Incongruent radiographic indication of calvarial metastatic diploic space invasion with absent histologic findings in a patient with basal cell carcinoma of the scalp

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Abstract

Background: Radiographic imaging is often used to determine basal cell carcinoma (BCC) extension and invasion and to define a surgical plan. However, imaging modalities may overestimate tumor invasion and lead to unnecessarily aggressive treatment.

Methods: A 77-year-old woman was seen with a growing BCC of the scalp with MRI imaging indicative of calvarial diploic space invasion. The patient underwent Mohs surgery followed by a parietal craniectomy.

Results: Contrary to the MRI findings, histological evaluation of the cortical parietal calvarium and the diploic space did not demonstrate BCC.

Conclusions: Surgeons should be wary of diploic space changes in the absence of cortical erosion demonstrated in MRI as it may not explicitly indicate tumor invasion. Biopsy of the diploe is necessary in such cases to determine the surgical course and to avoid morbidity associated with calvarium removal.

Keywords: basal cell carcinoma, calvarium invasion, diploic space invasion, radiographic imaging, scalp invasion

1 INTRODUCTION

Basal cell carcinoma (BCC) is the most common cancer in white individuals and the most prevalent skin cancer globally.1 BCC most often follows a nonaggressive course,2 although cases of BCC in the head and neck are typically more aggressive.3 These regions are particularly susceptible to BCC, accounting for 85% of all cases.3 Only 2.6% of BCC cases involve the scalp.4 Invasion of the calvarium by scalp BCC occurs only occasionally and intracranial invasion is even rarer.5 Nevertheless, radiographic imaging modalities are useful to assess such invasions and may be key in determining a surgical plan, especially when evaluating potential cortical bone and diploic space invasion.6 These imaging techniques, however, may also overestimate the invasiveness of a tumor, leading to unnecessarily aggressive surgical treatment.

In this report, we discuss a case of scalp BCC with no inner or outer cortical erosion documented on imaging, but obvious changes in the diploic space below the scalp malignancy, suggesting calvarium invasion. However, histological analysis of the calvarium exhibited residual BCC in subcutaneous tissue and periosteum, but with no cranial bone invasion.
CASE 1

A 77-year-old woman with a history of BCC was seen with a growing scalp lesion. The lesion appeared 5 years ago but the patient's work schedule caused a delay in seeking medical evaluation. Biopsy confirmed BCC (infiltrative type). The lesion bled periodically but did not cause pain. Head CT with contrast confirmed an ulcerative midline high convexity lesion on the parietal scalp abutting the adjacent cortical surface. Subsequent brain MRI confirmed these observations and identified abnormal trabecular parietal bone signal changes (Figure 1). No adjacent dural enhancement, nodularity, or intracranial mass lesions were noted. The patient underwent Mohs surgery by a dermatologic surgeon.

One day following the completion of Mohs resection, the patient underwent a parietal craniectomy (Figure 2). A mesh cranioplasty was placed to reconstruct the cranial bone defect and the scalp defect was reconstructed with a latissimus dorsi free flap and skin graft (Figure 3). Intraoperative frozen examination of the scalp revealed clean peripheral margins with no evidence of diploic space involvement. The calvarium was entirely submitted for histopathological evaluation. Final histological examination confirmed residual BCC invading subcutaneous tissue and periosteum at the site of prior surgery (Figure 4). However, the carcinoma did not invade the cortical bone, nor was there any evidence of bone marrow involvement, contrary to the MRI imaging findings. The patient tolerated the procedure well, had an unremarkable postoperative course, and was cleared for discharge 7 days postop. Patient is doing well at 1 month postop.

DISCUSSION

When managing scalp BCC, surgeons should be cognizant of the potential for direct invasion of BCC into the calvarium. Although the risk of intracranial invasion of
BCC is estimated to be only 0.03%,\(^7\) aggressive forms of BCC (e.g. giant BCC) and instances of long-term patient neglect are associated with higher rates of skull invasion.\(^2,8-10\) In this case, however, radiographic imaging did not accurately reflect what was happening biologically, leading to an unnecessarily invasive surgery.

A BCC diagnosis does not typically require imaging as part of a routine workup for preoperative planning, as metastasis is very rare and tumor growth is slow. Imaging of the tumor site, however, can be used to assess invasion of nearby structures and determine a surgical plan. Intracranial invasion by a BCC arising in the scalp requires aggressive treatment and can be detected by a combination of radiographic imaging modalities, including CT and MRI. Specifically, CT is used to determine bony invasion by detecting cortical bone changes and irregular mineralization, which may be indicative of calvarial invasion or remodeling at the advancing front of the tumor.\(^6\) MRI is useful for identifying marrow invasion, as it is highly sensitive to changes in bone marrow and soft tissue.\(^6\) As such, it is important to use a combination of imaging techniques rather than relying solely on CT, as high resolution MRI with contrast may identify bony invasion missed initially by CT.\(^11\)

Although the extreme sensitivity of MRI to changes in marrow and soft tissue is useful in detecting tumor invasion, it may also lead to an overestimation of this invasion.\(^12\) As such, the diagnostic accuracy of MRI in predicting the presence of bone marrow invasion is controversial.\(^13\) While a negative MRI result excludes the possibility of bone marrow invasion, a positive MRI result is less reliable (low positive predictive value). For instance, when MRI was used to determine mandibular cancer invasion in a group of patients with oral and oropharyngeal cancers, the results were approximately only 75% accurate due to false-positive reports.\(^14\) False-positive results can be attributed to reactive changes as these were mainly reported for patients who had prior radiation therapy and osteoradionecrosis.\(^14\) Tissue and marrow edema and mass effect next to the bone lesion may be seen on MRI and falsely attributed to tumor invasion.\(^12\)

The patient in this case report exhibited diploic space changes without cortical erosion on CT and MRI, yet had absent findings on final pathology. Diploic space changes detected by MRI can be attributed to a variety of factors including marrow reconversion and metastastic disease. Red marrow reconversion occurs in environments of physiological stress, such as chronic anemia or bone marrow disorders.\(^15\) Marrow reconversion attributed to stressful physiological conditions, however, results in diffuse low signal on MRI scans of cranial bone marrow, unlike the focal changes of this patient’s MRI.\(^16,17\)

BCC entry into the diploe in the absence of cortical invasion can occur via intravascular metastasis multiple years after initial presentation.\(^18\) Metastasis of BCC is very rare, with reported rates ranging up to 0.5% out of all BCC cases.\(^7,19\) Risk factors for metastasis include persistent BCC, head and neck BCC, and size of BCC.\(^7,20,21\) Primary scalp BCC that metastasizes to calvarium diploe through intravascular invasion has been previously reported.\(^18,22\) The parietal bone has the highest density of diploic vascular channels and emissary veins, which may be a route of direct spread of disease from the diploic space into the dura.\(^23,24\)

While metastasis often involves the spread of tumor cells to sites distant from the primary tumor, an alternative theory hypothesizes that metastatic deposits of epithelial cells can induce BCC stromal proliferation in local tissue.\(^25\) Indeed, tumor invasion of bone marrow

![Figure 4](https://wileyonlinelibrary.com)
without cortical erosion can also lead to decreased signal intensity on MRI, but no reports have identified bone marrow invasion without metastasis. In this patient, reactive changes are unlikely to be responsible for the observed diploic space changes as the patient was not previously irradiated. Thus, for this case specifically, there are no suitable differential diagnoses for the findings on radiographic imaging.

Alternative techniques that may be useful in determining the extent of BCC invasion are high frequency ultrasounds, MRI aided by a microscopy coil, and Positron Emission Tomography/CT (PET/CT). High frequency ultrasounds are an accurate assessment of the cutaneous layers of BCC involvement. The ultrasonographic depth index is comparable to the histological depth index with a correlation of approximately 98%. MRI using a microscopy surface coil is shown to be effective in identifying extension of BCC tumors, and can function as a diagnostic tool to exclude bone infiltration. PET/CT may also be useful, as it is more specific and has a higher positive predictive value than MRI. As such, a negative PET/CT result can be used to rule out bone marrow invasion in instances when the MRI is positive. Imaging techniques can be used to facilitate the determination of the local extent of large or aggressive high-risk tumors, as well as to detect invasion of important structures. In this case of scalp BCC, however, radiographic findings with respect to diploic space changes overstated the extent of disease, leading to a more aggressive surgery than warranted. To our knowledge, this is the first reported case of BCC causing diploic space changes, unrelated to bony invasion, and should serve as a word of caution for physicians. Surgeons should be wary of diploic space changes in the absence of cortical erosion demonstrated in MRI as it may not explicitly indicate tumor invasion. In future cases, a biopsy of the diploe may be useful in determining a more conservative surgical course to avoid the morbidity associated with calvarium removal.

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Conflict of Interests
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Declarations of Interest
None.

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