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Literature Review

DISTINCT YET CONNECTED: A COMPARATIVE REVIEW OF LYTIC SKULL LESION PATHOLOGIES

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Abstract

Background: *Skull lesions, although rare, diagnostically represent a diagnostically challenging spectrum of pathologies that encompass infectious, benign and malignant. They share various overlapping presentations, such as scalp masses and osteolytic defects, yet their underlying etiologies differ markedly that demand different therapeutic strategies and prognosis.*

Methods: *The literature review presents a comparative analysis of three distinct cases: calbvarial tubercular osteomyelitis in a 14 year old female, angiomatous meningioma in a 72 year old male, and metastatic follicular thyroid carcinoma in a 54 year old female. Each case is examined and evaluated alongside relevant literature to delineate the key distinctions in epidemiology, imaging, histopathology, management and outcomes. This review compares epidemiology, pathogenesis, clinical and radiological features, diagnostic approach, management, and prognosis for these three entities, emphasizing distinguishing features and practical diagnostic algorithms. Reporting follows PRISMA 2020 principles for literature identification and reporting.*

Findings: *Tubercular osteomyelitis typically affects younger individuals and presents with granulomatous inflammation and lytic skull lesions; it responds well to timely anti-tubercular therapy with or without surgery. Angiomatous meningioma, a rare WHO grade 1 subtype shows prominent vascularity and peritumoral edema, is histologically benign, and complete surgical excision shows a cure. Conversely, skull metastases from follicular thyroid carcinoma are rare, aggressive and show poor outcome often requiring multimodal strategies including radioactive iodine, thyroid hormone suppression and surgery.*

Conclusion: *These cases underscore the importance of accurate differentiation of skull lesions and their reliance on a high index of clinical suspicion, supported by detailed imaging and histopathology. Early diagnosis and accurate differentiation of the lesions are critical for management. The cases discussed highlight the pathological variation and the importance of appropriate management to improve patient outcomes.*

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Key words:
Lytic Skull Lesion, Skull TB, Meningioma, Metastasis, Literature Review

Introduction

Skull lesions, whether infectious, benign or metastatic pose a diagnostic challenge due to their rare occurrence an diverse underlying etiologies. Although uncommon, they are clinically significant because they may originate from infectious, benign, or malignant processes, often presenting with overlapping features, yet their management and prognosis differ markedly. The following comparative analysis juxtaposes three illustrative cases of tubercular osteomyelitis,

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angiomatous meningioma and metastatic follicular thyroid carcinoma, elucidating their differentiating features and clinical implications in light of published cases.

Case summary

Case 1

A 14-year-old female, normotensive, nondiabetic & non-asthmatic, presented with the complaints of swelling over the right side of the scalp for 3 months. Initially, the swelling was soft and nodular in type, it was growing rapidly and occasionally painful. She felt pain during the combing of her hair & while taking a shower for 3 months. She also complained of discharge from swelling, which was clear fluid in nature for 7 days. There was no history of fever, loss of consciousness, convulsions, vomiting, blurring or loss of vision, or difficulties in hearing. She also did not report any history of weight loss, night sweats or loss of appetite or contact with any TB patient.

On examination, the swelling was present on the right frontoparietal region, which was 5 cm in size, having a smooth surface, firm in consistency, margins in continuity with bone ridges, and immobile, but the skin over it was free and without signs of local inflammation. Lungs were clear. Examination of the nervous system reveals no abnormalities.

Her haemoglobin was 9.8 g/dl. ESR: 61 mm/hr. Total WBC count 5300/cm³. Neutrophils 59j, lymphocyte 34j, monocyte 4j, eosinophil 3j. Chest x-ray showed a normal study. Mantoux test showed no induration after 72 hours.

CT scan of the brain with bony window with 3D reconstruction revealed a lytic bony lesion at the right parietal bone with an associated epidural soft tissue component at the right parietal top, causing compression over adjacent parenchyma- possibly eosinophilic granuloma or chronic osteomyelitis.

We managed the patient surgically. We aimed to identify the primary cause by doing histopathological examination along with excision of both extradural and extra-calvarial pathological tissue and reconstruction of the bone defect by cranioplasty. The tissue sample showed granulomatous inflammation consistent with tuberculosis. She was started on anti-tubercular therapy and made a full recovery, with no recurrence to date.

This presentation aligns the calvarial tuberculosis which, although rare, disproportionately affects children and adolescents with approximately 75-90% of cases affecting ages under 20.[1] Frontal and parietal bones are among the most commonly involved in tubercular skull involvement [2] which aligns with our case as well. In such lesions, Mycobacterium tuberculosis seeds the diploe via hematogenous spread, often from a latent or subclinical primary focus. As seen in our case as well, the pathology is marked by granulomatous inflammation, caseous necrosis, lytic bone destruction and sequestrum formation. Radiologic findings include irregular lytic defects and histology reveals granulomas with Langhans giant cells. When started early and promptly, anti-tubercular therapy usually achieves the best outcomes in such cases.

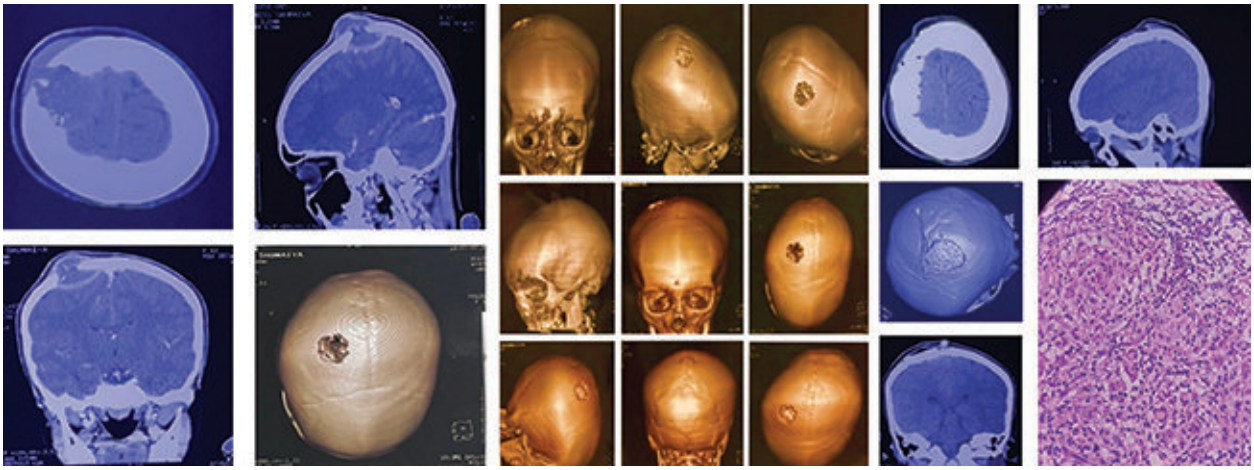

Figure 1: *(A) CT Scan of Brain with Bony window with 3D Reconstruction revealed lytic bony lesion at right parietal bone with an associated epidural soft tissue component at right parietal top causing compression over adjacent parenchyma. (B) Craniotomy and excision of scalp swelling and cranioplasty by bone cement - polymethyl methacrylate (PMMA). (C) Histopathology which shows granulomatous inflammation histologically consistent with tuberculosis*

Case 2:

72-year-old male, diabetic, hypertensive, presented with slow-growing swelling in the right frontal region for 9 months with headache for 4 months in right fronto-parietal region initially then global which was mild in severity, insidious in onset, dull aching in nature, intermittent, no diurnal variation, no radiation, no aggravating factor, pain relieved by taking analgesic, not associated visual disturbance but associated with nausea and relieved by vomiting for the same duration. There was no history of fever, loss of consciousness, convulsions, or difficulties in hearing. He also did not report any history of weight loss, night sweats or loss of appetite, haemoptysis, or contact with any TB patient.

On examination, the swelling was 8 cm in diameter, with a smooth surface, firm in consistency, margins in continuity with bone ridges with an incisional mark over the swelling which was well healed, denoting a previous attempt of surgery. There was no FNAC or Histopathology available for previous attempts.

Plain X-ray Skull A/P & Lateral view reveals: A/P view showed soft tissue swelling indicating scalp involvement. The lateral view showed a solitary, rounded lytic lesion with a sclerotic margin noted at the right frontal region.

Non-contrast CT scan of the brain with a bony window with 3D reconstruction revealed a hyperdense lesion with intra- and extracranial extension of a lytic bony lesion in the right frontal bone, causing a pressure effect on the adjacent brain parenchyma.

We managed the patient surgically. Our aim was to identify the primary site by doing histopathological examination along with excision of both extradural and extra-calvarial pathological tissue and reconstruction of the bone defect by cranioplasty.

A pterional craniotomy was planned, and an incision was made behind the tumor to make a wide craniotomy all around the tumor.

Histopathology showed the Neoplasm consisted of meningothelial cells admixed with many small and medium-sized vessels. To date, the Patient has no neurological deficit or recurrence of swelling.

Angiomatous meningiomas are extremely rare, representing about 2% of all meningioma histologies, often manifesting in middle to older age and having slight male predominance. Despite their aggressive radiologic features, histologically they are benign and WHO grade I, generally showing low proliferation (Ki-67) and favorable prognosis after Simpson grade I resection (complete surgical removal) which was performed in our case also, hence chances of recurrence will be very low.

Case 3

A 54-year-old female presented with a slow-growing swelling in the occipital region over the external occipital protuberance for 7 months. Initially, there was no headache, but for the last 2 months, as the swelling enlarged in size, the pain was dull in nature, intermittent, more marked in the morning after waking from sleep, associated with nausea & vomiting. Due to swelling patient felt discomfort while sleeping. There was no history of fever, pain or any discharge, weight loss, convulsion, any history of unconsciousness, difficulty in walking or unconsciousness. Her bowel and bladder habits were normal.

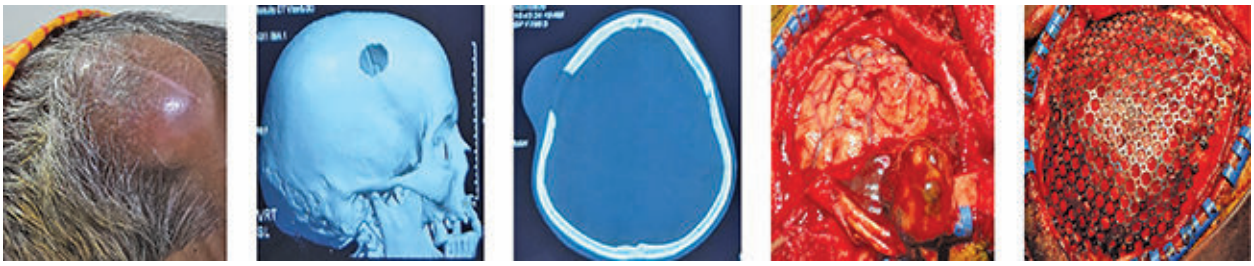

Figure 2: *Plain X-ray Skull A/P & Lateral view reveals: A/P view showed soft tissue swelling indicating scalp involvement. Lateral view showed a solitary rounded lytic lesion with sclerotic margin noted at right frontal region.Non contrast CT scan of brain with bony window with 3D reconstruction revealed hyperdense lesion with intra and extra cranial extension of lytic bony lesion at right frontal bone caused pressure effect to adjacent brain parenchyma. Craniotomy and Excision of Tumor followed by titenium mesh cranioplasty was done .*

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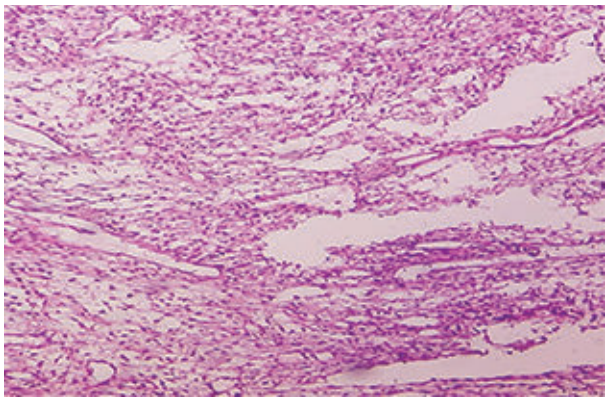

Figure 3: *Neoplasm consist of meningothelial cells admixed with many small and medium sized vessels. Mitoses are rare.*

Dx: Angiomatous Meningioma – WHO Grade I

MRI of the Brain revealed a large extra-axial mass predominantly seen over cerebellar vermis-occipital convexity; the lesion had intraosseous extension, destroying the adjacent occipital squamous. T1 iso intense, T2 iso to hyper intense and strong homogenous enhancement of the lesion seen with an enhancing dural tail.

MRA and MRV showed there is focal compression, marginal irregularity, with severe luminal narrowing seen in both transverse sinuses.

Our radiological diagnosis was meningioma, and we managed the patient surgically. We aimed to confirm the diagnosis by doing histopathological examination along with excision of the tumor tissue and reconstruction of the bone defect by cranioplasty. Though peroperatively we found dural adhesion with the tumor. The involved dura with tumour was excised, maintaining a normal tissue margin. The left transverse sinus was injured during surgery, but was managed accordingly. Water-tight dural closure done with artificial dura (G-patch). The bone defect was covered by titanium mesh cranioplasty.

Histology showed a tumor composed of anaplastic follicular epithelial cells arranged in papillary fronds. The tumor cells show nuclear clearing and ground-glass appearance. Nuclear grooving and pseudoinclusions are also seen. The tumor has invaded the bony tissue.

Immunohistochemistry revealed CK7, TTF1, Thyroglobulin: Positive in tumour cells

CK 20: Negative in tumour cells, which confirmed metastatic follicular variant of papillary thyroid carcinoma. She was referred for thyroid surgery and further oncological treatment with no neurological deficit.

The skull is a very uncommon location (2.5%) of osseous metastases for differentiated thyroid cancer,

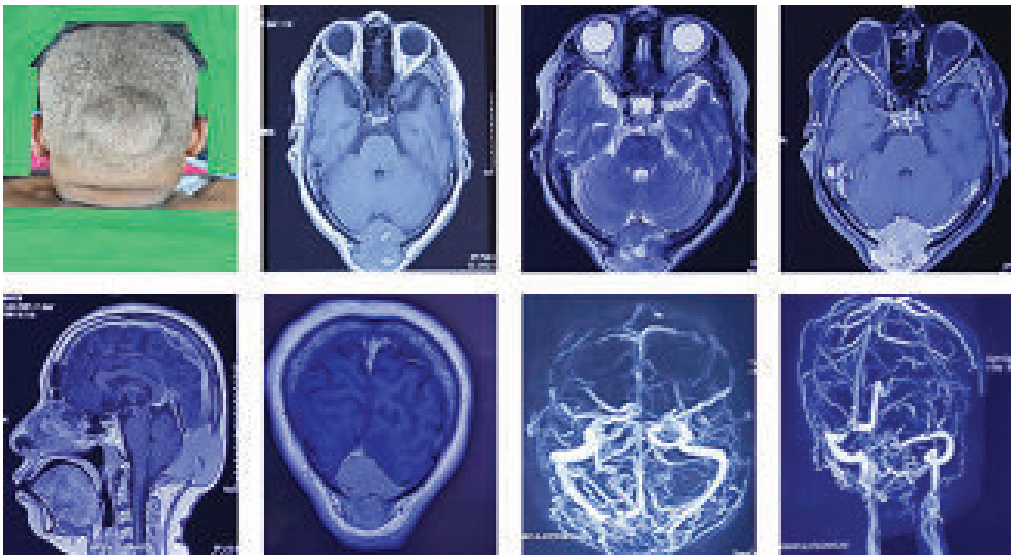

Figure 4: *MRI of Brain revealed a large extra axial mass predominantly seen over cerebellar vermis-occipital convexity, the lesion had intra osseous extension caused destruction of adjacent occipital squamous. T1 iso intense, T2 iso to hyper intense and strong homogenous enhancement of the lesion seen with enhancing dural tail.*

MRA and MRV showed there is focal compression, marginal irregularity with severe luminal narrowing seen in both transverse sinuses.

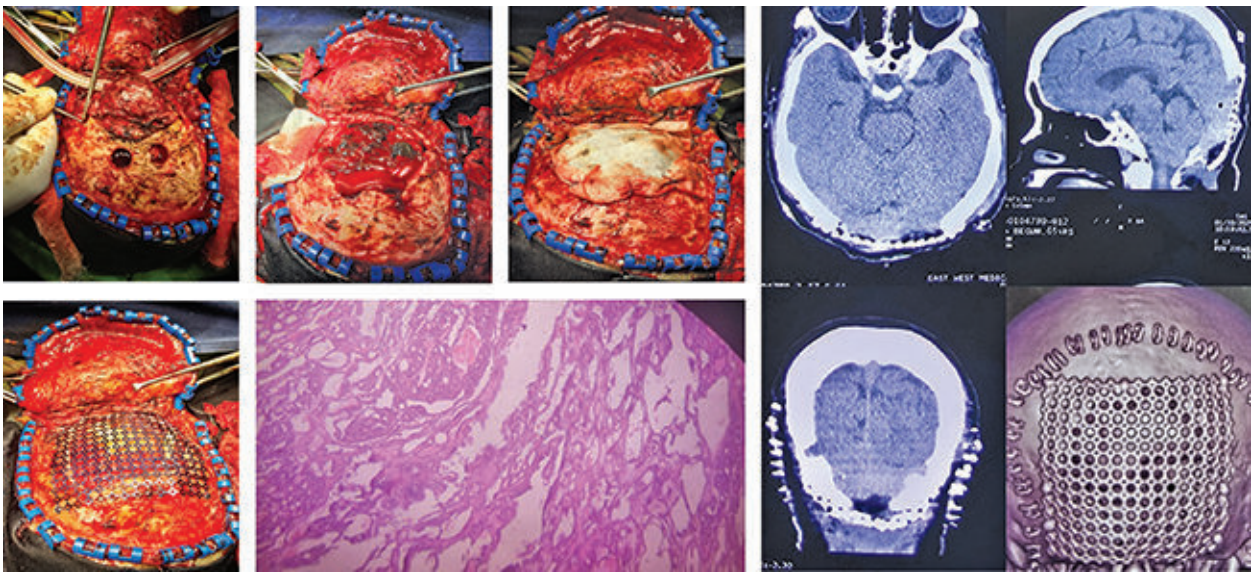

Figure 5: *Per operative photograph where A suboccipital craniotomy was planned and an inverted U shape incision was made behind the tumor over occipital region to make wide craniotomy all around the tumor. Dura was adhere with tumor. Involved dura with tumor was excised maintaining normal tissue margin. Left transverse sinus was injured during surgery but managed accordingly. Water tight dural closure done with artificial dura (G-patch). Skull defect was covered with titanium mesh cranioplasty. Histopathology revealed tumor composed of anaplastic follicular epithelial cells arranged in papillary fronds. The tumor cells show nuclear clearing and ground glass appearance. Nuclear grooving and pseudoinclusions are also seen. The tumor has invaded the bony tissue. Immunohistochemistry revealed CK7, TTF1, Thyroglobulin: Positive in tumor cells; CK 20: Negative in tumor cells; Diagnosis: Metastatic follicular variant of papillary thyroid carcinoma*

but it has a mean survival of 4.5 years.[3] Upon histology, it was of follicular subtype (FTC), which is more common than (7- 28%) than in papillary thyroid cancer (PTC) (1.4-7%).[3] Skull metastases from thyroid cancer are uncommon but recognized, especially with the follicular subtype, which favors hematogenous spread to bones, including the flat calvarial bones. After suboccipital craniotomy and total resection of metastatic tumor, the patient continued radioactive iodine therapy and has been kept under surveillance.

Methods

Study Design

This work adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 framework.[4] Given the rarity of these conditions, a qualitative comparative synthesis was performed.

Data Sources and Search Strategy

Databases searched: PubMed/MEDLINE, Scopus, and Google Scholar.

Search period: Inception–23 October 2025.

Search terms included combinations of: “calvarial tuberculosis,” “skull tuberculosis,” “cranial TB,” “intraosseous meningioma,” “osteolytic meningioma,” “primary intraosseous meningioma,” “skull metastasis,” “thyroid carcinoma metastasis,” “follicular thyroid carcinoma skull,”

combined with Boolean operators (“AND,” “OR”) and filters (English, human).

Reference lists of included papers were hand-searched for additional reports.

Eligibility Criteria

Inclusion

- Case reports, case series, reviews, and imaging studies detailing skull TB, intraosseous meningioma, or skull metastasis from FTC.
- Articles containing clinical, imaging, histopathologic, or management information.

Exclusion:

- Non-English papers without English abstracts
- Reports lacking individual patient or imaging data

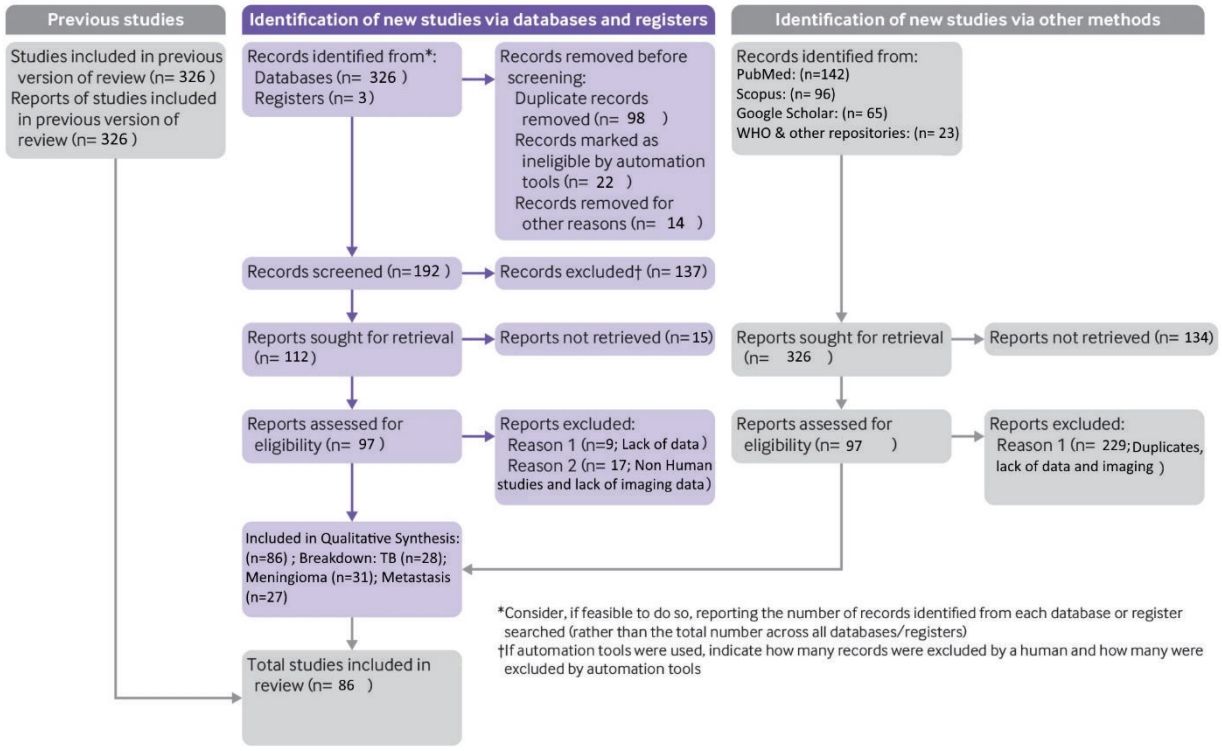

Figure 6: *Consort Chart Following PRISMA GUIDELINE 2020*

- Purely molecular or non-cranial studies.

Study Selection: Two reviewers independently screened titles and abstracts. Full texts were reviewed for eligibility. Discrepancies were resolved by consensus.

Data Extraction and Analysis

Extracted data included:

- Demographics and clinical presentation
- Imaging modality and characteristics
- Histopathologic findings
- Treatment modalities
- Outcomes and follow-up

Because studies were heterogeneous and mainly descriptive, statistical pooling or meta-analysis was not attempted. Results were synthesized narratively and comparatively.

PRISMA Flow Summary:

Records identified: 326

Records screened: 192 after duplicates removed

Full-texts assessed: 97

Included in qualitative synthesis: 86

Breakdown: 28 (TB), 31 (intraosseous meningioma), 27 (FTC metastasis).

Literature Review

Calvarial tuberculosis is an exceptionally rare manifestation of skeletal tuberculosis, constituting roughly 0.1-3.7% of skeletal TB and approximately 0.2-1.3% of all bone tuberculosis cases.[1] Most commonly affecting patients younger than the age of 20 (approximately 70-90%), reflecting a predilection for children and adolescents.[2] The frontal and parietal bones are most commonly involved as also seen in our cases and this is likely due to the relatively rich diploic vascular channels in those areas. Some series seen amongst these cases report male-to-female ratio near 2:1 although maybe cases in literature involving females may perhaps be due to reporting bias.

Clinically, calvarial TB often presents as a scalp swelling, which may be painless or tender and even in some cases show as discharging sinuses or neurological features arise when intracranial extension occurs.[3] Radiolographically, plain skull films may show lytic lesions with minimal sclerosis whereas CT imaging more clearly demonstrates full thickness bone

destruction, diploic involvement, soft tissue extension and any rare intracranial components. MRI, mostly superior, reveals meningeal enhancement, parenchymal extension or abscess like features. Treatment of calvarial Tb is primarily medical, with prolonged anti tubercular therapy and most outcomes are favorable when diagnosis is timely and combined with medical and surgical therapy. Delays however, often lead to neurological sequelae or intracranial spread.[1]

Angiomatous meningioma is a rare histologic subtype that represents about 2% of all meningiomas.[5] Meningiomas typically are more common as intracranial tumours and may secondarily involve the skull by hyperostosis or bone invasion and the angiomatous is distinguished by its abundant vascular channels. These tumours can radiologically mimic other lesions as well, particularly when bone involvement is present. On imaging they typically appear as dural based, strongly enhancing axial masses, and often times consisting of a dura tail and often time produce hyperostosis rather than lytic destruction. Angiomstous meningiomas also have high vascular permeability, most cases showing significant PTBE (peritumoral brain edema), which suggests preoperative embolization for large lesions. Since angiomatous meningiomas are WHO Grade 1, the principal management is surgical resection, aiming for Simpson Grade 1 and are shown to have low recurrence risk when completely excised. [6]

Skull metastases from follicular carcinoma are also rare but well documented in medical literature. Among patients with differentiated thyroid carcinoma, bone metastases are rare and involvement of skull continues a very small fraction of approximately 2.5-5.8%.[7] FTC generally has a late age of onset with a higher mortality rate compared to papillary thyroid carcinoma which is the most common thyroid malignancy.[8] Clinically, skull metastases often present as scalp masses or swelling, occasionally with pain or neurological symptoms. On imaging they typically appear as expansile osteolytic lesions often rendered as “hamburger” or “sandwich cookie” configuration with soft tissue extension and may even mimic meningiomas.[8] In one of the reported cases similar to ours, a 30 year old women underwent craniotomy , thyroidectomy, and radioiodine following diagnosis of solitary frontal skull FTC metastasis [8] while in another systemic review of 20 patients, complete or incomplete surgical resection was achieved in 30-50% of the cases and local control with radiotherapy was successful in 70-80% yet the median survival rate was only 6-12 months.[10]

Thus, when comparing the three entities of skull metastases, tubercular osteomyelitis, angiomatous meningioma and follicular thyroid carcinoma, there are clear distinctions in imaging, epidemiology and management. Tubercular lesions primarily affect the younger population and cause lytic destruction of bone with soft tissue swelling, often responding best to combination therapy. Angiomatous meningiomas appear in older age, manifest as dural bases tempers with bone remodeling and typically can be cured with surgical resection. Follicular thyroid carcinoma occurs in middle to older aged adults, presenting aggressively, often mimicking meningiomas by showing expansile osteolytic lesions and requires multimodal oncologic approach yet lack a promising prognosis. Early diagnosis and tailored treatment maximize the chance of a favorable outcome in all cases.

Comparative Analysis

Feature	Calvarial TB	Intraosseous Meningioma	FTC Metastasis
Typical age	<40 years	30–60 years	40–70 years
Onset	Subacute	Slow, chronic	Variable, often late
Pain	Mild / sinus	Rare	Usually painless
Imaging	Lytic with sequestrum	Lytic ± sclerotic, dural tail	Lytic, vascular, soft-tissue mass
Histology	Caseating granuloma	Meningothelial cells	Follicular thyroid cells
Key lab	AFB, GeneXpert	—	Thyroglobulin ‘!
Treatment	ATT ± surgery	Excision ± RT	Surgery + RAI ± RT
Prognosis	Excellent	Good (if complete)	Depends on metastasis burden

Therapeutic Strategy Comparison:

Modality	Tubercular Osteomyelitis	Angiomatous Meningioma	Skull Metastatic FTC
Surgery	Debridement, sequestrectomy when required	Simpson Grade I resection (including involved bone/dura)	Metastasectomy (craniectomy) when feasible
Medical / Adjuvant	Long-term anti-tubercular therapy	Rarely needed (benign nature)	Total thyroidectomy, RAI, TSH suppression, EBRT or radiosurgery
Preoperative adjuncts	Usually none	Possible arterial embolization in hypervascular lesions	Preoperative vascular control may be considered
When surgery not feasible	Prolonged medical therapy	Radiotherapy for residual tumor	EBRT / stereotactic radiosurgery for unresectable or residual disease
Prognosis	Good if early diagnosis & treatment	Excellent, low recurrence rate in benign cases	Guarded; survival often limited if systemic disease present

Conclusion

In conclusion, skull lesions such as tubercular osteomyelitis, angiomatous meningioma and metastatic thyroid carcinoma all require a high index of suspicion and a systemic diagnostic approach. All three entities differ significantly in terms of imaging, affected demographic, histopathology, treatment strategies and prognosis. Early identification is especially critical in infectious and metastatic cases where timely intervention can significantly result in better outcomes. The three presented cases highlight the broad pathological spectrum, from a curable granulomatous infectious to a benign yet vascular tumour, to a malignant metastatic lesion with a guarded prognosis. Ultimately, attention to subtle clinical and radiological features is key to guiding effective management and optimized treatment outcomes.

Limitations of the study

The available literature largely comprises case reports and small series; heterogeneity precludes quantitative analysis.The study of our cases has several limitations as the cases included are single-patient reports, limiting generalizability in a population. Significant heterogeneity in imaging protocols, surgical approaches, follow up of patients, and adjuvant therapies all complicate direct comparisons. Also, selection and reporting biases may skew outcomes as successful and atypical cases are mostly published. Furthermore, many older reports lack advanced imaging, medical findings, and molecular profiling, which limits diagnostic and prognostic precision.

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