Hair Restoration Update

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Hair on a man's head is an important emblem of health, youth and vitality **(Vogel, 2000)**. For a long time physicians and surgeons searched for a cause and cure for alopecia. Ancient Egyptians recorded their efforts in this regards thousands of years ago **(Swinehart, 1996)**. With the advances made in the field of aesthetic surgery, many aesthetic options became available for addressing the problem of hair loss. However, the increase in number and sophistication of surgical modalities has still not produced one ideal solution that is applicable to all cases of alopecia. In fact, what appears to be a straightforward problem is usually as complex as any in the field of plastic surgery. Multiple variables like hair color, texture or others have an enormous influence on the final outcome of alopecia management. Excellent results of hair restoration can be obtained with good knowledge of the different options of treatment and with proper long-term planning of management **(Hubbard, 1997)**. This article reviews from the surgical aspect, the management of the most troublesome hair disorder, hair loss.

Hair anatomy and physiology

Hair grows from follicles, which are stocking-like infoldings of the superficial epithelium, each of which encloses at its base a small stud of dermis known as the dermal papilla. The cylinder of hair may be regarded as a holocrine secretion arising by division of cells in the region known as the bulb. The follicles are sloped in the dermis and longer ones extend into the subcutaneous layer. An oblique muscle, the errector pilorum, runs from a point in the mid-region of the follicle wall to the dermo-epidermal junction. Above the muscle, one or more sebaceous glands and in some regions of the body, an apocrine gland open into the follicle. The bulk of any hair is composed of a thick cortex made up of keratinized cells, which in pigmented hairs contain melanin granules. The cortex is surround by a cuticle and may have a continuous or discontinuous core or medulla **(Dawber et al, 1998)**.

The average scalp contains 90000-140000 terminal coarse, medullated & pigmented hairs and many more vellus and indeterminate fine hypopigmented unmedullated hairs. At any time approximately 90% of terminal hairs are in the anagen (growing phase) lasting around 1000 days and the rest is in the catagen (regression) phase lasting typically 3-4 months. The shedding of around 100 hairs daily is normal **(Swinehart, 1996)**.

Aetiopathology of Alopecia

Alopecia can be caused by a wide variety of conditions, most important of which from the surgical point of view is androgenetic alopecia (common baldness) and cicatricial alopecia. Alopecia can be caused by a variety of skin disorders, most important of which is alopecia areata. Other causes include, hereditary defects, metabolic, endocrinal, nutritional defects, bad use of cosmetics, or exposure to chemicals, chemotherapeutic agents or irradiation **(Sommer & Wilson, 1999)**. The course of alopecia in these conditions is cause dependent, some cases are reversible after removal of the aetiological factor and some are not **(Dawber et al, 1998)**. They are beyond the scope of hair restoration and will not be discussed in this article.

Androgenetic Alopecia (Common baldness, male pattern & female pattern baldness)

Aetiology

Androgenetic alopecia remains the main cause of male pattern baldness (MPB) & female pattern baldness (FPB) **(Koo et al, 2000)**. Both types of alopecia are caused by the gradual deterioration of terminal hairs into vellus ones caused by the genetically determined increased level of dihydrotestosterone (DHT) which is the metabolite of testosterone produced by 5-α reductase enzyme. DHT acts on androgen binding receptors on the hair follicles. It is not known why androgenetic alopecia starts nearly always on the crown and spreads inferiorly eventually sparing only the lower temples and the lower posterior scalp. At present although the genetic basis of androgenetic baldness in confirmed, the predisposing genes are not identified, however the relatively strong concordance of the degree of baldness in fathers and sons is not consistent with simple Mendelian trait and a polygenic basis is therefore most likely **(Hoffmann & Happle, 2000)**

Male pattern baldness (MPB)

Classification

Male pattern baldness may be classified by one of several methods. The most widely classification was proposed by **Norwood (1975)**. It should be emphasized however, that only few patients fit exactly into these classifications, more likely each patient is visualized as being in transition from one type into a more advanced one.

Type I: Minimal recession along hairline
Type II: Early bilateral temporal recession stopping at least 2 cm anterior to a vertical coronal plane passing through external auditory canals
Type III: More bitemporal recession approaching that vertical coronal line and more posterior recession of anterior hairline
Type III Vertex: A zone of coronal baldness appears and the bitemporal recession may not be as deep as in type III
Type IV: A larger zone of vertex alopecia and a deeper bitemporal recession and a deeper posterior recession of hairline. The three alopecia zones seem moving centrally to join each other.
Type V: The three zones join each other
Type VI: The patient posses a complete alopecic zone in the anterior, central or posterior crown. A horseshoe shaped zone of hair persists in the parietal and occipital regions.
Type VII: An advanced form of alopecia where only a fringe of hair persists in the lower parietal and lower occipital areas.
Type VIII: Occasionally a patient has almost no hair-bearing zone at all.
Type A variants: In these variants of types II, III, IV & V the hairline recession proceeds directly posterior without simultaneous development of vertex alopecia. This pattern is often incomplete and the hairline frequently does not recede as far inferiorly in the parietal or occipital regions.

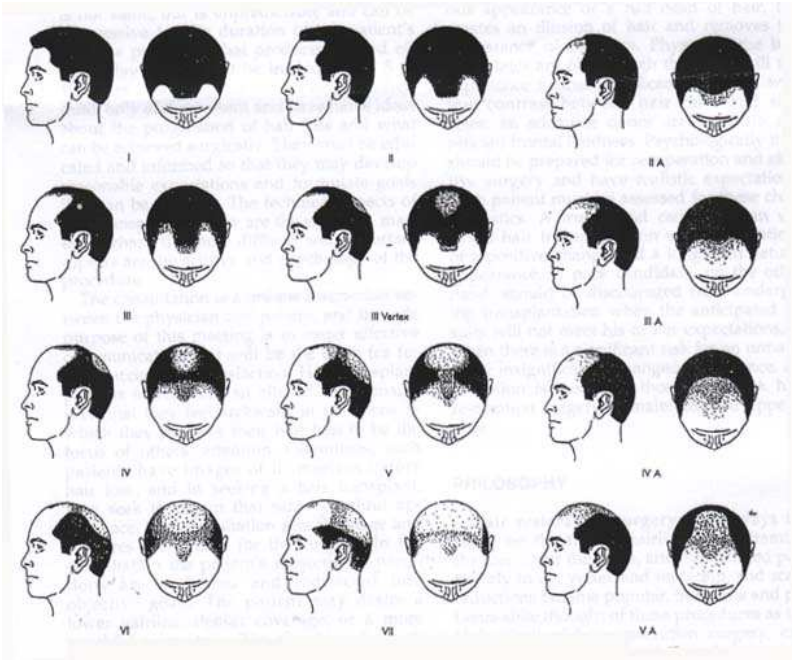

Figure 1 : Norwood's MPB classification (Norwood , 1975)

Female pattern baldness (FPB)

Ludwig (1977) has more recently proposed a classification for FPB into three types. Unless suffering from a verilizing disease, females generally never lose anterior hairline, rather female pattern baldness is characterized by incomplete coronal hair loss, with diffuse thinning across the anterior, central & posterior crown. FPB is classified into mild, moderate and severe types. In all types the hair in the usual parieto-occipital donor region is healthy, making females good candidates for extensive hair transplantation surgery.

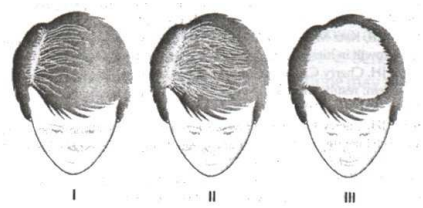

Figure 2 : Ludwig's FPB classification (Ludwig ,

Treatment of androgenetic alopecia

Medical treatment

Hormonal treatment

Hormonal therapy of androgenetic baldness is based of inhibition of 5-α reductase (5AR), the enzyme responsible for converting testosterone to its metabolite DHT responsible for initiation and progression of androgenetic alopecia.

Antiandrogen therapy

Finasteride (Propecia)

A pure 5AR inhibitor, which has been used for the management of benign prostatic hypertrophy. It blocks the peripheral conversion of testosterone to DHT resulting in a significant decrease in its level in the scalp. It has been recently introduced for the treatment of androgenetic alopecia. It is mainly effective in the crown area with no or little effect on receding anterior hairline & temples. Any results achieved by treatment will be lost on cessation of treatment. Anti-Androgenic effects of finasteride have been found to be temporary **(Hogan & Chamberlain, 2000)**. Trials are conducted on the use of finasteride as a topical formulation and encouraging results have been obtained **(Sintov et al, 2000)**.

Other Anti-Androgens

Drugs like spironolactone or the combination of CPA (cyproterone) & ethinyl-estradiol have been shown in high doses to produce a significant

increase in cosmetically useful hair. However this line of therapy has a lot of major disadvantages inhibiting its wide use including:
1-Anti-androgenic effect in males
2-The treatment should be continued for at least 1 year before a subjective improvement is reached
3-Complete reversal of hair loss cannot be achieved if treatment is not started within 2 years form the start of alopecia **(Dawber et al, 1998)**.

Non Hormonal treatment

Topical Minoxidil (Rogaine)

It is by far the most widely used medical treatment available for androgenetic alopecia. The oral form of the drug used in the 1970s for the treatment of hypertension was observed to have the side effect of stimulating hair growth. Subsequent studies on the local form of Minoxidil 2% ointment in an alcohol and water base containing 10% propylene glycol (Rogaine) have yielded encouraging results and it is now the drug of choice for medical control of androgenetic alopecia. Recently a 5% solution of Minoxidil became available as Rogaine Extra Strength for Men **(Farrell & Epstein, 1999)**.

Minoxidil is a powerful vasodilator, which increases blood flow to the scalp, but it is not clear whether this action or direct action on hair follicles is responsible for hair growth as many other vasodilators have been tested and none of them showed the ability to grow hair. It causes conversion of vellus into terminal hairs in up to 30% of individuals **(Reitschel & Duncan 1987)**. Terminal hairs appear to regrow at the margins but complete coverage of bald areas in seen in less than 10% of cases. The clinical results show that it works best in early stages of baldness with bald area of maximum diameter less than 10 cm. An additional benefit is that topical Minoxidil seems to prevent further alopecia with continuous use. Topical Minoxidil appears to be a safe therapy with side effects only of local irritation and a low incidence of contact dermatitis. Minoxidil has the disadvantage of loss of the gained results and failure of protection from further alopecia once the drug is stopped **(De Villez, 1985)**.

Surgical treatment

An individual is born with a fixed number of hairs. The surgeon can stretch the scalp, lift it, rotate it to another more desired location or move hair from one location to another, but unless experimental hair follicle cloning is refined, surgeons cannot create more hairs. So, the goal of hair restoration surgery remains the maximum, most efficient use of present and future donor areas to cover patient's present and future predicted hair loss pattern.

The state of the art surgical treatment for hair restoration is hair transplantation. Yet, the armamentarium of the surgeon includes also alopecia reduction, with or without the use of scalp extension by expansion, scalp lifting or the use of scalp flaps again with or without scalp expansion.

Hair Transplantation

Principle

Hair transplantation is the backbone of hair restoration surgery. It is the primary or secondary mode in almost all cases. Often it is used alone employing grafts of different sizes in a carefully planned approach, at other times grafts accompany scalp reductions or scalp flaps.

Hair transplantation is based on the concept of "donor dominance" in MPB **(Orentreich, 1959)**. If a graft is taken from an area destined to be permanently hair bearing and is transplanted into an area of MPB or future MPB, it will after an initial short period of effluvium, continue to grow hair in its new site. Thus all planning of redistribution of permanent hair is predicated on an accurate assessment of the ultimate extent of alopecia and its counterpart, the permanent donor rim **(Unger, 1997)**.

Hair transplantation has evolved through successive waves of innovation. The use of large punch grafts was the initial means of transplantation from the 1950s till the early 1980s **(Orentreich, 1959)** .It was met with considerable excitement, which was replaced over the years with some disappointment and a tainted reputation. This was mainly due to the un-natural pluggy appearance that large punch grafts produced. In the 1980s the concept of minigrafts evolved through the work of **Marritt (1984)**.

In the 1990s the concept of follicular unit has revolutionized hair transplantation **(Swerdloff & Kabaker, 1999)**. Human hair emerges from the scalp in groupings known as follicular units. In follicular unit transplantation **(Jimenez & Ruifernandez, 1999)**. Follicular unit transplantation is a method of hair restoration surgery where hair is transplanted in its naturally occurring individual follicular unit. This led to the use of smaller micrografts and finally single hair transplants **(Bernstein & Rassman, 1999)**. Using different-sized smaller grafts helps avoiding the corn rowing "the doll's head appearance" and dramatically improves results **(Marritt, 1993)**.

Types of hair grafts

There are various types of hair grafts are defined by **Knudsed (1994)**:

1.Standard grafts: Round grafts 3.5-4.5 mm or sometimes larger containing 8-10 hairs and placed into holes punched out with slightly smaller round trephines.
2.Minigrafts: Grafts containing 3-4 hairs (small minigrafts) or less commonly 5-6 hairs (large minigrafts). They are obtained by sectioning strips of donor tissue or less commonly larger round grafts. If placed in scalpel slits in the donor area they are called slit grafts, and if placed into holes made with a round trephine they are called round minigrafts.
3-Micrografts: 1-2 hair grafts obtained by sectioning strips of donor tissue. They are placed into holes prepared by a 16-gauge needle.

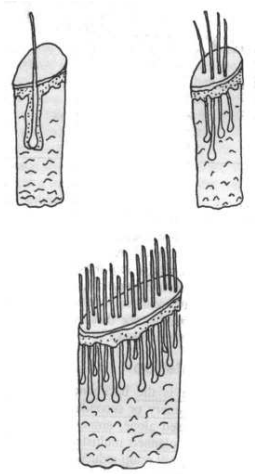

Figure 3 : types of hair grafts (Hubbard , 1997)

The majority of surgeons now employ a variety of grafts according to zones. Standard grafts should be used in areas where maximum density is desired. Micrografts and minigrafts are utilized whenever the ultimate hair density objective is less than maximum density. Micrografts are virtually always used in the hairline zone followed posteriorly by an area of minigrafts that are all one size or increasing in size in different zones **(Buchwack, 1994)**.

Zones of varying-sized grafts should be considered at other border areas as well. In more severe baldness, it may become difficult or impossible for grafts to span the distance between the temporal fringes because donor hair in these patients is limited. For these patients, either no surgery or creation of an isolated frontal forelock is planned.

In general, small slit grafts are superior to small round minigrafts in producing light coverage with minimal clumpiness. This is because of their linear shape. Slit grafts will also produce a greater increase of hair density than small rounded minigrafts when working on an area that still contains hair

because making round holes will always remove some of the existing hairs. Scalpel incisions for slit micrografts can be made between original hair follicles without damaging them, thus the net increase in hair will be equal to the amount of transplanted hairs. On the other hand, greater hair density can be produced with round grafts as a part of bald skin is actually removed at the same time round grafts are added. Megasessions of thousands of micro and minigrafts in a single sitting and dense packing of the bald area is the best solution to accomplish the maximum result in the least number of sessions **(Swinehart, 1996)**.

Planning

Planning is essential in hair transplantation, poor planning can easily lead to unsatisfactory results which may be impossible to correct. This may be because of unanticipated progression of hair loss, exhaustion of grafts or mis-sized, misplaced or misdirected grafts or scars.

Norwood (1992) described 6 major factors in patient selection and planning

1- Classification: Using Norwood's Classification, good candidates for hair transplantation are types III, IV & V. Candidacy of types VI, VII depend greatly on other major factors.
2- Scalp & hair color: Best result of hair transplantation is achieved when there is little contrast between scalp and hair colors as an optical illusion gives a more dense and natural appearance. Dark hair transplantation on light colored scalps is problematic, more and smaller grafts should be used to soften the contrasting effect. Scalp coloring agents may help minimize this contrast **(Unger, 1995)**
3- Curliness: Curliness is favorable as it inherently covers and camouflages any tufted arrangement **(Randall & Schauder, 1993)**.
4- Texture (Caliber): Surgeon must choose less coarse hair to cover the hairline by harvesting from lower occipital area or just above the ears. The thin hairs can be easily combed backwards and has a more natural look.
5- Density: Greater density is an advantage in the donor area, in fact low density of the donor area may rule out hair transplantation. However, this may yield dense grafts producing a pluggy appearance. For those patients, smaller minigrafts and micrografts should be used
6- Amount of donor hair: Again very small donor area as in types VII & VIII rule out this procedure.

Donor site anesthesia

With the patient in the prone position, hair in the previously marked donor area is trimmed to a length of 2-3 mm.

The donor area is anesthetized with a 50/50 mixture of 1% xylocaine and 1:100000 epinephrine and 0.5% plain bupivacaine, approximately 15 cm of each is injected into a 1 X 15-cm donor area. After waiting for 15-20 minutes to allow for maximum vasoconstriction, the surgeons infiltrates the donor area with approximately 30 cc of tumescent solution (0.1 % xylocaine with epinephrine 1:1000000) to add more local anesthesia and tumesces the donor region, lifting the scalp away from, the occipitalis muscle fascia and occipital vessels and causing hair follicles to stand erect at less acute angle from the scalp **(Swinehart, 1996)**.

Donor hair harvesting

Two donor zones are used: one inferiorly in the occipital area and another one more superiorly extending from the midline into the parietal area and as far anteriorly as a line drawn perpendicularly from the tragus. There are basically two methods for donor harvesting; first, the multibladed knife that can be loaded with 3-8 blades to produce 3-8 thin strips with a single pass of the knife and secondly, the creation of an elliptical incision using a single blade to harvest one strip of scalp tissue for further dissection into micrografts. Many surgeons prefer the second method as it avoids inadvertent damage to the hair follicles in the harvested strip that may be produced by a faulty angle of the multibladed knife **(Limmer, 1996)**.

The depth of strips should include approximately 2 cm of subfollicular fat to avoid follicle damage and to prevent unnecessary bleeding from deeper dissection **(Marritt & Konior, 1994)**. A no 15 scalpel is used to produce a triangular tapering of both ends. One end of the donor tissue is held with a small-toothed forceps and small curved scissors are used to separate tissues from its underlying bed. Wound is closed in a running continuous fashion.

Figure 4: Donor sites (Swinehart , 1996)

Graft dissection

Micrograft dissection is a demanding, tedious, yet critical process in extensive micrograft hair transplantation. Dissection is done under either microscope or at least 2.5 X loop magnification under two different light sources at different angles **(Cooley & Vogel, 1999)**. The hair bearing skin strip is placed over a sterile tongue depressor and stabilized by another tongue depressor held by the surgeon's nondominant hand. A single-edged razor blade is used to cut the skin strip into fine slices approximately 1.0-1.5 mm thick. Slices are cut exactly parallel to the direction of hair follicles to avoid damaging them. The blade should be changed every 10 cuts or whenever the slightest dullness or drag is felt. The fat is then carefully trimmed from the bottom of each slice. These slices are placed into chilled saline prior to dissection.

Each slice is dissected by a razor blade or fine scissors into micrografts bearing I-2 hairs. Micrografts are then deepithelialized by slicing off the top of the graft at approximately a 45-degree angle to skin surface. This will allow the hair to align itself in a single file and will minimize the possibility of compression of hair into unsightly dense dark area of coarse hair. Grafts are then sorted according to their hair content into petri dishes containing chilled saline (Marked by colored tape to identify different sizes) and held on ice packs until needed for implantation. With the growing use of lengthy megasessions of 1000 hair transplantation or more, the issue of graft survival outside the body for some hours is important. According to **Limmer (1994)**, 90% of 1-mm grafts survive an 8-hour interval outside the body provided they are kept in 4ºC chilled saline **(Raposio et al, 1999)**.

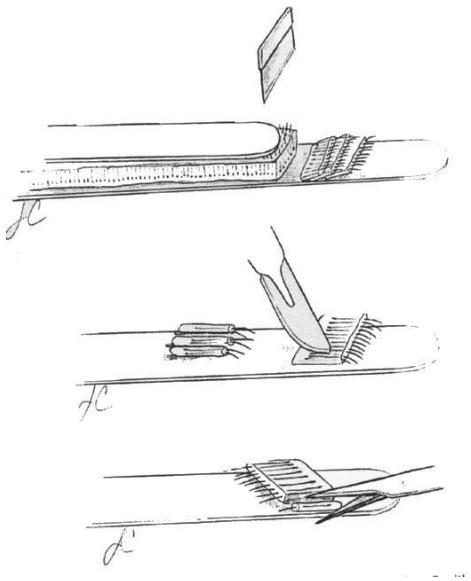

Figure 5 : Graft dissection (Swinehart , 1996)

Anesthesia of recipient site

With the patient is in the supine position the anterior recipient zone is anesthetized using the same technique used in the donor area. Bilateral blocks of lateral zygomaticotemporal, supraorbital & supratrochlear nerves are done using a 50/50 mixture of 1% xylocaine and 1:100000 epinephrine and 0.5% bupivacaine. After 10-15 minutes ring block of the whole recipient area is done using the same mixture.

During graft insertion, sponges soaked with 1% xylocaine with 1:100000 epinephrine is directly applied to the recipient site, may grant additional hemostasis as the anesthetic diffuses into the recipient sites **(Swinehart, 1996)**.

Recipient site preparation

The skill of hair replacement surgeon is maximally reflected in his grafting of the recipient site.

Creation of slits

Instruments used to create slits, holes as well as microdilators should be carefully matched to the anticipated sizes of the grafts. Many instruments can be used including: needles, small blades, or small punches. Microslits are placed between existing hair follicles in patients with earlier thinning or with previous micrografting sessions. These microslits can be created with a no 16-18-gauge needle or with the use of high-energy pulsed CO_2 laser **(Fitzpatrick & Marchell, 2000)** and can be very closely spaced in bald scalps in 1000+ micrografts sessions.

Placement of microdilators

Dilators are small devices temporarily placed into recipient slits. They are favored by some surgeons as they keep slit or hole open, facilitate graft insertion, act as markers for accurate spacing, maximize recipient site visibility in areas with existing hair, aid in hemostasis and prevent piggybacking or missing recipient slits **(Marritt, 1988)**. Other hair restoring surgeons find dilators time-consuming and cumbersome and therefore rarely use them **(Tessler, 1996)**.

Insertion plan

In the recipient site, the surgeon always establishes the fine zones destined to receive micrografts. The hairline is best created with 100 or more closely spaced single hair micrografts. Posterior crown baldness can be filled with larger minigrafts. The hair zones are carefully planned, delineated and marked to receive one-, two-, three- or four-hair grafts. The angle of each slit is carefully created to match the angle and direction of the patient's original

remaining hair; these angles are often oriented radially. When grafting a posterior whorl attention should be directed to the center, location of remaining hair and orientation (clock or anti-clock wise) **(Pomerantez, 1999)**.

Graft insertion

It is important to avoid graft trauma. A head light magnification system dramatically decreases the amount of existing hair trauma **(Brandy, 2000)**. Curved fine jeweler's forceps with diamond tipped jaws are used. The surgeon may line up the grafts on the scalp or on his non-dominant hand. Procedure is best performed with one assistant removing the dilator immediately prior to insertion of the graft by the surgeon. Grafts are not grasped from their follicular end to avoid damaging the hair matrices. Steady pressure is applied to control any bleeding in the area and to ensure that the grafts are flush with the surrounding skin. Care is taken to avoid burying the grafts beneath the level of the skin. It is better to leave a graft protruding slightly above the surrounding skin than below it, as inclusion cyst may result from the latter **(Whitworth et al, 1999)**.

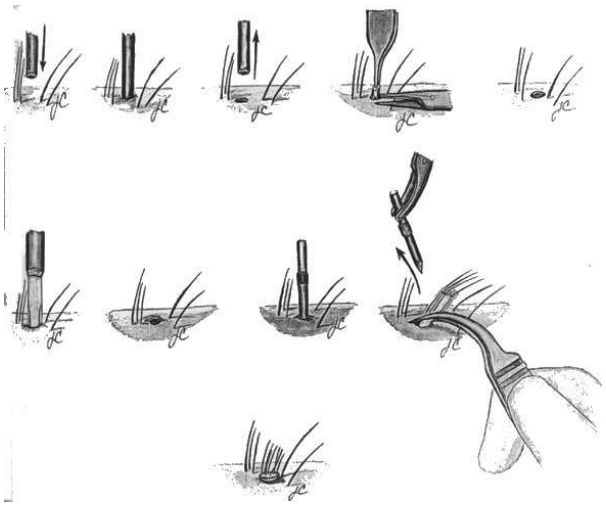

Figure 6 : Graft insertion (Swinehart , 1996)

Bandaging

A small overnight dressing that does not cover the ears is applied and the patient should return the next day for confirmation that the grafts are still in position properly and for careful cleaning away of any blood clots that may have developed overnight **(Slough & Miner, 1997)**.

Postoperative Course

Small crusts will form over the grafts and usually fall over the first 2 weeks. The grafts will shed their hairs in 2-6 weeks. New hair growth usually begins 10-20 weeks after surgery and patient should be informed that it would take at least 6 month postoperatively for hair to grow and to give a good idea about the final appearance. The use of 2-3 % Minoxidil solution twice daily for 5-6 weeks postoperatively will often accelerate hair growth.

Scalp (alopecia) reduction and scalp lifting

Scalp or alopecia reduction is defined as the removal of bald skin on any part of the scalp with extension of the remaining hear-bearing scalp to cover the resulting defect. It can be used alone as an exclusive method of hair restoration in older men with stable area of crown baldness **(Unger & Unger, 1978)** but more commonly it is used as an adjunct to hair transplantation to reduce the size of the bald area to be transplanted **(Tessler, 1996)**.

Increasing the surface area of hear bearing scalp depend on two phenomena, mechanical & biological creep

Mechanical creep (alopecia reduction)

Unwaving and alignment of collagen bundles give rise to a limited amount of scalp expansion over a short time as in intraoperative scalp expansion or during scalp reduction or scalp lifting **(Blanchard & Blanchard, 1977)**. Scalp reduction is most suitable for crown and midscalp **(Unger, 1988)**. The surgeon can use a variety of incision patterns to customize direction and advancement and better hiding of scars **(Unger, 1992) (Schauder et al, 1992)**.

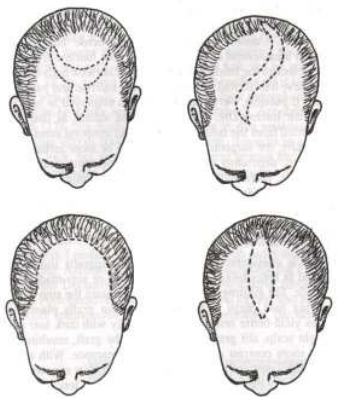

Figure 7 : Alopecia reduction incisions (Hubbard .

More extensive alopecia reduction (Bilateral scalp & bilateral temporal lifts)

The bilateral scalp lift

Bilateral scalp lift is a form of alopecia reduction with extensive dissection and undermining of hair bearing scalp allows for excision of a larger amount of the bald area of the scalp. Doppler identification of both superficial temporal arteries should be done prior to surgery. Then an incision is made approximately one cm posterior of the temporal hairline but well in front of the marked superficial temporal artery. The bilateral occipitoparietal incision is extended superiorly following the outline of the crown. The initial undermining is carried out in the avascular plane beneath the galea but above the temporalis muscle fascia. The dissection continues lateral to the inferior extension of the ear lobe in the hairless postauricular area. Then the undermining is directed posteriorly to the central portion of the scalp. The undermining is initially subgaleal till the nuchal ridge. When the occipitalis muscle is encountered, it is divided bilaterally and the dissection is continued by splitting the trapizius and sternocleidomastoid muscle fasciae and undermining superficial to their muscle bulks till the nape of the neck is reached. The surgeon literally has the entire scalp in his hands and he can perform a clean sweep from one ear to the other. Final hemostasis is performed and a drain is inserted through a stab wound. The bilateral scalp flap is then lifted and the amount of posterior overlap over the bald area is determined. Approximately the posterior third of the bald scalp is excised and the posterior aspect of the scalp flap is secured by a stable suture. Then the temporal flaps are advanced medially, the amount of overlap again evaluated and excised and the wound is closed by deep subcutaneous sutures and then a running buried 4-0 prolene suture **(Brandy, 1993)**.

The bilateral temporal lift

The 2nd of the 2 commonly used scalp lifting patterns, generally following bilateral scalp lift by 3 or more months and may be aided by the insertion of a Frechet extender at the time of the previous scalp lift. Scar from previous bilateral scalp lift is excised, dissection is done in the same plane of previous operation but then the advancement of flaps is done from the temporal areas towards the center excising the remainder of the bald area and closing the wound with drainage in the mid-scalp **(Swinehart, 1996)**.

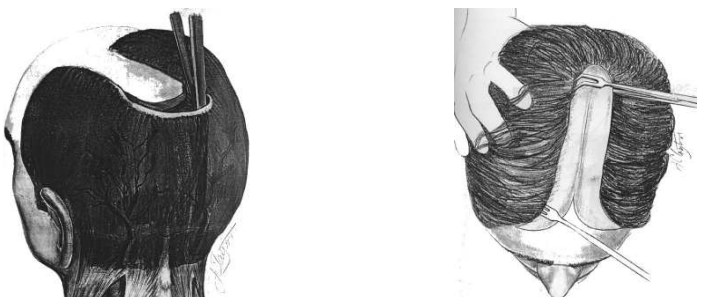

Figure 8 : Bilateral scalp lift (Lt) & bilateral temporal lift (Rt). (Swinehart , 1996)

Biologic creep (alopecia reduction with scalp expansion)

This is the predominant phenomenon in both chronic scalp expansion or scalp extension and involves actual synthesis of new collagen bundles that greatly improve the results obtained by alopecia reduction maneuvers overcoming scalp tightness and the resistance of the galea that inhibit closure of defect resulting form bald area removal.

Scalp expansion

This depends on actual volumetric expansion of the hair-bearing scalp. One or more silastic saline filled expanders are placed under the hear bearing scalp through incisions at the junction of bald and hairy scalp. Expanders are filled with saline 2-3 times weekly for a period of 6-8 weeks. After completion of expansion, flaps of the expanded scalp can be used to cover the defect resulting from removal of the bald area **(Guzel et al, 2000)**.

Most popular flaps include:

1-The expanded BAT flap (Bilateral advancement transposition flap), which uses bilateral vertical temporal posteriorly based transposition flaps. It provides excellent frontal coverage with a more natural hairline and a desirable temporal recession. It also has the advantages of ideal hair direction, ease of design and the absence of dog-ear deformity.

2-The expanded TAT Flap (Triple advancement transposition flap), which is similar to BAT flap with the addition of a third, expanded occipital flap to cover the bald crown and vertex areas. The transposed occipital flap combination avoids midline vertex scar and is an advantage to the patient for postoperative styling of hair in that region **(Anderson, 1994)**.

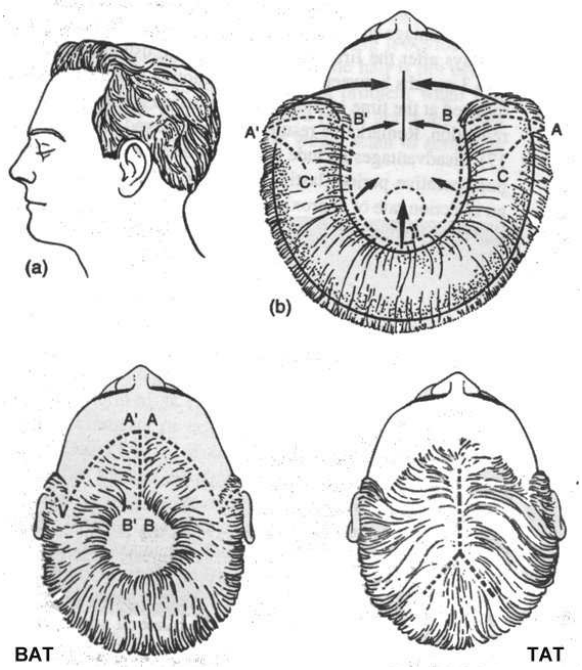

Figure 9 : BAT & TAT flaps (Hubbard , 1997)

Scalp extension

This is a form of non-volumetric scalp expansion where there is only a linear increase in the scalp area by the use of Frechet extenders implanted under the bald scalp. The extender is formed of two parallel silicone elastomer strips (elastic and possessing a memory), oriented perpendicularly to, and stitched to two titanium strips. These strips each contain hooks, which are engaged to the undersurface of the galea of the hair-bearing scalp on either sides of the bald area. The entire expander rests when implanted, on a thin pliable silicone elastomer sheet, which serves as a bed over which the contracting parallel strips can recoil without damaging the periostium.

The extender is generally placed through a midline excision, the bald and hair-bearing scalp is undermined as far as possible, the amount of overlap of bald skin along skin incision is evaluated and this amount is excised completing the first alopecia reduction surgery.

The extender is then implanted. The first row of hooks is engaged to the galea under one side of hair bearing scalp, the extender is elongated to at least double its original size, then the next row of hooks is engaged to galea under the hair bearing scalp on the other side. The scalp wound is then closed in the usual surgical fashion.

Continuous traction by the hooks of the contracting extender produce gradual narrowing of the bald area bringing hear bearing scalp from both sides closer to each other.

The desired stretch is obtained generally over only 4 weeks, then the device is removed and a second more extensive scalp reduction is performed. Complications of extender are few in the form of pain from the hooks, which can be alleviated by a pain killer, and infection, which is usually easy to control by antibiotics **(Frechet, 1993)**.

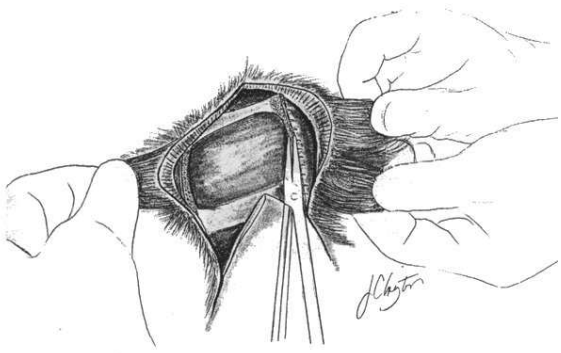

Figure 10: Frechet extender (Frechet , 1993)

Scalp flaps

Dramatic results in the treatment of alopecia have been obtained by various flaps, most popular of which is the parietooccipital flap (Juri's Flap) for reconstruction of the anterior hairline. However, because of a number of disadvantages the use of flaps has fallen out of favor. The hair orientation is in the wrong direction and without prior expansion the closure of the donor site is difficult and limits flap width. Also tension on closure tends to create a noticeable scarring. The area harvested is under risk of further alopecia and a scar at the frontal hairline cannot be avoided **(Juri, 1975)**.

Figure 11: Juri's Parietooccipital flap (Vallis , 1987)

Planning hair restoration surgery for common baldness

It is of paramount importance that hair restoration surgeon formulate a master plan for each patient. The master plan is based not only on the present patient's appearance but on the anticipated appearance in the years to come.

For patients with hairline alopecia only (Norwood types I,II), the best solution is to use hair micrografting to recreate a new hairline using graft bearing I-3 hairs, and placing single haired grafts as the frontal transional zone between the bald forehead and the actual hairline.

For patients with more extensive alopecia, a combination of scalp reduction or scalp lifting with micrografting may offer the best solution. Posterior crown baldness is treated first by scalp reduction or lifting followed by micrografting for alopecic hairline and anterior crown.

Megasession micrografting, offers the potential for treatment of larger bald area with extensive micrografting alone **(Swinehart, 1996)**.

The future of hair restoration in common baldness

The future carries much hope for great achievements in the hair restoration field. The search continues to identify the hair loss gene(s), the exact pattern of its inheritance, and its location on a specific chromosome. Trials to characterize the cellular location and molecular structure of dihydrotestosterone will enable scientists to develop drugs that can stimulate or block hair growth. Further research on 5-α reductase inhibitors including the development of topical creams is certainly warranted.

In vivo hair follicle cloning is still in its infancy but the ability to effect in vivo follicle cloning will be a giant leap in the scope of hair restoration surgery. Although new developments surface daily in the field of instrumentation, yet the dream of every hair transplant surgeon is a device that can slice the donor scalp graft, dissect it into hair grafts and then implant it into the recipient site in a totally automated process that determine the exact number and size of the grafts and avoids injury of existing hair. A new device has been developed which can be considered a first step in that direction and still needs much evaluation is the System Calvitron micrograft sectioning device which takes the flat donor strip and dices it into multiple slices by pressing a hinged top containing multiple sharp knives onto the strip. The dissected grafts are then suctioned one by one into a saline filled tube and are then surgically implanted in previously prepared slits by a foot switch-controlled, hydraulically powered handpiece **(Swinehart, 1996)**.

Cicatricial alopecia

Cicatricial alopecia results from accidental trauma including burns & scalds, bacterial infections & fungal infection, following tumor excision and radiodermatitis. Whatever the type of scarring alopecia, once the process has been shown to be static, surgical correction of cicatricial alopecia is started **(Roenigk & Wheeland, 1987)**.

The backbone of the treatment of cicatricial alopecia is the use of scalp flaps to transfer hair-bearing skin from inconspicuous areas to more obvious ones. One of the prime objectives in treating those patients is to re-establish a frontal hairline. Knowledge of the arterial supply and the direction it takes through the scalp is essential in designing the proper flap.

Rotation flaps

Small areas of cicatricial alopecia can often be excised and replaced with hair bearing rotation flaps that are usually larger than the original area of alopecia. The flap margin which will be the axis of rotation over which the flap will travel should be at least 5 times the length of the defect to be covered **(Dingman & Argenta, 1982)**

Transposition flaps

The knowledge of pattern of arterial supply of the scalp has allowed the use of narrow based long pedicle flaps which have the great advantage of easy rotation and less wasting of hair bearing skin in the dog ear that usually form at the base of wide based flaps. The most popular of these flaps is the **Juri** flap mentioned earlier in the creation of frontal hairline in male pattern baldness

Bipedicled flaps

They are used only in selected cases of cicatricial alopecia to transfer hearing bearing skin from the occipital region to the critical frontal area.

Tissue expansion

The introduction of tissue expanders has revolutionized the surgical treatment of cicatricial alopecia. The use of one or two expanders under hair bearing scalp can produce a considerable expansion of hair bearing skin, which can be used, in a variety of flaps to cover the alopecic part of the scalp **(Silfen et al, 2000)**.

Hair transplantation

Hair micro grafting appears to be a promising restorative technique for the inelastic plaques of postburn alopecia provided that there is good elasticity and hair density over the occipital donor site **(Moreno & Fresneda, 1999)**.

Artificial Hair Implantation

Recently, a new concept of artificial hair implantation has been introduced and started to gain popularity in certain parts of the world. Artificial hairs "Biofibre ® " are made of a synthetic co-polyamide which has characteristics similar to prolene but with the advantage of resistance to environmental factors. Fibres come with a knot at their inferior end and when inserted by a special apparatus, the knot is secured under the galea. It is claimed to have the advantages of simplicity, safety, ease of application, and immediate aesthetic result .It may be a possible solution of problems connected with lack of a donor area, with an atrophic or cicatricial scalp, with patient's refusal of invasive technique. Yet, it has the disadvantages of the need of periodical medical check-ups and periodical maintenance treatment. It has been licensed for use in Egypt in 1999, yet its use needs a lot of evaluation and experience before it can be a widely used option for the treatment of alopecia **(D'Ugo, 1997)**.

Alopecia Areata

Alopecia areata cases constitute about 2% of new dermatological outpatient attendances in the UK and USA. At present cases of AA cannot be

attributable to a single cause **(Messenger & Simpson, 1997)**. Two major factors have been incriminated in the aetiology of AA, namely, Genetic factors and Autoimmunity **(Friedmann, 1981)**. The characteristic initial lesion is commonly a circumscribed totally bald smooth patch with a very varied subsequent progress. The initial patch may regrow within a few months or further patches may appear after a 3-6 weeks interval and then in a cyclical fashion. A succession of discrete patches may rapidly become confluent by the diffuse loss of the remaining hair **(Messenger & Simpson, 1997)**.

The variable and uncertain natural history of AA accounts for the multiplicity of uncritical claims of a large variety of therapeutic procedures:

1-Non specific counter irritants (Dithranol, Phenol)

Feidler-Weiss & Buys (1987) reported a good cosmetic response in 25% of cases but with the side effects of pruritis & local erythema

2-Systemic corticosteroids

Systemic corticosteroids will restore normal hair growth in many cases but the risks of using systemic high doses of steroids and the re-occurrence of hair loss on cessation of treatment rarely justifies this line of therapy **(Unger & Schemmer, 1978)**.

3-Topical and intralesional steroids

Can be used to accelerate regrowth if a disfiguring alopecic patch **(Abell & Munro, 1973)**.

4-Topical immunotherapy

The use of potent sensitizing *diphencyprone DCP* to induce contact dermatitis of the scalp has produced regrowth of hair in some sufferers. **(Madani & Shapiro, 2000)**. It is felt to be the treatment of choice by many dermatologists **(Bolduc & Shapiro, 2000)**.

5-Photochemotherapy (PUVA)

Usage of combination of 8-methoxypsolaren & UVA **(Lassus et al, 1984)** & total body PUVA **(Monfrecola et al, 1987)** have been found to induce hair regrowth in a number of cases but the needed high dose of irradiation make this line of therapy rarely justified

6-Topical Minoxidil

The mechanism of action of Minoxidil in cases of alopecia areata is still unknown but promising initial trials necessitate further evaluation **(Fiedler-Weiss, 1984)**.

7-Immune modulation (Cyclosporin)

Oral cyclosporin produces hair regrowth in alopecia totalis but the drug is both nephrotoxic and hepatotoxic. Topical cyclosporin has reported success in producing patchy hair regrowth, which need further evaluation **(Dawber et al, 1998)**.

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