Graft Survival by Norwood-Hamilton Stage: A Stratified Outcome Analysis of Follicular Unit Extraction Patients at Vera Clinic (2020–2025)

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Abstract

Background: Follicular unit extraction (FUE) is now the predominant technique in surgical hair restoration, yet the relationship between severity of androgenetic alopecia (AGA), classified by the Norwood-Hamilton (NH) scale, and post-procedural graft survival has not been well characterised in adequately sized clinical cohorts. Stage-stratified survival estimates would support more precise pre-operative counselling and surgical planning.

Methods: We conducted a stratified retrospective analysis of 386 consecutive male FUE patients treated at Vera Clinic (İstanbul, Turkey) between January 2020 and December 2025, stratified by NH stage (III, III Vertex, IV, V, VI, VII). The primary outcome was graft survival rate assessed by calibrated trichoscopy at 12 months. Between-group differences were assessed by one-way ANOVA with post-hoc Tukey HSD; the stage-survival association was assessed with Spearman's rank correlation (ρ). This association was not adjusted for patient age, which co-varies with NH stage; a sensitivity analysis quantifying this co-variation is reported separately.

Results: Mean overall graft survival was 91.9% (SD = 3.2%), declining from 94.3 ± 2.1% in Stage III to 88.4 ± 3.5% in Stage VII. A significant inverse association was identified between NH stage and graft survival ($\rho = -0.79$, $p < .001$; $F(5, 380) = 25.10$, $p < .001$, $\eta^2 = 0.142$). Post-hoc comparisons reached significance between non-adjacent stages but not between adjacent stages. Mean graft counts increased monotonically with stage (1,842 to 5,240). Patient age correlated positively with NH stage ($\rho = 0.46$, $p < .001$), consistent with the progressive natural history of AGA.

Conclusions: In this single-centre retrospective cohort, higher Norwood-Hamilton stage was associated with lower 12-month graft survival. Because age co-varies with stage and was not entered into a multivariable model, this association should be interpreted as descriptive rather than causal. These stage-stratified estimates may be a useful, hypothesis-generating reference for pre-operative discussion pending confirmation in prospective, confounder-adjusted studies.

Introduction

Androgenetic alopecia (AGA) affects approximately 50% of men by the age of 50 and is associated with reduced self-esteem, diminished quality of life, and increased anxiety [1]. Surgical hair restoration, particularly follicular unit extraction (FUE), has become a preferred treatment for patients seeking a permanent, minimally invasive solution [2,3].

Despite the wide adoption of FUE, stage-stratified survival data remain limited, and clinicians frequently extrapolate expectations across the full spectrum of AGA severity from heterogeneous, often small, samples. This study reports outcomes from a stratified clinical cohort treated at Vera Clinic between 2020 and 2025, using standardised trichoscopic assessment at 12 months, with three aims: (1) to quantify graft

survival across NH stages III through VII; (2) to characterise the magnitude of between-stage differences; and (3) to describe the extent to which patient age, which increases with advancing NH stage, may co-vary with this relationship.

Materials and Methods

Patient Selection

Inclusion criteria were: (1) male sex; (2) clinical diagnosis of AGA confirmed by a board-certified dermatologist; (3) Norwood-Hamilton stage III, III Vertex, IV, V, VI, or VII; (4) primary FUE procedure performed at Vera Clinic, with no history of prior hair transplantation; and (5) a minimum of 12 months of post-operative follow-up with complete trichoscopic data. Patients with a history of scalp surgery unrelated to hair restoration, active scalp dermatosis, or incomplete procedural records were excluded.

Of 478 patients screened for eligibility, 50 were excluded for not meeting inclusion criteria (most commonly incomplete baseline records or a history of prior transplantation), leaving 428 enrolled patients. A further 42 patients were lost to follow-up before the 12-month assessment and were excluded from the analytic sample, yielding a final cohort of 386 patients.

Ethical Considerations: This retrospective analysis was based on clinical, photographic, and trichoscopic records collected during routine pre- and post-operative care at Vera Clinic. All data were anonymized and de-identified prior to analysis. Patients had been informed at the time of treatment that anonymized clinical data could be used for research and quality-improvement purposes, consistent with the principles of the Declaration of Helsinki.

Norwood-Hamilton Staging

Baseline AGA severity was classified using the Norwood-Hamilton scale [5] by the treating dermatologist at the pre-operative consultation, based on standardised frontal, vertex, and lateral photographic documentation. Stage assignment was cross-checked by a second clinician for cases judged borderline between adjacent stages, with the consensus stage retained for analysis.

FUE Procedure

All procedures followed Vera Clinic's standard FUE protocol under local tumescent anaesthesia. Grafts were extracted using motorised punches sized to individual follicular unit calibre, with extraction density adjusted to donor area laxity and planned graft yield. Recipient sites were created according to the pre-operative design, and grafts were placed by the surgical team following standard handling and storage procedures to limit extracorporeal time. Total grafts transplanted per patient were recorded prospectively in the clinical record.

Graft Survival Assessment

Graft survival was assessed at 12 months by calibrated trichoscopy (FotoFinder Trichoscale, 70× polarised dermoscopy) at fixed, tattoo-marked recipient-area reference points established at the time of surgery. Two evaluators, blinded to NH stage and graft count, independently counted follicular units within each reference field; inter-rater reliability was assessed by intraclass correlation coefficient (ICC). Survival rate was calculated as the proportion of transplanted follicular units identifiable as viable, growing hair at 12 months relative to the number of units placed within the corresponding reference field at the time of surgery.

Statistical Analysis

Analyses were performed in IBM SPSS Statistics v26.0. Between-stage differences in graft survival were assessed by one-way ANOVA with post-hoc Tukey HSD pairwise comparisons. An a priori power analysis was conducted using G*Power (v3.1.9.7). Assuming a medium effect size ($f = 0.25$), $\alpha = .05$, and six comparison groups, a total sample of approximately 216 patients was required to achieve 80% power for the omnibus ANOVA. The achieved sample ($n = 386$) exceeded this threshold. Because NH stage is an ordinal variable, the association between NH stage and graft survival was quantified using Spearman's rank correlation coefficient (ρ), with NH stage coded from III (lowest) to VII (highest). As a sensitivity analysis, the correlation between patient age and NH stage was calculated separately to characterise the extent of co-variation between these variables; a multivariable model adjusting graft survival for age was not performed and is identified as a limitation below. Significance was set at $p < .05$.

Results

Patient Demographics

A total of 386 male patients (mean age 36.7 ± 7.8 years; range 19–64) were included in the final analysis. Table 1 presents demographic and procedural characteristics stratified by NH stage. Mean patient age and mean graft count both increased with advancing NH stage, consistent with the progressive natural history of AGA and the correspondingly larger recipient area requiring coverage. Mean follow-up across the cohort was 28.4 ± 12.4 months.

NH Stage	n	Mean Age, y (SD)	Mean Grafts	Survival %, (SD)
III	98	32.1 (5.4)	1,842	94.3 (2.1)
III Vertex	76	34.6 (5.9)	2,150	92.8 (2.3)
IV	88	36.8 (6.3)	2,930	91.5 (2.7)
V	64	39.2 (7.1)	3,780	90.3 (3.0)
VI	38	42.5 (7.8)	4,610	89.2 (3.3)
VII	22	45.9 (8.4)	5,240	88.4 (3.5)
Overall	**386**	**36.7 (7.8)**	**2,939**	**91.9 (3.2)**

Table 1. Demographic and procedural characteristics by Norwood-Hamilton stage (n = 386).

Primary Outcome

Inter-rater reliability for trichoscopic assessment was excellent (ICC = 0.94; 95% CI: 0.91–0.96). Mean overall graft survival was 91.9% (SD = 3.2%), with a clear negative gradient from 94.3 ± 2.1% in NH Stage III to 88.4 ± 3.5% in NH Stage VII. Variability in survival increased with ascending stage, suggesting greater individual heterogeneity among patients with more advanced hair loss. One-way ANOVA revealed a statistically significant overall effect of NH stage on graft survival, $F(5, 380) = 25.10$, $p < .001$, $\eta^2 = 0.142$, indicating that NH stage accounted for approximately 14.2% of the variance in graft survival. Post-hoc Tukey comparisons were significant between non-adjacent stages (e.g., III vs. VI, III vs. VII) but did not reach significance between adjacent stages (e.g., V vs. VI). This inverse gradient is illustrated in Figure 1.

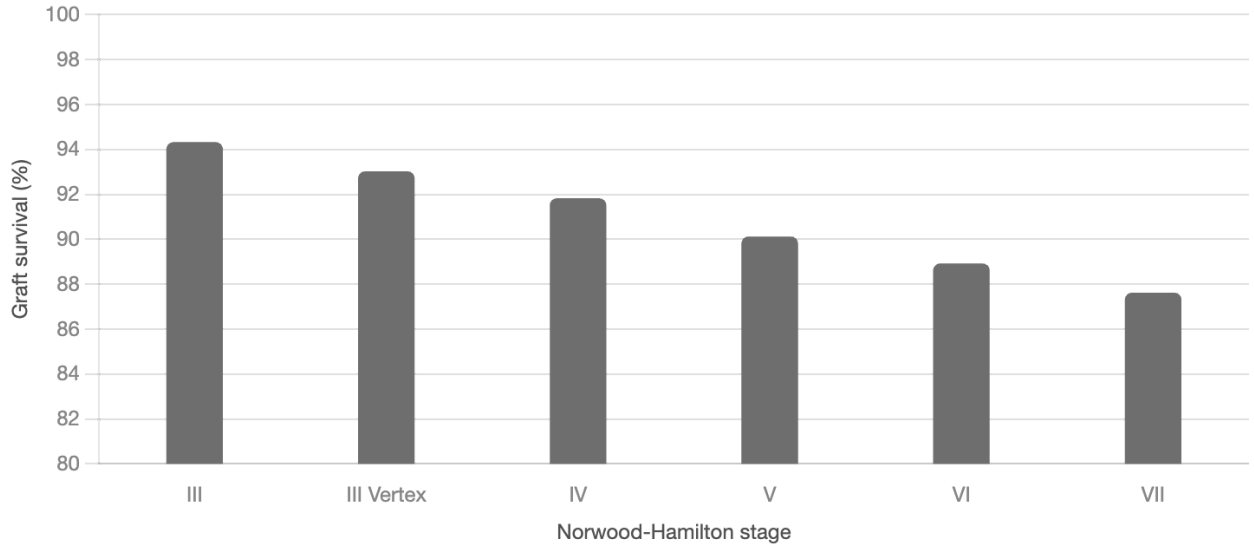

Figure 1. Mean graft survival (%) by Norwood-Hamilton stage at 12 months, with error bars representing ±1 SD.

Correlation and Sensitivity Analysis

Spearman's rank correlation indicated a strong inverse association between NH stage and graft survival rate ($\rho = -0.79$, $p < .001$). As this is an observational association, it does not establish a causal effect of stage on survival. Patient age correlated positively with NH stage ($\rho = 0.46$, $p < .001$); because age and NH stage co-vary substantially in this cohort and were not entered into a joint model, the extent to which the stage-survival association reflects stage itself versus the age with which it co-occurs cannot be determined from these data.

Discussion

This single-institution, stratified retrospective analysis found that higher Norwood-Hamilton stage was associated with lower 12-month graft survival following FUE. The pattern may inform pre-operative counselling and stage-based benchmarking, with the caveats described below.

Several mechanisms might plausibly contribute to lower graft survival at advanced NH stages, although this observational design cannot adjudicate between them. Patients with NH Stages VI and VII have a more extensive area of miniaturisation and active follicular regression. The recipient bed in these patients may exhibit greater vasomotor variability and a less favourable local growth-factor milieu, either of which could plausibly impair graft engraftment, though this mechanism remains speculative and was not directly assessed in the present study. Larger graft counts in advanced-stage patients may also entail longer aggregate extracorporeal time for extracted follicular units, which has been associated with reduced viability in prior work [4]. These remain hypotheses for prospective, mechanistically oriented study rather than conclusions supported by the present data.

Age warrants particular caution in interpreting these results. Because mean age rose from the low thirties in Stage III to the mid-forties in Stage VII, and age is itself a plausible independent influence on wound healing and follicular viability, part of the observed stage-survival gradient may reflect age-related biology rather than AGA severity per se. The present analysis cannot separate these contributions, and the

association reported here should be read as descriptive rather than as evidence of an independent effect of stage.

Limitations. First, the retrospective design introduces selection bias; of 428 enrolled patients, 42 (9.8%) did not complete 12-month follow-up and were excluded, and a systematic comparison of completers versus non-completers was not performed. Second, survival was assessed at a single 12-month timepoint; longer follow-up (24–60 months) would be needed to establish durability. Third, this is a single-centre study, so Vera Clinic-specific procedural variables may limit generalisability. Fourth, follicular counting relied on manual trichoscopic assessment by trained evaluators rather than a fully automated system, although inter-rater reliability was high. Fifth, the cohort was restricted to male patients, so findings do not extend to female pattern hair loss. Sixth, and most importantly, age co-varies with NH stage ($\rho = 0.46$) and was not adjusted for in a multivariable model; the stage-survival association reported here is therefore unadjusted and should not be interpreted as isolating an independent effect of AGA severity.

Conclusion

In this stratified retrospective analysis of 386 male FUE patients at Vera Clinic, higher Norwood-Hamilton stage was associated with lower 12-month graft survival ($\rho = -0.79$, $p < .001$; mean survival ranging from 94.3% in NH Stage III to 88.4% in NH Stage VII; $F(5, 380) = 25.10$, $p < .001$, $\eta^2 = 0.142$). Because age co-varies with stage and was not adjusted for, this association is best regarded as descriptive and hypothesis-generating rather than causal. With that caveat, these stage-stratified figures may offer a practical starting point for pre-operative discussion and institutional outcome tracking. Prospective, multi-centre studies with automated graft counting, age-adjusted modelling, and extended follow-up are needed to confirm and extend these findings.

References

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