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The Art and Science of Hair Transplantation

Damkerng Pathomvanich, MD, FACS

Institution Stough Clinic 408/138 Phaholyotin Place 32nd D, Phaholyotin Road, Phayathai, Bangkok 10400, Thailand.

Abstract

Background: **Big round grafts (plugs) were extensively used in hair transplantation since 1960 till late 1988. Realizing the doll look, the size of the grafts were getting smaller to split and quarter grafts and finally mini and micro-grafts in the late 1980. In the past few years, the use of follicular unit graft in large quantity have replaced mini-micro grafts to create mother nature looking result. Hair line designed which was straight and bell shape in the past have been changed to irregular and slightly asymmetric to achieve natural and undetectable result.**

Materials and Methods: **Hair line is drawn in irregular fashion with or without temple hair line restoration. Single strip harvesting under local anesthetic is carefully dissected into follicular unit grafts that contain 1 to 4 hairs. Single hair follicular unit grafts are transplanted in the front row . Follicular unit containing 2 to 4 hairs are mixed and transplanted behind the single hair. Dense packing is required to achieve good density. Natural and undetectable hair growth in good candidate can be observed 10 to 12 months after surgery. Two to three sessions may be needed for added density.**

Discussion: **Hair transplantation is the art and science challenging the hair transplant surgeons. Understanding the pathogenesis of hair loss, anatomy and hair flow (direction, angle) in conjunction with training in hair restoration are essential for successful and natural results. All follicular unit grafts look best and unnoticeable. Mini-micrografts can also result in natural look if the frontal zone, part side and the crown contain the area at least two centimeters of follicular unit grafts**

Baldness is an inevitable thus results in lack of confidence and the appearance of older than age.

The legend stated that baldness or hair loss is linked with powerless consider infants, elderly and the biblical Samson. The beauty of chicken is feather. The head of subjugated prisoners and soldiers are shaved to obfuscate their individualism and power. With the modern technique of hair restoration, if you are a candidate you don't have to be bald. In the past few years, the use of follicular unit graft in large quantity have replaced mini-micro grafts to create mother nature looking result.[1,2]

Successful hair bearing transplant in human was first performed by Don Unger (1822). In 1939 Okuda,[3,4] a Japanese dermatologist was first to describe the use a small full thickness autografts of hair bearing skin for the correction of alopecia of the scalp, eyebrow, moustache and beard. Since it was World War II his work was not recognized outside Japan. In 1959 Norman Orentreich[5] used the same method with 4-5 mm circular metal trephines (4-5 mm in diameter) to bore out grafts from hair bearing areas of the scalp. A similar instrument was used to prepare the recipient sites. He also introduced the concept of Donor Dominance (DD) and Recipient Dominance (RD). DD describes autografts that maintain their integrity and characteristics after transplantation to a new site. RD describes autografts that take on the characteristic

of the recipient site. This concepts help to understand how the hair autografts survive for life as long as the donor of origin is still existing.

From 1960 to 1985 the majority of hair transplant surgeons used large round grafts for hair restoration which often produced pluggy, bristle brush or "Barbie doll" hairlines that were unsightly and conspicuous.[6-10] Since 1990 the grafts were becoming smaller to mini and micro grafts and subsequently the follicular unit grafts (F-U).[1,2]

Hair transplant grafts greater than 2 mm are intrinsically "pluggy". Grafts less than 1.5 mm or those with the hair count between 1-4 hairs in caucasian and 1-3 hairs in Asian each in substantial quantities, produce relatively unnoticeable results and the appearance of a normal distribution of natural hair. Development of a master plan in hair transplantation requires merging the artistic, and scientific elements of the donor hair and balancing these factors with the patient's expectations and budget. The end results are strongly influenced by hair and skin color, hair texture, density, hair bulk, hair growth pattern, surgeon and anticipated final stage of future hair loss. The random placement of grafts in substantial numbers will avoid the appearance of inadequate density and minimizes cobble stoning and donutting.

When the donor hairs are trimmed and magnified, the hair follicle appear to arrange in random and contain between 1-4 hairs in which the majority of the follicular unit contain two hairs (Figure 1).[11-18]

Some physicians call such natural hair pattern bundle hair but more appropriate term is follicular unit. Today most hair transplant surgeons use follicular unit grafts for transplantation. This mother nature arrangement had been recognized by Dr Bobby Limer[19,20] since 1988. He used elliptical donor harvesting and Binocular Stereoscopic Dissecting Microscope to assist in cutting into follicular unit grafts and transplanted in large quantity as individual unit.

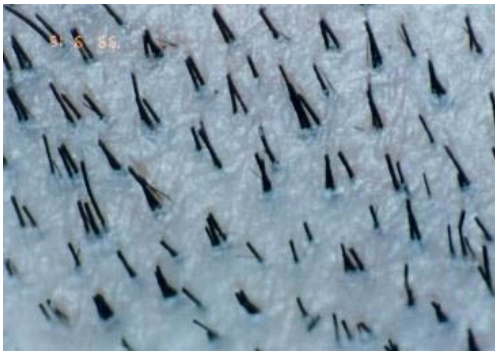

Fig. 1 The photograph shows the normal arrangement of scalp hair at occipital region. Each follicular unit contains from 1 to 4 hairs.

Materials and Methods

Once the male pattern baldness or cicatricial alopecia are diagnosed and the patient is a good candidate for hair transplantation the inform consent is first obtained. The new hair line is drawn to fit individual's face in irregular fashion.[21-23] On average, it is about 7 cms above mid glabellar with the range from 6 to 9 cms. Two to three mounds are drawn and in some cases a widow peak is added. For excessive loss of temple hair, this area should be included in restoration since the forehead will appear too wide. In Norwood class VII due to inadequate donor supply only the frontal forelock and portion of the mid scalp is drawn to frame the face. The posterior hair line is drawn in circle to mimic normal baldness. The fronto-temporal angle is usually wide or rounder in Asian as compared with acute angle in Caucasian (Figure 2).

There are several ways to draw the hair line which is beyond the scope of this discussion.

The total area of the baldness is then measured in square centimeters. Knowing the total surface area of baldness (A), the total number of follicular unit need is then calculated as follow :

$$A \times \text{Number of unit desire per cms}^2 = B$$

The donor area is selected and trimmed short (Figure 3). Hair count is obtained as in follicular unit per cms^2 (C) measures with Rassman densitometer. The length and width of the strip is calculated as :

$$B \div C = \text{Total area of the strip in cms}^2$$

There are several methods for donor harvesting.[24-30] Single strip donor harvesting under local anesthetics[31-35] is first performed as described by Damkerng Pathomvanich.[36]

Strip are carefully dissected under microscope into follicular unit grafts (1-4 hairs) and 2 F-U or cut to size as minigrafts as desired by surgeon (Figure 4).

The recipient area was cleansed and marked with gentian violet (Figure 2) for zoning of the size and amount of grafts distribution under local twilight anesthetic with or without EMLA[28,37,38] ring block with

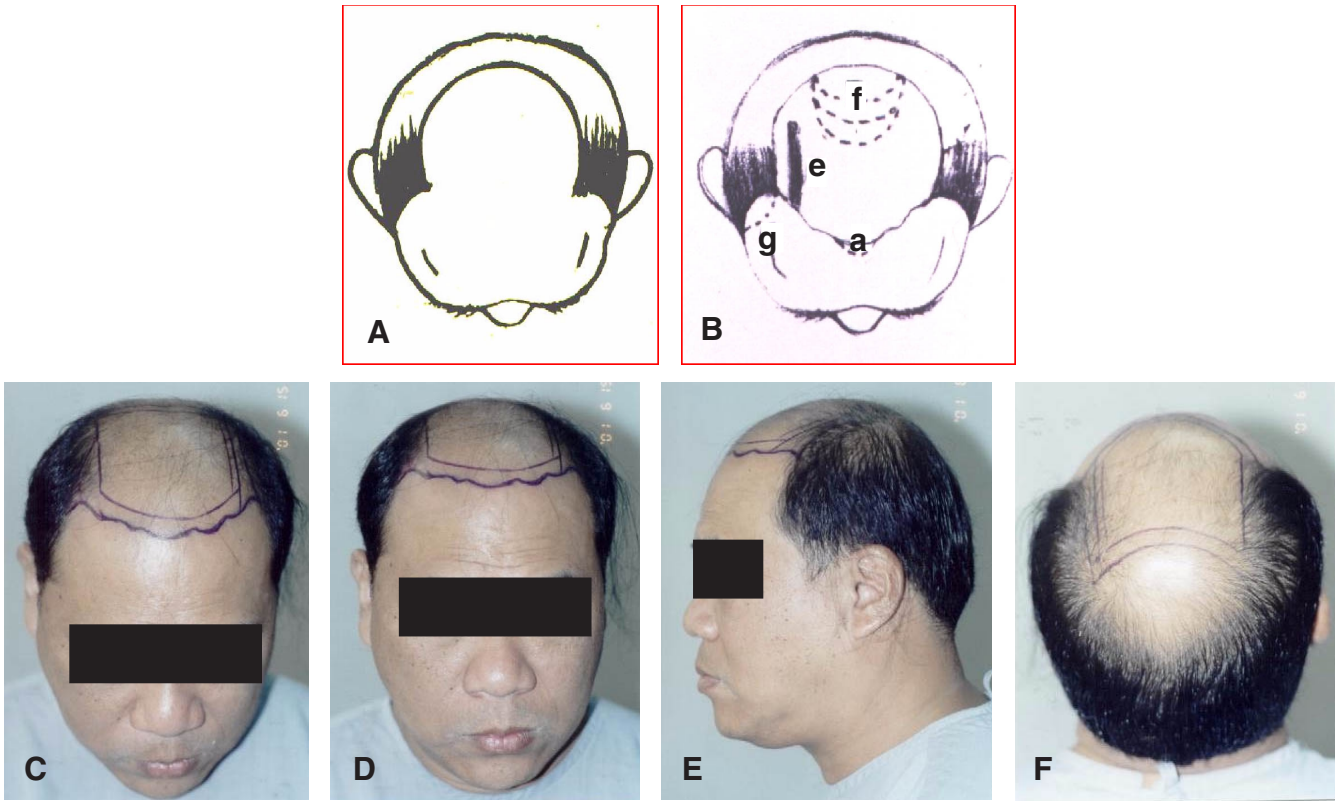

Fig. 2 A-B : Drawings depict the hair line as described in text
g is the temple, **e** is the part side, **f** is the posterior hair line, **a** is the anterior hair line.
C-F : Photographs showing the hair line completely drawn before surgery. The crown area is to be transplanted last if more donor hair available

Fig. 3 Photograph showing densitometer measurement of the hair density.

1% Xylocaine with Epinephrine 1:100,000 supplement with tumescent fluid[39,40] in a small area at the time.

1. ***For all follicular unit grafts.***

The front row will be transplanted with one hair grafts. A width of at least one centimeter is needed for naturalness. The follicular unit that contains more than one hair will be mixed behind this zone. My preference is to use either 19 or 18 G needle for 2-3 hair grafts pre-made incision and implant. For single hair graft I use either pre-made incision or stick and place via 20 G needle (Figure 5).[41,42]

2. ***For mini-micrografts.***

One hair micrografts are transplanted in the front row by the feathering zone technique[43,44]. A width of at least two centimeters wide containing a mixed of one and two hair micrografts are needed.[45] Minigrafts are transplanted behind this zone using slit incision.[46,47] The part side and posterior hair line are also transplanted with one and two hair micro grafts. Minigralfs are placed via 1.5 mm spearpoint or 16 G needle.[48-50]

Results and Discussion

The results in the good candidate after two to three session of hair transplantation to reach at least 50% of the normal density[15] (100 follicular units per cms^2) are comparable in both follicular unit grafts and

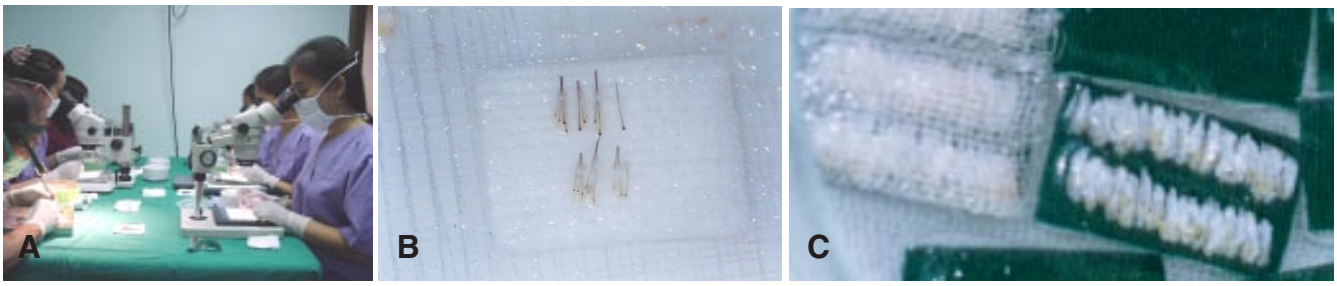

Fig. 4 Photographs demonstrating (A) the assistants cutting the grafts with binocular stereoscopic dissecting microscope, (B) the follicular unit grafts on the top row, and (C) mini grafts ready for transplantation.

Fig. 5 Photographs depicting patients with small slit incisions pre-made on the crown for all follicular unit grafts.
(A) Patient who has 2021 small slit incisions
(B) Another patient who has 1139 small slit incisions.

Fig. 6 Photographs showing the patient pre-op Norwood III
(A) At five months after first hair transplant session.
(B) One year post-op after second hair transplant session with all follicular unit grafts.

mini-micrografts (Figures 6-12), all follicular unit grafts containing uniform looking follicular unit graft would gain more natural look that is almost unnoticeable (Figure 6).

Transplants with mini-micrograft especially in patient with very coarse hair pluggy effect may be seen in part side on the minigraft site. In contrast to those who have gray hair this effect is less prominent (Figure 8).

Fig. 7 Photograph of a patient (A) before and (B) post-op after two hair transplant sessions with all follicular unit grafts.

Fig. 8 Photographs of two patients of hair transplant.
(A) and (C) pre-op,
(B) and (D) post-op one year after two sessions.

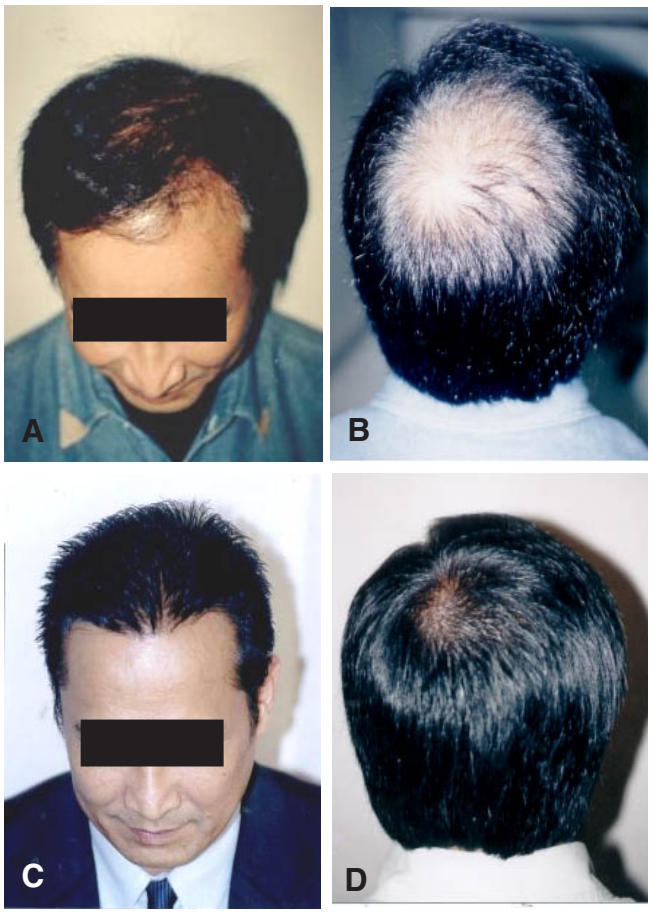

Fig. 9 Photographs of patient's appearence.
(A) and (B) : Pre-op
(C) and (D) : Eight years after three sessions with the hair cut short.

Fig. 10 Photographs of patient with cicatricial alopecia since childhood (A), and at one year after two hair transplant sessions (B).

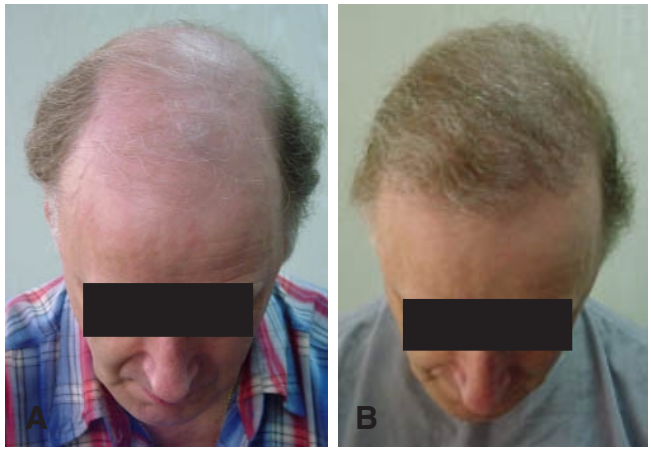

Fig. 11 Photographs of patient at 10 months after two sessions of hair transplantation ten months post-op.
A : Before hair transplant.
B : After hair transplant.

Successful hair restoration requires merging the artistic and scientific elements of donor hair available to frame the face as natural as possible. The art of drawing the new hair line which will remain with the patient even when aging is crucial. Extensive use of follicular unit grafts or in selected cases mini-micrografts in large quantity per session require to create illusion of full look and density to achieve satisfactory result. A few sessions are needed to meet 50 per cent of the normal density. Complications such as bleeding, swelling, folliculitis, ingrown hair, hypertrophic scar are not common and beyond the scope of discussion.

Megatransplant session by using extensive amount of small grafts dense packing creates the illusion of fuller head of hair by redistributing the hair in small skin unit placed in random pattern. The more density these unit are placed, the better the illusion of fullness.

Factors that contribute to successful hair restoration are as follow:

1. Contrast between hair and skin color. Better results are easier to achieve in persons with low contrast hair to skin color.[16,51]

2. Hair bulk. Coarse hair carry more visual weight in creating a hairy appearance. However 1-2 hair grafts are need to avoid the plugginess.[16,51,52]

3. Hair character. The curlier the hair (Afro-American) the fuller the hairs appear. Straight hairs, commonly found in Asian, allow the eye to follow the hair shaft to the scalp accentuating the contrast between the scalp and color of hair shaft.

4. Hair density. Average hair density in Asian is 170 hairs (100 F-U) per cms^2. Those who have poor

Fig. 12 Photographs showing the appearance (A) before and (B) eight months after two hair transplant sessions that resulted in his face is framed. Photograph (C) demon-strated the hair line with natural result.

density and fine hair may not be a good candidate for hair transplantation. In the contrary those who do have average to good density will obtain good result.

5. Hair transplant surgeon. Implanted hair follicles generally take and grow well. This may be desirable or not depending on the skill and esthetic eye of the surgeon. Well trained hair transplant surgeon (with fellowship training) is essential and highly recommended by American Society of Hair Restoration Surgeons, International Society of Hair Restoration Surgeons, Europeon Society of Hair Restoration Surgeons, World Society of Hair Restoration Surgeons for those who want to enter this rapid growing specialty of medicine. After successfully completed the training he or she is not only to provide the service of hair restoration to the public but will carries on the research and development in the art and science of hair restoration which now become a branch of medical specialty and has its own board, American Board of Hair Restoration Surgery.

6. Extend of baldness and donor availability. The greater the baldness the lesser the result and vice versa. However frontal forelock to frame the face is effective in extensive baldness as seen in the Figure 12.

7. Future hair loss. Hair loss is progressive. Surgeon must recognize the future hair loss and inform this to the patient for future planning. A master plan should include medical treatment to stop the hair loss.

Research toward hair cloning and culture to provide unlimited donor supply are currently in progress. Understanding the pathogenesis of Androgenetic Alopecia will bring us some day to discover more effective drug to stop and gain the hair loss.

REFERENCES

1. Limmer B. Thought on the extensive micro grafting technique in hair transplantation. Hair Transplant Forum International 1996; 6: 16-8.
2. Shapiro R. Total micrograft megasessions-a follow-up. Hair Transplant Forum International 1997; 7: 23-4.
3. Okuda S. Klinische und experimentelle Untersuchungenuber die Transplantation von lebenden Haaren. Jpn J Dermatol *(in Japanese)* 1939; 40: 537.
4. Okuda S. Clinical and experimental studies of transplantation of living hair. Jpn J Dermatol *(in Japanese)* 1939; 46: 135-8.
5. Orentreich N. Autografts in alopecias and other selected dermatological conditions. Ann NY Acad Sci 1959; 83: 4463.
6. Unger W. Punch hair transplantation. In: Epstein E, editor. Dermatology clinics, skin surgery. Philadelphia: WB Saunders; 1984. p. 303-17.

7. Nussbaum B, Lewis L. Hair transplantation, a three-stage approach for creating the hairline. J Dermatol Surg Oncol 1992; 18: 327-8.
8. Orentreich DS, Orentreich N. Hair transplantation. J Dermatol Surg Oncol 1985; 11: 319-24.
9. Alt T. Hair transplantation and scalp reduction. In: Coleman WP, III, Hanke CW, Alt T, Asken S, editors. Cosmetic of the skin. Philadelphia: BC Decker; 1991. p. 103-46.
10. Norwood O'T. Hair transplant surgery. Springfield IL: Charles C Thomas; 1973.
11. Gibbon RD, et al. Quantification of scalp hair - a computer-aided methodology. J Invest Dermatol 1986; 86: 78-82.
12. Gibbons RD, Fiedler-Weiss VC. Computer-aided quantification of scalp hair. Dermatol Clin 1986; 4: 627-39.
13. Norwood O'T. Hair transplant surgery. 2nd ed. Springfield IL: Charles C Thomas; 1984.
14. Pecoraro V, Astore IPL. Measurements of hair growth under physiological conditions. In: Orfanos CE, Happle R, editors. Hair and hair diseases. New York: Springer-Verlag; 1989.
15. Rassman WR, Pomerantz MA. The art and science of mini-grafting. Int J Aesthetic Rest Surg 1993; 1: 27-36.
16. Unger WP, Nordstrom REA. Hair transplantation. 2nd ed. New York: Marcel Dekker; 1988. p. 151-3.
17. Van Neste D, Dumortier M, DeCoster W. Phototrichogram analysis: technical: aspects and problems in relation to automated quantitative evaluation of hair growth by computer-assisted image analysis. In: Van Neste D, Lachapella JM, Antoine JL, editors. Trends in human hair growth and alopecia research. Boston: Kluwer; 1989.
18. Van Neste D. Dynamic exploration of hair growth: critical review of methods available and their usefulness in the clinical trial protocol. In: Van Neste D, Lachapelle JM, Antoine JP, editors. Trends in human hair growth and alopecia research. Boston: Kluwer; 1989.
19. Limmer BL. Survival of micrografts as a function of time from donor site removal to recipient site implantation. Presented at the First Meeting of International Society of Hair Restoration Surgeons. Dallas, TX: April 30-May 2, 1993.
20. Limmer BL. Elliptical donor harvesting, hair replacement, surgical and medical. Dow B. Stough, editor. Mosby-Yearbook; 1996. p. 142-7.
21. Lucas M. The treatment of male baldness exclusively with mini-grafts. Z Hautkr 1987; 62: 1735-45.
22. Lucas M. The use of minigrafts in hair transplanting surgery. J Dermatol Surg Oncol 1988; 14: 1389-92.
23. Norwood OT. Patient selection. Hair transplant design, and hairstyle. J Dermatol Surg Oncol 1992; 18: 386-94.
24. Unger W. Punch hair transplantation. In: Epstein E, editor. Dermatology clinics, skin surgery. Philadelphia: WB Saunders; 1984. p. 303-17.
25. Cohen I. Donor island harvesting for micro- and minigrafting. J Dermatol Surg Oncol 1989; 15: 384-5.
26. Unger WP. Total excision techniques in donor area harvesting for hair transplanting. Am J Cosmet Surg 1994; 11: 15-22.
27. Straub P. The donor site revisited. Hair Transplant Forum 1991; 1: 4.
28. Straub P. Evaluating the knife tecnique. Hair Transplant Forum 1992; 2: 2-4.
29. Scarborough D. The triple-bladed knife in perspective. Hair Transplant Forum 1991; 2: 5
30. stough D. Proper use of the knife. Hair Transplant Forum 1992; 2: 10.
31. Stegman S, Tromovitch T, Glogan R. In: Anesthesia, basic of Dermatologic Surgery. Chicago: Year Book Medical Publisher; 1983. p. 23-31.
32. Fox B. Anesthesia. In: Norwood O, Shiell R, editors. Hair transplant surgery. Springfield IL: Charles C Thomas; 1984. p. 245-64.
33. Alt T. Hair transplantation and scalp reduction. In: Coleman W, III, Hanke CW, Alt T, Asken S, editors. Cosmetic surgery of the skin. Philadelphia: BC Decker; 1991. p. 103-46.
34. Grekin RC, Aulatta MJ. Local anesthesia and dermatologic surgery. J Am Acad Dermatol 1988; 19: 599-614.
35. McKay W, Morris R, Mushlin P. Sodium bicarbonate apenuate pain on skin infiltration with lidocaine with or without epinephrine. Anesth Analg 1987; 66: 572-4.
36. Pathomvanich D. Donor harvesting a new approach to minimizing follicular transection. Dermatol Surg 2000; 26: 335-48.
37. Wagner R, Flores C, Argo L. A double-blind placebo controled study of a 5% lidocaine/prilocaine cream (EMLA) for topical anesthesia during thermolipis. J Dermatol Surg Oncol 1994; 20: 148-50.
38. Lycka BAS. EMLA, a new and effective topical anesthetic. J Dermatol Surg Oncol 1992; 19; 859-62.
39. coleman W, III, Klein JA. Use of the tumescent technique for scalp surgery. Dermabrasion Soft Tissue Reconstr 1992; 18: 130-5.
40. Norwood OT. Tumescent anesthesia (Editorial Response). Hair Transplant Forum 1991; 1: 6.
41. Marritt E. Single hair transplantation of hairline refinement : a practical solution. J Dermatol Surg Oncol 1984; 10: 962.
42. Nordstrom REA. "Micrografts" for improvement of the frontal hairline after hair transplant. Aesthetic Plast Surg 1981; 5: 97.
43. Jimenez FJ, Avram SR, Stough DB. The surgical pearl : the Yeh needle-a solid needle for single-hair recipient sites. J Am Acad Dermatol 1995; 32:1041-2.
44. Stough DB, IV. Hair transplantation by the feathering zone technique : new tools for the nineties. Am J Cosmet Surg 1992; 9: 243.
45. Nordstrom REA. "Micrografts" for improvement of the frontal hairline after hair transplant. Aesthetic Plast Surg 1981; 5: 97.
46. Stough DB, III, Nelson BR, Stough DB, IV. Incisional slit grafting. J Dermatol Surg Oncol 1991; 17: 53-60.
47. Swinehart J, Griffin EI. Slit grafting: the use of serrated island grafts in male and female-pattern alopecia. J Dermatol Surg Oncol 1001; 17: 243-53.
48. Shiell RC, Norwood OT. Micrografts and minigrafts. In:

Norwood OT, Shiell RC, editors. Hair transplant surgery. 2nd ed. Springfield Ill: Charles C Thomas; 1984. p. 107-10.
49. Brandy DA. Conventional grafting combined with mini-grafing : a new approach. J Dermatol Surg Oncol 1987; 13: 60-3.
50. Brandy DA. A new instrument for the expedient production of minigrafts. J Dermatol Surg Oncol 1992; 18: 487.
51. Norwood OT, Shield RC. In: Norwood OT, Shiell RC, editors. Hair transplant surgery. 2nd ed. Sprignfield Ill: Charles C Thomas; 1984.
52. Frechet P. Micro and mini hair grafting using the standard hair implantation procedure. J Dermatol Surg Oncol 1989; 15: 533-6.