Evolution of Hair Transplantation

Kayiran O*

Department Plastic and Reconstructive Surgery Clinic, Ankara Research and Training Hospital, Turkey

Abstract

Background: Numerous non-surgical methods and surgical options are available for the solution of baldness in the practice. Technology gives mighty weapons in this field. Thus, individualized solutions are best carried out with well-trained and qualified practitioners. Here, a modification of follicular unit extraction, direct hair implantation is introduced with previously licensed unique pens.

Materials and Methods: Follicular unit extraction and direct hair implantation methods were carried out in 207 hair transplantations between January and December of 2014. The nests for the grafts were created via pieces of hand-cut razor blade in follicular unit extraction. In addition, a new modification of follicular unit extraction, direct hair implantation, is done via pens that are produced for this purpose.

Results: Thirty eight direct hair implantations were performed in addition with 169 follicular unit extractions. An average number of 2973 grafts were transplanted. Mean operation time was calculated as 385 minutes.

Conclusion: Hair transplantation is still the best solution for hair loss. In conjunction with the surgery, the addition of non-surgical interventions may give a better result to the patient. On the other hand, the promising results in the field of regenerative medicine with cell-based solutions may alter hair transplantation and change the options solely into this field.

Keywords: Hair transplantation; Direct implantation; Razor; Nest

Introduction

Hair transplantation has gone a big revolution with the pioneers in this field [1-7]. However, it is still controversial for the practitioners which transplantation method is the best so far. To achieve a good cosmetic result in hair transplantation, a natural-looking hairline with adequate density shall be established. There are numerous modifications of defined techniques with each one explaining and suggesting verified solutions. Hair follicle harvesting techniques are either hand-held or robotic methods. The practitioner-dependent methods are comprised of direct excision of the donor area and extraction of the follicles by punches; whereas SAFE (Surgically Advanced Follicular Extraction) and ARTAS are the robotic systems [8-12]. After harvesting of the follicles, the transplantation can be carried out by punches, needles or scalpels [13-16]. Overall success is attributable to meticulous handling of the follicles as well as gentle transplantation. Regarding the graft survival (hair, cartilage, etc), the main concern is the "take" [17]. Appropriate preparation of the recipient bed is crucial to enhance the take.

This note describes the available options in hair loss surgery, the concepts of non-surgical approaches and an experience share with a few patients grafted via direct hair implantation (DHI) method. In addition, we describe a new method by using sliced razor blades to create comfortable nests for the follicles that are to be transplanted. Thus, the evolution of hair transplantation is summarized as well.

Material and Methods

This retrospective study consisted of 207 patients who had hair transplantation between January and December 2014. The patients with scar tissue on the scalp and side-burn, beard and/or moustache transplantation, multisession transplantations and female patients were excluded. The harvested grafts out of the scalp were also not evaluated. Moreover, the patients with type III, IV and V in Norwood classification were included in the study. On the other hand, the patients getting medications, injections or having administrations to enhance hair density were excluded.
All the procedures were carried out under local anesthesia. The hair was cut 1-2 mm in length. Micromotor system was used in the harvesting of the hair follicles [13]. This system consists of punches attached to the hand-piece of the micromotor system (1500-3000 rpm). Punches were chosen according to the diameter of the follicles ranging between 0.8 and 1.2 mm. Harvesting of the follicles was handled in supine position. With the aid of the sharp punch attached to the motorized system, the follicle is detached from the surrounding tissue (approximately 3-4 mm in depth=deep dermis layer). Later on, it is released manually with fine-curved microforceps produced for this purpose. Temporo-occipital region was used as donor site. The harvested grafts were aligned in Petri dishes with cooled saline (4°C). A dressing is made with sterile saline coated gauze to the donor area and the patient was turned to the supine position.

In follicular unit extraction (FUE) technique, razor blades that was cut into pieces was used to open the nests in vertically-oriented fashion that are to be grafted (Figure 1). With this, we aimed to diminish the incarceration of the implanted follicles. However, in DHI technique, the grafts were loaded to the DHI pens with one charged staff for this purpose (Video 1). The implantation of the follicles was carried out in accordance with the natural hair angles by the author under loupe magnification (Video 2 and 3).

After the entire implantation was established, the patient was dressed with antibiotic coated, moisturized gauze to both donor and recipient areas that were removed three days later at which the first hair washing would also be carried out. The patients were recommended to have their first hair-cut 15 days later.

At the end of the first postoperative year, patients were asked to evaluate their satisfactions as bad, good and excellent.

Results

A total number of 615400 grafts were transplanted in 207 patients. Of these, 38 were DHI (19%) and 169 had FUE (81%). Patients were classified as Norwood III, IV and V in 1 (0.5%), 30 (14.5%) and 176 (85%) patients, respectively. The main reason of hair loss was androgenetic alopecia in our patients.

An average number of 2973 grafts were transplanted. Mean graft numbers transplanted in FUE and DHI methods were 2982 and 2934, respectively. The mean density was observed around 75 units/cm² for DHI technique and 50 units/cm² for FUE method.

Mean operation time was noted as 385 minutes in which mean FUE and DHI times were calculated as 373 and 437 minutes, respectively. The patients were followed-up between 1 and 5 years. Table 1 describes the distribution of the patients.

None of the patients had infection. Inclusion cyst formation was observed in 4 patients who were treated successfully.

A few results with DHI technique are presented in (Figure 2 and 3).
to the literature percentages (2-8%) [13,18,19]. No graft loss was documented in transplanted areas. Regarding satisfaction, excellent scores were noted in 193 patients (93.2%) and 13 patients (6.3%) gave good scores. One patient could not decide to give a score. We regarded his score as bad (0.5%).

Discussion

Male type baldness may cause a negative effect on individual’s self-esteem. Hair transplantation gives a unique permanent solution for those patients.

Non-surgical therapies for hair loss can be used mainly in early phases. On the contrary, these options will be the first-line therapy when the donor supply is limited or adjunctive after a surgical hair modality is carried out [20]. Minoxidil, finasteride, dutasteride, spironolactone or cyproterone acetate can be prescribed in selected patients with temporary actions [20-25]. Moreover, low-level light or laser therapy can be utilized in patients with early-phase hair loss where the practitioner may choose home-use and/or in-office systems. It is known that prostaglandin analogues such as prostaglandin F2a and prostaglandin E2 promote hair growth in both mice and human follicles [26]. In practice, latanoprost (a prostaglandin F2a analogue) is a solution that provides a significant increase in hair growth [27]. Mesotherapy and platelet-rich plasma can be utilized in patients needing additional therapies in the enhancement of hair growth. Mesotherapy consists of superficial injections of pharmaceuticals and vitamin compounds to the follicles. Platelet-rich plasma (PRP) is used in almost every section of the medicine and includes several platelet-derived factors [28]. It is proven that PRP injections enhance hair growth in transplanted follicles [29-31]. Nevertheless, more studies are needed to evaluate PRP as a hair loss therapy.

Since the concept of “donor dominance” in male pattern hair loss was first published in 1959, it is still not clear why the occipital hair is spared [4]. The most accepted reason seems that occipital scalp is not androgen dependent [23]. Whatever the reason is, it is the feature that occipital hairs have permanent serves for hair transplantation in both female and male pattern hair loss [4].

The permanent solution for hair loss can be achieved with hair transplantation. The grafts harvested from the donor area are transplanted to the recipient area in qualified, well-trained hands and at optimum conditions. Nevertheless, graft viability depends on several factors determined by the hair type, delicate technique, physical trauma, vascular factors, biochemical injury, infection, patient disruption and idiopathic reasons [32].

Hair transplantation is comprised of consecutive steps: planning, preparation and anesthesia, graft harvesting, secure of the harvested grafts, graft transplantation, and dressing. Each step may be individualized in practice. Planning of the patient consists
of some blood tests, a thorough history of medical situation and marking. After shortening of the hair if needed and preparation with antiseptic solutions, anesthesia is carried out. Mostly, local anesthesia is preferred; however, regional anesthesia or local anesthesia with sedation can be chosen. When an entire anesthesia is established, a tumescent solution is injected both to the donor and recipient area. This enables an expansion to harvest the follicles in donor area and graft them easily. The survival of the harvested graft is dependable on temperature, hydration, infection and trauma [33]. The surgeon and staff shall not transect or crush and dehydrate the follicles during the procedure. This meticulous technique will ensure the best outcome. It is also advised to maintain the follicles that are to be transferred in a cold solution in order to reduce the ischemia and reperfusion injury. Some holding solutions exist such as intravenous holding solutions (eg: normal saline, lactated Ringer), cell culture media (eg: Dulbecco’s Modified Eagle Medium, Williams E) and hypothermic holding solutions (eg: HypoThermosol, BioLife Solutions, Bothell, WA) [32]. Nevertheless, stored grafts are mostly kept cold in ice blocks or cold solutions with the temperature rate between 4°C and 10°C. Harvesting of the follicles can be done via manually or motorized systems. The practitioner can choose sharp or dull tipped punches with a wide variety of diameter and bevel type. Eventually, the follicles are transplanted delicately into the recipient area with appropriate angle to establish similar grow pattern with the normal hair. Nests for the grafts that are to be implanted can be created via a sharp-punch and needles or scalpels in selected sizes [13-16]. On the front line, we prefer to make the transplantations in a zig-zag fashion to achieve a natural-looking frontal hairline design [14]. The follicles are transplanted into the recipient area with the appropriate angle to establish similar grow pattern with the normal hair. Nests for the grafts that are to be implanted can be created via a sharp-punch and needles or scalpels in selected sizes [13-16]. On the other hand, Okuda was the first that used self-made sharp circular punches in various diameters (1-4 mm) [42]. He proposed to use 2-4 mm punches with regard to 1 mm because, according to him, the transection rate was interestingly high in 1 mm harvests. In contrast to FUT, follicular unit extraction (FUE) is a technique with the extraction of follicular units with one or two roots using circular punches. Okuda was the first that used self-made sharp circular punches in various diameters (1-4 mm) [42]. He proposed to use 2-4 mm punches with regard to 1 mm because, according to him, the transection rate was interestingly high in 1 mm harvests. In the market, there are several FUE donor harvesting devices available; of which some are hand-held punches, some are motorized and some are single user-directed robotic system which is also known as SAFE (Surgically Advanced Follicular Extraction) and ARTAS robotic systems [8-12]. Success with FUE depends on being able to predictably dissect excellent-quality grafts with minimum transaction rates from the donor region [7,9,18,40].

Ominigraft (Mecicamat S.A., Malakoff, France) has been introduced to optimize mini and micrograft transplantation [9]. This device consists of three major parts: Hairtome; a hand-held pneumatic graft implanter; and a hollow-shafted micromotor hand piece with a punch blade in 0.8-1.25 mm. The transaction rates and the operation time are significantly lower with this device. Here, we used a new method in the transplantation of the hair follicles via sliced razor blade rather than needles or scalpel. On the other hand, the conventional harvesting technique remained same. There are some advantages and disadvantages of FUE over FUT which was very well discussed previously [10]. FUE needs longer learning curve and operation time, excellent hand-eye coordination, patience, stamina and hair must be short enough for appropriate harvesting. Moreover, the practitioner may be a candidate for potential repetitive motion disorder in time [10]. Besides, the outcomes of FUE may be better and the number of follicles transferred may be higher when compared with FUT. In addition, FUE gives a scarless solution.

### Table 1: The distribution of the patients.

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>FUE</th>
<th>DHI</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>Time (min.)</th>
<th>Graft</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>207</td>
<td>169</td>
<td>38</td>
<td>1</td>
<td>29</td>
<td>177</td>
<td>615400</td>
<td></td>
</tr>
<tr>
<td>January</td>
<td>11</td>
<td>11</td>
<td>5</td>
<td>6</td>
<td>359.2</td>
<td>2904.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>February</td>
<td>15</td>
<td>15</td>
<td>1</td>
<td>14</td>
<td>353.7</td>
<td>2733.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>March</td>
<td>15</td>
<td>15</td>
<td>1</td>
<td>2</td>
<td>12</td>
<td>346.3</td>
<td>2693.3</td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>15</td>
<td>14</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>354</td>
<td>2793.3</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>14</td>
<td>13</td>
<td>1</td>
<td>14</td>
<td>369.6</td>
<td>2842.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>19</td>
<td>17</td>
<td>2</td>
<td>19</td>
<td>357.1</td>
<td>2784.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>21</td>
<td>20</td>
<td>1</td>
<td>21</td>
<td>349.8</td>
<td>2845.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>20</td>
<td>12</td>
<td>8</td>
<td>3</td>
<td>17</td>
<td>422</td>
<td>3145</td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>15</td>
<td>10</td>
<td>5</td>
<td>2</td>
<td>13</td>
<td>441.3</td>
<td>3306.6</td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>19</td>
<td>12</td>
<td>7</td>
<td>1</td>
<td>18</td>
<td>392.1</td>
<td>3173.7</td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>21</td>
<td>16</td>
<td>5</td>
<td>3</td>
<td>18</td>
<td>407.6</td>
<td>3157.1</td>
<td></td>
</tr>
<tr>
<td>December</td>
<td>22</td>
<td>14</td>
<td>8</td>
<td>5</td>
<td>17</td>
<td>437.7</td>
<td>3118.2</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>17.25</td>
<td>81%</td>
<td>19%</td>
<td>0.5%</td>
<td>14.5%</td>
<td>85%</td>
<td>385</td>
<td>2973</td>
</tr>
<tr>
<td>Total</td>
<td>207</td>
<td>169</td>
<td>38</td>
<td>1</td>
<td>29</td>
<td>177</td>
<td>615400</td>
<td></td>
</tr>
</tbody>
</table>

for the patients insisting on not accepting an incision.

Another hair transplantation method, direct hair transplantation, is presented to attenuate the transit time which may reduce the graft survival [21]. Here, follicles are implanted as soon as they are harvested. This technique was found a simple and feasible modification of FUE.

An automated FUE technique, Neograft®, enables a suction-based follicle harvesting with one or two-step extraction technique. The follicles are collected in a suction canister in which they are transplanted later by using a hand-piece with 0.8, 1 and 1.2 mm punches that are produced specifically for this purpose. The motor is silent and vibration free; however the steep learning curve and the cost of the machine are the disadvantages [41].

Micromerized microfollicular hair transplantation is a recently described method in which anterior hairline is constructed with FUE whereas the bald area is transplanted with FUT including strip harvesting (with beveled incisions) and slivering of the strip under magnification. The author proposes the graft transaction rate to nearly 0% [14].

Direct hair implantation (DHI), a modified version of FUE, has similarities with FUE in hair follicle harvesting, whereas the implantation of the follicles is carried out with unique instruments that is licensed by Konstantinos (US 8,801,743 B2) and produced specifically for this purpose. The needle of the pen may vary in size; since there are 0.40-2 mm oblique-cut needles in the market. After follicle harvesting, each pen is loaded with a micrograft containing 1 to 3 hair follicles and subsequently implanted to the recipient area that was not previously perforated. This technique allows the practitioner graph the recipient area denser and gives less trauma and bloodless field when compared with FUE. Moreover, this procedure lacks additional punching for grafting as noted in other transplantation techniques. On the contrary, the learning curve is high meaning that this surgery needs more qualified personnel per patient. In addition, the procedure is carried out with 3 or 4 personnel, because every stage is assigned to a unique staff which means that the room is more crowded than the other techniques. The pens and so these procedures are relatively expensive when compared to FUT or FUE. Nevertheless, follicle harvesting is significantly cheaper than robotic systems.

Complications after hair transplantation can be placed in the following categories: a) standard surgical risks b) physician planning errors; c) physical technical errors; d) patient compliance factors; e) patient physiology factors; and f) miscellaneous causes [42]. In addition, we may observe some site-specific complications after all including donor and recipient site problems [42]. Donor site complications include wide variety of unwanted scar formation, donor-site depletion, wound dehiscence, necrosis, effluvium (shock-loss), hypopigmentation, hair color mismatch, chronic folliculitis, necrosis, effluvium, ingrown hairs, cysts and low graft yield.

Animal studies reveal creation of human follicles from cultured dermal and epidermal cells in a mouse model [43]. A revolutionary breakthrough in this field is the discovery of induced pluripotent stem cells enabling to reprogram differentiated fibroblasts into an embryonic stem cell state [44, 45]. A recent study exhibits the creation of a bioengineered hair follicle germ using embryonic skin-derived epithelium and mesenchymal donor cells where the transplanted germ integrate to the host epithelium producing a complete functional hair [46].

Forthcoming studies will ensure better results. As the technology contributes to the medicine, it is possible that the whole process will be carried out entirely with robotic and automated systems. Indeed, the future may give the solutions by solely cell-based applications enabling hair growth without a surgery. Up-to-date, we believe that the combination of the surgical methods with the help of additional options may give the best option for the patients to re-gain their natural-looking hair with adequate density.

References


41. NeoGraft Hair Transplant Machine for FUE.


