Dietary, Medical, and Hair-Care Adherence in Relation to Graft Survival After Follicular Unit Extraction: A Prospective Cohort Study at Vera Clinic

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Abstract

Background: Post-operative adherence following follicular unit extraction (FUE) hair transplantation is frequently assumed to influence graft survival, yet the relative contribution of individual aftercare components, dietary adherence, supplement use, adjuvant medical therapy, hair-care practices, and timing of return to physical activity, has not been quantified within a single cohort.

Methods: In this prospective cohort study, 612 patients undergoing FUE hair transplantation were followed for 12 months. Post-operative diet adherence, supplement use, use of topical minoxidil and/or oral finasteride, hair-care adherence, and day of return to strenuous activity were recorded using structured questionnaires administered at 1, 3, 6, and 12 months. Graft survival was assessed using standardized photographic density analysis. Multivariable linear regression was used to identify independent predictors of 12-month graft survival, adjusting for age, baseline Norwood stage, and graft number.

Results: Mean graft survival at 12 months was 89.4% (SD 6.7). Diet adherence score ($\beta = 1.82$, 95% CI 1.01–2.63; $p<0.001$), care adherence score ($\beta = 0.94$, 95% CI 0.25–1.63; $p=0.007$), supplement use ($\beta = 1.15$, 95% CI 0.01–2.29; $p=0.048$), and combined minoxidil–finasteride use ($\beta = 6.94$, 95% CI 5.19–8.69; $p<0.001$, relative to no adjuvant therapy) were independently associated with higher graft survival. Earlier return to strenuous activity was associated with lower survival ($\beta = -0.38$ per day, 95% CI −0.67 to −0.09; $p=0.012$). The model explained 34% of the variance in graft survival ($R^2 = 0.34$).

Conclusions: Post-operative adherence behaviors, particularly dietary adherence and adjuvant medical therapy, were independently associated with graft survival following FUE, even after accounting for baseline patient characteristics. These findings support structured aftercare counselling as a component of hair transplantation protocols, although the observational design precludes causal inference.

Keywords: hair transplantation; follicular unit extraction; graft survival; post-operative care; adherence; minoxidil; finasteride

1. Introduction

Follicular unit extraction (FUE) is among the most widely performed techniques in hair restoration surgery, and graft survival is the primary determinant of both aesthetic outcome and patient-reported satisfaction after the procedure [1]. While surgical technique, graft handling, and implantation density have been extensively studied as determinants of survival, the post-operative period, during which patients themselves become the primary agents of care, has received comparatively little systematic attention.

Several individual components of aftercare have been studied in isolation. Adjuvant use of topical minoxidil and oral finasteride following transplantation has been associated with improved density outcomes in prior work [2,3], and wound-care protocols affecting graft desiccation and mechanical dislodgement have been described in the surgical literature [1]. Nutritional and micronutrient status, particularly biotin, zinc, and vitamin D, has been studied as a potential modifiable factor in hair follicle cycling, though the evidence base for supplementation-specific benefit remains limited even outside the post-transplantation setting [4].

What is not established is how these aftercare domains perform relative to one another when assessed within the same cohort, and whether their apparent effects persist once adherence to one behavior for example, medication use is adjusted for adherence to others, such as diet or activity restriction. Studies addressing a single aftercare variable in isolation risk overstating its independent contribution, since adherence behaviors are likely to cluster within motivated patients.

The aim of this study was to prospectively evaluate the association between multiple domains of post-operative aftercare adherence, diet, supplementation, adjuvant medical therapy, hair-care practice, and timing of return to physical activity, and graft survival at 12 months following FUE hair transplantation, using a multivariable framework to account for confounding among adherence domains.

2. Methods

2.1 Study Design and Setting

This was a prospective, single-center cohort study conducted at Vera Clinic. Patients undergoing FUE hair transplantation between March 2023 and February 2024 were consecutively enrolled and followed for 12 months, with final follow-up assessments completed by February 2025.

2.2 Participants

Eligible patients were aged 18–65 years, Norwood–Hamilton stage II–VI, and undergoing a first hair transplantation procedure. Patients with a concurrent scalp disease, a history of autoimmune alopecia, or a second transplantation procedure within the 12-month follow-up window were excluded. Of 687 patients enrolled, 612 (89.1%) completed the full 12-month follow-up and were included in the analysis; 75 patients were lost to follow-up (34 uncontactable, 21 voluntary withdrawal, 20 incomplete data at one or more time points).

2.3 Variables

The primary outcome was graft survival at 12 months, defined as the proportion of transplanted follicular units estimated to be viable relative to the number of grafts implanted at surgery, assessed by standardized photographic density analysis (trichoscopy) at a fixed camera angle and lighting configuration.

Five post-operative adherence domains were assessed as exposures: (1) dietary adherence to the clinic's recommended high-protein, biotin-supportive nutritional guidance, scored on a 5-item, 1–5 self-report scale; (2) supplement use, defined as use of a biotin–zinc–vitamin D combination for a recommended 90-day course (yes/no, with duration in days); (3) adjuvant medical therapy, categorized into four mutually exclusive groups: combined topical minoxidil 5% and oral finasteride 1 mg, minoxidil only, finasteride only, or neither; (4) hair-care adherence, scored on a 5-item, 1–5 self-report scale reflecting compliance with post-operative washing and handling instructions; and (5) day of return to strenuous physical activity, recorded as a continuous variable in days. Baseline covariates included age, sex, baseline Norwood–Hamilton stage, and number of grafts implanted.

2.4 Data Sources and Measurement

Adherence variables were captured through a 12-item, clinic-developed questionnaire administered at 1, 3, 6, and 12 months, supplemented by the Skindex-16 instrument, a validated general dermatologic quality-of-life measure, adapted for the hair transplantation context [5]. The clinic-developed questionnaire has not undergone formal psychometric validation and is treated as a pragmatic clinical measure rather than a validated research instrument; this is addressed as a limitation in the Discussion. Graft survival was assessed independently of self-reported adherence, using standardized photographic density analysis performed by clinic staff blinded to each patient's questionnaire responses.

2.5 Bias

Selection bias was possible because the 75 patients lost to follow-up were excluded from analysis; their baseline characteristics were compared with those of the analytic cohort to assess for differential attrition. Information bias was a concern for the self-reported adherence measures, which are subject to recall bias and social-desirability bias, particularly given that adherence was reported retrospectively at each follow-up interval rather than logged in real time. Confounding among adherence domains for example, patients who followed dietary guidance closely may also have been more likely to use adjuvant medication as directed was addressed through multivariable adjustment rather than univariate comparison alone.

2.6 Statistical Methods

A sensitivity power analysis indicated that with a sample size of 612 and nine predictors in the multivariable model, the study had at least 80% power to detect a standardized effect size of $f^2 = 0.02$ ($\alpha = 0.05$), substantially smaller than the effect sizes observed for the primary predictors of interest. Descriptive statistics summarized baseline characteristics. Univariate group comparisons of graft survival across adherence categories were performed using independent-samples t-tests or one-way ANOVA as appropriate. Pearson correlation coefficients were calculated for continuous adherence measures. A multivariable linear regression model was constructed with 12-month graft survival as the dependent variable and all five adherence domains entered simultaneously, adjusting for age, baseline Norwood–Hamilton stage, and graft number, to isolate the independent contribution of each adherence domain. Given the a priori concern that adherence domains would be correlated with one another, variance inflation factors (VIF) were calculated for all predictors in the multivariable model; all VIF values were below 2.5, indicating no problematic multicollinearity. Missing data were handled by complete-case analysis; patients lost to follow-up were not included in imputation.Statistical analyses were performed using SPSS version 28.0 (IBM Corp., Armonk, NY, USA). A two-sided p-value below 0.05 was considered statistically significant throughout.

3. Results

3.1 Participants

Of 687 patients enrolled, 612 (89.1%) completed 12-month follow-up and were included in the analysis. Baseline characteristics of the analytic cohort are summarized in Table 1.

Characteristic	**Value (N = 612)**
Age, years, mean ± SD	34.6 ± 8.2
Sex, male, n (%)	577 (94.3)
Sex, female, n (%)	35 (5.7)
Norwood–Hamilton II, n (%)	110 (18.0)
Norwood–Hamilton III, n (%)	208 (34.0)

Norwood–Hamilton IV, n (%)	178 (29.1)
Norwood–Hamilton V, n (%)	86 (14.0)
Norwood–Hamilton VI, n (%)	30 (4.9)
Grafts implanted, mean ± SD	3,142 ± 486
Graft survival at 12 months, %, mean (95% CI)	89.4 (88.9–89.9)

Table 1. Baseline characteristics of the analytic cohort.

3.2 Primary Outcome

Mean graft survival at 12 months was 89.4% (95% CI 88.9–89.9%; Table 1).

3.3 Univariate Comparisons

Graft survival differed significantly across adherence categories in univariate comparisons (Table 2).

Adherence Variable	**Graft Survival, % (mean)**	**p-value**
Diet adherence, high (score ≥4) vs low	92.1 vs 85.3	0.003
Supplement use, yes vs no	90.8 vs 87.6	0.041
Adjuvant therapy: minoxidil + finasteride	93.4	<0.001*
Adjuvant therapy: minoxidil only	90.1	<0.001*
Adjuvant therapy: finasteride only	88.7	<0.001*
Adjuvant therapy: neither	84.2	<0.001*
Activity resumption (correlation, r)	r = −0.24	0.012
Satisfaction score (correlation, r)	r = 0.41 (95% CI 0.34–0.48)	<0.001

*Table 2. Univariate comparisons of graft survival by adherence domain. *Overall omnibus comparison across the four adjuvant-therapy groups (one-way ANOVA); pairwise contrasts were not independently corrected.*

3.4 Multivariable Analysis

In the multivariable linear regression model ($R^2 = 0.34$; $F(9,602) = 34.87$, $p<0.001$), diet adherence score, care adherence score, supplement use, and both adjuvant-therapy categories relative to no adjuvant therapy remained independently associated with graft survival after adjustment. Earlier return to strenuous activity was independently associated with lower survival. Age and baseline Norwood–Hamilton stage were retained as covariates; stage was independently associated with survival, while age was not (Table 3).

Predictor	**β**	**95% CI**	**p-value**
Diet adherence score (per point)	1.82	1.01 to 2.63	<0.001
Care adherence score (per point)	0.94	0.25 to 1.63	0.007
Supplement use (yes vs no)	1.15	0.01 to 2.29	0.048
Minoxidil + finasteride (vs neither)	6.94	5.19 to 8.69	<0.001
Minoxidil only (vs neither)	4.31	2.64 to 5.98	<0.001
Finasteride only (vs neither)	3.02	1.23 to 4.81	<0.001
Activity resumption day (per day)	−0.38	−0.67 to −0.09	0.012
Baseline Norwood–Hamilton stage	−1.21	−2.03 to −0.39	0.004
Age, years	−0.03	−0.09 to 0.03	0.317

Table 3. Multivariable linear regression predicting 12-month graft survival (%). Model adjusted for graft number in addition to the covariates shown; graft number was not independently associated with survival (p=0.402) and is omitted from the table for brevity.

4. Discussion

The principal finding of this study is that post-operative adherence behaviors were independently associated with graft survival following FUE hair transplantation, even after adjusting for baseline patient characteristics and for adherence to other aftercare domains. Dietary adherence and combined adjuvant use of minoxidil and finasteride showed the strongest independent associations, while earlier return to strenuous physical activity was associated with lower survival.

These findings are broadly consistent with prior evidence describing a benefit of adjuvant minoxidil and finasteride use on transplanted-hair density [2,3], and extend this literature by situating adjuvant therapy within a broader set of concurrently assessed aftercare behaviors rather than considering it in isolation.

The persistence of an independent dietary-adherence association after adjustment for supplement use and adjuvant therapy suggests that broader nutritional adherence during the peri-operative period may carry an effect beyond that of a defined micronutrient course, though the mechanism cannot be established from this design. The association between earlier activity resumption and reduced graft survival is consistent with a mechanical hypothesis of increased scalp tension, sweating, or inadvertent trauma to grafts during the early graft-anchoring period, when transplanted follicles remain vulnerable to mechanical dislodgement before neovascularization is complete [6], though this study did not directly measure mechanical stress and this interpretation remains speculative.

This study has several strengths, including its prospective design, multi-domain assessment of aftercare, and use of a multivariable framework to address confounding among adherence behaviors. Several limitations should be considered alongside these findings. Adherence measures relied on self-report using a non-validated, clinic-developed instrument, introducing risk of recall and social-desirability bias; patients with better outcomes may retrospectively report better adherence regardless of true behavior. The four-category adjuvant-therapy variable was not randomized, so allocation to therapy group likely reflects unmeasured patient characteristics such as baseline motivation or clinician recommendation, which may confound the observed associations. The study was conducted at a single center, limiting generalizability. It should also be noted that some associations, while statistically significant, were modest in magnitude; the 1.15-point difference associated with supplement use, for example, is unlikely to be clinically distinguishable on its own and should be interpreted alongside the larger effects observed for adjuvant medical therapy and dietary adherence. Finally, although the multivariable model adjusted for adherence domains simultaneously, the number of concurrently assessed exposures approaches the limit of what this sample size can reliably disentangle, and residual confounding among adherence behaviors that cluster within motivated patients cannot be excluded. As an observational design, this study demonstrates association, not causation.

These findings support the inclusion of structured, multi-domain aftercare counselling, covering diet, adjuvant medication, and activity restriction, as a component of post-transplantation protocols, and suggest that the marginal benefit of any single aftercare behavior should be interpreted in the context of the others rather than assumed independently. Future prospective work with objectively measured adherence and randomized allocation to adjuvant therapy would strengthen causal inference in this area.

5. Conclusions

In this prospective cohort of 612 patients undergoing FUE hair transplantation, post-operative adherence to dietary guidance, hair-care instructions, and adjuvant medical therapy was independently associated with higher 12-month graft survival, while earlier return to strenuous activity was associated with lower survival. These associations persisted after multivariable adjustment for baseline patient characteristics and for adherence to other aftercare

domains, supporting structured, multi-domain aftercare counselling as a component of hair transplantation protocols, while the observational design limits causal interpretation.

Ethical Considerations

This prospective cohort study was based on structured clinical assessments, standardized photographic follow-up, and patient-reported outcome measures collected as part of scheduled post-operative care and research follow-up. Patients were informed at the time of treatment that data collected during scheduled follow-up visits, including questionnaire responses and follow-up photographs, could be used for research and quality-improvement purposes, and written informed consent for research participation was obtained prior to enrolment. All patient records were anonymized and de-identified prior to analysis, in accordance with the principles of the Declaration of Helsinki.

Conflict of Interest

All authors are affiliated with Vera Clinic, where the study was conducted. The clinic provided patient records, clinical infrastructure, and follow-up access. No external funding was received. Data analysis and manuscript preparation were conducted independently of marketing, sales, or commercial decision-making functions of the clinic. The authors declare no other competing interests.

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Data Availability

De-identified data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to ethics committee review.

Author Contributions

This study was conceived, conducted, and analyzed by the Vera Clinic Academy research team. Vera Clinic Academy was responsible for study design, data collection, statistical analysis, and manuscript preparation.

References

1. Parsley WM, Perez-Meza D. Review of factors affecting the growth and survival of follicular grafts. J Cutan Aesthet Surg. 2010;3(2):69–75.
2. Avram MR, Cole JP, Gandelman M, Haber R, Knudsen R, Leavitt ML, et al. The potential role of minoxidil in the hair transplantation setting. Dermatol Surg. 2002;28(10):894–900.
3. Leavitt M, Perez-Meza D, Rao NA, Barusco M, Kaufman KD, Ziering C. Effects of finasteride (1 mg) on hair transplant. Dermatol Surg. 2005;31(10):1268–1276.
4. Thompson KG, Kim N. Dietary supplements in dermatology: a review of the evidence for zinc, biotin, vitamin D, nicotinamide, and Polypodium. J Am Acad Dermatol. 2021;84(4):1042–1050.
5. Chren MM, Lasek RJ, Sahay AP, Sands LP. Measurement properties of Skindex-16: a brief quality-of-life measure for patients with skin diseases. J Cutan Med Surg. 2001;5(2):105–110.

6. Garg AK, Garg S. Graft anchoring in hair transplantation. Dermatol Surg. 2006;32(2):S119–S123.