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Comprehensive approach to reestablishing form and function after radical parotidectomy

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A B S T R A C T

Introduction: The reconstructive goals following radical parotidectomy include restoration of symmetry, reanimation of the face, and reestablishment of oral competence. We present our experience utilizing the anterolateral thigh (ALT) free flap, orthodromic temporalis tendon transfer (OTTT), and facial nerve cable grafting to reestablish form and function.

Material and methods: From 2010 to 2016, 17 patients underwent radical parotidectomy followed by immediate reconstruction. An ALT was harvested to accommodate the volume and skin defect. Additional fascia lata and motor nerve to vastus lateralis (MNVL) were obtained. Anastomosis of the ALT to recipient vessels was performed, most commonly using the facial artery and internal jugular vein. OTTT was performed by securing the medial tendon of the temporalis to orbicularis oris through a nasolabial incision. Fascia lata was tunneled through the lower lip, then secured laterally to the temporalis tendon. The MNVL was cable grafted from either the proximal facial nerve or masseteric nerve to the distal facial nerve branches. ALT fascia was suspended to the superficial muscular aponeurotic system.

Results: Average follow up was 19 months. Only one patient failed to achieve symmetry attributed to dehiscence of OTTT. All patients achieved oral competence and dynamic smile with OTTT activation. Facial nerve recovery was seen in 8 patients. 5 reached a House Brackman Score of 3. Two donor site seromas and two wound infections occurred.

Conclusion: Simultaneous ALT, OTTT, and facial nerve cable grafting provides early reestablishment of facial symmetry, facial reanimation, and oral competence with minimal morbidity.

1. Introduction

Malignant parotid neoplasms are a rare yet diverse group comprised of primary salivary gland tumors and cancers metastatic to the intraparotid lymph nodes [1]. Management of parotid neoplasms is primarily surgical and every effort is made to preserve the facial nerve through careful dissection. However, in cases of advanced disease, a radical parotidectomy, defined as a total parotidectomy with facial nerve resection, may be required to obtain negative surgical margins [2]. Disease that invades beyond the parotid may additionally require a cutaneous resection, mastoidectomy, or a lateral temporal bone resection. These defects present a unique challenge for the reconstructive surgeon, as deficits of both form and function must be addressed.

Aesthetically, patients suffer from a soft-tissue volume deficit along the angle of the mandible leading to noticeable and, in some instances, disfiguring facial asymmetry [3, 4]. Multiple reconstructive methods for addressing post-parotidectomy contour deformities have been described. These include autologous dermal fat grafting, regional muscle transfers, and various free flaps; all with the goal of lasting, atrophy resistant volume restoration at the defect site [5–9].

As a result of facial nerve sacrifice, patients are left with immediate hemifacial paralysis, which has been repeatedly demonstrated to carry significant psychosocial penalties [10, 11]. Functionally, patients are at risk for exposure keratopathy, visual impairment, nasal obstruction, and oral incompetence which results in impaired eating and speech. Options for rehabilitation include facial nerve cable grafting, regional muscle transfers, and static suspension procedures [12, 13].

Factors including advanced age, burden of comorbidity, need for adjuvant radiation, and poor oncologic prognosis favor immediate rather than delayed reconstruction. With these principles in mind, the ideal reconstruction following a radical parotidectomy should address contour deformity, facial paralysis, and cutaneous defects while imparting little additional morbidity beyond the extirpative procedure.

In this study, we describe our experience with 17 patients that underwent anterolateral thigh (ALT) free flap, orthodromic temporalis tendon transfer (OTTT), lip suspension, and reinnervation (when

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Table 1
Patient characteristics.

Preoperative characteristics					Surgical details			Postoperative details					
Patient	Age	Gender	Diagnosis	Stage	Skin Defect	Cable Graft	LOS	Follow up (mo.)	XRT	Adjuvant Procedures	HB	Resting Sym.	Survival (mo.)
1	82	M	Adenocarcinoma	T4aN0M0	N	Y	8	21	Y	EW, ER	5	Y	DOD (29.8)
2	79	M	SCCa	Unstaged	N	Y (V3)	12	4	Y	EW, ER	6	Y	DOD (5.2)
3	82	M	SCCa	Unstaged	N	N	8	8	Y	EW, ER, Rev. OTTT, BL	NA	N	LTFU (9.0)
4	57	M	SCCa	T0N2bM0	Y	Y	5	8	Y	EW, ER	3	Y	DOD (9.2)
5	52	F	Mucoepidermoid carc.	T4aN0M0	N	Y	4	28	Y	EW, SR, BX, RC	3	Y	NED (37.7)
6	51	F	Adenoid cystic carc.	T4bN0M0	Y	Y	4	24	Y	EW	3	Y	NED (34.1)
7	80	F	Melanoma	TxN3M1	Y	Y	7	6	N	ER, BL	6	Y	DOD (23.8)
8	66	F	Mucoepidermoid carc.	T4N0M0	N	Y	7	11	Y	EW, WR	4	Y	NED (22.1)
9	47	F	Carcinoma ex PA	T4N2bM0	N	Y (V3)	5	3	Y	EW	6	Y	NED (21.6)
10	58	F	Adenocarcinoma	T4aN2bM0	Y	Y (V3)	8	11	Y	EW	6	Y	NED (20.6)
11	66	M	SCCa	Unstaged	Y	Y	7	4	Y	EW, ER, BL	6	Y	NED (19.6)
12	68	F	Carcinosarcoma	T4N2bM0	N	Y	8	6	Y	EW, ER	6	Y	Rec. (18.3)
13	32	F	Spindle cell carc.	T0N2bM0	N	Y	7	7	Y	RC	4	Y	NED (17.0)
14	67	M	Salivary duct carc.	T4aN2bMX	N	Y	15	9	Y	EW, ER	6	Y	NED (15.7)
15	49	M	Adenoid cystic carc.	T3N0M0	N	Y	4	3	Y	EW, ER	6	Y	NED (7.5)
16	58	M	Adenocarcinoma	Unstaged	N	Y	7	14	Y	EW, ER, BX, IF, RC	3	Y	LTFU (27.5)
17	35	F	Adenoid cystic carc.	T4aN0M0	N	Y	7	7	Y	EW	3	Y	NED (15.1)

Yrs, years; SCCa, squamous cell carcinoma; carc., carcinoma; PA, pleomorphic adenoma; N, no; Y, yes; V3, indicates cable graft utilizing masseteric nerve; LOS, length of stay; mo, months; xrt, radiation therapy; ew, eyelid weight; er, ectropion repair; Rev. OTTT, revision orthodromic temporalis tendon transfer; BL, brow lift; SR, scar revision; BX, onabotulinumtoxinA injection; RC, recontouring; WR, wedge resection lower lip; IF, injectable filler; HB, House Brackman Score; NA, not applicable; Sym, symmetry; DOD, died of disease; LTFU, lost to follow up; NED, no evidence of disease; Rec; recurrent disease.

possible) to address the aforementioned deficits of form and function following radical parotidectomy.

2. Material and methods

Institutional Review Board approval was obtained from the Cleveland Clinic (Cleveland, OH). Seventeen patients underwent radical parotidectomy with complete facial nerve sacrifice followed by immediate ALT free flap, OTTT, lip suspension, and attempted facial nerve cable grafting from January 1, 2010 to December 31, 2016. Patients were excluded if they had less than three months of follow up after their initial surgery. A summary of preoperative details is displayed in Table 1. The average age at the time of surgery was 60.5 years old. Eight (47.1%) patients were male, 9 (52.9%) were female. Metastatic squamous cell carcinoma was the most common indication for surgery. All patients underwent a concurrent planned neck dissection.

2.1. Reconstructive surgical technique

A comprehensive description of each step of the reconstruction by Fritz et al. is available [14]. Briefly, the reconstruction was performed as follows: ALT free flap harvest occurred simultaneously during the ablation using a perforator dissection technique. A branch of motor nerve to vastus lateralis (MNVL) and an additional slip of fascia lata was obtained (Fig. 1). The ALT was debulked and/or deepithelized as needed to account for the defect volume. Mastoidectomy with facial nerve dissection was used for oncologic margins and/or to obtain exposure of the proximal facial nerve for grafting. Revascularization of the free flap was performed using vessels exposed during the extirpative procedure. The senior author prefers the facial artery and the internal jugular vein (end to side anastomosis) as recipient vessels, however other options include the superior thyroid artery paired with the internal jugular vein or the transverse cervical vessels. The superficial temporal vessels are often ligated during the extirpative procedure and are not available for microvascular anastomosis. In most instances following a radical parotidectomy, the coronoid insertion of the temporalis tendon is readily accessed. The medial tendinous fibers of the temporalis were freed from the mandible with a subperiosteal dissection. The coronoid was removed with a sagittal saw. The temporalis tendon fibers were secured to the superficial muscular aponeurotic system (SMAS) at the orbicularis oris through a nasolabial incision with 4-0 PDS suture. A lower lip suspension was accomplished by tunneling a slip of fascia lata secured to the midline orbicularis with 4-0 PDS to the temporalis tendon (Fig. 2). A branch of the MNVL was used as a cable graft from either the proximal stump of the facial nerve or masseteric nerve to the distal facial nerve branches (Fig. 3). Finally, the fascia of the ALT was suspended to the SMAS and surrounding tissues to control volume correction and the deep and superficial soft tissues were reapproximated.

Data regarding postoperative form and function including facial symmetry, evidence of reinnervation, and oral competence was obtained retrospectively from outpatient documentation as evaluated by the senior authors.

3. Results

A summary of preoperative, operative, and postoperative details is displayed in Table 1. Four (23.5%) patients had large cutaneous defects requiring a fasciocutaneous flap. One patient did not undergo facial nerve cable grafting due to the extent of the resection of the distal facial nerve. In three instances, when the proximal facial nerve stump was unavailable, the masseteric nerve was grafted to distal facial nerve branches. The average follow up period after surgery was 19 months. Complications included three donor site seromas, two wound infections, and one partial dehiscence of the OTTT. No chronic leg weakness secondary to MNVL harvest was reported. All but one patient underwent postoperative radiation. Sixteen patients achieved good facial symmetry (Figs. 4, 5). The individual that did not achieve symmetry was found to have dehiscence of their OTTT and required midface resuspension. All patients achieved a dynamic smile defined as elevation of the ipsilateral oral commissure with activation of their OTTT and good oral competence. Eight of the 16 patients that underwent cable grafting exhibited signs of neural recovery, with 5 of the 8 reaching a House-Brackman (HB) Score of 3. Adjuvant procedures performed concurrently or in the postoperative setting included upper eyelid weight, ectropion repair, scar revision, flap recontouring, mid-forehead brow lift, and onabotulinumtoxinA injection. Three patients died of metastatic disease, 2 within one year of their initial surgery.

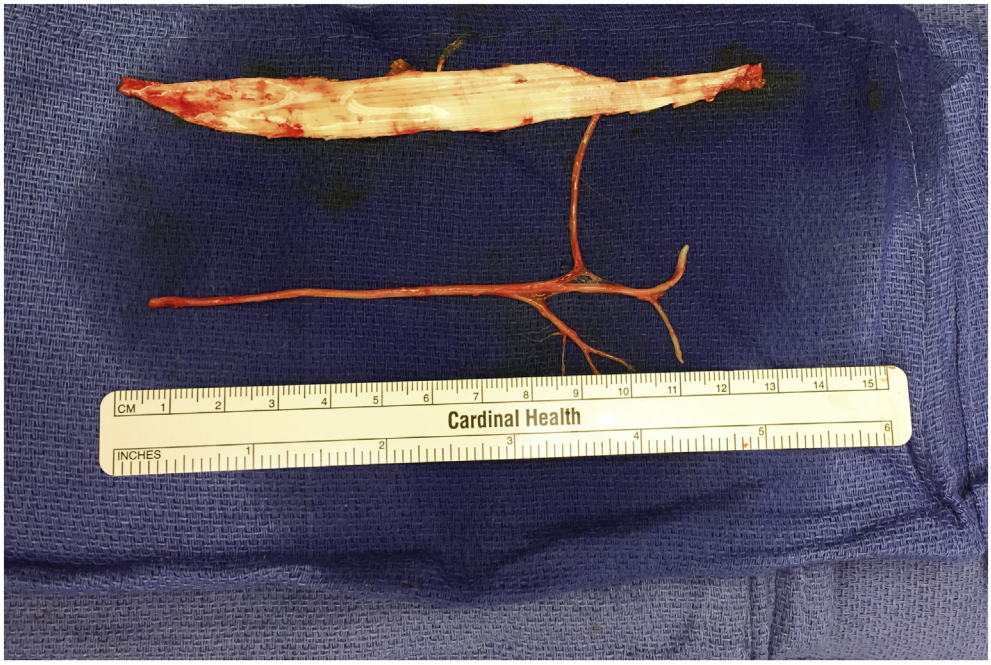

Fig. 1. The anterolateral thigh harvest site provides ready access to a slip of fascia lata and a branch of the motor nerve to vastus lateralis to be used for lip suspension and cable grafting.

Fig. 2. A slip of fascia lata is tunneled through the lower lip, then secured medially to the orbicularis oris and laterally to the fibers of the temporalis tendon.

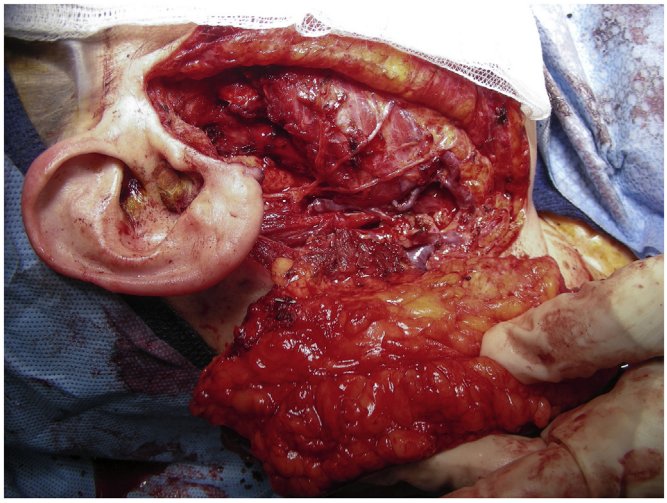

Fig. 3. Once the anterolateral thigh flap is reperfused, cable grafting of the facial nerve is performed.

3.1. Case report 1

A 66-year-old female presented with a 2.5 cm well circumscribed mass of the right parotid gland. She had no evidence facial weakness. Initial final needle aspirate suggested a benign Warthin's tumor. A superficial parotidectomy was attempted, however the mass was found to be infiltrative and densely adherent to the facial nerve. Intraoperative pathology was significant for high grade mucoepidermoid carcinoma. The ablative procedure was aborted at this time and the patient was seen in follow up for the discussion regarding management of her extensive disease. The patient was brought back to the operating room 1 month later. She underwent a radical parotidectomy and the above described reconstruction. There was no cutaneous defect. The facial artery and facial vein were selected as recipient vessels for the flap. A cable graft was performed to the proximal facial nerve and distal stumps of the marginal and buccal branches. The patient's postoperative course was uncomplicated. She underwent postoperative

Fig. 4. Case 1: 11 months following reconstruction (a) smiling and (b) in repose.

radiation. She required an eyelid weight and lower lip wedge resection to optimize eye closure and oral competence respectively. Fig. 4 was obtained at 11 months postoperatively. At this time, she had excellent facial contour with resting symmetry. She exhibited a dynamic smile with activation of her OTTT and neural recovery to a HB 3.

3.2. Case report 2

A 52-year-old female presented with a 2-year history of a right parotid mass that had become painful in recent months. No facial weakness had developed. CT Neck with contrast was significant for an ill-defined 2.5 cm mass. She was taken to the operating room for an

Fig. 5. Case 2: 13 months following reconstruction (a) smiling and (b) in repose.

open biopsy. The mass was poorly defined and was adherent to the facial nerve. Final pathology was notable for high grade mucoepidermoid carcinoma. She was brought back to the operating room 3 weeks later for a radical parotidectomy and the above described comprehensive reconstruction. There was no cutaneous defect. The facial artery and common facial vein were used as recipient vessels for the ALT. A cable graft was performed between the proximal facial nerve and distal stumps of the marginal branch, buccal branch, and zygomatic branch. Her postoperative course was uncomplicated. She underwent adjuvant radiation. She required an eyelid weight to correct lagophthalmos as well as scar revision and minor recontouring of the ALT. Fig. 5 was obtained at 13 months following her reconstruction at which time she had excellent facial contour with resting symmetry. She exhibited a dynamic smile with activation of her OTTT and neural recovery to a HB 3.

4. Discussion

The reconstructive goals following radical parotidectomy are as follows: (1) restore symmetry, (2) address the cutaneous defect, (3) reanimate the face, (4) protect the eye, and (5) reestablish oral competence. Ideally, reconstruction should take place immediately following the ablative procedure, with minimal additional morbidity. There are numerous reconstructive methods described in the existing literature; many of which detail means of addressing one or several of the aforementioned reconstructive goals. Contour defects can be filled with free fat grafts, acellular dermis, local muscle transfer, or free flaps [5, 9, 15]. Facial paralysis can be rehabilitated with immediate cable grafting or regional muscle transfer [16, 17]. Yet, beyond our described technique, there is a paucity of literature on comprehensive reconstruction following radical parotidectomy. Teknos et al. detailed their approach for a single harvest site reconstruction by utilizing the lateral arm free flap with harvest of the posterior cutaneous nerve of the forearm used as a cable graft [7]. This approach provides contour restoration and the potential for neural recovery, yet has greater donor site morbidity as compared to ALT. Furthermore, this approach lacks a method for immediate facial reanimation.

The advantages of the ALT over other donor sites are threefold. First, given the distance from the ablative field, there is optimal setup for simultaneous flap harvest. The two-team approach decreases operative time, a factor which has been independently linked to postoperative complications and increased length of stay following free flap reconstruction [18, 19]. Two, the ALT is a low morbidity harvest site [20]. In this series, several donor site seromas occurred which were managed with needle aspiration in the office setting. Finally, ALT harvest provides ready-access to adjunctive structures for reconstruction including the MNVL and fascia lata, sparing the need for an additional harvest sites.

The MNVL is easily identified during ALT harvest [21]. Its branching pattern and length make it an ideal candidate for facial nerve cable grafting [22]. In our series, no further morbidity such as quadriceps weakness was observed with branch to MNVL harvest. In addition to avoiding the sensory deficit created from other popular donor sites such as the sural, lateral antebrachial cutaneous, or greater auricular nerve, as a motor nerve, the MVNL may promote superior recovery over sensory nerve cable grafts. In rodent models, nerve regeneration is greater across motor versus sensory grafts, potentially due to the differences in fiber diversity and Schwann cell composition between the graft types [23–25].

The most crucial step in reconstruction is reestablishing facial contour and resting symmetry regardless of the extent of the defect. In our method, facial symmetry and contour was accomplished in a single effort in all but one patient through a two-fold approach. First, the extirpative volume deficit was restored through sculpting of the ALT free flap. The versatility of the ALT allows it to accommodate a spectrum of defects, from total parotidectomy to more extended lateral temporal bone resections [9, 26]. The ALT may be used for large cutaneous defects, as was necessary in 4 of our patients. Slight volume excess was tolerated intraoperatively to account for edema during harvest, but gross overcorrection was not routinely performed. A majority of patients required postoperative radiation and, as was found in previous observations, radiation had little effect on long-term flap volume [27]. The second step in establishing immediate resting symmetry involves resuspension of the midface through an OTTT with lip suspension. This balances midface position, recreates the nasolabial fold, insures oral competence, and mitigates lower lip atrophy due to orbicularis denervation. The importance of this step is underscored by the fact that the only patient with poor symmetry postoperatively was found to have a dehiscence of the OTTT.

While it is impossible to recreate the subtle and intricate movements of the intact facial neuromuscular unit, reinnervation offers the potential to achieve symmetric facial tone and the ability for spontaneous facial expressions. Crucial non-aesthetic functions of the facial nerve such as oral competence and eye closure may also be restored. In our cohort of patients, 8 of 16 demonstrated evidence of facial nerve recovery, with 5 of the 8 reaching a HB Score of 3. This outcome is comparable to previously published rates of anywhere from 45 to 90% recovery; even accounting for a lack of long term follow up and early recurrence in several of our patients [7, 28–30]. As has been repeatedly demonstrated in the literature, younger subjects in our series tended towards improved neural outcomes [28, 31, 32]. Animal models have established that axonal transport and axonal sprouting become less effective with age, which may account for poorer functional outcomes in older subjects after peripheral nerve injury [33, 34]. The effect of radiation therapy on facial nerve grafting outcomes has been debated [28, 29, 32, 35, 36]. Based on contemporary evidence, the need for adjuvant radiation should not deter reconstructive surgeons from cable grafting the facial nerve in this setting.

It has been our practice to use the stump of the facial nerve for the proximal anastomosis of the cable graft, when at all possible. When the proximal stump of the facial nerve is unavailable due to the extent of the resection, the masseteric nerve has proven to be an available alternative. The masseteric nerve is readily identified using the anatomic landmarks of the subzygomatic triangle, and when selected for grafting, has little demonstrable morbidity [37, 38]. Due to the increased density of axons and proximity to the distal facial nerve branches as compared to the proximal stump of the facial nerve, the masseteric nerve often provides earlier return of neural function [39]. Patients grafted solely with the masseteric nerve can achieve strong oral excursion, but lack the spontaneity and resting tone achieved with facial to facial nerve grafting [38–40]. Given this consideration, most recent modifications of our technique have included a dual innervation approach in which the masseteric nerve is grafted to the buccal branch in order to generate a more reliable voluntary smile and the proximal facial nerve is grafted to remaining distal branches.

As a result of the poor prognosis associated with advanced parotid malignancies, many patients may not live long enough to experience full neural recovery. In our series, two patients died within one year of surgery. Given the possibility of a poor prognosis we advocate for concomitant reanimation procedures such as the OTTT, irrespective of reinnervation potential for immediate and reliable reanimation without affecting nerve graft success. The OTTT is a well-described dynamic muscle transfer that with contraction of the transposed temporalis, leads to elevation and excursion of the oral commissure. Proper neuromuscular retraining aided by postoperative physical therapy allows patients to achieve a spontaneous controlled smile [17]. With low morbidity and relatively short operative time associated with nerve harvest and anastomosis, we believe the additional effort is justified by the significant benefit of restored facial tone and function over the lifetime of those who fare well.

While the ALT free flap, OTTT, and cable grafting provide the foundation for optimal outcomes following radical parotidectomy, fine-

tuning of results is achieved through postoperative office-based procedures. If a patient does not have preoperative corneal exposure due to lagophthalmos, it is our practice to delay management of the eye until the postoperative period. Once edema has resolved, the patient can be accurately fit for an upper eyelid platinum chain, thus optimizing eye closure and minimizing ptosis or lid distortion [41]. This is typically placed under local anesthesia and commonly combined with an ectropion repair by means of a lateral tarsal strip [42]. Following the completion of adjunctive cancer therapy, other office-based procedures are offered to the patient to maximize functional and aesthetic results. These include midforehead browlift, scar revision, flap contouring, and onabotulinumtoxinA injection for contralateral symmetry and to minimize synkinesis after reinnervation. These adjuvant office-based procedures can be tailored to meet the expectations and goals of each individual patient.

Although we feel our outcomes pose a strong argument in favor of immediate reconstruction following radical parotidectomy, there are limitations and pitfalls that warrant discussion. The addition of a free flap, facial reinnervation, and reanimation adds considerable operative time to an often lengthy extirpative procedure. As a result, the risk of postoperative complications may be increased in those patients with significant comorbidities [43–45]. We attempt to mitigate this risk through a two-team approach, allowing for simultaneous tumor extirpation with flap, fascia, and nerve graft harvest. Arguably, this additional risk to patients would be matched by the risk of returning to the operating room for secondary reconstruction following radiation and chemotherapy exposure.

A second limitation of our approach is the inability of the ALT to provide optimal color-matched skin for large cutaneous defects. This is addressed at the time of surgery through locoregional advancement techniques, which minimize the defect that must be filled by the free flap skin paddle. If the color mismatch is of sufficient cosmetic concern to the patient the skin paddle can be serially excised under local anesthesia in an office setting.

5. Conclusion

Radical parotidectomy is a disfiguring procedure that challenges the reconstructive surgeon to address complex deficits of both form and function. Our series demonstrates that simultaneous ALT free flap, OTTT with lip suspension, and facial nerve cable grafting provides early reestablishment of facial symmetry, facial reanimation, and oral competence with minimal morbidity.

Declarations of interest

None.

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