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PRS GLOBAL OPEN

ORIGINAL ARTICLE
Reconstructive

Management of Immobile Scalp Skin Tumors and Analysis of Skin Graft Survival on Burred Calvaria

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Background: Surgeons face challenges associated with adherent cutaneous scalp malignancy. Traditional general anesthetic excision involves periosteal removal and burring of the outer table of the calvaria for deep margin clarity and tissue reconstruction. Research on this practice is limited, and graft survival in burr-treated bones is underexplored. This study aimed to assess the clinical margin accuracy for immobile scalp malignancies, identify deep-invading malignancy types, and evaluate graft survival in burr-treated calvariae. It compares split-thickness grafts (STSGs) and full-thickness grafts (FTSGs).

Methods: Twelve fixed scalp malignancies were excised under anesthesia, allowing immediate STSG or FTSG for defect reconstruction. Postsurgery, graft take, malignancy type, and margin clearance were evaluated.

Results: Histopathological diagnosis identified seven squamous cell carcinomas, two melanomas, one basal cell carcinoma, one adenocarcinoma, and one metastatic squamous cell carcinoma. Deep margins ranged from 0 to 0.9 mm, and peripheral margins ranged from 0 to 15 mm. The graft take was 100% in eight cases, with total failure in two cases, and 75%–90% in two cases. The five STSGs had 100% take and 90% take. The three FTSGs had 100%, 75%, and two failed.

Conclusions: Clinical examination effectively gauges the tumor fixation depth, but large lesions may require imaging. Most deep-invading tumors were SCCs. STSGs performed better on burr-treated Calvaria than FTSGs. *(Plast Reconstr Surg Glob Open 2024; 12:e5757; doi: 10.1097/GOX.0000000000005757; Published online 19 April 2024.)*

INTRODUCTION

Understanding scalp anatomy is crucial for plastic surgeons. The scalp extends from the external occipital protuberance to the supraorbital margin and consists of several layers, including the epidermis, dermis, subcutis, galea aponeurosis, and adjacent periosteum and cranium. Tumors that arise in this area can be morphologically classified into keratinocytic and melanocytic tumors, adnexal tumors, hematopoietic and lymphatic tissue neoplasms, soft-tissue tumors, and neural tumors. Interestingly, the growth pattern of scalp tumors is significantly affected by the resistance to infiltration caused by the galea and cranial bones, leading to a characteristic horizontal growth pattern.[1,2]

The incidence of scalp tumors is higher than that of tumors occurring elsewhere in the skin, with the majority being benign.[2] Malignant scalp tumors account for 1%–2% of all scalp tumors but represent 13% of all malignant cutaneous neoplasms.[3]

Basal cell carcinoma (BCC) is the most common cutaneous malignancy in White people, followed by squamous cell carcinoma (SCC). The incidence of these tumors increases on the scalp, with 2%–18% BCCs and 3%–8% SCCs, respectively.[3,5,6] Notably, both tumors tend to ulcerate when they are present on the scalp. BCCs on the scalp commonly exhibit nodular and pigmented characteristics compared with those elsewhere on the skin.[7]

SCCs are known to exhibit rapid growth and invasiveness. Although no studies have confirmed the prevalence of this invasion in advanced tumors, they are more likely to invade the deep galea aponeurosis or the periosteum.

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Received for publication September 12, 2023; accepted March 5, 2024.

DOI: 10.1097/GOX.0000000000005757

Disclosure statements are at the end of this article, following the correspondence information.

According to the British Association of Dermatologists guidelines from 2020, invasion of squamous cell carcinoma beyond the subcutaneous fat is classified as a very high-risk tumor, requiring 10-mm peripheral margins.[8]

Clinical examination plays a vital role in the diagnosis and treatment of suspected cutaneous scalp malignancies. Evaluating special features such as size, ulceration, mobility over deep structures, and lymph node status is crucial. Skin lesions of more than 30-mm size generally require reconstruction with either a skin graft or a flap.[9]

The immobility of cutaneous tumors suggests invasion of the galea or periosteum at the center of the lesion, requiring tumor excision that includes the periosteum to achieve curative margins. This is particularly important because these lesions tend to be large, and patients often have multiple comorbidities.[7] Consequently, primary closure may not be feasible in these cases. The simplest reconstructive method in these scenarios is a skin graft, providing quick and reliable healing, fewer technical challenges, and easy monitoring of the graft site for tumor recurrence.[9] However, grafts are less likely to survive on bare bone due to the lack of a suitable vascular bed.[10–15]

Burring of the outer table followed by the application of split-thickness grafts (STSGs) in a one-stage procedure is a safe, fast, well-tolerated, and cost-effective method for defect reconstruction of the skull when the periosteum is lost due to desiccation or excision to achieve clear excision margins. This approach is particularly advantageous for older and multimorbid patients. The reported survival rate for STSG in this procedure is 100%.[4]

If involvement of the deep margins or signs of bone invasion is detected after including the periosteum, referring the patient to neurosurgeons for excision and histological examination of the outer table is recommended to ensure complete tumor excision.[4]

Preoperative radiological assessment using MRI or computed tomography is warranted for very large or deep ulcerative lesions in which bone invasion is suspected. These imaging modalities assist in assessing the depth of invasion, planning the procedure, anticipating the need for neurosurgeons, and evaluating possible metastatic spread to the parotid gland or lymph nodes.

METHODS

This retrospective study assessed surgical management of 12 clinically immobile scalp malignancies. The lesions, including size, mobility, and lymphadenopathy, were carefully examined for features suggestive of malignancy. Lesions that were very large and required neurosurgical intervention necessitating MRI or computed tomography were excluded from the study. Patients were counseled regarding the procedure, which involved removal of the lesion with sufficient curative margins, burring of the underlying bone, and subsequent reconstruction of the defect with a skin graft. The risks and benefits of the procedure, such as incomplete removal of cancer, graft loss, infection, and the potential need for further procedures, were discussed with patients.

Takeaways

Question: What is the most suitable approach for managing immobile scalp skin tumors and ensuring graft survival on a burred calvaria?

Findings: This study affirms that clinical examination is an effective method for assessing tumor fixation, and most split-thickness grafts exhibit improved success rates when applied to burred calvariae.

Meaning: Immobile scalp skin tumors may initially undergo treatment involving direct burred calvariae procedures and the application of split-thickness grafts to ensure a secure margin resection.

All excisions were performed under combined general anesthesia with the administration of a local anesthetic to facilitate a dry surgical field and provide postoperative pain relief. The excision of all lesions adhered to the margin guidelines recommended by the British Association of Dermatologists, ensuring the inclusion of the periosteum down to the bare bone. The excised specimens were subjected to histological analysis.

The procedure was performed under sterile conditions, and the exposed surface of the outer table was carefully removed using a pneumatic power drill with a rosehead burr. Drilling was continued until punctate bleeding was observed. Irrigation of the area with standard saline solution is essential to minimize thermal injury to the exposed diploe. Subsequently, the resulting defect was immediately reconstructed using either an STSG harvested from the thigh using an electrical Zimmer dermatome, or an FTSG harvested from the base of the neck or groin. For STSG, fenestration was performed to allow blood drainage. The graft was sutured to the wound edges and covered with a nonadherent layer and foam dressing.

Patients were reviewed 1 week after surgery to assess graft uptake. Simple dressings were required a few days after graft assessment. On average, the grafts took approximately 6 weeks to heal completely.

All histological results were evaluated and discussed by a skin cancer multidisciplinary team (MDT). One patient required further radiotherapy administered by an oncology team (Figs. 1–3).

RESULTS

Between February 2021 and February 2023, 12 immobile scalp cutaneous tumors in 10 patients (seven men and three women) underwent excision of the lesions, including periosteum and bone burring, followed by immediate skin graft reconstruction. The mean patient age was 79.2 years (range, 62–92 years). Skin flap reconstruction was not considered suitable for these patients because of complex comorbidities or previous adjacent skin cancer surgery.

Intraoperatively, all the lesions adhered to or invaded the galea aponeurosis. Histopathology reports revealed seven cases of SCC, two cases of malignant melanoma, one

Fig. 1. A 77-year-old patient with SCC left parietal scalp, immunosuppressed.

case of BCC, one case of adenocarcinoma, and one case of metastatic SCC.

The clearance of deep margins ranged between 0 and 0.9 mm, with a mean deep margin clearance of 0.25 mm. Five patients had deep margins involved. The clearance of the peripheral margins ranged from 0 mm to 15 mm, with a mean peripheral margin clearance of 5.85 mm. Two patients had peripheral margins involved.

Skin graft take was successful in eight cases, resulting in 100% graft survival. Two patients experienced total graft failure, which was treated conservatively, whereas the remaining two had graft takes of 75% and 90%, respectively.

Regarding the type of skin graft used, out of six STSGs, five cases (83.3%) had 100% graft take, and one case (16.7%) had 90% graft take. Of the six FTSGs, three (50%) had 100% graft take, one (16.7%) had 75% graft take, and two (33.3%) experienced total graft loss (Table 1).

Upon follow-up, which extends to 3 years for very high-risk SCC, two patients were found to have recurrence, one patient did not return after one appointment, and four patients passed away for unrelated causes.

Fig. 2. SCC excised and reconstructed with SSG. Image 3 years after reconstruction.

Fig. 3. Patient developed further SCC on right side of vertex, which required calvarial burr and FTSG. The patient later developed further recurrence on left vertex, underwent calvarial burr and FTSG, which failed partially and treated conservatively.

DISCUSSION

Immobile invasive scalp cutaneous malignancies pose a significant challenge to dermatologists, head and neck surgeons, oncologists, and plastic surgeons. Managing

Table 1. Demographic and Tumor Characteristics of the Cohort Who Underwent Burring of the Outer Cortex

Patient	Age (y)	Sex	Tumor	Peripheral Margins (mm)	Deep Margins (mm)	Type of Skin Graft	Graft Survival
1	92	M	SCC	7	0.3	SSG	100%
2	85	M	Desmoplastic MM	7.2	0.7	SSG	100%
3	77	M	SCC	3	0	FTSG	75%
4	77	M	SCC	7	0.9	FTSG	0%
5	77	M	Metastasis	0	0.9	FTSG	0%
6	83	M	BCC	1.1	0.1	FTSG	100%
7	85	M	SCC	0	0	FTSG	100%
8	83	M	SCC	11	0	SSG	100%
9	73	M	SCC	15	0	SSG	90%
10	62	F	SCC	4.8	0.1	FTSG	100%
11	69	F	Adenocarcinoma	2	0.1	SSG	100%
12	83	F	MM	12.2	0	SSG	100%

MM, malignant melanoma.

these high-risk cancers requires careful identification of patients and assessment of the possible spread to nearby lymph nodes or bone and dural invasion. Typically, these patients are older with multiple comorbidities, which may limit their ability to undergo lengthy operative procedures, such as tumor excision, parotidectomy, neck lymph node dissection, or complex regional or free tissue transfer.

A low threshold for radiological assessment is necessary to comprehensively evaluate these patients along with preoperative anesthetic assessment to facilitate informed discussions about management options. The involvement of MDT in skin cancer is paramount in managing these complex cases, as alternative treatment options may be available.

Clinical examination has been shown to be a reliable method for treatment planning of suspected immobile skin malignancies that are not believed to invade the bone. In our study, histological excision margins did reveal all lesions with a deep margin clearance of less than 1 mm, which typically warrants periosteum removal and burring of the outer table of the calvaria. Patients with involved deep margins but no signs of bone invasion (no patients with signs of bone invasion were identified) were subsequently discussed with the MDT and reviewed by the oncology team for potential radiotherapy.

Although BCC is the most common malignancy of the scalp, our study confirmed that SCC is the most common invading tumor. This finding was expected because SCC tends to metastasize, underscoring the importance of lymph node assessment in these cases.

The high survival rate of STSG on the burred calvaria aligns with the existing literature and supports the findings of the present study. However, the survival of patients undergoing FTSG in this situation has yielded mixed results. FTSGs are typically used to treat minor defects, and the varying outcomes may be attributed to the additional nutritional requirements of FTSGs, which may not always support neovascularization. In contrast, fenestrated or meshed STSG, which heals partly by secondary intention and requires less nutritional support, may be a more reliable reconstructive option.

Another alternative is two-stage scalp reconstruction after calvaria burr, with the first stage involving the use of an acellular dermal matrix (ADM), followed by STSG. However, this approach carries the added risk of ADM infection and necessitates an additional staged procedure, which should be carefully considered (Fig. 4).

Clinical Recommendations and a Proposal for an Algorithmic Approach

Clinical examination remains an accurate method for determining the tumor fixity in deep structures. However, radiological imaging may be necessary to comprehensively assess extensive lesions larger than 4 cm.

Among the various tumor types, squamous cell carcinoma (SCC) is the most common tumor type that invades deep structures. Therefore, a thorough lymph node assessment is crucial for managing these cases.

Regarding reconstruction, our study showed that skin grafts on the burred calvaria yielded satisfactory results. However, it is essential to note that STSGs demonstrated a higher success rate than FTSGs did. Therefore, STSGs should be considered the preferred option when planning reconstructive procedures.

Based on our findings, we recommend clinical examination to assess tumor invasion into deep structures while preserving radiological imaging for large lesions. Additionally, lymph node assessment should be performed, particularly in SCC cases. When reconstructing scalp defects, surgeons should prioritize STSGs because of their higher success rates than those of FTSGs. Furthermore, drawing strength from the gathered data and a comprehensive literature review of the management of scalp skin lesions, we present a novel decision-making algorithm, as depicted in Figure 4. This algorithm incorporates key clinical findings, imaging outcomes, and available surgical options and offers an innovative approach to address these challenging cases.

CONCLUSIONS

The management of immobile invasive scalp cutaneous malignancies requires a multidisciplinary approach and careful consideration of patient factors. Radiological assessment, preoperative anesthetic evaluation, and involvement of the skin cancer MDT are

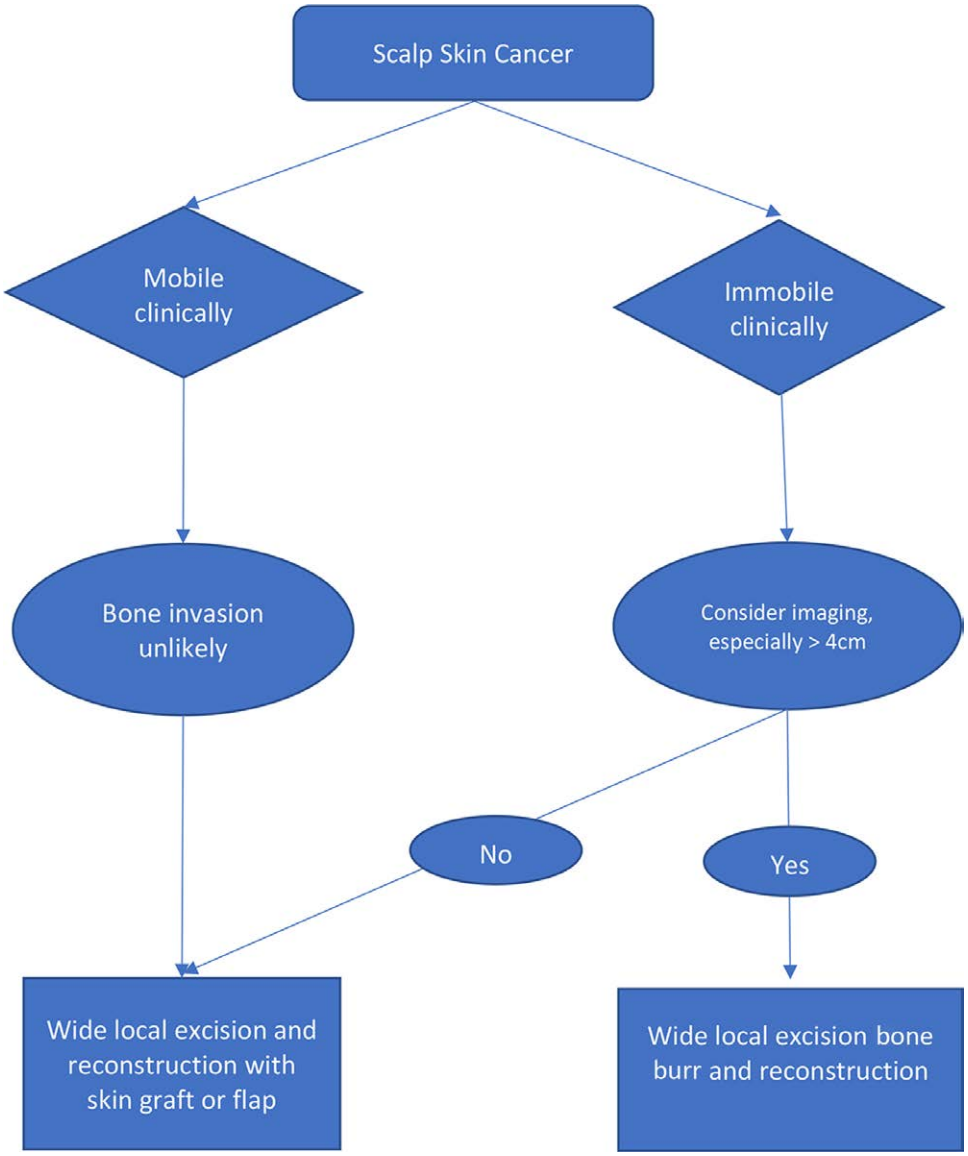

Fig. 4. Algorithmic approach to immobile scalp skin cancer.

essential. Clinical examination can serve as a reliable method for treatment planning when bone invasion is not suspected. SCC is the most common tumor invading the scalp, emphasizing the importance of lymph node assessment. STSGs demonstrated high survival rates on the burred calvaria, whereas FTSGs yielded mixed results. Fenestrated or meshed STSGs may provide a more reliable reconstruction option. Two-stage scalp reconstruction with ADM followed by STSGs is an alternative but carries additional risks and requires careful consideration.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

ETHICAL APPROVAL

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration.

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