



# Investigation and analysis of 1030 primary hair transplantation cases: a retrospective study

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## Abstract

**Background** Hair transplantation has progressed since the introduction of the concept of follicular unit transplantation, a method that recognizes the follicular unit as the basic element of tissue to be transferred. It was aimed to estimate the area of donor scalp with the greatest probability contains the number of follicular units desired to transplant and to analyze the complications in all patients who underwent hair transplantation procedure.

**Methods** A retrospective study was conducted in our clinic from January 2014 to January 2018.

**Results** One thousand thirty hair restoration procedures were performed. Each patient was evaluated for age and gender in addition to the follicular unit density and postoperative complication rates. The mean age was 37.2 years. It was noted that the most common type of hair grouping was the 2-hair follicular unit grafts. The FU density ranged between 70 and 90 and the hair density ranged between 130 and 220 hair/cm<sup>2</sup>. Postoperative frontal edema was the most common postoperative complication.

**Conclusions** Data collected from this series can help to estimate the area of donor scalp with the greatest probability of containing the number of follicular units desired to transplant.

Level of Evidence: Level IV, therapeutic study.

**Keywords** Hair transplantation · Graft · Follicle

## Introduction

Hair transplantation has progressed remarkably since the introduction of the concept of using follicular unit transplantation, a method of hair restoration surgery that recognizes the follicular unit as the basic and exclusive element of tissue to be transferred in the transplant [1, 2].

Since the hair is transplanted in the same way as it grows, follicular unit transplantation is considered the most logical way to accomplish a hair transplantation procedure and gave birth to megasessions of micrografts [3].

A meticulous dissection for harvesting and the follicular units and for placing them to the recipient area is essential for this method since the preservation of the

whole morphology of the follicular unit can play a significant role in graft survival. It was Seager [4] who showed that single hair grafts that have been split away from naturally occurring follicular clumps have a decreased survival rate when compared with intact follicular units.

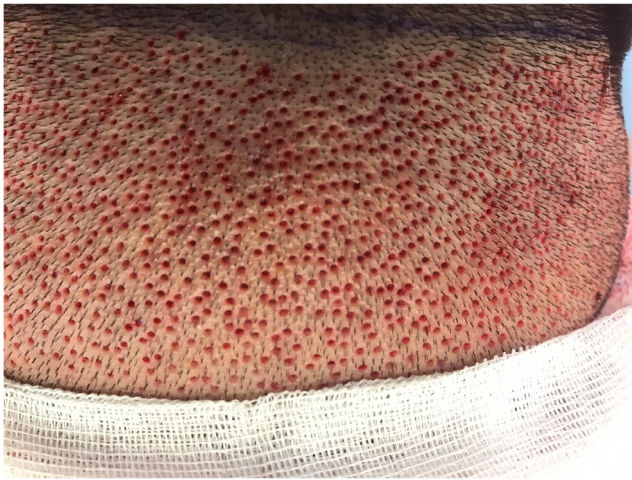
Follicular units are composed of 1, 2, 3, rarely 4, or 5 hairs that form a distinct group bounded by a circumferential band of adventitial collagen [5]. It is essential to harvest these units as a whole without damaging for survival of the hair follicles. It is also important to emphasize the relation between hair density and follicular unit density. Hair density refers to the number of hairs emerging from the scalp per square centimeter. Follicular unit density is the number of hair groupings per square centimeter. In order to achieve a cosmetically pleasing result from a hair transplantation procedure, it is essential that one must have an opinion about the density of the follicular units of the scalp which possibly will be transferred.

The absolute number of follicular units per unit area remains relatively constant (1 unit/mm<sup>2</sup>), and that it is

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**Fig. 1** The view of the donor area after harvesting

the proportion of natural hair groupings that determines the patient's hair density [2, 6]. Although the follicular density remains relatively constant, the hair density varies significantly. A review of the literature reveals a significant variation among different authors regarding the counts of hair density, which is either probably due to racial variations or to the methodology used to count the hairs per unit area. Hair density, together with hair diameter has a tremendous impact on the cosmetic outcome of hair transplantation surgery [7].

The success of the procedure not only lies on the skill of the attending surgeon and its team, but also is likewise dependent on the amount of follicular unit (FU) grafts that can be harvested from the safe donor zone of each patient. Every donor region has specific characteristics that allow the hair restoration surgeon to customize the unique design for each individual.



**Fig. 2** Grouping of the hair grafts

In this study, it was aimed to collect data from a large proportion of patients which can help us to estimate the area of donor scalp with the greatest probability contains the number of follicular units desired to transplant. It was also aimed to analyze the complications in all patients who underwent hair transplantation procedure.

## Material and Method

A retrospective study was conducted in our clinic from January 2014 to January 2018 involving 1030 patients (994 male, 36 female). One thousand thirty hair restoration procedures were performed for 1030 patient. All patients were first-time hair transplantation candidates. Patients who received secondary hair transplantation procedures were excluded. All patients had scalp only hair transplantation procedures. Mustache, eyebrows, or beard transplantation patients were excluded from the study.

All patients trimmed their donor area hair 1 mm short prior to the surgery. The donor areas of all patients were photographed. The quantification of hairs and follicular units per unit area (1 cm × 1 cm) was made from digitized photographs. One-millimeter-short hair is mandatory to allow the harvesting of individual follicular units using 0.8- to 1.1-mm punches. All operations were performed under local anesthesia or local anesthesia plus sedation with proper preparation in the operation theater. Anxiolytics, painkiller, and antibiotics were administered in the beginning of surgery. Surgical asepsis was taken care of and ring block anesthesia was provided to the donor area using a combination of xylocaine and bupivacaine. Patients were positioned in the prone position for harvesting the grafts from the posterior scalp. As in micrograft preparation for hair transplantation procedures, each follicle was isolated intact as a whole, always maintaining a significant amount of tissue (epidermis, dermis, subcutaneous fat) around the entire length of the follicle. All follicular unit extraction was performed with the help of a powered punching device. When each follicle was isolated, intact as a whole, two microsurgical forceps were used in order to remove each follicle for classification. When the harvest of the hair follicles by extraction method using micromotor punches from the safe donor area was completed (Fig. 1), follicular units were dissected and stored in saline/ringer lactate in 4 °C until implantation since it is generally recommended to preserve the grafts at a low temperature in order to enhance the survival rate of the grafted hair follicles. Supraorbital and supratrochlear block was given to anesthetize the recipient area. Tumescence solution was also injected into the



**Fig. 3** The view of the recipient area 1 week after surgery

recipient area. Recipient area was prepared by creating multiple slits which were 1–1.4 mm away from each other depending on patient's hair density (Fig. 2). The recipient area slit creation was made with 1.2 mm or 1.5 mm microblades depending on hair type and scalp area. Follicular units were implanted into the slits using two forceps with the punctiform technique, which means each follicular unit, inserted manually with two surgical microforceps into the slits.

All patients received postoperative antibiotic therapy, oral corticosteroids, and analgesic medications. All patients were discharged same day of the operation with a pressure dressing that remains on overnight (Fig. 3). Dressing on the donor area



**Fig. 5** Postoperative swelling

was removed next day. Patients were advised to apply topical antibiotics to the donor region twice daily for 1 week postsurgery. They shower each day by allowing the water to rinse off the scalp but to avoid scrubbing or scratching at the scalp. The patients were advised in a head up position for

**Fig. 4** Postoperative bandages





**Fig. 6** 42-year-old male patient. Preoperative vs postoperative 1st year. 4200 grafts



1 week. The perifollicular crusting that forms around the grafts resolve in 5 to 8 days. At the end of the 1st month, patients were allowed to resume full physical activities such as sports or sexual intercourse. Patients were followed up in the immediate postoperative period, at the 3rd, 7th, and 14th days, and then monthly up to 1 year postoperatively. If necessary, an additional transplantation session was carried out after at least 12 months follow-up but none of their patients were included to the study. All

complications during the postoperative period were recorded (Figs. 4, 5, 6, 7, 8 and 9).

Each patient was evaluated for age and gender in addition to the follicular unit density and postoperative complication rates.

The total numbers of 1-, 2-, 3-, 4-, and 5-hair follicular units were counted during harvesting of the follicular units and classified (Fig. 10). Due to the scarcity of 4- and 5-hair follicular units and for the sake of simplification, all 4- and 5-hair follicular units were counted as 3-hair follicular units.

**Fig. 7** 36-year-old male patient. Preoperative vs postoperative 8th month. 4800 grafts



**Fig. 8** 32-year-old male patient. Preoperative vs postoperative 2nd year. 4800 grafts



## Results

One thousand thirty patients (994 male, 36 female) underwent hair restoration procedure. The FUE method was performed for hair extraction for all patients. The mean age was 37.2 (18–66) years. Forty-five percent of all patients (461) were 31–40 years old which is the most popular age group among patients for hair transplantation. The age distribution for all ages was demonstrated in Graphic 1.

The average number of grafts, which were harvested from donor area, was 3038 (615–5900). It was noted that the most common type of hair grouping was the 2-hair follicular unit grafts, followed by the 3-hair and 1-hair unit grafts. The average number of grafts, which contains 2-hair follicular units, was 1382 (2700–100). The number was 918 (3000–50) for grafts which contains 3-hair follicular units and 738 (2200–60) for graft which contains 1-hair follicular units. The distribution for grafts, which have different amount of hair follicles, was demonstrated

**Fig. 9** 35-year-old female patient. Preoperative vs postoperative 16th month. 2000 grafts



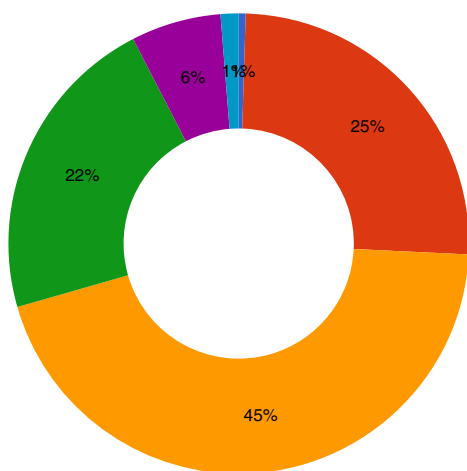
**Fig. 10** 30-year-old male patient. Preoperative vs postoperative 2nd year. 3900 grafts



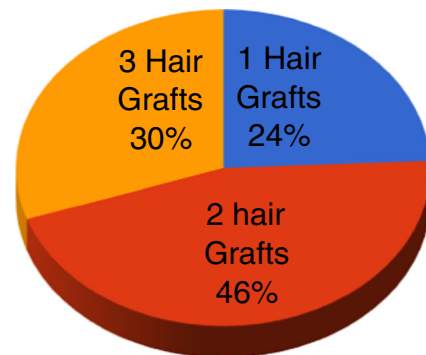
in Graphics 2 and 3. The number of follicular units per square centimeter in the occipital scalp ranges between 70 and 90 and the hair density ranged between 130 and 220 hair/cm<sup>2</sup>.

Several types of complications were noted in the postoperative period and they were listed in Graphic 4. Postoperative frontal edema was the most common postoperative complication which was noted nearly half of the patients (Fig. 11). Thirty-one patients suffered from excessive frontal and orbital edema postoperatively that the patients cannot even open their eyes. Pruritis was a

common condition in the donor area in early postoperative period and in the recipient area in the late postoperative period but in total, 13 patients described prolonged pruritis (up to 6 months) in the postoperative period. Twenty patients described the long-term numbness/paresthesia over temporal or occipital area (4–8 months). Shock hair loss was seen in 18 patients who healed spontaneously without any intervention. It was noted that 33% of female patients suffered from shock hair loss. Sterile folliculitis was noticed in the recipient area in 14 patients. PRP (protein-rich plasma) treatment was applied to all those patients. All those cases resolve within time and no additional intervention was performed. Topical antibiotics were advised for

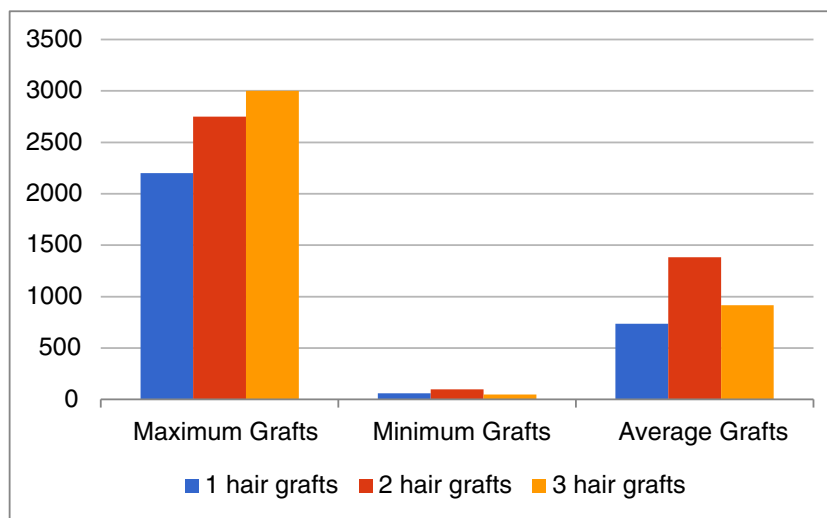


**Graphic 1.** Age Distribution



**Graphic 2.** Follicular unit distribution among all patients

**Graphic 3.** Maximum, average and minimum number of grafts for all patients



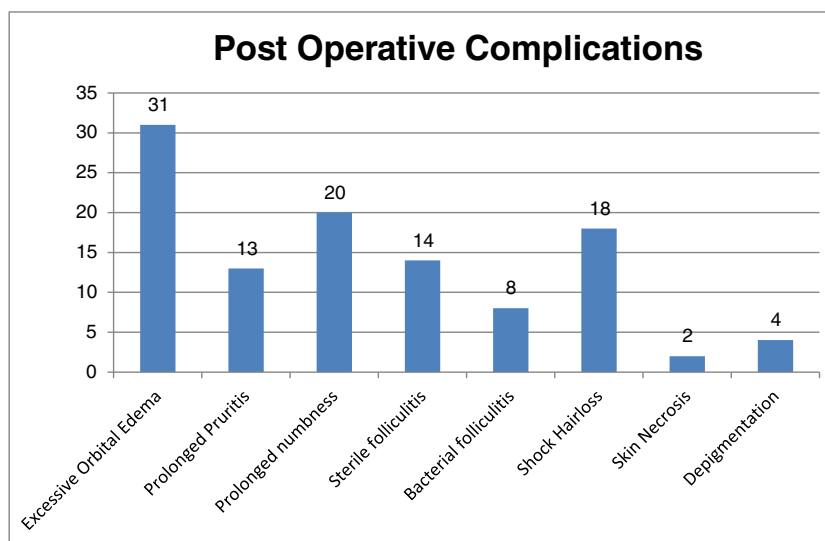
further complications. Bacterial folliculitis was noticed in the recipient are in 8 patients. Oral antibiotic treatment and daily topical antibiotic application were advised. All patients responded well to the treatment. Four patients had developed postoperative depigmentation in the recipient area. Partial necrosis in the recipient area was seen in two patients. Both patients were smokers and healed satisfactory with secondary intention.

Notable complications were observed in 102 patients (9.9%) in a total of 1030 procedures. But, it is important to emphasize that nearly half of the patients

suffered from slight or mild frontal edema and pruritis in the donor area.

## Discussion

Hair transplantation surgery is a promising and permanent method of hair restoration among the many treatment options for androgenetic alopecia. Hair transplantation surgery is based on the fact that the hair in the grafts continued to grow in the area of the alopecia (the recipient area) and that it maintained the same texture and color, and



**Graphic 4.** Postoperative complications



**Fig. 11** 36-year-old male patient. Preoperative vs postoperative 1st year. 5000 grafts



apparently grew at the same rate and with the same period of anagen that governed the nature of the hair in the donor site [8].

Due to the high interest and demand on hair transplantation surgery, several new terms came to light such as minigrafts, micrografts, and follicular unit grafts. With the use of follicular unit grafts, hair transplantation can be applied not only to androgenetic alopecia, but also to other hairless areas such as the eyebrows and pubic area.

Follicular units are composed of 1, 2, 3, rarely 4, or 5 hairs that form a distinct group bounded by a circumferential band of adventitial collagen [5]. It is essential to harvest these units as a whole without damaging for survival of the hair follicles. It is also important to emphasize the relation between hair density and follicular unit density. Hair density refers to the number of hairs emerging from the scalp per square centimeter. Follicular unit density is the number of hair groupings per square centimeter. In this study, it was aimed to investigate the distribution of follicular units in the donor (occipital) area of human scalp. The data obtained were used to have a general opinion prior to every procedure that allows surgeons to calculate the number of 1-, 2-, and 3-hair follicular units in the donor area.

It is possible to find several publications in the literature which investigates the hair density and the follicular hair density [1, 2, 9]. These publications reveal a significant variation among different authors regarding the

counts of hair density but the rates are rather similar. For example, Bernstein et al. [2] found significant racial variations in the hair density and follicular unit density among Caucasians, Asians, and Africans. The African individual has a lower hair density (average 160 hairs/cm<sup>2</sup>) than the Asian (average 170 hairs/cm<sup>2</sup>) and Caucasian (average 200 hairs/cm<sup>2</sup>). Limmer [1] found a range of 120–240 hairs/cm<sup>2</sup> and Jimenez et al. [8] found between 124 and 200 hair/cm<sup>2</sup>. It was no surprise that the hair density was different but similar in our study. The hair density in our study was 180 hairs/cm<sup>2</sup> (130–220). Majority of our patients were Caucasian; therefore, it is reasonable to claim that the result of our study was similar to the literature.

In human scalp, the majority of the hair emerges as 2-hair follicular units. The second most common unit is the 3-hair unit. Only in individuals with very low hair density (with severe male pattern baldness) are the 1-hair unit more abundant than the 3-hair units. These follicular units tend to maintain a certain distance between each other, which can range from 1.00 mm in patients with high hair density to 1.40 mm in low-density patients. Theoretically, this is the distance in which the hair grafts should be placed in order to achieve a density equal to the donor site [10].

Avram [11] noted that the average FU density in the donor scalp of Caucasians ranges from 70 to 100 FU/cm<sup>2</sup>. Likewise, Jimenez [10] reported that the occipital



donor scalp has FUs ranging from 65 to 85 FU/cm<sup>2</sup>. The FU density in our study was 80 FU/cm<sup>2</sup> (70–90). The data that we collected was similar to the literature.

Serious complications arising from hair transplantation procedure are relatively uncommon following well-performed and well-planned surgery but even though complications in hair transplantation procedure are very low compared to other esthetic surgical procedures. But, there are wide varieties of possible complications that are less severe and manageable [12]. As the number of surgeries continues to increase, the total number of complications that occur in the course of these operations and beyond will increase. This increase will surely present major challenges to novice and seasoned surgeons alike [13].

Complications of the procedure have included alterations in scars (cobblestoning, riding (elevation of skin in the transplanted area), and various degrees of fibrosis and/or keloids), pigmentation disturbances, hair kinking (deformity of the hair posthair transplant), arteriovenous fistulas, dehiscence, scar enlargement and necroses (described in donor and in receptor sites), areas of postoperative folliculitis, scalp infection, and osteomyelitis of the cranium [13]. Due to the technological developments within follicular unit extraction techniques, it is now possible to avoid majority of these complications. In follicular unit extraction, healing occurs by secondary intention, similar to the classic open-donor method reported by Orentreich [8]. The major difference is the wound size. It is only the very small 1-mm wounds of FUE that provide for rapid healing, produce an imperceptible donor scar, and offer a distinct advantage over the strip method with respect to donor healing. In our study, complication rates of the donor area were shown to be very limited. We believe that the FUE technique has a great impact on safety and duration of hair transplantation. It was seen that most of the troublesome complications that we experienced were recipient area-related complications such as frontaledema or folliculitis.

Many methods have been recommended to reduce the edema, which include both physical methods and administration of steroids. Physical methods include the use of firm headband, maintaining semi-lay down position postoperatively, applying adhesive tapes below hair-line and usage of ice packs, or bags of frozen peas. However, none of these methods have been found fully satisfactory.

Sterile folliculitis in the recipient area is a frequent complication seen weeks or months after transplantation.

In our study, it was found in 14 patients. The causes are not clear. Theories include “ingrown” hair, foreign body reactions, epithelium logged into slit sites during recipient site creation, piggybacked grafts, and the “idiopathic” intrinsic properties of the host scalp. In the majority of cases, the pathogen cannot be cultured from the lesions, and hence, the name sterile folliculitis. They are, usually, managed by oral antibiotics, warm compresses, and unroofing the cysts.

Infections of the scalp are very rare because it is well vascularized. Serious infections occur in less than 1% of cases and are, usually, associated with poor hygiene, excessive crust formation, or preexisting medical risk factors. In our study, 8 patients suffered from bacterial folliculitis and all of them responded well to antibiotic treatment.

Hypopigmentation can occur in either the donor or the recipient areas. Recipient-site hypopigmentation is more prevalent with larger slits and can be especially problematic when low graft yields fail to produce sufficient hair for adequately camouflaging the scalp. In our study, 4 patients suffered from hypopigmentation which were persisting in their first-year controls. Two of our patients experienced patchy skin necrosis which healed spontaneously without intervention. Both patients were smokers but both of them had a bad scar in the necrosis area.

To our knowledge, no clinical study focusing such a high number of hair transplantation procedure was performed before. In our study, patients were evaluated for age and gender in addition to the follicular unit distribution in the donor area and both the type and frequency of complications in a series of 1030 hair transplantations.

## Compliance with ethical standards

**Conflict of interest** The authors have no conflict of interest.

**Ethical approval** For this kind of retrospective study formal consent from a local ethics committee is not required.

**Patient consent** Patients provided additional consent for the use of their images. Informed consent was obtained from all individual participants included in the study.

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