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Comparison of Preoperative and Postoperative Anti-Mullerian Hormone Levels in Patients Operated for Ovarian Torsion

Over Torsiyonu Tanısı ile Opere Olan Hastalarda Preoperatif ve Postoperatif Anti-Müllerian Hormon Değerlerinin Karşılaştırılması

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ABSTRACT

Objective: This study aimed to investigate how surgical treatment affects ovarian reserve in patients with ovarian torsion who desire fertility, by comparing preoperative and postoperative serum anti-Mullerian hormone (AMH) levels. Additionally, it explored clinical and procedural factors potentially influencing AMH fluctuations, including the surgical method, side of torsion, and type of operation.

Methods: A total of 23 patients who underwent surgical management for ovarian torsion between 2020 and 2022 and had both pre-and postoperative AMH levels recorded were included. All hormone measurements were conducted using the same Beckman Coulter assay at a single institutional laboratory. Postoperative AMH assessments were performed at least three months following the intervention. Subgroup analyses were conducted based on operative features, including detorsion with or without cystectomy, oophorectomy status, surgical technique (laparotomy vs. laparoscopy), and laterality of torsion (right vs. left ovary).

Results: Although an overall upward trend in AMH levels was noted postoperatively, this increase did not reach statistical significance across the entire sample. A significant postoperative rise in AMH was observed among patients who did not undergo oophorectomy (p=0.014). When analyzed by surgical technique, a statistically

ÖZ

Amaç: Bu çalışmada, over torsiyonu nedeniyle opere edilen ve fertilite arzusu bulunan hastalarda cerrahi müdahalenin over rezervine etkisinin serum anti-Müllerian hormon (AMH) düzeyleri üzerinden değerlendirilmesi amaçlanmıştır. Ayrıca, AMH düzeylerindeki değişime neden olabilecek cerrahi yaklaşım, torsiyon tarafı ve uygulanan operasyon tipi gibi klinik faktörler incelenmiştir.

Yöntemler: Çalışma, 2020-2022 yılları arasında over torsiyonu tanısıyla opere edilen ve preoperatif ile postoperatif AMH düzeyleri ölçülmüş olan 23 hastanın ile gerçekleştirilmiştir. AMH ölçümleri Beckman Coulter cihazı ile aynı kit kullanılarak yapılmıştır. Postoperatif AMH düzeyleri cerrahiden en az üç ay sonra değerlendirilmiştir. Detorsiyon ± kistektomi, ooferektomi varlığı, cerrahi yaklaşım (laparotomi/laparoskopi) ve torsiyon tarafına göre alt grup analizleri yapılmıştır.

Bulgular: Genel hasta grubunda postoperatif AMH düzeylerinde artış eğilimi gözlenmiş, ancak bu fark istatistiksel olarak anlamlı bulunmamıştır. Ooferektomi yapılmayan hastalarda AMH artışı anlamlıydı (p=0,014). Laparotomi uygulanan hastalarda postoperatif AMH düzeylerinde anlamlı artış saptanırken (p=0,021), laparoskopi grubunda bu fark anlamlı değildi. Sol over torsiyonu olan hastalarda postoperatif AMH düzeylerindeki artış anlamlıydı (p=0,039).

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ABSTRACT

significant increase was found in the laparotomy group (p=0.021), while no significant change occurred in the laparoscopy group. Additionally, patients with left-sided torsion showed a significant improvement in AMH levels after surgery (p=0.039).

Conclusion: Detorsion may serve as a viable surgical strategy for preserving ovarian reserve in women concerned about future fertility. The choice of surgical approach and the side of torsion appear to play a role in hormonal recovery and should be considered during preoperative planning.

Keywords: Ovarian torsion, AMH, ovarian reserve, detorsion

ÖZ

Sonuç: Detorsiyon işlemi, özellikle fertilite arzusu taşıyan hastalarda over rezervinin korunmasında etkili bir yöntem olabilir. Cerrahi yaklaşım ve torsiyonun tarafı gibi değişkenler AMH düzeylerini etkileyebileceğinden, tedavi planlamasında bu faktörlerin dikkate alınması önerilmektedir.

Anahtar Sözcükler: Over torsiyonu, AMH, over rezervi, detorsiyon

INTRODUCTION

Ovarian torsion, a gynecological emergency, is when the ovary rotates around the utero-ovarian and infundibulopelvic ligaments. Ovarian vascular flow is compromised by this rotation, which first impairs lymphatic and venous outflow before gradually compressing the infundibulopelvic ligament and impairing arterial circulation. The vascular disruption may cause ischemia and necrosis that results by reducing the ovarian tissue's ability to receive blood flow. While venous congestion occurs more quickly, arterial perfusion usually lasts longer because arterial walls are thicker and more elastic than venous walls. Significant ovarian enlargement and stromal edema may result from this mismatch. About 2.7% of all emergency gynecologic procedures are due to ovarian torsion (1). It is most often detected in women of reproductive age, especially those with underlying ovarian masses; however, it may occur at any age, including during pregnancy and the neonatal period (2,3). Because of the pelvis's physical structure, which includes a shorter left utero-ovarian ligament and a sigmoid colon on the left side that supports the neighboring ovary structurally right-sided torsion is more often documented (4). An ovarian mass is shown to be a contributing cause in about 85% (5) of cases of torsion. Therefore, to maintain ovarian viability and reproductive potential, prompt diagnosis and surgical intervention are crucial (6).

In clinical settings, ovarian torsion usually manifests as moderate to severe unilateral or widespread pelvic pain that starts suddenly and is often accompanied by nausea and vomiting, particularly in individuals who have adnexal masses (2,7). Laboratory results are not pathognomonic. Because of hemorrhagic and ischemic alterations, the afflicted ovary may appear larger, edematous, and heterogeneous on ultrasound imaging compared to the contralateral side. Comparative assessment with the opposite ovary is necessary because Doppler ultrasonography may show normal, reduced, or nonexistent blood flow in the torn ovary (8,9). Furthermore, a "whirlpool sign" that indicates a twisted vascular pedicle may be seen, and in a small number of studies, this sign has shown a diagnostic sensitivity of over 90% (10).

For the diagnosis and treatment of ovarian torsion, surgery is still the gold standard since it allows for prompt detection and therapy. Depending on the clinical situation, either a laparotomy or a laparoscopy may safely accomplish detorsion (11). A black, enlarged ovary was often thought to be necrotic, but newer research indicates that ovarian activity may frequently be maintained in these situations (12,13).

The amount and quality of a woman's accessible oocytes are both included in her ovarian reserve, which is a reflection of her reproductive potential (14). Clinicians usually use a mix of biochemical markers and ultrasonographic studies to assess ovarian reserve, even though there isn't a single, well-recognized test for this purpose. Anti-Mullerian hormone (AMH) is one of the frequently used markers among these (15). AMH, which is produced by preantral and early antral follicles, is thought to be a sign of general ovarian activity and provides insights into the size of the primordial follicle pool (16). Its clinical utility is enhanced by its reduced vulnerability to environmental variations and relative stability during the menstrual cycle (17). However, high and fluctuating AMH concentrations are common in people with polycystic ovarian syndrome. AMH levels gradually drop with age as the primordial follicle pool shrinks, and they often stop being detectable around menopause (18,19). In clinical settings, AMH screening is often used to evaluate ovarian reserve in patients undergoing ovarian surgery, infertility testing, or therapies like chemotherapy or radiation therapy that carry a risk of gonadal damage (20).

By measuring blood AMH levels in patients with ovarian torsion, this research sought to determine the possible impact of detorsion surgery on ovarian reserve and to investigate potential clinical and surgical variables that may be involved in these hormonal alterations.

MATERIALS AND METHODS

The Department of Obstetrics and Gynecology at the Şahinbey Research and Training Hospital, which is connected to Gaziantep University Faculty of Medicine, conducted this retrospective observational research. Patients with an ovarian torsion diagnosis who had surgery and had their blood AMH levels assessed both before and after the procedure. Patient anonymity was preserved throughout the entire data analysis process, and all clinical data were obtained via the hospital's secure electronic health record system.

Patient Selection and Data Collection

Serum AMH levels were measured during the clinical course of patients with a desire for fertility who had surgery at the Department of Obstetrics and Gynecology, Şahinbey Research and Training Hospital, Gaziantep University Faculty of Medicine, between 2020 and 2022 after being diagnosed with ovarian torsion. Patients whose procedures were carried out by the same skilled gynecologic surgical team were chosen as the research population.

Measurements taken at least three months after surgery were used to assess postoperative AMH levels. Age between 18 and 44, a desire for future fertility, and the availability of both preoperative and postoperative AMH readings. Exclusion criteria included being older than 44, lacking preoperative and/or postoperative AMH data, not attending postoperative follow-up, and having had further ovarian surgery after detorsion. The medical records of 33 individuals who received treatment for ovarian torsion, within the allotted time frame, were examined. Ten individuals were eliminated due to lack of hormonal data or surgical follow-up. The research also included oophorectomy patients, who were assessed independently in a subgroup analysis.

Serum AMH levels were measured at the hospital's hormone laboratory using the same assay kit and equipment (Beckman Coulter) for all patients receiving treatment at the same facility. AMH1" refers to AMH levels recorded before surgery, while "AMH2" refers to levels tested at least three months after surgery. The hospital's electronic medical record system was used to gather demographic and clinical data, such as age, obstetric history, preoperative ultrasound results, and operation type. Finally, 23 patients who met the inclusion criteria were included in the final analysis. The patient selection process is summarized in Figure 1.

This study was conducted in accordance with the ethical standards outlined in the Declaration of Helsinki. Ethical approval was granted by the Ethics Committee of Gaziantep University (decision number: 2022/380, date: 07.12.2022).

Statistical Analysis

The R programming language was used to conduct statistical studies and create graphical representations (version 2024.04.2+764). While continuous variables were presented using descriptive statistics as such as mean ± standard error (mean ± standard deviation) or median (minimum-maximum), if applicable, categorical data were shown as percentages (%). The Shapiro-Wilk test was used to evaluate the data's distribution. The Wilcoxon Signed-Rank Test was used to analyze differences between preoperative and postoperative AMH levels for paired data that did not have a normal distribution.

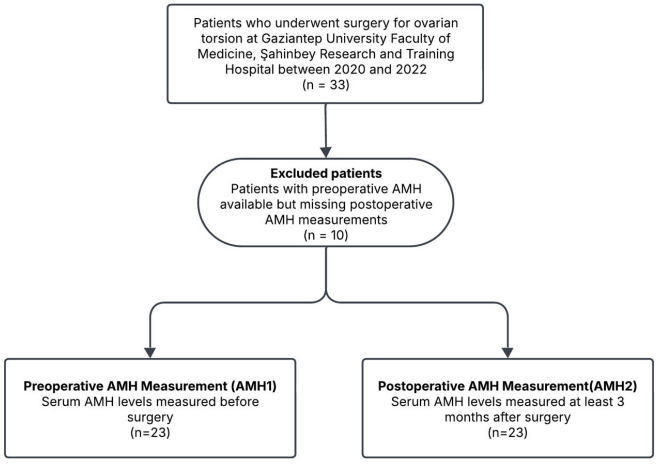

Figure 1. Flowchart of the patient selection process for inclusion in the study.

AMH: Anti-Mullerian hormone

Two independent groups were compared for differences using the Mann-Whitney U test. Statistical significance was defined as a p-value of less than 0.05.

RESULTS

This research assessed a total of 23 individuals who had surgery to treat ovarian torsion. The research cohort's demographic and surgical characteristics are reported in Table 1. The median age of the participants was 28, and their ages varied from 18 to 44. 26.1% were unmarried, whilst 73.9% were married. Parity ranged from 0 to 5, and gravidity ranged from 0 to 9. Left ovarian torsion occurred in 34.8% of cases, whereas right ovarian torsion was observed in 65.2% of cases. Regarding surgical method, laparotomy (L/T) was performed on 56.5% of patients, while laparoscopy (L/S) was performed on 43.5% of patients. Before surgery, the mean blood AMH content was 3.22±2.4 ng/mL; after the operation, it rose to 4.51±2.1 ng/mL (Table 1).

Figure 2 presents the individual changes in AMH levels observed in the study. Most patients demonstrated increased postoperative

Table 1. Clinical and demographic characteristics of patients included in the study

Variables	n=23
Age, Median(min.-max.)	28 (18-44)
Single, n (%)	6 (26.1%)
Married, n (%)	17 (73.9%)
Gravidity, median (min.-max.)	2 (0-9)
Parity, median (min.-max.)	1 (0-5)
Side of torsion-right, n (%)	15 (65.2%)
Side of torsion-left,n (%)	8 (34.8%)
Type of surgery-laparotomy, n (%)	13 (56.5%)
Type of surgery-laparoscopy, n (%)	10 (43.5%)
Preoperative AMH, (mean ± SD), ng/mL	3.22±2.4
Preoperative AMH, (mean ± SD), ng/mL	4.51±2.1

AMH: Anti-Mullerian hormone, SD: Standard deviation, min.-max.: Minimum, maximum

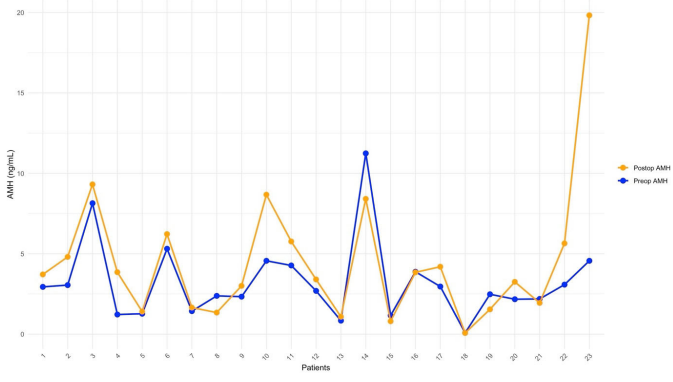

Figure 2. Individual preoperative and postoperative AMH levels of patients undergoing detorsion surgery.

AMH: Anti-Mullerian hormone

AMH levels compared to their preoperative measurements, with several individuals exhibiting a marked rise following surgery. However, a decline in AMH levels was observed postoperatively in a few patients compared to their preoperative measurements.

The variations in AMH levels according to the type of surgery performed are shown in Table 2. Postoperative AMH levels exhibited an increasing tendency in instances when detorsion was followed by cystectomy; however, the rise was not statistically significant (p=0.098). Patients who had detorsion without cystectomy, likewise, showed a comparable non-significant increase in outcomes (p=0.135). AMH readings before and after surgery did not significantly vary in the subset of individuals who had oophorectomy (p=0.500). On the other hand, postoperative AMH levels increased significantly among individuals who did not have an oophorectomy (p=0.014).

Changes in AMH levels according to the surgical approach and side of torsion are presented in Table 3. A statistically significant increase in postoperative AMH levels was observed in patients who underwent laparotomy (L/T) (p=0.021). In contrast, no significant difference was found between preoperative and postoperative AMH levels in the group that underwent laparoscopy (L/S) (p=0.375). Among patients with right-sided torsion, the increase in AMH levels was not statistically significant (p=0.187), whereas a significant increase in postoperative AMH levels was observed in those with left-sided torsion (p=0.039) (Table 3).

DISCUSSION

This study assessed the influence of surgical management on ovarian reserve by measuring serum AMH levels before and after surgery in patients with ovarian torsion. It also evaluated a range of clinical and intraoperative factors that could potentially influence hormonal changes. As a well-established biomarker of ovarian reserve, is closely related to the number of remaining primordial follicles (21,22). Despite the absence of a universally accepted standard for evaluating ovarian function, AMH remains widely used in clinical practice due to its stability throughout the menstrual cycle and relative resistance to external influences (23). Studies have demonstrated that AMH is a superior predictor of ovarian response to stimulation compared to other markers such as age, follicle-stimulating hormone, estradiol, and inhibin B, and its diagnostic performance is considered comparable to that of antral follicle count (AFC) (24).

In our cohort of 23 patients, there was no statistically significant change in overall AMH levels when comparing preoperative (AMH1) and postoperative (AMH2) values measured at least three months after surgery. Nonetheless, 16 patients (69.5%) showed an increase in AMH following surgery, while 7 patients (30.5%) exhibited a decrease. Several factors may explain the observed postoperative reductions in AMH, including excessive use of electrosurgical devices, inflammatory damage, accidental excision of healthy ovarian tissue, or trauma related to the surgical technique (25,26). Additionally, the literature highlights the role of reperfusion injury-alongside ischemia-as a contributor to follicular damage. Reactive oxygen species generated during the reperfusion phase may cause cellular injury in already compromised ovarian tissue (27). Some reports have suggested that detorsion itself may exacerbate tissue injury (28). However, such detrimental effects were not clearly observed in our study; on the contrary, most patients demonstrated a postoperative increase in AMH. This finding may reflect the restoration of blood flow to previously edematous ovarian tissue, allowing for greater AMH release into circulation.

Subgroup analyses further revealed that patients who underwent detorsion combined with cystectomy exhibited a postoperative increase in AMH, though the difference did not reach statistical significance (p=0.098). Similarly, in patients treated with detorsion alone, no statistically significant change was noted (p=0.135). Previous studies have reported a postoperative decline in AMH levels following cystectomy, with some showing recovery by the

Table 2. Comparison of preoperative and postoperative AMH levels according to the type of surgical intervention

Surgical group	Preoperative AMH (median, min.-max.)	Postoperative AMH (median, min.-max.)	p
Detorsion + cystectomy	2.94 (1.43-5.31)	3.71 (1.54-8.67)	p=0.098
Detorsion without cystectomy	2.35 (0.08-11.24)	3.54 (0.07-19.82)	p=0.135
Oophorectomy performed	1.27 (1.16-2.19)	1.40 (0.80-1.94)	p=0.500
No oophorectomy	2.95 (0.08-11.24)	3.84 (0.07-19.82)	**p=0.014**

Data are presented as median (min.-max.); p-values were calculated using the Wilcoxon Signed-Rank Test. Statistically significant p-values (p<0.05) are shown in bold.
AMH: Anti-Mullerian hormone, min.-max.: Minimum-maximum

Table 3. Comparison of preoperative and postoperative anti-Mullerian hormone levels based on surgical method and side of torsion

Variable	Preoperative AMH (median, min.-max.)	Postoperative AMH (median, min.max.)	p
Laparotomy	2.34 (0.84-5.31)	3.71 (1.08-19.82)	**0.021**
Laparoscopy	2.96 (0.08-11.24)	3.60 (0.07-9.31)	0.375
Right-sided torsion	2.69 (0.08-11.24)	3.4 (0.07-9.31)	0.187
Left-sided torsion	2.57(1.22-5.31)	3.78 (1.40-19.82)	**0.039**

Data are presented as median (min.-max.); p-values were calculated using the Wilcoxon Signed-Rank Test. Statistically significant p-values (p<0.05) are shown in bold.
AMH: Anti-Mullerian hormone, min.-max.: Minimum-maximum

third month (29), while others have demonstrated a more prolonged reduction, particularly in patients with endometriomas and higher preoperative AMH levels (30). Our results support this observation, as most patients had AMH levels that exceeded baseline values by three months postoperatively, suggesting that cystectomy may not have long-lasting detrimental effects on ovarian reserve.

Although AMH levels declined after oophorectomy, this change was not statistically significant (p=0.500). In contrast, patients who did not undergo oophorectomy experienced a significant increase in postoperative AMH levels (p=0.014). This finding supports the negative effect of oophorectomy on ovarian reserve, though conclusions should be drawn cautiously given the limited sample size in this subgroup.

Regarding the surgical approach, a statistically significant change in postoperative AMH levels was observed in patients who underwent laparotomy (L/T) (p=0.021). In contrast, no significant difference was found in those who underwent laparoscopy (L/S) (p=0.375). While this difference may reflect variations in surgical exposure or intraoperative handling, it should be interpreted with caution due to the small sample size and lack of objective perfusion assessment. Nevertheless, the wide variation in AMH levels within the laparoscopy group suggests that the surgical approach alone may not be the sole determinant of outcome.

Previous studies have shown that laparoscopic detorsion can effectively preserve ovarian reserve without significantly impairing AMH levels or AFCs, supporting the efficacy of minimally invasive techniques when performed by experienced surgeons (31). Notably, previous reports have emphasized that experienced laparoscopic surgeons can perform atraumatic and effective detorsion even with limited operative fields, suggesting that operator skill may outweigh the choice of surgical method. Additionally, it has been highlighted that surgical expertise, intraoperative decision-making, and the severity and duration of torsion are critical factors influencing ovarian reserve preservation, rather than the surgical approach itself (32). Moreover, the extent of ischemic injury caused by prolonged or severe torsion is a critical determinant of ovarian functional recovery, regardless of the surgical technique used. These considerations suggest that the higher postoperative AMH levels observed in the laparotomy group in our study may reflect multifactorial influences rather than the surgical technique's inherent advantages.

Furthermore, it is essential to recognize that postoperative changes in AMH levels do not necessarily translate into reduced fertility potential. Prospective data have demonstrated that although AMH levels may decrease after ovarian surgery, the likelihood of achieving pregnancy and live birth remains comparable over long-term follow-up (33). Therefore, while AMH dynamics offer valuable insights into ovarian function recovery, they should be interpreted within a broader clinical context, particularly in fertility-desiring women undergoing detorsion.

When analyzed according to the side of torsion, a significant increase in postoperative AMH levels was observed in patients with left-sided torsion (p=0.039), whereas the change was not substantial in right-sided cases (p=0.187). This may be explained by the anatomical and physiological advantages of the left ovary, including better venous drainage and lymphatic flow. The literature also notes that the left ovary is more resistant to torsion due to support from the sigmoid colon and a shorter utero-ovarian ligament, which may potentially result in less tissue damage during torsion events (4). These anatomical features may contribute to better functional recovery.

Even when the ovary appears dark or bluish-black intraoperatively, detorsion has been regarded as a safe and effective fertility-preserving option in patients wishing to retain reproductive potential, as previously noted in the literature (34). The present study supports this perspective, as postoperative AMH levels were frequently found to be elevated. These findings suggest that while ovarian reserve may experience a temporary reduction during the acute phase of torsion, timely and appropriate surgical management can allow for the preservation of ovarian function.

A key strength of this study lies in its exclusive focus on women with fertility desire who underwent surgical treatment specifically for ovarian torsion. Moreover, various surgical approaches, such as detorsion, cystectomy, and oophorectomy, and their evaluation through subgroup analyses, provide a comprehensive view rarely explored in similar research. By investigating patient-specific fluctuations in AMH levels, this study offers valuable insights into the potential for preserving ovarian function following torsion.

Study Limitations

However, several limitations should be acknowledged. The relatively small number of patients limits the generalizability of the results. Additionally, although AMH values were recorded both before and after surgery as part of routine clinical monitoring, the study's retrospective nature may reduce the strength of causal interpretations. Ideally, a prospective study design would have enabled stronger conclusions. Furthermore, postoperative AMH was measured at a single time, three months after surgery, which may not adequately capture long-term changes in ovarian reserve. Another limitation is the absence of intraoperative Doppler ultrasonography or other standardized techniques to assess ovarian blood flow objectively before and after detorsion. This limits the ability to definitively interpret the relationship between surgical approach and postoperative AMH dynamics. Nevertheless, all hormonal assessments were performed within the same institution using identical assay kits and equipment, ensuring consistency and reliability in laboratory measurements.

CONCLUSION

In conclusion, this study's findings demonstrate that serum AMH levels are largely preserved-or even increased-in patients who undergo detorsion. Surgical approaches other than oophorectomy, particularly when performed on time, appear to support the maintenance of ovarian function. The observed effects of surgical technique and torsion laterality on ovarian reserve further emphasize the importance of conservative management. Therefore, in cases of ovarian torsion where fertility preservation is a priority, detorsion can be safely performed using an appropriate surgical approach.

Ethics

Ethics Committee Approval: This study was conducted in accordance with the ethical standards outlined in the Declaration of Helsinki. Ethical approval was granted by the Ethics Committee of Gaziantep University (decision number: 2022/380, date: 07.12.2022).

Informed Consent: Retrospective study.

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Footnotes

Authorship Contributions

Surgical and medical practices: E.Y., İ.T., S.S., Concept: E.Y., İ.T., S.S., A.I.K., Design: E.Y., A.I.K,. Data Collection and Processing: E.Y., D.A.A., F.Ç., Analysis or interpretation: İ.T., Y.S., Literature search: İ.T., S.S., Y.S., Writing: F.Ç., A.I.K, İ.T.

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