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Title:
Efficacy of argon plasma coagulation (APC) in the reduction of gastrojejunal anastomosis for weight regain after Roux-en-Y gastric bypass

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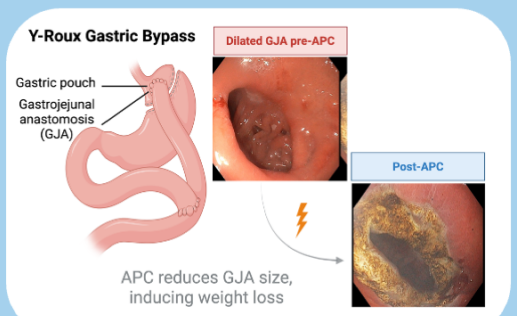
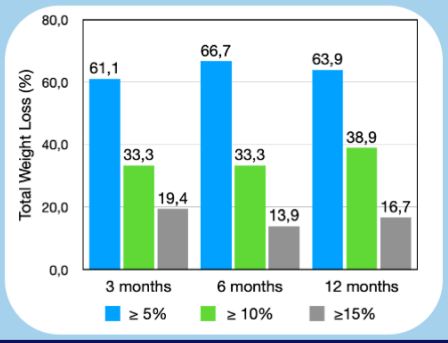
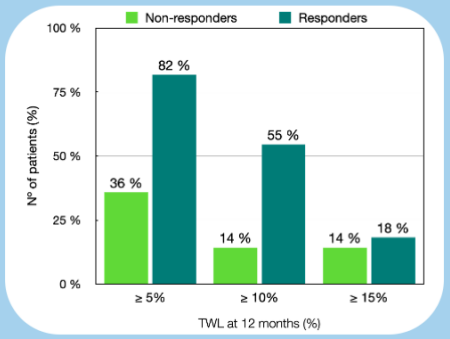
N = 36 , ♀ (78%), Age 44







- 3 APC sessions
- No predictive factors were identified
- 8% Adverse events (all mild)

- Total weight loss (**TWL**) categorically assessed at 3, 6, 12m
- Responders: ≥ 5% TWL at 3 months

- Early weight loss may predict long-term success
- 12m: **BMI <30** in 27% of responders

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Efficacy of argon plasma coagulation (APC) in the reduction of gastrojejunal anastomosis for weight regain after Roux-en-Y gastric bypass

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ABSTRACT

Background & aims: Argon plasma coagulation (APC) is a recognized endoscopic therapy for weight regain after Roux-en-Y gastric bypass (RYGB). We aimed to validate its efficacy and safety in a Spanish tertiary center and to explore predictors of response.

Patients and methods: We conducted a single-center retrospective study of 36 RYGB patients who underwent standardized APC for weight regain between 2018 and 2023. The primary endpoint was percentage total weight loss (%TWL) at 3, 6, and 12 months. Secondary outcomes included BMI change, reduction of gastrojejunal anastomosis (GJA)

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diameter, safety, and exploratory predictors of response. Responders were defined as patients achieving ≥5% TWL at 3 months.

Results: Mean %TWL was ~8% at 3, 6 and 12 months. At 12 months, 63.9% of patients maintained ≥5% TWL, 38.9% ≥10%, and 16.7% ≥15%. Early response (≥5% TWL at 3 months) predicted sustained efficacy. Responders achieved significantly greater weight loss than non-responders at all time points, reaching ~11% TWL at one year. No associations were found between %TWL and baseline demographics, comorbidities, or GJA diameter. The mean GJA reduction was 10 mm (−36.9%), with 72% of patients achieving a final GJA ≤18 mm, although this did not correlate with %TWL. Technical success was 100%. Three adverse events (8%), all mild, were reported.

Conclusions: APC is a safe and simple option for post-RYGB weight regain, achieving clinically meaningful weight loss in over 60% of patients. Early response is a predictor of long-term benefit and may guide timely initiation of adjunctive therapies in non-responders.

Keywords: Obesity surgery. Roux-en-Y gastric bypass. Weight regain. Argon plasma coagulation.

INTRODUCTION

Obesity is widespread and costly in developed countries. Bariatric surgery is an effective treatment for obesity with Roux-en-Y gastric bypass (RYGB) being one of the most commonly performed procedures. However, about 20% of patients experience weight regain during the follow-up (1,2); impacting obesity-related comorbidities

RYGB failure stems from both non-surgical and surgical factors (3). Non-surgical causes include behavioral issues like inactivity, low self-esteem, and disordered eating. Surgical causes mainly involve dilation of the gastric pouch and enlargement of the GJA (4). The latter is a key issue and may be linked to rapid gastric emptying (5,6). Several endoscopic procedures have been reported to reduce the diameter of the GJA (7–11).

Argon plasma coagulation (APC) is a non-contact endoscopic modality delivering radiofrequency energy through ionized argon gas, inducing gradual GJA diameter reduction,

enhancing satiety, and promoting weight loss (12).

APC is recognized as an effective endoscopic therapy for weight regain after RYGB. We aimed to validate its efficacy and safety in a Spanish tertiary center and to explore potential predictors of treatment response. The primary endpoint was %TWL at 3, 6, and 12 months, with secondary endpoints including BMI change, GJA diameter reduction, safety, and exploratory predictors.

PATIENTS AND METHODS

Design study and participants

A retrospective study was conducted at a Spanish tertiary center, including 59 patients treated with APC for GJA reduction between 2018–2023. Twenty-three were excluded due to dumping syndrome without significant weight regain. Although retrospective, data were prospectively collected.

Ethical approval was granted (C.I. 24/011-E), and all participants provided informed consent, in line with the Declaration of Helsinki.

Eligible patients were adults with prior RYGB, ≥10% weight regain from nadir, and inadequate response to lifestyle or pharmacological interventions. APC was performed when GJA diameter exceeded 15 mm.

Demographics, BMI (baseline, nadir, pre-APC), time since surgery, and weight loss post-APC were extracted from electronic records.

Endoscopic procedure

All procedures were performed by a single endoscopist. Patients fasted for 12 hours and received propofol-based sedation under anesthesiology supervision in left lateral decubitus.

A gastroscope (Olympus CV-1500) was used to assess GJA diameter pre- and post-procedure with a flexible-tip guidewire as described by de Quadros et al (13). APC was delivered circumferentially using an ERBE USA APC™ 2.3 mm probe at 80 W and 0.8 L/min, with sessions lasting ~15 minutes.

After a 1-hour recovery, patients were discharged the same day. Post-procedure care included a soft diet for 2 weeks, limited fluid intake, PPIs, and analgesics.

Patients received 1–4 APC sessions depending on GJA diameter. Follow-up occurred monthly for 6 months, then every 3–6 months, including clinical review and weight tracking. Additional sessions were performed as needed in selected patients.

Statistical analysis

Continuous variables were reported as mean ± standard deviation (SD), and categorical variables as percentages. Group comparisons for continuous data were performed using the independent t-test or the Mann-Whitney U test for non-normally distributed data. Categorical variables were analyzed with the Chi-square test. Analyses were conducted using SPSS (v26.0) and JASP (v0.18.1).

Due to the small sample size (n=36) and limited outcome events, multivariable analysis was not feasible. We therefore focused on univariate analyses and reported effect sizes with 95% CI. Exploratory logistic regression with 1–2 predictors was considered but offered limited additional value.

RESULTS

Demographic, anthropometric, clinical evaluation and adverse events.

Thirty-six patients were included; their demographic and anthropometric characteristics, along with pre-surgery comorbidities such as diabetes, hypertension, dyslipidemia, obstructive sleep apnea (OSAS), and eating behavior disorders (EBD), are summarized in **Table 1**.

At the time of APC, the mean weight had increased to 97.15 ± 15 kg (BMI 36.02 ± 5.2 kg/m²). APC was performed in 1–2 sessions for 30.6% of patients and in 3–4 sessions for 69.4%. No patient required more than four attempts.

Adverse events were reported in 8% (n=3): two GJA stenoses and one ulceration, all mild. Stenoses were treated successfully with endoscopic dilation; the ulcer healed spontaneously.

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Table 1. Demographic-anthropometric profile and pre-surgery comorbidities of patients submitted to GJA reduction with APC. *BMI: Body mass index. DM: Diabetes mellitus.*

Quantitative variables	**Mean** ± SD
Anthropometric profile	
Height (m)	1.64 ± 0.07
Pre-surgery weight (kg)	122.68 ± 13
Pre-surgery BMI (kg/m^2)	45.51 ± 4.49
Nadir BMI (kg/m^2)	29.83 ± 3.5
Pre-APC BMI (kg/m^2)	36.02 ± 5.2
Demographic variables	
Age	43.95 ± 10
Qualitative variables	**N (%)**
Sex	
Women (n/%)	28 (77,8)
Men (n/%)	8 (22.2)
Pre-surgery comorbidities	
Any	19 (52.7)
Type 2 DM	5 (13.9)
Hypertension	7 (19.4)
Dyslipidemia	5 (13.9)
OSAS	9 (25)
EBD	5 (13.9)

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Gastrojejunal anastomosis (GJA) diameter

Mean GJA diameter decreased from 26.6 ± 5.4 mm to 16.4 ± 5.0 mm post-procedure ($p < 0.001$). In 72% of patients (n = 26), final GJA diameter was <18 mm. Absolute reduction in anastomosis diameter (RAD) was 10.22 ± 6.39 mm (−36.9 ± 19.3%).

Total weight loss (TWL).

TWL was assessed at three time points: at 3, 6 and 12 months. Mean absolute TWL was 8.3 ± 7.1% at 3 months, 8.0 ± 6.6% at 6 months, and 8.2 ± 8.6% at 12 months. BMI dropped from 36.02 ± 5.2 pre-APC to 32.91 ± 4.7 at 12 months ($p < 0.01$).

Mean values may misrepresent outcomes by underestimating high responders and overestimating low responders. As mean absolute TWL plateaued after 3 months, we additionally assessed categorical TWL (≥5%, ≥10%, ≥15%) at all time points (**Figure 1**). Results are summarized in **table 2** with corresponding 95% CI.

Time point	**Absolute TWL** (%) [95% CI]	**≥5% TWL** (%) [95% CI]	**≥10% TWL** (%) [95% CI]	**≥15% TWL** (%) [95% CI]
3 m	8.3% [5.9 – 10.7]	61.1% [43.5–76.9]	33.3% [18.6–51]	19.4% [8.2–36]
6 m	8.0% [5.7 – 10.2]	66.7% [49–81.4]	33.3% [18.6–51]	13.9% [4.7–29.5]
12 m	8.2% [5.3 – 11.1]	63.9% [46.2–79.2]	38.9% [23.1–56.5]	16.7% [6.4–32.8]

Table 2. Weight loss outcomes after APC

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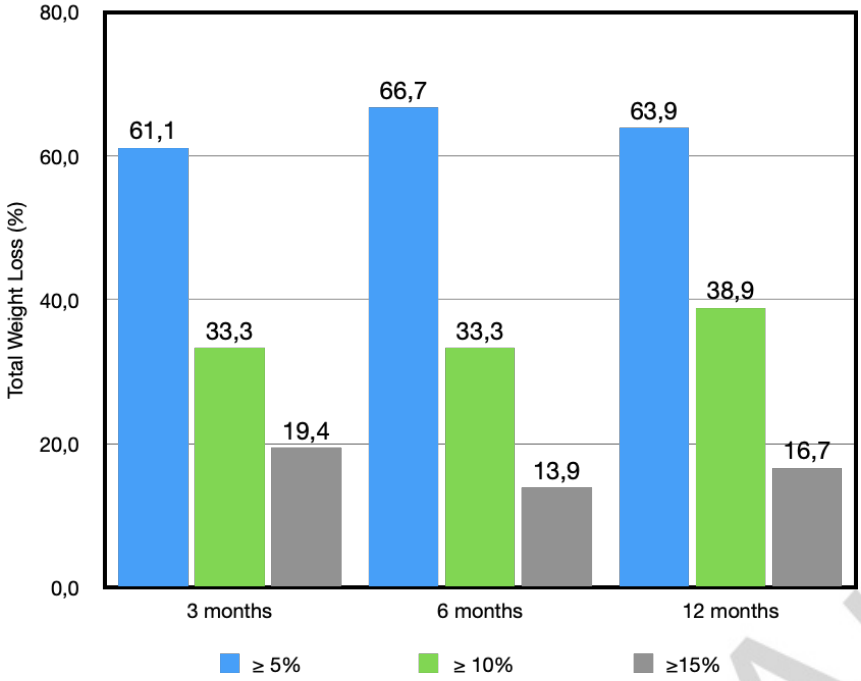

Figure 1. Results for categorized TWL ≥ 5%, ≥ 10% and ≥15% at 3, 6 and 12 months in all patients.

Categorical TWL (≥5%, ≥10%, ≥15%) was compared at 3, 6, and 12 months using the McNemar test, with no significant differences observed across time points.

Possible variables associated with %TWL

To identify predictors of greater %TWL, analyses focused on the 3-month time point, where weight loss was most pronounced. Absolute TWL at 3 months was evaluated in relation to demographic, anthropometric, and clinical variables, including comorbidities. Patients were also stratified by the number of APC sessions (1–2 vs. 3–4).

Quantitative variables were analyzed using Spearman's Rho (ρ = 0.163, weak correlation), and categorical variables with the Mann-Whitney U test. No significant associations were found between TWL and comorbidities (hypertension, diabetes, dyslipidemia, OSAS, EBD), or the number of APC sessions at any time point.

APC-responders and possible associated factors,

At 3 months, 22 patients (61%) achieved ≥5% TWL and were classified as "responders", while 14 patients (39%) with <5% TWL were considered "non-responders". Responders

maintained greater weight loss at 6 and 12 months. The highest reduction occurred between 3 and 6 months, with responders achieving nearly 15% TWL compared to 5.4% in non-responders (**Figure 2**).

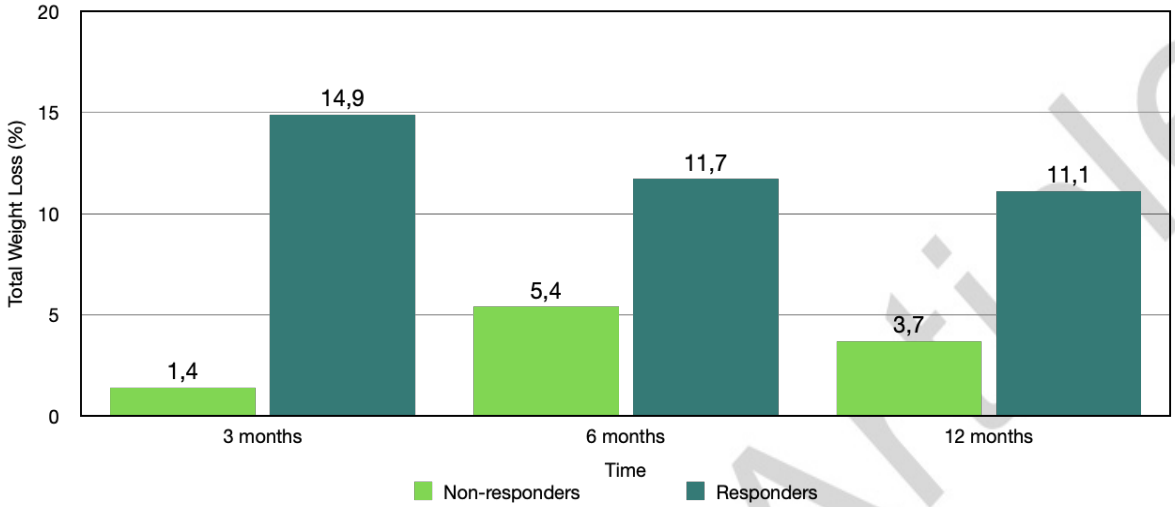

Figure 2. Results for absolute TWL at 3, 6 and 12 months comparing responders vs non-responders.

At 12 months, over 80% of responders maintained a TWL of ≥5%, and more than 50% reached ≥10%. In comparison, only about one-third of non-responders achieved ≥5% TWL (**Figure 3**).

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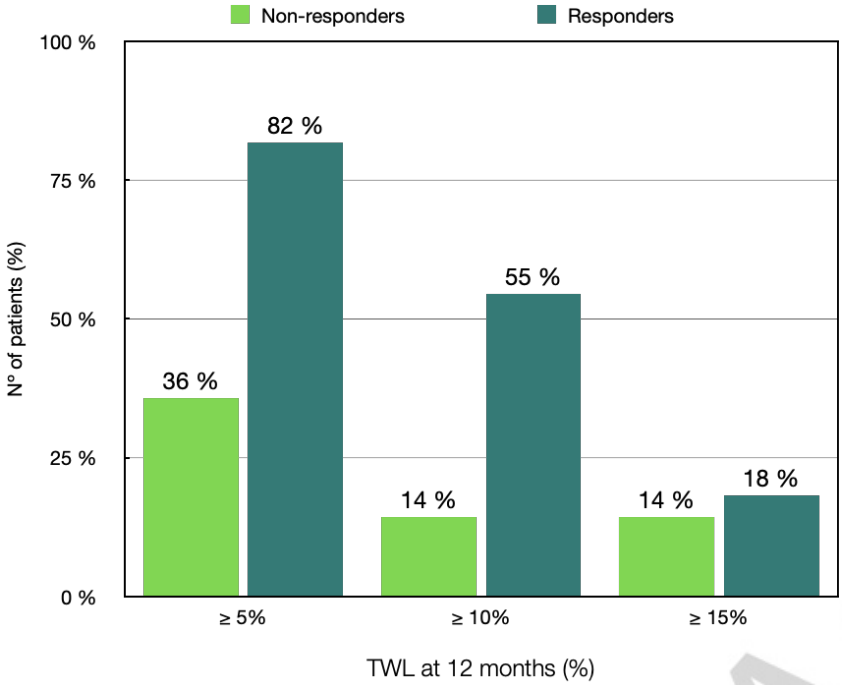

Figure 3. Results for categorical TWL **at 12 months** in responders and non-responders.

At 12 months, mean BMI was lower in responders (31.7 ± 4.1) than non-responders (34.8 ± 5.1 ; p=0.049). Also, 27.3% of responders achieved BMI <30 kg/m2 which may be considered a significant clinical success. Predictive factors were assessed between groups using appropriate tests, but no significant differences were found (**Table 3**).

Variable	**Responders (n=22) [IC 95%]**	**Non-responders (n=14) [IC 95%]**	**p value**
BMI pre-APC (kg/m²)	35.9 [33,4 – 38,3]	36.3 [33,3 – 39,3]	0.824
BMI at 3 months (kg/m²)	31.3 [29,1 – 33,5]	35.8 [32,8 – 38,8]	**0.015**
BMI 1 year post-APC (kg/m²)	31.7 [29,9 – 33,5]	34.8 [31,9 – 37,8]	**0.049**
Baseline GJA (mm)	26.7 [24,1 – 29,2]	26.5 [23,6 – 29,4]	0.923
Final GJA (mm)	16.8 [14,4 – 19,1]	15.8 [13 – 18,5]	0.577

GJA ≤18 mm after APC, n (%)	15 (68.2% [45,1 – 86,1])	11 (78.6% [49,2 – 95,3])	0.706
Number of APC sessions (median)	3 [2 – 3]	3 [2 – 3]	0.557

Table 3. Predictors of response (≥5% TWL at 3 months). All values correspond with mean value and confidence intervals **[IC 95%].**

DISCUSSION.

This retrospective study supports APC's efficacy for post-RYGB weight regain and, to our knowledge, represents the first Spanish tertiary-center report, with outcomes consistent with international series.

Although most patients lost weight initially, only 13.9% and 16.7% maintained ≥15% TWL at 6 and 12 months in our cohort, underscoring obesity's chronic nature and the limited durability typically observed with endoscopic outlet-reduction approaches (14). Our 6-month mean TWL of 7.96% ± 6.57 is consistent with multicenter APC data (by Moon et al. 6.7 ± 0.3) (15), and slightly lower than smaller series reporting ~10.5% (16). At 12 months, 27.3% of responders reached a BMI <30, no longer meeting obesity criteria—representing a meaningful clinical success.

A marked difference in APC response was evident at 3 months, with responders achieving nearly tenfold greater weight loss than non-responders, and sustaining a twofold advantage in TWL at 6 and 12 months. Early response (≥5% TWL at 3 months) appears predictive of long-term success, consistent with reviews recommending stepped-care strategies such as pharmacotherapy (17) or suturing-based transoral outlet reduction (TORe) for non-responders (18). In our cohort, early responders achieved ~11% TWL in one year. Similarly, in a previous institutional study using APC for postprandial hypoglycemia, a comparable one-year %TWL was observed, but only in patients with weight regain (19).

No baseline clinical or endoscopic variables—including GJA size, %RAD, or demographics—predicted response, suggesting non-anatomical factors may play a greater role. Although lifestyle advice was provided, adherence was not formally assessed. Evidence

indicates that multidisciplinary follow-up may influence outcomes more than the endoscopic technique itself (20). Future studies should better assess and support behavioral compliance post-procedure.

When comparing techniques, APC has shown short and mid-term efficacy, similar to suturing TORe (s-TORe). Carvalho et al. confirmed APC efficacy in a randomized controlled trial (21), and Brunaldi et al. reported comparable outcomes at 12 months (8.3% vs. 7.5% TWL) (16). Meta-analyses suggest APC combined with suturing improves durability over suturing alone (22). s-TORe has demonstrated ~9% TWL maintained at 5 years (23), although other series report attenuation by 3 years due to GJA redilation (24). Thus, TORe may provide greater long-term efficacy, but at the expense of higher complexity, cost, and risk of bleeding or stenosis. Purse-string suturing appears more effective than interrupted stitches, with 12-month TWL similar to ours (8.6%) (25). In refractory cases, sequential APC followed by TORe achieved superior results compared with suturing alone (22).

Other outlet reduction methods, such as OTSC, have also shown efficacy, with ~80% GJA reduction and BMI decrease at 12 months (11). However, OTSC is technically demanding and can lead to dysphagia requiring endoscopic dilation. By contrast, APC can be repeated, performed under conscious sedation, and has a lower rate of serious adverse events. Nonetheless, durability remains its main limitation, as both APC and TORe tend to lose effect after 2–3 years due to redilation of the GJA (24). In contrast to contemporary practice, where GLP-1 receptor agonists are increasingly prescribed as adjuncts for obesity management, none of our patients received these agents during follow-up. This allows our study to isolate the effect of APC as a standalone endoscopic therapy.

Technical parameters may also influence results. Higher power in APC settings (70–80 W) has been linked to deeper tissue effects and greater efficacy than lower settings (45–55 W) (26). All patients were treated with 80 W, but unmeasured variables (duration, probe distance), may also contribute. GJA diameter decreased by 10mm (-36.9%), with 72% of patients achieving ≤18 mm. Although previous studies show GJA reduction predicts TWL (10,27,28), we found no association, likely due to limited power. Similarly, no correlation was seen between the number of sessions and TWL, although prior studies suggest otherwise (26).

APC was safe, with an 8% adverse events rate, comparable to 3% in large series (15), and no major complications, likely due to it's superficial tissue effect (1–3 mm) (27).

Our follow-up was limited to 12 months, consistent with most APC and TORe series (16,21,25). Longer-term data show attenuation of APC outcomes at 2-3 years (24), whereas suturing-based TORe maintains ~9% TWL at 5 years (23). Future follow-up of our cohort at 18, 24, and 36 months will help clarify durability, although current evidence suggests APC effectiveness diminishes over time.

Limitations include the single-center, small-sample, retrospective design and lack of multivariable analysis. Only univariate results with 95% CI were feasible. Nonetheless, APC reversed weight regain in more than half of patients, in line with international reports (14,15,21). Larger prospective studies are needed to validate predictors of response.

In conclusion, APC is a safe, cost-effective and simple option for post-RYGB weight regain, achieving clinically meaningful weight loss in over 60% of patients. Early response (≥5% TWL at 3 months) appears to predict greater long-term efficacy, allowing identification of responders and timely initiation of alternative therapies for non-responders.

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