

Original Research

Safety and efficacy of knotless barbed suture in cesarean section using postpartum ultrasound: a retrospective cohort study

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Abstract

Background: While speed, safety, and efficacy are necessary in the operation of cesarean section (CS), a number of new devices have been introduced to support the technique. This retrospective study was conducted to assess the usability and safety of knotless barbed suture, compared to conventional method, for closure of uterine myometrium during cesarean section. **Methods:** Patients who underwent cesarean delivery at Korea University Ansan Hospital between August 2018 and December 2019 were reviewed. Surgical outcomes including uterine closure time, operating time, estimated blood loss, and sonographic results of residual myometrial thickness at the site of incision at 6 to 8 weeks after operation were analyzed. **Results:** Out of total 78 women, 44 patients had knotless barbed suture and 34 patients underwent conventional suture. Compared to conventional method, the uterine closure time was significantly reduced ($p = 0.012$). Operative time, estimated blood loss during operation, hemoglobin difference on the third operative day, and the number of cases with transfusion, postpartum infection, and bleeding demonstrated no significant differences between the two groups. At 6 to 8 weeks after operation, transvaginal ultrasound revealed no differences in residual myometrial scar thickness. **Conclusion:** Knotless barbed suture resulted in significantly shorter uterine closure time and no increased rate of perioperative complications. Our work supports that knotless barbed suture can be effectively used for cesarean section.

Keywords: Knotless barbed suture; Cesarean section; Uterine closure time; Ultrasound; Myometrial thickness

1. Introduction

Cesarean section is the most frequent obstetrical surgery worldwide, with markedly increasing rates along the last several decades. The rising proportion of cesarean delivery is considered to have resulted from increased average age, obesity, development in obstetrical technology such as electronic fetal heart rate monitoring, and maternal request [1,2]. In this regard, competent surgical technology regarding speed, safety, and efficacy is essential in operating cesarean section. Various new devices including scrub agents, retractors, and suturing products have been developed to support the necessary techniques and minimize maternal morbidity and mortality [3].

As one of the innovative materials, bidirectional knotless barbed suture has barbs aligned in a helical pattern, which are cut into a monofilament suture at approximately 1 mm intervals and progress in opposite directions from the small central part that is unbarbed. This suture reduces suture and operative time by eliminating the duty of tying knots, evenly distributes tension along the incision line, and provides possibility of improved cosmesis [4]. In recent years, numerous studies proved safety and efficacy of barbed sutures in gynecologic surgeries [5–8] while there

was little study about their usage in open surgeries [4,9] and one metaanalysis showed insufficient safety measures in surgical fields [10]. However, some of recent trials demonstrated competence of knotless barbed suture in cesarean section as a reasonable alternative to conventional sutures, reducing closure time of uterine incision [11,12]. But these studies did not evaluate cesarean section (CS) scars by postpartum ultrasound which is clinically useful method to determine CS scar integrity.

Transvaginal ultrasound is highly accurate in detecting CS scar integrity and dehiscence. CS scar dehiscence and myometrial thinning are associated with uterine rupture, placenta previa, abnormally adherent placenta, cesarean scar pregnancy, and abnormal uterine bleeding in non-pregnant patients [13,14]. Labor precede CS and multiple cesarean deliveries are predisposing factors for dehiscence [14]. Assessment of CS scar status is becoming essential for clinical assessment of future pregnancy planning, gynecologic symptoms and possible surgical treatment for dehiscence [15,16].

The purpose of this study was to estimate the efficacy and safety of bidirectional knotless barbed suture for closure of myometrium in cesarean section, comparing with conventional suture.



2. Material and methods

We retrospectively reviewed the medical records of all the women who underwent CS at Korea University Ansan Hospital between August 2018 and December 2019. This study was approved by institutional review board of Korea University Ansan Hospital, which included a waiver for the obtainment of informed consent (2020AS0047). The study was conducted in accordance with the Declaration of Helsinki. CS was performed by one expert obstetrician who has >10 years' experience in high pregnancy unit. CS procedures were performed as follows. The abdomen was opened by a Pfannenstiel incision, the lower uterine segment was transversely incised with the scalpel followed by blunt expansion with fingers and this incision was repaired with two layers of a continuous suture, either bidirectional knotless barbed suture or conventional suture with polyglactin. For polyglactin suturing, two layers were in a running unlocked manner with knotting on both ends. Decidua was not involved when myometrium was approximated. All patients received prophylactic intravenous ceftazolin (2 g) once. Intravenous oxytocin after extraction of placenta was routinely used in our group. Additional uterotonic agents such as prostaglandin and/or methylergonovine were used when postpartum bleeding was diagnosed. Women who underwent vertical cesarean section, hysterectomy and pelvic arterial embolization following a cesarean section and underwent bilateral tubal ligation and women with chorioamnionitis and/or other infection were excluded from the study.

We recorded demographic characteristics of the patients including age, body mass index (BMI), parity, abortion, and smoking status. Obstetric outcomes were assessed; CS indications, multiple pregnancies, pregnancy induced hypertension (preeclampsia (PE), eclampsia, superimposed PE on chronic hypertension (HTN), and gestational HTN), diabetes, preterm birth, conception by assisted reproductive technology, birthweight and gender of baby. Surgical outcomes were determined by uterine closure time, total operation time, estimated blood loss, hemoglobin difference between preoperative result and result on third postoperative day, transfusion, puerperal infection and postpartum bleeding. Total operation time was defined as the time from the skin incision to the end of skin closure. Uterine closure time and total operation time were recorded by fully experienced nurse in the operating room.

The patients were followed up at 6 to 8 weeks postpartum. Expert physicians performed a two dimensional transvaginal ultrasound scan using 4–9 MHz Samsung Medison UGEO H60 (Samsung, Seoul, Korea) or 5–8 MHz GE Voluson E8 (Austria GmbH & Co OG, Austria).

The angle between the longitudinal axis of the uterus and the cervix determines the position of uterus. Retroversion is defined when the uterine long axis is located posteriorly relative to the cervical long axis. Residual myometrial thickness or CS scar thickness is defined in a sagittal sec-

tion as the shortest length between the endometrium and the uterine serosa at the level of the CS scar (Fig. 1). The percentages of the myometrial thickness at the CS scar depth to the thickness of the adjacent normal myometrium in the sagittal plane represent the degree of thinning [17].

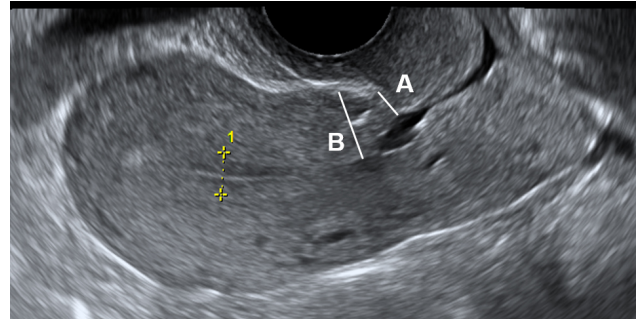


Fig. 1. Sonographic myometrial thickness evaluation at cesarean section scar. (A) Residual myometrial thickness. (B) Adjacent normal myometrial thickness.

The Shapiro Wilk method was used to assess the normality of the data. Comparisons between two groups were performed using student *t*-test or Mann-Whitney rank sum tests as appropriate. Categorical values were compared with χ^2 or Fisher exact test. All continuous data with normal distribution were reported as either mean and standard deviation and data with non-normal distribution were presented as median. Statistical analysis was performed using SPSS 20 (SPSS, Inc, Chicago, IL, USA). We considered a *p* value < 0.05 to indicate statistical significance.

3. Results

3.1 Demographic and clinical characteristics

Table 1 demonstrates demographic and clinical characteristics. A total of 78 women were selected and 44 women received knotless barbed suture for the repair of CS uterine incision. The age of women in polyglactin suture group was slightly older than knotless barbed suture group. There was no difference in portion of primiparity, BMI, smoking, and abortion. CS indication including previous CS, nonreassuring fetal heart rate, malpresentation, failure to progress, induction failure, and placenta previa were similar between two groups. There was no difference in prevalence of multiple pregnancies, pregnancy induced hypertension, diabetes, conception by assisted reproductive technology, and preterm birth between two groups. Neonatal birthweight and gender showed no differences between two groups.

3.2 Surgical outcomes

Uterine closure time in knotless barbed suture group demonstrated significantly reduced compared to polyglactin suture group (*p* = 0.012) (Table 2). There were

Table 1. Demographic and clinical characteristics.

Characteristics	Knotless barbed (n = 44)	Conventional (n = 34)	p = value
Age (years)*	29.1 ± 4.6	31.7 ± 6.4	0.041
Primiparity (%)	50	32.3	0.170
BMI, kg/m ²	28.2 ± 5	31.4 ± 6.7	0.720
Smoking (%)	0	0	-
Abortion (%)	40.9	20.5	0.086
Csec indication (case number)			
SuPrevious csec	14	11	1
NRFHR	2	6	0.066
Malpresentation	11	5	0.401
Failure to progress/Induction failure	7	4	0.751
Previa	3	3	0.695
Multiple pregnancy (%)	15.9	5.8	0.288
PIH (%)	29.5	32.3	0.806
Diabetes (%)	13.6	20.5	0.379
ART (%)	6.8	5.8	1
Preterm birth (%)	59.1	52.9	0.822
Preterm labor (%)	11.4	17.6	0.514
PPROM (%)	18.2	20.6	0.777
Birthweight (g)	2596 ± 787	2470 ± 986	0.552
Gender male (%)	61.3	50	0.362

Csec, cesarean section; PIH, Pregnancy induced hypertension: Preeclampsia/Eclampsia/chronic HTN/gestational HTN/Superimposed preeclampsia; NRFHR, nonreassuring fetal heart rate; ART, assisted reproductive technology; PPROM, preterm premature rupture of membranes.

*p-value < 0.05.

no differences in total operation time, estimated blood loss and hemoglobin difference between preoperative and third-day postoperative result. The percentage of transfusion and postpartum bleeding were similar between two groups. There was no puerperal infection in both groups.

3.3 Ultrasonographic results at postpartum

There were no differences in thickness of myometrium at site of CS scar and nearby CS scar between two groups. The percentage of residual myometrial thickness showed no difference between two groups. The rate of retroverted uterus were similar between two groups (Table 3).

For subgroup analysis (Table 4), surgical outcomes were compared between two groups in terms of first CS cases after we excluded previous CS cases. The percentage of uterine retroversion and thickness of myometrium at the site of CS scar and nearby CS scar were similar between two groups. Uterine closure time was significantly reduced in knotless barbed suture group ($p = 0.006$) but total operation time and hemoglobin difference were comparable to polyglactin group.

4. Discussion

4.1 Main findings

Knotless barbed suture in CS reduced significantly uterine closure time. Shortterm surgical outcomes and residual myometrial thickness percentage at CS scar by transvaginal ultrasound after 6 to 8 weeks from surgery showed no differences compared to conventional method. To eliminate interference from multiple CS deliveries, we performed subgroup analysis by primary CS and the results showed no significant difference in all variables except uterine closure time.

4.2 Strength and limitation

This was the first study to evaluate residual myometrial thickness by transvaginal ultrasound at postpartum after uterine closure using knotless barbed suture. However, there are several pitfalls and caution that should be taken to interpret principal findings. First, the study has retrospective approach that there are subjective surgical outcomes underestimated or overestimated such as estimated blood loss. Second, economic aspect was not assessed since knotless barbed suture material is five times more expensive than one polyglactin thread in South Korea, so it is disputable whether the advantage of using knotless barbed suture overcomes the cost. Third, we could not analyze long-

Table 2. Surgical outcomes.

Surgical parameters	Knotless barbed (n = 44)	Conventional (n = 34)	p = value
Uterine closure time (sec)*	407 ± 98	560 ± 202	0.012
Operation time (min)	57.9 ± 10.6	58.7 ± 8.7	0.715
Estimated total blood loss, mL	355.4 ± 164	375 ± 123.2	0.561
Hemoglobin difference (g/dL)**	2.1 ± 1.3	1.6 ± 1.5	0.146
Transfusion (%)	2/44	1/34	1
Puerperal infection	0	0	0
Postpartum bleeding	1/44	1/34	1

*p-value < 0.05, **Hemoglobin difference = preoperative Hb-third operative day Hb.

Table 3. Ultrasonographic results at 6–8 weeks after cesarean section.

Ultrasound parameters	Knotless barbed (n = 34)	Conventional (n = 28)	p = value
Thickness of myometrium at site of cesarean section scar (mm)	9.5 ± 2.6	8.8 ± 2.2	0.321
Thickness of myometrium nearby cesarean section scar (mm)	12.4 ± 3.3	11.8 ± 2.5	0.408
Residual myometrial thickness (%)	76.6 ± 9.2	75.5 ± 12.4	0.702
Uterine Retroversion(%)	32.3	35.7	0.794

Table 4. Ultrasonographic results at 6–8 weeks after primary cesarean section.

Ultrasound parameters	Knotless barbed (n = 26)	Conventional (n = 20)	p = value
Thickness of myometrium at site of cesarean section scar (mm)	9.8 ± 2.3	9.5 ± 1.9	0.731
Thickness of myometrium nearby cesarean section scar (mm)	12.7 ± 2.9	12.3 ± 2.5	0.581
Residual myometrial thickness (%)	77.3 ± 8.4	78.7 ± 11.2	0.638
Uterine retroversion (%)	34.6	40	0.765
Uterine closure time (sec)*	423.8 ± 103.2	670 ± 251.6	0.006
Operation time (min)	55 ± 9	58 ± 8	0.123
Hemoglobin difference (g/dL)**	2.3 ± 1.3	1.9 ± 1.5	0.278

*p-value < 0.05, **Hemoglobin difference = preoperative Hb-third operative day Hb.

term ultrasound images because there were no follow up after postpartum follow up for CS unless they are pregnant again. Complete tissue healing usually takes more than 6 months, which implies the need to examine long-term follow up of CS scar either sonographically or grossly to determine safety measures. Follow up in 6–8 weeks was still considered worthwhile, however, since there was a past study that demonstrated that the incidence of scar defects between 6-weeks follow up and 12-months follow up was not significantly different [18].

4.3 Interpretation

The reason for selection of knotless barbed suture in CS was to improve uterine scar quality. Thinning of the myometrium is reported to occur 37–39% due to incomplete healing of CS scar which leads to long-term complications [19,20]. Wound tension with traditional sutures might result in tissue ischemia or adverse scar when tension is irregularly distributed throughout the closure. Pressure necrosis from sutures is the primary factor in wound dehiscence and excessive tension can also result in reduced wound strength and inflammation [21]. The particularly

important evolution about barbed suture is that there is no need to tie knots, and therefore can distribute tension evenly along the incision line with possibly faster suture. However, one important drawback about barbed suture is that cutting barbs reduces the tensile strength of the suture by weakening core and narrowing its functional diameter [9]. Therefore, barbed sutures provide instructions stating that safety and effectiveness have not been established for use in fascial closures.

Two previous RCT reported reduced time in repair of the CS uterine incision and slightly reduced estimated blood loss compared to conventional polyglactin suture [11,22]. Our results are consistent with these previous trials but these studies did not analyze sonographic outcomes of the scar at postpartum. Measurement at uterine scar thickness after CS gives the opportunity to evaluate whether the scar is completely healed or not and the influence of closure technique on scar healing. CS scar myometrial thickness is one important factor that determines success of trial of labor after CS. Because the thickness of myometrium is correlated with uterine rupture risk, the precise measurement of myometrium at the site of CS may help expect future compli-

cation of uterine rupture and dehiscence in the next pregnancy. Previous studies have measured the thickness of lower uterine segment and suggested lower likelihood of uterine rupture and better chance of successful vaginal delivery after CS with thicker lower uterine segment [23–25].

Niche was defined as an indentation at the site of the CS scar with a depth of at least 2 mm in Delphi study [26]. It may be the causative factor for abnormal uterine bleeding, dysmenorrhea, obstetrics complications in subsequent pregnancies and subfertility [15,27]. Both niche volume and the ‘healing ratio’ (residual myometrial thickness (RMT)/adjacent myometrial thickness (AMT)) have been reported to be associated with abnormal uterine bleeding [27,28]. Our study estimated this ‘healing ratio’ using myometrial thickness at site of CS scar at 6 to 8 weeks after operation, which emphasized on perioperative transformation according to the type of suture. Our results of no differences in residual myometrial thickness between knotless barbed and polyglactin sutures implicate comparable gynecologic complications after CS between two groups.

5. Conclusions

Knotless barbed suture in CS yielded significantly reduced uterine closure time compared to conventional method. There were no increased rate of perioperative complications including operative time, estimated blood loss, and other complications such as infection and postpartum hemorrhage with knotless barbed suture. It is notable that this is the first study to show no difference in residual myometrial scar thickness postoperatively using knotless barbed suture. The current study highlights that the use of knotless barbed suture is the reasonable alternative to conventional suture. However, longterm complications such as abnormal uterine bleeding and subsequent pregnancy outcome should be evaluated to conclude safety measures of knotless barbed suture in CS.

Author contributions

JYH—Data collection, manuscript writing. HYK, HSB—Project development, manuscript writing. GJC—Data curation, methodology. KHA—Data management, manuscript review. SCH—Data analysis, manuscript review. MJO—Data collection, manuscript review. HJK—Project development, manuscript writing and review.

Ethics approval and consent to participate

This study was approved by institutional review board of Korea University Ansan Hospital (2020AS0047). Informed consents were unable to be obtained due to retrospective nature of this study.

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Conflict of interest

The authors declare no conflict of interest.

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