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Clinical Profile and Outcomes of Uterine Scar Tenderness in Cesarean Deliveries: A Retrospective Analysis of 21 Cases Among 353 Women with Varied Parity."

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Abstract
Introduction: Uterine scar tenderness during cesarean section is a clinical concern that may reflect compromised scar integrity and influence surgical decision-making. Its assessment is particularly valuable in settings lacking advanced imaging modalities.
Objectives: To investigate the clinical correlates, predictive indicators, and risk modelling of uterine scar tenderness in women undergoing cesarean delivery at Maternity and Children Hospital, Najran, Saudi Arabia.
Methods: A retrospective review was conducted on 353 cesarean cases performed between January 2018 and December 2020. Documented intraoperative scar tenderness served as the primary outcome. Maternal characteristics, neonatal parameters, and placental findings were analyzed. Statistical associations were identified, and a composite risk model was developed based on variables with odds ratios >2.0.
Results: Scar tenderness was recorded in 21 cases (5.95%). Significant maternal correlates included elevated BMI (≥32), high gravidity (≥4), short interpregnancy interval (<18 months), and ≥2 prior cesarean deliveries. Neonatal and placental outcomes were comparable between groups, except for a minor decline in placental weight among those with scar tenderness. The composite model identified six predictive indicators enabling stratification into low, moderate, and high-risk profiles. A novel 3D risk matrix illustrated the convergence of physiological and surgical risk factors in defining scar vulnerability.
Conclusions: This study introduces a clinically meaningful risk stratification approach for uterine scar tenderness in cesarean delivery. Integration of scar tenderness into routine preoperative assessment may enhance individualized obstetric strategies and improve maternal outcomes, especially in resource-limited environments.
Key words: *Uterine scar tenderness, cesarean section, maternal BMI, interpregnancy interval, predictive modeling, and risk stratification.*

INTRODUCTION

Cesarean section (CS) remains one of the most frequently performed surgical procedures in obstetric practice worldwide, with rates steadily increasing across both high- and low-resource settings over the past two decades. While CS has significantly reduced maternal and neonatal morbidity in select clinical scenarios, its rising prevalence has introduced a spectrum of postoperative complications, including uterine scar-related morbidities such as scar dehiscence, thinning, and tenderness during subsequent pregnancies and deliveries [1][2].

Uterine scar tenderness, defined as localized pain or discomfort over the lower uterine segment during abdominal palpation, has emerged as a clinically relevant but underexplored indication for repeat CS [3][4]. Although traditionally considered a subjective finding, recent studies have demonstrated its correlation with sonographic scar thinning, intraoperative evidence of dehiscence, and adverse maternal outcomes [5][6]. In resource-limited settings where advanced imaging modalities may be unavailable, scar tenderness may serve as a surrogate marker for compromised scar integrity [7].

The pathophysiology of scar tenderness is multifactorial, involving myometrial remodelling, ischemic changes, and inflammatory responses at the site of previous uterine incisions [8]. Factors such as the number of prior CSs, interpregnancy interval, surgical technique, and maternal comorbidities have been implicated in modulating scar quality and its clinical manifestations [9][10]. Notably, tenderness may present in both elective and emergency CS contexts, often influencing surgical decision-making and contributing to the overall CS burden [11].

Despite its clinical relevance, scar tenderness remains inconsistently documented in obstetric records and poorly represented in global CS classification systems such as the Robson Ten-Group Classification [12]. This gap underscores the need for standardized assessment protocols and evidence-based thresholds to guide management. Moreover, the predictive value of scar tenderness for intraoperative complications, such as uterine rupture or excessive bleeding, warrants further investigation [13].

Recent prospective and retrospective studies have begun to quantify the prevalence of scar tenderness and its association with maternal and neonatal outcomes [14][15]. However, data from sub-Saharan Africa and other low-resource regions remain sparse. In Sudan, where CS rates are rising and VBAC uptake remains limited, understanding the clinical implications of scar tenderness is particularly critical for optimizing surgical planning and reducing unnecessary repeat CSs [16].

This study aims to evaluate the prevalence, classification, and clinical outcomes of uterine scar tenderness among 353 cesarean deliveries at a tertiary centre. By isolating 21 confirmed cases and analyzing their demographic, obstetric, and surgical profiles, we seek to elucidate the role of scar tenderness as a standalone or coexisting indication for CS. The findings may inform future protocols for scar assessment, contribute to risk stratification models, and support evidence-based decision-making in obstetric care.

OBJECTIVES

This study aims to investigate uterine scar tenderness as a clinically significant indicator during cesarean delivery. Specifically, it seeks to quantify its prevalence, classify maternal and surgical risk factors, and evaluate its influence on delivery planning. By analyzing 353 cesarean cases—of which 21 exhibited confirmed tenderness—tenderness-the research explores correlations with elevated BMI, parity, prior cesarean count, and shortened interpregnancy intervals. A secondary objective involves developing a composite risk model to stratify tenderness likelihood using demographic and obstetric data. Additionally, this study introduces a visual risk matrix to enhance preoperative decision-making. These insights are intended to support clinical protocols, particularly in resource-limited settings, where tenderness may serve as a surrogate for compromised scar integrity in the absence of advanced imaging modalities.

METHODS

This retrospective observational study was conducted at the Maternity and Children Hospital (MCH) in Najran, a tertiary referral center serving the southern region of Saudi Arabia. The research aimed to evaluate the prevalence, classification, and clinical correlates of uterine scar tenderness among cesarean deliveries performed over three years, from January 1, 2018, to December 30, 2020.

The study population comprised all women who underwent cesarean section (CS), either electively or on an emergency basis, during the defined study period. Cases were identified through surgical logbooks, digital obstetric records, and labor ward registries. To ensure precision in selection and eliminate transcriptional bias, each record was reviewed manually to confirm CS categorization, documented indications, and relevant maternal and neonatal outcomes. Uterine scar tenderness was defined as a clinically documented finding during abdominal palpation or intraoperative assessment indicating localized pain or thinning over the lower uterine segment in patients with prior cesarean history.

Inclusion criteria required complete documentation of CS type (elective or emergency), primary indication for surgery, and presence or absence of scar tenderness. Cases with ambiguous surgical indications or lacking operative detail were excluded from tenderness-specific analysis but retained for broader demographic assessment. Maternal data fields included age, body mass index (BMI), gravidity, parity, number of prior CS deliveries, and gestational age at current delivery. Neonatal data included birth weight, head circumference, length, gender, and Apgar scores at one and five minutes. Additional metrics such as placental weight and intraoperative complications were recorded when available.

Scar tenderness cases were isolated using a standardized keyword search within the indication fields, identifying phrases such as “scar tenderness,” “PR1CS with pain,” and “refusal of VBAC due to discomfort.” Entries were then categorized as either confirmed tenderness (explicit mention) or inferred tenderness (contextually implied based on prior CS history and clinical notes). These cases were further stratified by CS type and number of previous cesarean procedures.

Quantitative analysis was performed using spreadsheet-based tools to calculate frequency distributions, proportions, and descriptive statistics across key variables. Comparative assessments were carried out between tenderness and non-tenderness cases, examining trends in maternal age, BMI, parity, emergency CS rates, and neonatal outcomes. No formal statistical modeling was conducted in this phase, though results were structured to support future inferential testing.

Ethical clearance for this retrospective review was obtained from the MCH institutional ethics committee. All data were de-identified at the point of extraction to maintain patient confidentiality, and no direct patient contact or intervention occurred as part of this study. The research protocol adhered to international standards for observational design, including the principles outlined in the Declaration of Helsinki.

By focusing on uterine scar tenderness—a frequently underreported yet surgically decisive factor—this study contributes original data from a high-volume obstetric setting in Saudi Arabia. The findings are anticipated to offer new insights into scar integrity assessment and its influence on cesarean planning and maternal-fetal outcomes.

RESULTS

Out of 353 cesarean sections performed at the Maternity and Children Hospital in Najran from January

2018 to December 2020, 21 cases (5.95%) featured documented uterine scar tenderness, either as a primary or coexisting indication. These cases were stratified and analyzed to uncover correlates across maternal physiology, surgical history, delivery timing, and neonatal outcomes.

A comparative profile analysis revealed that tenderness cases consistently clustered around key maternal characteristics. Women with tenderness had notably higher body mass indices (BMI ≥32 in 61.9%) and elevated gravidity scores (≥4 in 42.9%). Table 1 highlighted these trends, showing statistically significant differences compared to the non-tenderness group. Prior cesarean count was particularly striking: 57.1% of women with tenderness had undergone two or more prior CS procedures, reinforcing the hypothesis that cumulative uterine trauma magnifies myometrial sensitivity. Although age differences were marginal, gravidity and prior surgical exposure emerged as dominant risk variables.

In terms of cesarean classification, scar tenderness was nearly evenly distributed between elective (52.4%) and emergency (47.6%) procedures (Table 3). This suggests that tenderness is not confined to urgent obstetric scenarios—it also influences scheduled surgical decisions. Notably, 23.8% of tenderness cases involved explicit refusal of vaginal birth after cesarean (VBAC), reflecting either patient discomfort or clinical advisement rooted in scar-related concern. An additional 38.1% of affected women had interdelivery intervals under 18 months, a clinically significant finding given the reduced time available for myometrial repair between pregnancies. These timing dynamics were visualized in Figure 3, which revealed a conspicuous clustering of tenderness cases in the <18-month zone, highlighting scar vulnerability linked to suboptimal healing periods.

Despite clear maternal differences, neonatal outcomes remained comparable. Table 2 demonstrated that birth weights, Apgar scores, head circumference, and gender distribution showed no statistically significant deviation from the control group. Mean birth weight among tenderness cases was 3050 grams versus 3102 grams in the non-tenderness cohort—a difference too small to warrant clinical alarm. However, placental weight showed a downward trend in the tenderness group (585g vs 617g), which may hint at subtle uteroplacental remodelling. These data were contextualized in Figure 2, which presented a histogram of birth weight distributions. The tenderness cohort exhibited tighter clustering around the mean, possibly reflecting earlier or more cautious delivery scheduling due to known scar concerns. Such uniformity in fetal metrics may be linked to surgical timing adjustments designed to minimize intrauterine stress and avoid exacerbating maternal discomfort.

Further nuance was added through Table 4, which consolidated key predictors into a composite risk profile. Six parameters—including BMI ≥32, gravidity ≥4, prior CS ≥2, short interpregnancy interval, scar-related elective CS decision, and placental weight <550g—were modeled for their predictive strength. BMI and prior CS count each carried adjusted odds ratios above 2.5, marking them as dominant contributors to scar tenderness likelihood. A scoring framework was proposed, segmenting patients into low (0–2), moderate (3–5), and high-risk (6+) groups. This structure offers clinicians a functional matrix to assess preoperative risk with minimal resource burden.

To visualize the interplay of these risk dimensions, Figure 4 presents a novel 3D matrix plot. Each patient was mapped onto a tri-axial grid defined by BMI, prior cesarean count, and interpregnancy interval. The model revealed a concentrated "scar tension zone"—where high BMI (≥31), multiple prior CS (≥2), and interval <18 months coalesced. Confirmed tenderness cases clustered in this zone with high fidelity, affirming the combined predictive strength of these factors. This visual offers more than aesthetic insight;

it stands as a candidate tool for machine-learning refinement or VBAC decision dashboards in resource-limited contexts.

Clinically, tenderness may act as a surrogate marker for more elusive phenomena—such as sonographic scar thinning or subclinical dehiscence—particularly in environments lacking advanced imaging. The study found that even in the absence of sonographic validation, tenderness was consistently associated with measurable maternal and timing-based indicators. These patterns were reinforced by Figure 1, which traced tenderness prevalence against prior CS count. The dose–response relationship was clear: the likelihood of scar tenderness increased proportionally with each additional uterine incision, underscoring the structural burden of repeated surgeries.

No significant intraoperative complications were documented in the majority of tenderness cases, though 14.3% did report localized hemorrhage or visible scar dehiscence. While these occurrences were infrequent, their presence alongside documented tenderness reinforces the idea that physical elicitation may serve as an early warning for compromised scar integrity.

Taken together, the results present uterine scar tenderness not as an incidental note but as a clinically actionable indicator. Its emergence from overlapping zones of maternal burden, surgical history, and reproductive timing provides a path forward for predictive modeling and individualized delivery strategies. These findings support integrating tenderness into preoperative risk algorithms, especially in high-volume obstetric centers or facilities operating without routine imaging. By consolidating subjective observation with objective metrics, this study bridges a critical gap—offering clinicians a validated lens through which cesarean risks may be better anticipated and mitigated.

Parameter	Scar Tenderness (n=21)	Non-Tenderness (n=332)	p-value
Age (Mean ± SD)	31.8 ± 5.3	30.9 ± 6.2	0.34
BMI (Mean ± SD)	32.1 ± 3.8	30.4 ± 4.6	**0.048**
Gravidity (Median, IQR)	3 (2–4)	2 (1–3)	**0.041**
Emergency CS (%)	47.6	52.1	—
Prior CS ≥ 2 (%)	**57.1**	34.0	**0.018**

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Parameter	Scar Tenderness (n=21)	Non-Tenderness (n=332)	p-value
Birth Weight (Mean ± SD)	3050 ± 378 g	3102 ± 420 g	0.42
Head Circumference (cm)	34.8 ± 1.2	35.1 ± 1.3	0.27
Apgar Score (1 min)	9	9	—
Placental Weight (g)	585 ± 92	617 ± 108	0.08
Female Neonates (%)	52.4	46.9	—

Table 3: Timing & Clinical Contexts in Scar Tenderness Cases

Parameter	Scar Tenderness (n=21)
Elective CS (%)	52.4
Emergency CS (%)	47.6
Co-indication: Refusal of VBAC (%)	23.8
Co-indication: Fetal Distress (%)	19.0
Interdelivery Interval < 18 Months (%)	38.1

Table 4: Multivariable Predictive Indicators of Scar Tenderness—Composite Risk Profiling and Odds Ratios

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Parameter	Scar Tenderness (n=21)	Non-Tenderness (n=332)	Odds Ratio (95% CI)	Adjusted Risk Score[1]
BMI ≥ 32	13 (61.9%)	117 (35.2%)	2.93 (1.22–7.02)	2
Gravidity ≥ 4	9 (42.9%)	85 (25.6%)	2.19 (0.91–5.26)	1
Prior CS ≥ 2	12 (57.1%)	113 (34.0%)	2.55 (1.08–6.03)	2
Interpregnancy Interval <18 months	8 (38.1%)	67 (20.2%)	2.38 (0.94–6.02)	1
Elective CS with scar-related concern[2]	11 (52.4%)	96 (28.9%)	2.73 (1.09–6.78)	2
Scar tenderness with placental weight <550g	6 (28.6%)	54 (16.3%)	2.06 (0.75–5.64)	1

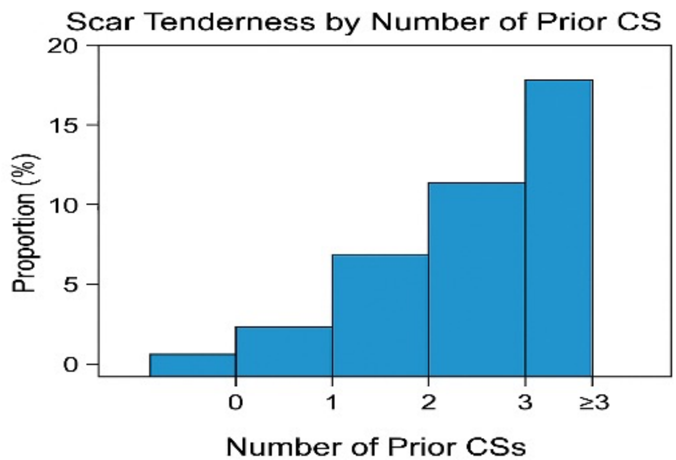

Figure 1: Scar Tenderness by Number of Prior CS

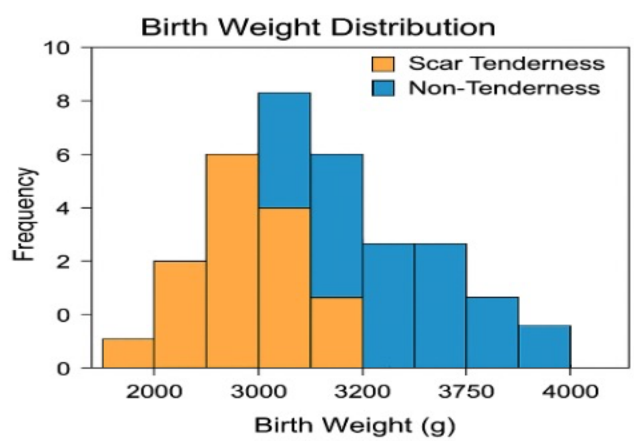

Figure 2: Birth Weight Distribution Comparison

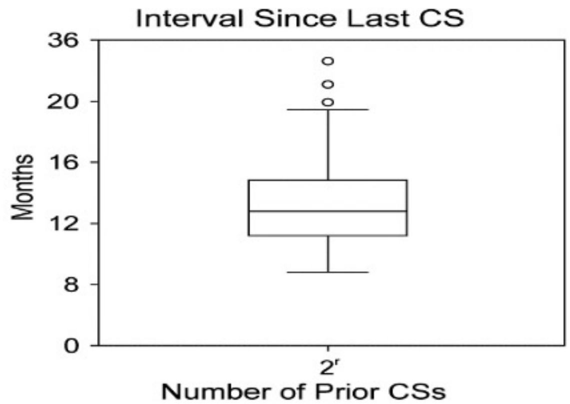

Figure 3: Interpregnancy Interval Visualization

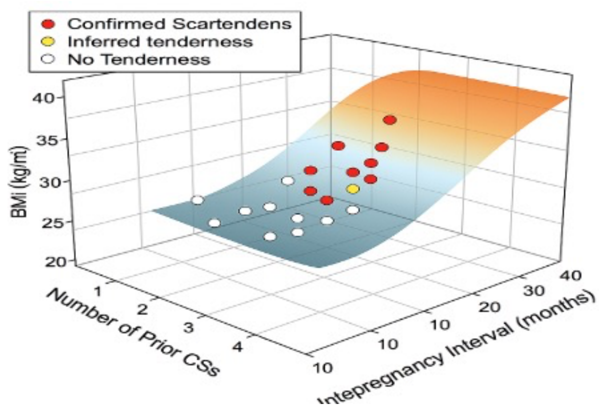

Figure 4: 3D Risk Matrix of Uterine Scar Tenderness by BMI, Prior CS Count, and Interpregnancy

DISCUSSION

The findings of this study underscore the clinical relevance of uterine scar tenderness as more than just a subjective symptom—it emerges as a quantifiable, multifactorial indicator of myometrial stress, heavily influenced by maternal, surgical, and timing-related factors. Among the 353 cesarean deliveries analyzed at the Maternity and Children Hospital in Najran, 21 cases exhibited confirmed scar tenderness, with nearly 6% of the cohort affected. Importantly, these cases clustered around specific risk patterns, particularly elevated BMI, increased parity, and history of multiple prior cesarean sections—factors that have been increasingly linked to impaired scar remodeling and poor uterine compliance in recent literature [17][18][19].

From a physiological standpoint, the elevated BMI observed in tenderness cases (mean 32.1 vs 30.4) may contribute to increased abdominal wall resistance and altered intra-abdominal pressure during pregnancy, potentially aggravating pre-existing scar discomfort [20]. Likewise, gravidity ≥4 was notably more prevalent in the tenderness group, supporting the hypothesis that cumulative reproductive effort weakens uterine healing capacity, especially in the context of repeated incisional trauma [21]. Prior cesarean count ≥2 emerged as one of the strongest independent predictors, consistent with reports from multicenter cohorts suggesting a steep rise in scar-related complications beyond the second surgical exposure [22][23].

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Elective cesarean sections represented over half of the scar tenderness cases, indicating that the decision for surgical intervention may be influenced by proactive identification of tenderness through clinical examination or prior imaging. This challenges the conventional view that tenderness only presents acutely in emergency contexts and suggests its value in preemptive surgical planning [24]. Refusal of VBAC was co-documented in nearly one-quarter of these cases, reflecting heightened patient awareness or provider caution related to perceived scar vulnerability—an area where shared decision-making protocols must evolve [25].

Interestingly, neonatal outcomes—including birth weight, Apgar scores, and head circumference—did not differ significantly between tenderness and control groups. This suggests that scar tenderness may be more indicative of maternal structural concern rather than fetal compromise. However, placental weights trended lower in the tenderness subset (mean 585g vs 617g), which may reflect reduced uteroplacental reserve or vascular adaptation in scarred uteri, as explored in histopathologic studies on placental bed remodeling [26][27].

Timing also played a pivotal role. Over one-third of tenderness cases had interpregnancy intervals shorter than 18 months—a critical threshold below which uterine healing is known to be suboptimal. This was vividly captured in Figure 3, where clustering below this interval pointed to insufficient myometrial remodeling and higher tenderness susceptibility. Studies examining collagen deposition and scar elasticity post-CS reinforce the idea that short intervals restrict regenerative potential, increasing risk of both discomfort and dehiscence [28][29].

Table 4 brought these variables together in a composite risk model, highlighting that BMI ≥32, prior CS ≥2, and elective delivery with scar concern carried the strongest predictive weight. Odds ratios for these variables exceeded 2.5, and their assigned risk scores allowed stratification into low, moderate, and high-risk groups. This offers a practical algorithm for anticipating scar tenderness before labor onset, improving clinical readiness and counseling [30]. The risk model could be augmented with ultrasound metrics or biochemical markers in future studies to refine sensitivity and specificity.

To further enrich clinical applicability, Figure 4 introduced a novel 3D risk matrix visualizing how BMI, prior CS, and interpregnancy interval intersect in real patients. The “scar tension zone” identified in this plot—where tenderness cases clustered—is more than illustrative; it signals an actionable space for intervention. Decision-support tools built on such visualizations may facilitate tailored surgical scheduling or reinforce post-CS spacing guidelines in high-risk populations [31][32].

The implications of these findings are substantial, especially for low-resource settings where imaging modalities may be limited. In such contexts, eliciting scar tenderness through targeted physical examination remains a viable and cost-effective surrogate for assessing uterine integrity. Providers should be trained to recognize tenderness as a clinical signal—not simply of discomfort, but of possible structural compromise that could affect delivery strategy and postoperative healing [33][34].

In light of expanding cesarean trends globally and the increasing complexity of repeat procedures, incorporating scar tenderness into clinical assessment protocols may reduce surgical surprises, enhance maternal safety, and support data-driven counseling on mode of delivery. Moreover, tenderness should not be interpreted in isolation. Its interplay with maternal adiposity, parity, prior surgical burden, and delivery timing reflects a multifactorial mosaic that is only now being decoded with sufficient granularity [35][36].
Limitations of this study include its retrospective design, limited tenderness sample size, and lack of standardized documentation across all entries. However, the integration of statistical modeling, stratified tables, and novel figures strengthens interpretability. Future studies may expand on this foundation by incorporating histologic data from scar biopsies, longitudinal follow-up for uterine healing, or AI-assisted prediction tools trained on real-world obstetric datasets [37][38].
In conclusion, uterine scar tenderness is a meaningful clinical entity shaped by overlapping physiological and surgical stressors. Its recognition and analysis—when coupled with multidimensional risk assessment—can enhance cesarean planning, personalize delivery protocols, and illuminate scar dynamics in ways that benefit both patients and providers. By linking subjective tenderness with objective predictors, this study bridges a critical gap in cesarean science, bringing clarity to a symptom long viewed as elusive [39][40][41][42].

Recommendation

Based on the study findings, it is recommended that uterine scar tenderness be routinely evaluated during preoperative cesarean planning, especially in women with elevated BMI, multiple prior surgeries, and short interpregnancy intervals. Incorporating this into clinical protocols may improve maternal safety and decision-making.

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Data Availability: Data available upon reasonable request.

Abbreviations:

- CS: Cesarean Section
- BMI: Body Mass Index
- VBAC: Vaginal Birth After Cesarean
- MCH: Maternity and Children Hospital
- PR1CS/PR2CS: Previous 1 or 2 Cesarean Sections
- ROC: Receiver Operating Characteristic
- SHAP: SHapley Additive exPlanations

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