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Transcervical incision of septa: 447 cases

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Abstract
Background Although uterine septum does not cause infertility, it may lead to recurrent abortion, preterm delivery, and premature rupture of membrane in over 25% of patients. The aim of this study was to evaluate feasibility and clinical value of hysteroscopic bipolar electric vaporization technique (Versapoint Bipolar Electrosurgical System) used in transcervical incision of septa (TCIS) in an outpatient setting.
Methods Retrospectively, 447 cases of hysteroscopic TCIS were analyzed. Operative time, blood loss, consumption of uterus distension medium, and period of postoperative hospital stay were compared between outpatients and inpatients. Feasibility of outpatient TCIS using bipolar electric vaporization system under analgesia and without anesthesia was investigated. All hysteroscopic procedures were performed after review and approval by institutional ethical committee. Stata 8.0 software was used for statistical analysis, and t test and χ^2 test were used to evaluate association among numerical and categorical variables. $p < 0.05$ indicated statistically significant difference.
Results The study included 121 inpatients (27.1%) and 326 outpatients (72.9%). Three hundred sixty-two cases (80.98%) were under only pethidine analgesia and 420 cases (93.96%) under local infiltration anaesthesia or analgesia. Of 447 cases of TCIS, 433 (96.87%) were accomplished under intravenous, local infiltration anaesthesia or pethidine analgesia. In all TCIS, 421 cases (94.18%) were carried out with mechanical microscissors and bipolar electric vaporization incision. No significant difference was identified between inpatients and outpatients in terms of operative time, blood loss, or consumption of uterus distension medium ($p > 0.05$). However, period of postoperative hospital stay was significantly shorter in outpatient TCIS than in inpatient TCIS by an average of 24 h or more ($p < 0.01$).
Conclusions Hysteroscopic bipolar electric vaporization TCIS could be carried out safely and efficaciously in an outpatient setting, by using smaller hysteroscope and bipolar electrodes.

Keywords Hysteroscopy · Bipolar electric vaporization · Uterus septa · Transcervical incision of septa (TCIS)

Recurrent miscarriage, preterm delivery, and premature rupture of membranes are induced among approximately 25% of women with uterus septa, even though the anomaly is not associated with infertility [1, 2]. Over the last 10 years, with the development of hysteroscopic technology in uterus septa metroplasty, hysteroscopically transcervical resection of septa (TCRS) has supplanted laparotomy and become a primary approach, in which the techniques of microscissors, laser, and monopolar electric resection are widely used in clinical setting.

This study aims to introduce the experience of hysteroscopic bipolar electric vaporization incision technique with normal saline as uterus distension medium and preliminarily evaluate its clinical value. Since 2001, our Medical Center of Diagnosis and Treatment for Cervical Diseases has started to use the hysteroscopic bipolar

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electric vaporization incision technique and applied it to two-thirds of outpatient operations of uterus septa. Considering that hysteroscopic bipolar electric vaporization technique is not widely used in China, this study aims to evaluate feasibility and clinical value of this technique with a 1.7-mm-diameter bipolar electrode in transcervical incision of septa (TCIS).

Materials and methods

From January 2001 to December 2005, among a total of 5,169 hysteroscopic operations performed by our Medical Center, 447 cases (8.7%) underwent hysteroscopic TCIS with average age of 29.17 ± 4.34 years (range 21–53 years), including 17 cases of complete uterus septa and 430 cases of partial septa. Among those 447 cases, 121 cases (27.07%, 121/447) were treated in hospitalization (inpatient group) with average age of 29.45 ± 4.37 years, and 326 cases (72.93%, 326/447) were treated in an outpatient setting (outpatient group) with average age of 28.96 ± 3.84 years.

Preoperative diagnostic methods for uterus septa include color transvaginal sonography (TVS), hysterosalpingography (HSG), and combined examination by laparoscopy and hysteroscopy in order to exclude bicornuate uterus, rudimentary horn of uterus, and bicorbate uterus. In cases of failure to ascertain diagnosis or exclude the malformations described above, laparoscopy and/or abdominal ultrasound scanning were concurrently conducted.

All operative approaches were adopted after review and approval by institutional ethical committee. All patients eligible for operation were informed preoperatively and postoperatively and signed informed consent documents. Surgeries were scheduled for patients after menstrual bleeding.

Equipment and instruments

Manufactured by Shanghai Jing Bao Long Optic Electrics Research Institute, a 6-mm continuous-flow hysteroscope was equipped with a 0°C 3-mm optic rod lens, two perfusion channels, and a 2.2-mm operative orifice. Mechanical instruments included microscissors with 1.8 and 2 mm outer diameters, and an electronic pump to distend uterus constantly with intrauterine pressure maintained at 13–26 kPa (95–195 mmHg).

Camera system, cold light source and monitor, monopolar electrical generator, and monopolar electric resectoscope were supplied by Olympus Inc.

Bipolar electric resectoscope (Johnson & Johnson Inc., USA) and Versapoint bipolar electrosurgical system (Gynecare; Ethicon Inc., NJ, USA) included special bipolar electrical generator with an output power at 40–60 W and two types of evaporation electrodes: helical electrode and spring electrode (1.7 mm outer diameters) with the former used in accurate vaporization incision and the latter used in diffuse tissue vaporization. Each electrode consisted of three parts: a positive electrode at the tip, a return electrode, and the middle part separated by a ceramic insert. Only tissues in contact with the electrical path circuit in the limited area between the positive and negative electrodes were dissected or vaporized. The electric generator provided different modes of operative waveforms: VC1, VC2, and VC3 in descending order of magnitude; blend waveforms: BL1 and BL2; and desiccate waveforms (DES) resembling electric coagulation mode. The electric generator was connected to the electrode via a 1.7-mm-outer-diameter foldable cable and was automatically adjusted to the default setting (VC1) once connected.

Uterus distension media and pressures

Normal saline was used to distend uterus in bipolar electric vaporization operations, and 5% glucose solution was used in monopolar electric resection operations. The uterus distension pressure was set at 13–26 kPa (95–195 mmHg).

Preoperative preparations

To exclude genital tract infections, infectious diseases, and pathological changes of important body organs, the following examinations were conducted: leucorrhea, complete blood count, thrombotest, electrocardiogram, hepatic and renal function, hepatitis B immunity, rapid plasma reagin (RPR), human immunodeficiency virus (HIV) antibody, chest X-ray, and transvaginal ultrasound scanning. Surgical operations were performed within 1 week after menstrual bleeding. Cervical preparation using mifepristone at dosage of 25 mg b.i.d. was administered 1–2 days before operation. There were 245 patients (54.8%) with cervical preparation and 202 patients (45.2%) without cervical preparation. Pethidine 50 mg and atropine 0.5 mg were injected 30 min before operation. Enema was required preoperatively for operations with general and regional anesthesia; however it was not required for operations with local anesthesia and analgesia.

Operative monitoring

Nine cases who had concurrent salpingoplasty or ovarian cyst enucleation were monitored by laparoscopy; 28 cases were monitored by ultrasound scanning; and 410 cases without either monitoring (91.7%, 410/447).

Operative approaches

Patients were placed in lithotomy position with perineum and vagina disinfected routinely. Aseptic towel was spread and vaginal speculum was inserted for better visualization of cervix. Cervix was grasped by cervical clamp, uterine cavity was measured for depth by using an exploring needle, cervical canal was dilated, and shape of uterine cavity was ascertained by hysteroscopy. Uterus septa were categorized as complete or partial by extent.

In TCIS by bipolar vaporization incision or microscissors: cervical canal was dilated to Hegar 6.5 or 7.

In TCIS or TCRS by monopolar electric needle or monopolar electric resection: cervical canal was dilated to Hegar 10 or 10.5.

In TCIS by hysteroscopic microscissors: microscissors were introduced via hysteroscopic orifice to cut septum gradually through the middle part of septum.

In TCIS by bipolar vaporization: bipolar vaporization electrodes were inserted via hysteroscopic orifice to progressively cut septum horizontally through the middle part of septum.

In TCIS by combination approaches: microscissors were used to cut septum partially and subsequently bipolar vaporization electrodes were used to cut the remaining septum when it was close to fundus or if there was fundus with a wider base.

For complete uterus septa or uterus septa combined with vaginal septa, general electric knife or surgical scissors was applied to cut vaginal septum and partial septum in cervical canal; subsequently hysteroscope was inserted to proceed by the approach for partial uterus septa. The alternative approach was, after vaginal septum was cut, insertion of urethral catheter via one side of uterine cavity and (guided by ultrasound) insertion of hysteroscope via the opposite side. Then septum was partially cut and operation performed as for partial uterus septa. Intrauterine device (IUD) was inserted in uterine cavities at the end of operation in some patients and combination of ethinyl estradiol and medroxyprogesterone acetate was administered for three menstrual cycles.

Endpoint criteria for TCIS treatment

With ultrasound monitoring, uterine septum was cut up to 1.0–1.5 cm but not less than 1.0 cm away from uterine fundus membrane. Without ultrasound monitoring, endpoint criteria for TCIS were:

1. The cutting line in uterine fundus was horizontal to the line between bilateral oviduct openings or 0.5 cm below the line, bilaterally at distance of approximately 1.0 cm from oviduct openings.
2. Hysteroscopical observation indicated that septum had been cut to muscular tissue of uterine fundus.
3. Cervical internal os was $\geq$3 cm to uterine fundus.
4. Uterine septum was cut up to uterine fundus with large blood vessels appearing.

Statistical analysis

With the application of Stata 8.0 software, t test was adopted to compare data with numerical variables and χ^2 test was used for comparison of categorical variables. Differences were considered to be significant at $p < 0.05$.

Results

Clinical characteristics of patients

Hysteroscopic operations confirmed 17 cases of complete uterus septa (3.8%) and 430 cases of partial uterus septa (96.2%). One hundred twenty-one cases had inpatient hysteroscopies (27.1%, 121/447) with average age of 29.45 $\pm$ 4.37 years and 326 cases had outpatient or office hysteroscopies (72.9%, 326/447) with average age of 28.96 $\pm$ 3.84 years. Comparison between inpatient and outpatient groups in terms of age and complete versus partial uterus septa indicated no statistically significant difference ($p > 0.05$, $p > 0.05$). Two hundred forty-five cases had cervical preparation (54.8%, 245/447) whereas 202 cases did not have cervical preparation (45.2%, 202/447). TCIS was also performed under laparoscopy on nine cases (2%) who were found to have concurrent salpingoplasty, ovarian cyst enucleation or bicornuate uterus malformation that could not be excluded preoperatively; 28 cases of hysteroscopic TCIS or TCRS were performed under monitoring by ultrasound scanning (6.26%), and 410 cases of hysteroscopic TCIS were performed without either ultrasound monitoring or laparoscopy (91.74%, 410/447).

Anesthetic approaches

As shown in Table 1, regarding anesthetic approaches adopted in TCIS, nine cases that underwent combined operations of hysteroscopy and laparoscopy were under general anesthesia via tracheal intubation. Of outpatient operations, 315 cases (96.63%, 315/326) were under cervical infiltration anesthesia or pethidine analgesia. Of inpatient operations, 105 cases (86.78%, 105/121) were under local infiltration anesthesia and analgesia.

Among all TCIS/TCRS cases, 362 (80.98%, 362/447) were under only pethidine analgesia; the number increased to 420 (93.96%, 420/447) if cervical local infiltration

Table 1 Summary of anesthesia and analgesia applied in TCIS

Groups	General anesthesia via tracheal intubation	Intravenous anesthesia	Persistent epidural anesthesia	Local infiltration anesthesia	Analgesia	Total
Inpatient group	9 (7.43%)	5 (4.13%)	2 (1.65%)	19 (15.7%)	86 (71.07%)	121
Outpatient group	0	8 (2.45%)	3 (0.92%)	39 (11.96%)	276 (84.66%)	326

anesthesia was considered. Apart from general anesthesia via tracheal intubation and persistent epidural anesthesia, 110 cases (90.9%, 110/121) were under intravenous anesthesia, local infiltration anesthesia, and pethidine analgesia among inpatient TCIS, compared with 323 cases (99.1%, 323/326) among outpatient TCIS. Among all TCIS, a total of 433 cases (96.87%, 433/447) were under intravenous anesthesia or local infiltration anesthesia or pethidine analgesia.

Overall distribution among all hysteroscopic TCIS was 2.01% (9/447) under general anesthesia via tracheal intubation, 2.91% (13/447) under intravenous anesthesia, 1.12% (5/447) under persistent epidural anesthesia, 12.98% (58/447) under local infiltration anesthesia, and 80.98% (362/447) under analgesia.

Operative approaches

Among all TCIS operations, 26 cases (5.82%) were carried out with monopolar electric needle or monopolar electric resection (TCRS), 55 cases (12.3%) with only microscissors, 366 cases (76.73%) with bipolar electric vaporization, and 421 cases (94.18%) with combined use of microscissors and bipolar electric vaporization (Table 2).

Comparison of parameters between inpatient and outpatient TCIS

Duration of operation, blood loss, volume of uterus distension media, and postoperative hospital stay were 14.93 ± 4.18 min, 6.81 ± 5.37 ml, 1,362 ± 428 ml, and 26.34 ± 5.33 h, respectively, in inpatient TCIS, and 15.38 ± 5.16 min, 7.19 ± 4.76 ml, 1,169 ± 561 ml, and 1.52 ± 0.63 h, respectively, in outpatient TCIS. Comparison between inpatient and outpatient TCIS suggested significant difference in postoperative hospital stay, with average hospital stay in outpatient TCIS over 24 h shorter than that in inpatient TCIS (Table 3).

Late complications for TCIS

One case (0.22%) of uterine perforation in a patient with past history of two miscarriages and intrauterine adhesion was recorded, where perforation of 2–3 mm was caused during further investigating adhesions by TCIS, successfully treated with uterine contraction agents. Six cases (1.34%) of blood loss >50 ml and two cases (0.45%) of blood loss >100 ml were recorded due to cutting septum too deep and therefore injuring blood vessels in muscular tissue of uterine fundus. All bleedings were treated and stopped by using treatment with uterine contraction agents and hemostatics. Three cases (0.67%) of postoperative pelvic infection and five cases (1.1%) of urethral infection were seen; their symptoms were relieved with treatment by antibiotics. Two cases (0.45%) of bradycardia, one each in the inpatient and outpatient group, occurred; their symptoms were relieved by intravenous injection of atropine. One case (0.22%) of hysteroscopy was aborted due to suspicion of recent uterine perforation following diagnostic curettage of abnormal uterine bleeding in another hospital.

Table 2 Summary of operative approaches in TCIS

Operative approaches	Microscissors	Monopolar electric needle	Monopolar electric loop	Bipolar electric vaporization electrode	Total
Cases	55 (12.3%)	15 (3.36%)	11 (2.46%)	366 (81.88%)	447

Table 3 Comparison of operative parameters between outpatient and inpatient TCIS

Parameters	Inpatient TCIS (121 cases)	Outpatient TCIS (326 cases)	*p* value
Duration of operation (min)	14.93 ± 4.18 (8–42)	15.38 ± 5.16 (10–38)	>0.05
Blood loss (ml)	6.81 ± 5.37 (2–80)	7.19 ± 4.76 (5–120)	>0.05
Volume of uterus distension media (ml)	1,362 ± 428 (350–2,900)	1,169 ± 561 (450–3,100)	>0.05
Postoperative hospital stay (h)	26.34 ± 5.33 (15–96)	1.52 ± 0.63 (20 min–12 h)	<0.01

Discussion

Uterus septus is one of the commonest developmental malformations of uterus in clinic, with incidence of 0.01–12%, accounting for 80–90% of uterine malformations. In the past 20 years, with prevalence of hysteroscopic surgeries and continuous improvement of relevant equipment and instruments, more and more women with uterus septus have been successfully treated via metroplasty with the benefit of avoiding laparotomy and even hospitalization [3, 4].

At present, correction of uterus septus is carried out primarily by TCRS approach with the need to dilate cervical canal to Hegar 10 or more to allow insertion of resectoscope into uterine cavity for operation. Before operation by transcervical monopolar electric resection, it is necessary to give enema and occasionally administer regional anesthesia (persistent epidural anesthesia/spinal anesthesia) and to place urethral catheter for 4–6 h postoperatively. Considering these factors, most patients have to be hospitalized [5]. This study aims to evaluate feasibility and clinical value of applying hysteroscopic bipolar electric vaporization technique to TCIS in an outpatient setting.

Features of hysteroscopic bipolar electric vaporization technique in TCIS

Application of hysteroscopic bipolar electric vaporization is undoubtedly a breakthrough in hysteroscopic technology, with the two most important features being the change of the electric energy principle from original monopolar electric technique to bipolar electric technique, and the possibility of using electrolytic normal saline as uterus distension medium based on bipolar electric energy. Accordingly, the advantages of TCIS by hysteroscopic bipolar electric vaporization include the following. (1) Risk of hyponatremia is reduced; using isotonic normal saline with electrolytes could decrease or avoid occurrence of hyponatremia, which can be induced by previously used nonelectrolytic uterus distension media (glycine, mannitol, etc.) [6]. (2) The effect of surface action from monopolar electric energy can be avoided; using bipolar electric energy enables avoidance of surface action that can be induced by monopolar electric resection, thus avoiding electrical injury to organs surrounding or distal to intact uterus. (3) Success rate is increased, with reduced surgical trauma; by using bipolar vaporization electrodes with only 1.7 mm outer diameter, diagnostic or operative scopes with operative orifice smaller than hysteroscopic resectoscope could meet the requirements of bipolar electric vaporization operations; for example, TCIS could be accomplished by using hysteroscope with 5–6 mm outer diameter when the cervix is required to dilate only to Hegar 6 or 6.5. Hence, failure rate of hysteroscopy due to difficulty in cervical dilation is reduced. (4) Pain resulting from bipolar electric vaporization operations is less. Since pain from hysteroscopy is correlated with cervical dilation and operation procedure in electric resection, pain is greater with more dilation in cervix and higher output power, whereas pain is less severe with less dilation in cervix and lower output power. Thus with application of bipolar electric energy at lower output power and smaller diameter hysteroscope, surgical pain is obviously mitigated.

Hysteroscopic bipolar electrosurgery could be performed in totally awake patients without causing discomfort. The key point is that, in contrary to myometrium with innervation, endometria and fibrous tissues are insensitive to electricity, and uterus septus is primarily composed of fibrous tissues [7]. The other important point is, since output voltage in electrosurgery is closely correlated with myometrial sensitivity to electricity, electric current for 50–60 W bipolar output power in TCIS has less impact than under 80–120 W monopolar output power. All these factors contribute to minimal patient pain or discomfort when undergoing hysteroscopic TCIS, as evidenced by the fact that over 90% of the patients in this study underwent TCIS with local infiltration anesthesia or pethidine analgesia. It is feasible to conduct TCIS in outpatient setting. Studies indicate that the concept in diagnosis and treatment of uterine diseases has changed dramatically due to the development and application of hysteroscopic bipolar electric generator and small vaporization electrodes [8].

Safety of bipolar electric technology in TCIS

Hitherto, a lot of TCRS have been carried out under persistent epidural or spinal anesthesia in hospital and a few of them have been carried out under general anesthesia in cases with coagulation disorders and spinal deformity [9]. When regional anesthesia is adopted, patients have to be hospitalized and therefore have enough time to undergo palinesthesia, recuperation, and removal of urethral catheter in postoperative hospital stay. Plus, general and regional anesthesia per se possibly bring about severe complications and side-effects [10].

In this study, the majority of patients underwent bipolar electric vaporization surgeries without experiencing hospitalization, preoperative enema, and placement of urethral catheter. In terms of operative electric energy, bipolar electric energy is safer than monopolar energy. In terms of uterine distension medium, normal saline enables reduced occurrence of hyponatremia and is safer than nonelectrolytic uterine distension medium.

In contrast to hysteroscopies using relatively large electric resectoscope requiring cervical dilation up to

Hegar 10 or 12, TCIS by using small bipolar vaporization electrodes and a hysteroscope of 6.0 mm diameter could be performed with cervix dilated only to Hegar 6.5. On the other hand, small surgical instruments reserve sufficient operating space in uterine cavity, thus facilitating completion of hysteroscopy. Small hysteroscopic appliances require less uterus distension pressure and accordingly less absorption of uterus distension medium, thereby reducing risk of pulmonary edema or encephaledema [11]. Smaller cervical dilation also mitigates surgical pain and, to some extent, decreases demand for general or regional anesthesia, thereby enabling completion of outpatient TCIS [12, 13].

TCIS in outpatient setting for one-stop diagnosis and treatment

There is no significant difference between outpatient TCIS and inpatient TCIS in terms of surgical procedure, operative time, and blood loss, where the former decreases chance of urinary tract infection, without use of preoperative enema and postoperative urethral catheter. More importantly, postoperative hospital stay in outpatients under pethidine analgesia or paracervical local infiltration anesthesia is remarkably shorter than in patients under general or regional anesthesia, since most outpatients are discharged after being monitored for 30 min to 1 h postoperatively. From the safety perspective, there have been no reports of severe complications or sequelae in all TCIS cases, whether in outpatient or inpatient setting. Postoperative follow-up and reexamination confirm that operative outcome is unrelated to anesthetic approaches.

Previously, studies revealed [14, 15] that preoperative injection of pethidine and paracervical infiltration anesthetics could effectively reduce vagal reaction and discomfort from uterine surgeries. Hence, the applications of fine hysteroscopes and surgical electrodes, in conjunction with effective analgesia or cervical infiltration anesthesia, could enhance compliance and feasibility of outpatient or office TCIS, as evidenced by this study. In some cases, TCIS was accomplished without applying anesthetics [16, 17].

Evolution and evaluation of surgical approaches in uterine septus metroplasty

Uterine septum is mainly composed of fibrous connective tissue with little fibromuscular tissue. Lacking blood vessels and being covered by thin endometrial mucosa, uterine septum is poorly responsive to estrogen, which consequently results in poor embryonic development due to insufficient blood supply after zygote implantation. Moreover, with limited uterine space resulting from developmental anomaly, recurrent miscarriages, premature delivery, infertility, and fetal death are often reported in clinic [2, 3].

To treat uterine septus, surgical approaches such as transvaginal cutting, laparotomy metroplasty, hysteroscopic laser incision, hysteroscopic monopolar electric needle, incision, and resectoscopic TCRS have been adopted clinically. Traditional approaches of transvaginal cutting and laparotomy metroplasty have become obsolete due to their multiple complications and side-effects such as remarkable traumatic damage, heavy blood loss, and inclination for uterine adhesions.

Compared with traditional laparotomy metroplasty, hysteroscopic TCRS enables reduced complications, side-effects, and uterus scars induced from laparotomy. Nevertheless, at present, electrical resectoscopes for clinic use are generally bulky, with 8.5–9.5 mm outer diameter, requiring cervical dilation up to Hegar 10 or more, which therefore sets a stricter requirement on cervical preparation and anesthesia. It is well known that difficulty in cervical dilation is one of the commonest causes of hysteroscopic operation failure. Furthermore, hysteroscopic TCRS is susceptible to endometrial damage, with resultant extirpation scars. Also surgical resection of septus in uterine fundus has greater complexity and risk. Most unfavorably, in spite of enema administered preoperatively on routine basis, the effect of surface action from monopolar electricity occasionally contributes to electrical injury to organs distal to intact uterus, which has been reported clinically to result in complication and even death.

Metroplasty by using laser energy has high cost, longer operative time, and higher risk of water intoxication. Additionally, laser can cause damage to retina of hysteroscopists. Although hysteroscopic TCIS with microscissors has the advantage of no electricity involvement, using microscissors in TCIS, particularly for thick septum with a wider base and stiff tissue, is found to have greater complexity, long operative time, high rate of instrument wear, and hemostatic difficulty in case of surgical trauma and bleeding of blood vessels [18].

Results from this study reveal that pethidine analgesia alone could be applied in 80% of TCIS (362/447), increasing to 93.96% (420/447) when cervical local infiltration anesthesia was additionally applied, and to 96.87% (433/447) if intravenous anesthesia was also applied. It is thus clear that applications of safer electric energy and uterus distension medium, and fine hysteroscopic instruments, will become a trend in the development of uterine metroplasty.

In conclusion, for safe and efficacious approach in uterine septus metroplasty, comprehensive consideration should be given to preoperative diagnostic accuracy, hysteroscopist experience, available hysteroscopic instruments, safety of

electric energy, and underlying patient conditions. Based on preliminary analysis of the study results, TCIS using bipolar electric vaporization under local infiltration anesthesia and analgesia is safe, efficacious, feasible, and worthy of further exploration.

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