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Current Status of Hair Restoration Surgery

Shobit Caroli, Damkerng Pathomvanich, Kulakarn Amonpattana, Anand Kumar

Damkerng Hair Transplantation Clinic, ISHRS Approved Fellowship Training Center, Bangkok, Thailand

Hair restoration has emerged as a subspecialty of aesthetic plastic surgery practiced by a wide range of doctors including plastic surgeons, general surgeons, dermatologists, and even general practitioners. As a current trend, most doctors practice ''Ultrarefined follicular unit hair transplantation'' in which the entire procedure is done precisely with minimal donor scar. In selected cases, Mega or even Giga sessions are now done with natural appearance and almost undetectable scar, in a single session with good density. This article is an attempt to review the history of hair restoration surgery, describe a novel technique currently practiced in our center, and summarize possible future innovations.

Key words: Hair transplant surgery – Ultrarefined follicular unit hair transplantation – Advances in hair restoration – Recent trend in hair restoration – Future in hair restoration

Hair restoration surgery has gained momentum, and the number of procedures, performed all over the world, has increased enormously in the past few years.[1] Historically, it begins with J. Dieffenbach in the year 1822 at Wurzburg, Germany. Limited reports noted that autotransplantation of human hair was first described by Dr. Shoji Okuda in Japan in 1939.[2] With the advent of World War II, hair transplantation surgery was ''rediscovered'' by the New York dermatologist Dr. Norman Orentreich in 1959.[3] The implantation of artificial hair has emerged and practiced in Japan since 1964.[4] In 1979, the Blanchard brothers started excising areas of male pattern baldness, the procedure is termed later as alopecia reduction.[5]

The art of hair transplantation has further progressed and refined. At present, the outcome of hair transplantation is more natural. Good density can be achieved in just one or two sessions compared with several sessions as required in the past. Previously impossible cases with Norwood class VI-VII pattern hair loss are now possible with frontal natural forelock reconstruction.[6] The current development, during the past 20 years, was made by using the single follicular unit graft containing 1 to 4 hairs instead of minigrafts or micrografts and by increasing the number of follicles transplanted in each session, thus the number of sessions required was reduced (Fig. 1). Societies, such as International Society of Hair Restoration Surgery (ISHRS), European Society

Reprint requests: Shobit Caroli, MBBS, DHT Clinic, 408/138, Phaholyotin Place Building, 32nd Floor, Phaholyotin Road, Phayathai, Bangkok 10400, Thailand.

Tel.: +02 619 0351 3; Fax: +02 619 0353; E-mail: shobitcaroli88@gmail.com, path_d@hotmail.com

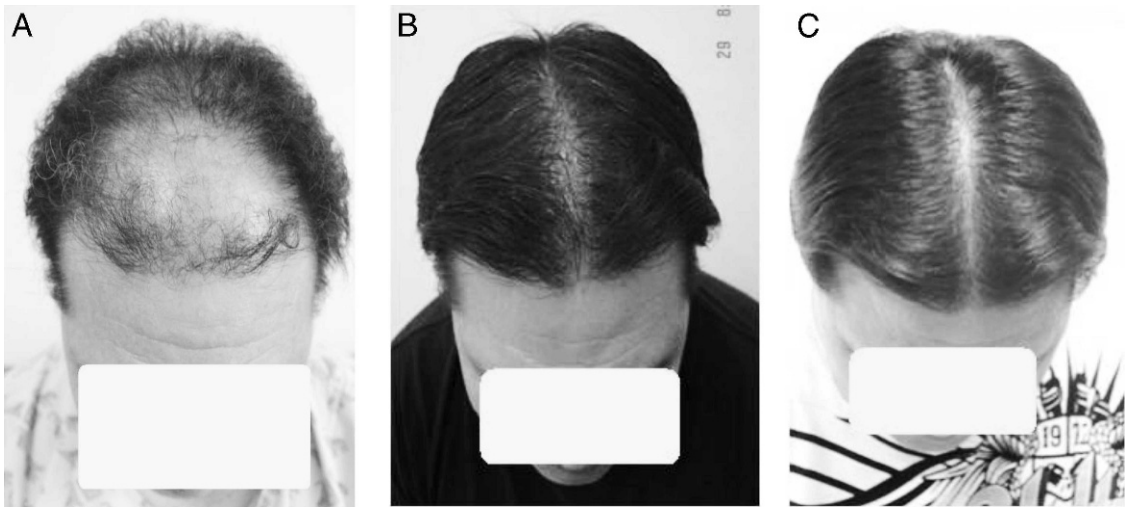

Fig. 1 A 48-year-old Oriental man undergoing a single session of hair transplant surgery with 2078 follicular unit (FU) grafts bearing 4901 hairs. (A) Preoperative snaps. (B) Postoperative, 12 months later. (C) Postoperative, 5 years later. Source: DHT Clinic, Bangkok, Thailand.

of Hair Restoration Surgery (ESHRS), and Asian Association of Hair Restorative Surgeons (AAHRS), were founded to maintain standards, encourage research, and continue training in this field.

Psychologic Impact of Hair Loss

Hair is psychologically more important than its physiologic function, as a shield to the scalp. It represents youth and health. Studies show that people prone to depression have a higher incidence of baldness. Hair loss can cause negative effects on the professional, personal, and sexual life of an individual. Hair restoration procedures help to overcome these negative psychologic effects. The individual's look and outlook toward life completely changes with a procedure.[7]

Pathogenesis of Androgenic Alopecia

Current evidence implicates both maternal and paternal ancestry. It can involve either an autosomal dominant and/or a polygenetic inheritance pattern. There is variable genetic penetrance, therefore based on pedigree, accurate prediction of hair loss of any individual is almost impossible. Androgen and genetic factors work together to produce a recognized clinical hair loss pattern. It is also associated with diminished hair growth and progressive miniaturization of the terminal hair to the vellus hair. With time it will progress to eventual loss of these vellus hairs, leaving the shiny bald scalp.[8]

Treatment of Androgenic Alopecia

Medical treatment

Topical minoxidil, 5% formulation with or without 5α-reductase inhibitor like finasteride 1 mg, daily and orally, is the only US Food and Drug Administration (FDA)-approved medical treatment for baldness in men.

For hair loss in women, the US FDA approves only topical minoxidil 2% formulation. There are many other drugs available, like dutasteride,

Table 1 Steps of assessment of a patient for hair transplantation surgery

1. Does he/she have androgenic alopecia, a dermatologic scalp disorder, or traumatic hair loss? If it is a pathologic hair loss, has the activity of the disease arrested?
2. Has patient been on any oral or topical medications for hair loss?
3. Has patient been suffering from any medical, surgical, gynecologic illness or allergies? If yes, is it safe to perform hair transplant surgery on that patient?
4. Is he/she a good candidate for the hair transplant surgery? Is donor area adequate? Does it contain any miniaturized hairs?
5. Evaluate the patient's priority recipient area for hair coverage.
6. Assess the patient's budget for the present and forthcoming transplant sessions.
7. Design mature hairline that best suits to his or her facial characteristics and ethnicity after detail discussion with the patient.
8. Measure the recipient area for hair transplantation by Refined Chang's Method.[9]
9. Selection of the safe donor area and marking.
10. Assess scalp laxity by Mayer and Paul laxity scale.[10]
11. Assess donor area density by Rassman's densitometer, trichoscope, or video microscope.[11]

Fig. 2 Invisible scar at donor area camouflaged with hair at 12 months postoperatively closed with trichophytic closure. Source: DHT Clinic, Bangkok, Thailand.

low-dose oral minoxidil, spironolactone, cyproterone acetate, ginseng, fish oil, vitamin E, and many herbal medicines, but these are not US FDA approved, and their efficacy is under debate.[12]

Surgical treatment

Scalp reduction is no longer practiced by most hair surgeons. However, scalp reduction with extender is still performed in France by Dr. Patrik Frechet[13] and a few surgeons in the world. Scalp flaps are still popular in Japan. Japanese plastic surgeons feel that scalp flaps work better than grafts for the black, coarse, and straight Asian hair and patients can comb the hair immediately, whereas with in hair grafts they need to wait 10 to 12 months. This technique is discouraged because of problems such as an abrupt, too thick, straight hairline with backward hair direction, blunting of the frontotemporal angle, and hair loss at the donor site. Recent advances in using follicular unit transplantation have lead to a decrease in the use of the flap technique.[14]

Fig. 3 Minimal scar with shaved donor area at 14 months postoperatively closed with trichophytic closure and plan for second mega session. Source: DHT Clinic, Bangkok, Thailand.

Follicular hair transplantation is the procedure of choice for most hair surgeons in the world. The strip technique and follicular unit extraction are the two methods currently used for graft harvesting. The strip technique is more commonly used than follicular unit extraction. Bad scarring as a result of the strip technique lead to the popularity of the follicular unit extraction. The concept of follicular unit extraction works well for patients with tight scalp, limited donor area, and those who keep their hair short. Because it is a slow and expensive process, and being a blinded technique has high transection rate, it is less practical compared with the strip technique. Various machines, like Omnigraft, Neografts, and Powered FUE, are promoted in the market, but they have a high reported transection rate.

The invention of the Open Technique by Pathomvanich[15] in 2000 has showed significant reduction in the follicular transection rate compared with the blind technique for strip harvesting or use of multibladed knifes. In 2005, the introduction of the trichophytic closure of the superior, inferior, or both the flaps, resulting in minimal scarring (Figs. 2 and 3), has brought back the use of the conventional strip technique.[16,17]

The patient for prospective hair surgery should be evaluated for points in Table 1.

Lateral slit

Experienced surgeons can transplant about 5000 grafts in a patient with good donor density and scalp laxity (Fig. 4A and 4B) in one session using the strip technique or at times in combination with the follicular unit extraction.[18] For gigasessions, the center needs to have a full-time commitment in to hair restoration surgery and a highly trained and experienced staff. At our clinic, we have 8 well trained staff for cutting grafts (Fig. 5), at the rate of 300 grafts per person per hour. Our clinic inserters can insert grafts at an average speed of 500 grafts per person per hour. Our staff starts slivering and graft cutting almost as soon as the first piece of strip is harvested hence, on average, within 2 hours we get almost 2500 plus grafts ready for the insertion step of the surgery. For gigasessions we harvest the second half of the strip during the fourth to fifth hour of surgery, to reduce time that the tissue is removed from the body and thereby we maintain the high survival rate of grafts. For insertion, we simultaneously use of the two-hand technique, stick and place technique, and the one-hand technique

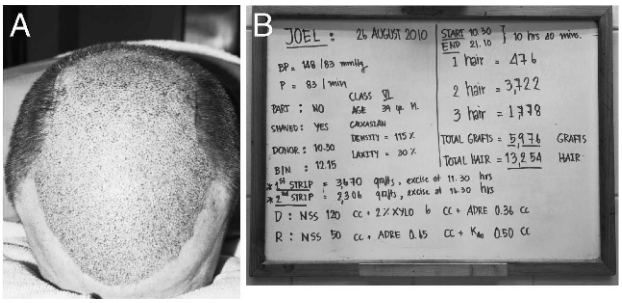

Fig. 4 (A) Total of 5976 follicular unit grafts bearing 13,254 hairs transplanted in just 10 hours, 40 minutes with a density of 45 follicular unit per cm^2 in frontal and mid scalp region. (B) Picture of the recording board on the day of surgery. Source: DHT Clinic, Bangkok, Thailand.

with two or three assistants (Fig. 6A and 6B), depending on the situation available in surgery. The procedure is much faster than in the past.

Dense packing is defined as placing grafts at 28 or more follicular units/cm^2. However, 40 to 50 follicular units/cm^2 can provide good coverage in one session. Tsilosani *et al.* reported dense packing up to 100 follicular units (FU)/cm^2 with good hair growth, but in that study the transplantation is limited to 1 cm^2 recipient area only.[19] Use of binocular stereoscopic microscopy (Fig. 5) has been the gold standard for graft cutting. The size of grafts has gradually decreased from chubby to more skinny grafts for dense packing. These smaller grafts require smaller recipient slits, and, at present, it is possible to densely pack up to 50 follicular units/cm^2. The significant area coverage with appreciable density can be obtained in single pass in selected patients.

Fig. 5 Eight assistants cutting grafts under ×10 stereoscopic magnification simultaneously along with donor harvesting and slivering. Source: DHT Clinic, Bangkok, Thailand.

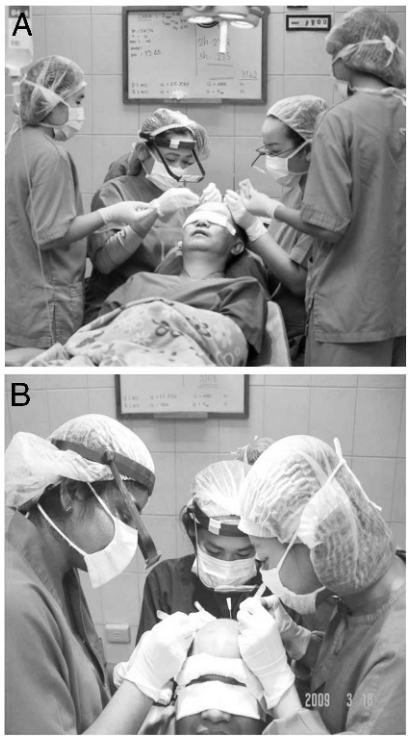

Fig. 6 Assistants inserting grafts using different techniques. Source: DHT Clinic, Bangkok, Thailand.

Stem cell/stromal vascular fraction

Stem cells have received significant attention as an ideal source of regenerative cells because of their multipotentiality and their ability to replicate. Stem cells of the hair follicle are found in the bulge area of the pilosebaceous unit. Because of the abundance of adipose tissue, abdominal wall fat aspirate provides a definitive source of stem cells. Intradermal injection of activated adipose tissue-derived autologous stem cells may stimulate these stem cells to restore the normal hair cycle, changing the vellus hair back into terminal hair, or halt the process of miniaturization in areas programmed for androgenic alopecia.

Now the questions that remain to be answered are[20]:

1. Will the effect on hair cycle be short lived or overrun the genetic dominance for androgenetic alopecia (AGA)?
2. Will adipose-derived stem cells be helpful to increase the lost pigment cells in gray hair?
3. Can adipose-derived stem cells be used in other parts of the body with thinning hair such as eyebrows, eyelashes, mustache, and sideburns?

A 10-month follow-up study was performed on 5 patients who had undergone adipose-derived stem cell treatment but the results were disappointing. There is no evidence of any hair growth for both eyebrows and scalp at 2-year follow-up. However, these observations were based on only a single injection treatment. However, further studies are required to determine the beneficial effect of multiple injections at a specific interval of every 2 months.

Growth factors

Growth factors are used in a variety of antiaging treatments. They are marketed for hair growth and change of nonpigment hair to pigmented hair. The three growth factors that are considered to have a direct consequence on hair growth are insulin-like growth factor-1, β-fibroblast growth factor, and vascular endothelial growth factor. Formulations containing copper peptide, the three growth factors with other ingredients like hyaluronic acid, co-enzyme Q10, amino acids, and vitamins are popular market items, but their efficiency is yet to be established in controlled studies.

Hair cloning

The success of hair transplantation is often limited by the availability of donor hair. Hair cloning is therefore considered the future of hair transplantation.

Hair cloning is based on the inductive capacity of the dermal papilla cell to form a new hair follicle. This property of the dermal papilla is retained throughout adult life. It is important to note that epithelial cells must be present with dermal papilla cells to form new hair follicles.

Each dermal papilla contains 200–400 cells. These cells can be cultured in the laboratory to several million offspring cells. Upon re-injection into the bald scalp of the same individual, the cultured dermal papilla cells will induce the development of new hair follicles. This process is basically hair multiplication or follicular neogenesis rather than true ''cloning.'' The term hair cloning is therefore a misnomer.[21]

Practical problems of the technique for clinical use[21]:

1. The new hair follicles induced are usually disorientated and grow at all angles.
2. Hair follicles induced by hair cloning do not have an even distribution over the skin. They appear as clumps of hair, which is not acceptable.
3. According to studies once cloned hair sheds, it will not follow the cycle and will not grow again.
4. There is no study published to prove that hair cloning would work in humans.
5. There are concerns that cells that induce hair follicle growth may also induce tumors.

The quoted success rate of the technique is unfortunately poor.

Follicular cell implantation

The size of the dermal papilla is directly related to the size of the hair follicle and the fiber produced. Recent studies have, however, shown that cells multiply in the lower dermal sheath and then migrate into the dermal papilla at the start of anagen. At catagen, the cells migrate out again back into the dermal sheath. Therefore, both the dermal papilla and dermal sheath cells define the size of the hair fiber produced and how long that hair stays in the anagen stage.[21]

Researchers cultured dermal papilla and dermal sheath cells, and then injected them into normal mouse ears. Mouse ears are covered with tiny hair follicles that produce tiny hair fibers. Cultured dermal papilla and dermal sheath cells injected into a mouse ear modified natural hair follicles already present and yielded tufts of long hair growth 4 months after injection. The injected dermal papilla and dermal sheath cells migrated and integrated themselves into the tiny natural hair follicles already present in the ears. The new cells had apparently altered the size and growth cycle of the tiny hair follicles to make them much bigger and longer, which in turn produced bigger hair fibers.[21]

Important Observations

1. If implanted cells can be integrated with resident hair follicles, then patients with male pattern baldness could be treated.
2. Hair follicles in the process of miniaturization could be boosted with implanted cells to force them back into a full-sized, terminal growth state.
3. The resident small natural hair follicle structures become the guide for the implanted cells and the problems of erratic follicle angle of orientation and distribution pattern over the skin, as seen in hair cloning studies, could be resolved.

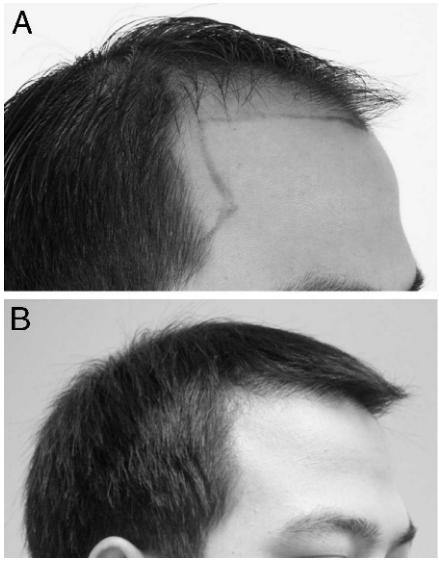

Fig. 7 A 27-year-old Oriental man undergoing a single session of hair transplant surgery with 2880 FU grafts bearing 5613 hairs. (A) Preoperative snaps. (B) Postoperative, 10 months.

Unfortunately there is also no study actually published to prove follicular cell implantation would work in humans and still more work needs to be done.

Diode Laser/Cold Laser Light Therapy

The US FDA has approved laser light therapy for hair loss treatments with no observable side effects, but there are doubts about the efficacy of the treatment, as the proven benefit in a controlled study is yet to be established.

Artificial Hair Transplantation as an Alternative to Hairpiece

The US FDA has banned the use of artificial hair fiber since 1982. Artificial fiber implantation is not acceptable as a medical procedure by most authorities worldwide. The most common problems observed with this procedure are formation of pits and sebum plug pits where the fiber enters the scalp, large amounts of fibers fall out each year, risks of infection and foreign body inflammatory reactions, at times hair clump together into little clusters, and even breakage of the fiber.[22] Disputes remain with regard to the frequency and severity of the potential risks of artificial fiber implantation.

In summary, the current trend in hair restoration surgery is to move large quantity of grafts from the safe donor area and transplant them to the bald area, if possible, in one pass, with good cosmetic outcome and density, in patient with good donor density and scalp laxity (Figs. 7 and 8). However, in class VI a minimum of two sessions is required to provide adequate density. Medical treatment is essential and should be used to stop further hair loss and increase hair growth in the thinning area.

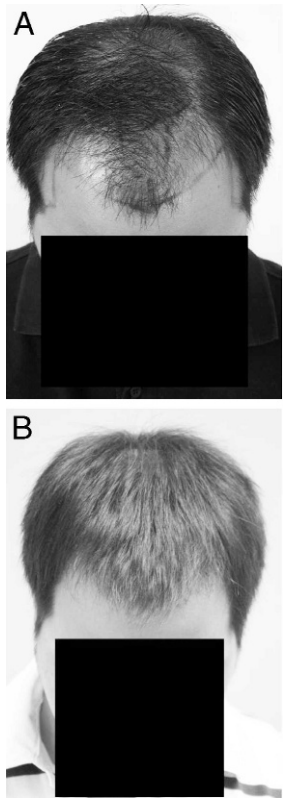

Fig. 8 A 27-year-old Oriental man undergoing a single session of hair transplant surgery with 2880 follicular unit grafts bearing 5613 hairs. (A) Preoperative snaps. (B) Postoperative, 10 months.

Acknowledgments

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