**INTRODUCTION**

Hair restoration surgery represents the only treatment option for advanced patterned baldness, in which pharmacological therapy with topical minoxidil and/or oral 5-alpha-reductase inhibitors is unsatisfactory, and may be performed in selected cases of cicatricial alopecia. With the advent of total micrografting and a sharp decline in scalp reduction procedures, autologous hair transplantation has become more satisfactory than in the past. The method takes advantage of the feature of donor dominance, i.e., that tissue taken from the donor zone (the remaining rim of hair around the occipital scalp) retains characteristics independent of the recipient site (the balding crown area), as originally published by Orentreich in 1959.[1] Therefore, the amount of hair in the donor area represents a limiting factor in autologous hair transplantation. Moreover, autologous hair transplantation is not recommended in alopecia areata since it is conceivable that the organ-specific autoimmune reaction might eventually target the transplants.

Alternatively, since the 1980’s synthetic hair fibers have been considered an option for patients without adequate donor hair, patients with cicatricial alopecia, scars, and possibly alopecia areata. However, artificial hair implantation has historically been marred by poor quality fiber and performance resulting in a number of serious complications[2‑7] and ultimately a ban on their use.
by the USA Federal Drug Administration (FDA) in 1983 (Section 895.101 of 21 Code of federal regulations of FDA title 21 vol. 8 revised as of 01 April, 2004). The reasons cited for the ban are summarized in Table 1.[8]

Nevertheless, companies continue to market the procedure with the claim that previous problems have been sorted out. Originally, synthetic fibers comprised monacrylic, polyacrylic, and polyester, whereas currently available synthetic hair fibers are made of polyamide material, which has been claimed to be inert and safe. The fibers are implanted in a simple technique into the galea by a knot through an implanter device, and allegedly can be removed on demand with ease and without complications. At present, two products are available: Biofibre from Medicap Italy (available since 1996) and Nido corporation from Japan (available since 1999). Biofibre has received CE certification in Europe and has reapplied for the FDA approval which is as yet pending. Since the year 2000, a number of case series with 10–196 patients have been published, evaluating the safety and efficacy of modern artificial hair implantation and have found an overall complication rate of 7.4%–30% temporary superficial inflammation or infection that usually subsided within 15 days of topical cortisone and local/systemic antibiotic treatment and 1.02%–2.1% serious inflammation or infection necessitating removal of implants.[8-13]

We report a case of serious inflammation in synthetic hair implants, in which microbiological studies revealed infection with both Staphylococcus lugdunensis and Trichophyton tonsurans.

Table 1: Reasons for ban of prosthetic hair fibers (from[8])

| Reason for Ban |
|----------------|
| The fibers present risks of illness or injury due to nonbiocompatibility of the fibers and nonmedical performance of the implant |
| Recurrent infections |
| Rejection and periodic loss of fibers needing frequent replacement |
| Frequent allergic reactions leading to severe contact dermatitis, irritant effects |
| Fears about possible carcinogenicity |
| Cicatricial alopecia |
| Granulomatous hypersensitivity |
| Cyst formation |
| The fibers present fraud due to |
| Spreading of deceptive information on the efficacy of result |
| Inadequate information on risks deriving from implant |
| No benefit for public health |

CASE REPORT

A 58-year-old Caucasian male patient who had undergone synthetic hair implants for advanced androgenetic alopecia presented with the complaint of pain, pruritus, hemorrhagic oozing, and crusting in the area of the implants. After having undergone autologous hair transplantations on a yearly basis between 1981 and 1986 resulting in a poor donor area, he eventually submitted himself to his first synthetic hair fiber implantation with Nido synthetic hair from Japan offered to him and performed by his hair stylist. Within days of the procedure, he experienced symptoms of inflammation at the site of the implants. Nevertheless, due to a loss rate of 1–2 hair fibers/day he had artificial implants, eventually Biofibre from Italy, repeated by his hair stylist twice yearly until 2015. In addition, in an attempt to camouflage the alopecic vertex area, he had his scalp tattooed. All along and despite persistent symptoms of the scalp, medical assistance was never sought by the patient, who treated lesions to no prevail with topical fusidic acid and a compound of fusidic acid and betamethasone that were ordered by himself from the internet and without prescription.

Clinical examination revealed male pattern alopecia Grade VII on the Hamilton–Norwood scale with blotchy, slate-colored tattooing, and a frontotemporal fringe of synthetic hair implants associated with atrophy, crusts, and erosions of the scalp [Figure 1a].

Bacteriologic studies revealed Staphylococcus epidermidis and S. lugdunensis.

Initially, treatment with 1 × 500 mg oral levofloxacin and washing with povidone-iodine was prescribed, until growth in the mycological culture was identified as T. tonsurans [Figure 2a-c]. At this time point, treatment with 2 × 100 mg oral itraconazole was introduced for 4 weeks, and crusts were removed with a compound of clioquinol and salicylic acid in Vaseline.

Since there was residual inflammation [Figure 1b], despite a negative mycological culture on follow-up, the implants were removed with complete resolution of inflammation. On his one initiative, the patient hat new implants set [Figure 1c].

DISCUSSION

Synthetic hair implants are considered in the case of alopecia when the patient requests an immediate cosmetic result with minor surgery and cost and in the case of a
poor donor area. Originally, the materials were unsuitable; there was a lack of proper medical protocols and an absence of appropriate patient information on proper aftercare. Moreover, more often there were unqualified providers, who were not trained physicians. Consequently, patients developed cutaneous complications with the risk of permanent sequelae, such as premature loss of hair, allergic reactions, irritant effects, foreign body granuloma, infection, and scarring.\[1-7\] One hundred cases of postoperative complications were studied by Lepaw\[3\] for evaluation of modes of therapy to remedy these problems. The authors found that the best results were obtained by removing the offending material and deferring cosmetic reconstruction at least 3–6 months after the fibers have been removed. They also came to the conclusion that severity of the complications makes the implantation of synthetic hair fibers into the scalp for the treatment of alopecia a dangerous and futile approach with a low-cost benefit and should therefore be abandoned totally.

Currently, the implantation of synthetic hair fibers for the treatment of alopecia has reemerged with the claim that a combination of safe fibers, suitable implant instruments, trained doctors, careful patient selection, and proper aftercare would result in significant improvement of outcome in terms of safety and efficacy.\[13\] Therefore, in 1995, the synthetic hair implant technique was recognized as a medical procedure that should only be performed by an experienced, licensed medical doctor in a reputable medical clinic or university setting. The technique is not indicated in patients with diabetes mellitus, autoimmune disease, scalp diseases, alopecia that is not stabilized, lack of personal hygiene, or employment in dusty and dirty environment. Furthermore, these implants are not indicated in the temple area, low frontal scalp, or in any scalp area with thin tissue, such as the sideburns. The average implant is about 1000 fibers per session, respecting the appropriate distance between each fiber (2 mm) and correct inclination of the fibers (45°). One disadvantage of synthetic hair implants is that the artificial hair does not grow, requiring good aftercare and hygiene, periodical checkups, and yearly implant retouches to maintain the best cosmetic result. The implant technique has been validated with clinical studies and research from 2000 onward revealing a continuous improvement of the technique and related protocols.\[8-13\] In one study, fiber loss was no more than 10%/year in 91.4% of cases, 15% in 7.8% of cases, and 20% in 0.8% of cases. As for postimplantation tolerability and complications, in the same study, 90.3% of patients recorded no problems after surgery, 5.9% developed mild infection, and 3.8% presented with inflammatory changes (allegedly from the use of improper chemical substances). Resolution of these issues occurred in 97.9% of cases.\[13\]

Nevertheless, we observed a case of serious inflammation due to a mixed infection with *S. lugdunensis* and *T. tonsurans*, necessitating combined systemic antibiotic and antifungal treatment and removal of synthetic hair implants.

*S. lugdunensis* occurs both as a commensal on human skin and as a virulent coagulase-negative *Staphylococcus* that has been recognized to cause skin infections similar to *Staphylococcus aureus*.\[14,15\] Otberg *et al.* originally reported folliculitis decalvans developing after hair restoration...
surgery in punch grafts.[14] The presence of bacterial biofilms in the infrainfundibular part of hair follicles has recently been identified and proposed to be pathogenic in folliculitis decalvans, a disease characterized by chronic recurrent inflammation of the hair follicle, in which S. aureus has a central role.[17] A biofilm represents any group of microorganisms in which cells stick to each other within a self-produced matrix of extracellular polymeric substance on living or nonliving surfaces. Bacteria living in a biofilm have different properties from free-floating bacteria of the same species, as the dense and protected environment of the film allows them to cooperate and interact in various ways. One advantage of this environment for the bacteria is increased resistance to antibiotics. Bacterial biofilms may impair cutaneous wound healing and reduce topical antibacterial efficiency in healing or treating infected skin wounds.[18] No matter the sophistication, biofilms are known to develop on all medical devices and tissue engineering constructs. In the case of folliculitis decalvans, bacterial biofilms form at the interface of the hair shaft. In folliculitis decalvans following hair transplantation or synthetic fiber implants (peri-implantitis), it is conceivable that the respective bacteria, in this case Staphylococcus lugdunensis, may have been introduced in the course of the procedure.

*T. tonsurans* is an anthropophilic dermatophyte and a common pathogen in tinea capitis. Tinea capitis may manifest in a seborrheic dermatitis-like pattern, in a black dot ringworm type, or as kerion celsi.[19,20] However, this pathogen causes an indolent and even asymptomatic disease in the majority of affected adults, whereas more severe inflammatory cases are associated with zoophilic or geophilic species.[21] Apart from microbiological features and virulence of the fungus, inappropriate use of topical corticosteroids may worsen the infectious process since they suppress the local fungus-specific immune response. This complication is becoming more common by the increasing of self-diagnosed diseases and self-prescribed treatments,[22] as in the reported case. A question that arises is when and how the fungal pathogen was introduced into the scalp, suggesting again that the hygienic and aftercare standards for synthetic hair implants were not met by the provider in question (a hair stylist) and the patient.

In summary and conclusion, synthetic hair implants represent a minor surgery technique, performed under local anesthesia by a manual implanter, which enables an immediate cosmetic result with minimal pain. Nevertheless, there remain limitations to the method. Safer and more effective options are available for hair restoration, with both follicular unit transplantation and follicular unit extraction offering very satisfactory results in most cases, when they are provided by trained hands. The option of synthetic hair implants may be considered in patients who fail on hair growth promoting agents, do not have adequate donor hair, and for whom a hair prosthesis is unacceptable. The matter was reflected on by the International Society of Hair Restoration Surgery. After evaluating all aspects on the subject, the society stated that “It is the view of the Society that this is a surgical procedure and as such should be confined to active participation of an experienced, licensed medical doctor in a reputable medical clinic or university setting. As with any surgical procedure, complications may occur which should be handled under a physician’s care.”[23] Therefore, good postimplant care, periodical professional checkups, and yearly implant retouches are necessary to maintain best results. Usually, problems result from lack of asepsis during the procedure, lack of patient hygiene, excessive quantity and density of implanted fibers in one session, incorrect choice of implant area, and poor aftercare. In cases, where implant-related problems, such as minor inflammation, cannot be resolved with topical cortisone and local or systemic antibiotic treatment within 15 days, an extended microbiological antibiotic treatment is warranted, and it may be necessary to remove the fibers.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

This case report represents an integral part of Pedro Colli’s traineeship in Dermato-Trichology at the Center for Dermatology and Hair Diseases Professor Trüeb and was presented by Ralph M. Trüeb on the occasion of the Symposium “Dermokosmetika gegen Hautalterung – Neues aus der Forschung.” Society for Dermopharmacy, in Berlin, Germany, on December 02, 2016.

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