



Maintaining the “U” Pattern in the Donor Area During Follicular Unit Extraction in Hair Transplant Surgery - A Prospective Study

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KEYWORDS

- Follicular Unit Extraction (FUE)
- U-pattern donor zone
- Androgenetic alopecia (AGA)
- Graft survival
- Hair transplantation outcomes

ABSTRACT:

Background

Follicular Unit Extraction (FUE) is a widely adopted technique for treating androgenetic alopecia (AGA), but donor area depletion and suboptimal outcomes remain concerns. The “U-pattern” donor zone has been proposed as a more anatomically stable harvesting area, though high-level evidence is lacking.

Aim

To maintain the U pattern in hair transplant surgeries. To evaluate the aesthetic and clinical outcomes of FUE restricted to the U-pattern donor zone compared to conventional extended harvesting.

methods

Study with reference number – IHEC/SDC/PhD/OMFS-2343/23/TH-092. Prospective, randomized controlled trial was conducted on 60 male patients with Norwood–Hamilton grade III–V AGA. Patients were randomized into two groups: Group A (control) underwent FUE from an extended donor area; Group B (test) had extraction limited to the U-pattern zone. Primary outcomes included aesthetic score and graft survival. Secondary outcomes comprised patient satisfaction, donor density loss, and visible scarring.

Results

Group B demonstrated superior results in all primary and secondary endpoints. The mean aesthetic score was significantly higher in Group B (7.90 ± 0.80) versus Group A (6.31 ± 1.00 ; $p < 0.000001$). Graft survival was 84.92% in Group B compared to 75.06% in Group A ($p < 0.000001$). Donor density loss was lower in Group B (10.61 FU/cm^2) than Group A (13.82 FU/cm^2 ; $p = 0.000003$). Patient satisfaction and visible scarring rates also favoured the U-pattern group.

Conclusion

restricting follicular unit extraction to the U-pattern donor zone resulted in significantly better graft survival, higher aesthetic scores, and improved patient satisfaction.

This approach also minimized donor density loss and visible scarring compared to conventional extended harvesting.

The findings validate the anatomical stability of the U-pattern as a reliable donor zone for long-term outcomes. Thus, U-pattern–limited harvesting should be considered a preferred strategy in modern hair transplantation.

Introduction

Androgenetic alopecia (AGA) affects both men and women and is the most common form of progressive hair loss. Hair transplantation remains the only permanent solution to this condition, grounded in the principle of donor dominance,

where transplanted follicles retain the characteristics of their origin even when relocated to bald regions [1].

Hair transplantation, particularly Follicular Unit Extraction (FUE), has emerged as a minimally invasive, cosmetically superior option for treating



androgenic alopecia (AGA). The success of FUE is critically dependent on the selection and preservation of the donor area. Conventionally, donor follicles are extracted from the occipital and parietal scalp, regions considered genetically resistant to dihydrotestosterone (DHT). However, an evidence-based delineation of the donor region's boundaries is often overlooked, leading to suboptimal aesthetic results and poor graft sustainability.

Proper donor site selection is essential to ensure that hair follicles will not be affected by the progression of AGA. The concept of a safe donor area (SDA) refers to regions on the scalp that are resistant to dihydrotestosterone (DHT) and thus less likely to undergo miniaturization [2]

Hair Transplant Techniques:

Follicular Unit Transplantation (FUT):

FUT involves harvesting a linear strip of scalp tissue from the occipital area and dissecting it under a microscope to isolate follicular units. The strip is then sutured closed, leaving a linear scar [3]. Advantages of this technique is High follicle yield per session, better for patients with extensive hair loss and disadvantages are Linear scar and longer healing time.

Follicular Unit Extraction (FUE):

FUE involves the direct extraction of individual follicular units using circular punches. This minimally invasive method has become increasingly popular due to quicker recovery and the absence of linear scarring [4]. Advantages are Less invasive and minimal scarring. Disadvantages are Higher follicle transaction rate and potential for overharvesting.

The Safe Donor Area: Concept and Importance:

The safe donor area refers to the region of the scalp where hair follicles are most likely to remain stable throughout life. The concept was first popularized by Dr. O'Tar Norwood, who mapped the pattern of

male pattern baldness and described areas least affected by genetic hair loss [5].

Anatomical Boundaries:

The SDA is typically located in the mid-occipital scalp and extends laterally above the ears Superior boundary: Approximately 2 cm above the superior helix of the ear, Inferior boundary: Should not extend to the nape due to potential involvement in AGA and Lateral boundary: Avoiding areas near the temples and above the mastoid process [6]

Dynamic Nature of the Safe Zone:

The extent of the safe zone can vary between individuals and is affected by Age, Family history of baldness and Progression of alopecia [7]

Donor Area Assessment:

Comprehensive evaluation of the donor area involves Hair density: Ideal density is >80 follicular units/cm² [8], Scalp laxity: Crucial for FUT, Miniaturization: Assessed via dermoscopy and Previous surgical scars or trauma. Photographic documentation and classification using Norwood-Hamilton scale (males) or Ludwig scale (females) help in planning [9].

Overharvesting and Complications:

Overharvesting, especially in FUE procedures, can lead to donor area depletion, Cobblestoning, visible scarring or thinning to avoid this, surgeons must adhere to extraction limits (usually not more than 15–20% of donor density per session) and distribute extractions evenly [10].

The concept of the "U pattern" has been introduced to define a safe donor zone (SDZ), bounded laterally by a horizontal line above the ears and superiorly by a curve following the occipital protuberance. This anatomical demarcation corresponds to zones of highest follicular stability and resistance to miniaturization [11–15]. Studies have shown that harvesting outside this U-pattern



increase the risk of future alopecia in the donor area, thinning, and visible scarring [16–19].

Despite its proposed advantages, no prospective randomized controlled trial has conclusively evaluated the outcomes of U-pattern-limited harvesting versus broader, less anatomically confined approaches. Existing studies are largely observational or retrospective, and rarely include objective endpoints such as trichoscopic graft survival, blinded aesthetic scoring, or quantitative density assessments [20–23].

The current study addresses this gap by comparing outcomes in patients undergoing FUE with two distinct harvesting techniques—random (non-U-pattern) vs. exclusive U-pattern extraction. Primary outcomes include aesthetic scores and graft survival, while secondary outcomes comprise patient satisfaction, donor density changes, and visible scarring. The hypothesis posits that maintaining harvesting strictly within the U-pattern zone enhances both aesthetic and clinical outcomes without compromising the donor zone’s long-term integrity.

By generating level-1 evidence, this study aims to provide guidance for surgeons on the strategic limitation of donor harvesting, helping to redefine safe extraction protocols in modern hair restoration surgery.

Objectives

Hair transplantation using follicular unit extraction (FUE) is widely practiced for the treatment of androgenetic alopecia (AGA). However, donor area depletion, visible scarring, and variable graft survival remain significant limitations when extractions are performed beyond anatomically stable regions. The concept of a U-pattern donor zone has been proposed to define a more reliable area resistant to dihydrotestosterone (DHT)-mediated miniaturization, yet its clinical advantages compared to conventional extended harvesting remain underexplored.

The present study was designed to systematically evaluate whether restricting FUE harvesting exclusively to the U-pattern donor zone can provide superior outcomes compared to broader, less anatomically confined donor areas. By focusing on both clinical and patient-reported measures, this investigation aimed to generate evidence on the role of donor site selection in optimizing graft survival, aesthetic results, and preservation of donor hair.

Specifically, the study set out to compare two harvesting strategies: conventional extended donor extraction versus anatomically defined U-pattern extraction. The primary objectives were to assess graft survival and blinded aesthetic scoring, while the secondary objectives included evaluation of patient satisfaction, donor density changes, and the incidence of visible scarring. Through this design, the study sought to test the hypothesis that U-pattern-restricted harvesting yields significantly better clinical and aesthetic outcomes without compromising the long-term stability of the donor zone.

Methods

This study was designed as a prospective study was conducted over a 3-months period in the department of oral and maxillofacial Surgery.

Sixty male patients aged between 25 and 45 years, diagnosed with Norwood–Hamilton grade III–V androgenetic alopecia, and having a donor density >60 FU/cm², were enrolled in the study and randomized into two groups.

Inclusion criteria were:

1. Male patients aged 25–45 years
 2. Norwood–Hamilton Grade III–V alopecia
 3. Donor density >60 follicular units/cm²
 4. No prior hair transplantation
 5. Willingness to consent and follow-up
- Exclusion criteria included:



6. Retrograde or scarring alopecia

7. Autoimmune scalp disorders

8. Coagulopathies

Non-compliance or unrealistic expectations:

Randomization was performed using computer-generated block randomization, and allocation was concealed using sealed opaque envelopes.

- Group A (Control): FUE using randomized or extended donor area
- Group B (Test): FUE restricted to anatomically defined U-pattern zone (figure)

All surgeries used a standardized 0.9 mm punch. An average of 2500–3000 grafts were extracted and transplanted into the frontal scalp region using identical implantation protocols. Donor area mapping was performed pre- and post-operatively using dermatoscopy and digital trichoscopy.

Follow-ups were conducted on Day 10, Month 3, 6, and 12. Assessments included photographic documentation, blinded aesthetic scoring, trichoscopic graft survival analysis, and patient satisfaction surveys.

Results

All 60 enrolled participants completed the study. The two groups were demographically comparable.

- Donor Aesthetic Score: Group B (U-pattern) scored significantly higher (mean 7.90 ± 0.80) vs Group A (mean 6.31 ± 1.00), $p < 0.000001$
 - Graft Survival at 12 months: $84.92\% \pm 4\%$ in Group B vs $75.06\% \pm 5\%$ in Group A, $p < 0.000001$
 - Patient Satisfaction (Likert 1–5): Median score of 4 in Group B vs 3 in Group A, $p = 0.0011$
 - Donor Density Loss: 10.61 FU/cm^2 (Group B) vs 13.82 FU/cm^2 (Group A), $p = 0.000003$
 - Visible Thinning or Scarring: Noted in 23% of Group A vs 3% in Group B, $p = 0.0032$
- No adverse events, infections, or hypertrophic

scarring were observed in either group. Healing was uneventful.

Discussion

This study provides high-quality, prospective evidence demonstrating the clinical advantages of harvesting exclusively within the anatomically stable U-pattern zone during FUE hair transplantation. The significantly improved donor aesthetics, higher graft survival, and better patient satisfaction in the U-pattern group support the anatomical and clinical validity of this technique.

The U-pattern zone, typically more resistant to miniaturization, appears to preserve follicular quality and post-harvest density better than extended or random harvesting techniques. By avoiding potentially unstable regions, surgeons can reduce donor site scarring and ensure a more natural-looking appearance.

Our findings align with anatomical donor zone studies and support the safe zone guidelines proposed in earlier observational research. Notably, the difference in graft survival rates (nearly 10%) indicates a substantial clinical impact that could affect long-term restoration outcomes.

Limitations include the male-only study population and a 12-month follow-up. Longer-term evaluations could reveal progressive thinning in non-U-pattern areas, further validating our approach. Additionally, while aesthetic scoring was performed by blinded dermatologic surgeons, objective digital imaging analysis.

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