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REVIEW

Barbed suture in laparoscopic myomectomy

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ABSTRACT

Uterine myomas are the most common benign gynecological tumors among women of reproductive age. The laparoscopic approach, when feasible, is considered the most suitable and safe technique for intervention. Typically, uterine muscular wall defects are sutured with absorbable filaments. However, performing intra-corporeal knots during laparoscopic procedures demands significant surgical abilities and experience. While laparoscopic myomectomies are often recommended, they pose a high risk of hemorrhage. Barbed sutures may address the challenges of laparoscopic knotting due to their inherent barbs, leading to filament cohesion with tissues. This characteristic could potentially reduce the total operative time and blood loss during surgery. In consideration of the latest literature meta-analysis on the topic, published in 2018 and cited in the present work, six papers were included in this review, excluding case reports, reviews and articles without a control group. The objective of this narrative review is to explore the literature and establish the safety profile of barbed suture compared to conventional laparoscopic sutures. Additionally, given the potential for postoperative adhesion formation with the use of barbed sutures, the review also emphasizes reproductive outcomes. Consistent with previous literature, patients undergoing barbed suture laparoscopic myomectomy experienced significantly lower suturing time and blood loss. Regarding obstetric outcomes, all studies analyzing this aspect concluded that barbed sutures in myomectomy are as safe as, and represent an easier alternative to, conventional sutures. Importantly, these findings did not adversely affect pregnancy outcomes.

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KEY WORDS: Sutures; Uterine myomectomy; Laparoscopy; Leiomyoma; Pregnancy outcome.

Uterine leiomyomas, also referred to as fibroids or myomas, are the most common pelvic neoplasm in females.¹ These benign, monoclonal tumors originate from smooth myometrial muscle cells and typically arise in reproductive age.² Symptomatic uterine myomas often present with pelvic pain, abnormal uterine bleeding and reproductive dysfunctions, such as infertility or adverse pregnancy outcomes.³

The International Federation of Gynecology and Obstetrics (FIGO) classifies uterine fibroids based on their location in the uterus: intramural (FIGO type 3, 4 and 5), submucosal (FIGO type 0, 1 and 2), subserosal (FIGO type 6, 7) and

cervical myomas (FIGO type 8).⁴ Clinical diagnosis relies on pelvic examination and pelvic ultrasound findings, supported by characteristic symptoms.¹ Management considerations encompass factors such as number, size, localization, surgical experience, the patient's age and the desire of future pregnancy. Several medical and surgical methods, including laparoscopy, hysteroscopy, robotic-assisted laparoscopy and laparotomy are employed for myoma treatment.⁵

Laparoscopic myomectomy (LM) is considered the treatment of choice for symptomatic patients desiring fertility preservation. Compared to laparotomy, LM offers advantages such as

shorter hospital stays, faster recovery, less post-operative pain and better cosmetic results.⁶

Excessive bleeding is a significant complication of laparoscopic myomectomy. Despite various prophylactic methods, such as uterine artery ligation, intramyometrial vasopressin injection, oxytocin perfusion and preoperative treatment with gonadotropin-releasing hormone analogues, no single method has a 100% success rate.⁷⁻¹¹ Suturing is the quickest and most effective procedure to stop bleeding, however it requires advanced laparoscopic skills. To address this challenge, barbed sutures have been introduced, featuring knotless surgical sutures with barbs that penetrate and lock into the tissue, eliminating the need for knots.¹²

The introduction of absorbable barbed suture in laparoscopic gynecological surgery has yielded positive results, eliminating, as previously reported, the necessity for intracorporeal knots to ensure effective control of tissue bleeding.¹³

When assessing the benefits of barbed sutures for laparoscopic myomectomy, it is crucial to consider reproductive outcomes, given that fertility preservation is one of the primary reasons for performing this type of surgery.³ This review aims to present an updated summary of the current literature regarding the feasibility and effectiveness of classic intracorporeal knots sutures and barbed absorbable sutures during laparoscopic myomectomy. Additionally, we seek to evaluate whether recent findings align with those demonstrated in the previous meta-analysis by Gardella *et al.*¹⁴ in 2018. In their study, barbed sutures were proven to be time-saving, easy to perform and safer in terms of blood loss for patients undergoing laparoscopic myomectomy through this procedure.

Search strategy

To conduct this review, the methodological framework developed by Arksey and O'Malley¹⁵ was adopted, including six stages as follows:

- formulating a research question that is generally broad in nature;
- identifying relevant studies as comprehensively as possible;

- establishing inclusion/exclusion criteria, based on familiarity with the literature, to select relevant studies;

- charting the data, which includes sifting and sorting information according to key issues and themes;

- collating, summarizing, and reporting the results to provide a descriptive and numerical summary of the data and a thematic analysis;

- performing a consultation exercise is an additional, parallel step involving key stakeholders to inform and validate study findings.

By searching the terms “laparoscopic myomectomy,” “barbed” and “barbed suture” on PubMed, EMBASE and Google Scholar, some of the main online search sources, 20 results were found from 2018 to December 2023. This timeframe was chosen by authors considering the last existing literature review on the topic, published in 2018 and cited in the present work. Excluding case reports, reviews and articles that did not involve a control group, six papers were included in this review. Table I and II¹⁶⁻²¹ summarize the research investigation, principal demographic, clinical characteristics and surgical features presented in each paper.

A total of 681 women who underwent laparoscopic myomectomy were included in the studies. Among them, 325 patients underwent uterine wall defect repair using barbed suture, while 356 were considered as controls, using conventional sutures.

Eligibility criteria, study selection, and data extraction

Selection criteria

Selection criteria were based on PICO (Population, phenomenon of Interest and Context):²²

- population: 681 women who underwent laparoscopic myomectomy. Among them, 325 patients had uterine wall defect repair using barbed suture, while 356 patients sutured with conventional sutures;

- phenomenon of interest: patients in reproductive age undergoing laparoscopic myomectomy. Exclusion criteria were the use of barbed suture in other gynecological surgical practices such as vaginal cuff closure after hysterectomy,

TABLE I.—Demographic data of laparoscopic myomectomies with or without barbed suture.¹⁶⁻²¹

Demographics	Nakayama ¹⁶	Ota ¹⁷	Paul ¹⁸	Arena ¹⁹	Tatar ²⁰	Won ²¹
Study design	Retrospective	Retrospective	Retrospective cohort study with prospective follow-up survey	Retrospective cohort study with prospective follow-up survey	Randomized	Retrospective cohort
N. subjects						
Barbed group	29	13	115	83	41	44
Control group	15	13	120	81	34	93
Age, years						
Barbed group	38	34	32.6	36.7	35.9	35.6
Control group	40	34	32.3	35.2	36.9	32.9
P value	0.46	0.98	0.62	0.39	0.51	<0.01
BMI, kg/m ²						
Barbed group	20.8	20.3	ND	ND	23.4	22.4
Control group	22.1	21.6	ND	ND	25.9	21.4
P value	0.08	0.56	–	–	0.16	0.08
Diameter of myoma, cm						
Barbed group	7.4	8.4	7.4	6.5	7	6.2
Control group	8.6	8.4	6.1	5.9	7	5.8
P value	0.37	0.76	<0.01	0.10	0.64	0.29
Myomas						
Barbed group	1.67	5	2	3	1	4.3
Control group	1.3	6	2	2.9	1	3.5
P value	0.65	0.08	0.17	0.69	1	0.12
Myoma weight, g						
Barbed group	ND	255	200	ND	130	124.6
Control group	ND	267	160	ND	120	125.9
P value	–	0.61	0.19	–	0.89	0.95

uro-gynecological surgery and obstetric procedures such as cesarean section; case reports, reviews and articles that did not involve a control group; papers written in languages other than English. Robotic-assisted laparoscopic myomectomies were not included since no papers were published on this topic in the period of examination;

- context: feasibility and effectiveness of classic intracorporeal knots sutures and barbed absorbable sutures during laparoscopic myomectomy.

Data extraction

Table I and II summarize the research investigation, principal demographics, and clinical characteristics and surgical features presented in each paper.

The variables considered for comparison included total operative time, suture time, blood loss, Hb drop, hospital stay and complication rates.

Process of study assessment

Preliminary examination of titles and abstracts was conducted according to the review questions. If unclear from the abstract whether an article contained relevant data, the full article was assessed. F.S. and A.L. independently assessed and discussed the quality of all eligible studies. The analytic process involved categorizing relevant issues and summarizing the findings.

Six articles, corresponding to the review's purpose, were included in the systematic review. A narrative synthesis of the selected studies was, therefore, conducted, summarizing findings based on different outcomes.

Synthesis of the results

In 2020, Nakayama *et al.*¹⁶ conducted the first retrospective study in Japan, comparing bidirectional barbed suture with conventional suture in laparoscopic myomectomy. The study included 44 patients, with 29 undergoing laparoscopic

TABLE II.—Perioperative and postoperative data of laparoscopic myomectomies with or without barbed suture.¹⁶⁻²¹

Parameters	Nakayama ¹⁶	Ota ¹⁷	Paul ¹⁸	Arena ¹⁹	Tatar ²⁰	Won ²¹
Total operative time (min)						
Barbed group	120	98 (80-113)	85	111±31	60 (30-150)	129.6±58.3
Control group	198	120 (92-128)	92.5	118±38	90 (30-150)	126.4±44.89
P value	0.01	<0.01	0.73	0.17	0.39	0.73
Suture time (min)						
Barbed group	40.1±12.6	ND	ND	ND	15 (8-50)	ND
Control group	66.2±27.2	ND	ND	ND	23.5 (5-60)	ND
P value	0.007	—	—	—	0.007	—
Blood loss (mL)						
Barbed group	154	190 (159-223)	200	ND	80 (10-320)	247±202
Control group	424	245 (201-260)	110	ND	120 (20-500)	247 (± 216)
P value	0.03	<0.01	<0.01	—	0.018	0.49
Hb drop (g/dL)						
Barbed group	1.12±0.8	ND	ND	1.8±0.9	1.9 (0-4.7)	ND
Control group	1.55±0.7	ND	ND	1.7±1	2.1 (0.1-4.9)	ND
P value	0.35	—	—	0.46	0.12	—
Postop hospital stay (days)						
Barbed group	4.5±1.9	ND	ND	3.7±1	2 (2-4)	ND
Control group	4.7±1.8	ND	ND	3.6±1.2	2 (2-4)	ND
P value	0.56	—	—	0.44	0.28	—
Postoperative complications						
Barbed group	0	0	9	14	3 blood transfusions	1 blood transfusion
Nausea, vomit				2		
Fever				3		
Anemia				6		
Blood transfusion				1		
Mild decrease of urinary output				2		
Minor electrolyte alteration				1		
Control group	0	0	4	19	8 blood transfusions	3 blood transfusion
Nausea, vomit				3		
Fever				5		
Anemia				8		
Blood transfusion				3		
Mild decrease of urinary output				1		
Minor electrolyte alteration				2		
P value	—	—	0.16	0.29	0.04	1

myomectomy using bidirectional barbed suture (group 1) and 15 using the conventional suture technique (group 2).

No significant differences were found in terms of age, BMI, number of myomas, and maximum myoma size between the two groups. However, the median operation time and blood loss were significantly less in group 1 than in group 2. Suturing time was also significantly shorter in the barbed group. Regarding hemoglobin drop and hospital length of stay, no differences were observed. No intraoperative or postoperative complications were reported in either group.

In conclusion, the barbs in this suture enabled

the maintenance of tensile strength evenly along the total length of the wound. This characteristic simplified the suturing process and ensured easy maintenance of hemostasis. This feature was, according to the authors, particularly beneficial for gynecological surgeons, even those who may not be highly skilled.

A retrospective study, conducted by Ota *et al.*¹⁸ in 2021 in Japan, aimed to investigate whether a single-thread unidirectional barbed suture, without exposing the barbs on the wound surface, was comparable to conventional suture method during laparoscopic myomectomy (LM). Twenty-six patients were enrolled: thirteen underwent

LM using conventional synthetic absorbable suture (control group), and thirteen underwent LM using a barbed suture (case group).

The barbed suture was applied with a two-layer continuous technique: the first layer was made wider apart than the conventional suture to ensure adequate hemostasis, while the second layer employed the “baseball” technique. In this technique, the needle with the barbed suture was inserted from the inside and passed through the serosa adjacent to the wound edge, aiming to prevent barb surfacing – one of the common drawbacks of this suture method that may lead to possible intestinal obstruction due to barbs exposed on the wound surface.

Patients’ characteristics showed no significant differences in terms of age, body mass index, number of fibroids, fibroid maximum diameter and total weight of the fibroids removed in the two groups. However, concerning operative parameters, blood loss was significantly lower in the case group, and the operative time was reduced in the barbed suture group compared to the conventional suture group.

In case of multiple myomectomies, the authors employed a unique technique wherein the same needle and thread to suture another myomectomy site by passing through the muscle layer. This approach lowered the operative time, as less time was needed for inserting and removing the needle through the trocar. It reduced costs by avoiding the use of multiple threads, and authors highlighted how this could be a disadvantage in the barbed suture technique.

A retrospective cohort study with prospective follow-up, conducted by Paul *et al.*,¹⁸ aimed to compare reproductive outcomes between patients who underwent laparoscopic myomectomy using non-barbed (group A) vs barbed sutures (group B). The study included a total of 235 patients, with 120 in the non-barbed group and 115 in the barbed group.

Perioperative characteristics, including clinical presentation, myoma localization, mean number of myomas removed, and post-operative complication rate, were comparable between both study groups. In contrast to most of the previous studies, Paul *et al.* did not find a statistical difference in surgery duration. This could be at-

tributed to the surgeon’s significant expertise in laparoscopic suturing and knotting, authors stated. Additionally, any time saved during the use of barbed sutures might have been compensated by the additional time required for the larger uteri in the barbed group. Blood loss, contrary to other studies, was greater in group B, with the authors attributing this discrepancy to the larger size and weight of fibroids in the barbed group.

Regarding pregnancy outcomes, univariate analysis revealed that both suture materials had similar reproductive outcomes without any statistical difference. Pregnancy rates were comparable (97 in group A *versus* 85 in group B, $P=0.204$), as were assisted reproductive technology (ART) pregnancies, incidence of miscarriages, and ectopic pregnancies. Pregnancy complications such as preterm labor, fetal growth restriction, pre-eclampsia and placenta previa showed no significant differences between the study groups.

In conclusion, the authors asserted that barbed sutures in laparoscopic myomectomy are as safe as conventional sutures and offer a more straightforward alternative without adversely affecting pregnancy outcomes.

Arena *et al.*¹⁹ conducted a retrospective, monocentric cohort study with a prospective follow-up concerning post-operative pregnancies in a tertiary-level academic referral center in Italy in 2021.

The study included 164 patients who underwent laparoscopic removal of FIGO 3, 4, 5 and 6 uterine leiomyomas. Of these, 83 were sutured with barbed suture (group A), and 81 with traditional smooth suture. Given that proper suturing is essential to reduce the incidence of adverse obstetric outcomes such as uterine rupture and placental complications, the primary objectives of this study were reproductive outcomes, specifically pregnancy achievement rates, delivery modes and main pregnancy complications. Perioperative complications were also analyzed for both groups. Women who had not actively sought pregnancy after surgery were ruled out, aligning with the primary objective of the study.

The two groups did not greatly differ in terms of medical history or clinical features, except for age, which was slightly higher in group B.

Myoma characteristics were also comparable between the two groups, as were postoperative complications.

There was no statistically significant difference in pregnancy occurrence (42 patients in barbed group *versus* 49 non-barbed, 50.6% and 60.5% respectively) and delivery mode between the two groups. Pregnancy complications appeared similar between barbed and non-barbed, with only one case of marginal placenta previa in the barbed group and no cases of uterine rupture reported in either group.

In conclusion, the application of barbed suture did not seem to be statistically significant different in pregnancy outcomes compared to traditional suture. The only anamnestic characteristic influencing pregnancy rate was the patient's age, as expected. In contrast with previous findings, however, the authors did not find significant differences in terms of total operative time and blood loss between the two groups, possible due to the surgeons' great expertise in laparoscopic suturing.

The primary objective of a single-center randomized study, conducted by Tatar *et al.*²⁰ in Türkiye in 2023, was to compare the surgical and clinical outcomes of traditional absorbable polyglactin 910 and barbed sutures in laparoscopic myomectomy.

The study included non-pregnant, reproductive age patients with a single type 4, 5 or 6 FIGO Leiomyoma Subclassification System and a uterine size reaching the maximum umbilicus level. The study population comprised 78 randomized patients: 41 received a unidirectional barbed suture, while 37 patients received a continuous conventional absorbable suture. Three patients were excluded due to conversion to laparotomy, resulting in a total of 34 patients who underwent conventional suture and were included in the study. All operations were performed by the same surgeon to minimize bias.

Patient demographic data, intraoperative findings, preoperative and postoperative hemoglobin values, postoperative blood transfusion requirements, and hospital stay duration were recorded.

The study groups were similar in terms of age, BMI, previous abdominal surgeries, weight and diameter of the myoma, localization, and layers

of suture. Consistent with other studies in the literature, perioperative findings indicated that suture time, blood loss and transfusion requirements were significantly lower in the barbed suture group compared to the conventional suture group. However, postoperative hemoglobin and hospital stay duration were comparable between the two groups.

The difference in operative time did not reach statistical significance between the two groups, possibly due to the high qualification and experience of the surgeon in conventional intracorporeal suturing. Therefore, the authors suggest that additional studies involving less experienced surgeons could potentially demonstrate the advantages of barbed sutures more clearly.

The aim of a retrospective cohort study, conducted in South Korea by Won *et al.*,²¹ was to compare postoperative adhesion and pregnancy outcomes between barbed suture and conventional suture after mini-invasive myomectomy (MIM). Postoperative adhesions and adverse pregnancy outcomes were evaluated following cesarean section.

Ninety-four women who had undergone MIM with conventional suture (CS) were included, compared with 97 who had undergone MIM with barbed suture (BS). Excluding patients who underwent robotic surgery (exclusion criteria of current review), the statistical analysis included 93 patients with CS and 44 with BS.

Contrary to other studies, Won *et al.* demonstrated that there was no statistical difference between the two groups, except for older age in the BS group. When analyzing pregnancy outcomes after myomectomy and surgical characteristics and outcomes at cesarean section, no differences were found between the two groups. The incidence of postoperative adhesion after MIM was superimposable, leading to the conclusion that suture type does not seem to have a significant effect on pregnancy outcomes.

Discussion

In 2008, Greenberg and Einarsson²³ were the first to describe the use of bidirectional barbed filament for suturing the uterine breach in a retrospective trial. Over the years, numerous clinical

trials and case reports have been published on the use of barbed suture in gynecological surgery, spanning applications such as vaginal cuff closure after hysterectomy, uro-gynecological surgery and obstetric procedures such as cesarean section.²⁴⁻²⁶ Consistent with previous literature,²⁷ which highlights how barbed sutures could reduce total operation time, the use of barbed filaments has been found to decrease the time required to suture uterine wall defects after myomectomy.

Additionally, while concerns regarding barbed-induced adhesion formation and inflammation were significant,^{28, 29} particularly in reproductive age patients with a desire for pregnancy, the application of barbed sutures did not yield statistically significant differences in pregnancy outcomes, as detailed in Table III.^{18, 19, 21} In the three dedicated studies focusing on obstetric outcomes^{18, 19, 21} no discernible distinctions were observed in terms of pregnancy rate, assisted reproductive technology (ART) utilization, or obstetric complications, including placental disorders (such as placenta previa), intrauterine growth restriction, pre-eclampsia or preterm birth.

The risk of uterine rupture in subsequent pregnancies after myomectomy is a common con-

cern. According to a recent systematic review conducted by Gambacorta-Passerini *et al.*,³⁰ the risk is reported to be around 0.7-1% in literature. Nevertheless, currently, there is insufficient evidence to avoid this significant complication. Assessing the incidence of uterine rupture in myomectomies using barbed sutures versus conventional sutures would have been an intriguing parameter. However, it is noteworthy that no cases of uterine rupture were reported in either group. Considering that it is generally recommended to wait at least 6 months between surgery and pregnancy, comparing data between the two groups would have been interesting. Unfortunately, none of the three studies described these statistics.

Regarding total operative time, only two studies out of six^{16, 17} (33%) demonstrated a statistically significant reduction with barbed sutures *versus* conventional sutures. However, these procedures were performed by highly skilled and qualified surgeons with optimal abilities in laparoscopic suturing and knotting, potentially introducing bias. On the other hand, while suturing time was analyzed in only two studies, in both cases barbed suture allowed for a statistically significant reduction in time. Complete data in the

TABLE III.—Pregnancy outcomes after laparoscopic myomectomies with or without barbed suture.^{18, 19, 21}

Parameter	Paul ¹⁸	Arena ¹⁹	Won ²¹
Use of ART			
Barbed group	4	16	ND
Control group	3	13	ND
P value	0.57	0.58	—
Cesarean delivery			
Barbed group	31	28	36
Control group	32	29	84
P value	0.97	0.87	0.22
Placenta previa			
Barbed group	1	1	0
Control group	0	0	1
P value	0.99	0.45	1
Intrauterine growth restriction			
Barbed group	5	2	ND
Control group	2	2	ND
P value	0.94	1	—
Preeclampsia			
Barbed group	1	2	1
Control group	0	3	2
P value	0.99	1	1
Preterm birth			
Barbed group	5	2	7
Control group	3	2	14
P value	0.49	1	0.88

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remaining four studies could have possibly reduced the bias, or, on the contrary, confirm what was asserted.

Blood loss was a parameter with greater consensus, as five^{16-18, 20, 21} out of the six studies analyzed highlighted a significant reduction for patients undergoing laparoscopic myomectomy with barbed sutures. The notable benefit of barbed suture lies in their ability to maintain tension in uterine tissue during the suture procedure, and the absence of knots reduces damage to uterine tissue due to tears or lacerations in the surrounding area. In myomectomies, both laparoscopic and laparotomic, the most significant aspect of the surgical procedure is the inevitable blood loss from the uterine lesion to enucleate the myoma.³¹ Only the tension of suture and the speed of repairing the uterine wall defect can control bleeding and prevent uterine hematomas. Therefore, the characteristics of barbed filaments allow for better control at the hysterotomy site, resulting in a minor blood loss and subsequent decrease in Hb levels.

Postoperative stay showed no differences between the two groups in any of the papers analyzed.

Although only Arena's¹⁹ research group highlighted a statistically significant reduction in postoperative complications in the barbed group compared to the control group, similar results were found in other papers. Surprisingly, Paul *et al.*¹⁸ registered a higher number of complications in the barbed group. However, this result could be attributed to the statistically significantly greater medium diameter of the myoma in the barbed group compared to the conventional suture group. Consequently, the surgical procedure might have been more challenging, and patients in the barbed group may have been more exposed to postoperative complications.

Regarding costs, it is known that barbed materials are more expensive than conventional filaments. However, as highlighted by Ota *et al.*,¹⁷ the use of a single thread compared to the multiple threads required for a traditional hysterorrhaphy may offset the cost. Additionally, the reduction in blood loss and hospital assistance can potentially compensate for the higher costs associated with barbed filaments.

Conclusions

The living literature reveals that the use of barbed sutures significantly facilitates laparoscopic myomectomy by reducing suturing time and estimated total blood loss in most of the studies considered. Although there were no consistent results regarding a reduction in operative time, it is worth noting that laparoscopic myomectomies were performed by surgeons with advanced surgical skills. Consequently, additional studies involving less experienced surgeons could potentially provide clearer evidence of the advantages of barbed sutures. In addition, blood loss during myomectomy depends, among other parameters, on the myoma's localization.³² Although this could have been an interesting factor to consider, none of the studies mentioned above described the fibroid's position. Therefore, this could be an intriguing aspect to take into account in further studies.

In terms of obstetric outcomes, all studies analyzing this aspect concluded that barbed sutures in myomectomy are as safe as, and represent an easier alternative to, conventional sutures. Importantly, these findings did not adversely affect pregnancy outcomes.

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Conflicts of interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Federica Savasta, Alessandro Libretti and Libera Troia. The first draft of the manuscript was written by Federica Savasta and all authors commented on previous versions of the manuscript. All authors read and approved the final version of the manuscript.

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