

Alopecia Induced by Fluoroscopy-guided Embolization: A Case Report

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ABSTRACT

Alopecia resulting from radiation exposure occurs 2-8 weeks after exposure. It can be temporary or permanent depending on the dose of exposure. Alopecia following fluoroscopy-guided procedures are increasing in frequency. We report the case of a 22-year-old female who underwent fluoroscopically-guided embolization of an arteriovenous malformation. Twelve days after embolization, significant hair shedding was noted, resulting in a large rectangular hairless patch with no erythema or pain on the irradiated site. Hair pull test was positive and the hair mount showed dystrophic anagen hairs. Hair tug test was negative. Trichoscopy showed yellow dots, black dots, vellus hairs, and flame hairs. Histopathologic examination showed an increase in catagen and telogen hairs. On review of the procedure, she received a total peak skin dose of 4.67 Gray from the procedure. The diagnosis of radiation-induced alopecia was made and topical minoxidil was started, resulting in complete hair growth after six months. Patients undergoing fluoroscopy-guided procedures should have adequate follow-up weeks to months post-procedure to monitor for skin and hair reactions. Physicians should also consider delayed radiation reactions in patients with a history of radiation exposure. Safety protocols must be in place, and measures should be done to minimize the dose delivered.

Keywords: alopecia, radiation-induced, fluoroscopy, trichoscopy

INTRODUCTION

Fluoroscopy makes use of continuous ionizing X-ray radiation to produce real-time images for diagnostic and interventional procedures. Endovascular embolization is a minimally invasive procedure for aneurysms and arteriovenous malformations (AVM) that is guided by fluoroscopy. Radiation can produce dose-dependent effects on the skin, such as radiation dermatitis, necrosis, and hair epilation.¹ Fluoroscopy-guided procedures are increasing in use, thus reports of alopecia occurring after these procedures are increasing as well.² Thus, proper monitoring and safety precautions should be observed for both the patient and operators. We present a case of alopecia resulting after excessive radiation exposure from endovascular embolization.

CASE REPORT

A 22-year-old female was diagnosed with ruptured arteriovenous malformation (AVM) at the right occipital lobe two years prior. She was prescribed levetiracetam for the focal seizures caused by the AVM with good control of the seizures, but with persistent headaches and blurring of vision. She has a history of dyslipidemia, no family history of alopecia or skin diseases, and no vices. She also has a history of hair treatments, which includes hair rebonding done two years prior and hair coloring done five months before the consult. She underwent quarterly cranial CT scan



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for monitoring and 4-vessel angiogram five months prior. Three weeks prior to consult, she had an elective admission for a repeat cranial CT scan and cerebral angiogram with glue embolization. The latter procedure lasted for six hours and yielded a total peak skin dose of 4.67 Gray. There was no noted erythema, pruritus, or pain after the procedure. She then underwent cranial CT scans on the first and sixth day after the procedure due to persistent headaches and blurring of vision. Twelve days after the embolization, there was sudden shedding of multiple clumps of hair over the right parietal to

occipital areas, which continued for six days until there was a large rectangular alopecic patch noted, prompting immediate referral by the interventional radiologist to our clinic.

On examination, there is a 24 x 14 cm geometric alopecic patch with sparse terminal hairs spanning the right temporal, parietal, and occipital region of the scalp (Figure 1), which are consistent with the areas irradiated. Hair tug test was negative, while hair pull test was positive, yielding anagen hairs with pointed tips (Figure 2). Dermoscopy showed white dots, black dots, vellus hairs, and flame hairs (Figure 3).



Figure 1. Geometric alopecic patch spanning the right temporal, parietal, and occipital regions of the scalp.



Figure 2. Hair mount of shed hairs showing dystrophic anagen hair with a tapered bulb (40x).

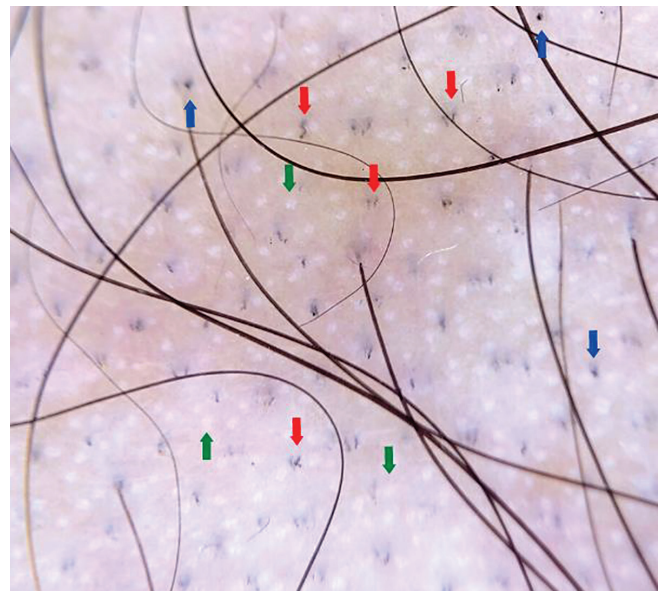


Figure 3. Trichoscopy of the alopecic patch showing black dots (blue arrows), white dots (green arrows), and flame hairs (red arrows) (10x).

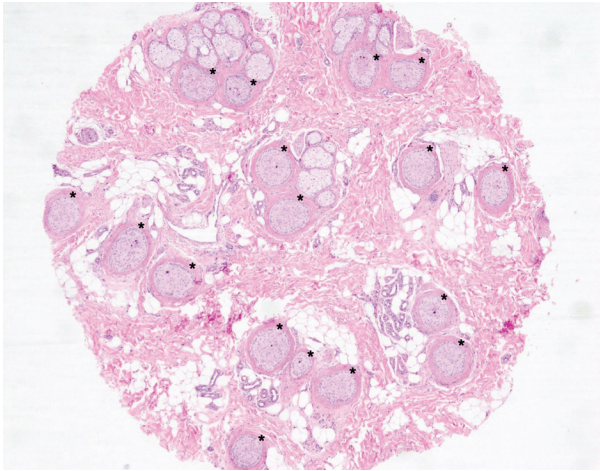


Figure 4. Histopathology at the level of the subcutaneous fat showing an increase in catagen hairs (*) with no perifollicular infiltrates (40x).



Figure 5. Complete hair regrowth six months after the procedure.

Punch biopsy showed increased number of catagen and telogen follicles with no perifollicular infiltrates, which is consistent with radiation-induced alopecia (Figure 4). Minoxidil 2% solution was started twice daily over the affected scalp with good compliance reported during follow-ups. There was noted complete regrowth of dense curly hair after six months (Figure 5). Dermoscopy was not repeated since follow-ups were performed through teleconsultation. There were no complaints of pruritus, stinging or increased hair shedding from the application of minoxidil. Repeat cranial CT scan was done 10 months post-procedure with complete resolution of previously documented hemorrhages. No recurrence of the hair shedding was noted thereafter.

DISCUSSION

Alopecia caused by radiation exposure results from acute damage to the rapidly proliferating cells in the matrix of the hair follicles, preventing cell proliferation and new cell production.^{2,3} Anagen hair follicles also enter the catagen then telogen phases prematurely, causing premature hair shedding.^{2,4,5} Thus, the onset of the reaction depends on the timing of the hair cycle. Hair epilation appears 2-8 weeks after radiation exposure, together with other early radiation reactions, like erythema and moist desquamation. On the other hand, the severity of the reaction is dose-dependent with respect to the amount of surviving stem cells and follicles.³ The threshold dose for temporary epilation of hair is 3-6 Gray, while 7 Gray can result in permanent epilation when all follicles are lost.^{2-4,6} Other factors that influence the severity of the alopecia are the cumulative radiation dose, total duration of exposure, interval between irradiations, size of the skin irradiated, and angle of irradiation, patient co-morbidities, and smoking.^{2,7} In this patient, radiation from the previous cranial CT scans prior to the procedure

may have also contributed to the reaction. The scalp is least resistant to the effects from radiation compared to the rest of the body, but scalp hair epilation, particularly in light-colored hair, occurs at lower doses of radiation.^{3,7}

Radiation-induced alopecia is characterized by well-defined, usually geometric hairless patch with no erythema or scaling located on the treatment site.⁴ The most common trichoscopic findings seen in patients were yellow dots, black dots, short vellus hairs, absence of exclamation mark hairs. Other findings include coiled hairs, peripilar sign, lack of terminal hairs, broken hairs, dystrophic hair roots, white dots, and blue-gray dots in a target-like pattern. The absence of exclamation mark hairs is an important distinguishing factor against alopecia areata, which is a close differential diagnosis.⁸ Flame hairs were also reported, which are pigmented pilar residues with thin and wave ends, resembling flames. They are also found in trichotillomania, and acute chemotherapy- and radiation-induced alopecia.⁹

Trichogram shows dystrophic anagen hairs,² with a few reporting rapidly tapered tip, or bayonet hair, which resulted from inhibition of cell proliferation in the hair matrix.⁷ Histopathology shows increase in catagen and telogen hairs with no peribulbar inflammation, differentiating it as well from alopecia areata.^{2,8} Aside from alopecia areata, other differential diagnosis that should be considered include pressure-induced alopecia and alopecia secondary to impaired blood supply caused by therapeutic embolization or radiation-induced luminal fibrosis. Patients with pressure-induced alopecia usually present with tenderness, swelling, crusting, and the alopecic patch is confined to the area with prolonged contact. Histopathologic findings of pressure-induced alopecia are nonspecific and may also present with increase in catagen and telogen hairs, but the absence of the other signs make the diagnosis less likely. The impaired blood supply may be ruled out by palpating for good pulses, but

is also less likely due to the rich vascular collateral supply of the scalp.

Prognosis of radiation-induced alopecia is favorable, with spontaneous hair regrowth expected 2-24 weeks, up to 12 months, after exposure.⁸ In the patient, topical minoxidil was prescribed to support hair growth. It is also notable that the the new hair was curlier and thicker than the patient's original hair. The patient also had history of hair treatments, with hair rebonding procedure done two years prior and hair coloring done five months prior. These procedures may have contributed to hair fragility, but the negative hair tug test shows that it is not significant enough to cause the hair shedding.

Due to numerous effects of radiation on the skin and hair, which may have a delayed presentation, adequate follow-up must be done by physicians to anticipate these effects.¹⁰ There have been few but serious injuries documented from different interventional fluoroscopic procedures, such as in coronary angioplasty, endovascular embolization in other areas of the body, and shunt placements.¹¹ These procedures have a more significant effect on the skin caused by the ionizing radiation, rather than the hair, resulting in erythema, desquamation and atrophy, depending on the total dose received.¹⁰ Safety protocols must be in place, and measures should be done to minimize the dose delivered, if possible. Patients should also be informed of the possible effects on the skin and hair after the procedure to mitigate the distress from these adverse effects.

CONCLUSION

Radiation-induced alopecia is an early radiation reaction occurring 2-8 weeks after exposure characterized by geometric alopecic patches with no signs of inflammation. Temporary hair epilation occurs at doses above 3 Gray, while permanent hair loss occurs at 7 Gray. It is a self-limiting condition that resolves weeks to months after the onset. Patients undergoing fluoroscopy-guided procedures should have adequate follow-up 2-8 weeks post-procedure to monitor for early skin and hair reactions. Physicians should also consider delayed radiation reactions in patients with a history of radiation exposure.

Statement of Authorship

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Author Disclosure

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