

CASE REPORT

Bilaminar dermal regeneration template for the coverage of exposed dura in a patient irradiated for tinea capitis

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Summary

Introduction: Before the discovery of antimycotics powerful enough to penetrate the hair follicle, the use of X ray radiation was a worldwide accepted method for scalp epilation as part of the treatment for tinea capitis in children. More than five decades later, the consequences of radiation in ringworm therapy became evident and included high rates of recurrent and aggressive forms of non-melanoma skin tumors, brain tumors and meningiomas, as well as osteoradionecrosis. Scalp reconstruction presents a challenge due to the unique anatomic characteristics of the scalp as well as tissue inelasticity. Cases of bilaminar dermal regeneration templates applied directly on dura in the literature are seldom described.

Case report: A male patient irradiated due to tinea capitis as a child, presented at our institution for the management of multiple recurrent infiltrative basocellular carcinomas (BCC) and osteoradionecrosis of the scalp. Severe skin atrophy affected all areas of the scalp except for the forehead, which showed moderate atrophy. The patient had multiple surgeries over the next few years due to the emergence of new and recurrent BCCs as well as zones of osteoradionecrosis of the scalp. Post-surgical defects were commonly reconstructed using local fasciocutaneous flaps and skin autografts. Surgical site complications, including partial flap necrosis or autograft loss, frequently followed the procedures. After exhausting all reconstructive options by repeated previous surgeries, a post-surgical defect following osteotomy of newly developed ORN in the occipital region was reconstructed using a dermal substitute applied directly on the dura and covered with a skin autograft, in a two-step procedure. Due to a high perioperative risk for general anesthesia, the intervention was performed under local anesthesia with anesthesiologic monitoring. The postoperative period was uneventful and the skin autograft had a 100% take.

Conclusion: The use of bilaminar dermal regeneration template Integra® can be efficiently utilized for the reconstruction of full thickness skin and calvaria defects in complex cases when all other reconstructive methods are exhausted.

Key words: Tinea capitis, skin atrophy, osteoradionecrosis, basal cell carcinoma, bilaminar dermal regeneration template

INTRODUCTION

In 1950s, tinea capitis, commonly known as ringworm or favus, was one of the most common fungal diseases of childhood. Before the discovery of antimycotics powerful enough to penetrate the hair follicle, hair was physically removed by radiating the scalp before the application of topical antimycotic ointments (1–4). Epilation via X-ray radiation has been widely accepted as an efficient treatment approach (1–4).

More than five decades later, the consequences of radiation therapy for ringworm became evident. Malignancies of the head and neck, including basal cell carcinoma (BCC) and squamous cell carcinoma of the skin, thyroid gland tumors, brain tumors and meningiomas, as well as high rates of aseptic osteoradionecrosis (ORN), have been associated with childhood irradiation due to ringworm infection (4–6).

In irradiated patients, a dose-dependent association has been proposed, as well as a predisposition for the occurrence of multiple BCCs at a younger age compared to general population (5). Another major issue is the poor skin and underlying bone quality in terms of radiation induced atrophy, which requires significant consideration and surgical experience for the selection of the optimal method of tissue defect reconstruction after surgical tumor removal (7). In full thickness defects of the skin and skull bones with exposed dura, the use of bilaminar dermal template Integra® placed directly on the dura is rarely described in literature but it is an efficient method of reconstruction in the challenging event when all other options are exhausted.

Here we present our experience in reconstruction of a full thickness scalp defect with exposed dura due to aggressive recurrent bone invading BCCs as well as ORN, in a patient who was irradiated due to tinea capitis as a child.

CASE REPORT

A male patient, born in 1938, irradiated due to tinea capitis as a child, presented at our institution for the management of BCC of the scalp. The dose of irradiation was unknown due to a lack of official protocols at the time. In his medical history, two acute myocardial infarctions were noted and the patient was being treated for chronic obstructive pulmonary disease with corticosteroid therapy. Severe skin atrophy affected all areas of the scalp except for the forehead, which showed moderate atrophy.

The first occurrence of infiltrative subtype of BCC localized in the right temporal region was at the age of 57. The tumor was removed down to the periosteum, and the post-surgical defect was successfully covered by a partial-thickness skin autograft. Five years later, two infiltrative BCCs emerged in the parietal region. Due to the

invasion of the periosteum, the tumor was excised along with the external tabula of the parietal bone below the tumor. After sufficient granulation tissue was obtained, the defect was restored with a partial-thickness skin autograft. One year after the procedure, a significant parietal bone exposure in the anterior segment was present, with only marginal exposure in the posterior segment. Tumor recurrence was histopathologically excluded, and the diagnosis of aseptic bone necrosis was confirmed (Figure 1). The patient was lost to follow-up for several years due to his poor overall health.



Figure 1. Patient presenting with significant bone exposure due to osteoradionecrosis.

When the patient returned for examination, BCC localized parietally, anterior to the previous tumor, was noticed as well as new zones of ORN. Due to bone invasion by the tumor, the tabula externa of the parietal bone was excised, and the defect was reconstructed with a local fasciocutaneous flap harvested from the forehead. The secondary defect from the flap donor site was covered using a Blair II skin autograft. The flap survived without complications. The aseptic bone necrosis was managed by osteotomy and reconstructed with a Blair I autograft placed on previously obtained granulation tissue. After 2 months all wounded surfaces epithelized, however, after 6 months new areas of bone exposure in terms of ORN were noted. Wound swabs showed normal bacterial skin flora. The patient was conservatively treated until the conditions for surgery were met, and a Thiersch skin autograft was used to cover the defect. Partial loss of the skin autograft was found postoperatively. Simultaneously, additional areas of ORN appeared in the occipital region.

Further occurrence of ORN in the occipital region was managed by an osteotomy of the necrotic bone with a subsequent exposure of dura. All reconstructive options were exhausted by repeated previous surgeries, and the patient's overall health limited complex reconstructive methods requiring general anesthesia. Thus, a post-surgical defect following osteotomy of newly developed ORN in the occipital region was reconstructed by placing a bil-



Figure 2. Integra® covering the defect after osteotomy. Severe skin atrophy is present in most regions of the scalp as well as previous surgeries, amplifying the obstacles limiting other reconstructive methods.

aminar dermal regeneration template Integra® directly on dura (**Figure 2**). In collaboration with the anesthesiology department, the procedure was successfully done under local anesthesia with anesthesiologic monitoring. After 3 weeks, the dermal template was successfully covered with a Thiersch skin autograft (**Figure 3**).



Figure 3. After 3 weeks, Integra® was covered with Thiersch skin autotransplants with a 100% successful take in further recovery.

After each surgery, all tumor samples were sent for histopathological verification with all reports verifying complete tumor removal. Additionally, all samples obtained from the surgeries of ORN were also sent for exclusion of tumor recurrence and verification of avascular necrosis.

In the following years, the patient occasionally presented with small wounds successfully managed conservatively, while BCC did not occur. The patient died due to cardiovascular disease at the age 80.

DISCUSSION

Full-thickness skin defects on irradiated scalp provide a particular challenge for both the reconstructive surgeon and the patient. These scenarios are made even more difficult when the defect involves the cranium, exposing the underlying dura. Before opting for the appropriate reconstructive approach for the patient, localization, tumor diameter, depth of invasion and type, risk of a recurrence, as well as overall patients' health should be thoroughly assessed (7,8). Radiation-damaged skin typically shows as moderate or severe skin atrophy, clinically manifesting as thinning of all skin layers, disappearance of skin appendages, hair follicles, sebaceous and sudoriferous glands, poor vascularization and insufficient oxygenation, with subsequent impairment of wound healing even after basic excisions (9–11). With this in mind, the method of defect reconstruction should be carefully chosen. Our patient's surgical therapy was followed by several complications at the surgical site, such as partial flap loss or partial skin autograft loss.

Dermal substitutes are described in literature as a suitable option for reconstruction of defects following burns, tumor resections, trauma, or radiation, particularly in full-thickness defects including underlying bony structures, when the use of a free flap is not possible (12–15). Reports of application of Integra® directly on dura is scarce in literature, still several authors promote its successful use in certain challenging cases (12,14–18). Leach et al. supported the use of Integra® for scalp skin and skull bone defects, even in cases of severe fibrotic dura (12). When compared to split-thickness skin grafting, the most evident advantage of dermal substitutes is its larger and more substantial coverage. Dermal substitutes combined with split-thickness skin grafting can offer suitable tissue coverage with better underlying structure protection and are more useful to skin grafting alone in situations where other reconstructive methods are not available (18). The two-stage process of Integra® placement allows for a controlled neodermis formation in a vascularly impaired setting such as in tinea capitis patients. Additionally, Integra® is found to tolerate well the adjuvant radiotherapy in oncologic patients (14).

Osteoradionecrosis is a severe complication of radiation therapy for head and neck cancer, or tinea capitis in this case (19,20). Radiation causes vascular damage in irradiated bones, resulting in hypoxia and tissue necrosis with clinical presentation ranging from minor, asymptomatic areas of exposed bone that heal with conservative care, to severe necrosis with pathologic fractures that require multiple surgical interventions and reconstruction, like in our patient (18–20). Multiple ORNs of the parietal and occipital bones presented an immense challenge for our patient making successful reconstruction difficult to accomplish. Severe skin atrophy affecting almost all areas of the scalp, multiple previous surgeries, as well as

the presence of multiple recurrent ORN limited the use of local and regional skin flaps, while tissue expanding in such patients is contraindicated. Additionally, an ultrasound Doppler examination demonstrated no blood vessels appropriate to serve as a recipient blood vessel for a microvascular flap. Given the challenges faced during the usage of local flaps, as well as the inability of applying distant flaps, we determined that the use of dermal substitutes would be an adequate choice.

Given the patient's poor general health due to cardiovascular disease and obstructive lung disease, which increased the patient's perioperative risk, high rate of tumor recurrence, and multiple avascular necroses, a two-stage bilaminar dermal template Integra® under local anesthesia was the reconstructive method of choice for full-thickness scalp and calvaria defect with exposed dura. The benefits of this procedure include lower perioperative risks related to general anesthesia duration, as well as reduced morbidity of donor areas. In our experience, this method of reconstruction of full-thickness scalp defects should be recommended particularly in

patients who have undergone multiple surgeries and have exhausted all other reconstructive options (16,17,21). The downsides of using dermal substitutes covered by skin autografts over local flaps include decreased resistance, lack of skin appendages, and different skin color and texture. If calvaria bone reconstruction is planned in terms of artificial bone substitutes, dermal substitutes cannot be applied. Additionally, the disadvantage of this technique is the costly price of dermal substitutes such as bilaminar dermal regeneration template Integra® which remains a barrier to its common utilization.

CONCLUSION

The use of bilaminar dermal regeneration template Integra® can be efficiently utilized for reconstruction of scalp skin and calvaria defects in complex cases when all other reconstructive methods are exhausted.

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Conflict of interest – None to declare

REFERENCES

- Shvarts S, Sevo G, Tasic M, Shani M, Sadetzki S. The tinea capitis campaign in Serbia in the 1950s. *Lancet Infect Dis*. 2010 Aug;10(8):571–6.
- Even D, Shvarts S. Understanding and addressing populations whose prior experience has led to mistrust in healthcare. *Isr J Health Policy Res*. 2023 Apr 21;12(1):15.
- A Werner, B Modan, D Davidoff. Doses to Brain, Skull and Thyroid, following X-ray Therapy for Tinea Capitis. *Phys Med Biol*. 1968 Apr 1;13(2):247–58.
- Modan B, Mart H, Baidatz D, Steinitz R, Levin Sheldon G. The Lancet. *The Lancet*. 1974 Feb;303(7852):277–9.
- Oshinsky S, Baum S, Huszar M, Debby A, Barzilai A. Basal cell carcinoma induced by therapeutic radiation for tinea capitis—clinical-pathological study. *Histopathology*. 2018 Jul 2;73(1):59–67.
- Antunes L, Bento MJ, Sobrinho-Simões M, Soares P, Boaventura P. Cancer incidence after childhood irradiation for tinea capitis in a Portuguese cohort. *Br J Radiol*. 2020 Jan;93(1105):20180677.
- Nikolić Živanović M, Jurišić M, Marinković M, Grujičić D, Stanimirović A, Šćepanović V, et al. Reconstruction of Moderately and Severely Atrophic Scalp—A Multicentric Experience in Surgical Treatment of Patients Irradiated for Tinea Capitis in Childhood and Surgical Algorithm. *Medicina (B Aires)*. 2023 Sep 17;59(9):1678.
- Stojičić M, Jovanović M, Rasulić L, Vitošević F. Reconstruction of large acquired scalp defects: ten-year experience. *Turk Neurosurg*. 2016;
- Simman R, Bach K, Abbas F, Klomparens K, Brickman BJ. Management of Radiation-induced Tissue Injuries: A Review of Current Treatment Strategies. *Plast Reconstr Surg Glob Open*. 2023 Jun;11(6):e5043.
- Hegedus F, Schwartz RA. Cutaneous radiation damage: updating a clinically challenging concern. *Giornale Italiano di Dermatologia e Venereologia*. 2019 Oct;154(5).
- Wang Y, Tu W, Tang Y, Zhang S. Prevention and treatment for radiation-induced skin injury during radiotherapy. *Radiat Med Prot*. 2020 Jun;1(2):60–8.
- Leach GA, Chaffin HM, Mathew D, Holcombe T. Placement of Dermal Regeneration Template on Fibrotic Dura. *Cureus*. 2020 Jul 14;
- Wain RAJ, Shah SHA, Senarath-Yapa K, Laitung JKG. Dermal substitutes do well on dura: Comparison of split skin grafting +/- artificial dermis for reconstruction of full-thickness calvarial defects. *Journal of Plastic, Reconstructive & Aesthetic Surgery*. 2010 Dec;63(12):e826–8.
- Johnson MB, Wong AK. Integra-based Reconstruction of Large Scalp Wounds: A Case Report and Systematic Review of the Literature. *Plast Reconstr Surg Glob Open*. 2016 Oct;4(10):e1074.
- Marcasciano M, Mazzocchi M, Kaciulyte J, Spissu N, Casella D, Ribuffo D, et al. Skin cancers and dermal substitutes: Is it safe? Review of the literature and presentation of a 2-stage surgical protocol for the treatment of non-melanoma skin cancers of the head in fragile patients. *Int Wound J*. 2018 Oct 4;15(5):756–68.
- Marcasciano M, Mazzocchi M, Kaciulyte J, Spissu N, Casella D, Ribuffo D, et al. Skin cancers and dermal substitutes: Is it safe? Review of the literature and presentation of a 2-stage surgical protocol for the treatment of non-melanoma skin cancers of the head in fragile patients. *Int Wound J*. 2018 Oct 4;15(5):756–68.
- Magnoni C, De Santis G, Fracalvieri M, Bellini P, Portincasa A, Gicomelli L, et al. Integra in Scalp Reconstruction After Tumor Excision: Recommendations From a Multidisciplinary Advisory Board. *Journal of Craniofacial Surgery*. 2019 Nov;30(8):2416–20.
- Momoh AO, Lypka MA, Echo A, Rizvi M, Klebuc M, Friedman JD. Reconstruction of Full-Thickness Calvarial Defect. *Ann Plast Surg*. 2009 Jun;62(6):656–9.
- O'Dell K, Sinha U. Osteoradionecrosis. *Oral Maxillofac Surg Clin North Am*. 2011 Aug;23(3):455–64.
- Leonetti JP, Weishaar JR, Gannon D, Harmon GA, Block A, Anderson DE. Osteoradionecrosis of the skull base. *J Neurooncol*. 2020 Dec 11;150(3):477–82.
- Abbas Khan MA, Chipp E, Hardwicke J, Srinivasan K, Shaw S, Rayatt S. The use of Dermal Regeneration Template (Integra®) for reconstruction of a large full-thickness scalp and calvarial defect with exposed dura. *Journal of Plastic, Reconstructive & Aesthetic Surgery*. 2010 Dec;63(12):2168–71.

UPOTREBA BILAMINARNIH ZAMENIKA DERMISA APLIKOVANIH DIREKTNO NA DURU KOD PACIJENTA KOJI JE ZRAČEN ZBOG TINEA CAPITISA – PRIKAZ SLUČAJA

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Sažetak

Uvod: Pre pronalaska antimikotika sposobnih da prodrude do folikula dlake, tretman tinee capitis kod dece zasni-
vao se na radijacionoj epilaciji poglavine, a potom aplikaciji tada dostupnih antimikotika kao i cink paste. Tačna doza zračenja nije poznata, a posledice zračne terapije postale su vidljive nakon više od pet decenija u vidu povećane učestalosti nemelanocitnih tumora kože, tumora mozga i moždanih ovojnica kao i osteoradionekeoze kod ovih pacijenata. Rekonstrukcija poglavine predstavlja izazov zbog anatomskih karakteristika regije kao i neelastičnosti tkiva poglavine. Slučajevi upotrebe bilaminarnih zamenika dermisa aplikovanih direktno na duru u literaturi retko su opisani.

Prikaz slučaja: Muškarac koji je zračen u detinjstvu zbog tinee capitis lečen je u našoj ustanovi zbog multiplih, rekurentnih bazocelularnih karcinoma kože (BCC) infiltrativnog tipa i multiplih zona osteoradionekeoze na poglavini. Težak stepen atrofije kože bio je prisutan na skoro celoj poglavini izuzev na čelu gde je bila prisutna atrofija srednjeg stepena. Pacijent je u više navrata lečen

u našoj ustanovi zbog de novo i recidiva BCC, novih kao i recidiva BCC, i multiplih zona osteoradionekeoze na kostima poglavine. Defekti koji su nastajali nakon ekscizija lezija rekonstruisani su kombinovanjem lokalnih fasciokutanih režnjeva i kožnih autotransplantata. Učestalost komplikacija u vidu parcijalne nekroze flapa ili lize kožnih autotransplantata bila je relativno visoka. Nakon što su iscrpljene druge terapijske opcije, odlučeno je da se zaostali defekt pune debljine mekih tkiva i kosti nakon uklanjanja osteoradionekeoze rekonstruiše bilaminarnim zamenikom dermisa koji je postavljen direktno na duru, a nakon tri nedelje pokrije kožnim autotransplantatima (u drugom aktu). Imajući u vidu značajne komorbiditete, operacija je izvedena u lokalnoj anesteziji pod nadzorom anesteziologa. Postoperativni period je protekao bez komplikacija.

Zaključak: Upotreba bilaminarnih zamenika dermisa je efikasna metoda za rekonstrukciju defekata pune debljine poglavine i kosti lobanje, u slučajevima kada su druge opcije iscrpljene.

Ključne reči: Tinea capitis, atrofija kože, osteoradionekeoze, bazocelularni karcinom kože, bilaminarni zamenici dermisa.

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