CHAPTER 44

Artificial Hair: Automatic Biofibre® Hair Implant

Background

Since the beginning of the twentieth century, there have been attempts at creating artificial hair to treat baldness. The very first experiences with artificial hair implants date back to the beginning of the twentieth-century as recorded by a US patent.[1] In 1930 Dr. M. Sasagawa reported his experiments with the implantation of cut human hair[2]. Nonetheless, its greatest evolution did not take place until the 1970's. In 1976, Dr S. Yamada and Dr. K. Fukuta presented their technique to JMJ[3]. From 1976 fierce competition within the North American market resulted in a number of different companies offering inadequately fibers for human hair replacement (doll's hair, wig's hair, fishing threads, etc.) that were implanted without the application of any medical protocol and resulting in sub-standard results[4-7]. In those years, without any regulation, the technique was often being performed inappropriately by non-medical operators (often hairdresser), in non-medical environments (beauty salon). That led to frequent complications as medium and severe infection, inflammation, broken hair embedded in the scalp, etc,, resulting from unsuitable materials and poor technique. In the USA, the above situation provoked a Government inquiry followed, in 1983, by a suspension of the artificial hair implantation with special reference to the materials utilized at that time as human hair and colored industrial fibers such as polyester, modacrylic and polyacrylic fibers (FDA, June 13, 1983)[8].

During the following years, some European companies specialized in the bio-medical field started researching on artificial hair in cooperation with University Departments. In 1993 biocompatible fibers (Biofibre®) were developed in Italy by Medicap company. From 1993 onward clinical trials[9-11] and histological studies[12-15] were performed with encouraging results, leading to additional research on the biocompatible material field and medical protocol application. In 1995 the UE recognized the artificial hair implant technique as a medical act and outlined the rules related to the procedure[16]. From now onwards the technique can be performed only by qualified doctors, preferably dermatologists and plastic surgeons, on suitable environment. In 1996, the European Union Authorities, with the Universal Medical Device Nomenclature System™ (UMDNS) classified artificial hair as medical devices[17]. A strict and ethical medical protocols was developed in the following years to provide correct guidelines for appropriate treatment and minimize the possibility of complications. The approval of this methodology was a great advantage for patients since it legally prevented the procedure from being performed by unqualified people. From the beginning of the 2000's many cases of patients treated by artificial hair implant were worldwide presented to the scientific community[18-22], getting favorable outcome and interest also for many US doctors. On 2007, a study about the use of Biofibre® hair implant to treat scalp scars was published[23] as an additional indication for this technique. In 2011, Biofibre® hair implant technique was included in an academic text of cosmetic dermatology[24]. On 2013, the first Automatic machine for Biofibre® hair implant was presented by Medicap Italy with significant advantages for the technique[25-26] improving patients comfort and reducing possible mistakes on the procedure. In 2014 was released the new high-density

version of Biofibre®, named as MHD® hair, which allows triple hair quantity with the same number of implants. Such fibers are presently used for the crown area only allowing very mild after care and very quick result, while for the front hairline the single Biofibre® is recommended to ensure a more natural aesthetic result. Recent PubMed publications bring additional evidence of the reliability of the present artificial hair implant technique[27-30] and larger use.

Materials

The main characteristics required for a hair implant fiber are: biocompatibility, resistance to physical-chemical stress, resistance to traction, low tissue trauma and good aesthetics. Biofibre® hair is composed by a mixture of medical grade polyamides. This fiber was tested on laboratories accredited by the Italian Ministry of Health, and also submitted to large clinical trials and histopathological studies. These artificial hairs are available in multiple colors, different shapes as straight, wavy, curly and afro and with different lengths. It is also available in the new high-density version that allow with each implant to have three hairs implanted. The high-density version fibre is used for crown area only and for the front-line single Biofibre® is suggested. It is important to remember that the success of the procedure depends on safety of the fibers, the use of the correct implant instruments, trained qualified doctors, patient selection and comply with post procedure care[31-34].

Indications

Automatic Biofibre® hair implant is indicated for diffuse alopecia or hair thinning both for male and female patients.

Table 1- Hair implant materials and devices by medicap

Biofibre®	Available in variations of: • 13 different colors and white; • Various shapes: straight, wavy, curly and afro; • Different lengths: 15 cm, 30 cm, and 45 cm.

Medicap High Density® (M.H.D.) Biocompatible Artificial Hair for implant	• Available in the same colors of Biofibre hair.
	• Offers a triple hair density outside the scalp just implanting a single fiber.
	• This product was developed to:
	  • Minimize the implantation time;
	  • Reduce number of implants and implant sessions;
	  • Achieve the maximum volume with the smallest number of implants.

Automatic Biofibre® Hair Implant device: device for artificial hair implant	• Device created to provide orientation to the procedure and to perform correct implant depth with maximum fixation rate and reducing implant time.
Adjustable Implanter®: handle Implant Instrument	• Projected to provide the best hair implant precision and minimize any implant trauma. It is also a spare part of the Automatic Device

This technique ensures an immediate aesthetic result and sufficient quantity of hair in short time without requiring any donor area. It is a very soft surgery not requiring hospitalization and can be used alone or in combination with other hair restoration techniques to improve final aesthetic results when required[35-37] or in case of poor donor area. It is also performed to correct scars or scalp burns. This technique is not indicated for implant on the temples, on low frontal hairline, scalp areas with very thin dermal tissue, for no stabilized alopecia or in case of pathologically atrophic scalp.

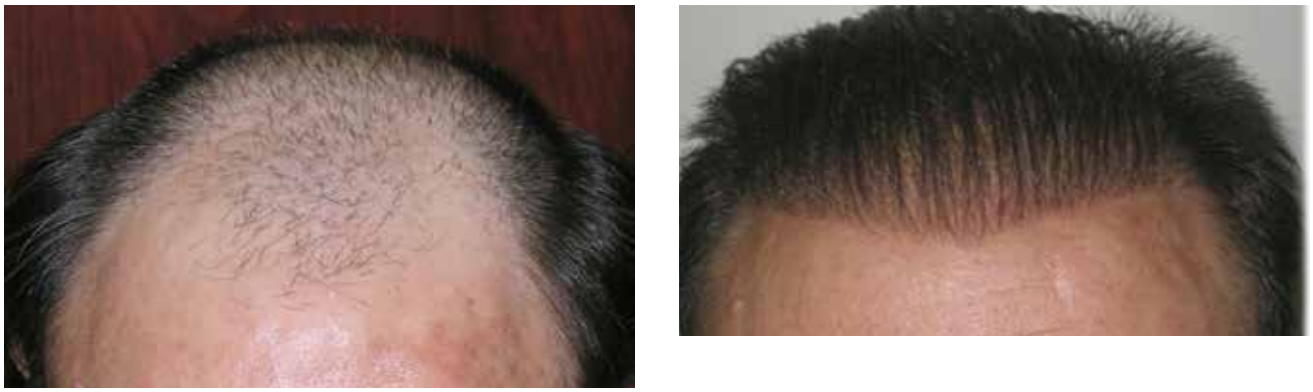

Fig 1 a, b): Patient with androgenetic alopecia treated by 5 implant sessions with 4,000 Biofibre® as a whole.

Advantages

It is a reversible outpatient procedure;

- It is a soft surgery technique;
- Ensures Immediate results;
- Provides immediate psychological comfort for the patient;
- No patient downtime is required;
- Increases the hair density in a few hours (800 hairs/hour);
- Provides a gradual and progressive hair thickening;
- The implanted hair does not age;
- The implant procedure can be performed alone or in combination with other medical or surgical treatments.

Disadvantages

- It needs some small re-implants from time to time to maintain the aesthetic result;
- The hair does not grow;
- It needs a suitable hygiene of the scalp and respect of after care;
- It is not recommended for sensitive patients to the pre-implant test or patients suffering from scalp diseases or overall illnesses such as diabetes, lupus, HIV, hepatitis, autoimmune diseases, etc;
- The procedure is not indicated for the temples area, on low frontal hairline, or areas with very thin dermal tissue, in case of pathologically atrophic scalp and in case of no stable alopecia.

Patient Selection

Preventive measures begin with taking a careful history of the patient and physical exam of the entire scalp and the area to be implanted. Patient's expectations should be accessed and clarified. Obtaining Informed consent is mandatory. Biofibre® hair implant is not indicated sensitive patients to the pre-implant test or patients suffering from scalp diseases or overall illnesses such as diabetes, lupus, HIV, autoimmune diseases, scalp chronic diseases, severe psychosis, not stabilized alopecia areata, when there is lack of personal hygiene, or with employment in dusty or dirty environments. A preliminary screening of the patient, including blood testing, is essential before proceeding with an implant test. Blood tests list include: Complete blood count, Urea, Creatinine, Bilirubin (total and direct), Gamma-Glutamyl Transferase (GGT), Alanine aminotransferase (ALT), Aspartate aminotransferase (AST), Fibrinogen, Treponema Pallidum Haemagglutination (TPH), Anti-HIV, Hepatitis A-B and C Markers/Hbsag, Erythrocyte Sedimentation Rate (ESR), Venereal Disease Research Laboratory (VDRL), Prothrombin Time (PT), Partial Thromboplastin Time (PTT), C Reactive Protein, Fasting Blood Sugar Levels, Serum protein electrophoresis, Urinalysis, and Electrocardiogram. Before proceeding with implant sessions, a small number of implant tests must be performed. They should be observed over a period of at least 1 month. If no significant problems are observed, larger sessions can be performed at intervals of 1 month each.

Implant Technique and Medical Protocol

To correctly perform Automatic Biofibre® hair implant technique the following steps are mandatory: pre-operative patient selection, mutual consent of patient, appropriate implant equipment, asepsis of operation field, preparation of the patient, correct implant technique and medical protocol, compatibility test, implant on suitable implant areas, patient records, post-operative treatment and drug prescription, after care patient instruction with provides a list of forbidden products and treatments, periodical dermatological check-ups and post-implant management.

Selection of a suitable patient is very important. A preliminary medical screening allows the exclusion of those patients who have contraindicating skin conditions to be submitted to artificial hair implant. A consequent tolerance implant test allows the exclusion of those patients who are not suitable for the artificial hair implants for sensitive personal

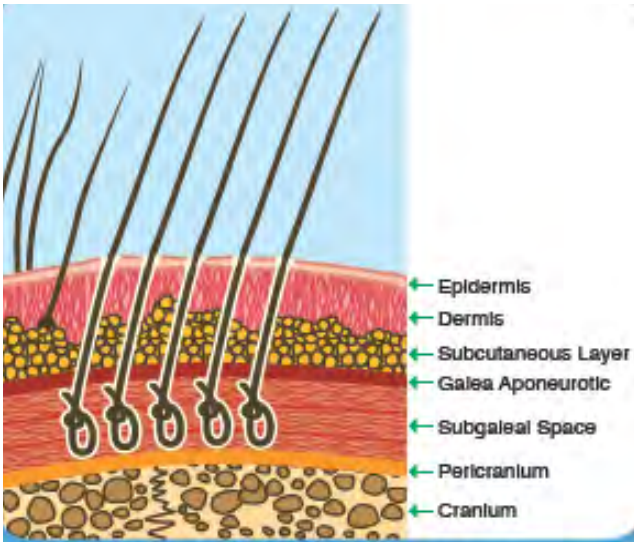

Figure 2: Correct implant depth.

reasons. Patient must avoid smoking, drinking alcohol for 2 days before implant and avoid taking salicylic acid for at least 3 days before surgery.

The tolerance implant test is performed with 100 fibers and results are evaluated during 5 weeks. The implant technique is based on small hooking needles that go out the implanter and hook the Biofibre® reversible knot, placing it under the scalp at galea level. In this way the root can be held by the fibrous tissue and avoid premature hair loss. The implantation performed by Automatic Biofibre® Hair Device allows reaching always the right deepness of implant and with right orientation and allows to implant until 800 hair per hour.

The area to be implanted is cleaned, disinfected and draped. A 2% xylocaine or lidocaine solution with adrenalin 1:100.000 is locally injected in subdermal layer with 30G needles for local anaesthesia and vasoconstriction under strict aseptic conditions. The suggested quantity of anaesthesia is 1 cc for 200 implants each. Biofibre® hair packet is opened and knots are exposed. Each fiber is hooked individually by the implant device and implanted in the scalp at right deepness.

The distance between two fibres should be around 2 mm - i.e. around 40 fibers/cm^2. The respect of this distance reduces a lot the risk of infection. Never put 2 fibers in one hole or too close to each other. If that happen you have to remove fibers in excess to back to the required safety distance.

The average implant session is about 1000 Biofibre® each.

The direction of the fibres should follow the direction of existing natural hair.

During implantation, be careful not to apply any traction on the newly implanted fibres as the fibers will be pulled up in one of the superficial layers of the scalp resulting in premature fall of the fibers. There is hardly any bleeding.

Implants performed by the Automatic Biofibre® Hair Device minimizes implant trauma and hastens cicatrization of the implanted area by allowing a higher degree of fixation, thereby allowing a quicker, better aesthetic result.

On concluding implantation, the scalp is disinfected with chlorhexidine or povidone-iodine and ice wrapped in gauze piece is applied for 5-10 mins to reduce implant inflammation. Broad spectrum antibiotic, like gentamycin, is applied locally. Without applying any traction, the hair are gently combed with a large wood toothcomb holding them at the base to prevent surfacing, and the risk of premature fall. The extra length of the fibers is cut accordingly with very sharp scissors. For the front hair line always implant fibers in a zigzag and staggered manner because a line which is too regular and straight looks very unnatural.

There is no need of any bandage or rest. The patient can go back to his work immediately after procedure. The first cleaning with ketoconazole shampoo is suggested after 3 days. Systemic antibiotic coverage and local antiseptic spray is recommended for one week after the implant, allowing adjustments in therapy depending upon local circumstances and patient's medical history. The patient must avoid sports, sauna, swimming and other activity that can increase sweating for the first 5 weeks until cicatrisation takes place. He should also avoid smoking and drinking alcohol for at least one week after implant session. Contact with dirty, sandy and dusty environment have to be strictly avoided as well as the use of headgear or helmet. Before proceeding with the following implant sessions, a 5 week of pause have to be respected. Following implant have to be performed in different scalp area. Most frequent mistakes during the implant procedure that can lead to patients side effects include: lack of asepsis, excessive density of implanted fibers (closer than 2 mm or two in same hole), big quantity of implanted fibers in one session (more than 1.500 each), traumatic implant procedure cause excessive pressure on the implanter (that is avoided with the use of Automatic Biofibre® Hair Device), wrong implant area (temples, sideburns, too low in the frontline).

Follow up and After Care Protocol

Maintenance of scalp hygiene and periodic medical check-ups are required to keep the expected aesthetic results. The dermatological follow-up is very important in order to check the patient's scalp conditions and possible fibers modification and to prevent or resolve possible complications such as infection or inflammation. Biofibre® after-care protocol

Figure 3: Front line implant in staggered way for natural effect.

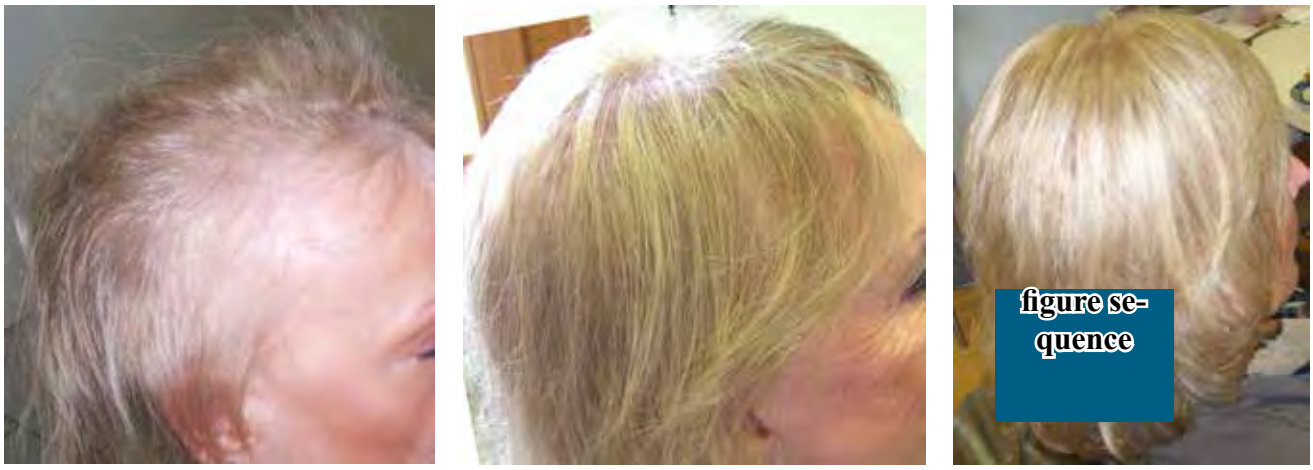

Figure 2. a): A 53 years old woman with chronic telogen effluvium; b-c): Final results after 3 implant sessions with 2,000 Biofibre® as a whole

consists of regular follow up, proper scalp hygiene, use of suitable products, and avoidance of dangerous products or treatments such as: hair bleaching, permanent waving, thermal shocks and hair curlers. The after-care protocol form including the list of dangerous and suitable products and treatments have to be delivered to each patient. Patient have to sign copy of this form to get evidence that he received it.

Special attention has to be reserved to the scalp sebum. Sebum is an important and useful natural shield for the scalp, but when it is in excess, it must be removed before it leads to sebum accumulation around implanted fibers (comedos) that can cause early fiber loss and may predispose the patient to scalp infection and scalp pits. Sebum accumulation can be prevented using proper keratolytic products and removed by gently massaging the scalp with soft toothbrush during the shower once every 2 weeks, according to the patient scalp, or periodically removed with forceps extraction at the implant clinic. After that treatment, the scalp has to be cleansed with an antiseptic spray (e.g chlorhexidine).

Complications

No surgical procedure is without complications. Similarly, this procedure has also certain limitations and side effects associated with it. One of the most important complications though rare is foreign body reaction seen in around 1-2% cases. Another complication is recurrent infections/inflammation in around 9% of cases. Others are collection of sebum around fibres or small pits or depressions at the entry point of fibers. Pits and comedones are generally insignificant cosmetically. Curling and breakage is very rare with these medical grade co-polyamide fibers and that is also because of noncompliance of protocol. Most of the time recurrent complications is because of noncompliance to the after-care protocol especially poor scalp hygiene, severe seborrhea and excessive sweating. Generally, it remains very mild and responds very well to topical antibiotic and or steroids therapy both local and systemic. But very rarely every treatment is ineffective until the fibers are explanted (removal of fiber) out. Explantation of the fiber is also required if foreign body allergic reaction does not subside with anti-allergic medicines.

Complications may occur and they include:

- Foreign body reaction: 1-2%
- Infection: 5-6%
- Inflammation: 3-4%

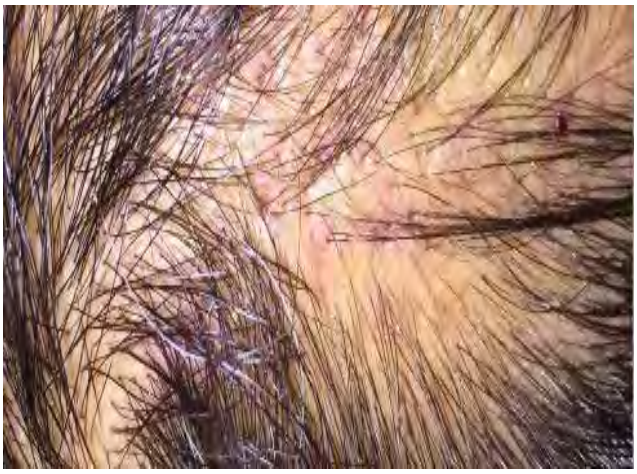

Figure 5: Local infection and inflammation after hair implantation.

- Early excessive fiber loss: 1%
- Frizzing/damage of the quality of the fibers: 1-2%

Complications Management

In case of complications is always important to promptly consult the physician, who carried out the implant. The majority of complications can be resolved with appropriate therapies like steroids and antibiotics and change of hygiene habits. A neglected infection or inflammation can be more difficult to be solved and may leave small scalp scars. When the problem is recurrent or can't be solved with appropriate therapy it is necessary to proceed with fiber removal. The reversible knot of Biofibre® does not allow the fiber to fall out but it can be entirely removed with the technique. For correct removal of fiber, it is necessary to grab the fiber near the entry point with a tweezer and then gently pull the fiber along the direction of implantation with a waving motion carefully not to break in between. All the explanted fibers must be checked for the presence of knots to ensure complete removal. If for any reason some parts of fibers stay embedded on the scalp, they have to be removed surgically. The fibers removal allows in the 99.1% of cases the *restitutio ad integrum* of the scalp in very short time.

Clinical and Histological Studies

The implant technique was validated with clinical studies and scientific research from the 1990's onwards. Differences in the results achieved during these years is represent a constant improvement of the technique and related protocols.

Serdev and colleagues evaluated the safety and effectiveness of Biofibre® hair implants in a group of 133 patients. Ninety-eight male patients and 38 female patients with alopecia underwent to the procedure. All of them had a healthy scalp, good hygiene habits and had a good state of health. The most represented group consisted of men between the ages of 30 and 60 and belonged to a scale of Hamilton of III to IV. These patients received up to 6000 fibers (average of 5.5 implants procedure over 3 years). The researchers performed a clinical evaluation after 1 month, 4 months and every 4 other months after the procedure. The safety and effectiveness were evaluated in each patient. The results of the study showed that the fiber loss was no more than 10% per year in 91.4% of the cases, 15% in 7.8% of the cases and 20% in 0.8% of the cases. Regarding the post implant complications and tolerability, 90.3% of patients presented no complications, 5.9% presented mild infection and 3.8% presented inflammation. The complications were resolved in the majorities of cases on an average of 15 days with the use of systemic antibiotic and/or steroid local therapy, leading the average of success to 97.9% of the cases. The researchers reported that in 2.1% of cases, it was necessary to remove the fibers. The removal procedure was successful and left no scars. Only 3.8% of patients declared not to be satisfied with the procedure while 96.2% declared to be satisfied.

Another recent study by Rateb and colleagues conducted on 213 patients from different geographical areas and ethnicities reported similar results. Unlike other cases, results are noticed from variations on patients' habits and different after care standard. Minor differences are determinate due to the climate.

Histological studies after 2,3 and 5 years on Biofibre® hair shown that the implanted fibers appear surrounded by a keratin layer which appears to be compact and to adhere closely to the fibers in the uppermost sections and to be separate from them with a basket-like structure lower down, hindering bacterial penetration. Thin diameters and proper distances between the fibers reduced the occurrence of rejection phenomena. No dyes nor pigments were noticed outside the fibers. Histopathologically, a sort of infundibulum comprised of Malpighian epithelium, similar to the cutaneous one, formed around the implanted fiber. We can consider it as the basis for adequate fiber anchorage. Histologic changes consequent to fiber implantation are mainly represented by consecutive phases of hyperemia/leucocyte inflow, histiocytic/fibroblast reaction, and fibrosis. Histiocytic decrease in time until 12th month and thereafter maintain a minimum level. Fibrosis

Figure 6. Reversible knot of Biofibre® after extraction. No residues stay embedded in the scalp allowing prompt scalp healing.

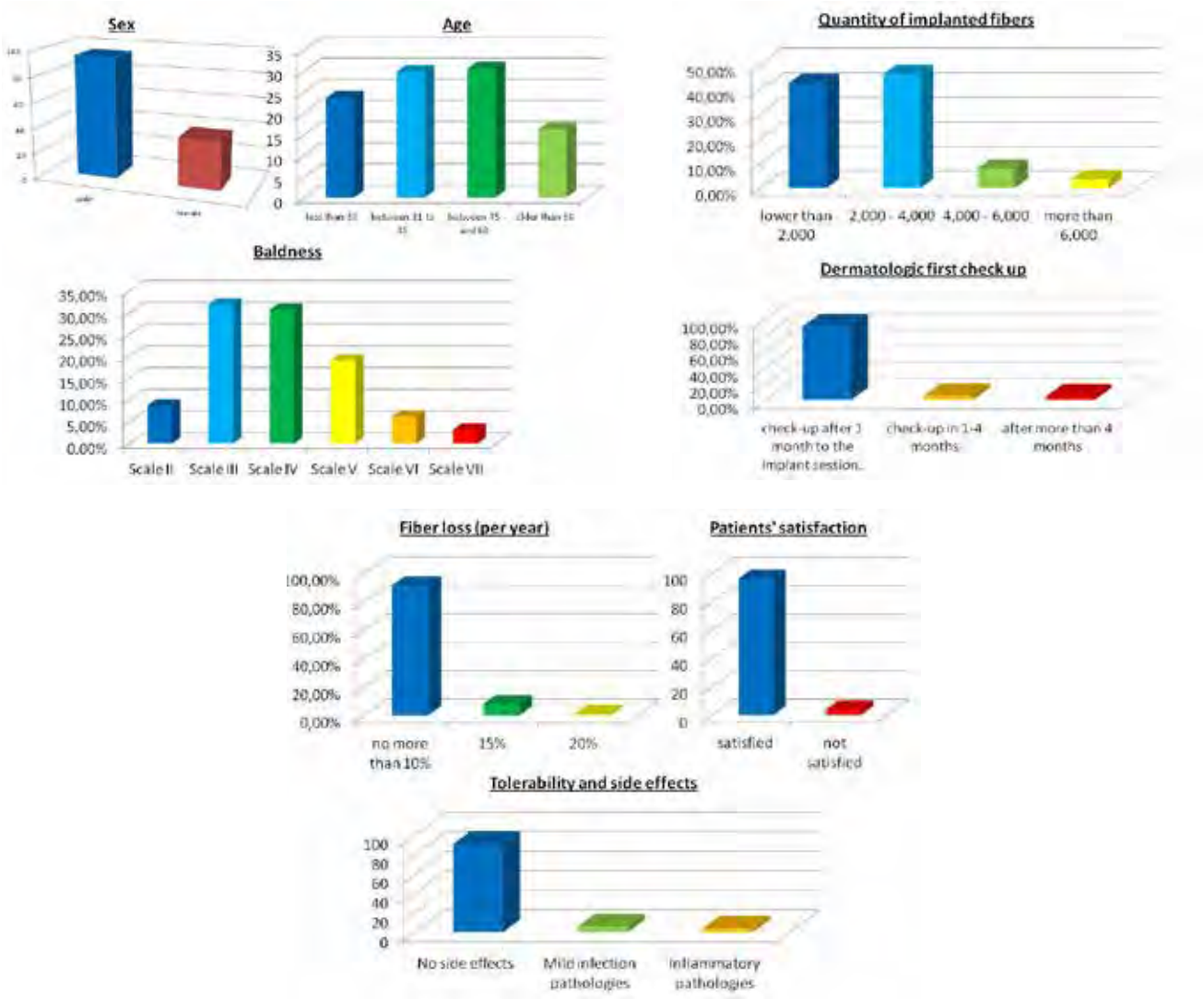

Figure 7. a): clinical features of the patients; b): technique information; c): efficacy and tolerability of implants.

appears in the second week after implantation and keep growing till 3rd month, remaining unchanged till 24th month. A moderate, controlled inflammatory infiltrate was noticed in the middle and deep reticular dermis. In the deepest dermis and the hypodermis, the fibers are surrounded by fibroplasia and no inflammatory infiltrate is noted. Although the modifications vary depending on the anatomical structures in the path of the fiber, the inflammatory phenomena are extremely limited and do not produce clinically evident signs of inflammation. Such histological changes are not different from those that follow cutaneous and/or subcutaneous implantation of any other biocompatible material. As time goes by the amount of histiocytic giant cells decreases, while fibroblasts and collagen cells proportionally increase creating a stable fibrosis which is observed from the 2nd to the 5th year.

Dermatologic sonography imagistic of the scalp with ultrasound 21-25 mhz was recently used to get more evidence about the effect of Biofibre® hair implantation on the sub-galea scalp layer. The penetration of the artificial hair in the dermis and subcutaneous layer it can be observed by interrupted hyperechoic lines. The end of the fibers it can be observed as increased round hyperechoic aspect due to the thickness of the knot. The sonographic aspect and dermatoscopic aspect after 2 months from the implant session show no signs of interaction or damages between natural hair follicles and the implanted Biofibre® hair. Healing of the dermis and subcutaneous tissue don't show inflammation signs. A hyperechoic thickening on

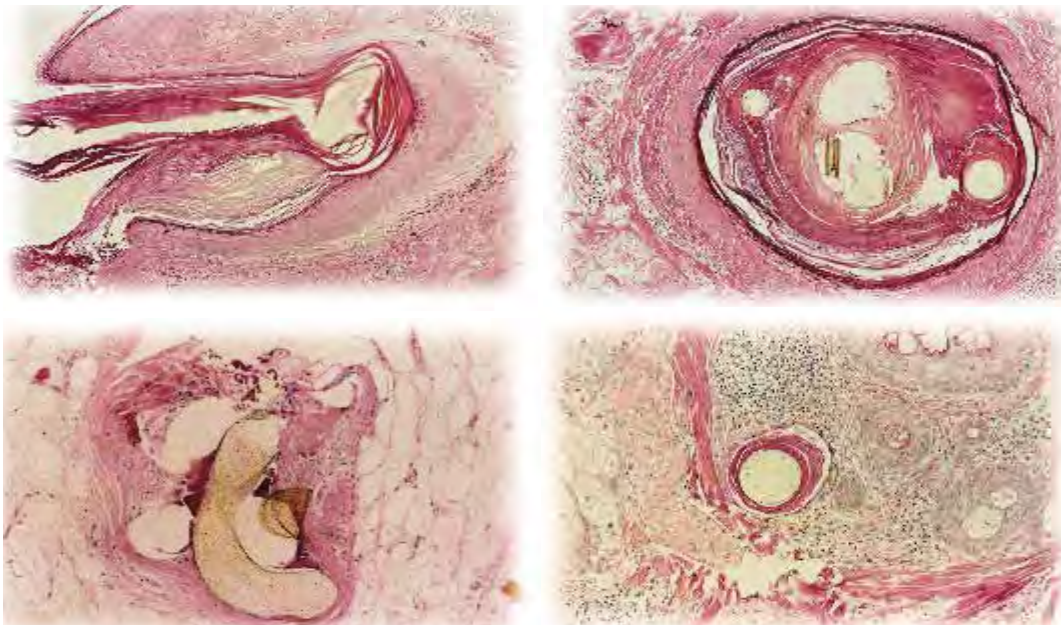

Figure 8 a–d): Biofibre® hair histology

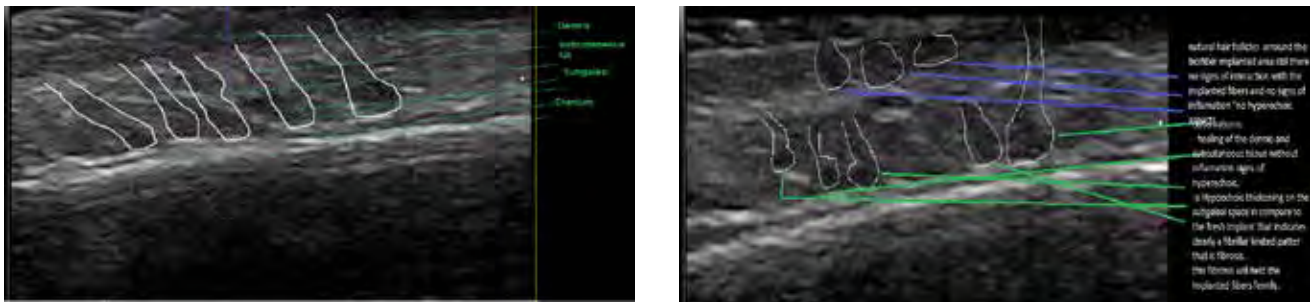

Figure 9 a, b): Dermatologic Sonography with ultrasound 21mhz after Biofibre® hair implant

the subgalea space in compare to the fresh implant indicates the fibrosis process that will held the implanted fibers firmly.

Hair Implants for the Treatment of Scars

Scalp scars are often a challenging problem with significant psychosocial consequences. Scars rarely pose a health risk, but patients may present physical and aesthetic discomfort, social and psychological distress[38]. Patients presenting burning scars may experience posttraumatic stress disorder due the traumatic nature of the burn accident[39]. The causes of scalp scars are multiple and include direct scalp trauma, local infection, burns, previous hair transplant surgeries (flaps, donor site excision and scalp reduction), among others[40].

Santiago and colleagues performed a study to access the utility of artificial hair fibers to treat scalp scars. The researchers collected data from 44 patients with 54 scalp scars including 36 male patients and 8 female patients, with ages ranging between 17 and 64 years. They found no complications in 49 scars, mild adverse outcomes in 4 scars that resolved after use of topical corticosteroid and antibiotic treatment and moderately adverse outcomes in 1 scar that required the removal of the implant. Some patients experienced minor skin reactions; seborrhea and sebum plugs that were controlled and the fibers fall rate found in this study was 20% on average annually. This study showed that Biofibre® hair implants can be used as and adjunctive treatment for scalp scars.

Figure 10 a, b): Scalp scars treated with 1500 Biofibre® in 2 sessions

Figure 11 a, b): Female patient implanted with 25.000 Biofibre® in 15 sessions

Quality of Life Improvement and Psychosocial Impact

Hair loss has a significant impact on the quality of life, psychological and social status of an individual. Patients may experience the feelings of loss of self-confidence, low self-esteem, depression and anxiety[41-42]. Female patients are a particularly vulnerable group to present psychosocial impact of hair loss and hair thinning[43]. These group of patients may benefit from the hair implantation since the procedure offers immediate aesthetic result and psychological comfort to the patient[29].

Alopecia totalis is a challenging disease with profound psychological impact to the patient and family members. Although hair implantation is not considered the most appropriate treatment to *alopecia totalis* due the large number of hairs that should be implanted and possibility of complications, several cases were successfully treated[44-45]. According to Ramos and colleagues, the clinical results of these treatments were in average lower than the standard application in small areas. But the patients had an enormous psychological benefit. Additional studies and a development of a protocol to treat this specific group of patients are necessary. It is also important to consider that the implant sessions should be performed with 3-4 weeks interval or according to medical indication. This interval between the sessions allow a gradually change of image, adaptation to self-perception and a better psychological acceptation for the patient and other people.

Conclusion

Why biocompatible artificial hair implant is approved in many countries and not in some others is still mysterious. The improper use of this technique during the pioneering era is part of an historic process, which ended in 1995 when the European Union and the Australian Authorities approved and ruled the treatment. During the last decade, the quality of artificial hair implant fibers and the implantation procedures had improved significantly.

The biocompatible artificial hair implant Biofibre® that we experienced is composed of a mixture of polyamides tested on clinical trials in laboratories accredited by the Italian Ministry of Health. Automatic Biofibre® Hair Implant is a soft surgery technique, performed under local anesthesia that provides immediate aesthetic results, without patient down time and with relevant psychological comfort and physical rebound for male and with particular attention to female patients. This technique has multiple indications including the treatment of androgenic alopecia, general hair thinning, depletion of a donor area for hair transplant, scalp scars or scalp burns, among others. It can be used alone or in combination with other hair restoration techniques.

Patients with psychological disorders, autoimmune diseases, immunodeficiency, lack of personal hygiene, scalp chronic diseases, or unstable forms of alopecia have to be excluded. Implant in some scalp areas must be avoided as temples, low front line on the forehead and in very thin or atrophic scalp.

To maintain the expected aesthetic result periodicals implant re-touches are required. Spontaneous Biofibre® hair implants loss is very subjective as it is influenced by many factors such as the patient's scalp and habits, the climate and the implant procedure. The use of automatic Biofibre® hair implant devices reduces the average implant loss since they allow to place the fibers always in the right depth and right orientation. Use of wrong substances, of unsuitable treatment and a lack of hygiene or correct after-care can compromise the expected result leading to local infection or inflammation problem. If that problem appears an appropriate dermatologic therapy have to be prescribed. If it can't be successfully treated, a complete fiber removal can be performed. Fiber extractions although very rare, allows a prompt solution of the problem without remains.

Conditions for success of the implant are: suitable patient selection, healthy scalp, compliance with implant protocol and post-implant protocol, correct patient after-care and periodical dermatological check-up.

Studies on safety, effectiveness, tolerability of the product as well as quality of life improvement and psychosocial impact post procedure showed positive results. Emerging studies are proving its efficacy in case of total alopecia and some selected cases of alopecia aerate.

References

1. United States Patent Office, Patent #1,059,63, patented on the 22nd of April 1913
2. Sasagawa M. Hairshaft implantation method. *Jpn J Dermatol Oncol* 30(5):493 (1930)
3. Fukuta K, Narita I, Jodo T. A New procedure of cosmetic prosthetic surgery for baldness. *Jpn J Plast Reconstr Surg* 19:6;613 (1976).
4. Hanke CW, bergfeld WF. Fiber implantation for pattern baldness. *JAMA* 1979; 241:146-8.
5. Schwartz RS, Downham TF. Dangers of synthetic fiber implantation for male pattern baldness, *Cutis* 1980; 25:491-2.
6. Di Gregorio VR, Rauscher G. Experience with the complications of synthetic hair implantation. *Plast Reconst. Surg* 1981; 68:498-504.
7. Taniguchi S. A histopathological study of the percutaneous implantation of polyester fibers. *Aesth plast surg* 1984:8;67-74
8. Food and Drug Administration: Proceed Listing of banned devices, prosthetic hair fibres. Code of Federal Regulations, 21:895.101 (1983)
9. D'Ugo A., Follow-up study of 503 patients three years after surgical implantation of artificial fibres on the scalp, XXV Congreso Argentino di Cirugia Plastica, Buenos Aires, ARGENTINA, November 26-30, 1995
10. Zhilina N.V., Igytyan G.G., Antonova L.E., Clinical anlyses of the results of treatment of alopecia with the Biofibre® implant methodology. *Ann of Plastic Reconstr Aethetic Surg* 2000; 1:34-36.
11. Palmieri B., Griselli G., D'ugo A., Palmieri G., Salti G., Evaluation of polyamide synthetic hair. A long-term clinical study. *Panminerva Med* 2000; 42(1):49-53.
12. Fanti P.A., Comparison between cases with and without clinically evident inflammatory complications in patients subjected to artificial hair implantation, Dept of Dermatology, University of Bologna, Italy, April 11,1994.
13. Fanti P.A., Pistorale T., D'urso C., et al. Histological study on 5 cases of patients who underwent artificial hair implantation without complications, XXXII Annual Meeting, American Society of Dermatopathology, New Orleans, USA, February 01-03, 1995
14. Santiago M., Estudo histológico de couro cabeludo implantado com fibras artificiais de poliamida, XXXV Congreso Brasileiro de Cirurgia Plástica, Goiânia, BRAZIL, November 1-4 1998
15. Santiago M., Histological study of the scalp implanted with polyamide artificial fibers (Biofibre® CE 0373/TGA). Analyses after 5 years, International Society of Hair Restoration Surgery, 10th Annual Meeting, Chicago, USA, October 9-13, 2002
16. Directive 93/42/EEC of the Council concerning Medical Devices, 14th of June 1993.
17. Universal Medical Device Nomenclature System, Prostheses, Hair, Universal Medical Device Code 16611
18. Gonzalez M., Biofibre hair replacement, ASAPS 35th Anniversary Meeting, Las Vegas, NV, USA, April 27 - May 3, 2002
19. D'ugo A., Santiago M., Chaker C., et al.., Safety of Biofibre® CE 0373/TGA artificial hair implants: importance of the scalp anchoring system, International Society of Hair Restoration Surgery, 10th Annual Meeting, Chicago, USA, October 9-13, 2002.
20. Santiago M., Extreme artificial hair implant: Biofibre® treatment of total alopecia. International Society of Hair Restoration Surgery, 10th Annual Meeting, Chicago, USA, October 9-13, 2002.
21. Santiago M., Fiber Hair Restoration – A Surgical Option to Treat Female Pattern Baldness, International Society of Hair Restoration Surgery, 11th Annual Meeting, New York, USA, October 15-19, 2003 – poster presentation
22. Brady G., Cases without Hope – Innovative Solutions in Difficult Cases, International Society of Hair Restoration Surgery, 13th Annual Meeting, Sydney, AUSTRALIA, August 24-28, 2005
23. Santiago M., Perez Rangel R., D'ugo A., et al., Artificial Hair Fiber Restoration in the Treatment of Scalp Scars, Derm Surg 2007; 33(1):35-44.
24. Perez Rangel R., Cabello Inorganico Biocompatible, Dermatologia Cosmética, Texto Académico, I° edicion 2011, presentacion February 2012 in 8th WCOCD.
25. Sheta M., Muntean D., Biofibre Hair Implant: the Evolution of Artificial Hair, 1st Anti-Aging Medecine European Congress, Paris, France 11-12 October 2013 – Poster presentation
26. Sheta M. Modern Artificial Hair Implant. FACE congress, London, UK, 20 -22 June, 2014.
27. N. Serdev, A.M. D' Erme, J. Hercogova, Z. et al. Polyamide hair implant (Biofibre®): evaluation of efficacy and safety in a group of 133 patients, J Biol Regul Homeiostat Agents, 2015; 29(1 Suppl):103-9
28. G. Tchernev Et Al, Biofibre Hair Implant: What is New, What is True?, JBRHA, 2016 Apr-Jun;30(2 Suppl 2):27-34
29. Ramos O, Tchernev G, Chokoeva AA, et al. Biofibre Hair Implant – Impact on the Quality of Life, J Biol Regul Homeost Agents. 2016 Apr-Jun;30(2 Suppl 2):21-5.
30. Agrawal M, Lotti J, França K, et al. The evolution of artificial hair implantation, JBRHA, Vol. 31, no.2(S2), 169-177 (2017)
31. D'Ugo A., Hair implantation, the exact method to carry it out, 32° Congresso Brasileiro de Cirurgia Plastica, Brasilia, Brazil, November 11-15, 1995
32. Brady G., Fukuta K., Santiago M., Shiell R., Synthetic Fibers in Hair Restoration: Potential Benefits, Patient Selection, Possible Complications, International Society of Hair Restoration Surgery, 11th Annual Meeting, New York, USA, October 15-19, 2003

33. Rateb A., Twenty years' experience with artificial hair insertion for the treatment of alopecia, 19th IMCAS international congress, 26-29 January 2017, Paris, France
34. Franca K., Current and Emerging Therapies in Hair Transplantation and Hair Implants, Oxford Clinical Handbook, May 2017
35. Seery G. Hair Repair. ISHRS Hair Transplant Forum International 2003; 13(1): 260-261
36. Brady G., Case Presentation: 23 Years of Hair Restoration Procedures in a Single Patient, International Society of Hair Restoration Surgery, 11th Annual Meeting, New York, USA, October 15-19, 2003 – poster presentation
37. Careno N. - Injerto de pelo: qué hacer cuando no hay pelo donante?, Jornadas Universitarias de la Asociacion de Dermatologia de Chile, Santiago, Chile, 23 of June, 2015
38. França, et al. Psychological Impact of Scars. In Scars and Scarring. Ed Yongsoo Lee. NovaScience Publishers 2013
39. Rahoui M., Biofibre et Cicatrice de Brulure du cuir Chevelu, 6° Congres National Algérienne de Chirurgie Esthétique, 28-29 Avril 2016, Alger, Algérie
40. Williamson D1, Gonzalez M, Finlay AY. The effect of hair loss on quality of life. J Eur Acad Dermatol Venereol. 2001 Mar;15(2):137-9.
41. Lotti T., Aesthetic Disability, SIME 38TH congress, 12-14 May 2017, Rome, Italy
42. Cash TF1, Price VH, Savin RC. Psychological effects of androgenetic alopecia on women: comparisons with balding men and with female control subjects. J Am Acad Dermatol. 1993 Oct;29(4):568-75.
43. Van Der Donk J1, Hunfeld JA, Passchier J, Knegt-Junk KJ, Nieboer C. Quality of life and maladjustment associated with hair loss in women with alopecia androgenetica. *Soc Sci Med*. 1994 Jan;38(1):159-63.
44. 21- Alfani S1, Antinone V, Mozzetta A, Di Pietro C, Mazzanti C, Stella P, Raskovich D, Abeni D. Psychological status of patients with alopecia areata. *Acta Derm Venereol*. 2012 May;92(3):304-6. doi: 10.2340/00015555-1239.
45. M. Rahoui Artificial hair implant Biofibre in 2 cases of alopecia totalis and experimental test in eyebrows, 17th IMCAS Annual Congress, Paris, France, 29 Jan – 01 Feb, 2015.