The Extended Forehead Flap: Expanding the Armamentarium for Forehead and Anterior Scalp Reconstruction

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ABSTRACT

Background: The forehead and scalp play a crucial role in the aesthetic appearance of the face. Extensive oncological resections that result in significant defects create challenges for reconstruction and require various surgical techniques.

Objective: To present the planning and surgical technique required for a simple, reproducible one-stage flap to reconstruct an extensive forehead defect.

Methods: A cohort of six patients underwent reconstruction of large anterior forehead or scalp defects using a one-stage axial fasciocutaneous flap. All procedures were performed under general anesthesia. The defects resulted from tumor resections. The sizes ranged from 5.5 cm to 11 cm. The flap was used to reconstruct various regions of the forehead and anterior scalp.

Results: All the flaps were successful. The aesthetic outcomes were favorable, and no significant complications were noted.

Conclusions: The extended forehead flap is a versatile option for safe, simple, and reproducible one-stage reconstruction of large forehead and anterior scalp defects, yielding satisfactory aesthetic results.

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KEY WORDS: forehead reconstruction, forehead flap, regional flap, surgical technique

Large forehead and scalp defects often present significant aesthetic and functional reconstruction challenges. The lack of mobile excess skin for primary closure and the inability to graft skin over exposed bone necessitate advanced reconstruction techniques [1]. One alternative involves burying the bone in the diploë layer to create a vascularized bed for wound healing. However, the time required to develop granulation tissue can be substantially longer for larger defects. Vacuum-assisted closure can be employed for secondary intention healing, followed by skin grafting [2]. This approach should be considered for patients at higher risk of flap or graft failure, such as smokers and those with a history of local radiation. Patients experiencing balding, those with significant co-morbidities, and individuals for whom tumor surveillance is a priority are also suitable candidates.

The mainstay of reconstruction for large defects with exposed bone involves using large, local pedicled flaps based on major scalp vessels or free tissue transfer [3]. Scalp flaps can match color, contour, and texture, providing a like-with-like reconstruction. The lack of tissue laxity limits the use of advancement flaps to small defects only [3]. Large rotational flaps may be considered for scalp defects larger than 3 cm [4]. However, for extensive scalp defects, the length of the arcing incision can be up to six times the greatest dimension of the defect, limiting this approach for large defects [5]. For forehead reconstruction, transposition flaps can be suitable due to greater tissue laxity, unlike scalp tissue, which lacks this characteristic [3].

Microvascular reconstruction might be the best choice for addressing many large scalp defects. However, potential drawbacks include the long duration of the surgery, donor site morbidity, and risks related to anesthesia for the patient [3]. In addition, factors such as costs, labor issues, and the availability of microvascular surgeons may pose challenges to this type of reconstruction [3].

One of the cornerstones of treatment for reconstructing the forehead and nasal area is the paramedian forehead flap [6,7]. The earliest modern description of this flap involved a vertically oriented flap from the midline of the forehead supplied by paired supratrochlear vessels [6]. Millard [8] showed that the forehead flap can be reliably transferred using a unilateral paramedian blood supply, suggesting that bilateral supratrochlear artery pedicles are not necessary for flap survival [8]. McCarthy and colleagues [9] supported Millard's findings, demonstrating that a robust anastomotic plexus centered on the medial canthal region can supply a unilaterally based forehead flap even after dividing the supratrochlear, supraorbital, and infraorbital vessels. The classic paramedian forehead flap is mainly vascularized by the supratrochlear artery with additional arterial supply from the supraorbital plexus, which forms anastomoses with the supraorbital artery and the nasal branch of the angular artery [10].

We present an updated method of the traditional paramedian forehead flap, called the extended forehead flap (EFF), for reconstructing large defects of the forehead and anterior scalp.

PATIENTS AND METHODS

Study population

We present a series of six patients with large skin defects and exposed bone on the forehead and scalp. The patients underwent resection of malignant skin lesions from the forehead. Four patients had radical excision of squamous cell carcinoma. One patient received a wide excision due to malignant melanoma, while another underwent a wide excision of dermal sarcoma. All these defects were reconstructed using EFF flaps.

Surgical technique

The surgical procedure began by evaluating the defect's size, depth, and location. Under general anesthesia, the lesion was removed with oncological margins. An unfolded surgical gauze was used for flap planning, and the measurements for the flap's length and width were taken and marked. A Doppler ultrasound was used to locate the supraorbital and supratrochlear vessels. The flap base was designed to include both vessels, usually extending from the midline to the mid-pupillary line. Flap harvesting was performed carefully, elevated from the superior pole, and dissected caudally at the subgalea plane. If extra length and mobility were needed, a subperiosteal plane was developed 3 cm to 4 cm above the orbital rim.

After raising the flap, it was positioned over the defect and stitched in place. The donor site, which had exposed periosteum, was then covered with a split-thickness skin graft.

RESULTS

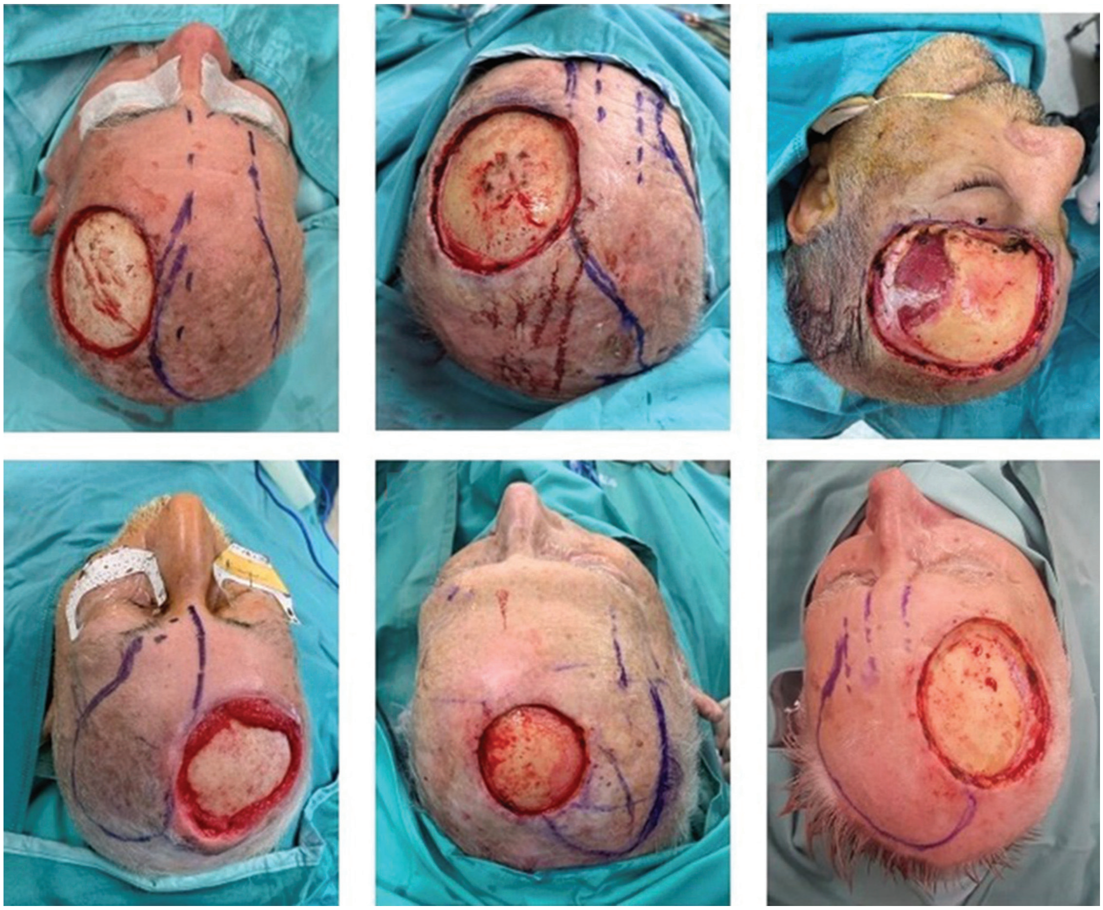
The EFF flap technique was utilized in six patients [Table 1]. All patients were male, with an average age of 81 years (ranging from 63 to 98 years). Wound defects ranged from 5.5 cm to 11 cm and affected the central lateral forehead and anterior scalp [Figure 1]. The average follow-up duration was 21.5 months (ranging from 6 to 50 months). All flaps survived, and there were no infections or significant complications. Aesthetic outcomes were favorable, and patients reported satisfaction. One patient required revisional surgery for direct browpexy on the defect side due to brow ptosis, likely caused by injury to the frontal branch of the facial nerve during oncologic resection. In the immediate post-surgical period, a dog ear developed in all patients, with only one needing corrective surgery for this deformity.

Table 1

	Age in years	Defect location	Longest defect diameter	Pathology	Operative time (hour)	Postoperative course	Length of follow-up
1	83	Frontoparietal scalp (lateral)	8 cm	Wide excision of SCC	1:42	Unremarkable	24 months
2	80	Frontoparietal scalp (lateral)	7.5 cm	Failed skin graft after wide excision of malignant melanoma	2:48	Unremarkable	50 months
3	98	Frontoparietal scalp (middle)	5.5 cm	Wide excision of SCC	2:12	Unremarkable	18 Months
4	86	Frontoparietal scalp (lateral)	9 cm	Wide excision of SCC	2:08	Unremarkable	19 Months
5	63	Frontal scalp (lateral)	11 cm	Wide excision (dermal sarcoma)	2:52	Unremarkable	12 Months
6	76	Frontoparietal scalp (lateral)	8.5 cm	Wide excision of SCC	2:31	Unremarkable	6 months

SCC = squamous cell carcinoma

Figure 1. A1–A6: Defects following excision, before reconstruction with an extended forehead flap



DISCUSSION

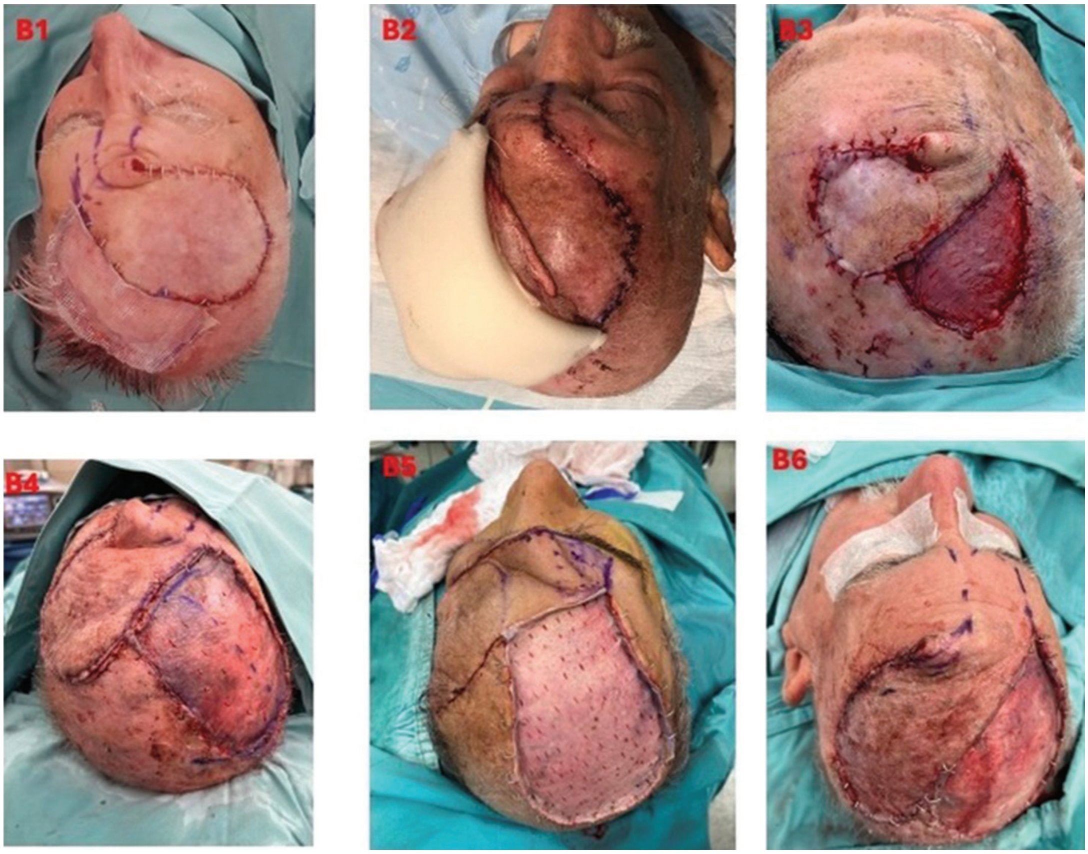
Reconstructing forehead defects caused by tumors, congenital lesions, trauma, and burns is a common procedure in plastic surgery. However, the relatively large area, its aesthetic importance, and the difficulty of matching skin color, contour, and texture make forehead reconstruction challenging [1]. The size and location of the defect determine the most suitable approach, with simpler methods often providing the best results. Nevertheless, more complex techniques are needed for larger defects [1].

There are several options for reconstructing forehead defects. Primary closure is sometimes possible but is limited to minor defects with excess mobile skin [11]. Second-intention healing is an acceptable solution because it is the least invasive method for closing this defect. However, complete closure may take weeks to months, depending on the size of the defect [1,3]. During this extended wound-healing period, cumbersome and time-consuming wound care is expected. Other options include skin grafts, local flaps, tissue expansion, regional flaps, and free flaps [1,3]. For larger defects, surrounding tissue must be recruited without tension to avoid compromising blood flow and to optimize scar formation [11].

We present an extended forehead transposition flap to repair central and lateral forehead and anterior scalp defects measuring up to 11 cm. To the best of our knowledge, this article is the first published case series of forehead flaps addressing such an extensive area. We think the EFF design offers several advantages over existing reconstructive techniques. The flap harvest is straightforward, and the surgical time is significantly shorter than that of free flaps. Therefore, the procedure can be performed on elderly patients with underlying health conditions. In our cohort, patient number 3 was

Figure 2. B1–B6: Final result after reconstructing with the extended forehead flap

Defects in Figure 1 (A1–A6) correlate with the reconstructed flaps in Figure 2 (B1–B6), respectively



98 years old, while patient number 5 was one month post-coronary angiography with stent insertion. He underwent surgery while on anticoagulation treatment. The flap provides like-with-like tissue, closely resembling the characteristics of the defect. This reconstruction achieves favorable aesthetic results compared to free flaps or skin grafts.

Over the years, minor modifications to paramedian forehead flaps have been developed without changing their blood supply [12-16]. Ding et al. [14] used an extended forehead flap for distal nasal reconstruction. They employed a narrow-based forehead flap that relied on the supratrochlear artery and extended it toward the hairy scalp to gain additional length. A laser treatment was used to remove the hair. Another modification to avoid the hair-bearing scalp was to design the flap with a lateral turn along the hairline. However, this lateral turn deviated from the vertical flow of the supratrochlear artery, potentially compromising the blood supply. In addition, this flap design might cause uneven vertical tension in the frontal skin, leading to asymmetry of the eyebrows.

The supratrochlear and supraorbital arteries are the primary vessels supplying the forehead, and their anatomy is well understood [16]. In 20% of cases, small additional vessels, such as the paracentral and central arteries, supply the superficial part of the frontalis muscle. The supratrochlear artery exits the orbit approximately 1.7 cm to 2.2 cm from the midline at the supraorbital rim [17,18]. It is located in the glabella frown lines in half of the patients, averaging approximately 3.2 mm laterally in the others [13,19]. The supraorbital artery emerges over the supraorbital rim along a vertical line that corresponds to the medial limbus of the cornea [20].

In most cases, the supratrochlear artery originates from the ophthalmic artery as a separate vessel, distinct from the supraorbital artery. In approximately 12% of cases, these arteries arise from the orbit as a single vessel. This vessel then bifurcates into two main branches that continue in a cephalad direction, eventually following the typical course of both arteries [17,18,20]. The supratrochlear and supraorbital arteries enter the subcutaneous plane at an average distance of 35 mm and 56 mm from the supraorbital rim, respectively [18]. Further cephalically, the vessels approach the hairline in the scalp at a subdermal position and connect to supply the scalp [14].

Reece and colleagues [10] supported the findings that the supratrochlear artery is the primary blood supply to the paramedian forehead flap. The dorsal nasal branch of the angular artery also contributes to perfusion. Furthermore, the flap may exhibit a dominant flow from the supraorbital artery, provided the superior orbital plexus remains intact. They recommended that, to maximize vascular safety with three-vessel perfusion, the surgeon should preserve 7 mm of tissue above the supraorbital rim and include the periosteum within 3 cm from the base of the flap. We implemented these measures during EFF elevation, designed a broader flap base than the standard paramedian forehead flap, and included both supraorbital and supratrochlear vessels.

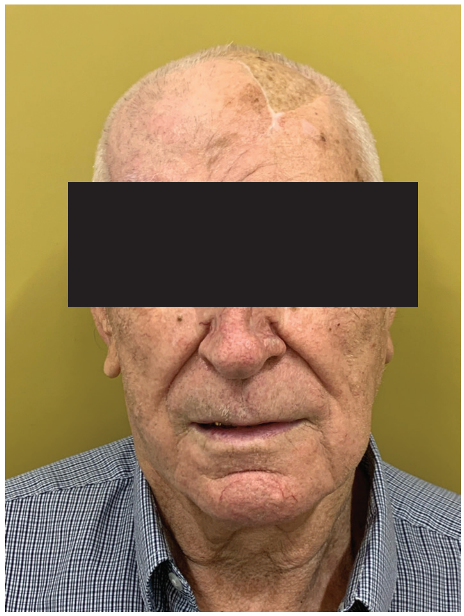
The narrow base of the traditional forehead flap makes it easier to move to the nasal area by reducing the arc of rotation and increasing the flap length. The EFF flap base is wider than that of a traditional paramedian forehead flap to include both the supraorbital and supratrochlear arteries. A broader flap base may complicate its transposition. In our study, the flap was used for forehead defects, which allowed for smaller rotation and reduced the kink and bend at the flap's base during transfer, with only a minor impact on the blood supply.

Based on our experience, the EFF can effectively reach nearly every region of the forehead and temple [Figure 2]. However, some technical limitations and specific patient selection issues should be considered. First, we prefer using the flap on male patients with baldness in the parietal area of the scalp. Female and younger male patients may benefit from other reconstruction methods, as this technique might bring hairy skin to the forehead. In cases of a hairy scalp, laser treatment can be used. Alternatively, a two-stage reconstruction, such as the crane principle [8], can be implemented. Second, in most patients, a dog ear forms in the glabellar area. This deformity usually resolves over time, but some patients may benefit from simple excision under local anesthesia in the second stage. Third, when the defect is on the lateral forehead or temple area, and healthy skin exists between the flap base and the defect, a tunnel should be created, and the tunneled flap area should be de-epithelialized. Alternatively, healthy tissue can be removed for direct flap transposition. A careful flap design will address this issue. Last, a split-thickness skin graft should be used for the donor site defect.

CONCLUSIONS

The EFF allows for a simple, one-stage reconstruction of large forehead defects. The skin in the parietal area closely matches the forehead, enabling tissue replacement with satisfactory aesthetic results [Figure 3].

Figure 3. Long-term result after 24 months (patient 1 in Table 1)



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References

1. Redondo P. Simplifying forehead and temple reconstruction: a narrative review. *J Clin Med.* 2023; 12 (16): 5399.
2. Argenta LC, Morykwas MJ, Marks MW, DeFranzo AJ, Molnar JA, David LR. Vacuum-assisted closure: state of clinic art. *Plast Reconstr Surg* 2006; 117 (7 Suppl): 127S-142S.
3. Angelos PC, Downs BW. Options for the management of forehead and scalp defects. *Facial Plast Surg Clin North Am* 2009; 17 (3): 379-93.
4. Temple CLF, Ross DC. Scalp and forehead reconstruction. *Clin Plast Surg* 2005; 32 (3): 377-390.
5. Earnest LM, Byrne PJ. Scalp reconstruction. *Facial Plast Surg Clin North Am* 2005; 13 (2): 345-53.

6. Smart RJ, Yeoh MS, Kim DD. Paramedian forehead flap. *Oral Maxillofac Surg Clin North Am* 2014; 26 (3): 401-10.
7. Pawar SS, Kim MM. Updates in forehead flap reconstruction of facial defects. *Curr Opin Otolaryngol Head Neck Surg* 2013; 21 (4): 384-8.
8. Millard DR Jr. Forehead flap in immediate repair of head, face and jaw. *Am J Surg* 1964;108: 508-13.
9. McCarthy JG, Lorenc ZP, Cutting C, Rachesky M. The median forehead flap revisited: the blood supply. *Plast Reconstr Surg* 1985; 76 (6): 866-9.
10. Reece EM, Schaverien M, Rohrich RJ. The paramedian forehead flap: a dynamic anatomical vascular study verifying safety and clinical implications. *Plast Reconstr Surg* 2008; 121 (6): 1956-1963.
11. Harris GJ, Garcia GH. Advancement flaps for large defects of the eyebrow, glabella, forehead, and temple. *Ophthalmic Plast Reconstr Surg* 2002; 18 (2): 138-45.
12. Angobaldo J, Marks M. Refinements in nasal reconstruction: the cross-paramedian forehead flap. *Plast Reconstr Surg* 2009; 123 (1): 87-93.
13. Moolenburgh SE, McLennan L, Levendag PC, et al. Nasal reconstruction after malignant tumor resection: an algorithm for treatment. *Plast Reconstr Surg* 2010; 126 (1): 97-105.
14. Ding F, Huang C, Sun D, et al. Combination of extended paramedian forehead flap and laser hair removal in the reconstruction of distal nasal defect. *Ann Plast Surg* 2021; 86 (3 Suppl 2): S293-S298.
15. Mecham JC, Abdel-Aty Y, Lettieri SC. Extended paramedian forehead flap for total upper lip: a case report. *Ear Nose Throat J* 2019; 98 (8): 475-7.
16. Cong LY, Phothong W, Lee SH, et al. Topographic analysis of the supratrochlear artery and the supraorbital artery: implication for improving the safety of forehead augmentation. *Plast Reconstr Surg* 2017; 139 (3): 620e-627e.
17. Erdogmus S, Govsa F. Anatomy of the supraorbital region and the evaluation of it for the reconstruction of facial defects. *J Craniofac Surg* 2007; 18 (1): 104-12.
18. Potparić Z, Fukuta K, Colen LB, Jackson IT, Carraway JH. Galeo-pericranial flaps in the forehead: a study of blood supply and volumes. *Br J Plast Surg* 1996; 49 (8): 519-28.
19. Vural E, Batay F, Key JM. Glabellar frown lines as a reliable landmark for the supratrochlear artery. *Otolaryngol Head Neck Surg.* 2000;123(5):543-546. doi:10.1067/MHN.2000.110540
20. Kleintjes WG. Forehead anatomy: arterial variations and venous link of the midline forehead flap. *J Plast Reconstr Aesthet Surg* 2007; 60 (6): 593-606.

Capsule

SP140–RESIST pathway regulates interferon mRNA stability and antiviral immunity

The conserved transcriptional repressor SP140 inhibits interferon-β (*Ifnb1*) expression through an unknown mechanism. **Witt** et al. reported that SP140 does not directly repress *Ifnb1* transcription. Rather, SP140 negatively regulates *Ifnb1* mRNA stability by directly repressing the expression of a previously uncharacterized regulator called RESIST (regulated stimulator of interferon via stabilization of transcript; previously annotated as annexin 2 receptor). RESIST promotes *Ifnb1* mRNA stability by counteracting *Ifnb1* mRNA destabilization mediated by the tristetraprolin (TTP) family of RNA-binding proteins and the CCR4-NOT deadenylase complex. SP140 localizes within punctate structures called nuclear bodies that have important roles in silencing DNA-virus gene expression in the nucleus. Consistent with this observation, the authors found that SP140 inhibits replication of the gammaherpesvirus MHV68. The antiviral activity of SP140 was independent of its ability to regulate *Ifnb1*. The results establish dual antiviral and interferon regulatory functions for SP140, and they propose that SP140 and RESIST participate in antiviral effector-triggered immunity.

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Capsule

Co-administered cagrilintide and semaglutide in adults with overweight or obesity

Semaglutide at a dose of 2.4 mg has established weight-loss and cardiovascular benefits, and cagrilintide at a dose of 2.4 mg has shown promising results in early-phase trials. **Garvey** and colleagues included a total of 3417 randomized participants with 2108 assigned to receive cagrilintide–semaglutide, 302 to receive semaglutide, 302 to receive cagrilintide, and 705 to receive placebo. The estimated mean percent change in body weight from baseline to week 68 was: 20.4% with cagrilintide–semaglutide compared with 3.0% with placebo (estimated difference, 17.3 percentage points; 95% confidence interval 18.1–16.6; $P < 0.001$). Participants receiving cagrilintide–semaglutide were more likely than those receiving placebo to reach weight-loss targets of 5% or more, 20% or more, 25% or more, and 30% or more ($P < 0.001$ for all comparisons). Gastrointestinal adverse events (affecting 79.6% in the cagrilintide–semaglutide group and 39.9% in the placebo group), including nausea, vomiting, diarrhea, constipation, or abdominal pain, were mainly transient and mild-to-moderate in severity.

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