Needle-Free Anesthesia Is Associated With Reduced Perceived Procedural Pain During Follicular Unit Extraction Hair Transplantation: A Retrospective Observational Cohort Study

Vera Academy, Istanbul, Turkey
Study Period: February 2021 – February 2025

Abstract

Fear of procedural pain and needle-related anxiety remain common barriers to acceptance of follicular unit extraction (FUE) hair transplantation. However, large-scale comparative data evaluating anticipated versus experienced pain during anesthesia administration are limited. This study evaluated patient-reported pain expectations and experienced pain among patients undergoing FUE hair transplantation with either conventional needle-based local anesthesia or needle-free pneumatic anesthesia.

Methods

This retrospective observational cohort study analyzed prospectively recorded routine clinical pain assessments from consecutive adult patients undergoing primary FUE hair transplantation at a single specialized center in Istanbul, Turkey, between February 2021 and February 2025. Patients received either traditional local anesthesia via 30-gauge needle injection (TLA) or needle-free pneumatic anesthesia (NFA) according to routine clinical practice and patient preference after standardized counseling. Pain intensity was assessed using a 0–10 Visual Analog Scale (VAS) immediately before anesthesia administration (expected pain [EP]) and within five minutes after anesthesia completion (actual pain [AP]). Between-group differences were evaluated using independent-samples t-tests, whereas within-group changes were assessed using paired-samples t-tests. Standardized mean differences (SMDs), Cohen's d effect sizes, and 95% confidence intervals (CIs) were calculated. Multivariable linear regression was used to evaluate the association between anesthesia modality and AP scores after adjustment for age, sex, graft count, and Norwood Hamilton stage.

Results

A total of 19,586 patients met the eligibility criteria (TLA: n = 8,228; NFA: n = 11,358). Baseline demographic and procedural characteristics were comparable across measured variables (all SMDs < 0.10). In the TLA group, mean EP was 7.47 ± 1.44 and mean AP was 3.82 ± 1.19 (mean reduction: 3.65 VAS points; $p < 0.001$). In the NFA group, mean EP was 7.36 ± 1.44 and mean AP was 1.70 ± 0.65 (mean reduction: 5.66 VAS points; $p < 0.001$). Actual pain scores were significantly lower in the NFA group than in the TLA group (mean difference: 2.12 VAS points; 95% CI: 2.04–2.20; $p < 0.001$), corresponding to a large effect size (Cohen's $d \approx 2.2$). In adjusted linear regression analysis, NFA remained independently associated with lower AP scores after covariate adjustment.

Conclusion

Patients undergoing FUE hair transplantation substantially overestimated procedural pain before anesthesia administration. Needle-free pneumatic anesthesia was associated with significantly lower patient-reported pain scores compared with conventional needle-based anesthesia in this large single-center cohort. Prospective randomized studies are warranted to confirm these findings and further evaluate the role of needle-free anesthesia in hair transplantation practice.

Keywords

Hair transplantation; follicular unit extraction; local anesthesia; needle-free anesthesia; procedural pain; Visual Analog Scale; patient-reported outcomes

1. Introduction

Follicular unit extraction (FUE) hair transplant surgery has become one of the most commonly performed cosmetic procedures worldwide. Increasing international demand for hair transplant procedures in Turkey, particularly at Istanbul hair transplant centers, has contributed to substantial growth in procedural volume and technological innovation.

Despite advances in graft extraction techniques, donor-site management, and postoperative hair transplant recovery protocols, procedural pain remains a clinically important concern among prospective patients seeking hair restoration treatment.

Among individuals researching what a hair transplant is and how hair transplantation works, fear related to local anesthesia administration is frequently cited during preoperative consultations. Patients investigating hair transplant costs, hair transplant Turkey costs, or FUE hair transplant costs often report anxiety associated not only with surgical outcomes but also with anticipated procedural discomfort. Previous literature suggests that anticipatory fear and expectation-related cognitive processes may substantially influence procedural pain perception in outpatient cosmetic interventions.

In modern hair transplant clinics, patient experience increasingly represents a major component of procedural quality assessment. As competition among hair transplant providers in Turkey and international hair transplant clinics increases, optimization of procedural comfort has become both clinically and commercially relevant. Needle-free pneumatic anesthesia systems have therefore emerged as a potential alternative to conventional scalp injection techniques.

Needle-free systems administer anesthetic solution through high-pressure liquid jet delivery without direct needle penetration. Preliminary reports suggest that these systems may reduce needle-related anxiety and improve perceived procedural comfort during FUE hair transplant procedures. However, available comparative evidence remains limited by relatively small sample sizes and heterogeneous study methodologies.

The present study therefore evaluated a large cohort of patients undergoing primary FUE hair transplant procedures at a specialized hair transplant clinic in Istanbul, Turkey. The primary objectives were to evaluate: (i) differences between anticipated and experienced anesthesia-related pain, (ii) differences in procedural pain between conventional needle-based anesthesia and needle-free pneumatic anesthesia, and (iii) the consistency of patient-reported pain outcomes across anesthesia modalities.

2. Materials and Methods

2.1 Study Design

This retrospective observational cohort study analyzed prospectively recorded routine clinical pain assessments obtained from patients undergoing primary FUE hair transplantation at Vera Academy (Istanbul, Turkey) between February 2021 and February 2025.

All data were anonymized prior to analysis and evaluated in aggregate form.

2.2 Participants

All consecutive adult patients (≥18 years) undergoing primary FUE hair transplantation during the study period were screened for eligibility.

Exclusion Criteria

- Previous scalp surgery or radiation therapy
- Chronic neuropathic pain disorders
- Systemic analgesic or anxiolytic use within 24 hours before the procedure
- Allergy to amide local anesthetics
- Incomplete pain assessment records

After exclusions, 19,586 patients were included in the final analysis.

2.3 Anesthesia Protocols

Patients received either:

- Traditional local anesthesia (TLA) delivered using a 30-gauge needle
- Needle-free anesthesia (NFA) delivered using a pneumatic jet injection device

Allocation was based on routine clinical practice and patient preference after a standardized explanation of both techniques. Because allocation was not randomized, the study was designed to evaluate associations rather than causal effects.

The anesthetic formulation and procedural coverage areas were standardized across both groups. Both protocols used lidocaine with epinephrine delivered to donor and recipient scalp regions according to institutional protocols.

2.4 Pain Assessment

Pain intensity was assessed using a 100-mm horizontal Visual Analog Scale (VAS), which was subsequently converted to a 0–10 scale for statistical analysis.

Two measurements were obtained:

- Expected Pain (EP): recorded immediately before anesthesia administration
- Actual Pain (AP): recorded within five minutes after completion of anesthesia delivery

Assessments were performed by trained nursing staff following standardized instructions.

2.5 Statistical Analysis

Continuous variables are presented as mean ± standard deviation (SD), whereas categorical variables are presented as frequencies and percentages.

Baseline comparability between groups was evaluated using standardized mean differences (SMDs). Within-group differences between EP and AP were evaluated using paired-samples t-tests. Between-group comparisons of AP scores were evaluated using independent-samples t-tests.

Effect size was quantified using Cohen's d. Ninety-five percent confidence intervals (95% CIs) were calculated for primary comparisons.

To account for potential confounding, multivariable linear regression analysis was performed with AP score as the dependent variable and anesthesia modality, age, sex, graft count, and Norwood–Hamilton stage as covariates.

A two-sided p-value < 0.001 was considered statistically significant.

All analyses were performed using SPSS Statistics version 29.0 (IBM Corp., Armonk, NY, USA).

3. Results

3.1 Patient Characteristics

A total of 19,586 patients were included in the analysis, including 8,228 patients in the TLA group and 11,358 patients in the NFA group.

Mean patient age was 32.8 ± 7.6 years in the TLA group and 32.9 ± 7.5 years in the NFA group. Male patients represented 91.2% and 90.7% of the cohorts, respectively. Mean graft counts and

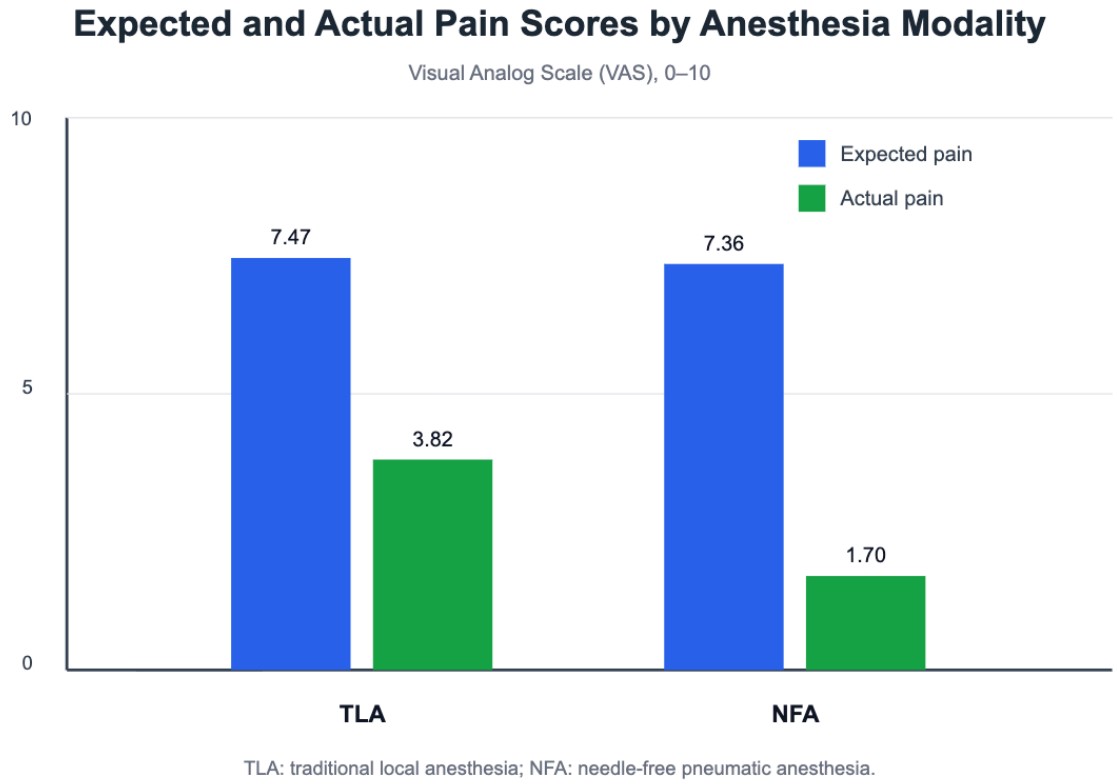
Norwood–Hamilton stage distributions were also similar across measured baseline variables. Standardized mean differences for baseline characteristics were below conventional imbalance thresholds.

3.2 Expected Versus Actual Pain

Patients in both groups reported substantially higher anticipated pain scores than experienced pain scores.

In the TLA group, mean EP was 7.47 ± 1.44 and mean AP was 3.82 ± 1.19, corresponding to a mean reduction of 3.65 VAS points ($p < 0.001$).

In the NFA group, mean EP was 7.36 ± 1.44 and mean AP was 1.70 ± 0.65, corresponding to a mean reduction of 5.66 VAS points ($p < 0.001$).



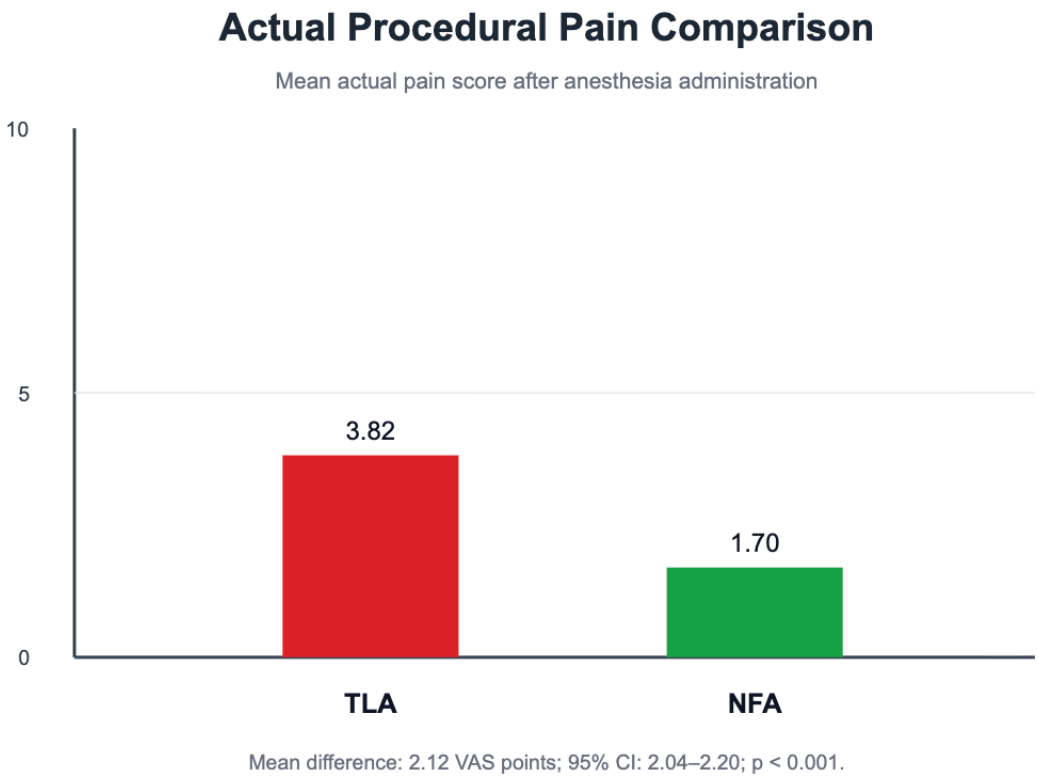
(Figure 1)

Figure 1 demonstrates the difference between anticipated and experienced procedural pain in both anesthesia groups. Although expected pain scores were similarly high before anesthesia administration, actual pain scores were markedly lower after the procedure, particularly in the needle-free anesthesia group. This visual pattern supports the observation that patients substantially overestimated procedural pain before FUE hair transplantation.

3.3 Between-Group Comparison

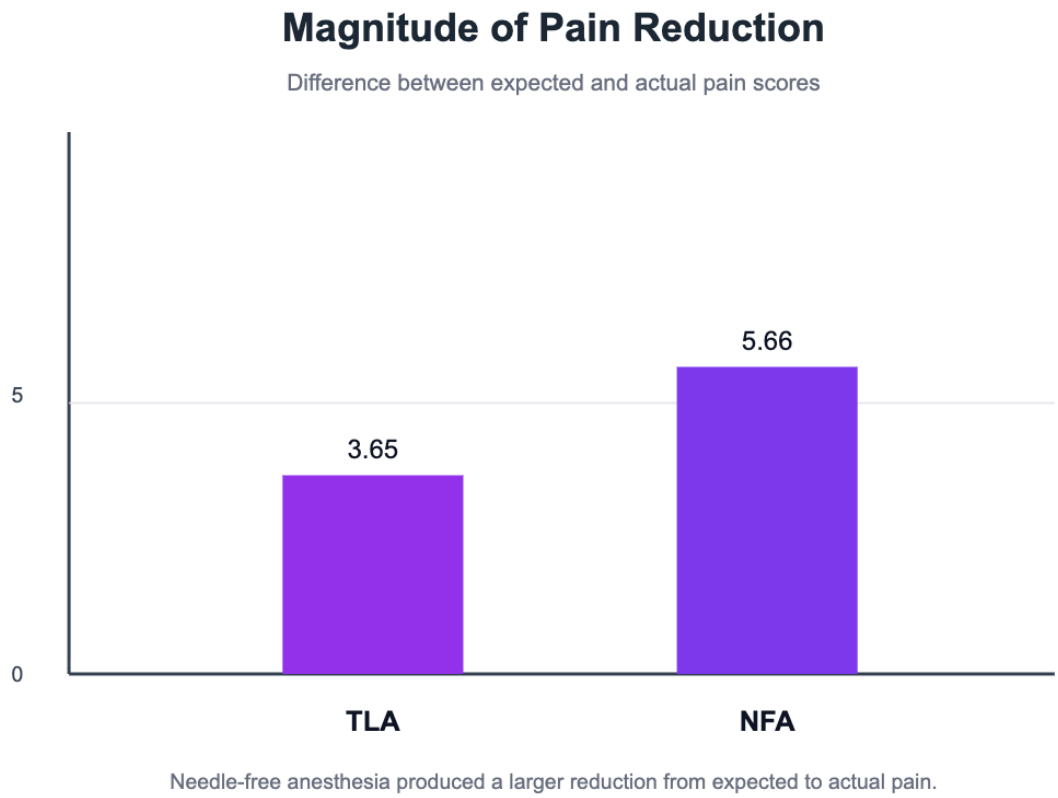
AP scores were significantly lower in the NFA group compared with the TLA group (1.70 ± 0.65 vs. 3.82 ± 1.19; mean difference: 2.12 VAS points; 95% CI: 2.04–2.20; $p < 0.001$).

The standardized effect size for the between-group difference was large (Cohen's $d \approx 2.2$).



(Figure 2)

Figure 2 shows that actual pain scores were substantially lower among patients receiving needle-free pneumatic anesthesia compared with traditional needle-based local anesthesia. The between-group difference of 2.12 VAS points indicates a clinically meaningful reduction in procedural discomfort.



(Figure 3)

Figure 3 illustrates the magnitude of pain reduction from preprocedural expectation to post-anesthesia experience. The reduction was greater in the needle-free anesthesia group, suggesting that this modality may improve both physical comfort and expectation-related anxiety during FUE hair transplantation.

3.4 Adjusted Analysis

In multivariable linear regression analysis adjusting for age, sex, graft count, and Norwood Hamilton stage, needle-free anesthesia remained independently associated with lower AP scores.

3.5 Safety Outcomes

No severe adverse events related to anesthesia administration were documented in either group.

Minor localized reactions were observed in both cohorts. In the TLA group, mild bruising and pinpoint bleeding at injection sites were occasionally documented.

In the NFA group, transient erythema and superficial petechiae were reported in a small proportion of patients. No adverse event required procedure termination or hospital-level intervention.

4. Discussion

The present findings have potential implications for both clinical practice and patient education within the rapidly expanding global hair transplant industry. Patients considering hair transplant surgery frequently obtain procedural information through online platforms, social media discussions, and commercial hair transplant clinic marketing materials. In this context, exaggerated expectations regarding procedural discomfort may contribute to unnecessary anxiety before FUE hair transplant procedures.To our knowledge, this study represents one of the largest real-world cohorts evaluating the discrepancy between anticipated and experienced procedural pain in FUE hair transplantation.

The observation that patients consistently overestimated procedural pain suggests that evidence-based counseling strategies may improve patient confidence before undergoing hair transplant procedures. This may be particularly relevant among international patients traveling for hair transplant procedures in Turkey, where online narratives and anecdotal reports strongly influence decision-making.

The observed discrepancy between anticipated and actual pain may be partly explained by cognitive and psychological mechanisms, including expectation bias and anxiety-related amplification of perceived discomfort. Previous research in procedural medicine suggests that anticipatory fear can significantly influence pain perception, often leading to overestimation of procedural discomfort. In this context, the findings of the present study highlight the importance of preoperative counseling strategies aimed at aligning patient expectations with realistic procedural experiences.

The significantly lower pain scores observed with needle-free pneumatic anesthesia may also contribute to improved patient satisfaction in high-volume hair transplant clinics. Reduced discomfort during anesthesia administration may positively influence overall perceptions of hair transplant recovery, procedural tolerability, and clinic experience.

From a clinical workflow perspective, improved predictability of pain outcomes may support greater procedural consistency during large-volume FUE hair transplant surgery programs. These findings therefore suggest that needle-free anesthesia technologies may represent a clinically meaningful adjunct in contemporary hair transplant practice.

From a clinical perspective, these findings have important implications for patient counseling and procedural planning in hair transplantation practice. Reducing anticipated pain through accurate education and potentially utilizing needle-free anesthesia techniques may improve patient satisfaction, reduce procedural anxiety, and enhance overall treatment acceptance. This may be particularly relevant in high-volume hair transplant centers where patient experience is a key determinant of clinical success.

5. Conclusion

In this large single-center retrospective cohort study, patients undergoing FUE hair transplantation consistently reported lower experienced pain scores than anticipated preprocedural pain expectations.

Needle-free pneumatic anesthesia was associated with significantly lower patient-reported pain scores compared with conventional needle-based anesthesia, including after adjustment for measured baseline variables.

These findings support further prospective investigation of needle-free anesthesia techniques in hair transplantation practice while highlighting the importance of evidence-based preoperative patient counseling regarding procedural pain expectations.

Patients undergoing FUE hair transplant surgery substantially overestimated procedural pain before anesthesia administration. Needle-free pneumatic anesthesia was associated with significantly lower patient-reported pain scores compared with conventional needle-based anesthesia in this large single-center cohort from an Istanbul hair transplant practice. These findings may have implications for patient counseling, hair transplant recovery expectations, and procedural comfort optimization in modern hair transplant clinics.

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