pressure on the measurement site, and the probe was positioned perpendicular to the skin. To minimize motion artifacts, participants were instructed to hold their breath and remain completely still before activating the Point Shear Wave Elastography (pSWE) mode. A 5 mm × 5 mm sampling box, referred to as the region of interest (ROI), was placed on the anterior myometrium, ensuring the exclusion of amniotic fluid and non-myometrial tissues. For each participant, at least 10 measurements with a reliability measurement index (RMI) greater than 0.4 were obtained. To ensure statistical accuracy, the interquartile range/median (IQR/M) ratio was maintained below 30% (15-18). Outlier values were excluded, and corresponding kPa, RMI, IQR/M, and m/s values were recorded and saved as screenshots for analysis. (Figure II).



S-Shearwave	Stiffness (kPa)	Stiffness (m/s)	Depth (cm)	RMI
[1]	12.2	2.01	1.4	0.7
[2]	9.6	1.79	1.7	0.7
[3]	12.8	2.07	1.6	0.4
[4]	11.8	1.98	1.7	0.5
[5]	8.3	1.66	1.7	0.8
[6]	6.6	1.48	1.8	0.8
[7]	11.0	1.92	1.7	0.8
[8]	9.2	1.75	1.7	0.6
[9]	11.6	1.97	1.7	0.8
[10]	9.8	1.81	1.7	0.5
Median	10.4	1.87		
IQR/Med.	28.1	13.94		

Figure II. Example of Point Shear Wave Elastography measurement for the myometrium.

Results

A total of 120 pregnant women, comprising 60 with a history of CD and 60 with a history of VD, were included in the study. All participants were between 28 and 32 weeks of gestation. The mean age of the patients was 29.24 ± 5.02 years. Within the subgroups, the mean age was 27.7 ± 5.38 years in the VD1 group, 31.1 ± 3.75 years in the VD2 group, 27.5 ± 4.32 years in the CD1 group, and 31.3 ± 5.1 years in the CD2 group (Table I). No statistically significant differences were observed in age distribution between the VD1 and CD1 groups or between the VD2 and CD2 groups (*p=0.335, p=0.906*).

Analysis of Myometrium Thicknesses

The mean myometrial thickness values were 4.76 ± 1.02 mm in the VD1 group, 5.01 ± 0.94 mm in the VD2 group, 4.2 ± 1.2 mm in the CD1 group, and 4.77 ± 1.36 mm in the CD2 group (Table I). There were no statistically significant differences in mean myometrial thickness between the groups (*p=0.061, p=0.146*).

Table I. Demographic Characteristics and Myometrial Thicknesses of the Cases

Groups	Age Mean ± SD	*p value*	Myometrial thickness (mm) Mean ± SD	*p value*
VD1 (n:30)	27.7 ± 5.38	*0.335*	4.76 ± 1.02	*0.061*
CD1 (n:30)	27.5 ± 4.32		4.2 ± 1.20	
VD2 (n:30)	31.1 ± 3.75	*0.906*	5.01 ± 0.94	*0.146*
CD2 (n:30)	31.3 ± 5.1		4.77 ± 1.36	

VD: Vaginal Delivery; CD: Cesarean Delivery; SD: Standard Deviation

Analysis of Shear Wave Elastography Results

The median elasticity value was 9.1 kPa in the VD group and 20.65 kPa in the CD group. Within the subgroups, the median elasticity values were 9.2 kPa in the VD1 group, 8.35 kPa in the VD2 group, 20.75 kPa in the CD1 group, and 20.45 kPa in the CD2 group (Table II). Myometrial stiffness was significantly lower in the VD group compared to the CD group (*p<0.001*). A statistically significant difference was observed between the VD1 and CD1 subgroups (*p<0.001*) as well as between the VD2 and CD2 subgroups (p < 0.001). However, no significant difference was found between women with one and two delivery histories within the same group (VD1 vs. VD2 and CD1 vs. CD2 subgroups) (*p=0.089, p=0.099*). (Figure III)

Table II. Shear Wave Elastography Measurements of the Cases

Groups	Myometrial Stiffness (kPa) Median	*p value*
VD	9.1 (3.5-22.9)	*<0.01*
CD	20.65 (7.4-51.4)	
VD1	9.2 (5.1-22.9)	*0.089*
VD2	8.35 (3.5-17.6)	
CD1	20.75 (8.6-51.4)	*0.099*
CD2	20.45 (7.4-50)	

VD: Vaginal Delivery; CD: Cesarean Delivery

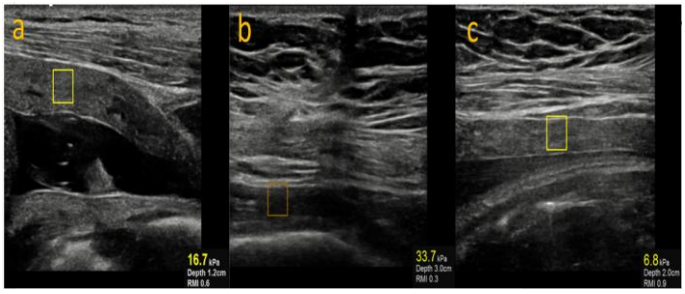


Figure III. Case examples

a) 20-year-old G2P1 with a history of 1 cesarean section at 29 weeks of gestation. **b)** 28-year-old G3P2 case with a history of 2 cesarean sections at 32 weeks of gestation. **c)** 41 years old G2P1 case with a vaginal delivery history at 31 weeks of gestation.

In the CD group, the relationship between the time elapsed since the last CD and myometrial stiffness was analyzed. In the CD1 group, the data followed a normal distribution, and a negative linear relationship was observed between myometrial stiffness and the increasing time interval (*p=0.005*). In the CD2 group, the data did not follow a normal distribution, but a similar negative linear relationship was identified (*p=0.002*).

A simple logistic regression model was applied to the myometrial stiffness values and the time since the last CD. The regression coefficient was calculated as 1.6, and a regression model formula was generated (Figure IV). Additionally, the CD group was divided into three subgroups based on the time elapsed since the last delivery: less than two years, between two and five years, and more

than five years. The corresponding myometrial stiffness values for each subgroup are summarized in Table III. A statistically significant difference was found between these subgroups (*p<0.001*).

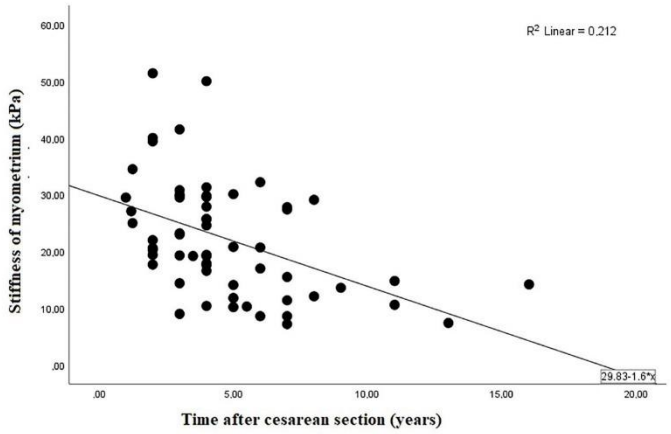


Figure IV. Elasticity-time Relationship in Cases with a History of Cesarean Delivery

Table III. Myometrial Elasticity Values According to Time Periods

	< 2 years (n= 12)	2-5 years (n= 30)	> 5 years (n= 18)
CD	28.9 ± 10.42	24.01 ± 6.98	14.45 ± 5.46
CD1	32.78 ± 12.14	24.72 ± 6.23	14.55 ± 5.35
CD2	23.48 ± 3.84	23.61 ± 7.54	14.3 ± 5.96

CD: Cesarean Delivery

Discussion

In this study, we observed that myometrial elasticity was significantly lower in pregnant women with a history of CD compared to those with a history of VD. However, as the time elapsed since the last CD increased, myometrial stiffness values approached those of pregnant women with a VD history. This finding offers valuable quantitative data that could guide the recommendation of VD for pregnant women with a history of CD.

The global rate of CD has been increasing dramatically, making it one of the most pressing issues in obstetrics. It has been reported that higher CD rates are associated with significant risks of morbidity and mortality in subsequent pregnancies, including uterine rupture, preterm labor, and placental adhesion anomalies (19,20). One of the primary drivers of this rise is a history of prior CD, which often leads to repeat CD (21). In 1980, the United States National Institute of Health (NIH) highlighted this issue during a conference, questioning the necessity of routine repeat CDs (22). Following this, the American College of Obstetrics and Gynecology (ACOG) supported initiatives to promote vaginal birth after cesarean (VBAC), publishing guidelines in 1988 and 1994 aimed at increasing VBAC rates (23). These efforts led to a substantial rise in VBAC rates, with the proportion of VDs after CD increasing from 3.4% in 1980 to a peak of 28.3% in 1996. However, as VBAC cases increased, reports of complications such as uterine rupture and maternal and fetal morbidities began to emerge in the literature. These complications, coupled with a rise in malpractice lawsuits, have contributed to a subsequent decline in VBAC rates in recent years (24).

In our country, the CD rate has rapidly increased from 21.2% to 57.3% over the past 20 years. In response to this dramatic rise, the Ministry of Health issued a bulletin in 2010 emphasizing that, in appropriate cases, VD could be offered to pregnant women with a history of CD after explaining the associated risks. Despite subsequent bulletins in the following years, VD after CD was implemented sporadically, limited to small patient groups and specific centers, but long-term continuity in practice could not be achieved.

The most recent bulletin from the ACOG regarding VD after CD was published in 2010. In this bulletin, it is recommended that VD should be prioritized for pregnant women with a single lower segment transverse incision, while cases involving two such incisions should be individually evaluated by the attending physician. Similarly, the NIH released its "New Information Guide on Vaginal Birth After Cesarean Section" in 2010, providing the latest comprehensive guidelines on the subject (25). This guide details the factors influencing the success of VD after CD, the short- and long-term benefits and risks of the procedure, the conditions that heighten these risks, and the criteria to be considered in patient selection for VD after CD (26). However, despite these

recommendations and interventions, the desired increase in VD rates after CD remains unachieved, primarily due to the perceived risk of uterine rupture.

Scar tissue formed during CS wound healing, characterized by myofiber irregularity, elastosis, myometrial hyperplasia, and fibrous tissue, leads to a loss of myometrial elasticity. This loss of elasticity may contribute to uterine rupture as intrauterine pressure increases in the later weeks of pregnancy. Although it is known that myometrial elasticity in scar tissue can be restored over time, sufficient and objective non-invasive data to support this phenomenon remain lacking (27). We hypothesized that demonstrating the recovery of myometrial elasticity using elastosonography, a technique that provides valuable insights into VD. To test this hypothesis, we designed a study comparing pregnant women with a history of CS and VD using the pSWE technique. During our literature review, while studies examining normal myometrium after CS were identified, we found no elastography studies conducted specifically on pregnant women.

In our study, as anticipated, myometrial stiffness values were higher in pregnant women with a history of CD compared to those with a history of VD. This difference was evident in women with both one and two previous deliveries. However, as the time elapsed since the last delivery increased, myometrial stiffness values in women with a CD history decreased, approaching those of women with a VD history. This effect was particularly noticeable in women who were 2–5 years post-CD and became even more pronounced in those exceeding 5 years.

This study is significant as it represents the first and only study to emphasize the importance of the time elapsed since the last delivery, supported by quantitative data, in guiding pregnant women with a CD history towards VD.

Studies have demonstrated that the interval between two pregnancies is associated with the risk of uterine rupture during VD after CD. In a study conducted in 2001 with 2409 pregnant women, Shipp et al. reported a uterine rupture risk of 2.3% for intervals of less than 18 months between deliveries and 1.1% for intervals exceeding 18 months (28). Similarly, studies by Bujold et al. in 2002 and 2010 revealed that intervals of less than 24 months (in 2002) and less than 18 months (in 2010) significantly increased the risk of uterine rupture (29,30). Consistent with these findings, our study shows that myometrial stiffness is higher in pregnant women with a CD history of less than two years. Conversely, we observed that myometrial elasticity in women who were five years or more post-CD approached the elasticity values of those with a VD history, suggesting a lower risk. While actual rupture rates could not be assessed in our study due to the lack of data on delivery management, the compatibility of our pregnancy-related findings with the literature indicates SWE could serve as a valuable tool in guiding the delivery method for these pregnant women.

Although there are studies in the literature evaluating the myometrium using elastography, none of these were conducted during pregnancy. In a study by Manchanda et al. (31) in 2019 involving 56 healthy individuals, the average myometrial elasticity was reported as 40.24 kPa. Similarly, in a study conducted by Turan et al. in 2021 with 15 healthy individuals, the median myometrial stiffness during the luteal phase was found to be 20.2 kPa (32). Additionally, a study by Acar et al. in 2016 reported an average myometrial elasticity of 24.4 kPa in a control group of 56 healthy individuals (33). In contrast, our study found the average myometrial stiffness in the VD group to be 9.6 kPa. This significant difference may be attributed to the relaxation effect of progesterone secreted during pregnancy, which is known to reduce uterine stiffness (34). In the study conducted by Sichitiu et al., which investigated the relationship between postpartum uterine atony and myometrial elastography, the myometrial shear wave velocity measured within the first 30 minutes after VD in 34 women was found to be 10.94 ± 5.55 kPa (35). These findings are comparable to the elastography values in our VD group; however, their assessment in postpartum patients distinguishes that study from ours.

In the present study, no significant difference was observed in myometrial thickness between pregnant women with a history of CD and VD when measured 2 cm proximal to the upper border of the bladder, corresponding to the lower segment transverse incision site. The literature includes studies examining myometrial thickness in pregnant women at different locations and gestational weeks (31-33). In a study involving 175 pregnant women, Durnwald et al. measured myometrial thickness at a location and gestational period similar to our study and also found no significant difference between women with a history of CD and VD (36). Similarly, in a 2010 study with 235 pregnant women between 35 and 38 weeks of gestation and a history of CD, Jastrow et al. classified participants into three groups based on the time elapsed after CD: less than 18 months, 18–24 months, and more than 24 months. They concluded that there was no relationship between the duration since CD and myometrial thickness (37). Consistent with these findings, our study also did not identify any relationship between the time elapsed after CD and myometrial thickness.

This study has several limitations. The first is the sample size, as the findings need to be validated through studies with larger patient populations. Another limitation is the fixed size of the sampling box used in the pSWE measurements. Additionally, pregnant women with vertex presentation were excluded from the study. This exclusion was intentional, as the fetal cranium in vertex presentation may cause deviations in the SWE measurements of the myometrium. Further prospective studies investigating the effect of fetal position on uterine elastography are needed.

In conclusion, as anticipated, myometrial stiffness was higher in pregnant women with a history of CD compared to those with a history of VD. However, this difference diminishes over time, with myometrial stiffness values in women with a CD history approaching those of women with a VD history as the interval after the CD increases. These findings highlight the critical role of time in guiding pregnant women with a history of CD toward VD and demonstrate the potential effectiveness of SWE in this context. Further studies involving larger cohorts of pregnant women and incorporating postpartum data are needed to validate and expand upon these findings.

References

1. Shah A, Fawole B, M'imunya JM, et al. Cesarean delivery outcomes from the WHO global survey on maternal and perinatal health in Africa. International Journal of Gynecology and Obstetrics 2009;107(3):191-197.

2. Şimşek HE, Ecevit ŞA. Sezaryen Sonrası Ağrı ve Hemşirelik Bakımı. İstanbul Gelişim Üniversitesi Sağlık Bilimleri Dergisi 2020;267-278.

3. Bailey P, Lobis S, Maine D, Fortney JA. Monitoring emergency obstetric care: a handbook, World Health Organization, 2009;1-38.

4. Demirbaş M, Karabel MP, İnci MB. Türkiye'de ve Dünya'da değişen sezaryen sıklığı ve olası nedenleri. Sakarya Tıp Dergisi 2018;7(4):158-163.

5. Stegwee SI, de Groot CJ, Lambalk CB, Huirne JA. Authors' reply re: Uterine caesarean closure techniques affect ultrasound findings and long-term maternal outcomes: a systematic review and meta-analysis. BJOG: An International Journal of Obstetrics and Gynaecology 2019;126(6):815-816.

6. Landon MB, Hauth JC, Leveno KJ, et al. Maternal and perinatal outcomes associated with a trial of labor after prior cesarean delivery. New England Journal of Medicine 2004;351(25):2581-2589.

7. Bennich G, Rudnicki M, Wilken-Jensen C, Lousen T, Lassen P, Wøjdemann K. Impact of adding a second layer to a single unlocked closure of a Cesarean uterine incision: randomized controlled trial. Ultrasound in Obstetrics and Gynecology 2016;47(4):417-422.

8. Roberge S, Demers S, Girard M, et al. Impact of uterine closure on residual myometrial thickness after cesarean: a randomized controlled trial. American Journal of Obstetrics and Gynecology 2016;214(4):507.e1-507.e6.

9. Verberkt C, Jordans IP, Van den Bosch T, et al. How to perform standardized sonographic examination of uterine niche in non-pregnant women. Ultrasound in Obstetrics & Gynecology 2022;420-424.

10. Lin PL, Hou JH, Chen CH. A common problem between gynecology, obstetrics, and reproductive medicine: Cesarean section scar defect. Taiwan J Obstet Gynecol 2024;63(4):459-470.

11. Qi YF, He YL, Ding N, et al. Assessment of Changes in the Cesarean Scar and Uterus Between One and Two Years after Cesarean Section Using 3D T2w SPACE MRI. Chin Med Sci J 2022;37(2):151-158.

12. Klein Meuleman SJM, Min N, Hehenkamp WJK, Post Uiterweer ED, Huirne JAF, de Leeuw RA. The definition, diagnosis, and symptoms of the uterine niche - A systematic review. Best Pract Res Clin Obstet Gynaecol 2023;90:102390.

13. Pierce TT, Ozturk A, Sherlock SP, et al. Reproducibility and Repeatability of US Shear-Wave and Transient Elastography in Nonalcoholic Fatty Liver Disease. Radiology 2024;312(3):e233094.

14. Pillai A, Voruganti T, Barr R, Langdon J. Diagnostic Accuracy of Shear-Wave Elastography for Breast Lesion Characterization in Women: A Systematic Review and Meta-Analysis. J Am Coll Radiol 2022;19(5):625-634.e0.

15. Choi K, Kong D, Hah Z, Lee H-K. A reliability index of shear wave speed measurement for shear wave elastography. 2015 IEEE international ultrasonics symposium (IUS). Taipei, Taiwan. 2015. p. 1-4.

16. Fang C, Jaffer OS, Yusuf GT, et al. Reducing the number of measurements in liver point shear-wave elastography: factors that influence the number and reliability of measurements in assessment of liver fibrosis in clinical practice. Radiology 2018;287(3):844-852.

17. Mulabecirovic A, Mjelle AB, Gilja OH, Vesterhus M, Havre RF. Repeatability of shear wave elastography in liver fibrosis phantoms-Evaluation of five different systems. PLoS One 2018;13(1):e0189671.

18. Sporea I, Gradinaru-Tascau O, Bota S, et al. How many measurements are needed for liver stiffness assessment by 2D-Shear Wave Elastography (2D-SWE) and which value should be used: the mean or median?. Medical Ultrasonography 2013;15(4):268-272.

19. Geller EJ, Wu JM, Jannelli ML, Nguyen TV, Visco AG. Maternal outcomes associated with planned vaginal versus planned primary cesarean delivery. American Journal of Perinatology 2010;27(09):675-684.

20. Silver RM, Landon MB, Rouse DJ, et al. Maternal morbidity associated with multiple repeat cesarean deliveries. Obstetrics and Gynecology 2006;107(6):1226-1232.

21. Bottoms SF, Rosen MG, Sokol RJ. The increase in the cesarean birth rate. New England Journal of Medicine 1980;302(10):559-563.

22. Cesarean Childbirth: Report of a Consensus Development Conference. National Institute of Child Health: US Department of Health and Human Services; 1982. p. 255-409.

23. Vaginal delivery after a previous cesarean birth. ACOG Committee opinion. Number 143-October 1994 (replaces No. 64, October 1988). Committee on Obstetric Practice. American College of Obstetricians and Gynecologists. Int J Gynaecol Obstet 1995;48(1):127-129.

24. Sachs BP, Kobelin C, Castro MA, Frigoletto F. The risks of lowering the cesarean-delivery rate. Mass Medical Soc; 1999;54-57.

25. ACOG Practice bulletin no. 115: Vaginal birth after previous cesarean delivery. Obstet Gynecol 2010;116(2 Pt 1):450-463.

26. National Institutes of Health Consensus Development conference statement: vaginal birth after cesarean: new insights March 8-10, 2010. Obstet Gynecol 2010;115(6):1279-1295.

27. Roeder HA, Cramer SF, Leppert PC. A look at uterine wound healing through a histopathological study of uterine scars. Reproductive Sciences 2012;19(5):463-473.

28. Shipp TD, Zelop CM, Repke JT, Cohen A, Lieberman E. Interdelivery interval and risk of symptomatic uterine rupture. Obstetrics and Gynecology 2001;97(2):175-177.

29. Bujold E, Mehta SH, Bujold C, Gauthier RJ. Interdelivery interval and uterine rupture. American Journal of Obstetrics and Gynecology 2002;187(5):1199-1202.

30. Bujold E, Gauthier RJ. Risk of uterine rupture associated with an interdelivery interval between 18 and 24 months. Obstetrics and Gynecology 2010;115(5):1003-1006.

31. Manchanda S, Vora Z, Sharma R, et al. Quantitative sonoelastographic assessment of the normal uterus using shear wave elastography: an initial experience. Journal of Ultrasound in Medicine 2019;38(12):3183-3189.

32. Turan Ö, Ertekin E, Abdullayev O, Kuh B. Sonoelastographic assessment of the normal uterus and ovaries using the Shear Wave Elastography according to different menstrual phases. Aegean Journal of Obstetrics and Gynecology 2021;3(2):55-58.

33. Acar S, Millar E, Mitkova M, Mitkov V. Value of ultrasound shear wave elastography in the diagnosis of adenomyosis. Ultrasound 2016;24(4):205-213.

34. Kosterin SA, Burdyga TV, Fomin V, Grover AK. Mechanisms of Ca2+ transport in myometrium. Control of uterine contractility: Routledge; 1994. p. 129-153.

35. Sichitiu J, Meuwly JY, Baud D, Desseauve D. Using shear wave elastography to assess uterine tonicity after vaginal delivery. Sci Rep 2021 May 17;11(1):10420.

36. Durnwald CP, Mercer BM. Myometrial thickness according to uterine site, gestational age and prior cesarean delivery. The Journal of Maternal-Fetal and Neonatal Medicine 2008;21(4):247-250.

37. Jastrow N, Gauthier RJ, Gagnon G, Leroux N, Beaudoin F, Bujold E. Impact of labor at prior cesarean on lower uterine segment thickness in subsequent pregnancy. American Journal of Obstetrics and Gynecology 2010;202(6):563.e1-563.e7.