International Journal of Medical Science and Clinical Research
www.journalofmedical.com
Online-ISSN: 2664-7761, Print ISSN: 2664-7753
Received: 02-11-2022, Accepted: 18-11-2022, Published: 05-12-2022
Volume 4, Issue 2, 2022, Page No. 69-74

Principles and methods of hair transplantation-Overview

Marimuthu P[1*], Gulam Sarwar Hashmi[2], Sajjad Abdur Rahman[3], MD. Kalim Ansari[4], Mohammad Danish[4]

[1] Department of Oral and Maxillofacial Surgery, Dr. Z.A. Dental College, Aligarh Musilm University, Aligarh, Uttar Pradesh, India

[2] Professor And Chairman, Department of Oral and Maxillofacial Surgery, Dr. Z.A. D.C And Hospital, Aligarh Muslim University, Aligarh, Uttar Pradesh, India

[3] Associate Professor, Department of Oral and Maxillofacial Surgery, Dr. Z.A. D.C And Hospital, Aligarh Muslim University, Aligarh, Uttar Pradesh, India

[4] Assistant Professor, Department of Oral and Maxillofacial Surgery, Dr. Z.A. D.C And Hospital, Aligarh Muslim University, Aligarh, Uttar Pradesh, India

Abstract

Background: Hair transplantation creates consistently natural-appearing transplanted hair for both men and women. It is an increasingly popular procedure to restore natural growing hair for both men and women with hair loss [1].

Various non-surgical methods and surgical options are available for the treatment of baldness in clinical practice. Thus, individualised solutions are best carried out by well-trained and qualified practitioners [2].

Objective: To Review of the English PubMed literature and specialty literature (Dermatology) in hair transplantation and various techniques.

Results: Hair transplantation is an ideal treatment plan for hair loss. In addition to the surgical techniques, non-surgical interventions may also optimise the patient's output. The promising results in the field of regenerative medicine with cell-based solutions may alter the options in hair transplantation and change the options solely in this field [2]. The hair transplantation include appropriate donor harvesting technique including elliptical donor harvesting, follicular unit transplantation, follicular unit extraction, robotic, platelet-rich plasma and low-level light surgery in hair transplantation [1].

Keywords: hair transplant, nonsurgical therapy, FUT, FUE

Introduction

Hair transplantation has gone through a big revolution with the pioneers in this field. To achieve a good cosmetic result in hair transplantation, a natural-looking hairline with adequate density should be established [3]. In 1931, Okuda was the first physician to describe in detail the technique of autologous hair transplantation. He explained how circular punches were used to excise grafts from the scalp, which were subsequently inserted into holes made with slightly smaller punches in areas affected by alopecia [4].

Table 1

Methods	Years
Punch graft transplantation by shoji Okuda in Japanese	1939
Punch grafting reported by Norman Orentreich	From 1959
Strip harvesting follicular unit transplantation (FUT)	From 1990
Development of FUE (follicular unit excision)	From 2000
Various techniques	End of 2000- till now… (5,6)

In this review article, we can understand various techniques of hair transplantation methods.

Review of Literature

On average, healthy men and women have 80,000 to 120,000 essential terminal hairs on their heads. Hair follicles go through a series of growth and rest cycles. Hair grows at a pace of approximately 0.3 mm per day, or

1 cm per month, during the growth (anagen) phase, which lasts 2–6 years. The hair then falls out after a short transitional (catagen) phase and a resting (telogen) phase that lasts 2–4 months. In recent years, large-scale controlled clinical trials have been conducted to assess the efficacy of both traditional and innovative medicines. They've laid the groundwork for evidence-based hair treatment.

Follicular Unit

The visible component of a histologic structure known as the follicular unit is where human hair emerges from the scalp in groups [7]. On the other hand, FU density (FUs/cm2) and hair density (hairs/cm2) differ from patient to patient, from one scalp zone to another, and across races. Hair density is around 2.5–3.00 times the FU density as a rule of thumb [8, 9].

Follicle of Terminal Hair

After a hair transplant, the terminal hair follicle develops the long, thick hair shaft that patients expect [10-13]. The majority of scalp follicles are in anagen (the growth phase of the cycle), while the remaining 10% are in catagen or telogen [14-18].

Alopecia Androgenetica

The most prevalent reason for hair transplantation is androgenic alopecia [19, 20]. It is progressive androgen-related hair thinning. The Hamilton-Norwood classification can be used to determine the severity of androgenic alopecia for male pattern hair loss [21, 22].

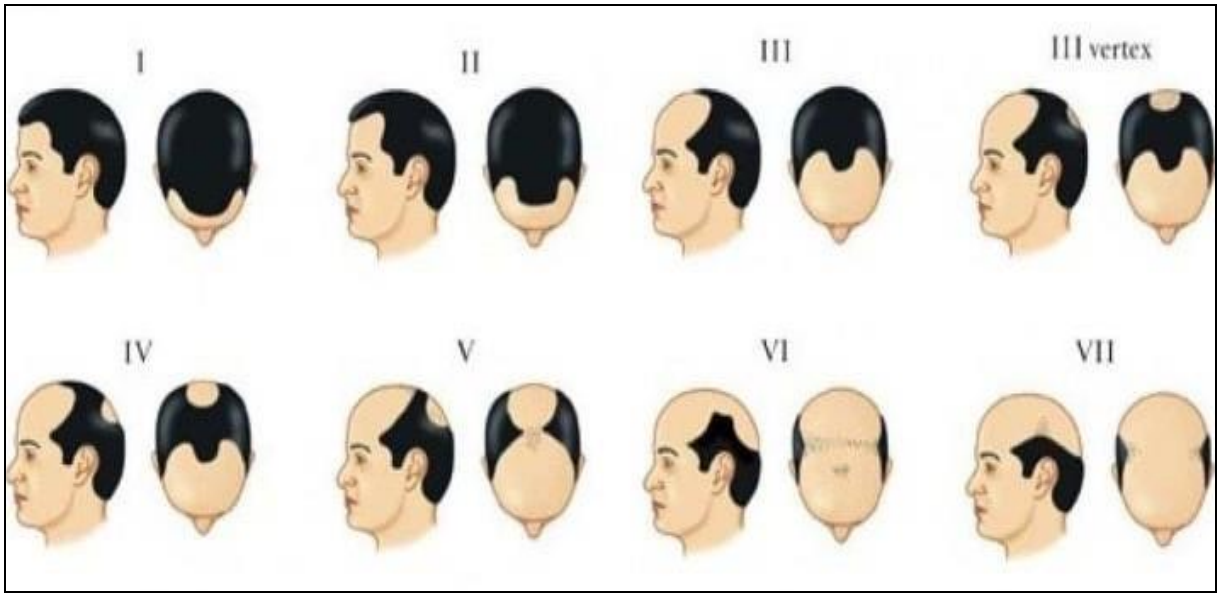

Fig 1

Table 2

Hamilton Norwood Scale	Pattern of Hair Loss
Scale I	No hair loss
Scale II	Mild recession in frontotemporal hair loss
Scale III	Frontal hair loss
Scale IV	Scale III with bald vertex area
Scale V-VII	Only occipital area maintains significant amounts oh hair.

Fig 2

Table 3

Ludwig scale	Pattern oh hair loss
Grade I	Slight thinning of hair loss
Garde II	Scalp visible
Grade III	Hair on mid scalp lost

Hair transplantation should be paired with medical therapy in female pattern hair loss, just as it is in male AGA, to decrease the continuing loss and perhaps reverse hair shrinkage [23].

Hair Loss and Medical Therapy

The two first-line treatments for male AGA that have been authorised by the US Food and Drug Administration are finasteride (oral) and minoxidil (topical). It should be done for at least 6 months to see how effective it is. The combination of these yielded substantially greater gains than either medication alone [24].

PRP injections (autologous) and low-level laser therapy (LLLT -635 and 678nm) are two further treatment possibilities [25, 26]. Several practitioners have had some success treating alopecia of varying severity (lichen planopilaris, alopecia), but the majority of the scant evidence has focused on PRP treatment for men and women with hair loss [27, 28]. A helmet, hat, band, or comb can be included with LLLT (synergistic).

Non-Surgical Management Effects and Complications

Dermatologists commonly prescribe hydroxyanthrone (Anthralin) and minoxidil lotion for circumscribed patchy alopecia, and both are safe, but there is no conclusive proof that they are efficacious.

Alopecia has also been treated with continuous or pulsed systemic corticosteroids, as well as PUVA. None can be suggested at this time because of the possibility of major adverse effects and insufficient proof of efficacy.

When given topically, minoxidil increases hair weight but not hair count, suggesting that its `therapeutic impact is mostly related to expanding the width of existing hairs. Although a limited number of men claim to have experienced lasting sexual dysfunction after stopping finasteride, the majority of big, double-blind, placebo-controlled trials do not validate these claims.

Selection of ideal candidates

Selection Criteria for Choosing Good Candidate for Hair Transplantation

Familial conditions, as well as the 1.history of the AGA (due to the polygenic inheritance of AGA, 2.Response to medical treatment (gives slowing the hair loss and act as adjuvant of long term transplant), 3.Follicular unit density (normal-to-high FU density (65 FU/cm2) and thick hair ([50-60 microns], hair density, and hair thickness are all factors to consider when evaluating a donor, Patients with generalised hair loss, low FU density (40-50 FUs/cm2), and tiny donor hair (20% miniaturised) are not good candidates. 4. Patients with moderate to advanced baldness (Norwood III-V and Ludwig II) are the ideal candidates for this procedure. The surgeon should be attentive to the patient's expectations, as well as the patient's psychological condition while selecting candidates and explaining the need for complementary medical therapy [29].

Surgical Techniques of Hair Restoration

Donor Harvesting

On the day of the procedure, the patient is given informed written consent as well as wound care guidelines and actions. The physician marks off the region to be transplanted and photos are taken. The surgeon should assure the patient that it was relaxing and pleasurable. A local anaesthetic, such as lignocaine with epinephrine, is being used to harvest the donor. The grafts are extracted from the posterior scalp while the patients are in the prone posture. At the moment, there are two methods for extracting donor hair: elliptical donor harvesting and follicular unit extraction (FUE) [30].

Elliptical Donor Harvesting

For over two decades, elliptical donor harvesting has been used. It's done under a local anaesthetic. Whether hundreds or thousands of follicular units from the posterior scalp must be implanted in the frontal scalp determines the length and breadth of the ellipse. Planning, preparation, Anaesthesia, graft harvesting, securement of harvested grafts, graft implantation, and postoperative monitoring are the processes involved in hair transplantation. In practise, each phase may be tailored to the person [31].

Follicular Unit Extraction

The direct removal of individual follicular units using 0.8-to 1.2-mm manual punches, mechanically aided devices, or robotically is known as follicular unit extraction. The whole rear scalp is cut to 1 mm during FUE surgery. It is required in order to harvest individual follicular units with punches ranging from 0.8 to 1.1 mm in diameter [32-35].

Graft Harvesting and Solutions for Graft Harvesting

There is no definitive evidence on how long grafts can be kept in a holding solution and still be viable. Normal saline has long been regarded as a safe and cost-effective solution that may be utilised at room temperature. Other elements, including temperature, osmotic balance, pH, and electrolyte balance, should be improved, according to research [36].

As established by Limmer's graft survival research in 1992, freezing the grafts may give a survival benefit. Plasma-Lyte is another solution that closely resembles the pH of human serum (both are 7.4 vs. saline, which is 5.0, and Lactated Ringers, which is 6.5) [36].

Another noteworthy product is liposomal adenosine triphosphate (ATP) (Energy Delivery Solutions), which may be added to any holding solution or used as a postoperative spray to improve graft longevity (2 months) [36].

According to research by Jerry Cooley, when grafts were put in hypothermosol alone or hypothermosol plus ATP, as opposed to normal saline, survival was dramatically enhanced [37]. PRP (platelet-rich plasma) has recently been proposed as an alternative holding option (under research).

Discussion

In regular clinical practise, managing patients with hair problems presents a unique obstacle. A chronic course is common in many hair conditions. The diagnosis may be made quickly and precisely using an organised, standardised strategy that employs objective criteria and diagnostic procedures. A thorough grasp of scalp anatomy and precise knowledge of patient variables are required for optimal scalp defect restoration.

Male-pattern baldness can have a detrimental impact on a person's self-esteem. For some patients, hair transplantation offers a one-of-a-kind, long-term solution. Non-surgical hair loss treatments are best used in the early stages. In certain people, minoxidil, finasteride, dutasteride, spironolactone, or cyproterone acetate, low-level light or laser therapy might be administered with transitory effects. In practise, latanoprost (a prostaglandin F2a analogue) is a solution that promotes hair growth significantly [38].

Patients who require extra therapies for hair growth augmentation might benefit from mesotherapy (injecting medicines and vitamin components into the follicles on a superficial) and platelet-rich plasma. PRP injections have been shown to promote hair growth in transplanted follicles [39].

It's still unclear why the occipital hair is spared, despite the fact that the idea of "donor dominance" in male pattern hair loss was originally described in 1959. Widely accepted explanation appears to be that the occipital scalp is not androgen-dependent [40].

Hair transplantation can provide a long-term remedy for hair loss. Grafts from the donor area are transplanted to the recipient area under ideal conditions by skilled, well-trained hands. However, transplant viability is influenced by a variety of factors, including hair type, sensitive technique, physical stress, vascular factors, biochemical harm, infection, patient disturbance, and idiopathic causes [41]. A tumescent solution is administered into both the donor and recipient areas once a full anaesthetic has been achieved. This allows for the easy harvesting and grafting of follicles from the donor location.

Temperature, hydration, infection, and trauma all have a role in the graft's survival. It's also a good idea to keep the follicles you're going to transplant in a cold solution to prevent ischemia and reperfusion harm [42].

Despite this, most stored grafts are maintained cold in ice blocks or cold solutions with a temperature range of 4 to 10 degrees Celsius. Follicle harvesting can be done manually or with the use of a machine. Punches with sharp or dull tips, a range of diameters, and several bevel types are available to the practitioner. Finally, the follicles are meticulously transplanted into the recipient region at an optimal angle to mimic the typical hair growth pattern.

To obtain a natural-looking frontal hairline design, we like to do zig-zag transplantations on the front line. The calculations for both the frontal and vertex areas may be used to determine the number of hair units necessary for the recipient size.

Hair density is often approximately 100 units per cm2. In most cases, hair transplantation achieves a density of about 30–40 units per centimetre. With high viability rates, higher densities, also known as dense packing (up to 60 units/cm2), can be attained [43-47].

Follicular unit transplantation (FUT) is a commonly used hair transplanting technique. The donor region is shaved, and an elliptical incision is created for hair follicle harvesting in this approach. The ellipse's dimensions are determined all the way up to the grafted recipient region [48].

The grafts are placed in Petri dishes containing chilled saline and clusters of one, two, or three follicles. The grafts are then placed in the recipient location as needed. FUE, unlike FUT, is a method that uses circular punches to extract follicular units with one or two roots.

Okuda was the first to employ self-made sharp circular punches in a variety of sizes (1-4 mm). He suggested using 2-4 mm punches instead of 1 mm since the transection rate in 1 mm harvests was very high, according to him.

There are a variety of FUE donor harvesting technologies on the market, including hand-held punches, powered punches, and single user-directed robotic systems such as Surgically Advanced Follicular Extraction and ARTAS robotic systems [49-53].

Ominigraft (Mecicamat S.A., Malakoff, France) was developed to make mini and micrograft transplantation more efficient. A hairtome, a hand-held pneumatic graft, and a hollow-shafted micromotor handpiece with a

punch blade in the range of 0.8-1.25 mm make up this instrument. With this technology, transection rates and operating time are greatly reduced [50].

FUE requires a lengthier learning curve and operation time, as well as great hand-eye coordination, patience, endurance, and hair that is short enough to harvest well. Neograft®, an automated FUE procedure, allows for suction-based follicle harvesting with either a one-step or two-step extraction approach.

Microrefined - microfollicular hair transplantation was newly documented approach in which the anterior hairline is created with FUE and the bald region is transplanted with FUT, which includes strip harvesting (with bevelled incisions) and strip slivering under magnification. The author suggests an almost 0% graft transection rate [54].

Hair transplant complications are classified as follows: (1) standard surgical risks; (2) physician planning mistakes; (3) physician technical errors; (4) patient compliance factors; (5) patient physiology variables; and (6) miscellaneous causes [55].

According to a recent study, induced pluripotent stem cells were used to generate folliculogenic human epithelial stem cells. Hair follicles that had been regenerated had a KRT15+ stem cell population and produced hair shafts that expressed hair-specific keratins. Future research will produce better outcomes [56].

Conclusion

With the advancement of technology in medicine, it is feasible that the entire procedure will be carried out entirely by robotic and automated devices. Indeed, in the future, purely cell-based treatments may provide answers for hair growth without surgery.

To date, that combining surgical treatments with additional methods may be the best option for patients who want to reclaim their natural-looking hair with sufficient density.

References

1. Avram MR, Finney R, Rogers N. Hair Transplantation Controversies. Dermatol Surg,2017:43(2):S158-S162. doi: 10.1097/DSS.0000000000001316. PMID: 29064980.
2. Kayiran O, Cihandide E. Evolution of hair transplantation. *Plast Aesthet Res*,2018:5:9. http://dx.doi.org/10.20517/2347-9264.2017.86
3. Kayiran O, Cihandide E. Evolution of hair transplantation. *Plast Aesthet Res*,2018:5:9. http://dx.doi.org/10.20517/2347-9264.2017.86
4. Okuda S. Clinical and experimental studies of transplantation of living hairs. Jpn J Dermatol Urol,1939:46:537-587.
5. Orentreich N. Autografts in alopecias and other selected dermatological conditions. Ann N Y Acad Sci,1959:83:463-479.
6. Orentreich DS. The history of hair restoration surgery. In: Stough DB, Haber RS, eds. Hair Replacement: Surgical and Medical. St. Louis: Mosby, 1996, 59-62.
7. Headington JT. Transverse microscopic anatomy of the human scalp. A basis for a morphometric approach to disorders of the hair follicle. Arch Dermatol,1984:120(4):449-456.
8. Kim JE, Lee JH, Choi KH *et al*. Phototrichogram analysis of normal scalp hair characteristics with aging. Eur J Dermatol,2013:23(6):849-856.
9. Birnbaum MR, McLellan BN, Shapiro J, Ye K, Reid SD. Evaluation of hair density in different ethnicities in a healthy American population using quantitative trichoscopic analysis. Skin Appendage Disord,2018:4(4):304-307.
10. Hsu YC, Pasolli HA, Fuchs E. Dynamics between stem cells, niche, and progeny in the hair follicle. Cell,2011:144(1):92-105.
11. Christoph T, Muller-R € over S, Audring H *et al*. The human hair € follicle immune system: cellular composition and immune privilege. Br J Dermatol,2000:142(5):862-873.
12. Paus R, Cotsarelis G. The biology of hair follicles. N Engl J Med,1999:341(7):491-497.
13. Jahoda CA, Reynolds AJ. Hair follicle dermal sheath cells: unsung participants in wound healing. Lancet,2001:358:1445-1448.
14. Stenn KS, Paus R. Controls of hair follicle cycling. Physiol Rev,2001:81(1):449-494.
15. Alonso L, Fuchs E. The hair cycle. J Cell Sci,2006:119(3):391-393.
16. Alam I, Hernandez I, Paus R, Jimenez F. Image Gallery: intravital visualization of the dynamic changes in human hair follicle cycling. Br J Dermatol,2018:178(6):e396.
17. Oh JW, Kloepper J, Langan EA *et al*. A guide to studying human hair follicle cycling *in vivo*. J Invest Dermatol,2016:136(1):34-44.
18. Hernandez I, Alam M, Platt C, *et al*. A technique for more precise distinction between catagen and telogen human hair follicles ex *vivo*. J Am Acad Dermatol,2018:79(3):558-559.
19. Avram M, Rogers N. Contemporary hair transplantation. Dermatol Surg,2009:35(11):1705-1719.
20. Vogel J, Jimenez F, Cole J, *et al*. Hair restoration surgery: the state of the art. Aesthet Surg J,2013:33(1):128-151.
21. Hamilton JB. Patterned loss of hair in man; types and incidence. Ann N Y Acad Sci,1951:53(3):708-728.
22. Norwood OT. Male pattern baldness: classification and incidence. South Med J,1975:68(11):1359-1365.

23. Ludwig E. Classification of the types of androgenetic alopecia (common baldness) occurring in the female sex. Br J Dermatol,1977:97(3):247-254.
24. Fabbrocini G, Cantelli M, Masara A, Annunziata MC, Marasca C, Cacciapuoti S. Female pattern hair loss: a clinical, pathophysiologic, and therapeutic review. Int J Womens Dermatol,2018:4(4):203-211.
25. Gupta AK, Cole J, Deutsch DP *et al*. Platelet-rich plasma as a treatment for androgenetic alopecia. Dermatol Surg,2019:45(10):1262-1273.
26. Avram MR, Finney R. Platelet-rich plasma therapy for male and female pattern hair loss. Dermatol Surg,2019:45(1):80-82.
27. Trink A, Sorbellini E, Bezzola P, Rodella L *et al*. A randomized, double-blind, placebo- and active-controlled, half-head study to evaluate the effects of platelet-rich plasma on alopecia areata. Br J Dermatol,2013:169:690-4.
28. Bolanca Z, Goren A, Getaldi c-´ Svarc B, Vucic M *et al*. Platelet-rich ´ plasma as a novel treatment for lichen planopillaris. Dermatol Ther,2016:29:233-5.
29. Stough D. The consultation. In: Haber RS, Stough DB, eds. Hair Transplantation. 1st ed. Philadelphia, PA: Elsevier Sauders, 2006, 43-48.
30. Avram MR, Finney R, Rogers N. Hair Transplantation Controversies. Dermatol Surg,2017:43(2):S158-S162. doi: 10.1097/DSS.0000000000001316. PMID: 29064980.
31. Limmer BL. Elliptical donor stereoscopically assisted micrografting as an approach to further refinement in hair transplantation. J Dermatol Surg Oncol,1994:20:789-93.
32. Rassman WR, Bernstein RM, McClellan R, Jones R *et al*. Follicular unit extraction: minimally invasive surgery for hair transplantation. Dermatol Surg,2002:28:720-8.
33. Bernstein RM. Commentary on robotic follicular unit extraction in hair transplantation. Dermatol Surg,2015:41:279.
34. Avram MR, Watkins SA. Robotic follicular unit extraction in hair transplantation. Dermatol Surg,2014:40:1319-27.
35. Onda M, Igawa HH, Inoue K, Tanino R. Novel technique of follicular unit hair transplantation with a powered punching device. Dermatol Surg,2008:34:1683-8.
36. Limmer BL. Micrografts survival. In: Stough DB, editor. Hair Replacement. St Louis, MO: Mosby Press, 1996, 147-9.
37. Cooley JE. Optimal graft growth. Facial Plast Surg Clin North Am,2013:21:449-55.
38. Garza LA, Liu Y, Yang Z, Alagesan B, Lawson JA, Norberg SM *et al*. Prostaglandin D2 inhibits hair growth and is elevated in bald scalp of men with androgenetic alopecia. Sci Transl Med,2012:4:126-34.
39. Li ZJ, Choi HI, Choi DK, Sohn KC, Im M, Seo YJ *et al*. Autologous plateletrich plasma: a potential therapeutic tool for promoting hair growth. Dermatol Surgm,2012:38:1040-6.
40. Orentreich N. Autografts in alopecia and other selected dermatological conditions. Ann N Y Acad Sci,1959:83:463-79.
41. Cooley JE. Optimal graft growth. Facial Plast Surg Clin North Am,2013:21:449-55.
42. Parsley WM, Perez-Meza D. Review of factors affecting the growth and survival of follicular grafts. J Cutan Aesthet Surg,2010:3:69-75.
43. Nakatsui T, Wong J, Groot D. Survival of densely packed follicular unit grafts using the lateral slit technique. Dermatol Surg,2008;34:1016-22.
44. Bernstein RM. Measurements in hair restoration. Hair Transplant Forum Int,1998:8:27.
45. Chang SC. Estimation of number of grafts and donor area. Hair Transplant Forum Int,2001:11:101-3.
46. Bernstein RM, Rassman WR. The logic of follicular unit transplantation. Dermatol Clin,1999:17:277-95.
47. Unger WP. Density issue in hair transplantation. Dermatol Surg,1998:24:297.
48. Bernstein RM, Rassman WR, Szaniawski W, Halperin A. Follicular transplantation. Int J Aesth Rest Surg,1995:3:119-32.
49. Onda M, Igawa HH, Inoue K, Tanino R. Novel technique of follicular unit extraction hair transplantation with a powered punching device. Dermatol Surg,2008:34:1683-8.
50. Avram MR, Watkins SA. Robotic follicular unit extraction in hair transplantation. Dermatol Surg,2014:40:1319-27.
51. Williams KL Jr. Current practices and controversies in cosmetic hair restoration. Dermatol Surg,2013:39:797-801.
52. Harris JA. New methodology and instrumentation for follicular unit extraction: lower follicle transection rates and expanded patient candidacy. Dermatol Surg,2006:32:56-61.
53. Rashid RM. Follicular unit extraction with the Artas robotic hair transplant system system: an evaluation of FUE yield. Dermatol Online J,2014:20:22341.
54. Gupta A. Microrefined microfollicular hair transplant: a new modification in hair transplant. Ann Plast Surg,2014:73:257-65.
55. Konior RJ. Complications in hair-restoration surgery. Facial Plast Surg Clin North Am,2013:21:505-20.
56. Yang R, Zheng Y, Burrows M, Liu S, Wei Z, Nace A *et al*. Generation of folliculogenic human epithelial stem cells from induced pluripotent stem cells. Nat Commun,2014:5:3071.