

A Review of Surgical Methods (Excluding Hair Transplantation) and Their Role in Hair Loss Management Today

There is more than one way to manage hair loss surgically. Apart from hair transplantation, there are other techniques which have been used by many to treat baldness. This article attempts to review the surgical methodology and philosophy that have acted as guiding lights in the approach to surgical treatment of baldness over the years and reviews the current role of other techniques in the armamentarium of hair restoration surgeons today.

KEYWORDS: Alopecia, alopecia reduction, pattern hair loss, scalp flaps, scalp reduction

INTRODUCTION

The search for an ideal treatment for baldness has been on for a very long time. The constant desire to produce natural-looking results and meet ever-increasing patient expectations has driven this evolution of techniques in the last few decades. Amongst the various techniques available today, follicular unit transplant (FUT) still remains, by an overwhelming majority, the most common procedure used to correct pattern baldness. Today, with hair transplantation techniques assuming a preminent rank in modern hair restoration, where do the older methods stand?

HISTORICAL BACKGROUND

J. Dieffenbach is credited with the first recorded report of hair restoration surgery in 1822 in which he reported on the performance of his procedure on birds as a test of its viability.^[1] Hair restoration subsequently evolved in two directions, one with those working on autografts and the other basically with reconstructive surgeons working on flaps and serial excisions. This article will primarily focus on the latter.

One of the earliest articles was by Hunt (1926) who proposed surgical procedures for correction of alopecia and alopecia areata.^[2] He suggested serial excision of small patches of alopecia and advancing hair-bearing scalp to close the defect. Passot in his classic text published in 1931 mentioned long narrow hair-bearing flaps for correction of alopecia.^[3] This is considered by many as the precursor of present-day scalp flaps. In 1939 Tauber applied Passot's techniques and described use of local flaps elevated from the lateral and posterior scalp for replacement of hair in 50 cases of male pattern hair loss.^[4]

Lamont in 1957 described lateral scalp flaps for the treatment of fronto-temporal baldness.^[5] Correa-Iturraspe and Arufe in the same year attempted several different methods to correct partial alopecia, one of which was excision of full-thickness segments of hairless scalp skin and primary closure of the wound margins.^[6] Orticochea described his three-flap method for scalp defects in 1971.^[7]

Small pedicle flaps of donor scalp were employed for decades for scar correction on the scalp but it was only after 1975, that they had a resurgence, largely due to the work of J. Juri in Buenos Aires. His long, twice delayed (delay - a surgical procedure for improving the survival of flap on limited blood supply) temporo-parieto-occipital (TPO) scalp flaps eliminated the curious tufted appearance of a punch graft hairline.^[8] But these flaps also did not become very popular, because of their high failure rate and even when successful, the frontal

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hair growth was frequently unnatural in density and direction. Harii, Ohmori and Ohmori (1974) made use of microsurgical techniques to transplant hair by free scalp flaps.^[9] To some extent the unnatural direction of hair in the Juri flap was tackled by Ohmori in 1980. He designed a large Juri flap but transferred it using microsurgical techniques. The advantage was to transfer large amounts of hair in one stage and position the flaps in such a way that the direction of hair is natural.^[10] In 1976 Blanchard and Blanchard (credited with the first scientific paper on scalp reduction) described the technique of scalp reduction, which they called "obliteration of alopecia by hair-lifting".^[11] The term "scalp reduction" was first used by Sparkuhl in 1978 and he defined it as surgical excision of redundant tissue from one or more areas of scalp alopecia.^[12] Scalp reduction had a somewhat variable course of success partly due to its complications. To some extent these shortcomings were addressed by Manders and associates, Nordstrom and Devine, and Leonard and Small with use of tissue expanders^[13,14] and later by Frechet in 1993^[15] with the use of an implanted extender. Subsequently, many procedures and devices were proposed to lessen the effects of stretch-back and other associated problems. These included Seery periosteal flap anchor,^[16] the Unger PATE (Prolonged Acute Tissue Expansion)^[17] procedure and the Nordstrom silastic suture, and Cohen's innovative skin-stretching device called the Suture Tension Adjustment Reel (Miami S.T.A.R.).^[18] Marzola tackled the problem of the unsightly scar from a different approach by using the "M"-shaped incision.^[19]

At the turn of century scalp reduction was appropriately rechristened "Alopecia Reduction" (AR). Modifications kept being made, in a bid to reduce complications and improve the indications.

SURGICAL HAIR RESTORATION

Surgical hair restoration can be classified into following headings:

1. Hair transplantation
2. Scalp flaps
 - a. Rotation flaps
 - b. Transposition flaps
 - c. Temporo-Parieto - Occipital - (pedicled)/Juri flaps (TPO flaps)
 - d. Temporo- Parieto - Occipital (free/microvascular) flaps
 - e. Lateral scalp flaps
 - f. Temporal vertical flaps
 - g. Other flaps
3. Alopecia Reduction (AR)
 - a. Simple AR
 - b. Major AR/scalp lift
 - c. AR with prior scalp extension (non-volumetric)

- d. AR with prior tissue expansion (volumetric)
- e. AR with intraoperative stretching (volumetric and non-volumetric)

As this article deals with methods other than hair transplantation, hair transplantation is not discussed here.

ANATOMIC CONSIDERATIONS

An understanding of the surgical anatomy of the scalp is the basis on which complication-free scalp surgery is based. However, only surgically relevant points are mentioned as detailed anatomy is beyond the scope of this article. The scalp skin is thicker than the skin of most places on the body and has of a rich network of anastomosing arteries (system of anastomoses between branches of the external and internal carotid arteries), veins, and lymphatics in the subcutaneous layer. The vascular supply of the scalp is centripetal (vessels enter from the periphery and run medially) and hence incisions in the peripheral scalp that transect arteries may grossly limit blood supply to areas both adjacent to and remote from the locus of transection.^[20] Subcutaneous fat is divided into multiple small compartments by fibrous septa which bind down the scalp skin firmly to the muscles and aponeurosis, making dissection in this plane difficult and bloody. The galea because of its inelastic nature is the main limiting factor in scalp reduction but to some extent, this can be overcome by the surgical procedure of galeotomy. The subgaleal compartment is largely avascular, containing only a layer of loose areolar tissue. This enables surgical dissection in the subgaleal plane during reconstructive procedures and large flaps can be safely raised without delaying procedures. It is this space that is exploited by surgical dissection. The pericranium is a dense membranous or fibrous sheet loosely fused on its outer aspect to the galea aponeurotica, from which it is readily separable via the subgaleal space. The pericranium is capable of retaining sutures even when subjected to significant tension. Incorporating a pericranial flap in deep wound closure seemingly contributes to decreasing wound tension and hence to the production of fine linear scalp scars.

UNDERSTANDING SCALP LAXITY

Scalp laxity is the basis of all scalp surgeries and has two very distinct components. First is the ability of the scalp to slide or glide on the underlying pericranium. The second component of scalp laxity is its elasticity or ability to elongate (loosely termed "stretch"). This is distinct from the sliding phenomenon. Some scalps are highly elasticized, and even in the presence of the relatively inelastic galea, are capable of reasonably significant elongation.^[21]

Application of tension to the skin for a period (temporarily) causes the skin to stretch; this response is known as mechanical creep.^[22] The stretch is minimal as no tissue growth occurs. This beneficial effect of creep is utilized by use of retention sutures or towel clips to facilitate closure of skin edges. On the other hand when the skin is stretched for a longer period (weeks to months) the stretching response is more and it is known as biological creep.^[22] The mechanism underlying biological creep is not exactly known, but possibly is related to a combination of epithelial proliferation, new extracellular matrix formation, and recruitment of surrounding tissue. When prolonged stress is applied, like an extender (Frechet) or an expander, tissue growth occurs which is responsible for increased amount of skin available for excision.

SCALP FLAPS

Scalp flaps were initially used in patients with soft-tissue defects of scalp and later were adapted for use in hair loss.^[23] Scalp flaps require careful planning and adequate knowledge of the vascular anatomy of the scalp. Doppler apparatus is invaluable for marking out the arteries. The type of flap used for restoration will depend on the area and location of alopecia. This holds true whether one is dealing with cicatricial alopecia or pattern hair loss.

ROTATION FLAPS

Rotation flaps are local random pattern flaps that use adjacent tissue, in which the tissue is rotated around a pivot point (arcuate slide) to cover a primary defect.^[24] Rotation flaps fill one defect by creating a secondary defect which can be closed primarily. Small areas of cicatricial alopecia can often be excised and covered with a hair-bearing rotation flap.

TRANSPOSITION FLAPS

When the local flap is carried over an intervening area of normal skin to be placed in its recipient site, it is known as a transposition flap.^[24] These could be random pattern (based on subdermal plexus) or axial pattern flaps (a flap which has an existing, anatomically recognized arteriovenous system running along the length of the flap). Transposition flaps are generally smaller and freer in their movement than rotation flaps. Simple transposition flaps are usually wide-based and used to cover scalp defects (traumatic) or areas of cicatricial alopecia and generally need a skin graft to cover the secondary defect.

TEMPORO-PARIETO-OCCIPITAL / JURI FLAPS

Till the mid-'70s frontal hair loss was usually treated with punch grafting and this led to a very typical corn row appearance. The curious tufted appearance of a

punch graft hairline was eliminated when Juri devised a long axial pattern flap which was narrow-based to correct frontal baldness in male pattern hair loss. His design provided a longer flap (up to 25 cm in length) that spanned the entire arc of the frontal hairline.^[8] A slightly modified version of the temporo-parieto-occipital (TPO) flap was used by Stough, Cates and Dean^[25] and Mayer and Fleming.^[26,27] This flap was shorter and did not require extensive dissection like the Juri flap for closure of the donor site.

PATIENT SELECTION FOR TPO FLAPS

A patient with predominantly frontal baldness and who desired rapid, dense coverage of the frontotemporal region and who possessed adequate parietal donor hair was eligible for TPO scalp flaps. Importantly, lifestyle habits like smoking could be a potential contraindication for this method.

ANAESTHESIA

The flap needs two procedures known as "delay" before actual transposition of the flap and these can be done as an outpatient procedure under local anaesthesia. The transposition or the final stage of the TPO flap requires extensive undermining and surgical mobilization, hence the need for general anaesthesia.

TECHNIQUE

Prior marking of the superficial temporal artery and its branches is done with the help of Doppler probe. The flap is designed with its base (approximately 4 cm) in the temporal area and having the terminal parietal branch of the superficial temporal artery running down its midline. It extends to the parietal and occipital areas staying within the permanent fringe area but inferior enough to the superior border of the fringe for hair to cover the scars.

Concept of delay

It is felt that the blood supply of a flap would not be adequate for its survival if it was raised and transferred straightaway. Its vascular efficiency can be enhanced by surgically outlining the flap prior to its actual transfer; the procedure and its effect are both referred to as delay. The delay procedure is meant to open up the choke vessels and allow the flap to survive only on the branches of the feeding vessel (axial pattern).

First delay

The first delay is carried out under local anaesthesia as an outpatient procedure. The hair is clipped short along the longitudinal margins only. Both the inferior and superior borders are incised right down to and through the galea. After achieving haemostasis the incisions are

sutured and dressing given. By doing this the blood supply from the neighbouring perforators is cut off on the superior and inferior borders.

Second delay

A week later the occipital (terminal 5-6 cm) end of the flap is incised and raised under local anaesthesia and sutured back. This manoeuvre cuts off the supply from the occipital branches and trains the flap to survive only on the parietal branch of the superficial temporal artery.

Transposition of the flap

This procedure is carried out under general anaesthesia and the flap is incised on three sides and up to the galea. The flap is carefully elevated right up to the base in the subgaleal plane. The donor defect is closed primarily in two layers after extensive undermining in the retro-auricular region right up to the neck inferiorly and the anterior scalp in the superior aspect.

Creating the recipient site for the flap to suture is the next part of the surgery. The proposed anterior hairline is marked. An incision which is bevelled anteriorly (to provide a better fit) is made along the proposed line. Some amount of the bald skin may be excised to fit the flap into the recipient area. The anterior margin of the flap is de-epithelialized about 2 mm deep and the frontal skin is sutured over this to ensure that the hair grow through the scar (trichophytic).

A second flap from the contralateral side may be raised similarly depending on the extent of frontal hair loss. The Juri (TPO) flap is the only method that can give instant results with an astonishing density as compared to the conventional hair transplant which requires 6-12 months to produce good cosmetic results. Reduction of the bald area is also achieved as some skin is excised for inset of the flap.^[18]

COMPLICATIONS

The potential complications include wide donor scars, and partial or complete necrosis of the flap.

A common problem seen with most transposition flaps – dog ear deformity – is seen with TPO flap.

LATERAL SCALP FLAPS

Technical difficulties and the hassle of delay were overcome when Elliot^[28] described the shorter version of the temporoparietal flap. This flap was based on the anterior hairline, which curved over the ear and directed posteriorly having a width averaging 2.5 cm. It was easier to execute given its narrower width and shorter length. The temporoparietal flap is too short to traverse the entire frontal hairline and usually a flap from the opposite side

is required to bridge the gap. Unfortunately, this narrow flap often appears unnatural, especially with progress of hair loss, leaving an isolated, narrow strip of hair that serves as the manufactured frontal hairline.

TEMPORO VERTICAL FLAPS

Nataf in 1984 designed a flap based superiorly in the parietal scalp, which extends vertically downwards either in the pre or retro-auricular areas. This flap was meant primarily for frontal baldness of male pattern hair loss and designed in such a way that the hair would be oriented in a forward direction. It can be as long as 25 cm but more importantly the quality of hair (retro-auricular) it contains, is ideal for frontal hairlines. Due to its narrow width and long length this flap too needs a delay but it leaves the temporal area intact.^[29]

TEMPORO-PARIETO-OCCIPITAL FREE (MICROSURGICAL) FLAP

Due to the fixed attachment of the pedicle, the positional adjustment of the flap in the recipient area is somewhat limited in the traditional scalp flaps. It is difficult to change the direction of hair and a redundant fold of skin may occur at the base of the pedicle (dog ear deformity). Harii, Ohmori and Ohmori overcame these two problems when they made use of microsurgical techniques to transplant hair by free scalp flaps. By using specialized microsurgical instrumentation and operating microscopes they could transfer large amounts of hair-bearing tissue in one stage.

In 1980 Ohmori described a free Juri flap. He transferred the TPO flap in one stage anastomosing the donor vessels to the contralateral temporal vessels. The advantage of this technique was that the flap could be positioned in such a way so that the hair was oriented in a natural direction and the dog ear deformity avoided. This method is technically demanding and needs the surgeon to be well trained in microvascular surgery.^[9,10]

OTHER FLAPS

Bipedicle (Visor) flaps from the occipital area have two pedicles and are rotated over the vertex like a visor to reach the frontal area. These flaps were basically described in cases of cicatricial alopecia. Smaller bipedicle flaps based on temporal areas can be used to cover areas of cicatricial alopecia in the frontal region.^[23] The advantage was one-stage transfer and primary closure of the donor defect.

Multiple flaps devised by Orticochea (1971) were used for scalp reconstruction. In this rather radical method he divided the intact scalp into three large flaps, with each having its own pedicle. He then transposed them

geometrically to cover the scalp defect.^[30,31] Additional flexibility was achieved by making parallel incisions in the galea.

ALOPECIA REDUCTION

Excision of hairless scalp as a treatment for baldness has undergone significant changes in the last couple of decades. Scalp reduction, now appropriately called alopecia reduction (AR), can be defined as excision of an area of alopecia. ARs are used for male pattern hair loss (MPHL) and also for cicatricial alopecia.

The extent of bald scalp that can be excised is limited by:

1. Scalp laxity
2. Surgical undermining
3. Amount of creep (stretching) obtained preoperatively or intra-operatively

Timing of AR

AR works best when used in combination with hair transplantation for correcting hair loss. It can be planned before or after the hair transplant, each sequence having its own advantages and disadvantages. AR performed before hair transplantation has the advantages that it ensures adequate blood supply and it avoids distortion of transplanted frontal and temporal areas.

PATIENT SELECTION FOR AR

Domnic Brandy had suggested patient selection criteria for AR. He concluded that the evaluation system should help the hair restoration surgeon determine who is a good candidate for AR and who is a poor candidate.^[32] Ideal candidates are males with Norwood Grade 4, 5 and 6, who are above the age of 40 with stable hair loss. These patients should have little or no hair in the scalp which is to be excised but have dense hair on the sides and back of the head (good arietal humps) with good scalp laxity. The occipital fringe should be at least 10 cm wide with no retrograde recession (low occipital hairline). In addition, patients should be counselled preoperatively on the likely further loss of some hair near the incision line.

AR is contraindicated in the following situations:

1. Very tight scalp
2. Thinning or poor density on sides and back of scalp
3. Area for excision has significant hair (better managed with medical treatment)
4. Very young patient with evolving hair loss or very high expectations
5. Grade 7 Norwood

PREOPERATIVE PREPARATION

Preoperative scalp massage

The ability of the scalp skin to stretch over a period

of time from prolonged tension (mechanical creep) is utilized preoperatively. To accomplish this scalp massage is advised at least four to eight weeks prior to surgery. The amount of laxity that is generated from this can be quite surprising.

ANAESTHESIA FOR AR

Simple ARs can be carried out under local anaesthesia with sedation. But the major ARs or the ARs with stretching or expansion would need general anaesthesia.

SIMPLE AR

A variety of patterns for AR have been described and the scalp is quite forgiving that just about any design is acceptable. The most common are the ellipse, the inverted Y or the rocket ship pattern, the flattened S shape, or the M-shaped design. The idea is to remove as much bald scalp as possible, preserving the part which contains hair. The choice of design depends upon individual patients and their pattern of hair loss. After the design has been marked, an incision is made on one side, right down to the galea all through its length. Bevelling the blade is helpful in preventing injury to the follicles along the margin. After achieving haemostasis undermining is begun in the subgaleal space. A combination of sharp and blunt dissection helps to create flaps on either side. Bleeding is rare and coagulation is required only in the occipital areas or the vertex where two or more perforators are usually transected. The amount of excess scalp is assessed by overlapping the flaps and excising the excess tissue. The closure is done in two layers.

MAJOR REDUCTIONS

Major ARs, also termed scalp lifting or extensive scalp lifting are different from simple reductions in the degree of undermining. The advantages are preserving donor scalp for future transplantation, advancing temporal hairline and thus treating temporal baldness, minimizing slot formation, minimizing scalp stretch-back, and significantly reducing the total procedures required to excise the entire bald scalp.^[33] It may involve severing of vessels and nerves (postauricular, occipital) to achieve greater mobility of the undermined scalp flap helping to excise greater amounts of bald scalp. Mangubat felt that ablating the occipital neurovascular bundles (ONB) significantly increases the risk of ischemic complications in extensive scalp lifting. He described extensive scalp lifting with preservation of the ONB. It adds more difficulty to the already challenging procedure but its increased therapeutic safety and flexibility are important considerations.^[34]

Major ARs require a formal operating room and general anaesthesia and mandate an overnight or a couple of days hospital stay. Brandy has mentioned the beneficial

role of prior bilateral occipital artery ligation when attempting major AR or scalp lifting.^[35] This reduces the chances of scalp necrosis postoperatively to less than 2%. Performed four to six weeks prior to the scalp lift, this works as a delay procedure. Ligation of the major arteries helps to open up the choke vessels from the superficial temporal arteries and postauricular arteries aiding development of collateral circulation. Just prior to surgery identification of both superficial temporal arteries is done with a handheld Doppler.

Technically, extensive scalp lifting involves two stages – the first stage is raising bioccipitoparietal flaps. The incision begins anteriorly 1 cm behind (posterior) to the hairline but well ahead of the marked superficial temporal artery. The incision then follows the outline of the bald area posteriorly on both sides. Undermining proceeds deep to the galea but above the temporalis fascia with proper assistance (retraction and illumination) and instrumentation (self-illuminating and suction retractors). Inferior limit of undermining is the area just above the level of the ears (laterally) and posteriorly to a line drawn horizontally from the inferior aspect of each earlobe along the nape of neck, involving transection of the occipitalis muscles. After undermining, the horseshoe-shaped crescent of the bald area is removed. Before closing the incision drains are inserted behind both the ears. The closure is effected in two layers. The key in avoiding stretch-back is to take good bites in the galea and a couple of retention sutures with a non-absorbable material like Ethibond or Prolene.

The second stage involving the bitemporal flap (BT) is usually carried out about three months after the first surgery. The incision includes the previous scar and traces the same course. Posteriorly both incisions meet and depending upon the patient's whorl the direction of the incision is veered in towards it. This helps to eliminate the possibility of a dog ear. With two procedures the right and left parietal scalp and the occipital scalp meet at the vertex covering this region with the patient's natural hair.

AR WITH PRIOR SCALP EXTENSION (NON-VOLUMETRIC)

To overcome the limitations of standard AR Frechet in 1993 devised the procedure which he called Scalp Extension.^[15] Scalp extension is a surgical procedure which utilizes a sheet of bioplastic (silastic) extender. The scalp extender consists of a thin sheet of bioplastic material, bearing a row of hooks at each end to be affixed to the galea. After conventional AR (midline excision) the extender is stretched and attached with the hooks to the undersurface of the galea in the hair-bearing area as near to the margin as possible. It is then stretched to 100% of its size and hooked to the undersurface of

the galea on the contra lateral side. The wound is then closed and the extender is left in place for 30-40 days. In this period the distance separating the two rows of hooks would have reduced considerably due to the process of biological creep. The second surgery involves removal of the extender (with special instrumentation) and undermining just as in a standard AR. The bald area is excised and the wound closed. If further reduction is desired another extender can be reinserted and the same procedure repeated after one month. According to Frechet the use of extenders reduces the number of reductions by one-third to one-half. Moreover, temporal baldness also can be reduced with extenders.

A common side-effect of AR is a deformity in the vertex known as "slot" which is created due to hair growing in different directions of the scar on either side. This is usually seen six to eight months after surgery. Frechet devised a flap which is actually a triple transposition flap used for correction of the slot secondary to scalp reduction surgery.^[36,37]

AR WITH PRIOR TISSUE EXPANSION (VOLUMETRIC)

Tissue expanders were designed to utilize the property of the skin to stretch using biological creep. These are basically silicon balloons which can be inserted beneath the skin and gradually inflated to increase the surface area of the overlying skin. In ARs with prior tissue expansion, tissue expanders are inserted, as a separate procedure 6-12 weeks prior to the AR. These are gradually inflated with normal saline at weekly intervals. Pain and blanching of the overlying skin are the endpoints at which each individual inflation is stopped. After the capacity of the expander is achieved, it is kept expanded for a couple of weeks. At the end of 8-12 weeks the expander is removed and the AR is carried out. The use of tissue expanders enables surgeons to excise as much as 10-12 cm of alopecic skin in one go.

The downside of using expanders is the significant cosmetic deformity that the patient has to bear during the process of expansion. This has limited the use of expanders to cases of cicatricial alopecia.^[38-40]

AR WITH INTRA-OPERATIVE STRETCHING (VOLUMETRIC AND NON-VOLUMETRIC)

To overcome the significant cosmetic deformity caused by the expander, Dr Martin Unger proposed the PATE (Prolonged Acute Tissue Expansion) procedure. In this procedure after the incision was taken and flaps undermined, an appropriate-sized expander was inserted under both flaps and the galea closed with sutures. Rapid inflation and deflation with distilled water was carried out on the table. Eighteen to twenty

such cycles were carried out before removing the galeal sutures and expanders. This produced mechanical creep and enough tissue laxity, once the expanders were removed, to allow for the excision of nearly 136% more tissue than the conventional AR. The advantage of the PATE procedure is that in one operative procedure itself more amount of tissue can be removed and the patient does not need to make frequent visits.^[17]

Dr Cohen developed and patented a skin-stretching device called the Suture Tension Adjustment Reel (Miami STAR) which also used the process of mechanical creep to allow for greater excision of alopecic scalp. The STAR could be used for preoperative tissue stretching, for intra-operative tissue stretching, and for tissue mobilization as applied to scalp reduction surgery.^[18]

COMPLICATIONS OF AR

The problems in scalp reductions primarily arise from lack of experience and poor selection of patients. Slack closures, careful dissection, staying in the right subgaleal plane, gentle handling of tissues and precision suturing all help to reduce complications.^[41]

The complications could be divided into surgical and cosmetic.

Surgical complications

Serious problems could be encountered during undermining.

Bleeding (most bleeding can be controlled with mechanical pressure, coagulation or over-running sutures), hematoma (can occur because of undetected bleeders or if bleeding occurs after closure and aspiration or drainage of the hematoma may be required), infection (never a major problem in the scalp and chances of infection are more when foreign bodies like expanders or extenders are used), non-closure and wound dehiscence, anaesthesia/ numbness is seen in extensive scalp lifting, occurs if the closure is tight, cysts and foreign body granulomas. Stretch-back is re-expansion of the bald area after reduction (Norwood, Sheill and Morrison).^[41] There is always some degree of stretch-back in AR and it varies from 10–50%. Pain (tight scalp feeling) initially is due to is due to tension in the wound but pain after three to five days postoperatively could be due to enlarging hematoma infection.

Cosmetic complications

Distortion of bald area is usually seen at the vertex where the normal round or U-shaped bald area gets converted into an extended oval, triangular area with slot formation, etc. This can be avoided to some extent with proper planning. Meeting of both the sutured edges in

the midline with hair growing in opposite directions is called a slot deformity. Retraction of the frontotemporal hairline can occur in cases of a transverse excision of the bald area. Scars are unavoidable but poor scars result because of tight closures, improper suturing and inadequate galeal fixation. Thinning is seen in temporal and occipital areas due to stretching of skin in these areas. Apparent acceleration of MPHL can be attributed to the fact that, area of future baldness is stretched over a wider area in a younger patient; the apparent increase in hair loss will be noted because of geometric reasons. The hairline over the ears can also appear elevated giving the impression of a recent haircut. Effluvium (Anagen as well as telogen) can be observed in some cases, especially near the suture lines.

DISCUSSION

This article has tried to outline the philosophy and strategy for hair restoration that has evolved with time. Hair restoration was given a major boost by the introduction of hair transplantation by Orentreich.^[42] But as time passed, the pluggy look left these patients desiring something better. It would not be fair to think that early methods were universally primitive and the results coarse and unaesthetic. While there were many poor results, some of the results from older procedures were indeed satisfactory. It was the pluggy look of these early efforts that was most apparent. This, along with the inadequacies in treating vertex hair loss were some of the reasons why scalp reduction gained importance. Scalp rotation (flaps) and AR started to wane as more complications and patient dissatisfaction began to get reported. Even if one were to look at the literature being published on hair restoration or papers being presented today, there is very little or practically no mention of ARs and scalp flaps.

One can evaluate their (ARs and scalp flaps) relevance today if one analyzes the patient who requests help for a hair loss problem. Today the average hair loss patient is a person who comes with very high expectations, is relatively younger, does not want invasive/major surgery and is extremely concerned with postoperative scars, permanence of results, etc. In short he/she wants a procedure which can boast of a very good risk:benefit ratio, i.e. very little risk (morbidity) and lot of benefit. Also, there is help available from the pharmaceutical industry which has in fact changed the whole approach to hair restoration in younger patients.

But if one were to look at long-term implications – ARs actually decrease the effective amount of hair that could be moved during subsequent hair transplantation to the front and top of the scalp, due to reduced donor density and scalp laxity. As a result the more

cosmetically important frontal area is denied the benefit of transplantation due to reduced donor reserves. Although a scalp reduction may be performed with the best intent, it can place the patient in the precarious position of having more cosmetic problems than he started with and the lack of donor reserves to correct them, due to the progressive nature of hair loss.

ARs today could be useful in treating cicatricial alopecia (pathological or traumatic) as transplanting scarred areas has its own set of problems and depends a lot on the vascularity and thickness of the scarred area. Reduction of the scarred area (depending on the size and location) could be a better option than transplanting it, especially smaller areas which do not require undermining. Slightly larger areas could be excised and covered by using the tissue expansion principle and hair restoration surgeons must know how to identify these cases in order to assure patients of the best outcomes. It is important that the person practicing hair restoration has to have a basic knowledge of these techniques and should be familiar with principles of plastic surgery. Scarred areas oriented in a linear fashion on the crown or vertex areas are better suited for tissue expansion. In scarring alopecia or in areas which are covered with skin grafts (areas where split or full-thickness skin grafts were placed over the cranium) which are not suitable for hair transplantation, are best excised and replaced by healthy skin containing hair.

A patient who desires rapid, dense coverage in the frontotemporal region and who possesses adequate parietal donor hair may be eligible for the TPO flap. Even with multiple sessions of hair transplant one cannot achieve the density seen in TPO flap transfer. But, with the scalp flaps, especially the Juri flap and temporal vertical flaps, the density and the direction of the hair are not natural and hence not very acceptable. Moreover, the flaps have a significantly high failure rate with flap necrosis at the tip and a very visible scar at the anterior hairline. The free flap described by Ohmori did take care of these issues but was technically very demanding and could not justify the means to the result. These procedures require a lot of skill and surgical experience and, even in the best of hands these procedures are risky and create too many cosmetic problems for the patient in the long run. In the current practice, the routine use of scalp flaps remains restricted for reconstructive measures and not as a first line choice for cosmetic hair restoration.

CONCLUSION

Hair transplantation has evolved to a state-of-the-art therapy, with notable refinements in the instrumentation and approach to the problem of pattern hair loss. Moreover, most patients today are more psychologically

inclined towards hair transplantation, and this technique remains the primary means by which we address pattern hair loss and which provides reasonably satisfying results for surgeon and recipient alike. In contrast ARs and scalp flaps have a very limited or practically no role in the restoration of patients of pattern hair loss because of the invasive nature of these procedures and the concern that surgical outcomes are not commensurate with the perceived added morbidity. Simply put they do not have a very good risk-benefit ratio. ARs could have a very favourable safety profile in selected cases of cicatricial alopecia, which have very small patches of hair loss. Scalp flaps could find favour in small cases of cicatricial alopecia where local flaps could be used without having a secondary defect to restore.^[43]

Presently, most of the surgical hair restoration is hair transplant-based with little or no contribution from scalp reduction and scalp flap procedures.

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