CT in the Assessment of Paediatric Calvarial Masses - A Prospective Observational Study, Hyderabad, Telangana

Madhavi Thatipamula[1], Sudha Bindu Tirumani[2], Sunitha Thaluri[3], Vijaya Kumari Mudunoor[4]

[1, 2, 3, 4] Department of Radiodiagnosis, Osmania Medical College, Hyderabad, Telangana, India.

ABSTRACT

BACKGROUND

Paediatric calvarial mass lesions are common and can have prognostic and therapeutic implications based on the type of lesions. The spectrum of lesions can extend from benign lesions like cephalhaematoma, which is a common postnatal swelling in the paediatric scalp to severe lesions like neuroblastoma metastases. Therefore, proper diagnosis of these lesions is of prime importance in day to day practice which can help in accurate management of these lesions. This study was conducted to evaluate the role of computed tomography (CT) in the assessment of paediatric calvarial masses.

METHODS

In our prospective observational study, during a period of 1 year (October 2019 to October 2020) 26 children with visible swelling on the calvarium were subjected to CT examination. The imaging features of various paediatric calvarial lesions on CT were noted.

RESULTS

Out of 26 paediatric patients, which included infants from 1 day of life to children of 7 years age, the most common age of presentation was less than one-year age group. The most common type of calvarial mass lesion was cephalhaematoma and the next most common mass lesion was dermoid cyst. CT could diagnose all the lesions based on the image morphology with clear delineation of their extent. 16 cases had isolated soft tissue involvement (cephal haematoma, sub galeal haematoma, lipoma, dermoid cyst) whereas ten lesions like encephalocele, osteomyelitis, Langerhans cell histiocytosis (LCH), fibrous dysplasia, neuroblastoma metastases, lymphoma deposits had both soft tissue and bone involvement.

CONCLUSIONS

Accurate detection, characterisation and delineation of the lesions are important in management of the various paediatric calvarial masses. CT is a useful imaging tool in confirming the diagnosis and also for anatomical delineation in certain cases requiring surgical management. It also helps in detecting associated intracranial extension of the lesions.

KEYWORDS

Calvarial Masses, Paediatric, Computed Tomography

Corresponding Author:
Dr. Sudha Bindu Tirumani
Level 2, Skyla #523 Avenue,
Plot No: 523, Road No: 10,
Kakatiya Hills, Madhapur,
Hyderabad – 500081,
Telangana, India.
E-mail: drtirumani@rocketmail.com

DOI: 10.18410/jebmh/2021/356

How to Cite This Article:
Thatipamula M, Tirumani SB, Thaluri S, et al. CT in the assessment of paediatric calvarial masses-a prospective observational study, Hyderabad, Telangana. J Evid Based Med Healthc 2021;8(23):1894-1898. DOI: 10.18410/jebmh/2021/356

Submission 29-01-2021,
Peer Review 08-02-2021,
Acceptance 21-04-2021,
Published 07-06-2021.

BACKGROUND

Calvarial lesions in paediatric population are common entities and pose a diagnostic challenge to the radiologist.[1] A thorough knowledge of imaging findings of various calvarial mass lesions is of paramount importance in day to day practice. The paediatric calvarial lesions can have a varied spectrum ranging from benign entities like cephalhaematoma, subgaleal hematoma, congenital lesions like dermoid cyst, encephalocele and neoplastic lesions like neuroblastoma metastases, lymphoma deposits. Infectious lesions like osteomyelitis or miscellaneous entities like LCH, fibrous dysplasia can also present as calvarial masses. The masses can be isolated soft tissue lesions or a bony lesion with visible soft tissue component. The initial clinical presentation can only be a calvarial mass lesions in certain systemic conditions and therefore helps in further evaluation of the patients for proper management of the disease. The clinical examination can be helpful in developing the differential diagnosis and the imaging strategy. Some benign self-limiting entities like cephalhaematoma and subgaleal hematoma can be managed conservatively whereas lesions like dermoid cyst and encephaloceles mandate surgical management. CT has an advantage of short time of exposure in paediatric patients in comparison to MRI and also scores well due to its efficacy in bone evaluation. Ultrasound being the first modality of choice, but cannot delineate the intracranial extent accurately whereas CT clearly helps in definitive anatomical localisation which also aids in preoperative planning in some lesions.

Objectives

- To evaluate the role of computed tomography in the assessment of paediatric calvarial masses.
- To confirm the diagnosis or suggest an alternate diagnosis and to assess the anatomical extent of the lesion based on CT morphology
- To assess structural features of the calvarial masses which help the clinician for planning the management.

METHODS

In this prospective observational study done at Niloufer hospital for women and children, Hyderabad, which is a tertiary paediatric hospital, after taking informed consent, 26 paediatric patients admitted in with calvarial masses clinically were evaluated with CT for a duration of one year (October 2019 to October 2020). Our study included patients of age groups 1 day of life to 7 years. There is a slight male predilection noted. Patients were initially evaluated with routine investigations and later ultrasound examination. Ultrasound findings of solid or cystic scalp lesions and its vascularity were noted. These lesions were further evaluated with computed tomography.

CT examination was performed on Toshiba Aquilon 16 slice machine before and after intravenous contrast administration of Iomeron which is a non-ionic water-soluble contrast medium. The paediatric patients were put to sleep by the attendant naturally or a dose of Pedicloryl was given orally and the CT was done after the child was calm. The calvarial masses were examined in axial, coronal and sagittal planes. On CT examination, the mass lesions were thoroughly examined to localise the lesion and confirm the nature of the lesion. The size, extent of the lesion, enhancement pattern and any intracranial extension or involvement of calvarium was noted. Associated intracerebral findings like ischaemic changes and ventriculomegaly were noted in detail. All the normal structures and any other pathology in the anatomical area scanned were also noted.

Statistical Analysis

Data obtained was entered in Microsoft Office Excel worksheet 2016. Descriptive statistical analysis was carried out. Quantitative variables were expressed as mean & range, whereas qualitative data was presented as the number of observations with percentages.

RESULTS

Age Group of Patient	No. of Male Patients	No. Female Patients
Less than 1 year.	9	7
1 to 5 years.	5	3
More than 5 years.	-	2
Total number of patients	**14**	**12**

Table 1. Distribution of Study Subjects According to Age and Sex

In Table 1, out of the twenty-six patients, the most common age group was less than one year. Next common age group was one to five years age group.

In Table 2, out of the twenty-six patients, the most common calvarial mass was cephalhaematoma and the next common being dermoid cyst.

Type of Lesion	Number of Cases
Dermoid cyst	5
Encephalocoele	3
Lipoma	1
Cephalhaematoma	6
Subgaleal haematoma	4
Osteomyelitis	2
Fibrous dysplasia	1
LCH	2
Neuroblastoma metastases	2
Lymphoma deposits	1

Table 2. Types of Calvarial Masses and Incidence

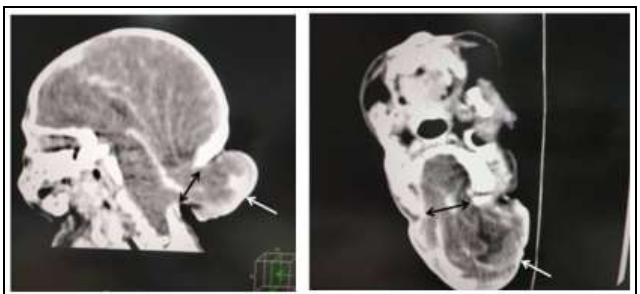

Figure 1. Contrast Enhanced Sagittal, and Axial CT Sections of the Brain Showing Defect in Occipital Bone (Black Arrow) with Herniation of Cerebellum and Bilateral Occipital Lobes (White Arrow) Through the Defect - Occipital Encephalocoele

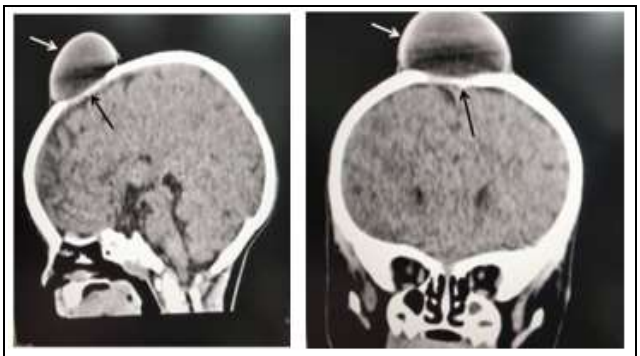

Figure 2. Plain CT Brain - Sagittal and Coronal Sections Show Well Defined Cystic Lesion (White Arrow) in Midline High Frontal Region at the Confluence of Coronal and Sagittal Sutures (Black Arrow) - Dermoid Cyst

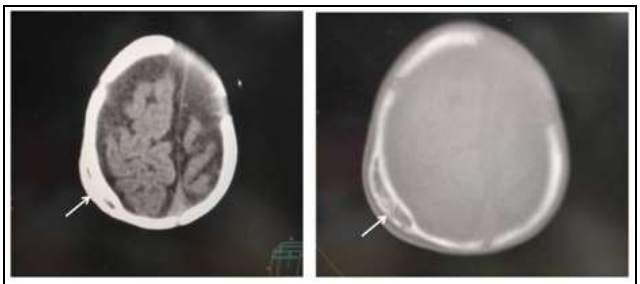

Figure 3. Plain CT Brain Axial Sections in Brain and Bone Window Show Calcified Subperiosteal Hematoma in Right Parietal Bone (White Arrow) - Calcified Cephalhaematoma

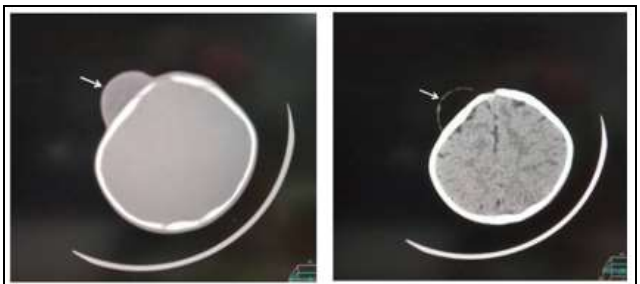

Figure 4. Plain CT Brain Axial Sections in Bone and Brain Window Show Well Defined Homogeneous Fat Attenuating Lesion (White Arrow) in the Scalp in Right Frontal Region - Lipoma

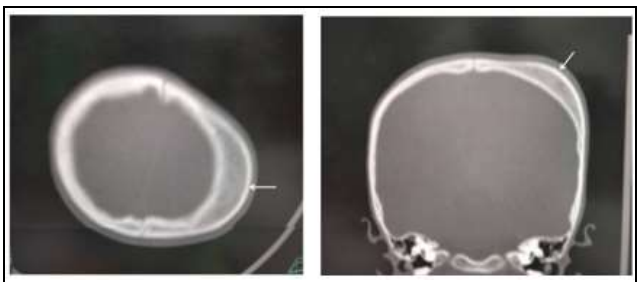

Figure 5. Plain CT Brain Axial and Coronal Sections in Bone Window Show Expansion of Left Parietal Bone with Ground Glass Matrix with Bulging of Outer Cortex (White Arrow)-Fibrous Dysplasia

DISCUSSION

Paediatric calvarial mass lesions are common and often pose a diagnostic challenge to the clinician and the radiologist. The skull vault is made of two cortical tables, inner and outer tables with marrow or diploic space between them. Calvarial lesions can be primary bone lesions or can be primary scalp lesions involving the calvarium or brain lesions extending to involve the cranial vault. The varied spectrum of masses that can present on the calvarium can either have bone and soft tissue involvement or can be limited to the soft tissues of the scalp. Out of the twenty-six cases sixteen cases had only soft tissue involvement whereas 10 had both soft tissue and bone involvement (encephalocele, osteomyelitis, LCH, fibrous dysplasia, neuroblastoma mets, lymphoma deposits). Few congenital lesions like encephaloceles and dermoid cysts, though they have specific site of location, they can be confused clinically with other entities. Along with these congenital lesions, cephalhaematoma and subgaleal hematomas which can cause post traumatic sequelae either as a part of birth injury or other trauma, infective lesions like osteomyelitis, benign lesions like lipoma, other entities like fibrous dysplasia and LCH, malignant lesions like neuroblastoma metastases and lymphoma deposits can occur on the paediatric head. Most of these lesions have distinct imaging features.[2]

All the lesions present as swellings on the scalp and the age of presentation of certain lesions might help in the initial evaluation. A suspicion of cephalhaematoma and subgaleal hematoma can occur soon after birth trauma. An associated abdominal mass in neuroblastoma can help diagnose calvarial metastatic deposit. However, knowledge of various imaging findings in these calvarial lesions can help diagnose and manage the cases effectively. On CT, lesions like osteomyelitis, neuroblastoma metastases, lymphoma deposits have periosteal reaction. LCH on the other hand has no periosteal reaction and are present as lytic calvarial lesions with or without adjacent soft tissue. On contrast CT infective lesions like osteomyelitis show peripheral enhancement pattern, whereas LCH, neuroblastoma metastases and lymphoma deposits have enhancing soft tissue masses. Other benign lesions do not show enhancement until unless associated with secondary infection of the lesion.

In encephalocele there is a calvarial defect with herniation of brain tissue.[1] Most common in occipital location (75 %), 15 % are frontoethmoidal and rest of the cases are basal in location.[3] They are called meningoceles when they contain only meninges and meningoencephaloceles if brain tissue is included in the herniated tissue. Atretic cephalocele consists of dura, fibrous tissue, and degenerated brain tissue. Significant associated intracranial anomalies may be present. They are operatively managed and hence cross-sectional imaging provides good presurgical planning of these cases.

We had 3 cases of occipital encephaloceles (figure 1). One case was an atretic encephalocele with very small lesion consisting of only dura and minimal brain tissue. Atretic encephaloceles represent involuted cephaloceles. Generally, encephaloceles have associated CNS anomalies like hydrocephalus, dandy walker malformation and corpus callosal dysgenesis. But none of our cases had associated CNS anomalies.

Dermoid cysts mostly located around midline but any bone in the calvarial vault can be involved.[2] Dermoid cysts

are well defined lytic lesions with sclerotic margins.[4] They result from persistent ectodermal elements at sites of suture or neural tube closure, as well as diverticulation of the cerebral hemispheres. Dermoids are composed of ectoderm and skin elements, whereas epidermoids contain exclusively ectodermal elements.[1] Most commonly seen in the midline, frontal, and temporal regions. They are present as well defined non enhancing soft tissue masses with variable density due to variable contents of epithelial origin. They can have intracranial extension or cause indentation of underlying bone. Our study had 5 cases of dermoid located in retroauricular region (1), periorbital (1), frontal (2) (Fig 2) and one in occipital region. None of the dermoid cysts in our study showed intracranial extensions.

Cephalhaematoma is a subperiosteal haemorrhage confined by the cranial sutures.[4] Majority resolves by 1 month[5] and are parietal in location.[6] They can calcify.[7] Majority of the masses in our study being a paediatric population, were of cephalhaematoma (6 patients). 3 of them were calcified with the age of the child being more than 1 month (figure 3). They can be managed conservatively. Some may get infected and can present with changes of osteomyelitis

Subgaleal hematoma is haemorrhage below the aponeurosis covering the scalp and is not confined by sutures. They can also be managed conservatively. There were 4 cases of subgaleal hematoma in our study. All the cases were conservatively managed and recovered well.

Skull osteomyelitis can be secondary to scalp infections or infected post-surgical sites or infected cephalohematomas. Two cases of osteomyelitis were noted in our study, one in occipital bone and the other in temporal bone. CT imaging findings of focal or patchy osteolysis with adjacent periosteal reaction and adjacent rim enhancing collection were seen. The presence of sequestrum as seen in osteomyelitis elsewhere in the body was also noted in some cases of calvarial osteomyelitis.

Lipomas are benign tumours of mature fat containing cells. They appear as lobulated fat attenuating lesions in the calvarial soft tissues. They may also be intra-osseous in location. One case of right frontal lipoma with well-defined lesion showing homogeneous fat attenuation values was noted in our study (figure 4). No associated remodelling of underlying bone was noted in scalp lipomas.

Fibrous dysplasia is a non-neoplastic tumour like congenital process with immature bone replacing the normal trabecular pattern. In fibrous dysplasia, skull is involved in both monostotic and polyostotic form of disease.[2] The condition is often an incidental finding and is usually painless. Patients present with swelling or may present with symptoms of nerve involvement. Sometimes it can be an incidental finding on a routine skull imaging. CT imaging findings vary with stage of disease. Ground glass matrix of the lesion with bulging outer cortex and thinning of inner table which does not protrude inward is noted.[8] Lesions of fibrous dysplasia tends to cease to grow beyond puberty. We had one case of fibrous dysplasia (Fig 5).

Langerhans cell histiocytosis is a rare disorder with lytic calvarial lesions. It is predominantly seen in children under the age of 14 years.[9] At clinical presentation they may be asymptomatic or may have a soft tissue mass. It has a predilection for the flat bones. The skull is the most common flat bone involved, followed by the mandible, ribs, pelvis, and spine. Focal lytic lesions with bevelled edges and enhancing soft tissue mass are characteristic. Calvarial disease lacks periosteal reaction. Smaller lesions can coalesce and can give the appearance of geographic skull. Dural involvement is better assessed on magnetic resonance imaging (MRI) than CT. Two cases of LCH were noted in our study. In our case there was no associated soft tissue component.

In children, the malignant tumour that most commonly involves the calvarium is neuroblastoma.[10,11,12] Neuroblastoma can have diverse manifestations and sometimes can present as a neurologic disease in a child. Cranial metastases in neuroblastoma are seen involving the calvaria, orbit and skull base.[13] These calvarial lesions often extend to produce epidural deposits. Calvarial lytic lesions with hair on end appearance and associated enhancing soft tissues are noted. The hair on end appearance is due to periosteal reaction to tumour cells involving the calvarium. Calvarial mass can be presenting features of neuroblastoma. Dural metastases are often accompanying the calvarial lesions. These dural metastases are better imaged by magnetic resonance imaging than CT. Langerhans cell histiocytosis and metastatic neuroblastoma both characteristically involve the posterolateral part of the orbit at the junction of the frontal bone and greater wing of the sphenoid. We have two cases of metastatic neuroblastoma. Both cases had large retroperitoneal abdominal mass lesions, with foci of calcification and also with encasement of aorta.

Lymphoma can have skeletal deposits. Primary skeletal lymphoma is usually rare. The prevalence of skeletal involvement is more in children. The most common sites of metastatic bone disease is spine, pelvis and skull. Bone involvement can result from direct spread from nodal disease or haematogenous metastases. The axial skeleton is more often affected than the appendicular skeleton.[14] Multiple lytic lesions in the skull of paediatric case can be lymphoma, leukemic deposits, metastases, Langerhans cell histiocytosis. We had one case of lymphoma with deposit in the skull.

Other paediatric calvarial lesions commonly encountered are - sinus pericranii which is cranial venous anomaly in which there is an abnormal communication between intracranial dural sinuses and extracranial venous structures, usually via an emissary transosseous vein. Most cases appear to be congenital in nature and are frequently associated with other venous anomalies and syndromes. It is a type of low flow vascular malformation. It occurs in close communication with the cranial vault and most frequently involves the superior sagittal sinus. On CT, it is seen as well-defined iso to hyperdense mass lesion in scalp with associated defect in cranial vault and shows intense homogenous enhancement as with adjacent dural venous sinus and shows direct communication with sinus.

Haemangioma are seen as well-defined scalp swelling and show homogenous moderate post contrast enhancement. Usually no intracranial communication is

noted. Skull vault haemangiomas are benign slow-growing vascular lesions affecting the skull diploe. Usually presents as an expansile bone lesion with thin borders and a characteristic sunburst pattern of trabecular thickening radiating from a common center. Erosions of inner and outer tables can occur and may be associated with internal or external tumour expansion. Sometimes lesion can show pseudo "hair-on-end" periosteal reaction.

CONCLUSIONS

Paediatric calvarial mass lesions are common in day to day practice. In paediatric population, CT is an efficient modality for the evaluation of calvarial masses. The shorter acquisition time of CT is very useful in paediatric population. CT has the advantage of accurate delineation of the lesion and also provides better structural details compared to ultrasound which helps in the management of these lesions. CT also helps in the diagnosis of intracranial extent of the calvarial masses with better accuracy than ultrasound. The varied spectrum of imaging findings in conjunction with the clinical findings and associated systemic presentations can help narrow down the diagnosis in most of the cases. It also provides anatomical extent for cases requiring operative management. Radiologists should be well acquainted with the imaging morphology of these lesions in the paediatric population so that definitive diagnosis can be achieved and help in optimal patient management.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
Financial or other competing interests: None.
Disclosure forms provided by the authors are available with the full text of this article at jebmh.com.

REFERENCES

[1] Choudhary G, Udayasankar U, Saade C, et al. A systematic approach in the diagnosis of paediatric skull lesions: what radiologists need to know? Pol J Radiol 2019;84:e92-e111.
[2] Arana E, Martí-Bonmatí L. CT and MR imaging of focal calvarial lesions. Am J Roentgenol 1999;172(6):1683-1688.
[3] Naidich TP, Zimmerman RA, Bilaniuk LT. Midface: embryology and congenital lesions. In: Som PM, Curtin HD, eds. Head and neck imaging. 3rd edn. St. Louis: C.V. Mosby Company, 1996: p. 3-60.
[4] Lloret I, Server A, Taksdal I. Calvarial lesions: a radiological approach to diagnosis. Acta Radiol 2009;50(5):531-542.
[5] Wong CH, Foo CL, Seow WT. Calcified cephalohematoma: classification, indications for surgery and techniques. J Craniofac Surg 2006;17(5):970-979.
[6] Ortiz O, Schochet S, Bastug D. Imaging evaluation and clinicopathologic correlation of mass lesions involving the calvaria. Part I: congenital and traumatic lesions. Int J Neuroradiol 1999;5:96-108.
[7] Firlik KS, Adelson PD. Large chronic cephalohematoma without calcification. Pediatr Neurosurg 1999;30(1):39-42.
[8] Hodges E. Pathology of the skull. In: Taveras J, Fenucci J, eds. Radiology: diagnosis, imaging, intervention. Vol. 3. 2nd edn. Philadelphia: Lippincott 1989: p. 1-21.
[9] Guyot-Goubin A, Donadieu J, Barkaoui M, et al. Descriptive epidemiology of childhood Langerhans cell histiocytosis in France, 2000-2004. Pediatr Blood Cancer 2008;51(1):71-75.
[10] Shah MV, Haines SJ. Pediatric skull, skull base and meningeal tumors. Neurosurg Clin N Am 1992;3(4):893-924.
[11] Chung EM, Murphey MD, Specht CS, et al. Pediatric orbit tumors and tumorlike lesions: osseous lesions of the orbit. Radiographics 2008;28(4):1193-1214.
[12] Ortiz O, Schochet S, Bastug D. Imaging evaluation and clinicopathotolic correlation of mass lesions involving the calvaria. Part II: tumoral and inflammatory lesions. Int J Neuroradiol 1999;5:151-165.
[13] Zimmerman RA, Bilaniuk LT. CT of primary and secondary craniocerebral neuroblastoma. AJR Am J Roentgenol 1980;135(6):1239-1242.
[14] Ferry JA. Extranodal lymphoma. Arch Pathol Lab Med 2008;132(4):565-578.