

Squamous Cell Carcinoma of the Scalp Arising in a Site of Synthetic Hair Grafts

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Summary: Synthetic hair implantation was developed in the 1970s and initially gained popularity until major cutaneous complications, such as facial swelling, severe dermatitis, recurrent cellulitis, and cicatricial alopecia, became an issue. In particular, the procedure has been suggested to have a possible causal relationship with squamous cell carcinoma (SCC). This article describes the third reported case in the English literature of SCC arising in a site of synthetic hair grafts. The patient was an 80-year-old man with a prominent verrucous tumor in the parietal region; he had undergone synthetic hair implantation for the past 28 years. The pathological diagnosis of SCC was made by dermal punch biopsy, and computed tomography images revealed cranial osteolytic changes, with possible direct dural tumor invasion. Extensive resection of the tumor and reconstruction were performed following downsizing radiotherapy. The protruding tumor was excised with the adjacent portion of the parietal bone. Several synthetic hair grafts were found stuck in the cranium. The defect area was reconstructed with a synthetic bone material and a free latissimus dorsi muscle flap with skin graft. The pathological examination revealed well-differentiated SCC surrounded by numerous synthetic hair grafts inducing inflammatory cell infiltration and severe cicatrizing fibrous changes. The postoperative course was uneventful, and no recurrence or metastasis was observed at 9 months postoperatively. (*Plast Reconstr Surg Glob Open* 2022;10:e4428; doi: 10.1097/GOX.0000000000004428; Published online 25 July 2022.)

Alopecia, a common dermatological disorder of multifactorial etiology, can significantly impair the self-esteem, body image, and quality of life of patients.¹ A variety of hair replacement methods for alopecia have been described, including hairpieces, hair weaving, and autogenous or synthetic hair implantation. Synthetic hair implantation was developed in the 1970s and initially gained popularity, as the procedure is feasible even when there is not a sufficient donor site and is comparatively less expensive.² Although the initial cosmetic results were satisfactory, severe cutaneous complications occurred in a number of patients postimplantation, and the procedure was prohibited by the US Food and Drug Administration in 1983.^{2,3}

Chiarelli et al⁴ and Nakayama et al⁵ reported cases of squamous cell carcinoma (SCC) arising after synthetic

hair implantation. This is the third case of SCC arising in a synthetic hair graft site reported in the English literature. We hope this report will provide additional insight into the complications of synthetic hair implantation.

CASE REPORT

An 80-year-old man was referred to our hospital for surgical intervention of a parietal skin tumor to mitigate persistent oozing of fluid and purulent ulceration. The patient had undergone synthetic hair implantation on a regular basis for 28 years since the age of 50, stopping the procedures at the age of 78, when he developed skin problems in his parietal region. He visited another clinic one year before he presented to our hospital when he developed a reddened, verrucous, protruding tumor 85 × 85 mm in size surrounded by an erythematous halo in the parietal region, causing painful ulceration and a purulent, malodorous discharge (Fig. 1). The time-course change of scalp condition or tumor size was unclear because he first ignored the symptoms and avoided seeking medical care. His medical history included chronic renal insufficiency

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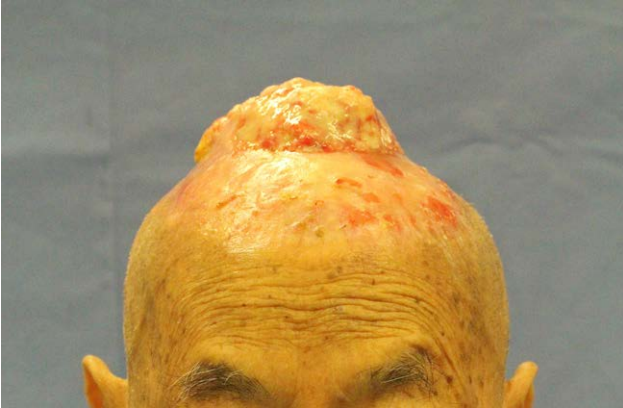


Fig. 1. Preoperative view of the reddened, prominent tumor with an erythematous halo in the parietal region.

due to diabetes mellitus, hyperlipidemia, and hyperuricemia, without remarkable surgical history, family history, or any history of severe exposure to ultraviolet. The pathological diagnosis of SCC was made by dermal punch biopsy. Although no metastatic lesion was identified, computed tomography findings indicated cranial osteolytic changes and the possibility of direct dural invasion of the tumor. An extensive resection of the tumor and reconstruction following radiotherapy were planned.

We first excised the prominent tumor in the parietal region and the periosteum immediately beneath the tumor with the surgical margin based on a preoperative mapping biopsy. Several synthetic hair grafts were found stuck in the cranium (Fig. 2). In collaboration with neurosurgeons, the invasive tumor infiltrating the cranium was resected with the surrounding parietal bone. There was no macroscopic sign of dural invasion, and intraoperative consultation aided in operative decision-making to preserve the dura mater. The resulting bone defect was reconstructed with calcium phosphate bone paste (BIOPEX) covering the dura mater. Then, a free latissimus dorsi flap was raised off the left back and transferred onto the artificial bone material in the created scalp defect 18×14 cm in size. Meshed split-thickness skin grafting was performed on the muscle flap.

The pathological investigation of permanent sections revealed well-differentiated SCC surrounded by numerous synthetic hair grafts, which appeared to have induced inflammatory cell infiltration and severe cicatrizing fibrous changes (Fig. 3). As the surgical margin was negative horizontally but positive vertically, postoperative radiotherapy became a future treatment option for this patient. No recurrence or metastasis was observed at 9 months postoperatively (Fig. 4).

DISCUSSION

Malignant tumors induced by an implanted foreign body in humans are uncommon, and the detailed mechanism of carcinogenesis remains unclear.⁶ According to some advanced cancer research studies using experimental animals, stromal inflammatory reaction may be the intrinsic component of tumorigenesis, and inflammatory



Fig. 2. One of several artificial hair grafts sticking out of the cranium, surrounded by the dotted line.

cells and fibrous stroma that secrete soluble factors in foreign-body-associated inflammation have been suggested to play a significant role.^{6,7} In particular, reactive oxygen species and reactive nitrogen species originating from neutrophils, as well as chemotactic cytokines and inflammatory mediators, are believed to be important in the initiation of carcinogenesis.^{6,7} Brand et al⁸ reported that the material and physical features of foreign bodies, such as shape, size, lubriciousness, hardness, porosity, and electronic charge, also have a large impact on their carcinogenic potential. For instance, bigger foreign bodies have a higher potential to cause tumor development, and concave as compared with convex foreign bodies are more likely to induce tumorigenesis; however, it does not simply mean that such physical features that may provoke more intense inflammation are directly related to higher carcinogenic potential. In fact, foreign body tumorigenesis has been reported to bear an inverse relationship to the intensity of inflammation, and is also reportedly suppressed by excessive reactive oxygen species or reactive nitrogen

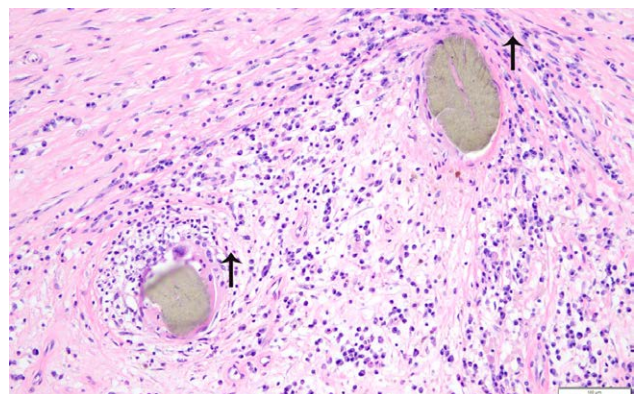


Fig. 3. The artificial hair grafts (arrowheads) induced phagocytosis by macrophages and infiltration of inflammatory cells.

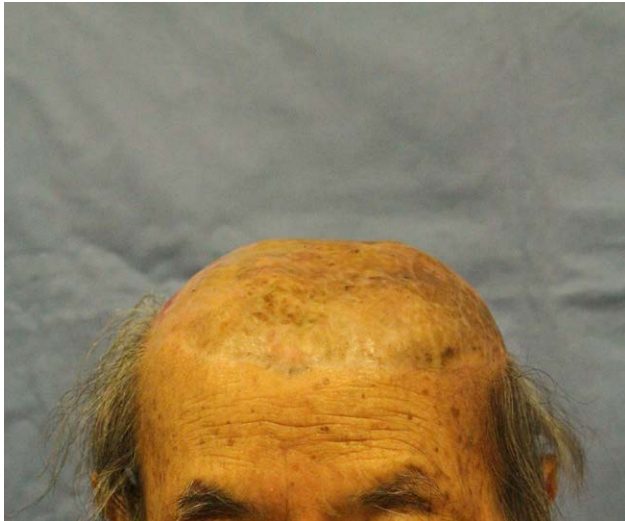


Fig. 4. No recurrence was observed at 9 months postoperatively.

species production.⁷ Prolonged, moderate production of free radicals may be essential for carcinogenic initiation.

Synthetic fabrics, such as polyester and polyamide, are widely used today in artificial hair fabrication. Both are petroleum products with excellent characteristics, such as superior dimensional stability, good electrical resistance, and outstanding surface gloss. The high invulnerability and smooth surface of artificial hairs resembling real hairs may be the properties that promote tumorigenesis in the same manner as the “Oppenheimer effect,” that is, undegradable materials with smooth surfaces tend to be more tumorigenic when implanted in rodents.^{6,9}

Our intraoperative findings included several artificial hair grafts embedded in the parietal bone. Those deeply pierced hair grafts might have caused pervasive and severe irritation to the scalp, provoking a significant inflammatory reaction. The pathological findings, meanwhile, revealed notably thinning subcutaneous tissue in the parietal region, with significant cicatrizing changes. (See figure, **Supplemental Digital Content 1**, which demonstrates the pathological finding of thinning subcutaneous tissue in the artificial hair graft site, <http://links.lww.com/PRSGO/C96>.) It is possible that the thinning subcutaneous tissue rendered it easier for the synthetic hair grafts to penetrate into the cranium.

According to Peluso et al,¹⁰ patients without any scalp symptoms after synthetic hair implantation exhibit no acute inflammation, but their pathological features are

otherwise very similar to those of symptomatic patients. It is possible that the foreign body reaction could take a chronic course leading to the progression of tumorigenesis insidiously. Even though the direct causal relationship between synthetic hair implantation and SCC generation remains speculative, we believe that the potential risk of carcinogenesis after synthetic hair implantation should be recognized more widely, and more consideration should be given to the safety of implanting methods.

We hope this report will contribute to the growing body of clinical expertise on the complications of synthetic hair implantation.

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PATIENT CONSENT

The patient provided written consent for the use of his image.

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