

Hair Restoration Surgery: an Up-to date for Maxillofacial Surgeons

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Abstract

Current techniques in aesthetic hair transplantation achieves natural and predictable results in patients. There are some specific indications in the field of Oral and Maxillofacial Surgery in which hair transplantation can offer a cosmetic improvement of the patient. In this review, the anatomy and natural cycle of the hair, the extraction and implantation techniques and the detailed indications will be revisited.

Introduction

Hair loss is one of the most self-esteem and emotional change in both man and woman. Although the most common cause of hair loss is the Androgenetic Alopecia (AGA), there are other conditions that we usually treat in our Oral and Maxillofacial Surgery Department. Some of these indications are the scars of our facial and skull approaches, cancer treatments or trauma sequel.

The Hair Anatomy

The basic anatomy of the hair is the so-called Follicular Unit (FU). We do not refer, in proper medical terms, as “hairs” but as FU. The FU is an aggregation of hairs that usually merge from the same point of the skin, which share some structures as the sebaceous glands, the smooth muscle (piloerector muscle) and some “fat niches” in where there are colonies of mesenchymal multipotent cells. The number of hairs in each FU is determined principally by the location in the scalp (i.e. at occipital area usually we can observe a three to four hairs in one FU, although in the frontal area we usually observe a single hair FU), the age of the patient (younger patients usually have more hairs each FU), the genetic charge (as it can be seen regarding the hair pattern of the family), the intake of toxics to the hair (heavy metals, cytostatics, chemotherapy, pollution) and the presence of pathologies that can affect the natural growth of the hair.

Figure 1: A Follicular Unit (FU) cycle

This FU is cyclic, and continuously runs through three major steps or hair phases [1]:



In human skin, the role of Mesenchymal Pluripotent Cells (MPC) is to restore and repopulate the cells above the basal membrane. The place in where the multipotent cells are located is so called “niches” [2]. There are three mayor niches in where MPC can be found: interfollicular epidermis, adjacent to the bulge of the hair follicle and in sebaceous glands [3]. Some studies consider crucial the role of the MPC in hair growth and loss [4].

Androgenetic Alopecia (AGA)

Androgenetic Alopecia (AGA) is the most common cause of hair loss in men, and one of the most common cause in women. It is characterized by a progressive thinning of the FU, also called “miniaturization” of the follicle. Usually affects before the 50’s, being auto regulated after this time. The pattern of hair loss affects to the frontal, bitemporal and vertex regions

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of the scalp [5]. Why hair loss only affected these areas was an exciting question. Currently it is known that hair follicles have uneven genetic susceptibility to the effects of androgens. Those FU, which are located in the occipital area, are less susceptible to androgens, while those FU in the hair loss area are more. The classic androgen, which becomes toxic for FU is the dihydrotestosterone, a product of a peripheral conversion of testosterone by the 5-alpha-reductase enzyme [6]. The microscopic effect of dihydrotestosterone on the hair is to shorten the anagen phase of the hair follicle (which means a less growth) and the reduction of the diameter of the hair (which means a poor density of hairs).

The main medical treatment for AGA is Finasteride, which is a 5alpha-reductase blocker, so the peripheral production of dihydrotestosterone is decreased without decreasing the peripheral levels of testosterone. A 1mg daily dose is recommended for those patients with AGA. Before starting the treatment is recommendable a blood test, in which the hormonal profile of the patient, as well as iron and vitamins profiles should be normal. Finasteride should be kept whilst the patient is not looking for pregnancy, and no side effects occur. The most feared side effect is decreased libido and male impotence, but both are rare in our daily practice. However, a recent meta-analysis of the adverse event reporting in clinical trials of finasteride for AGA concludes that the available toxicity information is very limited, is of poor quality and seems to be systematically biased [7].

Other treatment in our daily armamentarium is topical Minoxidil 5%. As a vasodilator, the effect of minoxidil was supposed to increase the blood affluence to the scalp in order to improve the nourishing of the FU. Recent studies suggest that minoxidil may influence the androgen receptors, decreasing transcriptional activity, reducing the expression of androgen receptor targets at the protein level, all in a complex intracellular signaling pathway [8]. The efficacy of topical Minoxidil in a recent meta-analysis [9], shows that hair growth was about 20% mean higher than in the placebo group. The compliance of the treatment is a limiting factor in hair improvement.

The Platelet-Rich Plasma (PRP) is used in scalp treatment to stimulate follicle growth, but also as a powerful conservation medium for the follicles during hair transplantation.

The greatest hit in hair treatment is the use of patient's cells to produce growth factors with long-lasting effects. Those cell therapies include two main techniques.

Derma Skin Cells

By one hand, a round punch of hair-bearing skin at the occipital area is smashed in a sophisticated device to obtain a heterogeneous cell suspension in which there are keratinocytes, fibroblasts, vessel cells, adipose tissue and blood rests among many other cell lines. This cell suspension generated by mechanical disruption of the skin biopsy is injected as a mesotherapy in the scalp.

The first system developed and approved for this therapy is the Regenera® system. The protocol of the Regenera® device starts collecting a small piece of skin with a cylindrical biopsy punch of 2mm. This tissue is inserted in the cutting unit with sterile saline solution, and smashed for 2 minutes. The suspension obtained, which is loaded with the complete mixture of cells that came from the donor skin, is finally injected in the treatment area [10].

Current trends in scar treatment include the use of intralesional corticosteroid, 5-fluorouracil, bleomycin, interferon, cryotherapy and verapamil. In this area, the use of dermal autologous micrografts results in a significant improvement in appearance and texture of the scars [11]. Furthermore, the Regenera protocol has also been successfully applied in the field of dentistry, in the regeneration of both atrophic maxilla [12] and periodontal tissue [13], and in esthetic surgery where it promoted the engraftment of transplanted hair [14]. The capacity of these micrografts to improve wound healing was also supported by in vitro results showing a high cell viability despite mechanical disaggregation that is performed to obtain them [15]. Additionally, these micrografts display a high regenerative potential, as indicated by increased positivity to mesenchymal stem cell markers such as CD90, CD73 and CD105.

Beyond esthetic uses, the disrupted skin graft technology is also useful in chronic wound management [16], either as isolated infiltration as after colonizing a scaffold. Other uses of the Regenera® device are the treatment of oncological post-surgical wound dehiscence [17]. In cases of non-healing wounds the cell suspension can be used either by perilesional injection or embed into a scaffold (equine collagenous sponge, i.e.).

Adipose Derived Stem Cells (ADSC)

By other hand, the cells can be obtained from an easy to harvest area, as it is the adipose tissue. Peripheral fat tissue contains up to 250-fold pluripotential mesenchymal cells than the bone marrow [18]. Festa et al [19] reported that adipocyte lineage cells support the stem cell niche and help drive the hair growth cycle, while Shin et al [20] documented the role of ADSC-conditioned media in promoting hair growth in women. The fat is harvested in a mini liposuction procedure, in an outpatient basis, with local anesthetics. The amount of fat necessary for an ADSC extraction ranges from 200cc to 300cc. The isolation procedure can be done in a white clean room (by a biologist) or in a semiautomatic commercial device. The enzymatic digestion that collagenase and elastase performs, allows the ADSC to separate from the adipocytes, which are discarded after the centrifugation process.

Basis of the Hair Transplantation

A hair transplantation involves three main aspects, which should be differentiate in order to clarify a whole process. Those aspects are the extraction of the grafts, the preparation of the grafts, and the placement of the grafts.

As we explained above, each individual has different number of hairs in each FU, so that the graft extraction will be different in each patient.

In most of the countries, the hair transplantation is a surgical procedure and only surgeons can perform it. There are different medical specialties interested in the field of hair microsurgery: Oral and Maxillofacial Surgeons, Facial Plastic Surgeons, General Plastic Surgeons, ENT, Dermatologist, and in some circumstances even Neurosurgeons (to treat scars on the scalp).

The Surgical Team is also important. Although the surgeon should do some parts of the surgery, some of them because of its complexity or its aesthetical requirements, there are some technical and mechanical parts, which can be done by a well-trained nurse (i.e. the grafts placement, the stripping of the grafts on FUSS technique, etc.).

The operating room in where the hair transplantation is performed should have a basic equipment to resolve the main medical complications that can appear after a non-invasive local anesthetic procedure. In my experience, up to 80% of my patients do not require intravenous sedation, and can be managed only with oral dose of benzodiazepines one hour before surgery. The room has to be well illuminated, and have room enough to feel free of movement with three to five people around the patient. Some comfort details as TV or ambient music makes more comfortable to the patient.

Normal hair transplantation lengths up to 6 hours. The experience of the surgical team and the complexity of the case can range this time from 3 hours to even 10 hours. As it will be further described, the hypoxic stress of the hair graft makes that the graft must be placed properly no longer than 3 hours.

Donor Area

We refer the “donor area” to the place where we are going to harvest the grafts. Scalp is not the only place from where the grafts can be taken. In some circumstances, surgeons must take grafts from the beard, the thorax, the thighs or even the arms. However, the most common donor area is the occipital area. A reason of this preference is that the occipital FU hasn't got the same susceptibility to the androgen receptor than the frontal or parietal FU, so that the deleterious effect of the dihydrotestosterone on the hairs do not appear in the transplanted grafts.



In this picture, a FUSS design of the strip. In normal hair-bearing scalp, the density is about 50 to 70FU/cm², so in a 20cm length x 1,6 cm width is enough to harvest about 1600 FU. The surgeon has to think about the 5 to 10% of damaged follicles during the stripping procedure, so in these cases we can obtain about 1500 viable follicular units.



In the picture, the donor area used in a FUE hair transplantation. It is important to evidence that the hair has to be shaved for the procedure. This requirement often invalids this technique in women. The anterior edges of the donor area are the interauricular line, the superior edge about 2cm below the vertex, and the inferior edge the natural end of the occipital hair.



In some special situations, the donor area is not on the scalp. The Body Hair Transplantation (BHT) technique harvest FU from thorax, shoulders, arms and thighs to replenish the bald scalp in patients in which the occipital area is not enough. These grafts are extracted as a FUE technique. As the area uses to be wide, a general anesthesia is recommended to minimize the trauma for the patient.

Graft Treatment

Once the grafts are extracted, either by FUSS technique or by FUE technique, a person of the surgical team (usually the nurse) must order the grafts into rows of 50 units (in multihair FUs) or in rows of 25 units in single-hair FUs. This is our protocol, but there are lots of them, all respectable and probably as useful as ours.

In some situations, as in the first hairline, the eyebrows, the eyelashes, the moustache or some facial scars, we need only a single-hair unit. In these cases, we need to dissect the grafts to obtain the adequate size that fits properly in the recipient site. This dissection is performed under magnification, usually with loupe-glasses from 2,5x to 3x augmentation. The surgical procedure is simple, and only requires a n°11 surgical blade, a micro forceps, and the skill of dissect microstructures. In oral and maxillofacial surgery, this skill is well recognized in our specialty because of the training in microsurgery and free flaps, so in my beginning it was easy for me as a maxillofacial surgeon trained in microsurgery start doing hair transplantation.

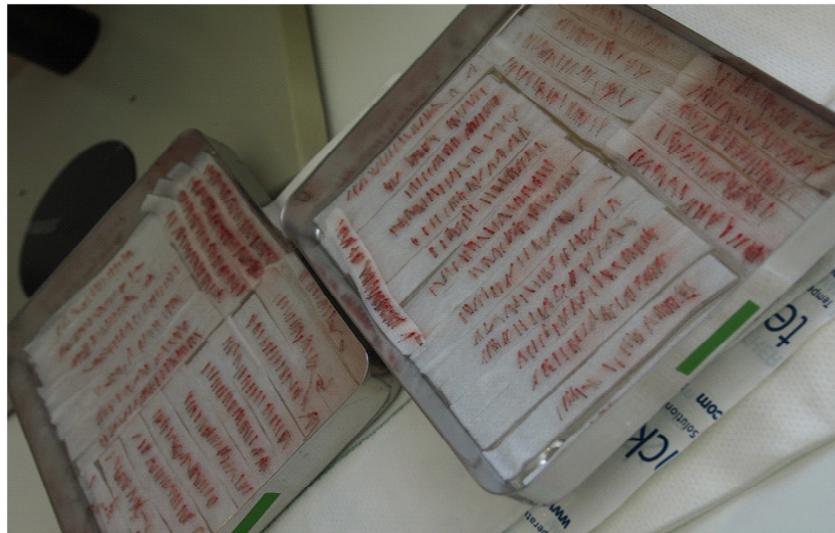
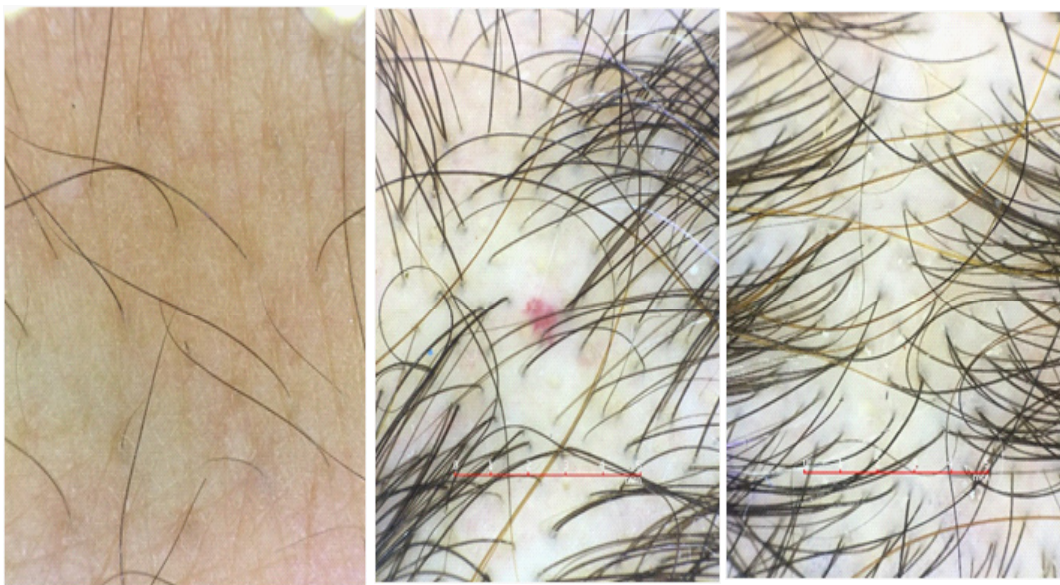


Figure 2: The harvested grafts that are ready to be placed into the scalp sockets

Receptor Area

We consider the “receptor area” to be the area where the grafts are going to be placed. This can be a completely bald area, or a low-density hair bearing area. In the receptor area, we need to assess the “Hair Density” (HD) as the number of hairs in each square centimeter. Optically it is very difficult to assess, so that we need microscopes to do this. A normal dermatoscope can be useful, but counting the hairs can be difficult in such devices. That is why I recommend the use of digital trichoscopes. This device allows us to make pictures of the interest area, and then count all the hairs in a screen. It is also useful to explain the treatment to the patient and as a comparison (before-after) tool. Optically, a normal individual can differentiate between “poor density”, which is usually less than 30 hairs/cm² and “rich density” which is higher than 30 to 40 hairs/cm² [21]. However, normal people cannot differentiate among a 40 to 60 hairs/cm², so our strategy is to obtain at least 40 hairs/cm² to restore normal density [22].

The placement of the grafts is done one by one in a previously created hole. This socket is little bit longer than the graft size in order to allow an easy insertion. An 18G needle with the smashed tip is a good option to do these sockets. Other option is a n°90 blade or a ophthalmology scalpel.



Dermatoscopic images of different hair densities. Note the difference of a 10 FU/cm² in the first picture, the 40 FU/cm² in the second picture, and the 55FU/cm² of the third picture. Normal eye can't well estimate the relevance from 40 to 55 FU, so the goal to replenish is as much as normal patients appreciate it as “full-covered”.



After the placement of the grafts, the scalp is treated with antiseptic solution, and covered for 24 hours. The dried blood clots usually falls after a week. The patient is alerted of head traumatism because the risk of popping the grafts.

Material and Methods

Here we will explain the two main techniques to perform the FU graft harvesting

Follicular Unit Strip Surgery (FUSS)

In this procedure, an occipital hair-bearing scalp strip is harvested with local anesthetics. Usually, the maximum length dissected is the intermastoid line, which is usually up to 20 to 28cm, depending on the patient's anatomy. The width of the strip use to be around 1cm to 2,5cm, but is mandatory that the edges of the wound should be approximated without tension. The surgery is started with a n°15 blade scalpel, which has to cut the skin in an oblique and straight line to do no harm the natural merging of the follicles. The corners of the strip should be triangular to improve wound closure and prevent unaesthetically "dog ears".

The depth of the dissection is to reach the galea, and the dissection plane is the loose areolar tissue. There are some deep vessels, often tributary of the occipital vascular pedicle, which can be easily coagulated with monopolar. The use of monopolar should be carefully restricted to those non hair-bearing areas, because of the temperature injury risk.

After the strip is harvested, a primary wound closure is done without drains. I prefer nylon 3/0 in a running suture, with some additional ties in the maximum tension areas.

Once the strip is dissected, the surgical team start the division of the strip in smaller segments, of 1 to 2cm long, to facilitate the posterior FU dissection. Once the grafts are prepared, the placement can start.

Follicular Unit Extraction (FUE)

The main difference of FUE technique is that there is no visible scar in the donor area. To extract the grafts, the hair has to be completely shaved at donor area. Either with an electrical motor or with a manual punch, a round scalpel of 0,7 to 0,9mm is inserted in the skin following the orientation of the FUs, getting deep just to reach the dermo-hipodermal junction. The incisions leave such cylindrical punches of the follicle and surrounding tissue. After the incision, the grafts can be removed with a micro forceps without harming the bulb.

In the following table is resumed the key points of both techniques.

PATIENT CONDITION	FUSS	FUE
AGE	Usually over 35	Usually under 35
DONOR AREA DENSITY	Rich (above 40FU/cm ²)	Poor (under 40FU/cm ²)
SCARS	Yes	No
DESIRABLE TO OBTAIN THINNER GRAFTS	No	Yes
NEED TO SHAVE THE HAIR	No	Yes
DURATION OF SURGERY	Faster	Slower
SURGICAL TEAM	At least 3 people doing the dissection of the strip	Can be done with 2 helpers

Results

In Oral and Maxillofacial Surgery, there are some indications in which hair transplant can be especially useful.

Reconstruction of Eyebrows and Eyelashes

Although the baldness is an aesthetically accepted option, madarosis (the absence of eyebrows or eyelashes) is unnatural and its treatment is particularly important. Other situations as previous trauma and burns also trichotillomania make this situation quite common. Hair transplant in eyebrows is a time-consuming and tedious procedure, but highly effective [23]. The hair can be grafted from the occipital scalp but also from the contralateral eyebrow [24] or other donor areas as beard or leg's hair.



A rare case of Madarosis. In these cases, the challenge is to draw the normal appearance of the eyebrows. There are some templates, but the artistic vision of the surgeon is crucial in hair surgery.



An eyebrow transplantation of a previously tattooed woman. The early results show the normal appearance of the transplanted FU.

CASE 1

59 years old male patient, claiming a history of more than 35 years of hair loss. His alopecia pattern was stabilized since 10 years ago at least. We offered him a FUSS hair transplant of about 2000FU. As referred above, the sequence is to make the incisions (the sockets) for the graft insertion, and then the placement of the grafts. In last picture, results after 2 years of the procedure.



CASE 2

37 years old male. He desired to cover his temporoparietal region. The procedure was a FUE hair transplant of about 500FU each side. The post operative picture was taken 1 year after the surgery.



CASE 3

A 59 years old man. His baldness pattern affects to extend frontal area. Hair loss was stabilized for more than 10 years, so it is the perfect patient to obtain predictable and long lasting results. In this case, we performed a "Combined Hair Transplantation" in which we did at the same time a FUSS and a FUE technique, to obtain up to 2800 FUs.



CASE 4

A 54 years old man, with poor density in his vertex. He desired to cover this area, so that we performed a FUSS technique with a total of 1900 FUs. Results after a year show the complete cover of the receptor area.



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