History of follicular unit excision

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FUE or follicular unit excision is a minimally invasive hair restoration surgery which involves extraction of grafts [Figure 1] from the donor area and implanting them in the recipient area. This technique is currently known to every hair transplant surgeon throughout the world. Even the patients are aware of the procedure and themselves demand it to their treating surgeon, but this was not always the case and FUE has evolved to its current status by many years of trial and meticulous research by the concerned doctors.

Evolution and Chronology

The evolution of FUE as a procedure is tricky as well as exciting. It all started with an idea to try surgical approach towards hair growth. The earliest attempts to implement this thought into action is credited to the Japanese doctors, whose work sadly went unnoticed for a long period of time.

Figure 1: Hair grafts obtained after extraction by follicular unit excision technique

Years later, Americans tried the punch grafting procedure as a surgical option for male pattern baldness. This was the first major step towards surgical hair restoration and a harbinger for both follicular unit transplant (FUT) and FUE. It was observed that these large-sized grafts underwent central necrosis due to inadequate oxygenation. This led to gradual reduction in punch size over a period of time, to harvest the grafts, which reduced the necrosis part.

In 1980s, the concept of follicular units evolved, which further strengthened the need for smaller and well-delineated grafts to improve their survival. This prompted the researchers back then to slice the larger grafts into smaller follicular units, paving the way for FUT method.

FUT produced a large donor scar, presenting a cosmetic concern especially among those who preferred to wear short hair. This prompted the surgeons to re-visit the original punch grafting technique, albeit using smaller extraction devices.

With the knowledge of follicular units, the surgeons of Japan, Australia and America worked separately towards the cause and introduced their techniques before the modern world. Combined efforts of these doctors helped in developing the modern FUE technique, which with few modifications is now being practiced throughout the world.

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Table 1: Important events in the history of follicular unit excision

Years	Event	Credits
1939	First description of punch grafting in scaring alopecia	Dr. Shoji Okuda
1943	Earliest concept of FUE, (not widely known)	Dr. Hajime Tamura
1984	Concept of minigrafts	Dr. Wayne Bradshaw
1988	Concept of micrograft	Dr. Robert Limmer
1995	First demonstration of FUE in Australia using 1 mm punch	Dr. Ray Woods
1996	Publication of FUE technique using single hair graft	Dr. Masumi Inaba
2001	Demonstration of body hair transplant	Hirai *et al*.
2002	First published and coined the term FUE	Dr. William Rassman and Dr. Robert Bernstein
2002	Suggestion to rename FUE as follicular isolation technique	Dr. Paul Rose
2004	Invention of SAFE system, both manual and motorized	Dr. John Harris
2007	Discussion of role of robotic hair transplants in ISHRS meeting	Dr. Bernstein and Dr. Rassman
2017	Renaming FUE, from follicular unit extraction to Follicular unit excision	Nomenclature committee of ISHRS headed by Dr. Parsa Mohebi

FUE: Follicular unit excision, SAFE: Surgically advanced follicular extraction, ISHRS: International Society of Hair Restoration Surgery

There also might be quite a few workers whose contributions went unnoticed due to some reasons. The authors would like to thank them for their work too. The important events registered in the history of FUE, few well known, few lesser known are arranged chronologically in Table 1.

The Pioneers

Dr. Norman Orentreich (1922-2019), an American dermatologist, would always be remembered for his contributions towards surgical hair restoration, and he is rightly called as "father of hair transplant surgery."[1]

He was the first in the modern world, to demonstrate a punch grafting technique using a 4mm punch for extraction of grafts, in the treatment of male patterned baldness in the year 1952.

This technique had many downfalls, like central necrosis of grafts, large and multiple donor area scars, and an unnatural appearance post-transplant.

Dr. Bobby Limmer pioneered the concept of "Follicular Units" in the 1990s. He demonstrated stereomicroscopic dissection of strip into individual follicular units. Which was a crucial point in the evolution of FUE.[2]

In 1994, American doctor, Dr. William Rassman discussed the possibility of revisiting Orentriech's punch grafting technique, with his college, Dr. Robert Bernstein. He proposed modifying the technique such that, the follicular units could be harvested directly from the donor area of scalp without the need to cut a strip. Thereafter both of them started working over the idea.

In the parallel world, Dr. Masumi Inaba, a Japanese dermatologist, in the year 1988 demonstrated a technique similar to modern-day FUE, using a two-step technique for graft harvesting. His work was first published in his book on androgenetic alopecia, under the chapter "operative treatment of androgenetic alopecia". He also described a technique for extracting single hair grafts and published it in the year 1996.[3] Dr. Inaba has a lion's share in developing the current technique of FUE.

During the same period, in Australia, Dr. Ray Woods was working towards the similar goal. In the year 1989, Dr. Woods had publicly demonstrated his version of FUE in Australia, which he named as "Wood's Procedure". Though it's not completely known what exactly is a woods procedure.

Taking a cue from Dr. Inaba's work, Dr. Rassman and Dr. Bernstein, published their work and coined the term FUE (follicular unit extraction), in the year 2002. Their work was published in "dermatologic Surgery" as "minimally invasive hair transplants". They used 1 mm punch to harvest individual follicular units. The punch was passed partially into the dermis, and the graft was extracted using forceps.[4]

This was a benchmark study and the beginning of safe and cosmetically acceptable, minimally invasive hair restoration, which is now being performed throughout the world with great results. This technique was reviewed and modified by quite a few workers, though the basic principle remains same till date.

One of the interesting reviews on FUE was given by Dr. Paul Rose in the year 2002. He suggested use of the term "Follicular isolation technique" instead of FUE.[5] He said that, the extracted grafts did not always contain all the follicles of a single follicular unit.

As the technique of FUE evolved, it was possible to harvest and implant a greater number of grafts in a single session. In 2004, Dr. Bernstein *et al*. published an article on FUE "mega session", where they performed around 1900 grafts in a single session, the procedure lasting 12 hours.[6]

As more and more surgeons practiced FUE, it was seen that, with the limited donor area of scalp, it was getting difficult

to cover larger areas of baldness. This led to the invention of "Body hair Transplant". Quite a few surgeons experimented with the body hair to scalp transplantation.

Dr. Hirai *et al.* in 2001, harvested beard hair, by cutting around a single hair follicle to the level of subdermis using a 18-G needle.[7]

Dr. Ray woods and his sister, Dr. Angela Campbell later published that chest hair micrograft's transplanted to scalp show extended growth to almost four times their length and the characteristics of implanted hair mimicked the growth of native scalp hair in the crown area.[8]

Thereafter, body hair transplants have been increasingly performed with good results.

This is how the process of FUE had started and established itself as a safe and minimally invasive hair restoration procedure.

Towards the Newer Avenues

It was observed that using manual punches for extraction of grafts was a time-consuming procedure and only lesser grafts could be extracted in a single session.

Dr. James Harris, an American doctor in the year 2004, introduced SAFE (surgically advanced follicular extraction) system for hair extraction.[9] It is a device which uses blunt dissection to isolate follicular units and was available in both manual and motorized options. The use of motorized instrument greatly increased the speed of the procedure. But use of blunt punches had its own disadvantages.

Dr. John Cole, pioneered and used motorized sharp punches and also published articles regarding the advantages of sharp over blunt punches. He named his procedure as 'Cole Isolation Technique."[10]

Many surgeons started using the sharp punches with motorized instruments to further speed up the process and increase the accuracy of extraction.

Dr.Pitchon put forward the idea of long hair FUE in his concept of "preview long hair", published in 2006. Working on this principle, Dr.Otavio Bonaventure from Brazil demonstrated his version of long hair FUE, where he used oscillating punch rather than rotational punch, which he developed further to produce a new kind of sharp punch called as "open punch", especially for this technique.[11]

Going one step further, Dr. Bernstein and Dr. Rassman pioneered robotic hair transplant using dual punch technique modification of FUE for graft extraction. This was discussed in ISHRS (international society of hair restoration surgery) meeting in the year 2007. First commercially available robotic hair transplant system was available by the name ARTAS. Going one step further, Dr. Bernstein *et al*. demonstrated that image-guided technology in ARTAS can be used to create recipient sites too. The robot used 19 gauge hypodermic needles to create the recipient sites.[12]

It underwent few modifications over the years and as of now upgraded version of same is available and is used by quite a few doctors worldwide. Currently, apart from ARTAS, many other robotic hair transplant systems are available.

In 2017, nomenclature committee of ISHRS, headed by Dr. Parsa Mohebi recommended the change in the name of FUE from "follicular Unit Extraction" to "Follicular unit Excision," which correctly explains the two-step procedure and is currently being followed worldwide.[13]

The Unsung Heroes

Way before the invention of modern FUE, there have been reports of hair transplant procedures as early as 1929.

Dr. Masao Sasagawa (1887-1932) from Japan reported a study in which he inserted human hair into subcutaneous tissue of cicatricial alopecia using a special needle, the first-ever surgical procedure for hair growth.[14]

In the parallel world, Dr. Menahem Hodara (1869-1926), a Turkish dermatologist, implanted a hair from unaffected area of the scalp to the scar that were left behind by favus.[15]

He presented his findings in 1897, but his experiments could not get the required attention.

Dr. Shoji Okuda (1886-1962) another Japanese doctor was the pioneer of the earliest punch grafting, which he used to grow hair in eyebrows, alopecia areata, female pubic atrichias or hypotrichosis.

He published his technique using a special circular punch, in "Japanese Journal of Dermatology and Urology" in the year 1939. He used the punches specially designed by him of size 2-3.5mm diameter.

For many years thereafter, his work had distinctly remained unknown in the west, the main reasons being his papers were written in Japanese and occurrence of World War II during the same period of which Japan was the participant.

Years later, Dr. Orentreich cited his papers and started doing punch grafting in androgenetic alopecia in males and rest is history. Not taking away anything from Dr. Orentrich, Dr. Okuda should be instated as another father of hair transplant along with him.

The papers written by Dr. Okuda recently became famous by the name "Okuda Papers" which is a masterpiece in itself and tells us how a meticulous research should be.

The Okuda papers were originally written in Japanese, but now are available in English language, thanks to Dr. Yoshihiro Imagawa, who neatly translated the manuscript into 211 pages of English literature, which was revealed in 2003 ISHRS meeting. These papers are now available for everyone to read thanks to the initiative by ISHRS (https://ishrs.org/okuda-papers/).

Dr. Hajime Tamura (1897-1977), a Japanese professor in urology, reported hair transplant procedure very similar to modern FUE way back in 1937.He used 'single hair grafts' to produce 'Natural results. He further stated that, "the donor is better if it is as small as possible". He worked at a time when World War II occurred, hence just like Dr. Okuda, his work was not recognized immediately.

His research was published in "Japanese Journal Of Dermatology and Venerology" in the year 1943.[16]

It is indeed a regret that the foresight of this surgeon could not be widely known. He should be called as one of the pioneers of modern FUE.

Dr. Orentrich accessed the papers of both these doctors and decided to work on the lines of Dr. Okuda instead of Dr. Tamure. Had he followed Dr. Tamure's work, FUE would have been in the game in early 1950s itself.

Dr. Keechi Fujita from Japan in 1947, performed eyebrow reconstruction using single hair grafts. He was the first to report that scalp hair transplanted as eyebrows, behaved as eyebrows after one year, the current concept of recipient dominance. This indeed was a very great finding which again did not get much appreciation.[17]

The findings of all these doctors confirm the work on hair transplant and FUE before the modern era and must be duly acknowledged.

Conclusion

FUE has progressed technically and result wise by leaps and bounds, since its inception in 2002. The rise of FUE we are witnessing, is all because of the hard work and research of all the doctors who toiled hard toward the cause, the world would forever be in debt of these stalwarts.

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Conflicts of interest

There are no conflicts of interest.

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