



# Surgical benefits of bidirectional knotless barbed sutures over conventional sutures for uterine repair during cesarean section-A meta-analysis of randomized controlled trials

*Sezaryen sırasında uterus onarımı için kullanılan çift yönlü düğümsüz dikenli sütürlerin geleneksel sütürlere göre cerrahi açıdan faydaları-Randomize kontrollü çalışmaların bir meta-analizi*

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## Abstract

To analyze the surgical benefits of bidirectional knotless barbed suture (BS) compared with conventional sutures for uterine closure during cesarean section. The databases were searched using the following keywords: "Cesarean Section," "Uterine closure," "Barbed suture" and "Conventional suture." Randomized control trials reporting the comparison of bidirectional knotless BS with conventional sutures for closing uterine incision were included. The outcome measures were closing time of uterine incision, the number of additional hemostatic sutures used, blood loss parameters, and the total duration of surgery. A random or fixed-effects model was used to obtain the pooled estimates using the inverse variance method. The heterogeneity was assessed using the I2 test and the GRADE approach was used to assess the quality of evidence. Out of 15 full-text assessed, three randomized controlled trials were included. We observed significantly short uterine incision closure time with BS [standardised mean difference -1.51; 95% confidence interval (CI): -1.97, -1.06; I2=64%; GRADE approach evidence: Moderate], significantly lesser need of additional hemostatic sutures (risk ratio: 0.39; 95% CI: 0.28, 0.54; I2=0%; GRADE approach evidence: High) and significantly less blood loss during uterine incision closure [-0.47 (95% CI:-0.75, -0.19); I2 =0%; GRADE approach evidence: moderate]. with no significant difference in total blood loss, the need of blood transfusion, and total duration of surgery. The use of bidirectional knotless BS for uterine closure can reduce suturing time and the additional suture requirement.

**Keywords:** Barbed suture, cesarean section, conventional suture, uterine closure

## Öz

Bu meta-analiz, sezaryen sırasında uterus kapatma için geleneksel dikişlerle karşılaştırıldığında çift yönlü düğümsüz dikenli sütürlerin (DS) cerrahi faydalarını analiz etmek için yapılmıştır. Veri tabanları "sezaryen", "uterin kapatma", "dikenli sütür" ve "konvansiyonel sütür" anahtar kelimeleri kullanılarak tarandı. Uterus insizyonunu kapatmak için çift yönlü düğümsüz DS'nin konvansiyonel sütürlerle karşılaştırılmasını bildiren randomize kontrollü çalışmalar dahil edildi. Sonuç ölçütleri, uterus insizyonu kapanma zamanı, kullanılan ek hemostatik sütür sayısı, kan kaybı parametreleri ve toplam cerrahi süresiydi. Ters varyans yöntemini kullanarak havuzlanmış tahminleri elde etmek için rastgele veya sabit etkiler modeli kullanıldı. Heterojenlik, I2 testi kullanılarak değerlendirildi ve kanıt kalitesini değerlendirmek için GRADE yaklaşımı kullanıldı. Değerlendirilen 15 tam metinden üç randomize kontrollü çalışma dahil edildi. DS kullanımı ile daha kısa uterus insizyonunu kapatma süresi [standartlaştırılmış ortalama fark -1,51; %95 güven aralığı (GA): -1,97, -1,06; I2= %64; GRADE yaklaşımı kanıtı: orta] önemli ölçüde daha az ek hemostatik sütür ihtiyacı [risk oranı (RR): 0,39; %95 GA: 0,28, 0,54; I2= %0; GRADE yaklaşımı kanıtı: Yüksek] ve uterus insizyonunun kapatılması sırasında önemli ölçüde daha az kan kaybı (-0,47 [(%95 GA: -0,75, -0,19); I2 =0; GRADE yaklaşımı kanıtı: Orta] tespit edildi. Toplam kan kaybı, kan transfüzyonu ihtiyacı ve toplam ameliyat süresinde anlamlı bir fark gözlenmedi. Sonuç olarak, uterus kapatma için çift yönlü düğümsüz DS kullanımı, dikiş süresini ve ek dikiş ihtiyacını azaltabilir.

**Anahtar Kelimeler:** Dikenli sütür, sezaryen, konvansiyonel sütür, uterus kapatılması

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## Introduction

Cesarean section is the most performed surgery in obstetrics. There are many variations in the technical aspect particularly uterine incision closing technique either a single layer or double layer, intermittent suturing or continuous suturing, locked or unlocked suturing. There is a lack of evidence to recommend one suturing technique over the other or one suturing material over the other regarding the risk of short-term or long-term complications<sup>(1,2)</sup>. Surgeons mostly use the technique and suture material based on their experience or preference. Conventional smooth sutures require knotting. A surgical knot simply helps in anchoring the smooth suture. Knotting causes uneven distribution of tension across the incision and reduces the tensile strength of the suture by thinning and stretching the suture material<sup>(3)</sup>. Studies have reported a 35%-95% reduction in tensile strength at the site of the knot or just adjacent to the knot. Also, there are chances of suture failure due to knot slippage. This concern leads to the over-tightening of knots with conventional sutures. Tighter knots are even worse for tissue healing as they can cause localized tissue hypoxia and reduced fibroblast proliferation leading to decrease strength in the healed tissue. The knot also acts as foreign body material and the amount of inflammatory response is related to the number and size of the knot. So, minimizing knot size or eliminating knots altogether by using bidirectional knotless BS should be beneficial, if tissue approximation of suture line is not compromised<sup>(4,5)</sup>.

Knotless BS are a relatively new type of suture. BS have been approved by Food and Drug Administration since 2004. It consists of a standard monofilament suture with tiny barbs cut along the length, facing in opposite directions at approximately 1 mm intervals. The BS may be unidirectional with a needle at one end and a loop at the end of the suture or bidirectional with a needle at both the ends and barbs changing direction at the middle of the suture<sup>(3)</sup>.

BS is frequently used in gynecological surgeries especially laparoscopic surgeries over a decade because of their beneficial role in reducing suturing time and blood loss. Later, BS was introduced in obstetrics to reduce operative time and blood loss in cesarean section. The current meta-analysis determines whether knotless BS can be considered a reasonable alternative to conventional sutures.

## Materials and Methods

This meta-analysis was conducted as per the PRISMA checklist (Figure 1).

### 2.1. Study Identification

We searched published literature using the following electronic database- PubMed, Google Scholar, Clinical trial registry (clinicaltrials.gov.in, ctri.in), and Cochrane Database of Systematic Reviews. We also searched bibliographies of relevant research and review articles. A combination of the

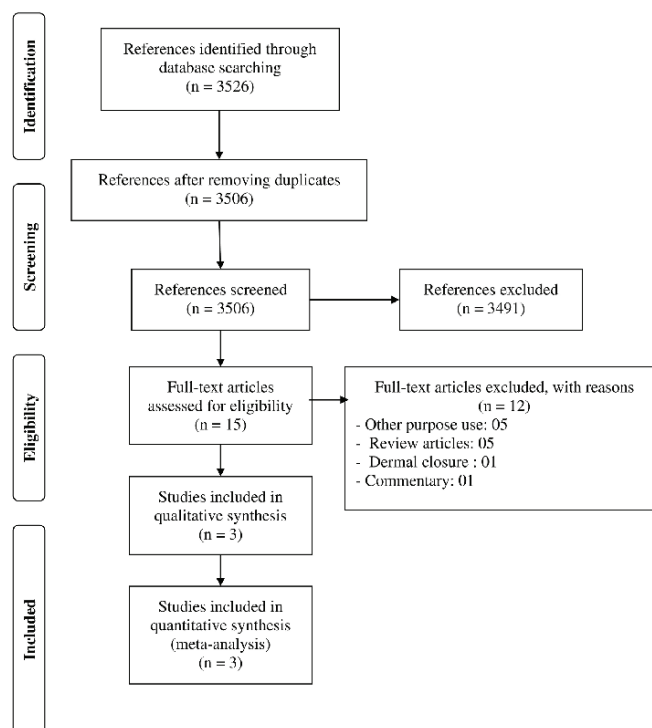
following search terms was used “Cesarean Section,” “Uterine closure,” “Barbed suture (BS)” and “Conventional suture.” Studies published up to August 2020 were included. The last search was run on 25<sup>th</sup> March 2021. Studies were selected on the basis of a review of the title and abstract by 2 independent investigators. There were no Language restrictions while searching for studies. The meta-analysis was registered on PROSPERO (CRD42020207029).

### 2.2. Selection Criteria

Articles reporting the comparison of a bidirectional knotless BS a conventional suture for closing uterine incision during cesarean section were assessed. Randomized control trials, which have provided data on the closing time of uterine incision with the use of bidirectional knotless BS and conventional sutures were included. Polyglactin and Catgut sutures were considered conventional sutures. All observational (cross-sectional, case-control, and cohort designs), non-comparative studies, review articles, and duplicate studies were excluded.

### 2.3. Risk of Bias Assessment of Included Studies

Three investigators assessed the methodological quality of the included studies as per revised Cochrane “risk of bias assessment tool for the randomized controlled clinical trials (ROB-II)”<sup>(6)</sup>. Each included studies were assessed for following parameters: the process of randomization, deviations from the intended interventions, missing outcome data, outcome measurement, and selective outcome reporting. Any disagreements were resolved by discussion and consensus among the authors.



**Figure 1.** Study selection- The preferred reporting items for systematic reviews and meta-analysis flow diagram

## 2.4. Data Extraction

The following data were extracted in a Microsoft Excel sheet, 2019: The first author, publication year, study design, the place of study, age, the indication of cesarean sections, number of previous cesarean sections, and outcome data as per intention-to-treat analysis. The data were cross-checked to ensure the accuracy of extraction.

## 2.5. Outcome Measures

The main outcome measure chosen for this meta-analysis was the closing time of uterine incision. Other outcome measures were the number of additional hemostatic sutures used, blood loss parameters, and the total duration of surgery.

## 2.6. Data Synthesis

All continuous outcome variables were presented as standard mean difference (SMD) with a 95% confidence interval (CI). The SMD of 0.2 was considered a small effect, 0.5 a moderate, and 0.8 a large effect as described previously<sup>(7)</sup>. All dichotomous variables were presented as a risk ratio (RR) and its 95% CI. The I<sup>2</sup> index was used to look for heterogeneity among included studies. Fixed-effects model was used if there is no significant heterogeneity. If the I<sup>2</sup> index >50% among analyzed studies, then a random-effects model was used. The funnel plot method was used to report publication bias. The meta-analytic summary was measured using the inverse-variance method.

A sensitivity analysis of all outcomes was performed based on the risk of bias assessment. The outcome measures were estimated by excluding studies having “some concern” or “high concern” on the risk of bias assessment.

The GRADE approach was used to present the quality of the evidence for each outcome variable. The following parameters were considered: study design, study limitations, inconsistency, indirectness of evidence, imprecision, and publication bias<sup>(8)</sup>. The meta-analysis was performed using Review Manager software version 5.4.

## Results

### 3.1. Study Characteristics

A total of 3,526 articles were found after a meticulous search using the search strategy. As shown in Figure 1, three

intervention trials (comprising of 136 bidirectional knotless BS cases and 136 conventional suture cases) were included out of 15 full-text articles assessed as per selection criteria in this meta-analysis. Relevant study characteristics of included trials (study design, size and types of sutures, and the number of participants) are summarized in Table 1<sup>(9-11)</sup>. Baseline characteristics of the patients from all included trials are summarized in Table 2. The most common indication for cesarean was failed/refused Trial of labor followed by arrest disorders, multiple gestations, cephalopelvic disproportion, etc. in all included studies.

Grin et al.<sup>(9)</sup> conducted a randomized controlled trial on 70 participants (35-35 in each group). The participants, data analysts, and postpartum staff were kept blinded to the treatment allocation. Surgeons were unmasked to randomization after scrubbing for the surgery, as it is impossible to keep them blinded due to the different appearance of suture materials. Baseline demographics, medical history, and antepartum characteristics were comparable in both groups. A standard operative technique was used in the cases. Uterine incision length and maximal myometrial thickness were measured using a sterile disposable ruler as they can be the potential confounding factors. In one group, the uterine incision was closed using bidirectional knotless BS in a two-layer continuous, non-locking technique. In another group, uterine closure was done using polyglactin in two layers, the first layer a continuous locking and the second layer a continuous non-locking manner. Peleg et al.<sup>(10)</sup> Conducted an open-labeled, randomized controlled trial, 102 women were randomized, 51-51 in each group. Randomization was kept masked till the time of surgery to minimize provider bias. Demographic and clinical characteristics were similar in both groups. Four experienced surgeons performed all the cesarean sections using a similar technique. In the bidirectional knotless BS group uterus was closed in two-layers continuous, unlocked fashion. In the polyglactin group, the first layer was in continuous locking with knotting on both ends and the second layer in a continuous unlocked fashion. The outcome data were assessed by blinded assessors.

Zayed et al.<sup>(11)</sup> Conducted an allocation concealed, randomized controlled trial, 100 women were randomized into 2 groups in a 1:1 ratio. The clinical profile of the included women (gravidity, parity, gestational age at the time of cesarean, number

**Table 1.** Characteristics of included studies

Study	Study design	Barbed suture	Conventional suture	Barbed suture group (N)	Conventional suture group (N)
Grin et al. 2019 <sup>(9)</sup>	RCT	Size-1.0 “Stratafix”	Size-1.0, Polyglactin suture, “vicryl”	35	35
Peleg et al. 2018 <sup>(10)</sup>	RCT	Size-2.0 “Stratafix”	Coated size-1.0 polyglactin 910 suture, “Vicryl Plus”	51	51
Zayed et al. 2017 <sup>(11)</sup>	RCT	Size-1.0 “Stratafix”	Size-1.0, polyglactin 910 suture, “vicryl”	50	50

RCT: Randomised controlled trial

Table 2. Base-line characteristics of patients in the included studies

Study	Number		Age (years) Mean ± SD		BMI (kg/m <sup>2</sup> ) Mean ± SD		Gravidity Mean ± SD		Parity Mean ± SD		Gestational age (weeks) Mean ± SD		Previous cesarean n, percentage/Mean ± SD*	
	Barbed	Conventional	Barbed	Conventional	Barbed	Conventional	Barbed	Conventional	Barbed	Conventional	Barbed	Conventional	Barbed	Conventional
Grin et al. 2019 <sup>(9)</sup>	35	35	32.4±5.4	32.9±6.1	30.7±5.9	32.6±6.4	3.1±2	2.9±1.2	1.6±1.8	1.5±1	38±2 <sup>o</sup>	38±2 <sup>o</sup>	17 (48.6)	18 (51.4)
Peleg et al. 2018 <sup>(10)</sup>	51	51	32.2±6.2	33.0±5.0	30.07±5.08	30.50±5.01	2.8±1.5	2.9±1.3	1.5±1.3	1.5±1.0	NR	NR	31 (60.8%)	39 (76.5%)
Zayed et al. 2017 <sup>(11)</sup>	50	50	NR	NR	NR	NR	2.3±1.7	2.1±1.1	1.5±1.2	1.5±1.2	37.8±0.74	37.8±0.95	1.9±1*	1.7±0.7*

SD: Standard deviation

of previous cesarean sections, indications of cesarean section, etc.) was comparable in both arms. Though, they did not mention baseline characteristics like age, BMI in their study. All the cesarean was done by a single surgeon. In the bidirectional knotless BS group, the uterus was closed in a two-layer continuous suturing technique. In the polyglactin group, the first layer was closed using the continuous suturing technique and the second layer was closed with interrupted sutures. The study did not comment on the blinding of outcome assessors.

### 3.2. Risk of Bias Assessment

The risk of bias assessment in individual trials is in Figure 2. Two randomized controlled trials were considered of having low<sup>(9,10)</sup> and one having “some concern”<sup>(11)</sup> as per the ROB-II tool. Zayed et al.<sup>(11)</sup> was considered to have ‘some concern’ for measuring outcomes.

### 3.3 Outcomes

#### 3.3.1. Uterine Incision Closing Time

All three included studies took uterine incision closing time as their primary outcome. Two studies mentioned closing time in seconds while the third one gave results in minutes. For comparing the data, results given in minutes were converted to seconds. The uterine incision closing time was significantly shorter in a bidirectional knotless BS group than that in the conventional suture group based on a pooled SMD of -1.51 [95% CI: -1.97, -1.06]; I<sup>2</sup>= 64%]. (Figure 3). As shown in Table 3, the GRADE approach suggests moderate-quality evidence of the uterine incision closing time outcome. The funnel plot appeared asymmetrical on visual inspection. On sensitivity analysis, a similar trend was observed. The result was found to be favoring BS group [SMD: -1.30 (95% CI: -1.69, -0.91); I<sup>2</sup>= 26%].

#### 3.3.2. Additional Suture Requirement

Similarly, the need for additional sutures for hemostasis was found to be significantly less in the bidirectional knotless BS compared to the conventional suture group. The pooled RR for additional suture was 0.39 [95% CI: 0.28, 0.54]; I<sup>2</sup> = 0%] (Figure 4). The GRADE approach suggests high-quality evidence of this outcome. On sensitivity analysis, the trend favored BS group [RR: 0.40 (95% CI: 0.29, 0.57); I<sup>2</sup> = 0%].

#### 3.3.3. Blood Loss Parameters

##### 3.3.3.1. Blood Loss During Uterine Incision Closure

Two studies contributed to blood loss during uterine incision closure analysis. The pooled SMD for blood loss during uterine closure was -0.47 [(95% CI: -0.75, -0.19); I<sup>2</sup>= 0%] (Figure 5). The GRADE approach suggests moderate-quality evidence of this outcome. On sensitivity analysis, the results favoured BS group [SMD: -0.56 (95% CI: -0.96, -0.16); n=1].

##### 3.3.3.2. Total Blood Loss During Surgery

On comparing total blood loss during surgery, the bidirectional knotless BS was not found to have an additional advantage over conventional sutures. Only two studies contributed to total blood loss analysis. The pooled SMD for total blood loss during surgery was -0.25 [(95% CI: -1.01, 0.51); I<sup>2</sup> =84%] (Figure 6).

##### 3.3.3.3. Need for Blood Transfusion

Two studies reported the need for blood transfusion. The pooled RR for the need of blood transfusion was 1.00 [(95% CI: 0.11, 9.45); I<sup>2</sup>= 0%] (Figure 7). The GRADE approach suggests moderate-quality evidence of this outcome (Table 3).

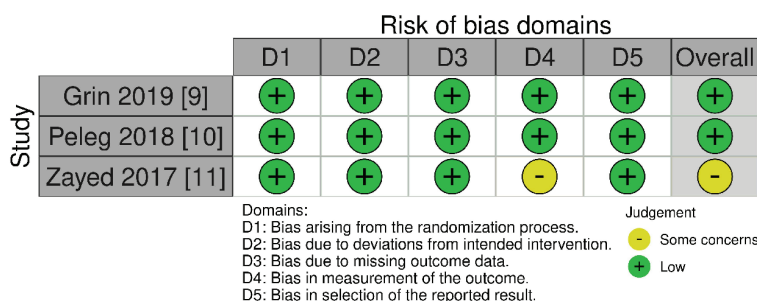


Figure 2. Risk of bias assessment as per “Revised Cochrane risk-of-bias tool for randomized trials (ROB-II)”

### 3.3.3.4. Perioperative Hemoglobin Change (Delta Hemoglobin)

Only one study by Grin et al.<sup>(9)</sup> reported a change in hemoglobin between preoperative and postoperative blood count. The authors found no significant difference in delta hemoglobin levels between both the groups at various time intervals (6, 18, 72 h postoperative).

### 3.3.3.5. Need of Additional Uterotonics and Need of Hemostatic Agents

Only one study by Grin et al.<sup>(9)</sup> reported a comparison on the need for additional uterotonics (misoprostol, methylergonovine,

and carboprost tromethamine) and the need for hemostatic agents (Surgicel Nu-Knit Absorbable Hemostat, Ethicon). They found a significant reduction in the hemostatic agent used in the BS group (RR-0.33) with no difference in the uterotonic requirement (p=0.8).

### 3.3.4. Other Outcomes

All 3 included studies contributed to the total duration of surgery analysis. The pooled SMD for a total duration of surgery was -0.43[(95% CI: -2.08, 1.21); I<sup>2</sup> =97%] (Figure 8). BS did not show any advantage compared to conventional sutures. The GRADE approach suggests low-quality evidence of this

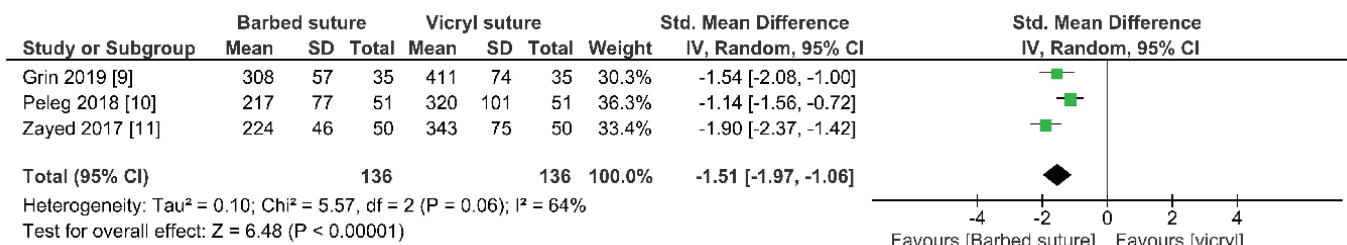


Figure 3. Meta-analytic summary of uterine incision closing time through the random effect of model

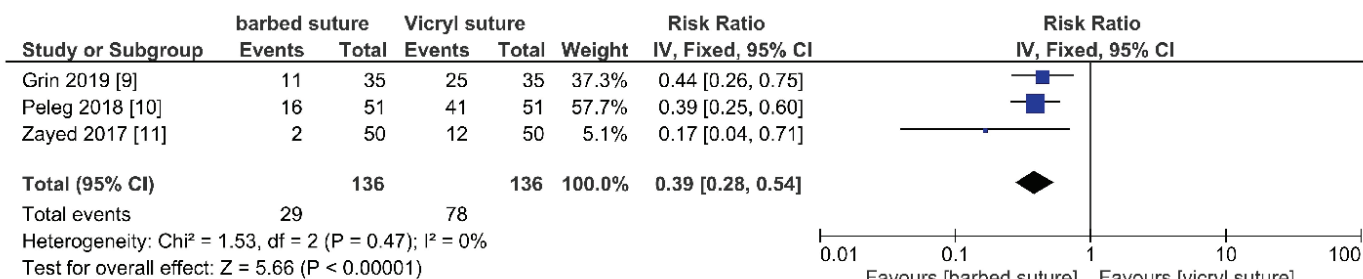


Figure 4. Meta-analytic summary of additional suture requirement through the fixed effect of model

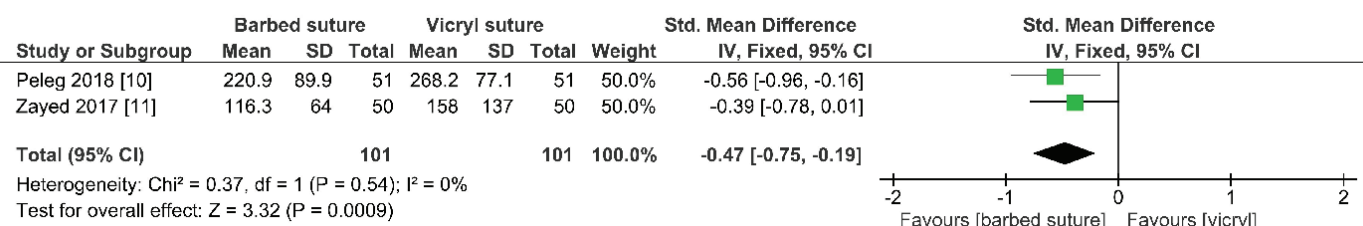


Figure 5. Meta-analytic summary of blood loss during uterine incision closure through the fixed effect of model

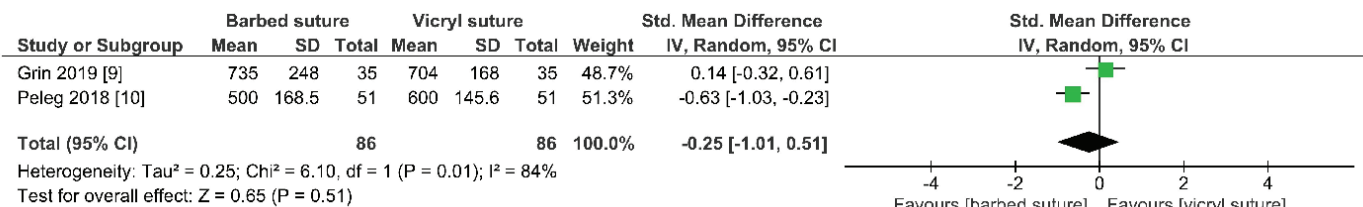


Figure 6. Meta-analytic summary of total blood loss during surgery through the random effect of model

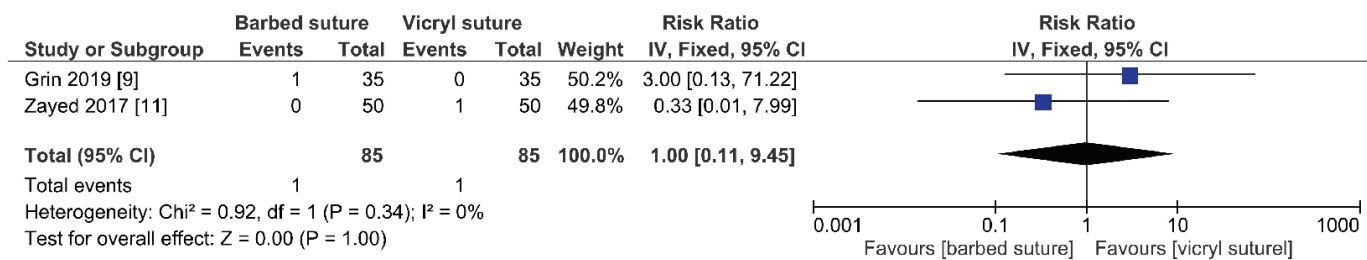


Figure 7. Meta-analytic summary of the need of blood transfusion through the fixed effect of model

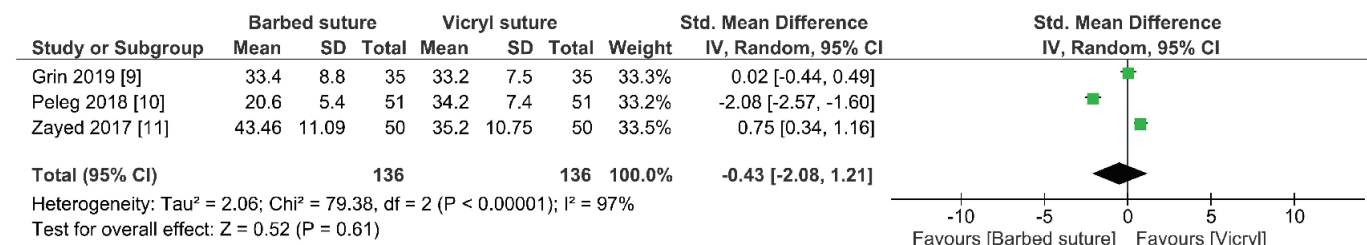


Figure 8. Meta-analytic summary of the total duration of surgery through the random effect of model

outcome (Table 3). The cost of sutures was reported in one study. Zayed et al.<sup>(11)</sup> mentioned the cost of sutures used in uterine incision closure, which was significantly higher in the BS group (22.75±0 versus 11.025±1.61 U.S. dollars, p<0.001, mean difference 11.725 U.S. dollars). But the number of sutures required was almost three times in the vicryl group, reducing the cost difference (1±0.00 in the barbed group versus 2.94±0.43 in the vicryl group).

**Discussion**

To summarize, BS offers a significant surgical advantage over conventional smooth sutures in terms of uterine incision closing time, the need for additional hemostatic sutures, and the amount of blood loss during uterine incision closure. GRADE approach suggests moderate to high quality of evidence; However, BS were not found to provide any benefit in terms of total blood loss during surgery, total duration of surgery, the need for blood transfusion, and perioperative complications. A similar trend was observed in the sensitivity analysis.

Suturing is one of the important steps during the cesarean section. Suturing techniques and choice of suture material can influence the healing of the cesarean section scar<sup>(12,13)</sup>. BS has been introduced in obstetrics recently, as they provide a combined advantage of continuous and interrupted sutures and reduce the suturing time and bleeding without causing tissue ischemia. Several factors are associated with BS, which contribute to a better outcome. First, it might be due to a reduction in suturing time of uterine incision. The reduction in suturing time can be because BS do not require knots as well as there is no backsliding of the suture<sup>(14,15)</sup>. Compared to

conventional continuous sutures, BS do not require tension to be applied to the suture thread by the assistant. Once the BS has been pulled taut, the points of commissure will not loosen even if the tension is not maintained on the suture thread by the assistant<sup>(16)</sup>. The self-anchoring property of BS contributes significantly in reducing the suturing time. Second, BS result in a good approximation of tissues at the start of suturing resulting in early hemostasis and reduced blood loss<sup>(17)</sup>. Third, much evidence suggests that BS are associated with better tissue healing. This may be because the presence of barbs on the suture thread at an equal distance result in an equal distribution of tension along the suture line and causes less ischemia to the tissues as well as an absence of knots reduces inflammatory reaction, which harms the healing of tissues<sup>(3,18)</sup>.

The significantly lesser time in uterine closure with the use of BS has important implications in terms of generalizability. Because, the skill and experience of the surgeon might play a crucial role regarding the uterine incision closing time. Conventional sutures being more widely used, replicability of this meta-analysis result requires prior surgeon training in suturing with BS as done in the included studies. However, long-term risks and benefits such as myometrial healing and effect on subsequent pregnancy are still unknown. Peleg et al.<sup>(10)</sup> compared uterine incision closing time among all operating surgeons. Three of four surgeons had significantly shorter closing times with BS, which suggest results should be easily replicable. Grin et al.<sup>(9)</sup> did further stratification in the primary cesarean group and repeat cesarean group. The time required to complete the uterine repair was significantly lower in both the strata when BS was used. This shows BS is equally effective in previous cesarean section patients.

**Table 3.** Quality assessment for outcome parameters as per GRADE approach

No. of studies (Study design)	Study limitations (Risk of bias)	Inconsistency	Indirectness	Imprecision	Publication bias	Quality	Outcome
Closing time - uterine incision							
Three (RCT)	Unclear (No serious limitations)	Substantial heterogeneity ( $I^2=64\%$ ), but of questionable importance (No serious inconsistency)	No serious indirectness	Sample size less than 400 (serious imprecision)	Asymmetric Funnel plot	Moderate	SMD: -1.15 (-1.97, -1.06)
Need for additional suture							
Three (RCT)	Unclear (No serious limitations)	No heterogeneity $-I^2=0\%$ (No serious inconsistency)	No serious indirectness	Sample size less than 400 (Serious imprecision)	Asymmetric Funnel plot	High*	RR - 0.39 (0.28, 0.54)
Blood loss during uterine incision closure							
Two (RCT)	Unclear (No serious limitations)	No heterogeneity $-I^2=0\%$ (No serious inconsistency)	No serious indirectness	Sample size less than 400 (Serious imprecision)	Asymmetric Funnel plot	Moderate	SMD: -0.47 (-0.75, -0.19)
Total blood loss							
Two (RCT)	Unclear (No serious limitations)	Substantial heterogeneity ( $I^2=84\%$ ), of unequivocal importance (Serious inconsistency)	No serious indirectness	Sample size less than 400 (Serious imprecision)	Asymmetric Funnel plot	Low	RR: -0.25 (-1.01, 0.51)
Need of blood transfusion							
Two (RCT)	Unclear (No serious limitations)	No heterogeneity $-I^2=0\%$ (No serious inconsistency)	No serious indirectness	Sample size less than 400 and wide confidence interval (Serious imprecision)	Asymmetric Funnel plot	Moderate	RR: 1.00 (0.11, 9.45)
Total duration of surgery							
Three (RCT)	Unclear (No serious limitations)	Substantial heterogeneity ( $I^2=97\%$ ), of unequivocal importance (Serious inconsistency)	No serious indirectness	Sample size less than 400 (Serious imprecision)	Asymmetric Funnel plot	Low	SMD: -0.43 (-2.08, 1.21)
*Rating updated from moderate to high due to large magnitude of effect ( $RR<0.5$ ); RCT: Randomized controlled trial, CI: Confidence interval, SMD: Standardized mean difference							

Our meta-analysis supports the findings of an earlier meta-analysis showing the beneficial effects of using BS during laparoscopic hysterectomy and myomectomy<sup>(19-21)</sup>. Over time, the use of BS has expanded in gynecological surgeries. Various studies have shown comparable efficacy to conventional sutures with the added advantage of decreasing suturing time, total

operative time, and blood loss during uterine defect closure in Myomectomies<sup>(14-16,18,22-24)</sup> and during vaginal cuff repair during laparoscopic hysterectomies<sup>(25-27)</sup>.

Our meta-analysis showed that the BS group required a significantly lesser number of additional sutures compared to the conventional group for closing uterine incision during

cesarean section (RR-0.39). The higher cost of BS can be offset as conventional suturing often requires additional hemostatic sutures, which eventually reduces the cost difference<sup>(22)</sup>. According to a USA study if we look at the average total charges of cesarean delivery, using BS only increases the total charges by 0.05%, which is an insignificant amount<sup>(28)</sup>. But the scenario could be different in developing countries. Future studies should compare the cost-effectivity of BS in developing countries.

Our meta-analysis could not detect a significant difference in the total duration of surgery as this may be influenced by multiple factors such as the presence of intraabdominal adhesions, adherent bladder in cases of previous cesarean sections, time consumption during the baby delivery, the time required for delivery of the placenta and achieving hemostasis. Furthermore, the experience and expertise of a primary surgeon can also play a role. Because using BS only affects uterine repair, the rest of the factors remain unchangeable, so its effect on the total duration of surgery could not be found. But a recent review of BS versus conventional suture at cesarean delivery found a significant reduction in total surgical duration. This could be because the authors also included a study comparing BS and conventional sutures for skin closure<sup>(29)</sup>. It is difficult to ensure comparability between uterine musculature closure and skin closure. In contrast with the meta-analysis on gynecological surgeries<sup>(19-21)</sup>, our meta-analysis failed to demonstrate a reduction in the blood loss during uterine incision loss and total blood loss during surgery. As there are many possible reasons for bleeding during cesarean delivery. The common causes are uterine atony, uterine incision extensions, adhesions, placental site bleeding, etc.<sup>(30)</sup>. Another reason could be the small number of studies included in this analysis.

Due to data limitations, a meta-analytic summary could not be calculated for the peri-operative complications. However, the use of BS did not cause any increase in the incidence of perioperative complications. There was no case of wound infection/endometritis or any other maternal morbidity in all included studies. This finding is also supported by a study by Alessandri et al.<sup>(31)</sup>, who used a fishbone technique with BS for uterine incision closure and compared residual myometrial thickness, incidence, and depth of isthmocele in both groups up to 12 months of follow-up. They found a significantly better result with BS. But till now there is uncertainty on long-term complications such as adhesion formation, poor wound healing leading to increased risk of wound dehiscence or uterine rupture, and morbidly adherent placenta in the next pregnancy. Future studies are needed to resolve such issues.

### Study Limitation

This meta-analysis has several limitations. Our findings on BS should be interpreted cautiously due to the inclusion of the open-labeled and small number of randomized studies

### Conclusion

The moderate to high-quality evidence suggests the use of bidirectional knotless BS can reduce suturing time and the additional suture requirement for uterine closure.

### Ethics

**Peer-review:** Internally and externally peer-reviewed.

### Authorship Contributions

Concept: P.D., Design: P.D., Data Collection or Processing: A.S., Analysis or Interpretation: A.S., Literature Search: T.P., Writing: P.D., A.S., T.P.

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