

Scalp Reconstruction after Excision of Radiation Induced Tumors

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Abstract

Background: Exposure of scalp tissue to radiotherapy in childhood or early adulthood period are at increased risk of developing nonmelanoma skin malignancies. The anatomical and histological changes of scalp tissue make it difficult to close large defects after excision. Skin grafting usually fails, and complex flaps or vascularized tissue may be required. **Objective:** To explain the risk of skin tumor in all patient who received scalp irradiation therapy in childhood and the options of reconstruction after excision. **Patients and Methods:** Seven males and two females developed non melanoma skin cancer on the scalp at many years after radiotherapy for tinea capitis or for management of brain tumors. **Results:** The large excision defect can be treated successfully by delayed reconstruction or by free flap. **Conclusion:** For any long-standing post-irradiation lesion a new malignancy must be ruled out by biopsy. Complications are the rule, not the exception, whenever radiation defects are repaired surgically. Free flap is the best way of reconstruction followed by delayed reconstruction method.

Keyword: Scalp, Tumor, Excision, Radiotherapy, Skin Grafting.

INTRODUCTION

The first reported case of radiation-induced skin cancer was a squamous cell carcinoma on the hand of an x-ray technician in 1902 only 6 years after the discovery of roentgen rays.^[1] Subsequent reports of skin cancers caused by skin irradiation led to the abandonment of radiotherapy for benign conditions.^[1-3] Several studies have shown that approximately 10% of patients who received facial or head and neck irradiation for benign conditions developed radiation induced skin cancers. The majority of the cancers were basal cell carcinomas, although there were several cases of squamous cell carcinomas. Latency periods averaged two decades, and the incidence of skin cancers increased with the time elapsed after radiotherapy. When the severity of radiodermatitis was measured, it was associated with a higher prevalence of skin cancer.^[4] The rate of metastasis from squamous cell carcinoma of the face and neck arising in irradiated tissue was 20%, higher than that of squamous cell carcinoma arising in nonirradiated skin.^[1,4-6] It is difficult to quantify the dose–effect relationship for radiation-induced skin cancer in

many of these studies because specific information about time, dose, and frequency of irradiation was unavailable after such long latency periods.

Radiotherapy and Reactions to Ionizing Radiation^[7-12] Acute Radiation Reaction

An initial erythema and edema may be seen within 24 hours of irradiating skin, and then a secondary and progressive erythema is manifested on the third to sixth day. If the epithelium is irradiated to a high dose, it will lead to hyperkeratosis, telangiectasia, dyspigmentation and atrophy.

Chronic Radiodermatitis

The skin is usually atrophic, but increased fibrosis occasionally causes stiffening and tethering. Radionecrotic ulceration may occur and it is associated with severe pain which is seldom seen with the malignant disease. Radionecrosis typically occurs approximately 1 year

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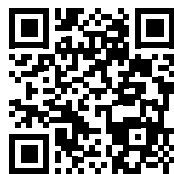
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following complete healing of skin after radiotherapy and often precipitated by trauma or infection.

Radiation - Induced Tumors

The types of tumors induced by radiation depend on both the cellular structure and the anatomical location of the damaged tissues.

Basal cell carcinomas occur following radiation to the face, scalp and trunk in about 63 % while squamous cell tumors may occur in about 37 % and other types of tumors very rarely occur, where as in the hand the squamous cell tumors mainly occur.

According to the Depth of the Scalp Defect, The Management Divided in to[13]

1. Partial thickness defects: (the pericranium not involved)
 - b. For small size defects management can be done by primary closure.
 - c. For large size defects management can be done by skin grafting which is the proper initial step, then secondary reconstruction can be done.
1. Full thickness defects :(the pericranium involved)
 - a. Defect size less than 6 cm². If direct closure cannot be done, local rotation flap must be done.
 - b. Medium size defect (more than 6cm² or less than 1/3 of the scalp surface area). Multiple flaps (orticochea) or single subtotal flap can be done.
 - c. Large size defects (>1/3 of the scalp surface area or 8-10 cm²), a single subtotal scalp flap can be raised based on superficial temporal and posterior auricular arteries, or by free tissue transfer.

The basic Methods used to Cover Exposed Bone[13]

1. Local scalp flaps with galeal scoring.
2. Pericranial flaps and skin graft.
3. Decortications with direct or delayed skin graft.
4. Tissue expansion.
5. Free flap.

PATIENTS AND METHODS

Patients

Between July 2007 and December 2012, 9 patients with post-irradiation scalp tumors were treated in the Hospital of Surgical Specialties and Alsader teaching hospital. There were 2 female and 7 males with different age groups as shown in the Figure 1:

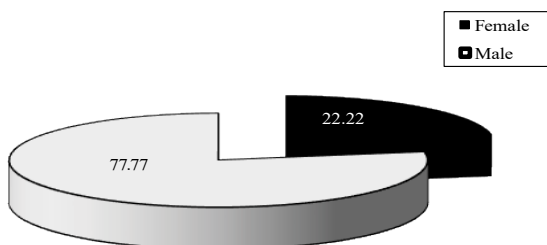


Figure 1: Sex Distribution of the Patients.

The sites of the tumors were found as shown in the table below.

Table 1: Distribution of the Patients According to the Site of the Tumor.

Site	No. of Cases	Percentage from the Total
Vertex	3	33.33%
Occipital	2	22.22%
Parietoccipital	3	33.33%
Temporoparietoccipital	1	11.11%

Method

- Clinical assessment of the general condition of the patients was done.
- Examination of the tumor site, size, shape, discharge, base and floor of the ulcer and for gross enlargement of the lymph nodes drained different scalp regions was done.
- Routine laboratory investigation, whole blood preparation, skull X-ray and CT-scan have been done (MRI was indicated to assess the micrometastasis to the lymph nodes).
- Shaving of the scalp, povidone iodide 10%, adrenaline in concentration 1/200.000 was injected subcutaneously as haemostatic measure in 2 cases.
- Incisional biopsy was done preoperatively in 5 cases under local anaesthesia.
- General anaesthesia was used for all patients except in one case in which we used local anaesthesia with sedation.
- The depth and size of the defects were assessed after tumor excision.
- Other methods used for hemostasis were pressure applied on the wound margins, clamping, electrocautery and ligation (pneumatic scalp tourniquet was not available).

Neurosurgical teamwork was cooperated for two cases where the calvaria was highly expected to be involved by the tumor.

The types of reconstruction were used are shown in the Table 2 below:

Table 2: Modalities of Treatment were used in Reconstruction of the Scalp Defects.

Type of Reconstruction	No. of Patients	Percentage from the Total
Split thickness skin graft	2	22.22%
Decortications and delayed grafting	3	22.22%
Local flaps	2	33.33%
Free flap	2	22.22%

RESULTS

There were seven men and two women and the age group ranging from (50 – 55) – (65 – 70) years. As shown in Table 3 is Indications for initial radiation therapy include six benign conditions, one for scalp tumor and other two patients for unknown reasons, Figure 2

Table 3: Sex Distribution According to Age Group.

Age Group / Year	Male	Female	Percentage from the Total
50 - 55	2	-	22.22%
55 - 60	2	-	22.22%
60 - 65	1	-	11.11%
65 - 70	2	2	44.44%

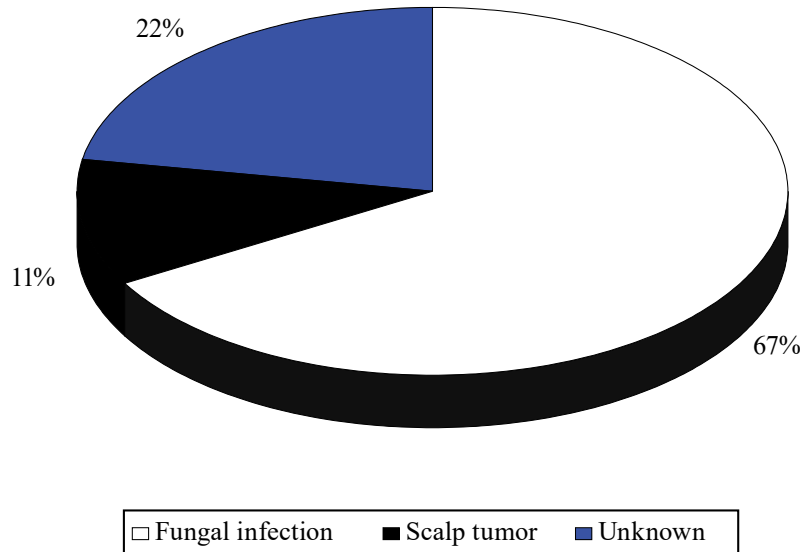


Figure 2: Causes of Scalp Irradiation.

The most predominant scalp tumor histopathology is basal cell carcinoma except in two cases where pathology was

revealed squamous cell carcinoma and adenocarcinoma. Figure 3.

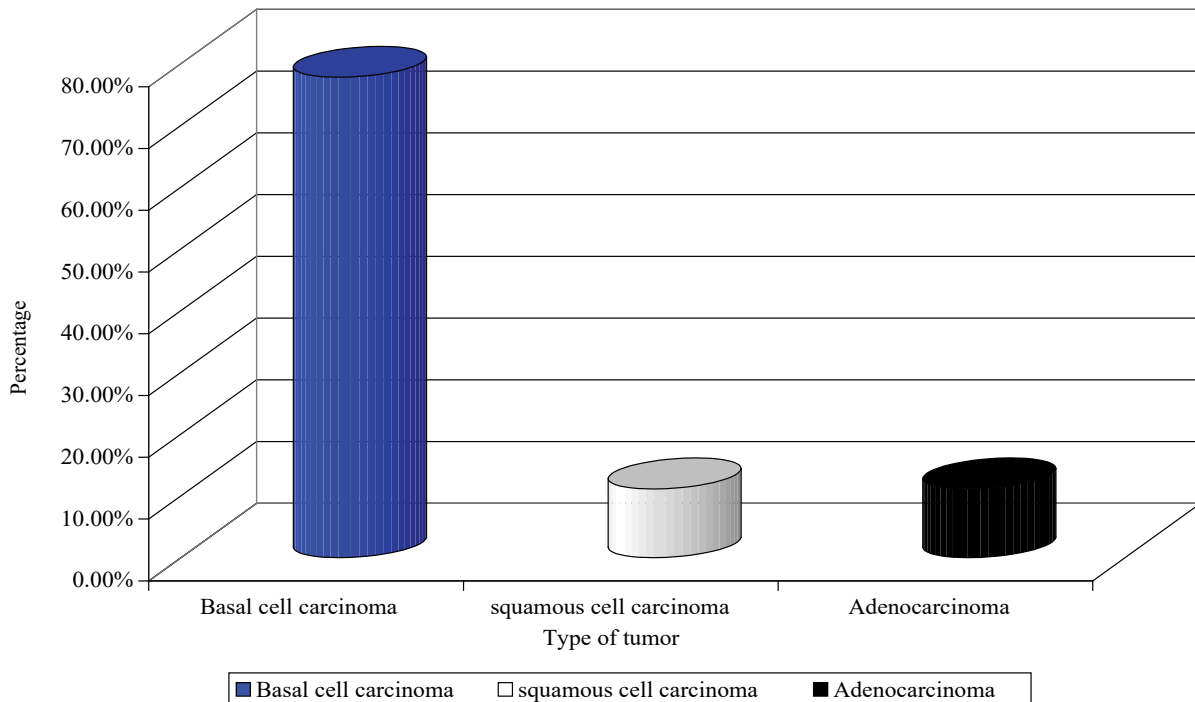


Figure 3: Histopathological Types of the Excised Tumors.

The dose of initial therapy of radiation was known in 4 patients only. The latency period between initial

radiotherapy and the diagnosis of scalp lesions ranged from 8 years to 46 years, Table 4.

Table 4: Dose of Radiation & Latency Period.

Age /Year	Dose of Radiation	Latency Period / Years
52	5.5 Gy*	35 years
53	5.5 Gy	39 years
56	Unknown	Unknown
58	Unknown	10 years
62	5.5 Gy	40 years
66	6.0 Gy	40 years
67	Unknown	38 years
67	Unknown	45 year
69	Unknown	46 year

* Gy= Gray radiation dose unit.

Table 5: Showing Details of Tumor Size after Excision, Site and Type of Reconstruction According to the Depth of the Defects.

Classification According to Depth	Size Subgroup	Case no.	Age (year)	Sex	Type of Tumor	Site	*Size		Reconstruction
							Length Width	Surface Area (cm ²)	
Partial thickness	(a) Large size Defects	1	66	F	BCC	Vertex	8 x 6	48	Immediate skin graft
		2	67	M	BCC	Frontal	5 x 5	25	Immediate skin graft
		3	56	M	BCC	Occipital	7x7	49	Rotational advancement flap
Full – thickness defects	(a) Medium size defects	4	69	M	BCC	Vertex	10x8	80	Single subtotal rotational flap with STSG to donor area
		5	53	M	BCC	Vertex	9x7	63	Decortication + delayed skin graft
	(b) Large size defects	6	52	M	BCC	Occipital	9x8.5	76.5	Advancement flap with STSG to donor area
		7	67	F	BCC	Parieto- occipital	11x9	99	Decortication + delayed STSG
	(b) Large size defects	8	58	M	Adenocarcinoma.	Temporo-parito- occipital	20x12	240	Latissimus dorsi muscle free flap with STSG covering & direct closure of donor site.
		9	62	M	SCC	Parieto- occipital	12x10.5	126	Latissimus dorsi muscle free flap with STSG covering & direct closure of donor site.
Total						9 patients			

* Size = (size of tumor + 1.5 cm as safe margin), BCC=Basal Cell Carcinoma, SCC=Squamous Cell Carcinoma, M=Male, F=Female.

Partial loss of skin graft was encountered in one case in which further debridement and grafting was necessary 3 weeks later.

Infection was occurred in other case but no additional operation was required and complete healing was achieved after 4 weeks.

Ischemia and necrosis of superficial portion of local flap (about one third of its size) was happened in one case which was treated by wound excision and daily dressing. There was a one case with local recurrence that was sent for post operative radio therapy (after 8 months of operation).

Table 6: The Complication and their Management.

Complication	No. of Cases	Treatment
1- partial loss of skin graft	1	Debridement and re grafting
2- Infection	1	Antibiotic cover +daily dressing
3- partial necrosis of local flap	1	Wound excision +Antibiotic cover and daily dressing
4- Hematoma	2	Evacuation of hematoma in the unite
5- Local recurrence*	1	Post operative radiotherapy**

* Local recurrence was confirmed by biopsy which revealed the same pathology of the previously excised tumor (BCC).

** 50 Gy (20 days regimen; 250 rad/day)

Table 7: Number of Complications in Relation to Time of Reconstruction.

Time of Reconstruction	Complications				
	Partial loss	Infection	Ischemia	Haematoma	Local Recurrence
A- Immediate Reconstruction					
- Skin graft	1	-	-	1	-
- Local flap	-	-	1	1	1
- Free flap	-	-	-	-	-
B- Late Reconstruction					
- Decortications STSG	-	1	-	-	-
- Decortications local flap	-	-	-	-	-
- Free flap	-	-	-	-	-

DISCUSSION

The chronic irradiated scalp wound remains one of the

most difficult reconstructions for the plastic surgeons, with its inherent radiodermatitis and poor healing potential.

If you cannot excise and cover the tumor area, chronic ulcers down to the bone will result.^[14]

When you can exclude malignancy, the pain is not a major symptom; symptomatic management with regular dressing may be advisable.^[15]

Reconstructive procedure as simple as a skin graft has a high complications rate in the irradiated wound and it produce a shiny non – mobile surface that is prone to ulceration after minor trauma.^[16]

If the surrounding local tissues are so altered that they are unsuitable for coverage, structures from a distance must be used. Prior planning of the coverage before the excision pays dividends by preventing disastrous complications.^[17]

The last alternative is a free tissue transfer. Although this is a major undertaking in an elderly patient, age alone should not be a bar to microvascular procedures and usefulness of such techniques in the reconstruction of heavily irradiated tissue has been well documented.^[15] The treatment of radio – induced scalp lesions remain controversial, as no single solution has proved entirely satisfactory.^[15]

The patients with age group (65 – 70 years) have a prolonged latency period from the initiation of therapy to the time of presentation in relation with other age groups, this may be attributed to infrequent exposure to sunlight in the age group (65 – 70 years) and this coincides with what was mentioned by Aslan *et al.*^[18]; even many years after the initial radiation exposure there is a possibility that a second injury to skin from sunlight will cause an increased frequency of skin cancers within the irradiated areas.^[18]

Males were affected more than females (approximately – 78 % ♂; 22 % ♀) this goes with what was said by Scotto *et al.*^[19], who was reported that U. S. A. males are at greater risk of non – melanoma skin cancer than female after radiation therapy. In our 4 patients in whom the doses of radiation were known we could not demonstrate any relationship between the dose of radiation and latency period which is the same evidence that was found by Pitcher *et al.*^[20], who was found no clear relationship between radiation dose and the time interval to development of tumors.

Most of the patients in our study were having basal cell carcinoma (approximately 78 %) which coincides with the study mentioned by Ron *et al.*^[21], who was stated that radiotherapy for benign conditions in the scalp was widely used previously and was associated with a four-fold increase in cancer, especially basal cell carcinoma. The occipital and parieto-occipital areas were involved more than other areas of the scalp which is may be due to different radiation dose absorption and subsequent effect or frequent minor trauma to these regions.

Delayed reconstruction allows short surgeries and less post-operative morbidity, which can be suitable in the case of elderly patients.

Wide excision including safe margin of (1-1.5 cm) is preferable, while patients requiring excision of the periosteum, decortication of the outer layer of the skull was done to reach the diploic space, which is highly

vascularized, achieving the granulation that enables the use of skin graft latter on.

The immediate reconstruction after tumor excision was associated with more recurrence rate than with delayed reconstruction. This is probably due to inadequate tumor resection which is partly due to an absence of frozen section technique. The other complications namely hematoma and partial skin graft loss were due to improper use of basic surgical skills (like improper haemostasis or inadequately drained wounds).

The drawback effects of delayed reconstruction was infection which was occurred in one case and this was happened due to cross infection as the patients were remained more time in the hospital, the other thing is the in compliance of the patients with long period of hospitalization and daily dressing. Limitation of surgical treatment in our study including poor health or personal choice limits reconstructive options, risk of complications with local flap or skin grafting is high because of limited scalp tissue mobility as radiation enhance fibrosis.

CONCLUSIONS

1. For any long-standing post-irradiation lesion, a new malignancy must be ruled out by biopsy.
2. Complications are the rule, not the exception, whenever radiation defects are repaired surgically.
3. When large cancers of the scalp have invaded through the galea, one should include a portion of the outer table of the skull in the excision.
4. Delay methods of reconstruction are preferable because they have lower incidence of complications and give us the time to confirm the diagnosis and adequacy of excision by histological examination.
5. Free flaps are the treatment of choice in all patients with radio-induced scalp lesions and they should perhaps be considered earlier in the management of those whose general health permits.^[15]

Recommendations

1. When the patient was received a therapeutic radiation dose, he should be warned of the possible hazards of exposing the irradiated area to sunlight.
2. When a small carcinoma is surrounded by multiple hyperkeratotic lesions, a wide excision including these potentially malignant lesions is indicated to avoid repeated surgery for neighboring areas.
3. Delayed methods of reconstruction are better to be adopted whenever possible if the facility of free flap surgery and frozen section examination are not available.
4. If there is gross radiological evidence that cranial bones are directly involved, a neurosurgeon should present during operative excision.

Ethical Considerations

This study has been ethically approved by the ethical committee in the University of Kufa (ID #37). All the participants have signed a written consent before enrollment in the study.

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