DOI: https://doi.org/10.54393/pjhs.v7i2.3540

PAKISTAN JOURNAL OF HEALTH SCIENCES
(LAHORE)
https://thejas.com.pk/index.php/pjhs
ISSN (E): 2790-9352, (P): 2790-9344
Volume 7, Issue 02 (February 2026)

Original Article

OPEN ACCESS

Natural Conception Rate in Sub-Fertile Couples Following Laparoscopy and Dye Test

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ARTICLE INFO

Keywords:
Hypothyroidism, Laparoscopy, Nulligravida, Sub-Fertility, Tubal Blockage

How to Cite:
Akram, F., Taj, A., Rind, R., Nazir, N., & Rajab, S. (2026). Natural Conception Rate in Sub-Fertile Couples Following Laparoscopy and Dye Test: Natural Conception Rate in Sub-Fertile Couples Following Laparoscopy and Dye Test. Pakistan Journal of Health Sciences, 7(2), 50-56. https://doi.org/10.54393/pjhs.v7i2.3540

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Received Date: 7th October, 2025
Revised Date: 4th December, 2025
Acceptance Date: 13th December, 2025
Published Date: 28th February, 2026

ABSTRACT

Infertility represents a major reproductive health issue, affecting between 8-12% couples worldwide. **Objectives:** To determine the natural conception rate in sub-fertile couples following laparoscopy and dye test (LDT). **Methods:** This single-center, prospective, observational, cohort study was performed at the Department of Obstetrics and Gynecology, Liaquat National Hospital, Karachi, Pakistan, during May 2024 to August 2025. A total of 131 couples with sub-fertility were consecutively enrolled if the female partner was scheduled for LDT. Baseline demographic and clinical data were recorded from both partners. All procedures were performed by experienced gynecologic surgeons. Participants were followed for six months to assess natural conception, confirmed clinically and by ultrasound. Statistical analyses included chi-square, t-test, or independent sample t-test, with $p<0.05$ considered significant. **Results:** Out of the 131 women, the mean age was 30.1 ± 6.0 years. The mean duration of subfertility was 25.6 ± 9.2 months. On laparoscopy, 69.5% had normal tubes, while unilateral and bilateral tubal abnormalities were seen in 16.0% and 8.4%. Natural conception within six months occurred in 76 (58.0%) women, with a mean interval to conception of 4.8 ± 1.1 months. Women who conceived were significantly younger ($p=0.035$), had lower BMI ($p=0.003$), and were more often nulligravid ($p=0.001$). Hypothyroidism was more prevalent among those who did not conceive ($p=0.004$). **Conclusions:** The study provides evidence supporting LDT as a valuable diagnostic and therapeutic modality in the management of sub-fertile couples. Younger age, lower BMI, and absence of hypothyroidism were associated with successful natural conception following LDT.

INTRODUCTION

Infertility represents a major reproductive health issue, affecting between 8-12% couples worldwide [1]. Infertility can lead to significant emotional, psychological, and social stress for those hoping to achieve parenthood [2, 3]. Structural abnormalities play a prominent role in subfertility [4]. Tubal factor infertility is estimated to account for almost one-third of female infertility cases across the globe [4]. Early and accurate diagnosis is vital for guiding appropriate management in infertility-affected couples [5]. In Pakistan, the prevalence of infertility is around 33%, with primary infertility at 5% and secondary infertility at 18% [6]. Laparoscopy with dye test (LDT) has become a leading diagnostic method in the evaluation of subfertility among women [7]. LDT is a minimally invasive procedure that allows direct visualization of the uterus, fallopian tubes, and ovaries, while also assessing whether the fallopian tubes are open or blocked through the injection of a colored dye. An additional advantage of laparoscopy is the ability to treat certain pelvic pathologies during the same procedure, which may restore natural fertility and reduce the need for advanced assisted reproductive techniques [8]. Despite its routine use in clinical practice, there is considerable variation in the reported rates of natural conception after LDT. Ikechebelu and colleagues reported a natural conception rate of 25% following the procedure [9]. Verhoeve et al. described a

DOI: https://doi.org/10.54393/pjhs.v7i2.3540

rate of 9.4%, whereas Mahtab *et al.* documented substantially higher conception rates of 62.9% in women with primary infertility [10, 11].

Data regarding the factors that may influence the chances of natural conception after LDT remain limited and diverse. Identifying these factors is essential for clinicians to provide accurate counseling, set realistic expectations, and design individualized treatment plans for sub-fertile couples. The findings of this study can help clarify the role of laparoscopy and dye test in the management of sub-fertility and may support clinicians in their decision-making process. Due to the wide variation in reported conception rates and limited data on influencing factors, this study aims to determine the natural conception rate in sub-fertile couples following LDT in our population.

METHODS

This single-centre, prospective, observational, cohort study was conducted at the Department of Obstetrics and Gynecology, Liaquat National Hospital, Karachi, Pakistan, during May 2024 to August 2025. Written informed consent was obtained from all participants, and institutional ethical approval was secured before study initiation (Ref: App # 1033-2024-LNH-ERC). Eligibility criteria included couples diagnosed with sub-fertility, where the female partner was scheduled to undergo a laparoscopy and dye test for diagnostic or therapeutic evaluation. Couples were excluded if the female partner had active genital infection, tuberculosis, overt tubal pathology such as hydrosalpinx, significant pelvic adhesions (American Fertility Society adhesion score > 10)[12], markedly distorted tubal anatomy (gross anatomical distortion) due to multiple uterine myomas, or distal tubal occlusion, as identified by preoperative assessment or intraoperative findings. Couples already pursuing fertility treatment or those with male partners having severely impaired semen parameters requiring IVF-ICSI were also excluded. All participants were recruited consecutively from couples presenting with subfertility. Sub-fertility was defined as failure to achieve conception after at least twelve months of regular, unprotected intercourse. Sample size calculation was performed using the Open-Epi online software, based on a 95% confidence level, with a 5% margin of error, and an estimated post-procedural natural conception rate of 9.4% [10], resulting in a required sample of 131 couples. Sample size was calculated using the formula: n = Z2 (1-α/2) * p * (1 - p) / e2. At enrollment, demographic and baseline clinical data were collected for both partners, including age, weight, and height. Female reproductive history, including parity and duration since attempting conception, was recorded. Both the pattern of menstrual cycles before and after laparoscopy (regular or irregular) and the presence of any comorbidities, specifically diabetes, hypertension, or hypothyroidism (as per history and medical record), were documented for both partners. Patterns of menstrual cycles, both before and after the laparoscopy, were classified as regular if menses occurred at predictable intervals of 21 to 35 days and as irregular if cycles fell outside this range or varied unpredictably. Information on previously diagnosed medical conditions, such as endometriosis or polycystic ovarian syndrome, was also collected. The reasons for laparoscopy with dye test were recorded. All enrolled women underwent laparoscopy with a dye test performed by experienced gynecologic surgeons (post-fellowship experience > 5 years) under standard protocols. Laparoscopy with dye test referred to a minimally invasive surgical procedure in which a laparoscope is used to visualize the pelvic organs, and a colored dye (methylene blue dye 0.1% solution) is injected through the cervix to assess the patency of the fallopian tubes and the overall anatomy of the uterine cavity. The successful passage of dye through one or both fallopian tubes, confirmed by its visual spill into the pelvic cavity, was considered evidence of tubal patency. Intraoperative findings, including tubal patency (normal, unilateral, or bilateral abnormalities), presence of pelvic adhesions, or other significant pelvic pathology, were meticulously documented. All procedures were performed using a Karl Storz 10-mm high-definition laparoscopic system (Germany) equipped with a xenon light source and HD camera unit. Dye testing was carried out using methylene blue 0.1% solution delivered transcervically through a Rubin's cannula under low-pressure infusion. Standard reusable laparoscopic instruments were employed, and all procedures were performed by consultants with over five years of post-fellowship experience. After the procedure, participants were followed for a period of six months to assess for natural conception, defined as a viable pregnancy achieved without assisted reproductive technologies. Pregnancy was confirmed through participant report, clinical evaluation, and ultrasound evidence of gestational sac development. For those who conceived, the interval from laparoscopy to conception in months was recorded. Follow-up assessments were conducted monthly, during which women were contacted through in-person visits or telephone interviews to document menstrual regularity, symptoms, and potential conception. Clinical evaluation and ultrasound were performed whenever pregnancy was suspected. Conception was defined as a clinically and ultrasonographically confirmed intrauterine pregnancy within six months of the procedure. Confirmation required visualization of a gestational sac on transvaginal ultrasound. The GE Voluson E8 ultrasound system was used with a 5–9 MHz transvaginal transducer, ensuring

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reproducibility and standardization of measurements. Women who did not achieve conception within six months of follow-up were recorded as having no conception. The conception rate was defined as the proportion of women who achieved clinically confirmed natural conception within six months following laparoscopy and dye test. The conception rate was calculated using the formula: Conception rate (%) = (Number of women with clinically confirmed natural conception / Total number of women undergoing LDT) X 100. All study data were maintained with strict confidentiality. Statistical analysis was conducted using IBM SPSS Statistics version 26.0. The primary outcome, natural conception within six months post-laparoscopy, was calculated as a proportion. Associations between baseline characteristics, intraoperative findings, and conception outcomes were evaluated using appropriate comparative statistical tests, including chi-square or Fisher's exact test for categorical variables, and t-test or Mann-Whitney U test for continuous variables (as per normal distribution of data checked by the Shapiro-Wilk test). Time to natural conception was analyzed using Kaplan–Meier survival curves, and the equality of distributions among subgroups was compared using the Log-Rank (Mantel–Cox) test. Statistical significance was set at $p<0.05$.

RESULTS

In a total of 131 women, the mean age and BMI were 30.1 ± 6.0 years and 28.0 ± 4.4 kg/m^2. There were 99 (75.6%) women who had regular menstrual cycles before laparoscopy. The mean duration since attempting to conceive naturally was 25.61 ± 9.19 months. Hypothyroidism, diabetes, and hypertension were the commonest comorbid conditions, documented among 37 (28.2%), 30 (22.9%), and 20 (15.3%) women, respectively. The primary indication for LDT was suspected tubal blockage, noted in 110 (84.0%) women, followed by pelvic pain investigation, reported in 5 (3.8%) women. On laparoscopy, the most common findings were normal tubes, noted in 91 (69.5%), unilateral tubal abnormalities in 21 (16.0%), bilateral tubal abnormalities in 11 (8.4%), and pelvic adhesions in 8 (6.1%). After LDT, 76 (58.0%) women conceived naturally within 6 months, while 55 (42.0%) did not. The mean duration required to conception was 4.79 ± 1.12 months among women who successfully achieved conception. Women who conceived were significantly younger (29.1 ± 7.1 vs. 31.4 ± 3.6 years, p=0.035), and had a significantly lower BMI (27.1 ± 3.9 vs. 29.4 ± 4.7 kg/m^2, p=0.003). Nulligravid status (9.5% vs. 3.6%, p=0.001) was more common among those who conceived. Hypothyroidism was significantly more prevalent among women who did not conceive (40.0% vs. 19.7%, p=0.004), whereas no significant differences were found for comorbid conditions like diabetes (p=0.415) or hypertension (p=0.214). There was no statistically significant difference in menstrual cycle regularity before or after laparoscopy, duration of attempting conception, or presence of polycystic ovarian syndrome between women who conceived or not. Among 76 women who conceived naturally, 42 (55.3%) had normal laparoscopic findings, while 19 (25.0%) had unilateral tubal abnormalities, 9 (11.8%) had bilateral abnormalities, and 6 (7.9%) had pelvic adhesions ($p<0.001$). Among 55 women who did not conceive, 49 (89.1%) had normal findings, and only 2 (3.6%) each showed unilateral, bilateral, or pelvic adhesions ($p<0.001$). Results showing the association of demographical and clinical characteristics of women undergoing laparoscopy and dye test with successful conception (Table 1).

Table 1: Association of Demographical and Clinical Characteristics of Women Undergoing Laparoscopy and Dye Test with Successful Conception Rate (n=131)

Characteristics		Conception, n (%)	No Conception, n (%)	p-value
Age	Years	29.13 ± 7.07	31.35 ± 3.62	0.035*
Body Mass Index	kg/m^2, Mean ± SD	27.08 ± 3.90	29.36 ± 4.70	0.003*
Gravidity	0	7 (9.5%)	2 (3.6%)	0.001*
	1	40 (54.1%)	13 (23.6%)	
	2	22 (29.7%)	29 (52.7%)	
	3	5 (6.8%)	11 (20.0%)	
Parity	0	72 (97.3%)	55 (100%)	0.219
	2	2 (2.7%)	–	
Menstrual Cycle Before Laparoscopy	Regular	60 (78.9%)	39 (70.9%)	0.291
	Irregular	16 (21.1%)	16 (29.1%)	
Comorbidities	Diabetes	14 (18.4%)	16 (29.1%)	0.415
	Hypertension	20 (26.3%)	–	0.214
	Hypothyrodism	15 (19.7%)	22 (40.0%)	0.004*
Time Since Trying to Conceive (Months)	Mean ± SD	25.03 ± 9.43	26.46 ± 8.84	0.388
Medical Conditions	Endometriosis	–	2 (3.6%)	0.098
	Polycystic Ovarian Syndrome	15 (19.7%)	14 (25.5%)	0.485
Reasons for Undergoing Laparoscopy and Dye Test	Suspected Blockage	65 (85.5%)	45 (81.8%)	0.419
	Endometriosis	–	2 (3.6%)	
	Pelvic Pain	3 (3.9%)	2 (3.6%)	
	Others	8 (10.5%)	6 (10.9%)	
Findings of Laparoscopy and Dye Test	Normal	42 (55.3%)	49 (89.1%)	<0.001*
	Unilateral Tubal Abnormalities	19 (25.0%)	2 (3.6%)	
	Bilateral Tubal Abnormalities	9 (11.8%)	2 (3.6%)	
	Pelvic Adhesions	6 (7.9%)	2 (3.6%)	
Menstrual Cycle after Laparoscopy	Regular	62 (81.6%)	37 (67.3%)	0.060
	Irregular	14 (18.4%)	18 (32.7%)	

Chi-square test/Fisher's exact test applied for the comparison of categorical data; Numeric data compared using an independent

DOI: https://doi.org/10.54393/pjhs.v7i2.3540

sample t-test. * Indicates statistically significant p-values (≤ 0.05).

Partners of women who conceived were significantly younger (30.6 ± 4.0 vs. 33.2 ± 3.8 years, p<0.001), and had significantly lower BMI (25.6±3.4 vs. 28.6 ± 3.4 kg/m^2, p<0.001). There were no significant differences in partner comorbidities, including diabetes (25.0% vs. 30.9%, p=0.512), hypertension (32.9% vs. 29.1%, p=0.571), or hypothyroidism(n=3, 3.9% vs. n=0; p=0.131)(Table 2).

Table 2: Association of Demographical and Clinical Characteristics of Partners with Natural Conception Rate (n=131)

Characteristics		Conception, n (%)	No Conception, n (%)	p-value
Age	Years, Mean ± SD	30.58 ± 4.02	33.18 ± 3.80	<0.001*
Body Mass Index	kg/m^2, Mean ± SD	25.59 ± 3.36	28.60 ± 3.36	<0.001*
Comorbidities	Diabetes	19 (25.0%)	17 (30.9%)	0.512
	Hypertension	25 (32.9%)	16 (29.1%)	0.571
	Hypothyroidism	3 (3.9%)	–	0.131

Chi-square test/Fisher's exact test applied for the comparison of categorical data; Numeric data compared using an independent sample t-test. *Indicates statistically significant p-values (≤0.05).

The mean time required for conception among cases with success was 4.79 months (standard error [SE]: 0.13; 95% confidence interval [CI]: 4.54–5.04). When stratified by the reason for undergoing LDT, women with suspected tubal blockage had a mean time of 4.82 months (SE: 0.13; 95% CI: 4.56–5.07). Those evaluated for pelvic pain investigation exhibited a mean time of 3.67 months (SE: 0.33; 95% CI: 3.01–4.32). A comparison of successful conception distributions among the three indication groups performed using the Log Rank (Mantel-Cox) test demonstrated a p-value of 0.028 across the different reasons for undergoing LDT, indicating that the reason for LDT was significantly associated with variations in time required to successful conception among the study population with the shortest mean time observed in the pelvic pain investigation group (Figure 1).

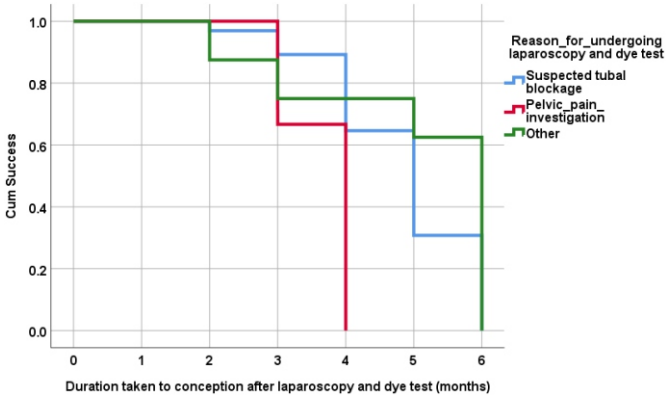

Figure 1: Kaplan-Meier Survival Curves by Time to Successful Conception Following Laparoscopy and Dye Test as Per Indications

Analysis of time to successful conception according to the findings of LDT revealed that the overall mean time to conception was 4.79 months (SE: 0.13; 95% confidence interval [CI]: 4.54–5.04). Among the subgroups, women with normal LDT findings had a mean time to conception of 4.67 months (SE: 0.17; 95% CI: 4.33–5.01), unilateral tubal abnormalities had a mean time to conception of 4.84 months (SE: 0.30; 95% CI: 4.26–5.43), bilateral tubal abnormalities had a mean time to conception of 5.33 months (SE: 0.17; 95% CI: 5.01–5.66), while those with pelvic adhesions, the mean time was 4.67 months (SE: 0.49; 95% CI: 3.70–5.64). Comparison of conception times among the LDT finding groups using the Log Rank (Mantel-Cox) test showed no statistically significant difference in time to conception (p=0.609)(Figure 2).

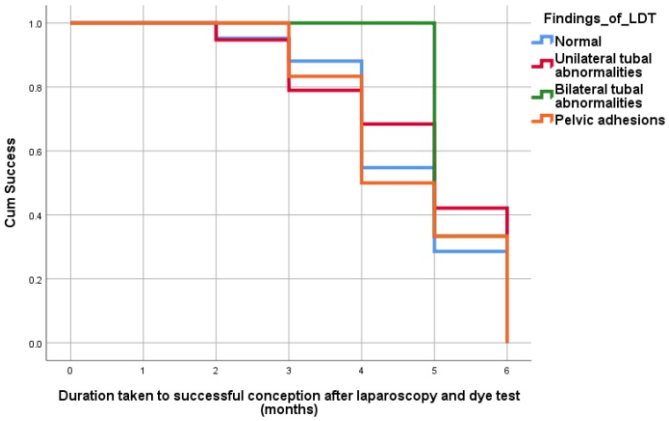

Figure 2: Kaplan-Meier Survival Curves by Time to Successful Conception Following Laparoscopy and Dye Test as Per Laparoscopy and Dye Test Findings

DISCUSSION

The present study explored the natural conception rate following LDT in sub-fertile couples and found a natural conception rate of 58% within six months. These findings position LDT as a potentially valuable tool in the fertility management algorithm for couples with unexplained or tubal-factor subfertility. Lee *et al.* documented a pregnancy rate of 41.9% over twelve months in infertile women with endometriosis, with nearly all conceptions occurring within six months postoperatively [13]. This timing reinforces the hypothesis that mechanical or physiological restoration effected by laparoscopy may facilitate early spontaneous conception in selected populations. In contrast, Younas *et al.* reported a slightly lower conception rate of 37.5% following LDT in women with minimal to mild endometriosis and pelvic adhesions, yet still found that 80% who conceived did so within eighteen months [14]. Differences in patient selection, the underlying cause of subfertility, and follow-up duration may explain variability in conception rates across these cohorts. The importance of patient selection and

DOI: https://doi.org/10.54393/pjhs.v7i2.3540

preoperative characteristics in predicting conception outcomes emerged in this study. Younger age among women and their partners was strongly associated with significantly higher conception rates following LDT. Zhang *et al.* identified patient age over 35 years as an independent risk factor for poor pregnancy outcomes after laparoscopic treatment in women with tubal infertility, a finding mirrored by a decline in conception rates with age in the current study population [15]. The effect of age is likely mediated by both oocyte quality and the cumulative impact of reproductive tract pathology, underscoring the urgency of timely intervention in younger women [16]. Another significant finding of this study was the association of BMI with successful natural conception following LDT, as both female, and their partners had significantly lower BMI who achieved natural conception post-LDT. Fataftah *et al.* also found a higher spontaneous pregnancy rate among non-obese women with unilateral proximal tubal obstruction following transcervical fallopian tube recanalization [17]. Elevated BMI is linked to multiple mechanisms detrimental to fertility, including ovulatory dysfunction, metabolic disturbances, and suboptimal endometrial receptivity, potentially diminishing the effectiveness of surgical intervention [18]. The duration of subfertility before LDT did not significantly differ between those who conceived and those who did not. This contrasts with findings from Zhang *et al.* where a longer duration of subfertility predicted poorer pregnancy outcomes [15]. Intraoperative findings remain critical for both prognosis and management. The highest conception rates were recorded among those with normal or unilateral tubal pathology, while those with bilateral tubal abnormalities or pelvic adhesions had lower, but not statistically different, rates. This trend resonates with the literature showing ongoing conception potential in women with proximal tubal blockage after selective salpingography and tubal catheterization [19, 20]. The diagnostic and therapeutic value of LDT is further supported by studies such as Mahtab *et al.* and Wankhede *et al.* which underscore the role of minimally invasive evaluation in identifying and correcting pelvic pathology [11, 20]. The finding that more than half (55.3%) of women who conceived had normal laparoscopy results, while 89.1% of those who failed to conceive also had normal findings, suggests that tubal patency alone does not guarantee successful conception. Unexplained subfertility often persists despite normal tubal morphology and spill, possibly due to subtle peritubal adhesions, impaired ciliary function, ovulatory or luteal phase defects, or unmeasured male factors. It may indicate that normal dye test results should be interpreted as a favourable but not definitive predictor of fertility potential. In the present study, nearly one-third of women were found to have comorbidities. The association between thyroid dysfunction and subfertility has been reported in the past, with thyroid hormone playing a crucial role in ovulation and endometrial receptivity [21]. Effective management of thyroid disorders may improve spontaneous conception rates following surgical intervention [22]. The presence of diabetes or hypertension did not show a significant association with conception outcomes in this study. This may reflect the multifactorial nature of sub-fertility, where metabolic and vascular comorbidities may influence fertility through indirect pathways or in conjunction with other risk factors [23]. In the current cohort, 1.5% women had a pre-existing diagnosis of endometriosis. Lee *et al.* reported that the severity of endometriosis and the type of laparoscopic intervention were not significantly associated with conception rate postoperatively [13]. Sharma *et al.* highlighted a high prevalence of endometriosis among women undergoing diagnostic laparoscopy, with no significant difference in demographic characteristics or BMI between those with and without the disease [24]. The study's strengths include prospective data collection, rigorous documentation of intraoperative findings, and systematic follow-up.

Several limitations merit consideration in interpreting these findings. The single-center nature of the study and relatively modest sample size may limit the generalizability of the results to other populations or settings. Selection bias may have been introduced by the exclusion of women with overt pelvic disease or those already pursuing assisted reproductive technologies. Outcome assessment relied on participant report, clinical evaluation, and ultrasound evidence, but potential for under-reporting of early pregnancy losses remains. Six-month of follow-up may have precluded identification of conceptions occurring later.

CONCLUSIONS

The study provides evidence supporting laparoscopy and dye test as a valuable diagnostic and therapeutic modality in the management of sub-fertile couples. Early conception post-procedure is facilitated by younger age, lower BMI, and absence of hypothyroidism, with favorable findings on laparoscopy further enhancing the likelihood of success.

Authors' Contribution

Conceptualization: AT
Methodology: FA, AT, RR, NN, SR
Formal analysis: RR
Writing and Drafting: FA
Review and Editing: AT, FA, RR, NN, SR

All authors approved the final manuscript and take responsibility for the integrity of the work.

DOI: https://doi.org/10.54393/pjhs.v7i2.3540

Conflicts of Interest

All the authors declare no conflict of interest.

Source of Funding

The author received no financial support for the research, authorship and/or publication of this article.

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