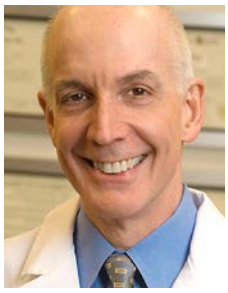

# Robotic Hair Transplants

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Follicular Unit Extraction (FUE) is a method of harvesting donor hair where individual follicular units (naturally occurring groups of 1-4 hairs) are removed directly from the scalp. This method differs from the standard Follicular Unit Transplantation (FUT) procedure where one thin, long strip is removed from the back of the scalp and is then dissected into individual follicular units with the aid of stereomicroscopes.

In FUE, an instrument is used to make a small, circular incision in the skin around a follicular unit, separating it from the surrounding tissue. The unit is then removed from the scalp, leaving a tiny hole. This process is repeated until the desired number of follicular unit grafts is obtained. The holes, approximately 1-mm in size, heal over the course of seven to ten days, leaving tiny white scars that are camouflaged by the hair in the back and sides of the scalp.

Tiny "recipient sites" are made in the balding area of the scalp, using a fine needlepoint instrument, where the extracted grafts will be inserted. The creation of recipient sites and the placing of follicular unit grafts are essentially the same in FUE and FUT. The differences between the procedures lie in the quality and quantity of grafts obtained as well as the appearance of the donor area.

## Follicular Unit Transplantation

In FUT, the removal of a donor strip from the back of the scalp leaves a long, thin scar. While the scar is usually camouflaged by the person's hair, it can be a problem if the patient wants to wear his or her hair very short. A linear incision can also be a problem for a very athletic person who doesn't want any limitations to physical activity post-op. In FUE the resultant tiny white scars are easily hidden; even with relatively short hair. The lack of a linear incision enables the active person to resume most activities immediately after the procedure.

History and Instrumentation in FUE

The use of direct extraction to harvest follicular units was initially conceived by Dr. Ray Woods in Australia and called the "Woods Technique," but he did not disclose the details of his procedure. The technique was first described in the medical literature by Drs. Rassman and Bernstein in their 2002 publication, "Follicular Unit Extraction: Minimally Invasive Surgery for Hair Transplantation." This paper gave the procedure its current name and described the FOX test that is used to identify patient variability in harvesting, an issue that continues to be a significant challenge for doctors today.

Follicular Unit Extraction is an instrument-dependent procedure. Therefore, the type of tool that is used significantly affects the results. The earliest methods of extraction consisted of a small, round cutting instrument, called a "punch," to separate the follicular units from the surrounding tissue. Dr. Jim Harris advanced a significant refinement in the procedure when he added an extra step using a blunt instrument for the part that penetrates deeper into the skin. This extra step of blunt dissection substantially reduced transection (damage) to the hair follicles.

FUE instrumentation continues to evolve as more physicians gain experience with the technique. Currently, there are a wide variety of instruments used in FUE. These instruments include punches of different diameters and sharpness and instruments that are rotated by hand or are motor driven. Some techniques require the separated grafts to be removed from the skin with forceps and others use suction. Some surgeons utilize the single step method and others the two-step technique. However, no method was able to avoid the human error and fatigue associated with removing the hundreds to thousands of individual follicular units needed for a single hair restoration procedure.

## Robotic FUE

Follicular Unit Extraction consists of two main steps: Separation of the follicular units from the surrounding skin, and extraction (removal) of the follicular units from the scalp. Step one is a highly repetitive and labor-intensive process that requires great precision. This step requires the centering of the punch over the follicular unit and the alignment of the dissecting instrument with the follicles to prevent damage. Since this process must be repeated hundreds to thousands of times in a typical FUE hair transplant, the patient is subjected to significant human variability and error on the part of the physician.

A major advance in FUE came in the Fall of 2011 with the introduction of the first robotically controlled extraction device that automates this crucial first step of FUE. The robotic system increases the accuracy of graft harvesting, which in turn minimizes damage to hair follicles and reduces harvesting time. Each of these factors potentially contributes to increased graft survival. The new technology also enables FUE to be performed on a wider variety of patients.

The current robotic technology is based on the two-step method of extraction. It uses a sharp punch to penetrate the skin and a dull rotating punch to separate the deeper part of the follicular unit from the surrounding tissue. The main difference from the older devices is that it uses a very precise, image-guided robotic arm to operate the dual-needle punch mechanism, ensuring a high degree of accuracy and precision.

Compared to manual systems, the robot is also more versatile in its ability to harvest grafts from patients with different hair characteristics, patients

from various ethnic backgrounds and hair from different parts of the scalp. It is particularly useful in extracting grafts from the sides of the scalp, where the hair lies flatter on the skin.

Introduction of the Robotic system into a physician's practice can present a formidable challenge. Besides the expense of the technology, the robot requires an operating room larger than those that exist in many doctors' offices and requires that the room be dedicated to this purpose. In addition to special training required to operate the system, the FUE procedure itself should be modified so that grafts are kept out of the body for as short a time as possible and kept in an environment that will ensure maximum growth. This can be accomplished by making recipient sites prior to the robotic harvesting and by using special biologic solutions to hold the grafts.

Dr. Bernstein performing Robotic FUE

## Indications for Robotic FUE

Since FUE does not leave a linear scar, it is useful for patients who want to wear their hair very short. It is also advantageous, when compared to FUT, for those, such as professional athletes, who are involved in very strenuous activities and who must resume these activities very soon after their procedure. The technique is also useful for patients who have healed poorly from traditional strip harvesting or who have a very tight scalp and so are not indicated for a strip procedure.

Another application of FUE is the camouflaging of a linear donor scar from a prior hair transplant procedure. In this technique, a small amount of hair is extracted from the area around a linear donor scar. It is then placed directly into the scar, making it less visible as the transplanted hair grows in the scar tissue. FUE potentially allows the surgeon to remove hair from parts of the body other than the donor scalp, such as the beard or trunk, although there are many limitations with this process.

Some patients desire FUE simply because they have heard that it is non-surgical. The reality is that FUT and FUE both involve surgery and in both cases the depth of the incisions (i.e. into the fat layer right below the hair follicles) is the same. The difference is in the type of incision made.

## Limitations of FUE

Follicular Unit Extraction harvesting requires a much larger area compared to strip harvesting (approximately 5x the area for the same number of grafts). This has two implications. The first is that, in order to perform large sessions of FUE, the entire donor area must be shaved. This can present a significant short-term cosmetic problem for many patients. In contrast, with FUT using strip harvesting, the donor incision can immediately be covered with hair – even in hair transplants that require very large sessions.

A second issue with the larger harvesting area in FUE is that with large sessions the doctor must often push the limit of what is actually "permanent" in order to get the desired number of grafts. This may present a long-term problem when transplanting a younger person in whom the extent of the permanent donor area cannot be precisely determined.

The method of graft harvesting also affects the quality of grafts and the fullness that may ultimately be achieved in the hair transplant. In FUT, follicular unit grafts are isolated with the aid of dissecting microscopes – a very precise method for preserving the integrity of follicular units. Although the Robotic FUE system appears to be the most accurate of the extraction devices, it is still not as accurate in generating intact follicular units as a surgical team that is skilled in the microscopic dissection process used in FUT.

Because the differences between FUE and FUT are significant and because there are distinct advantages and disadvantages to each, the needs of each person must be carefully considered when deciding which procedure to choose.

## The Future of Robotic Hair Transplants

With the trend toward less invasive surgery and the preference of men for shorter hairstyles, the popularity of FUE will continue to increase. Although only a small number of cases of FUE were performed in the United States prior to 2002, FUE is rapidly becoming a mainstream procedure in many hair transplant surgeons' practices. There were three FUE Robots in the hands of physicians at the end of 2011, twenty-two by the end of 2012 and there will be an estimated seventy in operation worldwide by the end of 2013. The rapid adoption of robotic hair transplants speaks to the increasing interest in FUE by patients and the realization, by physicians, that this technology holds the key to improving the quality and consistency of a very demanding, labor intensive hair transplant procedure.