Introduction to the Guide to Hair Restoration

Hair loss affects millions of men and women and can be a difficult and emotional problem for many. Fortunately, there are effective preventive measures that one can take if the condition is diagnosed early and there are successful treatments if your hair loss has progressed. The purpose of *The Guide to Hair Restoration* is to give you a better understanding of this common problem and to provide you with the tools to make the best possible choices if treatment is needed.

Although the emphasis of this text will be on our pioneering hair restoration procedure Follicular Unit Hair Transplantation, a surgical approach is not right for everyone. Many patients will benefit from treatment with medication alone or no treatment at all. The decision to seek treatment for hair loss is sometimes a difficult one and always very personal. At times the psychological impact of hair loss gets in the way of clear thinking and proper guidance will be the most important part of therapy. Hopefully, this book will help the reader keep things in perspective so that the right decisions will be made.

This book covers the basics of hair and hair loss, medical treatments for balding and modern hair transplant surgery. It will explain, in simple terms, the actual hair restoration process and offer tips on how to get the best possible care.

The Guide to Hair Restoration is based on the original text "The Patient's Guide to Hair Restoration" by Rassman and Bernstein. The new book has the same easy-to-understand writing that explains the causes of hair loss, how it is diagnosed and how baldness is best treated using medications and hair replacement surgery. The new writing incorporates the many advances in both the medical and surgical management of hair loss that have occurred since the last publication. This digital format allows for constant updating with the newest, most important information. The title, "The Patient's Guide to Hair Restoration," has been changed to *The Guide to Hair Restoration,* since one doesn't have to become a hair transplant patient to find value in this book.

1 Brief History of Hair

Throughout history, hair has been an important symbol of gender, social, religious and professional status. The significance of hair is as great as that of clothing, jewelry, tattoos, weapons, and crowns. The importance of hair goes back at least as far as the Stone Age.

In 1991, a man's body was found frozen in a glacier near the Austrian-Italian border. His hair was neatly cut to a length of 3.5 inches, and his beard was trimmed. Because he looked like a modern man, at first it was thought that he had died only a few years before. Upon examination of his clothing and weapons, archaeologists concluded that he had been frozen for more than 3,000 years. It is likely that trends and social mores of the time dictated that this preserved Neolithic man wear his hair in the fashionable cut and style of that age.

In Ancient Egypt, sons of the Pharaoh wore their hair tied in a distinctive bun on the right side of the head just behind the ear. The Pharaoh himself was never seen without a wig. Even today, male and female Parliamentary judges in England wear obviously artificial horsehair wigs when they preside in court.

The oldest known medical text is an Egyptian papyrus scroll. Its remedies include an ointment for restoring lost hair, consisting of equal parts crocodile fat and hippopotamus dung. The physician who wrote the text recommended that one rub this concoction into the bald scalp.

The ancient Greek physician, Hippocrates, recognized a connection between the sexual organs and baldness. He may have been the first to record the observation that eunuchs (men castrated before puberty) did not become bald. Hippocrates' own baldness stimulated his interest in the subject of hair loss. His prescription for preventing hair loss was the application of a mixture of cumin, pigeon droppings, horseradish, and nettles to the scalp. In fact, the area of permanent hair that encircles the back and sides of the head is sometimes referred to as the "Hippocratic wreath."

Dating back to Biblical times, the tale of Sampson is one of the familiar examples of man's concern over hair loss. Sampson had the strength to destroy the Philistines as long as his hair remained long and uncut. As soon as Delilah cut his hair, he lost all of his strength.

Early Christian monks and priests shaved the hair on the crown of the head to create a tonsure. This highly visible mark symbolized their renunciation of worldly fashion and esteem; it also expressed their personal dedication to God. During the Middle Ages, Christian society saw an emphasis of concern with the spiritual side of life and a studied neglect of physical functions. The tonsure became so extreme that, upon taking orders, a monk shaved his head almost completely bare, so that only a narrow fringe of hair remained encircling his head.

During the time of King Louis XIV of France, elaborate wigs became fashionable for the aristocracy. Some of these wigs incorporated paraphernalia such as model ships and cages with live birds. The more complex constructions often weighed 15-20 pounds.

Known for luxuriant hair in his youth, King Louis began this practice and may have adopted the fashion to disguise his balding as he grew older. Elaborate wigs continued to be a symbol of social status until the middle of the eighteenth century.

Hair has also been an important symbol of rank and religion in Asia. Buddhist monks shaved their heads completely bald. Japanese Samurai warriors shaved the front and top of their heads and drew the long back and side hair into a complex topknot. Even modern day Sumo wrestlers wear their hair in a distinctive knot at the back, although they do not shave the front and top. The ubiquitous queue or pigtail of Chinese men, a long single braid worn down the back, was a symbol of their bondage to a lord, landowner, or to the Emperor. Most urban Chinese men cut off their queues after the revolution in 1920, but the custom persisted in the countryside. During the revolution, any man found wearing a queue was publicly humiliated, with his hair cut off and burned.

Today, hair continues to be an important part of self-expression as it functions as a symbol of attitude, culture, and religion. For both men and women, hair is important to one's self-image and identity. Hair – a mere outgrowth of dead cells from the surface of the skin – has become a powerful social currency and a universal symbol of beauty, vitality and youth.

2 Hair and Its Functions

The condition and appearance of one's hair is an important indicator of age and the body's general state of health. Other similar indicators, such as skin condition, muscular coordination, brightness of the eye and alertness of manner, are often more subtle or may be masked by clothing. Hair, however, is in plain sight. There are many associations and social reactions that are elicited when a person observes someone with graying, or little or no hair. It has been thought that such reactions were based on primal judgments, such as whether the person is fit for warfare, reproduction, or active labor. A full, glossy head of hair is a signal that one is youthful, vigorous, and desirable.

What is hair anyway? Hair is composed of a complex protein called keratin. Of the human body's three basic compounds; proteins, fats, and carbohydrates; the synthesis of protein requires the greatest investment of energy. When a person becomes ill or malnourished, his/her hair stops growing. When illness or malnutrition is severe or prolonged, the hair may temporarily fall out (the medical term for this shedding is telogen effluvium). The resumption of hair growth is a sign that recovery has begun. Science continues to explore why hair grows or fails to grow, and why it disappears permanently in some people, but not in others.

Mammals share three main characteristics. Most mammals bear live offspring (as opposed to laying eggs) and nurture their young with milk made in special glands on the female's body. Mammals are warm-blooded, that is, they maintain constant body temperature independent of the outside temperature. A third feature, shared by all mammals, is the presence of hair. Like many mammals, man's skin is covered with hair. Human skin has more hair follicles per unit of surface area than the skin of most other primates. This is surprising since most primates appear to be much hairier than humans. This impression is caused by the greater length and coarseness of the individual hair shafts in primates such as monkeys and apes. In contrast, the majority of human body hair consists of a very fine, almost invisible, type of hair called vellus hair.

Human hair is classified into two main types: fine, vellus hair; and the coarser, more visible terminal hair. Except for the palms of the hands and the soles of the feet, most of the human body's areas of seemingly bare skin are actually covered with very fine vellus hairs that may be almost invisible except under very close or microscopic inspection. There are several distinct subtypes of terminal hair. For example, eyelash hairs, called cilia, are different from head and body hair. Pubic (groin) and axillary (armpit) hairs are also different from terminal hairs on the head and are associated with different types of glands in the skin. Even scalp hairs have several different sub-groupings. For example, there is a fringe of very fine hair surrounding the circumference of the head. This hair undergoes a gradual change in thickness from the bare skin appearance of the vellus hair to the dense, thick hair of the crown. Similarly, the hair above the ears or at the base of the neck is not as coarse as that of the crown or the top of the head.

Functions of Hair

The reasons we have hair, and the functions of its growth patterns, are not completely understood. Our pre-historic ancestors were much hairier than we are today; the reason for the decreased hairiness of modern man is unknown, although it is reasonable to assume that it parallels the use of clothing for warmth and protection from the sun and physical trauma. Hair serves as insulation from the cold; however, this does not explain why different human groups have distinct patterns of hair growth. Most people of Asian descent have very sparse body and facial hair, but some of these peoples such as the Inuit, Tibetans and Mongols, inhabit some of the coldest regions on earth.

Hair has the additional function of extending the sensory capability of the skin beyond its surface. Although human hair lacks the wealth of sensory nerve fibers found at the root of whiskers of some animals, each hair has a nerve fiber going to the bulb of the hair follicle. Mechanical displacement of each hair causes a sensation that translates into an awareness movement on the skin's surface. For example, when an ant or fly walks on one's arm, one feels the displacement of hairs caused by the insect.

Hair also plays a role in the defense mechanisms of most fur-bearing animals. When an animal confronts a potential enemy, its fur bristles; standing on end to make the animal appear to be larger and more threatening. In dogs, this response is most visible in the neck area where the neck hairs, called hackles, rise. In cats, the most visible response is in the tail. An extreme example of the use of hair for self-defense occurs in porcupines: their quills, which are modified hairs, stand out from the body when the animal feels threatened. Porcupines have converted a reflex (that in most animals is purely defensive) into a formidable weapon. In modern man, with relatively sparse body hair, only vestigial traces of these reactions remain. A tiny muscle, called the erector pili, connects the lower portion of each hair shaft with the underside of the skin. When you are frightened, cold or angry, these small muscles contract, causing your skin texture to change and your hair to stand on end; but since the hairs are so fine, all you actually see are "goose bumps" on your skin.

Each hair shaft also contains a small gland called the sebaceous gland, located next to the hair shaft. Sebaceous glands make a yellow, fatty substance called sebum that lubricates the hair. Each time the erector pili muscle contracts, the gland is squeezed, and a small amount of lubricant is applied to the surface of the hair.

Hair, along with skin pigmentation, is the major natural protection that we have against the sun's harmful ultra-violet rays. Scalp hair also plays an important role in preventing trauma to the skull. Hair acts to protect areas were the skin rubs together, such as under the arms and in the groin, and it serves to disperse pheromones, the body secretions that are involved in sexual attraction.

Hair is integral to our body image and can have a profound influence on our self-esteem and self-confidence. There is no other part of the human anatomy that can be changed or manipulated so easily. Hair can be groomed, styled, waved, straightened, dyed, braided, or cut, and, unlike tattoos or body piercing, changes made to our hair can

be completely reversed. Hair serves as an important means of self-expression, and the loss of this form of self-expression in those going bald may account, at least in part, for the despair that they may experience.

In spite of its simple appearance, hair is a complex organ. Although we usually think of hair only in terms of the visible portion of the hair shafts, hair is an intricate structure comprised of muscles, sebaceous glands, blood vessels and nerves – that must all be working in harmony to maintain its health.

Hair Anatomy

Anatomically, hair is a distinct part of the skin referred to as an appendage. Other skin appendages include sweat glands, fingernails and toenails. Skin is composed of three main layers. The outer layer of skin is the epidermis. This layer is less than a millimeter in thickness and is composed of dead cells that are in a constant state of sloughing and replacement. As dead cells are lost, new ones from the growing layer below replace them. Beneath the epidermis is the dermis, a tough layer of connective tissue (collagen) that is about 2 to 3 mm thick on the scalp. This layer gives the skin its strength, and contains both sebaceous glands and sweat glands.

Beneath the dermis is a layer of subcutaneous fat and connective tissue. The larger sensory nerve branches and the blood vessels that nourish the skin run deep in this layer. In the scalp, the lower portions of the hair follicles (the bulbs) are found in the upper part of this fatty layer.

An interesting characteristic of hair is that, in contrast to the commonly held notion that it grows as individual strands, it actually emerges from the scalp in groups of one to four (and sometimes even five or six). The reason for this is that hair follicles are not solitary structures, but are arranged in the skin in naturally occurring groups called follicular units. Although skin pathologists recognized this fact in the early 1980's, its profound importance in hair transplantation was not appreciated until the mid-1990's. The use of grafts composed of naturally occurring, individual follicular units, rather than an arbitrary number of hairs, has revolutionized hair transplant surgery.

Each hair follicle measures about 3-4 mm in length and produces a hair shaft about 0.1 mm in width. The hair follicle has five main parts. Starting from the bottom of the follicle, they are; the dermal papillae, matrix, outer root sheath (ORS), inner root sheath (IRS), and the hair shaft, which is the long, visible part.

The dermal papillae contains specialized cells called fibroblasts that regulate the hair cycle and hair growth. The dermal papillae contains androgen receptors sensitive to DHT. For many years, scientists thought that hair growth originated from the dermal papillae. Recent evidence has shown that the growth center extends from the dermal papillae all the way up to the region of the follicle where the sebaceous glands are attached. It is now believed that the primary function of the dermal papillae is to regulate follicular growth and differentiation. If the dermal papillae is removed (this sometimes happens during a hair transplant), the hair follicle is often able to regenerate a new one, although the growth of the new hair will be delayed.

The matrix sits over the dermal papillae and contains actively dividing, immunologically privileged cells. Together, the dermal papillae and the matrix are referred to as the hair bulb. The size of the bulb and the number of matrix cells will determine the width of the fully-grown hair. The cells of the matrix differentiate into the three main components of the hair follicle: ORS, IRS and hair shaft.

The outer root sheath or trichelemma (Greek for coating sac), surrounds the hair follicle in the dermis and then blends into the epidermis on the surface of the skin, forming the structure commonly referred to as the pore (from which the hair emerges).

The inner root sheath essentially forms a mold for the developing hair shaft. It is composed of three parts (Henley layer, Huxley layer, and cuticle), with the cuticle being the innermost portion that touches the hair shaft. The cuticle of the IRS is formed by a layer of overlapping cells that interlock with the cuticle of the hair shaft. This overlapping mechanism holds the hair shaft securely in place, but also allows it to grow in length.

The cells of the IRS keratinize giving it rigidity and strength. Racial variations are felt to be due to the asymmetric formation of the IRS. If you look at the cross section of the IRS, the shape is oval in Europeans, flat in Africans, and round in Asians.

The hair shaft is the only part of the hair follicle to exit the epidermis (the surface of the skin). The hair shaft itself is also composed of three layers. The cuticle, the outer layer that interlocks with the internal root sheath, forms the surface of the hair and is what we see as the hair shaft emerges from the follicle. The middle layer, the cortex comprises the bulk of the hair shaft and is what gives hair its strength. It is composed of an organic protein called keratin, the same material that comprises rhinoceros horns and deer antlers. The center, or core, of the hair shaft, is the medulla, and is only present in terminal hair follicles.

Hair Growth and the Hair Cycle

The normal human scalp contains between 100,000 to 150,000 follicles that produce thick terminal hair. These hairs do not emerge individually from the scalp, but are arranged in follicular units, small groups of 1 to 4 hairs each. There are approximately 50,000 to 65,000 follicular units on the human scalp. For comparison, the human body has approximately 5 million follicles that produce the fine, vellus hair.

At any given time, about 90% of terminal hairs on one's head are actively growing. This phase, called anagen, can last from 2 to 7 years, though the average is about three years. In catagen, which is the shortest phase lasting about 2-3 weeks, growth stops, the middle of the follicle constricts and the lower portion expands to form the "club." The other remaining 10% of scalp hairs are in a resting state called telogen that, in a normal scalp, lasts about 3 to 4 months.

If an average hair grows about ½ inch a month, then after three years it will attain a length of about 18 inches. With seven years of growth, the hair would be about 3 and one half feet long. In rare cases, hair doesn't cycle, but keeps growing – a condition referred to as "angora."

When a hair enters its resting phase, growth stops and the bulb detaches from the papilla. The old hair is pushed out as the new shaft starts to grow. When an old hair is shed, a small, white swelling is found at the bottom of the hair shaft. Most people assume that this is the growth center of the hair, but it is just the clubbed, detached lower end of the hair shaft. The dermal papillae and the growth center of the hair remain in the scalp. Scalp hair grows at a rate of about 0.44 mm/day (or 1/2 inch per month). Each hair follicle goes through the hair cycle 10-20 times in a lifetime.

Humans normally lose about 100 hairs per day; everyone has a few hairs stuck to the comb each time they comb their hair. The presence of a large number of hairs on the comb, in the sink, or in the tub, can be a sign of hair loss caused by disease or medications. Common genetic balding, however, is not caused by excessive hair loss, but rather by the successive replacement of hair that is normally lost with smaller, finer hair – a process called "miniaturization" that will be discussed in greater detail in other parts of this book.

3 Causes of Hair Loss

Most people who are losing their hair are losing it simply because they have inherited a genetic design that pre-disposes them for baldness. Hair loss can also be caused by underlying medical problems, drugs, infections and a variety of other factors. Medical problems that can cause diffuse hair loss include: anemia, thyroid disease, connective tissue diseases (such as Lupus), severe nutritional deficiencies, surgical procedures, general anesthesia, and severe emotional problems. In women, obstetric and gynecologic conditions, such as post-partum and post-menopausal states, and ovarian tumors can cause hair loss.

A relatively large number of drugs can cause a temporary form of hair loss called "telogen effluvium," a condition where hair is shifted from its growth phase into a resting stage and then, after several months, is shed. Fortunately, this shedding is reversible when the medication is stopped. Drugs that can cause diffuse hair loss include; blood thinners (anti-coagulants), medication for seizures, gout, high blood pressure, and thyroid disease, anti-inflammatory drugs such as prednisone, medications that lower cholesterol and other lipids, mood altering drugs, chemotherapy, oral contraceptive agents (particularly those high in progestins), diet pills, high doses of Vitamin A, and certain street drugs (such as anabolic steroids and cocaine).

Although there are a number of dermatologic conditions that cause hair loss, they produce a pattern that is different from that of common baldness (androgenetic alopecia) or the diffuse forms of hair loss mentioned above. Localized hair loss may be sub-divided into scarring and non-scarring types.

Alopecia Areata is a genetic, auto-immune disease that typifies the non-scarring type. It manifests with the sudden onset of discrete round patches of hair loss (although the condition can become generalized). In its mild form, it can be treated with local injections of steroids. Traction Alopecia, the hair loss that occurs with constant tugging on the follicles (as seen with tightly braided hair or "corn rows") is often reversible, but can become permanent if the habit persists for a long period of time. Treatment is only possible if the hair loss from traction is not extensive and if the habit of pulling is stopped.

Scarring alopecia can be caused by conditions such as Lupus, Lichen Planus, or radiation therapy. Hair loss can occur as a result of scalp trauma or cosmetic facial surgery and is often amenable to hair transplantation. Radiotherapy can cause both scarring and non-scarring hair loss and it also can be treated with surgical hair restoration if the area is localized.

Basic Facts on Common Baldness

All humans are born with a finite number of hair follicles. The diameters of the individual hairs in our follicles increase as we grow from infancy to adulthood. However, no matter what we eat, what our lifestyles may be, or what kinds of vitamins we take, we never grow any new hair follicles.

At puberty, most men have a low, broad hairline that usually recedes to its mature position by the age of 20 to 22 and then stabilizes. In men with a genetic tendency to go bald, this hairline will continue to recede and new areas of thinning may occur. Severe illness, malnutrition, or vitamin deficiency can speed or exacerbate the process of genetic hair loss, but this hair loss occurs in perfectly healthy men and is generally not a sign of disease. The common hereditary form of hair loss is also referred to as androgenetic alopecia, common baldness, or male pattern hair loss. It is only in recent years, with our greater knowledge of genetics and the chemistry of sex hormones, that we have begun to understand the causes. It is important to note that common genetic baldness also occurs in women, but generally it appears differently than it does in men.

In androgenetic alopecia, the hormone DHT, a byproduct of testosterone, affects the follicles that produce terminal hairs in certain parts of the scalp. Under the influence of DHT, susceptible follicles first produce thinner, shorter hairs with weaker shafts. Eventually, these follicles produce only fine, almost invisible, vellus hairs, and they may die out altogether. Androgenetic alopecia requires three conditions for its occurrence: the genes for hair loss, male hormones in adequate quantities, and time.

Genes

A gene is a single bit of chemically encoded hereditary instruction that is located on a chromosome and represents a tiny segment of DNA. Chromosomes occur in pairs (humans have 23 pairs), and every individual inherits one set of chromosomes from each parent. The genetics of androgenetic alopecia is complicated and hair loss is thought to involve more than one gene. When several genes govern a trait, it is called polygenic. Genes that are located on the X- or Y-chromosomes are called sex-linked. Genes on the other 22 pairs of chromosomes are called autosomal. It is currently believed that the genes governing common baldness are autosomal. This means that the baldness trait can be inherited from the mother's or the father's side of the family.

The commonly held notion that baldness comes only from the mother's side of the family is incorrect, although for reasons not fully understood, the predisposition inherited from the mother is of slightly greater importance than that inherited from the father. The term "dominant" means that only one gene of a pair is needed for the trait to show up in the individual. A "recessive" gene means that both genes must be present in order for the trait to be expressed. The genes involved in androgenetic alopecia are believed to be dominant.

Just because a person has the genes for baldness, it does not mean the trait will manifest itself and the person will actually become bald. The ability of a gene to affect one's characteristics, i.e. be visible in a particular individual, is called "expressivity." Expressivity relates to a number of factors; the major ones being hormones and age, although stress and other factors yet undetermined, may play a role.

None of the genes responsible for male pattern baldness have yet been identified. This suggests that any kind of genetic engineering to prevent common baldness is still

many years away. Even if the gene is identified, scientists must still figure out how to control or change them.

Hormones

Hormones are biochemical substances produced by various glands, such as the pituitary, adrenal and testes, that work on distant sites throughout the body, by secreting their products directly into the bloodstream. These chemicals are very powerful and minute amounts of them have profound effects upon the bodily functions.

The primary male sex hormone is testosterone. Testosterone and other related hormones that have masculinizing effects are produced primarily in the testicles. This means that the hormone levels that are seen in adults do not reach significant levels until the testicles develop and enlarge during puberty. These hormones are the cause of many changes that occur in puberty: deepening of the voice, growth of facial hair, development of body odor and acne, change in the muscular development, and change in body shape. These hormones can also cause baldness. The presence of androgens, testosterone, and its related hormone DHT, cause some follicles to regress and die. In addition to the testicles, the adrenal glands located above each of our kidneys, produce androgenic hormones; this is true for both sexes. In females, ovaries, like testicles, are a source of hormones that can affect hair.

The relationship between a man's testicles and hair loss has been recognized for centuries. In societies that had harems, guards were castrated to prevent sexual activity between the guards and women of the harem. In all of those societies, it was observed that men who were castrated before puberty did not become bald. Early in the 20th century, castration was common treatment for patients with certain types of mental illness as it seemed to have a calming effect on their personality. It was also noted that these patients did not become bald.

A psychiatrist discovered the specific relationship between testosterone and hormonally induced hair loss during this time. The doctor noted that a castrated, mentally ill patient had a full head of hair, while the identical twin brother of that patient was completely bald. The doctor decided to determine the effect of treating his patient with testosterone, which had recently become available as a drug. He injected his patient, the hairy twin, with testosterone to see what would happen. Within weeks, the hairy twin began to lose all but his wreath of permanent hair, just like his normal twin. The doctor stopped administrating testosterone; however, his patient never regained his full head of hair.

The hormone believed to be most directly involved in androgenetic alopecia is dihydrotestosterone (DHT). DHT is formed by the action of the enzyme 5-a reductase on testosterone. DHT acts by binding to special receptor sites on the cells of hair follicles to cause the specific changes associated with balding. DHT decreases the length of the anagen (growing) cycle of the hair and increases the telogen (resting) phase, so that with each new cycle the hair shaft becomes progressively smaller. This process is referred to as "miniaturization".

In men, 5-a reductase activity is higher in the balding area. Women have half the amount of 5-a reductase overall as compared to men, but have higher levels of the enzyme aromatase, especially in their frontal hairlines. Aromatase decreases the formation of DHT, and its presence in women may help to explain why female hair loss is somewhat different than hair loss in men.

Time

The mere presence of the necessary genes and hormones is insufficient to cause baldness. Hair loss also requires exposure of susceptible hair follicles to the responsible hormones over time. The length of time required for hair loss to start due to hormone exposure varies from one individual to another, and relates to a person's genetic expression and to the levels of testosterone and DHT in his bloodstream. Significantly, hair loss does not occur all at once, but tends to be cyclical. People who are losing their hair experience alternating periods of slow hair loss, rapid hair loss, and even long periods of relative stability. The progression of androgenetic hair loss, however, will generally continue over ones lifetime. The factors that cause the rate of loss to speed up or slow down are, for the most part, unknown.

Stress

When the body experiences stress caused by a traumatic experience, nutritional deficiency, or illness, the rate of hair loss can increase. Women's hair seems to be more sensitive to the effects of stress than men's hair. This may be because women with a genetic predisposition towards hair loss usually have a higher percentage of fragile, miniaturized hair. It is important to note that stress generally causes the type of hair loss referred to as telogen effluvium. This is very different from androgenetic alopecia. Telogen effluvium is the reversible shedding of hair in the resting phase when the body senses that it needs to divert its energies elsewhere. Therefore, stress temporarily changes the amount of hair that is shed, but the lost hair is likely to grow back.

Hair Loss Fiction

Lack of Blood Supply

Some assert that a lack of blood supply contributes to hair loss. Bald skin gradually loses some of its blood supply and, consequently, it becomes thin and shiny. These changes, however, are secondary to the loss of hair, not the other way around. When hair follicles are transplanted into thin bald skin, or scar tissue, both of which have a relatively poor blood supply, the presence of the grafted hair causes the local blood supply to gradually increase.

Clogged Pores

This claim usually accompanies microscopic photographs of an empty follicle clogged with a heaped up waxy substance that prevented the hair from growing. There is no scientific evidence that clogged pores interfere with hair growth. Common sense is

sufficient to refute these claims. Why would pores be clogged on the top of the scalp and not on the back and sides? And if clogged pores caused baldness, women would be as bald as men.

Hats and Hair Loss

Folklore says that men who constantly wear hats are more likely to become bald, as hats prevent air from circulating to the head. Like other tissues in the body, hair follicles get their oxygen through the bloodstream, rather than from ambient air.

Snake Oil Remedies and other Magic Cures

Many over-the-counter lotions and drugs claim to restore lost hair with new products appearing all the time. Whether sold through drug stores, salons or mass media, most are useless. A 1989 Supreme Court decision prevents these potions from being advertised or sold in the United States as medications that prevent hair loss or promote the re-growth of lost hair; however, such claims are still made. Charlatans of every age have eagerly tried to profit from a gullible public.

Excepting cancer and arthritis, hair restoration has been one of the most fertile areas for medical quackery. For example, in the same year that the principle of the magnetic field was described, "magnetic" and "electric" hairbrushes for the prevention and treatment of baldness appeared on the market. Concoctions that claimed to be "snake oils" were also sold for the treatment of arthritis and baldness. In hindsight, it is understandable that an unsophisticated person, who was crippled by pain from arthritis and who lived at a time when there was no better treatment for his illness, might be desperate enough to try "snake oil" as a treatment for arthritis. However, until the Supreme Court decision banning their promotion, ads for products that claimed to be able to restore hair filled the television airwaves. Infomercials complete with real doctors, pictures, and testimonials promoted these worthless potions every day. Even today, it is difficult for the layperson to differentiate between fact and fiction when it comes to hair loss remedies.

There are two FDA approved medications to treat androgenetic alopecia. Though they have limited benefit, they may be useful for many. These two drugs, minoxidil and finasteride, are discussed in detail in the chapter titled "Hair Loss Medications."

4 Hereditary Baldness

The first sign of genetic hair loss in men is often a bit of recession at the temples, or a little thinning in the crown. One may notice a subtle change in the texture of the hair at the hairline, or have the perception that one's hair feels less full overall. However, the experience of having large amounts of hair suddenly appear on the comb, brush or pillow, is generally not a sign of hereditary baldness.

In hereditary baldness (that also goes under the various names of male pattern hair loss, androgenetic alopecia, androgenic alopecia, and common baldness) healthy, full-thickness terminal hair is gradually replaced by finer, shorter hair. As we saw in a previous chapter, this process, called "miniaturization," is caused by the action of DHT on the hair follicle. Besides causing the hair to miniaturize, DHT also shortens the hair cycle so that hair that is at the end of its cycle is replaced by new, finer hair – each time at a slightly faster rate. The shortened hair cycle may contribute to the perception of slightly more hair falling out, but there is no significant shedding associated with common balding.

To say it another way, male pattern baldness is not a condition where hair falls out in mass, but rather a condition where full thickness terminal hair is gradually replaced by finer, miniaturized hair. At some point the DHT-affected hair will become so fine, that it will have no cosmetic value and the area will appear bald. Common baldness, therefore, is a process of hair "thinning" that only at its end stage leads to actual hair "loss".

Men who are going to become very bald usually see the first signs of hair loss in their late teens and early twenties. The younger the age that a person begins to thin, the more extensive the hair loss is likely to become. If a man passes though the twenties with no hair loss, it is unlikely (thought not impossible) that he will become very bald. Dark-haired men, particularly those with light skin, will generally notice hair loss earlier than light-haired men do, but the rate of hair loss is no different.

At the first signs of balding, some people panic, some become depressed, and others resort to using potions, shampoos, or other over-the-counter remedies. Possibly the worst choice would be to try to get a quick fix through surgery.

So if you think you are losing your hair, what should one do? Don't panic! Consider these three simple things:

1. Decide if the hair loss really bothers you.
   This may seem like a silly comment but, in fact, hair loss doesn't bother everyone. Some people just accept it and move on. If it does bother you, that is O.K. too. You should not feel bad or guilty about it, even if your response seems a bit excessive. It is common for people to be worried, concerned, and even depressed, when they think they are losing their hair.
2. Diagnose the cause.
   Before running to the store and buying an armful of hair loss remedies, have a consultation with a board certified dermatologist (these are the doctors whose

specialty includes the diagnosis of hair loss) to have an accurate diagnosis made. If you don't know any in your area, you may find one through the American Academy of Dermatology www.AAD.org. As we saw in a previous chapter, there are numerous causes of hair loss, many of them treatable, and the diagnosis is not always clear cut. A thorough medical history and examination of the hair and scalp by a professional can secure the diagnosis.

3. Consider medical treatments before surgery.
   Particularly when androgenetic hair loss is in its early stages, medications are the treatment of choice. Not only can prescription drugs, like finasteride (Propecia), slow or prevent further hair loss, they can actually grow hair back if started when the process is just beginning. Other treatments, such as changing hair styles and cosmetic camouflage, can also be useful in certain situations.

As a rule, you should always begin drug therapy early and have surgery late – after non-surgical options have been exhausted. It is a poor argument "to start surgery early, so that no one will notice" or to use surgery as prevention for hair loss. These strategies only serve the hair transplant surgeon, not the patient. Hair transplant surgery should not be done early if your intention is to do it only so that no one will notice a change in your appearance. If the results are too subtle, the surgery probably wasn't necessary in the first place.

Modern hair restoration surgery, properly performed, will be virtually undetectable after a week to ten days, and grows in slowly over the course of a year. Therefore, doing a hair transplant early, so that the existing hair will camouflage the procedure, is also unnecessary and not a good reason to have surgery. Have the procedure when you are unhappy with the amount of hair you currently have.

Diagnosing Hereditary Hair Loss in Men

The diagnosis of androgenetic alopecia in men is made by observing:

- a "patterned" distribution of hair loss (see Norwood classification below)
- the presence of miniaturized hair in the areas of thinning
- a normal, non-scarred scalp in the bald area

The diagnosis is supported by:

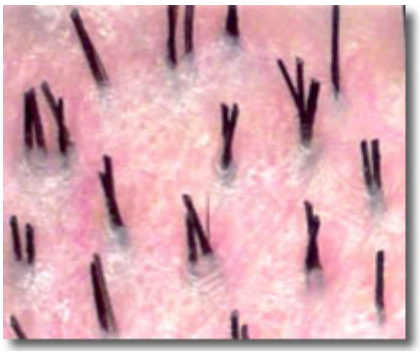
- a positive family history of androgenetic hair loss
- the elimination of other causes of hair loss (this is particularly important in diffuse alopecia where there is no specific pattern (see below)

As we have discussed, miniaturization is the progressive decrease of the hair shaft's diameter and length in response to androgens, specifically DHT. It can best be observed using a densitometer, a hand-held instrument that magnifies a small area of the scalp where the hair has been clipped to about 1mm in length.

Hair Densitometer

Hand-held Microscope

The photo, below left, was taken from a normal scalp. The follicular units (groups) are made of predominately thick, healthy terminal hair. Note the relatively uniform diameter of the hair shafts. The photo, below right, shows that many hairs have decreased in diameter (miniaturized). This is characteristic of androgenetic alopecia.



The diagnosis of androgenetic alopecia is supported by a family history of hair loss, although a positive history is not always identified. There is a slightly greater incidence of having a positive history on the mother's side but, as we have mentioned before, the inheritance of male pattern hair loss can come from either side of the family.

If the hair loss is diffuse (thin all over the scalp) rather than following one of the specific Norwood patterns, the diagnosis can be more difficult. However, the presence of miniaturization in the areas of thinning usually confirms the diagnosis of androgenetic alopecia. If the diagnosis is still unclear, a number of other conditions must be ruled out.

Medical conditions that can produce diffuse hair loss include thyroid disease and anemia. Certain medications, including some drugs used for high blood pressure and depression, and the use of anabolic steroids, can also cause male hair loss.

The following laboratory tests are often useful when a non-androgenetic cause for diffuse hair loss is suspected: blood chemistries, complete blood count, serum iron, thyroid functions, and tests for lupus and syphilis.

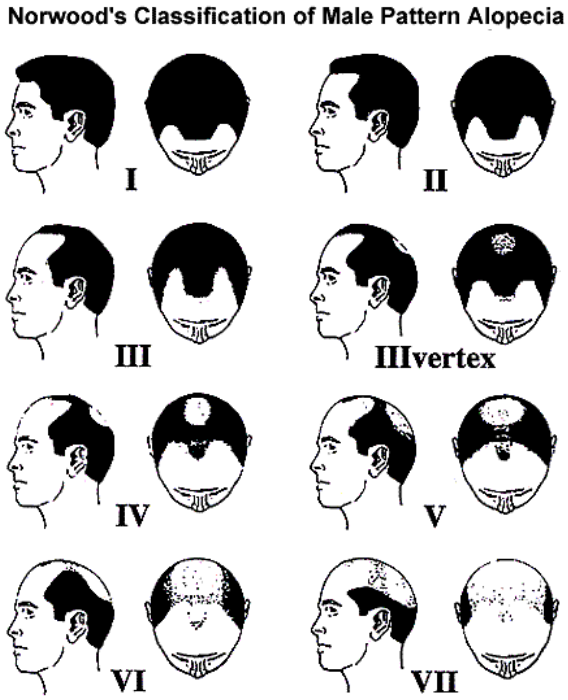
When the diagnosis of androgenetic alopecia is still uncertain, further diagnostic information can be obtained from a hair-pull test, a scraping and culture for fungus, a microscopic examination of the hair bulb and shaft, and a scalp biopsy. A dermatologic consultation is warranted whenever the cause of hair loss is unclear.

Classification of Hair Loss

Once a diagnosis of androgenetic hair loss has been confirmed, you can compare your degree of baldness with the standard charts that follow. The Norwood classification, published in 1975 by Dr. O'tar Norwood, is the most widely used classification for hair loss in men. It defines two major patterns, the regular pattern and the Norwood Class A pattern. A third, common type of androgenetic hair loss, that of diffuse pattern and unpatterned alopecia, has been detailed by this author [Follicular Transplantation: Patient Evaluation and Surgical Planning. Dermatologic Surgery 1997]. The most common system used to describe the pattern of hair loss in women is the three stage classification proposed by Ludwig.

Regular Norwood Pattern

In the regular Norwood pattern, hair loss begins in two distinct areas, the temples and the crown. Over time, these areas enlarge and gradually coalesce until the entire front, top and crown (vertex) of the scalp are bald. [The area where the hair forms a swirl in the back of the scalp, the same area where hair often begins to thin at an early age, will be referred to as the crown or vertex. These terms will be used interchangeably throughout the text.] The regular Norwood pattern of hair loss is divided into seven stages. Since hair loss is continuous, many patients will fall into overlapping categories.



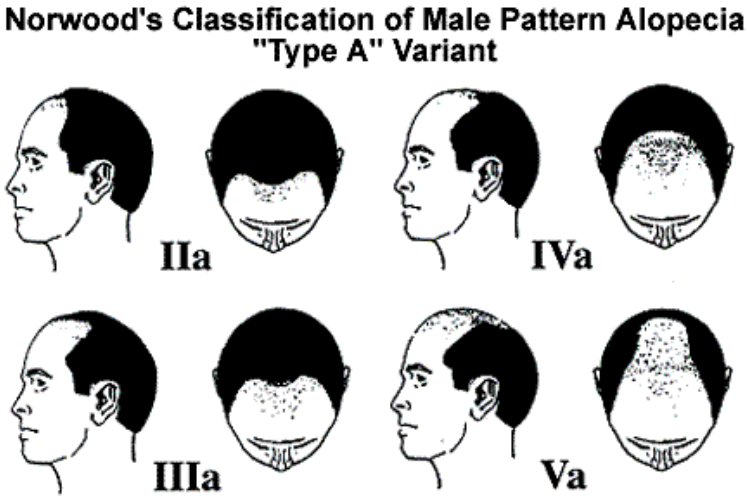
Norwood Class I represents a normal adolescent or juvenile hairline – it does not signify balding. The adolescent hairline generally rests on the upper brow crease (the highest wrinkle on the forehead) and has a horizontal or flat appearance. Class II indicates a progression to the adult or mature hairline. This position is approximately one finger's breath (1.5cm) above the upper brow crease in the middle of the forehead, with some recession towards the temples. This also does not represent balding. Class III is the earliest stage of male pattern hair loss. It is characterized by a deepening temporal recession. When there is also some thinning in the crown, the pattern is called a Class III Vertex. Early Class III hair loss should be treated with medication rather than surgery, particularly in a younger person.

Norwood Class IV is characterized by further frontal hair loss and enlargement of the vertex, but there is still a solid band of hair across top of the scalp that separates the front and vertex. In Class V, the bald areas in the front and crown continue to enlarge and the bridge of hair separating the two areas starts to break down. A person is classified as a Class VI when the bridge of hair disappears forming a single, large bald area that extends from the front of the scalp into the crown. The hair on the sides of the scalp remains relatively high. In Class VII, the most advanced stage, only a wreath of hair remains in the back and sides of the scalp to produce a characteristic "horse shoe" pattern.

Norwood Class A

The Norwood Class A pattern is characterized by a front to back progression of hair loss. In Norwood Class A's, there is one continuous area of balding. When the hair

loss extends into the crown, the area of balding is generally more limited than in the regular Norwood classes. The Class A pattern is divided into five stages.



In a Norwood lla, there is recession at the frontal hairline, particularly in the mid-portion. In a Norwood IIIa there is an extension of the hair loss further back with involvement across the entire frontal hairline. In a Class IVa patient the entire frontal area is bald. In a Class Va, the hair loss extends into the crown. At times a Norwood Class 5A will continue to bald and become a regular Class VI. It is very rare for a person with a Class A pattern to eventuate into a regular Norwood VII.

The Norwood Class A patterns are less common than the regular pattern (<10%), but are significant because of the fact that, since the hair loss is most dramatic in the front, the patients look very bald even when the hair loss is minimal. Men with Class A hair loss often seek surgical hair restoration early, as the frontal bald area is less responsive to medication and the dense back and sides contrast and accentuate the baldness on top. Fortunately, Class A patients are excellent candidates for surgical hair restoration.

Diffuse Patterned and Unpatterned Alopecia

Diffuse Patterned Alopecia (DPA) is an androgenetic alopecia manifested as diffuse thinning in the front, top and crown, with a stable permanent zone. In DPA, the entire top of the scalp gradually miniaturizes (thins) without passing through the typical Norwood stages.

In Diffuse Unpatterned Alopecia (DUPA) the back and sides thin as well, so that there is no stable permanent zone. The hair loss in persons with DUPA tends to advance faster than DPA and more often ends up in a horseshoe pattern resembling the Norwood class VII. However, unlike the Norwood VII, the DUPA horseshoe can look almost transparent due to the low density of the back and sides.

The progression of male hair loss in Diffuse Patterned Alopecia (DPA) and Diffuse Unpatterned Alopecia (DUPA). In DUPA, the back and sides thin as well.

Differentiating between DPA and DUPA is a fundamental part of the evaluation of hair loss, since those with DPA are often good candidates for hair transplantation, whereas DUPA patients almost never are, as they eventually have extensive hair loss without a stable zone for harvesting the donor hair.

Patients with DUPA often begin to thin in their teens. The early diagnosis of DUPA can be made with a densitometer by noting increased miniaturization in the donor area. Although these changes can be identified at a relatively early age, they can often be subtle and easily missed by the inexperienced physician. With time, the miniaturization becomes more obvious, so that by the age of 25, the identification of those patients who will eventuate in DUPA is relatively straightforward, even without densitometry. Insuring that the donor area is going to be stable over time, presents a compelling argument for not performing hair transplants on people that are too young.

Classification of Hereditary Hair Loss in Women

The Ludwig Classification uses three stages to describe female pattern genetic hair loss: Type I (mild), Type II (moderate) and Type III (extensive). In all three Ludwig stages, there is hair loss on the front and top of the scalp with relative preservation of the frontal hairline. The back and sides may or may not be involved.

Type I **Type II** **Type III**

In Ludwig Type I, there is early thinning that can be easily camouflaged with proper grooming. Type I patients have too little hair loss to consider surgical hair restoration.

Women with Type II hair loss have significant widening of the midline part and

noticeably decreased volume. Hair transplantation may be indicated if the donor area in the back and sides of the scalp is stable.

In Ludwig Type III, there is a thin, see-through look to the top of the scalp. This is often associated with generalized thinning over the entire scalp. Often patients that have progressed to this stage have too little donor hair to make surgical hair restoration worthwhile.

All women experiencing hair loss should have an accurate diagnosis made, preferably by an experienced dermatologist. This is particularly important since the diffuse hair loss that women typically develop, can occasionally be caused by a number of treatable medical conditions. Regardless of the extent or cause of hair loss, only women with stable hair on the back and sides of the scalp are candidates for hair transplantation.

5 Psychology of Hair Loss

Hair loss affects millions of men and women, both young and old. It can decrease self-esteem and confidence, and limit the ability to enjoy life to the fullest. Persons balding at a young age may feel deprived of an essential element of their youth. This feeling is created and affirmed by cultures all over the world. Images on television, in the movies and on print ads, constantly reinforce the association between a youthful appearance, sexuality, and a full head of hair.

Balding affects people in different ways, but certain emotional reactions seem to be shared by many.

The most common concern that people have when they begin to lose their hair is that they will be less attractive to the opposite sex. The interesting thing is that this is often only the view of the person that is balding and not that person's partner. The spouse or friend of those experiencing hair loss commonly state that the only thing that bothers them is that it makes their partner depressed. The balding does not bother them per se.

It is interesting that women sometimes express that they want their spouses to look good for the wedding pictures, but once married, they become far less concerned about their spouse's hair. In fact, when a married man suddenly becomes interested in having a hair transplant, we have seen the spouse become suspicious of extra-marital interests and even object to the husband having the procedure.

Hair loss is a universal marker for aging, with one's mane gradually diminishing over time. Your body slowly changes as well, with more sagging and wrinkles and ones muscle mass decreasing. However, hair loss hair can also occur suddenly at a young age, making you appear much older than you actually are.

A practical concern with looking older is that the person may not be as competitive in the work force. Unfortunately, studies have shown that this is a real phenomenon. When employers are screening job applicants, all other things being equal, those with hair are viewed more favorably than those who are bald.

People experiencing hair loss complain that the way they look does not fit with their own image of themselves. This occurs when someone begins to lose hair early i.e., in their late teens or twenties, but it is as much a problem when someone has had a full-head of hair for years (and is used to receiving compliments about their hair) and then their hair thins unexpectedly in middle age.

Another aspect of balding is that people feel a loss of control. Hair is one of the few body parts that you can actually manipulate yourself. You can grow hair long, cut if off, you can wave it, dye it, or pull it back in a pony-tail. It serves as a form of self-expression. As people start to lose this form of self-expression, they can become depressed and withdrawn. But not everyone responds this way. People react very differently to their hair loss, with some considering it only a minor nuisance and others finding it so debilitating that they won't be seen in public without their head covered.

One of the things that makes going bald difficult is that, for some reason, people feel that commenting or joking about hair loss is "fair game" when they wouldn't dare mention that someone had bad skin, or had a limp. I often point out to patients, that just because people chose to comment about thinning hair, doesn't mean they are judging that person or really care much about it. It just seems to be a socially acceptable thing to mention.

Women seem to believe that female hair loss is less acceptable than hair loss in men. While this may be true, the vast majority of women have hair loss in a pattern that can be easily camouflaged. Women are often reassured when they realize that about 40% of women experience hair loss over their lifetime, but it is to such a small degree that it is rarely recognized by others.

The important things to remember are that hair loss is very common, it is much more acceptable with age, and it is generally less important to other people than the person experiencing hair loss thinks. That said it is not unreasonable to be upset about going bald. Fortunately, for those who are bothered by their hair loss, there are now excellent medications to prevent hair loss and excellent surgical treatments to restore hair once it is gone.

In seeking treatment for their hair loss, younger men often consider a surgical option first. They shun the idea of having to take a medication "for life" and think that surgery will be a permanent solution to their problem; often not realizing that having surgery at a young age may create far more problems than it will correct. Unfortunately, these young people, in a panic, may fall prey to unscrupulous physicians whose practices are built on "selling" hair transplants to those in an emotionally fragile state.

It is the responsibility of the physician to make sure that an emotionally distraught patient is making informed choices and understands the long-term implications of any treatment option – especially surgery. In the younger patient, it is often prudent to slow down the decision making process. This can be accomplished with multiple consultations, stressing the importance of drug therapy and, when appropriate, getting parents or other significant persons involved. The doctor should allow the patient to reflect on the situation and the decisions involved – and should never rush to operate.

Older patients are often more deliberate about the decision to undergo hair transplant surgery. Many have considered the procedure for some time, and understand the challenges of making emotionally charged decisions, getting accurate information and finding a doctor they trust. They often research their options more thoroughly. Outsides factors may finally tip the balance in favor of having surgical hair restoration. These factors may include a search for a new job, a divorce, or simply the availability of financial resources. Alternatively, it may reflect the indulgence of a confident, successful person doing something extra for himself.

When hair loss becomes an obsession, it is rare that either medical treatments or surgery will satisfy the patient's need for perfection. In situations where the emotional reaction far exceeds the degree of hair loss or where the expectations of treatment is

more than can be achieved with existing technology, psychological counseling is in order.

Although each individuals motives may vary, it is not unreasonable for people at any age to want to improve their appearance, and it is hard to deny the great impact that hair plays in this regard. However, a decision to proceed with hair restoration should be made with a clear head, a specific objective and with as much factual information as possible.

6 Hair Loss Medications

The FDA approval of oral finasteride, in the form of Propecia, has been a major breakthrough in the medical management of male pattern baldness. Before Propecia, the only medically proven treatment was topical minoxidil (Rogaine) and this medication was only minimally effective and, for many, a nuisance to apply. Propecia, on the other hand, is a once-a-day pill that can significantly alter the progression of genetic balding, particularly if started when the hair loss is still in its early stages.

The recent availability of finasteride in a generic, 5mg tablet, has decreased the cost of the drug – for those who don't mind cutting up pills.

Avodart (dutasteride), a more potent medication that is related to finasteride, has been approved for the treatment of prostate enlargement, but not hair loss. Because of its affect on the balding process we will discuss this medication as well.

Rogaine (Minoxidil)

Rogaine, the brand name for minoxidil, was the first FDA approved medication for the treatment of hair loss. Rogaine is a topical solution that is applied directly to the scalp. Although originally a prescription drug, it can now be purchased over-the-counter in a generic form. It is sold in concentrations of 5% for men and 2% for women.

Rogaine was developed from the oral blood pressure medication minoxidil (Loniten). Minoxidil taken orally has potential serious side effects on the heart and circulatory system and is used only when other blood pressure medications have been unsuccessful. It was observed that patients who were taking minoxidil began growing body hair and it was reasoned that applying minoxidil directly to a bald scalp might cause hair to grow in this area as well – without producing the side effects of the oral medication. Studies showed that this was indeed the case, although the growth was generally modest.

The original studies on Rogaine were performed on the crown, so there is a misconception that it only works in this area. Although minoxidil usually works best in the crown, it also works to a lesser degree in other areas, such as the front of the scalp, as long as there is some fine (miniaturized) hair in the area. It will not work when the area is totally bald. The greatest benefit from the medication is seen from 5 months to 2 years. After this time there is a gradual decrease in effectiveness, so that those using minoxidil will continue to lose hair, but at a somewhat slower rate.

The exact mechanism by which minoxidil works is not known, but the drug is felt to increase the duration of the hair follicle growth cycle (called anagen). This improves the quality of the hair by increasing the diameter and length of fine, miniaturized hair. The simultaneous use of minoxidil and Propecia, which directly inhibits the formation of DHT, may have some synergistic benefit in the treatment of hair loss, although the latter medication is significantly more effective.

Minoxidil is most effective if applied to the scalp twice a day. The medication only works if it is in direct contact with the scalp (not the hair) and only works in areas

where it is applied. Therefore, it is important to use the medication in the front part of the scalp if this is an area of thinning.

The 5% formulation is twice as effective as the 2% solution, but contains propylene glycol, a compound that can irritate the scalp and can make the hair feel sticky and difficult to manage. If this is a problem, one should consider using the 5% solution at bedtime and the 2% solution (which is alcohol based and less sticky) in the morning.

When using minoxidil, it may take 6-12 months before any results are seen. The majority of patients who see an effect from minoxidil experience a delay, or decrease, in the rate of hair loss. The drug also serves to thicken already existing hair, but most patients who do have results, grow only short, thin fuzz. It will not grow any new hair on a bald scalp.

Once a day topical use of Rogaine (topical minoxidil 2% and 5%) seems to be almost as effective as using it twice a day. The reason is that although minoxidil has a relatively short half-life of several hours when given orally, when topically applied, it has a half-life of 22 hours in the skin. This suggests that once a day dosing is a reasonable option. It is important to realize, however, that Pfizer, the company that now makes Rogaine, specifically states that it will be less effective if used only once a day.

If minoxidil is discontinued, the effects of the drug wear off within three months and the previous pattern of hair loss resumes. When minoxidil is restarted, one generally does not regain the hair that was lost, so it is best not to stop and start the mediation, but to use it regularly.

Minoxidil has been prescribed (off-label) in conjunction with other medications, such as topical retinoic acid (Retin-A), to enhance its penetration into the skin and thus increase its effectiveness. This combination of medications, however, can greatly increase the absorption of minoxidil into the bloodstream and may increase the risk of potential side effects, including changes in blood pressure and severe scalp irritation that has led to scarring.

Only the 2% concentration of minoxidil has been approved for use in women. Female patients are generally more sensitive to the side effects of minoxidil in decreasing blood pressure (hypotension) and may get light-headed from the medication. Women also have an increased risk of developing allergic skin reactions (contact dermatitis).

An annoying local reaction that women sometimes get from topical minoxidil is the development of facial hair. Although the facial hair slowly resolves when the medication is discontinued, at times the hair may need to be removed. Carefully trying to avoid the medication dripping down onto the temples and forehead seems to reduce, but not totally prevent, this problem. There is a significantly greater incidence of these side effects if the 5% solution is used.

Propecia (Finasteride)

As we have discussed, male pattern baldness or androgenetic alopecia is caused by the effects of the male hormone dihydrotestosterone (DHT) on genetically susceptible hair follicles that are present mainly in the front, top, and crown of the scalp (rather than the back and sides). DHT causes hair loss by shortening the growth (anagen) phase of the hair cycle, causing a decreased size or miniaturization of the follicles. The effected hair becomes progressively shorter and finer until it eventually disappears.

DHT is formed by the action of the enzyme 5-alpha reductase on testosterone. Finasteride is a drug that works by blocking the enzyme 5-alpha reductase Type II that converts testosterone to dihydrotestosterone (DHT) in the hair follicle. Propecia (finasteride) decreases both scalp and blood levels of DHT and its effect is felt to be related to both of these factors. Finasteride 1-mg/day decreases serum DHT levels by almost 70%. Although many think that finasteride lowers a man's testosterone, the medication, on average, causes a rise in serum testosterone levels by 9%, although this is still within the range of normal.

It is commonly thought that finasteride was first conceived as a prostate medication and that, only by chance, was found to prevent hair loss. The fact is that in 1974, the researcher Imperato-McGinley and colleagues described a group of genetically male children from the village of Salinas in the Dominican Republic who were deficient in the enzyme 5-alpha reductase. These male children had very low levels of DHT and throughout their life, their prostates remained small and they did not develop male pattern hair loss or acne.

The objective of the scientists was to find a drug that could block the 5-alpha reductase enzyme and mimic the abnormality found in these men. They could then use this drug to prevent both prostate enlargement and hair loss. The decision was made, however, to obtain FDA approval for the medical indication first. In 1992, Finasteride 5-mg was released under the brand name Proscar, for use in men over 50 with prostate enlargement. In 1997, the FDA approved finasteride 1-mg/day (Propecia) for the treatment of male pattern baldness.

Finasteride is quite effective in the treatment of common genetic hair loss. Studies have shown that after five years of treatment, almost 50% of men treated with Propecia demonstrated an increase in hair growth and 90% at least maintained their hair over this time period. Only 10% were rated as having lost hair when compared to baseline. In men not on the medication, 75% were rated as having lost hair during the course of the study.

Propecia (Finasteride 1 mg) can hold on to hair at any age, but works best to re-grow hair in those who are younger. Occasionally we see patients in their 50s re-grow some hair with Propecia, but this is the exception rather than the rule. The benefits of finasteride will stop if the medication is discontinued. Over the 2-6 months following discontinuation of treatment with finasteride, the hair loss pattern will generally return to the state that it would have been if the medication had never been used.

Although it is often stated that "Propecia doesn't work in the front", the approved indication for Propecia does include the treatment of hair loss in the front part of the scalp. In our practice, we have seen many patients who have had early thinning in the frontal scalp and who have re-grown hair. The fact that DHT causes frontal hair loss and that Propecia blocks DHT gives a logical explanation for these effects. Of course, if there is no hair in the area at all, the medication is not going to work.

The absorption of Propecia is not affected by food, so one can take it any time during the day without regard to meals. Since finasteride takes up to a year or more to exert its full effects, in either re-growing hair or preventing further hair loss, patients must take finasteride for one year, or longer, before its effects can be accurately assessed. During the first six months, one may note some thinning of ones existing hair as the new growing hair replaces the miniaturized hair, so it is important to be patient during this period.

Side Effects

Side effects from finasteride at the 1-mg dose are uncommon, and fortunately reversible. Of men taking finasteride 1mg, 3.8% experienced some form of sexual dysfunction verses 2.1% in men treated with a placebo. The drug related side effects were just 1.5% greater than the controls and included decreased libido, erectile dysfunction, and decreased volume of ejaculate.

Most reported cases of sexual dysfunction occurred soon after starting the medication, but there have been reports of sexual dysfunction that have occurred at later points in time. The sexual side effects were reversed in all men who discontinued therapy, and even in 58% of those who continued treatment. After the medication was stopped, side effects generally disappeared within a few weeks.

For patients with sexual side effects it is recommended to stop the medication until the side effects go away and then restarting at a lower dose (either 1/4 or ½ of a 1-mg pill a day). If there are no side effects after several weeks on the lower dose, the patient can work up to the 1-mg per day dose. Even staying on a lower dose will offer some benefit. If side effects occur at the lower dose, one should abandon therapy with this medication.

When finasteride is discontinued, only the hair that had been gained or preserved by the medication is lost. In effect, the patient returns to the level of balding where he would have been had he never used the drug in the first place.

Rare adverse reactions included breast tenderness or breast enlargement (gynecomastia). This occurred in 0.4% of men on finasteride, but this was no greater than in the control group. Other side effects that were not statistically significant included hypersensitivity reactions including rash, pruritus, urticaria, swelling of the lips and face, and testicular pain. No interactions with finasteride and other drugs have been identified.

Finasteride causes a decrease in serum PSA (prostate specific antigen) by approximately 50% in normal men. Since PSA levels are used to screen for prostate

enlargement and prostate cancer, it is important that ones personal physician is aware that he is taking the medication, so that the doctor may take this into account when interpreting PSA results.

A study in the The New England Journal of Medicine in 2003, on finasteride 5mg (not Propecia) reported that men treated with finasteride 5mg for seven years had a 25 percent reduction in prostate cancer compared to the men treated with placebo. The study also showed high grade prostate cancers in 6.4% of the men treated with finasteride 5mg, compared to 5.1% in the placebo group. The authors concluded that finasteride 5mg prevents, or delays, the appearance of prostate cancer and that this possible benefit and a reduced risk of urinary problems must be weighed against sexual side effects and the increased risk of high-grade prostate cancer.

The explanation that has been proposed for the identification of higher grade tumors is that since the finasteride shrunk the benign tissue, the malignant part of the tumor was more easily reached with the needle biopsy. Supporting this explanation is the fact that those on Proscar had no more problems with their prostate disease than the controls. It is not known if this explanation is the correct one and what the effects a smaller, 1mg dose might have. Additional studies need to be done to have a definitive answer.

Using Finasteride

Finasteride has not been approved for women. In addition, women should not handle crushed or broken Propecia tablets when they are pregnant, or may potentially be pregnant, because of the possibility of absorption of finasteride and the subsequent potential risk to a male fetus. Propecia tablets are coated and will prevent contact with the active ingredient during normal handling, provided that the tablets have not been broken or crushed. In spite of these cautions, exposure of pregnant women to semen from men treated with Propecia poses no risk to the fetus.

Merck recently carried out a study to evaluate the efficacy of finasteride in post-menopausal women. After one year there was no significant hair growth and, as a result, the study was terminated. An explanation is that hair loss in women is related more to the action of the enzyme aromatase (which is unaffected by finasteride) rather than DHT. It is also possible that the low DHT levels observed in postmenopausal women are responsible for the lack of significant response to finasteride.

Men experiencing hair loss often think of either using medication or having a hair transplant; however, the two treatments are not mutually exclusive. Finasteride has shown to be useful in complementing a hair transplant for a number of reasons:

1) Finasteride works best in the younger patient who may not yet be a candidate for hair transplantation. Surgery can be used when the patient is older if the balding has progressed.
2) Propecia can re-grow, or stabilize hair loss in the crown, where a hair transplant may not have been performed.

3) Propecia is less effective in the front part of the scalp, the area where surgical hair restoration can offer the greatest cosmetic improvement.

For those who choose not to take Propecia, or who cannot take it due to its side effects, surgical hair restoration is just as effective. The only difference is that medications can prevent further hair loss whereas surgery cannot. It is important to note that medications are not needed for a hair transplant to be successful or for the transplanted hair to grow and be permanent.

Regarding the "optimal dose", patients sometimes ask if they "can get away with taking less?" Research shows that there is a dose-response relationship between 0.2 and 1 mg/day, with the lower dose showing reduced efficacy. Therefore, unless one is having side effects, it is best to take the recommended dose of 1mg a day. There is also little evidence that a higher dose helps, although doctors do increase the dose under certain circumstances. Even though the data shows that 5 mg is no better than 1 mg, the dosage is often increased when someone has been on the same dose of medication for three to five years and then stops responding (begins to lose hair after being stable).

Finasteride 5mg (brand name Proscar) is available in a generic formulation. For those who want to take generic finasteride, we recommend purchasing a pill cutter at the pharmacy and taking ¼ of a 5mg tablet every day. Be advised that there is no scientific data insuring that this will be as effective as Propecia 1mg a day. Also, remember that there is a potential risk to pregnant women from handling broken or crushed tablets.

It is recommended that men aged 50, or over, should inform their regular physicians or urologists if they are taking Propecia for hair loss. It is also recommended that all men aged 50 or over have a routine annual evaluation for prostate disease, regardless of whether or not Propecia is used. For those patients who are of African descent and/or who have a family history of prostate disease, these recommendations would apply beginning at age 40. An evaluation may include a rectal examination, a baseline PSA, and other tests that your examining physician feels are appropriate.

Propecia and Rogaine work synergistically since their mechanisms of action are different. Rogaine (minoxidil) stimulates the hair follicle directly, but Propecia (finasteride) permits hair growth by blocking the negative effects of DHT. Of the two, Propecia is far more effective. It is reasonable to use the two together as long as the medications are used regularly. For patients contemplating surgical hair restoration, we generally have them continue Propecia only, since applying minoxidil is too fussy and offers very little incremental benefit.

Finasteride: Fact vs. Fiction

There are many misconceptions about the use of finasteride for hair loss. The most common are:

Myth: Women can't touch the medication.

Fact: Pregnant women should not handle crushed or broken tablets

Myth: It only works in the crown.
Fact: It potentially works any where on the scalp where there is some hair, even in the front of the scalp.

Myth: Once you start it you must take it for ever.
Fact: You can stop the medication any time you want – you just lose its benefits when One stops.

Myth: Finasteride lowers testosterone
Fact: The medication, on average, causes a rise in serum testosterone levels by 9%.

Myth: The sexual side effects are frequent and irreversible.
Fact: The sexual side effects occur in 2% and are completely reversible when the medication is stopped.

Myth: Finasteride causes birth defects if a man takes it when his wife is pregnant.
Fact: Exposure of pregnant women to semen from men treated with Propecia poses no risk to the fetus.

Myth: Propecia was originally a prostate medication that was found to prevent hair loss.
Fact: Propecia is not a prostate medication that was by chance noted to have a side effect of hair growth, it is a medication that was known since its discovery that it could grow hair.

Avodart (Dutasteride)

In 2002, the FDA approved Avodart (dutasteride 0.5mg) for the treatment of prostate enlargement in men (the medical term is benign prostatic hyperplasia or BPH). Dutasteride is not approved for the treatment of male pattern hair loss. In fact, the clinical trials for hair loss were discontinued, so there is no safety data for its use in younger patients.

Like finasteride (the active ingredient in Propecia), dutasteride is an inhibitor of the enzyme 5 alpha-reductase that is responsible for the conversion of testosterone to DHT (dihydrotestosterone). However, unlike finasteride, which only inhibits the Type I form of the enzyme, dutasteride inhibits both the Type I and Type II forms of the 5 alpha-reductase enzyme. This dual effect makes the drug more potent, but it also increases the incidence of adverse reactions.

The Type II form of the enzyme is found predominantly in the hair follicle. The Type I form of the enzyme has been found in the scalp and sebaceous glands, but its exact role in hair growth has not been determined.

Dutasteride 0.5mg/day decreases serum DHT 91% and scalp DHT 54%. (Finasteride 5mg/day decreases serum DHT 71% and scalp DHT 38%). Based on these

effects, one would expect that dutasteride would be more effective in the treatment of androgenetic alopecia than finasteride. However, since the Type I form of the 5 alpha-reductase that dutasteride blocks is not present in significant quantities in the hair follicle, these effects may not be as significant as one might expect. Controlled clinical studies are needed to answer this important question.

There is a greater incidence of sexual side effects with dutasteride compared to finasteride. Dutasteride was investigated in controlled multi-center studies involving men aged 50 and above with prostate enlargement. Drug-related side effects during the first six months were as follows: impotence (4.7%), decreased libido (3%), breast tenderness and breast enlargement (0.5%) and ejaculation disorders (1.4%).

The incidence of most drug-related sexual adverse events decreased with duration of treatment. The incidence of drug-related breast tenderness and breast enlargement remained constant over the treatment period. Ejaculate volume may be decreased in some patients with continued treatment; however, this decrease did not appear to interfere with normal sexual function.

As with finasteride, dutasteride reduces the amount of PSA measured in the blood and this must be taken into account when PSA levels are used in the detection of prostate cancer. Women who are pregnant or may become pregnant should not handle dutasteride because of possibility of absorption of dutasteride and subsequent potential risk to a male fetus.

The half life of dutasteride is 5 weeks compared to 6-8 hours for finasteride and serum concentrations of dutasteride are detectable up to 4-6 months after discontinuation of treatment. Therefore, men treated with dutasteride should not donate blood until at least six months after their final dose to prevent giving dutasteride to a pregnant woman through a blood transfusion. Men with liver disease should talk to their doctor before taking dutasteride.

One last point regarding Dutasteride. Men in families that had a deficiency of the Type II 5-alpha reductase enzyme (the enzyme blocked by finasteride) were followed for years without showing any adverse effects. However, there is no natural biologic model for the blocking effects of dutasteride; therefore, we have less information about the long-term effects of dutasteride, than we do with finasteride.

7 Hair Transplant Basics

The principle behind hair transplantation is quite simple. The hair that grows on the back and sides the scalp tends to be permanent in most individuals. It persists even in advanced degrees of androgenetic hair loss because follicles in these locations are not subject to the affects of the hormone dihydrotestosterone (DHT).

The resistance or susceptibility of individual hair follicles to DHT is a genetic characteristic of that follicle and remains with the follicle even if transplanted from one part of the scalp (or body) to another. Therefore, permanent hair transplanted to a bald area will continue to grow at its new location. This phenomenon is termed "donor dominance" because the hair maintains the DHT resistant characteristics of the area where it came from (also called the donor area).

Interestingly, not all of the characteristics of hair are controlled by the genetics of the hair follicle. Wave, for example, is determined by the surrounding scalp, rather than by the follicle per se, so that straight hair transplanted from back of the scalp to the front will become wavy after a hair transplant, if the original hair in the front of the scalp was wavy.

The rate of hair growth and the ultimate length of the hair are affected by both the hair follicle and the skin that surrounds the transplanted hair. Therefore, slowly growing leg hair transplanted to the scalp will grow faster and longer on the scalp, but will not reach the length or thickness of the original scalp hair. The length of scalp hair transplanted to the eyebrow will decrease over time, but will most likely always need to be trimmed.

It is important to understand that in a hair transplant, permanent hair is redistributed to cover the areas of the head where the hair has thinned or has been lost. In hair transplantation surgery, no new hair is actually created – existing hair is just moved around, so there is no net increase in hair. In spite of this, a skillfully performed hair restoration procedure can make a person "look" as though he or she has more hair – often considerably more. In addition, a hair transplant by an experienced hair restoration surgeon will look totally natural with the transplanted hair continuing to grow for one's lifetime.

The amount of permanent donor hair a person has is a major factor in determining which people are good candidates for a hair transplant. It affects every aspect of the surgical planning and determines how full the results can potentially be. Therefore, a careful assessment of a person's available donor supply is extremely important in the hair transplant evaluation. The most accurate way for the donor area to be evaluated is through a densitometer or video-microscope – instruments that allow the hair transplant surgeon the ability to examine hair follicles under high power magnification.

In theory, when it is possible to clone hair, the limitations of the donor supply will disappear. In this case, persons with common baldness will not only be candidates for hair transplantation, but will be able to achieve almost any degree of fullness

desired. Until this time, however, the finite nature of a person's donor supply must always be kept in mind.

The process of hair restoration is both an artistic endeavor and a technical feat. The physician must create a natural looking result that is consistent with the available hair supply, the person's specific hair characteristics, and the patient's goals. One must design a hair transplant that will not only look good today, but be appropriate as the person ages. But art alone will not ensure a successful hair transplant. The movement of thousands of tiny grafts requires tremendous technical skill; therefore, a highly trained, experienced, clinical support staff is crucial when performing these long, organizationally complex procedures.

The physician must have an in-depth knowledge of the anatomy and physiology of human hair and scalp and have a complete understanding of the medical conditions that affect the scalp. The hair transplant surgeon must also know facial anatomy, possess excellent surgical skills and have a thorough knowledge of the different hair restoration procedures and reparative techniques. The best physicians must be committed to keeping abreast of the new developments in the field – or be directly involved in developing them. Preferably, the physician should devote the majority of his or her clinical practice to this highly demanding sub-specialty. It is literally impossible for the casual practitioner to perform state-of-the-art hair transplant surgery.

History

Reports of successful hair transplants appeared in the early 1930s in Japanese medical literature for the treatment of various types of hair loss of the scalp, eyebrows and moustache, as well as increasing hair in the female pubic area. In the course of developing their procedures, the Japanese physicians made a number of important observations. These included; noting that smaller grafts produced better cosmetic results than larger grafts, that the donor hair was best removed with a single, long incision that could be sutured closed, that the recipients sites (holes in which the grafts are placed) should be made with a needle, and that grafts would survive best if stored in normal saline (similar to the salt concentration of human serum). They even observed phenomenon called telogen effluvium – the annoying shedding of hair that may accompany hair transplant procedures even today. Most importantly, they demonstrated that single-hair grafting resulted in growth that was almost indistinguishable from naturally grown hair.

Unfortunately, because of the poor communication of scientific knowledge between the East and West, further exacerbated by WW II, it would be many decades before Western surgeons would apply these important insights to their own hair restoration procedures.

The first hair transplant in the United States was performed by Dr. Norman Orentreich in 1952. At first, the results of his research were rejected by the editors of several prestigious medical journals, due to their disbelief that such a procedure was possible. Ultimately, his work was published in the Annals of the New York Academy

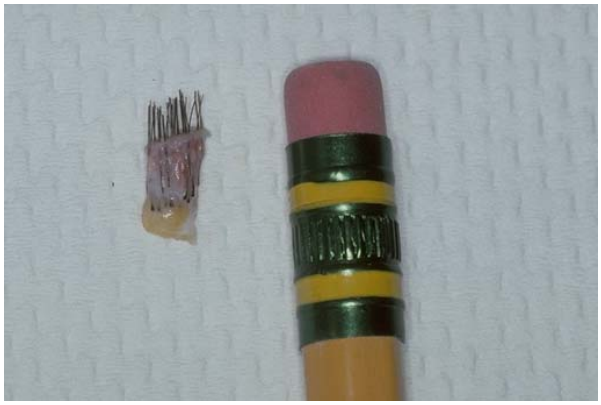
of Science in 1959. In his paper, he explained the concept of "donor dominance" – the idea that grafts continue to show the characteristics of the donor site after they have been transplanted to a new site. This remains the basic concept that underlies all hair transplant procedures.

Yet while donor dominance insured that transplanted hair could grow, it did not guarantee that the results would look natural. In Dr. Orentreich's original procedures, he used grafts measuring 6- to 8-mm in diameter. He picked grafts this size thinking that those larger than 6-8 mm would not allow sufficient oxygen to reach the center of the grafts (causing the hair at the center not to grow) and he felt that smaller grafts would not contain enough hairs to make the procedure worthwhile. (He later settled on 4-mm as the ideal graft size.)

In Dr. Orentreich's original work, and for most of the hair transplant procedures performed until the early 1980s, grafts were obtained using an instrument called a trephine or punch. This small, round, cookie-cutter like instrument, removed a cylinder of hair-bearing tissue from the back of the scalp. The same instrument was then used to make a hole in the bald scalp where the graft was to be inserted. The punch made a circular incision in the bald scalp, and then the core of hairless tissue was removed and replaced with the hair-bearing tissue obtained from the permanent zone in the back of the scalp.

The "punch instrument" used in early hair transplant procedures.

By the 1980s, the standard graft size was reduced to 3- to 3.5-mm, significantly smaller than the original sizes described in the 1959 paper, but still large enough to produce a poor cosmetic outcome for the majority of patients. The infamous "pluggy, baby-doll look, so characteristic of the older procedures was the consequence of using these large grafts.

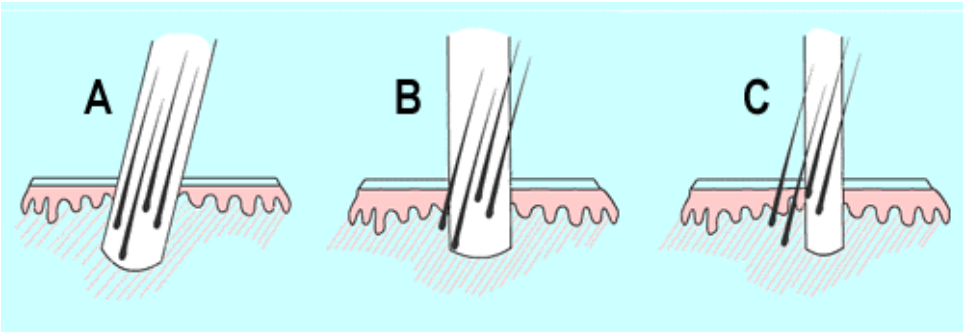


A large graft from the early days of hair transplantation was almost the size of a pencil eraser.

The older procedures would generally involve the transplantation of perhaps 25 to 50 grafts in a one to two hour procedure. A series of these procedures was often planned, with each hair transplant session spaced several months apart to allow for healing. The healing from these large plugs, meanwhile, was slow. The patient left the office in a large turban-like bandage that was kept on for several days. Once removed, the patient had thick adherent scabs that persisted for weeks. The patient also frequently experienced significant amounts of post-operative bleeding.

The pluggy look typical of the older hair transplant procedures that resulted from using grafts that were too large.

In an effort to make these large graft hair transplants less pluggy and more cosmetically acceptable, doctors started to use smaller punches. The problem was that the smaller punches caused more damage to the grafts. The reason was that it was hard to line-up the smaller punches with the angle of the hair. With the smaller punches, even a small deviation from parallel resulted in a significant amount of damage to the hair.



The poor alignment of the punch in (B) causes the lower part of the follicles to be cut off. With a smaller punch (C), the effect is even more dramatic with significantly more damage to the grafts.

Eventually realizing that the punch-type harvesting technique of any size produced a lot of damage to hair follicles (and also left open wounds in the back of the scalp that bled after the procedure and took weeks to heal) doctors began to remove donor tissue from the back of the scalp in thin, long strip. The open area was then sutured closed, resulting in one, long fine incision. The new procedure was called strip-harvesting in contrast to the older, open-donor technique

Because it was difficult and time consuming to obtain grafts from a single strip of donor tissue, doctors developed an instrument called a multi-bladed knife that enabled them to harvest (remove) the donor tissue in multiple, thin, long strips. The multi-bladed instrument contained up to 8 blades and could harvest as many as 7 strips at one time each several millimeters in width. The strips could measure as long as 30 or more cm in length.

A multi-bladed knife

The long, thin strips that it produced

The thin strips were then cut into smaller pieces containing up to approximately 6 to 8 hairs (called mini-grafts or slit-grafts) and were placed into pre-made sites in the bald area. These recipient sites were made either with the old punches that removed a cylinder of tissue to make room for the new grafts or with a scalpel that produced a

small slit that the graft was inserted into. The hair transplants performed in this manner were called "mini-grafting" or "slit-grafting."

It was soon realized that even these smaller grafts looked quite unnatural, particularly at the frontal hairline. For this part of the restoration, it was necessary to use only 1- and 2-hair grafts. These grafts were obtained by cutting up the mini-grafts into smaller parts. The 1- and 2-hair grafts were called "micro-grafts" and the procedure where 1- and 2-hair grafts were used at the hairline and 3- to 8-hair grafts were used in other parts of the scalp became known a mini-micrografting.

Despite the fact that mini-micrografting techniques were a significant improvement over the older punch-graft techniques, there were many problems with the procedure. The main one was that the procedure still did not look completely natural. In patients with very light hair, or if the patient combed his hair to the side, the results might be acceptable; however, if the patient had dark or coarse hair, or he wanted to comb his hair back exposing his hair line, the hair transplant was obvious.

The second major problem was that the use of a multi-bladed knife actually destroyed hair. The multiple blades cut though hair follicles causing damage to the tissue and poor growth. The result was a decreased supply of viable hair and an unnecessarily thin look to the hair restoration.

It was a slow evolution, but the large grafts used throughout the sixties and seventies eventually gave way to mini-grafts in the eighties and mini-micrografting in the early nineties. The stage was then set for Follicular Unit Transplantation. First described by Bernstein and Rassman in 1995, it quickly emerged as the state-of-the-art in hair restoration, supplanting mini-micrografting in the treatment of androgenetic hair loss and rendering other well-established procedures such as scalp reductions, scalp lifts and flaps virtually obsolete. The next chapter will be devoted to describing this revolutionary hair transplantation technique.

What is a Hair Graft?

During a hair transplant, small grafts of skin containing hair follicles are removed from the areas of permanent hair in the back and on the sides of the scalp, and moved to the areas of thinning or complete baldness. The grafts are placed into small openings created in the bald areas using a fine needle, scalpel or other fine instrument. The openings can be created using various instruments and may consist of needle holes, small slits (incisions where tissue is not removed), punch holes, or laser made holes (where recipient tissue is actually removed or destroyed to provide room for the graft).

As discussed above, both the size of the grafts and the size of the recipient sites have become smaller over the past 40 years. This decrease in size has made the transplants dramatically more natural in appearance.

Grafts can survive for a variable time outside the body depending upon how they are handled and stored. From the time the hair bearing tissue is removed from the back of the scalp, until the time it is placed back in the balding areas it must be kept in a cool, damp environment to insure maximum survival. With large hair transplant

procedures of long-duration, proper graft handling and storage is particularly important.

Because grafts are transplanted from one part of the body to another (an "autograft") rather than from one person to another (an "allograft"), the grafts are not rejected by the body. This had two important implications; first, the doctor does not generally need to test a person to see if a hair transplant will work and second, no medications are needed to insure the growth of the transplanted hair. This is in stark contrast to allografts (such as kidney or liver transplants) where the person receiving the transplant must remain on powerful immune suppressing drugs to prevent its rejection by the body.

Graft Sizes

Grafts are usually divided into five general categories: standard punch grafts, minigrafts, slit grafts, micrografts, and follicular unit grafts. Standard punch grafts are 3-4 mm in diameter and each may contain up to 30 hairs (and 10 or more intact or partial follicular units). Minigrafts are smaller, 1.2-2.5 mm in diameter, and have 4-12 hairs per graft. Slit grafts are similar in hair content to mini-grafts but are rectangular in shape, rather than round, due to the fact that they are cut from long, thin strips (rather than being removed from the scalp with a punch). Micrografts are even smaller, measuring 1.5-1.0 mm or less in diameter, with 1-2 (or 3) hairs per graft. Follicular unit grafts are composed of single follicular units. These naturally occurring groupings may contain from 1 to 4 hairs each.

Small Grafts vs. Large Grafts

Large grafts placed in a frontal hairline look pluggy and unnatural when the hair was combed back or to the side. With the older procedures, the hair transplant patient was forced to comb his hair forward to hide his hairline. To create more natural looking hairlines, physicians began decreasing the size of grafts and began placing these smaller grafts in front of the larger ones. The problem was that the larger grafts were visible if the hair was not perfectly groomed and other areas of the scalp would not look natural, particularly if the patient continued to lose hair.

The use of larger grafts also obligated the patient to have multiple hair transplant sessions in order to have even modestly decent results, with the patient's appearance often being strikingly unnatural before the restoration was completed. Even with additional work, the large graft transplants often fail to appear natural because they are intrinsically clumpy. On close inspection, it is literally impossible for large graft transplants to look and feel natural, even after the best work.

It became apparent that using all smaller grafts would be preferable, but the amount of time and work needed to transplant large number of very small grafts was much greater than the effort needed to transplant a smaller number of larger grafts. Also, smaller grafts were more easily damaged during the dissection and placing process and special skills were needed to handle them effectively. Although small mini-

grafts and micrografts looked more natural, they resulted in significant damage to the follicles. It wasn't until the introduction of stereo-microscopic dissection and special placing techniques used in the follicular unit hair transplant procedure that these problems would be solved.

As a cautionary note, some hair transplant surgeons invent unusual terms for grafts in an attempt to make it appear that they have some special, unique knowledge or technique. Do not be confused by fancy terminology. The potential patient should be wary when a doctor claims to have a unique technology or technique that no other doctor knows about or uses. Worthwhile procedures will be documented and published in peer-reviewed medical journals.

Methods of Harvesting Grafts

There are a number of methods commonly used to harvest grafts. The original one, devised by Dr. Orentreich, uses a hand operated punch to cut single grafts that were 4-mm in size and contained up to 30 or more hairs. Besides producing very large grafts, there was significant hair wastage due to the destruction of hair follicles around the perimeter of the punch. As described in the history section, this problem was exacerbated if the punch was not perfectly aligned with the hair follicles and made even worse when the punches were reduced in size. A variation of this method utilizes a motorized punch that rotates at high speeds with the same, poor result.

The large grafts obtained by punch methods can be made into minigrafts by cutting them into halves or quarters. The donor area can be closed by suturing or can be left open – the more common technique since the former was very tedious. If the donor sites are not closed, they develop significant round white scars that can become visible later in life. Most doctors have abandoned using these techniques.

Another method uses a series of scalpel blades attached in parallel on a handle, called a multi-bladed knife. This instrument generates multiple thin strips of hair-bearing donor tissue which are subsequently cut into smaller pieces. This method is fast and still quite popular. Unfortunately, this method can cause extensive damage to the donor tissue, as it is impossible to line up the multiple blades parallel to the hair follicles.

In a fourth method, called single strip harvesting, the donor tissue is removed as a single, long, thin strip. The great advantage of this method is that the tissue is removed from the scalp with the minimal amount of damage. Further dissection is then performed using a dissecting stereo-microscope. This technique keeps potential injury to follicles to an absolute minimum and allows preservation of intact naturally occurring follicular units – it is the technique used in Follicular Unit Transplantation procedures.

All donor "harvests" result in a scar but, if done properly, the scar from the hair restoration procedure should be undetectable. Not only is it important for the scar to be closed meticulously – so that it will be as fine as possible – but the incision must be placed in the proper location, so that it will remain covered with hair even with further balding. Scars that are placed very high on the back or sides of the scalp, run the risk of being visible if there is extensive balding. In addition, the hair that is obtained from

high positioned incisions may not be permanent. Scars that are place too low have an increased risk of stretching from the movement of the neck muscles transmitted to the scalp.

Removing the old scar in subsequent hair transplant procedures is important for two reasons. First it keeps the second incision will positioned within the permanent zone of hair and second, it leaves the patient with just one scar in the donor area. Some doctors harvest a new area for each surgery. When many surgeries are done, these patients have a stepladder appearance of the back of the scalp from the multiple procedures – a situation that can easily be avoided.

Appearance of Hair Transplants

A hair restoration procedure is particularly bad when everyone can tell it is a hair transplant. The uneven, patchy effect of the large pluggy grafts occurs when large grafts are used and the spaces between the grafts are wide. This causes a contrast between the bald skin and the islands hair scattered over it creating the infamous "dolls-head" appearance.

Traditional hair transplants also produce small subtle changes in the skin. With larger grafts, the surface of the transplanted skin may not be aligned with the surface of the surrounding scalp leaving slight irregularities when they heal. The base of larger grafts may also take on a white scarred appearance that can be permanent. As the graft size decreases, these changes become less obvious. With follicular units these surface change can be completely avoided.

However, even with the use of very small grafts, hair transplants can still look unnatural. Hairline placement and proper hair direction are critically important to the natural outcome of the procedure and the skill to perform this with absolute perfection is possessed by only a few of the most talented hair restoration surgeons.

Hairlines

The design and position of the hairline are perhaps the most critical aesthetic aspect of the hair restoration. Some physicians create the same standard hairline on every patient; however, natural hairlines vary greatly from one individual to another. The hair transplant surgeon must be acutely aware of the spectrum of variations that normally occur and tailor each hairline to the patient's specific facial features. He must also take into account that, as the patient matures his facial features will change and he will continue to bald, but the position of the transplanted hairline will be permanent.

Few natural hairlines are symmetrical; therefore, one should not attempt to create a perfectly balanced hairline, as it is distinctly unnatural looking. Errors can occur when over-demanding patients or over-aggressive doctors place the hairline too low on the forehead, or restore the juvenile (adolescent) hairline. Although it is important that the patient play and active role in decisions regarding the placement and design of the hairline, it is up to the physician to educate the patient and set the parameters to insure that the procedure will look natural, now and in the future.

Hair and Its Variations

Certain hair types may be more common in certain human groups. Understanding these characteristics may be critical in anticipating the results one can expect. African hair is very curly. This single characteristic makes African hair produce some of the best results in hair transplantation, but the dissection must be performed with extreme care to avoid damage to the curved follicles.

Most Asian hair is black, coarse and straight, making it critical that a deep zone of one-hair grafts are used at the hairline to insure a natural look. The use of the stereo-microscope can insure that only single units are placed in this area. Using only naturally occurring individual follicular units will produce natural results with all hair and skin types.

Hair grows in different directions in different parts of the scalp. Hair in the front and top of the scalp grows predominantly forward; hair in back of the scalp grows downward; hair on the sides of the head grows away from the middle. The place where the hair changes from the forward direction to the back is called the vertex transition point and is more commonly know as the crown. In designing the hair transplant, your surgeon should have a knowledge of these natural growth patterns, your hairstyle preferences, and how you want your hair to look when you hair is both groomed and un-groomed. A thorough understanding of all the nuances of the different hair characteristics and patterns that individuals may possess is essential in producing consistently superior results.

8 Follicular Unit Transplantation

Follicular Unit Transplantation is the technique that has revolutionized modern hair restoration surgery. It has given hair transplant surgeons the ability to restore a person's hair in just one or two sessions and to produce results that, when done properly, can look completely natural. This procedure, first described by Bernstein and Rassman in their 1995 paper "Follicular Transplantation" and detailed in over 50 subsequent publications, is now used by virtually every physician performing hair transplants today.

The idea of Follicular Unit Transplantation (FUT) is simple. Since hair grows in small groups of 1-4 hairs per group, in Follicular Unit Transplantation, hair is transplanted exactly this way. By mimicking the way hair grows in nature, the surgeon has the ability to produce results that will look totally natural. This "ability" to produce great results, however, is no guarantee that these results will be achieved and in Follicular Unit Transplantation, the artistry of the surgeon and the skill of the surgical team are critical to realizing the procedure's full potential. When poorly executed, FUT offers little advantage over older hair restoration techniques.

The conceptual simplicity of FUT belies the many important benefits of this procedure. Other advantages of the technique include; the ability to safely perform large hair transplant procedures involving thousands of grafts, the potential to complete the restoration in just a few sessions, very rapid healing, and the maximum utilization of a patient's donor hair supply. This chapter will explain the basic ideas behind Follicular Unit Transplantation and how they benefit patients undergoing hair restoration procedures. It will also describe some of the import aspects of this procedure, so that patient's will know what to expect (and demand) when considering this type of surgery.

What Exactly are Follicular Units?

Follicular Units are the functional hair bearing structures of the skin. On the surface of the scalp they are seen as tiny groups of hair that appear to be growing together. Viewed under a microscope, they are seen as well-demarcated structures. Although follicular units had been described by the histologist Headington in 1984, their existence had gone unrecognized by hair restoration surgeons. (See chapter 7, Hair Transplant Basics)

In the human scalp, follicular units are comprised of individual groups of 1-4 terminal hairs. In addition to the normally thick, terminal hairs, follicular units also contain 1-2 tiny vellus hairs, sebaceous (oil) glands, a small muscle, small nerves, blood vessels, and a thin band of collagen that surrounds the unit called the perifolliculum.

The follicular unit determines most of the important characteristics of one's hair including hair thickness, color, texture, curl, orientation on the scalp, growth rate and susceptibility to DHT. In areas of the scalp affected by androgenetic balding, the effects of DHT cause healthy, thick, terminal hairs that comprise follicular units, to gradually be replaced by hairs of shorter length and smaller diameter in a process called

"miniaturization". Over time the effects of DHT will cause follicular units susceptible to this hormone to disappear. (See Chapter 4, Hereditary Baldness.)

What is Follicular Unit Transplantation?

In Follicular Unit Transplantation, hair is removed from the permanent zone in the back and sides of a person's scalp, dissected into naturally occurring, individual follicular units and then transplanted into the areas affected by the balding process. In contrast to other forms of hair transplantation, where grafts may contain varying numbers of hairs depending upon the whim of the surgeon, in FUT, the graft is the follicular unit. Therefore, a follicular unit graft contains exactly the number of hairs that the follicular unit contained and it is exactly the same size.

In order to remove follicular units from the back of the scalp without damaging them, the donor tissue must be removed in one piece. This technique called, "single strip harvesting," is an essential component of Follicular Unit Transplantation as it not only preserves the follicular units, but also prevents damage (transection) to the individual hair follicles. It is a significant advance over the older minigrafting and micrografting techniques that used multiple bladed knives to remove the donor tissue, as these instruments broke up follicular units and caused unacceptable degrees of damage to hair follicles.

Another essential component of Follicular Unit Transplantation is "stereo-microscopic dissection." In this technique, the follicular units are removed from the donor tissue under microscopic control to avoid damage. Complete stereo-microscopic dissection techniques have been shown to produce an increased hair yield as high as 30% over other methods of graft production. Since all patients have donor supplies that are limited, the preservation of every follicle is a critical aspect of the technique.

However, the procedure of Follicular Unit Transplantation, as detailed in Bernstein and Rassman's landmark publications on the subject, is more than just a refined technique of graft harvesting and dissection. It is a philosophy of hair transplantation that directs the surgeon to carefully consider the needs of the patient and then, within the constraints of the patient's actual donor supply, to devise a realistic, long-term plan that can best meet his or her goals.

The ambitious nature of this procedure is stated in the introduction to the authors' original publication on Follicular Unit Transplantation. It reads:

> Follicular Transplantation is the logical end point of over 30 years of evolution in hair restoration surgery, beginning with the traditional large plugs and culminating in the movement of one, two and three hair units, which mirror the way hair grows in nature. The key to follicular transplantation is to identify the patient's natural hair groupings, dissect the follicular units from the surrounding skin, and place these units in the recipient site in a density and distribution appropriate for a mature individual.

> The critical elements of follicular transplantation are an accurate estimation of the donor supply of hair, meticulous dissection of the follicular units, careful design of the recipient area to maximize the cosmetic impact of the hair transplant, the use of large numbers of implants in fewer rather than more sessions, a long-term master plan that accounts for the progression of the male pattern alopecia, and realistic expectations on the part of the patient.
>
> *Bernstein and Rassman, 1995*

All of these elements need to be considered by the physician if the patient is to have the maximum benefit of the FUT procedure. The physician's medical judgment, his artistic sense, his surgical skills and the experience and abilities of the entire surgical team are important in making this very labor-intensive hair restoration procedure a success.

The Reasons for Transplanting Follicular Units

Complete Naturalness

The main reason for transplanting follicular units is to be able to produce completely natural results. This is possible because the follicular unit grafts themselves represent the way hair grows in nature - in tiny groups of 1 to 4 hairs each. If grafts smaller than follicular units are used, the results will look too thin. If one transplants groups larger than follicular units, the hair will look clumpy and uneven. When the doctor uses follicular units exclusively in the hair restoration, the hair transplant can be undetectable.

Just the use of follicular units, however, does not ensure that the hair transplant will look natural. Other aspects of the procedure must still be done properly; such as meticulous graft dissection, making the recipient sites the right depth, placing the grafts in the appropriate distribution, angling them in the right direction, as well as a host of important nuances in technique.

Maximizing Growth

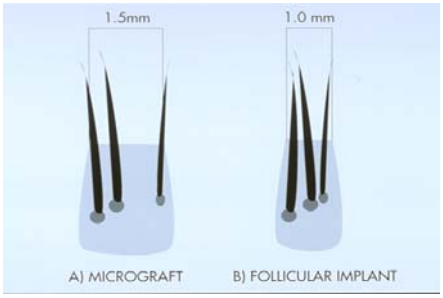
The follicular unit is a physiologic entity, rather than just an anatomic one. It is more than a tiny bundle of hair. It is a living structure, complete with nerves, blood vessels and a protective collagen sheath. When follicular units are transplanted intact, the surrounding tissue serves to protect them from drying and from mechanical injury during the placing process. It has been observed that when hair grafts were obtained by breaking up the naturally occurring follicular units, their growth was less than when the follicular units were kept intact. Keeping the structure whole, will increase the chance that all of the hair in the follicular unit will grow.

As we discussed, when individual follicles are cut (transected), their survival decreases dramatically. Besides, keeping the follicular units intact, the stereo-

microscopic technique of follicular unit transplantation insures that the individual hairs that comprise each unit will be preserved during the process of graft dissection. Therefore, using FUT techniques serves to protect both the follicular unit and the hair follicles that comprise them – insuring maximum growth of the transplanted grafts.

Creating Small Wounds

Using follicular units is the best way to get the most hair into the smallest possible recipient sites (the holes in the skin that the grafts are placed into). Small recipient sites are important for a number of reasons; First, the small wounds facilitate rapid healing; second, the small wounds cause less damage to skin in the recipient area, so that graft growth will be maximized; third, if the recipient sites are small, they can be placed closer together, allowing the grafts to be packed more densely; fourth, small wounds create a snug fit for the grafts; fifth, small wounds cause less interference with the underling blood supply, which in turn allows more grafts to be transplanted in one session.



The above diagram illustrates why follicular units allow the surgeon to place the most hair in the smallest possible recipient sites and still look natural. On the left is a 3-hair graft that was made using the old mini-micrograft technique that literally cut up the donor strip into small pieces, ignoring the fact that hair grew in natural groups. Note that the graft on the left is comprised of a 2-hair group and a single-hair, separated by a bit of bald scalp. Because it contains extra tissue, this 3-hair graft measures 1.5mm and, therefore, must be placed in a recipient site at least this wide.

In contrast, the graft on the right consists of a 3-hair follicular unit measuring only 1mm in diameter and allowing it to fit into a much smaller hole (while still containing the same amount of hair). This may not seem like a big difference, but when multiplied over thousands of grafts (and their corresponding smaller sites) the effects on the rapidity of healing, graft growth, and maintaining the scalp's normal blood flow is substantial. In addition, whereas a wound of 1.5mm may leave a permanent mark on the surface of the scalp, a wound of 1-mm never does (a 1mm incision is about the width of the needle used to draw blood from your arm).

Once a doctor tries to use grafts that are larger than a person's naturally occurring follicular units, the extra tissue contained in the grafts will necessarily increase the size of the wounds, impede healing and risk looking unnatural. This unnatural look is due to the fact that hair may look tufted and uneven when it grows and may produce pigmentation changes and scarring on the skin's surface. In addition, when larger grafts are used, the grafts may either elevate or heal with a slight depression, further altering the surface of the skin. The key to a natural appearing hair transplant is always to have the hair emerge from perfectly normal looking scalp. The only way to ensure this is to keep the recipient wounds small.

If the surgeon goes in the other direction and divides up follicular units (either through poor dissection techniques or by design) he is not increasing the total amount of hair transplanted; he is just unnecessarily increasing the number of grafts and the number of recipient sites that are needed to hold them. This increases the amount of wounding to the scalp, risks injury to the grafts from the splitting of follicular units and, of course, increases the cost of the procedure, when doctors charge by the graft. In fact, splitting up follicular units allows fewer hairs to be placed in a defined area of the scalp and results in a thinner look.

Using follicular units, therefore, allows the surgeon to transplant the greatest amount of hair with the smallest wounds and with the least trauma to the scalp. This maximizes healing and facilitates growth. It also creates the fullest look to the restoration while insuring the naturalness of the hair transplant.

A final important advantage of the small wound is a factor that can be referred to as the "snug fit." In order to place a large graft into a recipient site, when using older techniques, a small amount of tissue needed to be removed so that the graft could fit. This was typically accomplished with a small instrument called a "punch" that, in the process of cutting out tissue, destroyed the local elasticity of the skin and loosened the scalp's hold on the graft. In contrast, a follicular unit graft is so small that it can always fit into a very small wound, without having to remove tissue. A small incision, made with a needle, retains the basic elasticity (recoil) of the recipient site. When a properly fitted follicular unit is inserted into the scalp, the recipient site will hold it snugly in place.

This "snug fit" has several advantages. During surgery, it minimizes graft elevation (popping) and the need for the sometimes traumatic re-insertion or re-positioning of grafts. After the procedure, it ensures maximum contact of the graft with the surrounding tissue, so that oxygenation can be quickly re-established. This facilitates healing and graft growth. In addition, by allowing the tissue to hold the graft firmly in place the "snug-fit" enables the patient to shower and gently shampoo the scalp the day after the hair transplant. This allows the person to resume his daily routine as quickly as possible, without the procedure being detectable.

Large Hair Transplant Sessions

An important consequence of the follicular unit's ability to be inserted into very small recipient sites, and to thus minimize wounding to the scalp, is to give the surgeon the ability to be able to safely transplant large numbers of grafts in a single hair transplant session. This, in turn, allows the hair transplant process to be completed as quickly as possible. Of course, we do not mean rushing the patient to surgery, but rather completing the transplant in as few sessions as possible, so that there is less interference with a person's lifestyle.

The Advantage of Performing Large Sessions

Although large hair transplant sessions are made possible by the ability of follicular units to fit into very small recipient sites and to minimize wounding, one might ask what the actual advantage is for doing this. It is an important question, since large sessions are time consuming, require a larger surgical team, and are more costly for the patient (at least per procedure). There are a number of very important reasons.

Social Issues

The specific reasons that a person with hair loss seeks treatment may vary, but the common denominator of those undergoing surgical hair restoration is the hope that enhancing their appearance will improve the quality of their life; be it personal, social or professional. There is probably no better way for a surgeon to undermine this goal than to subject an already self-conscious patient to a protracted course of small, incomplete procedures. The disruptions from the scheduling of multiple surgeries, the limitations in activity, and the concern about their discovery, can place a patient's life "on hold." Until the restoration is finished, the patient will be conscious of the process and will find it difficult to move forward.

The physician should, therefore, try to accomplish the restoration as quickly, and in as few sessions, as possible. Even more important, is that each procedure should stand on its own, so that after one procedure the results will look natural and, if more than one procedure is planned, the patient can still continue with normal activities while awaiting the next session.

Account for Shedding

In genetic hair loss, full-thickness terminal hairs gradually decrease in length and diameter through a process called miniaturization. Miniaturization is a universal aspect of androgenetic alopecia and accounts for most of the early changes that we see. In other words, in the early stages of hair loss, the "thinning" that one notes is actually due to thinning (i.e. miniaturization) of the hair shafts, rather than the actual loss of hair itself.

Regardless of the surgeon's technique, an inevitable aspect of hair transplant surgery is that the patient's existing hair in, and around, the transplanted area has a chance of being shed as a result of the procedure. The hair that is at greatest risk of being lost is the hair that has already begun the process of miniaturization and, if this

hair is at, or near the end of its normal life span, it may not return. The medical term for this shedding is telogen effluvium. It is also referred to as shock hair loss.

Often this shedding is mild and insignificant, but at times is can be substantial. The reason is that in some patients, especially those in active stages of hair loss, large amounts of hair can be undergoing this process of miniaturization. Thus, identifying those patients especially at risk, explaining to all patients that some shedding may occur and planning for it surgically, are import aspects of the hair restoration process.

The risk of shedding can be lessened by using small recipient sites and limiting their depth, reducing the amount of epinephrine (adrenaline) used in the anesthesia, and minimizing the tension on the donor closure. However, regardless of the "claims" of a particular surgeon, the process is a natural response of hair follicles and the risk can not be eliminated entirely.

To plan for a possible effluvium surgically, the physician should consider the following:

1. Defer surgery to those who are very early in the balding process, i.e. those who are content with the way they look now, but are more concerned about future hair loss. A good rule of thumb is to wait until the patient needs a minimum of approximately 800 follicular units before considering surgery. Often medical therapy, rather than surgery, would be appropriate for these patients.
2. When considering surgery, carefully define the boundaries to be transplanted by gross visual inspection, as well as with the densitometer (a more sensitive indicator of miniaturization).
3. Transplant through, rather than avoiding, an area that is highly miniaturized, since it is likely that this area will be lost by the time the transplant has grown in.
4. Plan to use enough follicular unit grafts so that, if possible, the volume of transplanted hair is greater than the volume of hair that might be lost from telogen effluvium. Remember, we are never replacing "hair for hair" in the surgery. We are replacing a large number of fine, miniaturized hairs, with a much smaller amount of permanent, full-thickness terminal hairs. In areas of extensive miniaturization, it may be appropriate to transplant follicular units in the same density as one would if the area was totally bald.

Economizing the Donor Supply

The finite nature of the donor supply is the ultimate limiting factor in all hair restoration surgery. As we have discussed, proper harvesting techniques and precise follicular unit graft dissection is critical to ensuring maximum donor yield. Using a smaller number of larger transplant sessions, rather than multiple, small sessions, will also help to maximize this supply.

Each time an incision is made in the donor area, and each time sutures are placed, hair follicles are damaged or destroyed. This damage can be minimized, by keeping the sutures close to the wound edges so that they don't encompass much hair and/or removing them soon after the procedure in non-tension closures. Staples, in

particular, may minimize damage to surrounding hair follicles and conserve donor hair. However, regardless of how impeccable the technique, each surgical procedure is associated with some degree of hair wastage.

There are other more subtle effects of the surgery. In the healing process, collagen is laid down and reorganized. This distorts the direction of the hair follicles and increases the risk of transection in subsequent procedures. As we will discuss, this is a very significant problem with Follicular Unit Extraction (FUE), but also had some relevance to Follicular Unit Transplantation. In addition, the fibrosis makes the scalp less mobile for subsequent surgeries, thus decreasing the amount of additional donor tissue that can be harvested. With each hair restoration these factors come into play, so that transplanting in large sessions, which minimizes the total number of individual procedures, will maximize the total amount of donor hair available.

Enhancement of Graft Sorting

A final advantage of using large numbers of follicular units in the hair transplant session is that it permits graft sorting, an important technique that can enhance the cosmetic benefit of the procedure.

Unlike, the older procedure of mini-micrografting, where the doctor cut grafts to what ever size he desired (much to the cosmetic determent of the patient), in follicular unit transplantation, the follicular unit is the graft. Therefore, in a person who has mainly 1- and 2- hair follicular units, the resulting dissection will yield mainly 1- and 2- hair grafts. In contrast, a person with higher density will have a greater population of 3- and 4-hair units and thus more of these grafts.

Although this anatomic characteristic of the patient can not be changed, different size units serve different purposes, and the surgeon musts have a sufficient number of each to maximize his craft.

The cardinal principle in designing a hair transplant is to duplicate natural hair patterns. In most adults, the frontal, forelock area has greater density than the hair adjacent to this. This central frontal density gives the person a masculine look and can easily be differentiated from the diffuse thinning seen in genetic hair loss or in disease. Two of the tools the surgeon can use to create this central density are to place grafts closer together in this central area and to use larger follicular units (graft sorting).

The limitation of transplanting grafts too close together is that, if placed too close, the wounds may impede the blood supply and graft growth. In fact, the dense packing technique used by most physicians with expertise in FUT, already maximizes the close graft placement of grafts, so that there is uniformly closely placed grafts over the entire area to be transplanted. This leaves graft sorting as the other means to create natural density gradients. Graft sorting is simply using follicular units of different sizes for different purposes, so in this case larger follicular units (those of 3- and 4-hairs) would be placed into the forelock area to create greater density in this area. It should be obvious that when performing transplant with a greater total number of follicular units, graft sorting becomes a more powerful technique.

Another critical aspect of the hair transplant is to make the fontal hairline soft and natural. To accomplish this, the surgeon needs a significant number of 1-hair grafts – generally on the order of 250. In small sessions, there may not be enough naturally occurring 1-hair follicular unit grafts obtained fro the donor strip to accomplish this goal, leaving the surgeon with the only choice of dividing up larger grafts. This will not only increased the risk of graft injury and poor growth but will compromise the other goal of the transplant, namely creating adequate density.

The following example illustrates how the use of larger numbers of grafts per session can increase the power of graft sorting. The table below shows the number of follicular unit grafts obtained from a person with an average of 2.3 hairs per follicular unit in his donor area. The person has a Norwood Class 4a pattern of hair loss, which means that he has lost his frontal hairline and most of the hair in the front part of his scalp. The chart compares the number of each type of follicular unit that would be obtained in a 1,000 graft hair transplant session with the number of follicular unit grafts in a 2,000 graft session.

Size Distribution of Follicular Unit Grafts

		# of Grafts	
FU Size	**%**	**1000**	**2000**
1-hair	20%	200	400
2-hair	40%	400	800
3-hair	30%	300	600
4-hair	10%	100	200
Hairs/FU	**2.30**		

With a 1,000 graft session, there are only 400 follicular units available to be used in the forelock area, too few grafts to create any significant density in a patient with Class 4a hair loss. A 2,000 graft session in this patient, however, would yield 800 3- and 4- hair grafts, a sufficient number to create a nice central forelock with the remaining 1200 grafts to create a hairline and fill in the remainder of the frontal area.

One could argue that you could perform a 1,000 graft procedure and then just repeat it a year later. However, you then encounter the inefficiencies and wastage of multiple sessions as described above and, of course, the inconvenience to the patient by postponing the completion of the restoration for an additional year.

The other problem is that when the procedure is performed in two sessions, there would not be enough single hair grafts in a 1000 graft case to complete the frontal hairline. In our example patient, with a donor density of 2.3 hairs per follicular unit, only 200 1-hair grafts would be generated (approximately 50 to 150 grafts short of the 250-350 grafts normally needed to create a soft frontal hairline. The patient would than need to wait until the next procedure before the hairline was completed. The alternate strategy, dividing up 2-, 3-, or 4- hair units to generate the single-hair grafts, would risk injury to

the follicles and would result in a decrease in the size and/or number of the remaining grafts.

In sum, when using larger sessions, the greater numbers of 3- and 4-hair units will provide the "natural resources" to create significant fullness in select areas and a sufficient number of 1-hair grafts will allow the creation of soft, natural hairlines. Therefore, another reason for using larger procedures is that they will offer the surgeon the greatest flexibility in designing the transplant, without having to combine or split follicular units.

How is Follicular Unit Transplantation Different from Mini-Micrografting?

This is one of the most commonly asked questions and it is a very important one for those deciding which hair restoration procedure to choose. In contrast to Follicular Unit Transplantation, where the graft sizes are determined by nature, in mini-micrografting, the combination of minigrafts and micrografts, (see Chapter 7, Hair Transplant Basics) the graft sizes are arbitrarily determined by the doctor who cuts the donor tissue into the size pieces that he wants. Another name for this technique is mini-micrografts "cut to size."

In mini-micrografting, neither preserving follicular units, nor even keeping hair follicles intact, are felt to be that important. Rather, the speed and economics of the procedure are the deciding factors. Doctors performing mini-micrografting use a multi-bladed knife to quickly make thin strips of tissue and then use direct visualization (rather than microscopic control) to cut the tissue into grafts. The resulting grafts are generally larger than follicular units and, since the excess skin is not trimmed away, the donor sites (wounds) are larger as well.

It should be apparent from the comparison shown on the next page that Follicular Unit Transplantation is superior in producing a natural, undetectable result, in maximizing healing, and preserving precious donor hair. Mini-micrografting, however, requires a smaller staff and each procedure is cheaper and shorter (although in the end it takes more procedures and therefore may cost just as much for this technique).

The following table summarizes the major differences between Follicular Unit Transplantation and Mini-Micrografting:

	Follicular Unit Transplant	**Mini-Micrografting**
THE GRAFTS		
Follicular Units Only	Yes	No
Graft size	Uniformly small	Larger
Number of hairs per graft	1-4	1-6 (or more)
Hair/skin ratio in graft	High	Average
Extra skin transplanted	No	Yes
Wound size	Uniformly small	Variable

THE TECHNIQUE		
Harvesting type	Single-Strip	Multi-bladed knife
Microscopes required	Yes	No
Follicular Units Preserved	Yes	No
Follicular transection	No	Yes
Maximizes donor supply	Yes	No
THE RESULTS		
Healing time	Fast	Slower
Skin surface change	No	Yes
Maximum fullness	Yes	No
Undetectable	Yes	No
COST & CONVENIENCE		
Staff requirements	Moderate	Small
Duration of procedure	Long	Short
Time for full restoration	Short	Long
Cost per procedure	More	Less
Total cost for restoration	Similar	Similar

9 Follicular Unit Extraction

Although single-strip harvesting is the most efficient means of obtaining tissue for Follicular Unit Transplantation, it produces a linear scar in the donor area. With good surgical planning and meticulous techniques, FUT usually results in a very fine scar. However, if the donor strip is too wide, the patient's scalp is too tight, or poor techniques were used in either the strip removal or the closure, a widened scar can result.

Just as the poor surgical methods of the older hair transplant techniques produced a pluggy, corn-row appearance in the front of the scalp, they often left unacceptable scars in the back of the head as well. Fortunately, with properly performed modern follicular unit transplant procedures, the pluggy look has been eliminated and donor scars are no longer a significant problem. However, it is still important to be able to avoid a linear scar in certain situations and to correct them when the need arises.

In the latter half of the 1990s, doctors set out to find a way around the linear scar by directly extracting follicular unit from the donor area using a small punch. Dr. Ray Woods was the earliest pioneer of this procedure, but practiced in Australia and chose not share details of his technique with other physicians.

Early attempts at removing individual follicular units were frustrated by high transection rates. In Japan, Masumi Inaba used a punch to partially cut through the skin around the upper part of the hair follicle and then remove the remainder of the follicle with forceps. Inaba's insight led Rassman and Bernstein to search for less traumatic ways of extracting entire follicular units and to develop a test to predict which patients might be best suited for this technique. This research eventuated in the first publication on the subject in 2002 titled "Follicular Unit Extraction: Minimally Invasive Surgery for Hair Transplantation."

What is FUE

Follicular Unit Extraction (FUE) is a method of obtaining donor hair for Follicular Unit Transplantation (FUT), where individual follicular units are harvested directly from the donor area, obviating the need for a linear incision. In this procedure, a small punch is used to make a small circular incision in the skin around the follicular unit, which is then extracted directly from the scalp.

Follicular Unit Transplantation and Follicular Unit Extraction are sometimes viewed as being two distinct procedures. However, FUE is actually a type FUT where the follicular units are extracted directly from the scalp, rather than being microscopically dissected from a donor strip that has already been removed from the scalp. In other words, in Follicular Unit Transplantation, individual follicular units can be obtained in one of two ways; either through single strip harvesting and stereomicroscopic dissection (FUT) or through FUE.

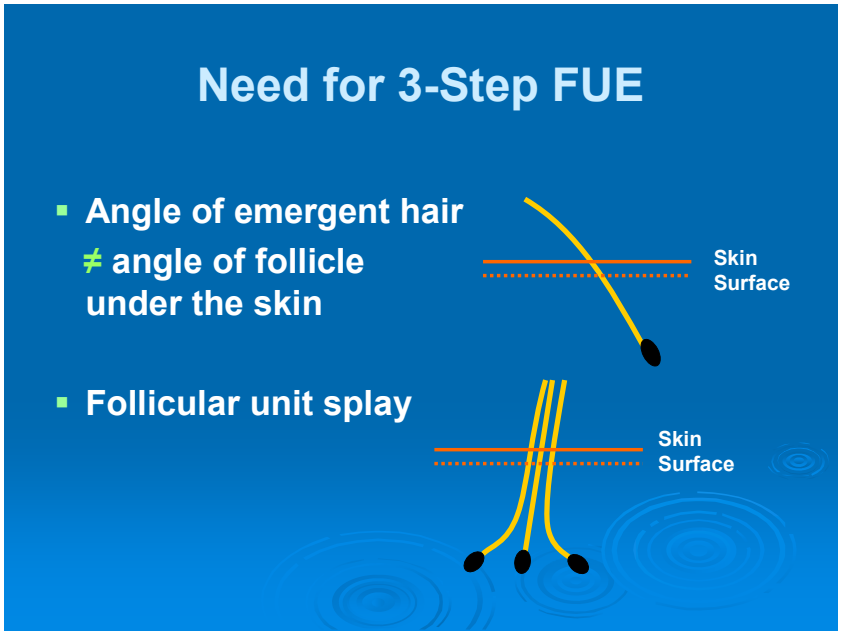
When comparisons are made between FUT and FUE, what is really being compared is the way the follicular grafts are obtained. The harvesting method does have other implications for the procedure such as the transection (damage) rate, distribution

of follicular units, number of grafts per session, post-op care and the total hair yield.

The Challenge

There are several problems inherent in removing individual follicular units with small punches. The first is that angle of the hair on the skin surface is different than the angle of the follicle below surface, making alignment difficult (see figure: Need for 3-step FUE). Any variation between the angle of the punch and the exiting hair can result in transection of the follicles. Keeping the punch perfectly parallel to the follicles throughout its entire length is nearly impossible, as the angle changes below the skin surface and the visual cues used to guide one's hand are lost once the punch passes into the depths of the tissue. This alignment is further compromised by the twisting motion used to advance the punch.

However, the main problem with FUE is related to the anatomy of the follicular unit itself. Follicular units resemble a small bundle of wheat gathered at the surface of the skin and splayed apart deeper in the skin, so that each follicle gently curves outward as it enters the dermis. In the subcutaneous fat, the follicles have lost their grouping and appear as individual bulbs. This curved course of the follicles through the skin is what makes the follicular unit so difficult to extract with a straight, sharp instrument like a punch.



Although a punch can neatly cut around a follicular unit on the surface, it risks amputating all or part of the widened lower portion of the units as it cuts through the deeper tissues. Trying to simply cut out follicular units with a punch, yielded results that would be anticipated from the anatomy. It produced an unacceptable rate of transection (about 30%) with wide patient-to-patient variability.

Towards a Solution

Dr. Inaba's process of removing hair from the donor area by first using a punch to cut only part of the way down the follicular unit and then grabbing the unit with forceps so that the remainder of the follicle could literally be pulled (extracted) from the scalp, seemed to be able to circumvent some of the anatomic problems of the follicular unit and reduced follicular damage. It was soon realized, however, that even with this "extraction" technique there was considerable patient-to-patient variability in obtaining intact follicular units.

In some patients, follicular units could be removed completely intact. In others, the grafts pulled apart during their removal, resulting in the follicles being fragmented. The search began to find different hair characteristics that would account for this variability. The most obvious was hair shaft diameter. It was felt that thick, coarse hair would act to hold the graft together as it was extracted. It was also assumed that Inaba's positive experience with the technique was based upon a select patient population, i.e., Japanese patients who characteristically have thick, coarse hair.

Unfortunately, the problem was not as straightforward as had been thought. Although successful extraction occasionally did correlate positively with hair shaft diameter, it was noted that a number of Asian patients whose grafts fragmented during extraction and some fine-haired Caucasian patients in whom extraction was relatively easy. It was apparent that other factors were involved.

It seemed that the tough, dermal layer of skin might provide strength to the graft during extraction and explain the variability between patients. In conjunction with the Department of Dermatology of Columbia University, Bernstein and Rassman began to examine the patient's donor tissue microscopically to see what specific factors might account for differences in the ability of follicular units to be extracted. They soon started performing tests on every patient contemplating FUE to determine, in advance, of the procedure who would be good candidates. The author's called this the "Fox Test," an acronym for Follicular Unit Extraction.

Although the specific characteristics of a person's scalp that determine who will be good candidates for FUE have not yet been identified, the FOX Test has been very useful in formulating a surgical plan, as it gives a great deal of information about a person's candidacy for the FUE procedure, how much transection one might expect and even which of the two main techniques of FUE will be the most effective, the two-step or the three-step technique.

Two-Step Technique

This technique has two main steps. In the first step, (the cutting part) a sharp 1 mm punch is placed over the follicular unit and aligned with the angle of the hair shafts below the skin surface. A rotational motion of the punch is then used by the hair transplant surgeon to cut through the skin and isolate FUs in the epidermis and upper dermis. When a "stop" is used to limit how far the instrument can pass into the skin, the FUE procedure is referred to as the Follicular Isolation Technique (FIT).

Success with this step depends on the ability of the surgeon to align the punch perfectly parallel to the axis of the hair shafts – a task that for reasons described above, is extremely difficult.

In step two (the extraction part), a fine rat-toothed forceps is used to apply gentle traction to the top of the FU until the unit is pulled loose from its deep dermal and subcutaneous connections. To help with situations in which the unit would not pull loose, the technique was refined further with the doctor gently dissecting away any remaining attachments of the lower portion of the graft to the surrounding skin. A fine needle, with a U-shaped tip, was the most common instrument used for this purpose.

Three-Step Technique

James Harris can be credited with refining Follicular Unit Extraction by adding a third step to the process. In this new three-step FUE procedure, a sharp punch is used to score the epidermis (rather than cut through the full thickness to the dermis) and then a dull punch is used (through a back-and-forth twisting motion) to bluntly dissect the FU graft from the surrounding epidermis and dermis. The three steps are: 1) scoring with a sharp punch, 2) dissection with a blunt instrument, 3) extraction with forceps.

The main advantage that this technique has over the original two-step process is that using a dull punch as a second step avoids follicle transection and allows intact follicular units to be extracted more easily. As the blunt-tipped instrument is advanced into the dermis, splayed follicles are gathered together as they are pulled from the skin, thereby avoiding transection.

As anticipated, the three-step technique adds considerable time to an already tedious FUE procedure, but its superiority over the two-step procedure in avoiding follicular transection and in preserving follicular units makes this increased effort worthwhile.

An unanticipated problem with the three-step technique, however, is a higher incidence of buried grafts. Buried grafts occur when grafts are inadvertently pushed into the subcutaneous tissue during FUE.

These grafts can be left alone, but they may develop into cysts that may eventually need to be removed. They can sometimes be extracted using a small instrument called a Shamberg extractor (the instrument used by dermatologists to remove black-heads), but often the doctor must widen the punch-hole so that the buried graft can be grasped with forceps and pulled out. Removing buried grafts is extremely time-consuming. If one has a buried graft rate over a fraction of a percent, it becomes a significant logistical problem for the hair transplant procedure.

Clarification on Terminology

Since the extraction process is common to both procedures, in future publications, the "steps" will refer only to the aspects of the procedure that precede extraction. Therefore, the two-step procedure (that uses cutting as the first step) will be referred to as the one-step technique and the three-step procedure (that uses scoring and

dissection as the first two steps) will be referred to as the two-step technique.

The Advantages of FUE

The reason for developing Follicular Unit Extraction was to eliminate the linear scar that resulted from strip harvesting. However, because properly performed FUT results in a linear scar that is usually very fine, it is important to carefully weigh the pros and cons of FUE when considering it as an alternate procedure. In other words, one must weigh the relative advantage of not having a linear scar in FUE against the relative disadvantage of having less transplantable hair. Rather than just listing the pros and cons of FUE vs. FUT, it is more useful to look at the perceived advantages and disadvantages in the context of the entire hair restoration process.

FUE is mainly considered in those who want to wear their hair very short on the back and sides, or in patients who want to shave their heads – generally, the desire of younger patients. If a person wants to shave their head after a hair transplant, or even wear their hair very short, one can argue that a hair transplant should not be considered in the first place. After all, the purpose of the transplant is to have hair, and if a person feels that a buzz cut or a shaved head is their desired look, then they should just do it.

There is a misconception that FUE is a scar-less procedure. The fact is that FUE produces more total scarring than FUT (over twice as much). It is just that the individual scars in FUE are tiny, but they are distributed over a much larger area. In fact, in most cases of FUE, a person can not shave their head, as the small round white scars of FUE would be visible.

FUE is felt to decrease healing time. The reality is that the small open wounds of FUE tend to ooze and crust for a number of days after the procedure, whereas the incision of a strip FUT is sutured closed, so that the oozing subsides by the next day. On the other hand, the linear incision of FUT takes weeks to months to regain its full strength, whereas in FUE the strength of the donor area is never compromised. If a person is engaged in contact sports and needs absolute minimum disruption from this activity, then FUE would be preferable.

It is also felt that FUE is more easily disguised after surgery than FUT; however it is just the opposite. In FUT, a thin strip of donor hair in the back of the scalp is clipped short before it is harvested. But that clipped hair is the part that is removed and the uncut areas are sewn together leaving no trace of the procedure (if the hair on the back and sites are worn a little long).

In contrast, to perform FUE, the surgeon must clip larges areas of donor area prior to harvesting the hair. As a comparison, the area of scalp needed to harvest 1000 grafts with FUE is about 60 cm, about 6 times the area needed for a comparable number of grafts when FUT is performed. And, where the harvested area is FUT is removed and sutured closed, the clipped area in FUE is harvested, but not removed, leaving a large are of mottled scalp to heal.

FUE can be performed in a person with long hair, with the sides shaved in strips, so that it can be covered by the hair around it, but this still presents a problem with

visibility, since the open area is not removed. In addition, this necessitates even smaller sessions in a procedure that is already somewhat inefficient (as will be discussed).

There is some discomfort in the donor area following a strip incision, particularly when staples are used for the closure, but it is temporary and can be controlled, if needed, with medication. This is little to no discomfort in the donor area following FUE and neither FUE nor FUT procedures cause any post-op discomfort in the recipient area.

Follicular Unit Extraction may be useful for those patients with a greater risk of donor scarring, such as Asians and African Americans. However, because of the decreased over yield from FUE, it generally is more useful to switch to FUE in those patients who have a problem, than to treat all patients with FUE preemptively. In patients who are known to heal with wide or thickened linear scars, any hair transplant procedure should embark upon with caution, if at all.

FUE is often the best treatment for widened scars resulting from traditional strip excisions. If the widened strip was do to poor surgical techniques, than a meticulous re-excision may solve the problem. If however, the initial techniques were good, then re-excision would expect to give a similar result and the surgeon should go directly to FUE.

In fact, FUE can be used to improve the appearance of any linear scar and can serve as the final step after all strip sessions have been completed if the patients want to wear his hair as short as possible. In this way, the patient benefits from the efficiencies of strip-harvesting and gets a final "touch-up" of the donor scar with FUE.

FUE provides an alternative to a strip excision in patients with a very tight scalp, but it must be kept in mind that patients with a tight donor scalp may also have more limited donor reserves. The reason is that a loose scalp not only represents increased scalp laxity (i.e. ability to stretch), but also represents increased movement due to redundant scalp – extra tissue containing hair. The point is that patients with a tight scalp may have limited donor reserves than may not be correctable with FUE.

An interesting aspect of FUE is the ability to extend the size of the donor area, since it can potentially access areas that ire inaccessible with a linear excision, such as lower on the back of the scalp (where the risk of a stretched scar increases) and closer to the temples or the ears. The finer hair obtained from these marginal areas (or other parts of the body) may be useful for specific aesthetic purposes such as in eyebrow restoration, or to soften the frontal hairlines in female hair transplantation. A problem, however, is that as you move away from the middle of the donor area, the quality of the hair decreases and the hair may not even be permanent (to be discussed).

FUE makes it possible to harvest non-scalp hair, i.e. ex. beard or body hair that can be used for the cosmetic areas just mentioned. This hair can also be transplanted to the scalp to complement the hair taken from the traditional donor areas. This hair, however, is not a good match for scalp hair and offers only marginal cosmetic benefit. In addition, the fine, white scars on the body that remain from FUE can be a cosmetic problem in itself.

Limitations of Follicular Unit Extraction

The main disadvantages of FUE, when compared to FUT, is that it is less efficient in harvesting hair from the mid-portion of the permanent zone and that is causes more damage to the follicular units that are removed. The beauty of Follicular Unit Transplantation, using strip harvesting, is that the donor tissue is taken from the optimal (central) part of the donor region, so the best quality hair is used for the restoration.

In FUE, hair is extracted, but the intervening bald skin between the follicular units is not removed. Therefore, the surgeon must leave enough hair in the area to cover the remaining donor scalp. Consequently, there is considerably less total donor hair available, perhaps half as much as with FUT. This represents a significant disadvantage, since a limited donor supply is the main factor that prevents a complete hair restoration in many patients.

To compensate for the inability to harvest all the hair from the mid-permanent zone, the surgeon performing FUE must extend the harvest into sub-optimal regions of the scalp, such as from the upper and lower margins of the original donor area, where the hair may not be permanent.

The wounds in Follicular Unit Extraction, although small, are left open to heal, leaving hundreds to thousands of tiny scars. Although not readily apparent, this scarring distorts adjacent follicular units and makes the extraction in subsequent sessions significantly more difficult. For doctors with limited experience in performing FUE, this problem may not be readily apparent, but it represents a significant problem that restricts the total hair available for the restoration. FUE initially allows patients to wear their hair very short but, after large numbers of graft are extracted, fine stippled scars may become visible due to the thinning of the donor area.

Although three-step FUE significantly decreases the amount of transection and damage compared to the two-step technique, the inability to fully access the mid-portion of the permanent zone significantly limits the total amount of hair that can be accessed through FUE, rendering it a far less robust technique than strip FUT for moderate to advanced hair loss.

Another major disadvantage of FUE is that there is invariably greater follicular transection (damage) with this procedure compared to FUT. The difference is less with the three-step technique but is a significant problem never-the-less and this, combined with the inability to harvest all the hair in the central potion of the donor area makes the total hair yield in the follicular unit extraction procedure markedly less than with the strip harvesting of FUT.

The problems of increased follicular transection and the difficulty in preserving intact follicular units with the FUE technique were discussed earlier in this chapter, but a few other issues warrant discussion. The use of the stereo-microscope to dissect follicular units from the donor strip is makes Follicular Unit Transplantation uniquely suited for literally every hair type. With a skilled team of dissectors, there is essentially no difference in the transection rate between coarse, straight Asian hair, the fine, blond hair characteristic of Scandinavians and the tightly kinked hair of the African races.

On the other hand, kinky or very curly hair presents specific problems for follicular unit extraction, as does white hair, hair that is very fine, or patients with very soft scalps. In each of these cases and in some situations that we just don't yet understand, the extraction technique can be extremely difficult. And although the FOX test can identify some of these patients in advance, even region to region variability in the same person's scalp can present an unanticipated problem for the surgeon.

Another important limitation of FUE is that in this procedure, the grafts are more fragile, since they don't have as much protective tissue around them as the microscopically dissected grafts of FUT. Therefore, the grafts of FUE are more subject to drying, warming and mechanical trauma during the hair transplant process. Specifically, FUE generated grafts often lack the protective dermis and fat present around the follicle – the tissue that can be preserved by careful dissection using the stereo-microscope.

An additional problem is that, during the extraction attempt, the epidermis and upper dermis may separate from the rest of the follicle. This phenomenon has been called "capping" and is unique to the follicular unit extraction technique.

With FUE, it is more difficult to capture the entire follicular unit, particularly if the hair in the unit has greater splay or the follicular units are especially large (i.e. contain 4 hairs). Yet, it is these large naturally occurring follicular units that, when kept intact, allow FUT procedures to produce gradients of density.

In FUT procedures, the dissected strip yields a normal distribution of 1-, 2- 3- and 4-hair units, exactly as it grows. With FUE there is necessarily a selection process by the doctor who picks and chooses the units that are easiest to remove. This inevitably leaves the surgeon with a distribution of grafts different than that what occurs naturally. There is a tendency is for the doctor to attempt to remove the larger follicular units, as this will yield the most hair, with the fewest number of holes in the donor area. The consequence of this however is that there are often too few single hair grafts for the hairline and, as a result the doctor must split up the larger units to artificially create the one-hair grafts. This is magnified by the fact that FUE procedures are, in themselves, small in regard to the number of grafts used compared to strip FUT procedures.

Another problem is that some doctors performing FUE place the dissected grafts immediately into the recipient scalp, without first examining them under the microscope. This short-cut saves time, but does not enable the doctor to remove hair fragments that can become inflamed and it does not insure that every graft placed at the frontal hairline will only contain one hair – as multiple hair grafts at the hairline can pose a significant cosmetic problem for the patient and can't always be identified without the microscope.

Because, in FUE, the grafts are extracted one at a time from the donor area, it is very difficult to do steps in parallel. In contrast, with FUT, once the donor strip is removed from the back of the scalp, half-dozen skilled technicians can dissect the tissue at one time. This necessarily makes FUE a much slower process and limits the size of the

session. As a consequence, FUE often requires multiple sessions to equal the size of a single FUT procedure and the entire restoration takes much longer to complete.