Original Article

Bony lesions of cranium and spine: A study of 123 cases

ABSTRACT

Context: Bony lesions involving the cranium and spine have a wide range of etiologies, ranging from congenital, traumatic, inflammatory, to neoplastic.

Aim: The aim was to analyze the histological spectrum of various bony lesions of cranium and spine received as biopsies from the neurosurgery department in our hospital.

Materials and Methods: There were 123 cases of bony lesions of cranium and spine diagnosed over a period of 5 years during 2015–2019 in the neuropathology laboratory. These cases were studied retrospectively.

Results: Out of the total 123 cases of bony lesions analyzed, 75 affected the cranium and 48 affected the spine. Overall, neoplastic lesions (83) were more frequent than the nonneoplastic lesions (40). In the cranium, neoplastic lesions (66/75) outnumbered the nonneoplastic ones (9/75), whereas in the spine, nonneoplastic lesions (31/48) were more common. Chordoma (40/83) was the most common neoplasm, whereas tuberculous osteomyelitis (30/40) was the most common nonneoplastic lesion encountered. Majority of the patients were adult males aged between 21 and 50 years. Rare lesions such as spinal osteochondroma, poorly differentiated neoplasm metastatic to the cervical spine from a primary salivary gland neoplasm, spinal metastasis of a glioblastoma, and intraosseous meningioma of cranium were recorded.

Conclusions: The study provides epidemiological information regarding the incidence and nature of bone lesions of the spine and cranium.

Keywords: Bony lesion, cranium, histopathology, spine

INTRODUCTION

Bony lesions of cranium and spine comprise a vast repertoire of lesions, which may be neoplastic or nonneoplastic. Majority of the published studies in the literature on bony lesions comprise isolated case reports or case series on individual lesions. We, therefore, undertook this retrospective study of the histological spectrum of bony lesions of cranium and spine and observed their relative frequency along with their clinical profile.

MATERIALS AND METHODS

During a 5-year period between the years 2015 and 2019, a total of 5412 specimens were received from the neurosurgery department for histological analysis. Out of these, there were 123 cases where the bones of either the spine or cranium were involved. These cases are studied retrospectively. Patients' clinical details were obtained from records. Specimens were fixed in 10% formalin, and routine histopathological processing was done. Hematoxylin and eosin staining was supplemented by special stains and immunohistochemistry, wherever required.

RESULTS

Of the total 123 bony lesions, 75 involved the cranial bones and 48 involved the spinal bones. Neoplastic lesions

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accounted for 83 cases (67.48%) and nonneoplastic for 40 cases (32.52%). The clinical data are detailed in Table 1. Most of the lesions affected patients in the age group of 21–30 years [Table 1]. The histopathology diagnoses of the tumors are shown in Table 2. On histopathological analysis, chordoma (40/83) was the most common neoplastic lesion and tuberculous osteomyelitis (30/40) was the most common nonneoplastic lesion [Table 2]. Malignant tumors (67/83) were more frequent than benign (16/83) tumors. Nonneoplastic lesions affected spine (31/48) commonly, whereas cranium was a favored site for neoplastic lesions (66/75). Clivus was the most commonly affected site by a variety of lesions. Overall, males (70/123) were more affected than females (63/123), however gender predilection varied with the type of lesions [Table 2].

Neoplastic lesions involving the bones were classified according to the World Health Organization (WHO) classification of tumors of bone and soft tissues (2014) based on their histogenesis and differentiation. A total of forty cases of chordomas were identified with a slight male preponderance (22/40 cases). Clivus (30/40) was the most common location, with the other sites being sellar-suprasellar (5 cases) and C1–C3 vertebral region (5 cases). Histopathology showed plump vacuolated and classic physaliphorous tumor cells with pale nuclei arranged in cords and clusters, forming lobules separated by incomplete fibrovascular septae. Abundant myxoid matrix was seen amidst the tumor cells. Focal lymphohistiocytic cell infiltrates, areas of hemorrhage, foci of necrosis, focal chondroid matrix, and overall inconspicuous mitotic activity were the variable features noted [Figure 1]. Five cases which showed areas of true cartilaginous differentiation in addition to the chordomatous component were labeled as chondroid chordoma [Figure 2]. One case showed focal area of dedifferentiation.

There were five chondrogenic tumors of which one was osteochondroma – a benign tumor affecting laminae and spinal processes of C5–C6 vertebrae in a 15-year-old male, showing bony trabeculae covered with a hyaline cartilage cap on microscopy [Figure 3]. The other four were malignant chondrogenic tumors – two of which were low-grade (WHO Grade I) chondrosarcoma affecting the clivus and sella. These were composed of lobules of myxohyaline chondroid matrix separated by incomplete fibrovascular septae and uninucleate and occasional binucleate cells with vacuolated cytoplasm. The other two cases affected dorsal spine (D5) and Meckel's cave. These were more cellular with a greater degree of nuclear atypia, mitotic activity, and foci of necrosis and were labeled as WHO Grade II chondrosarcomas.

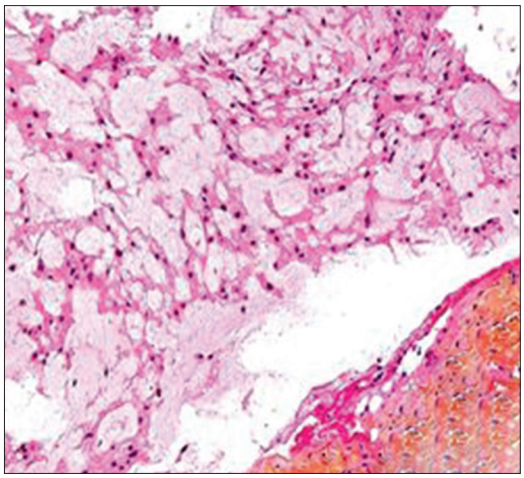

Figure 1: Chordoma; cords of tumor cells in a myxoid background (H and E, ×100)

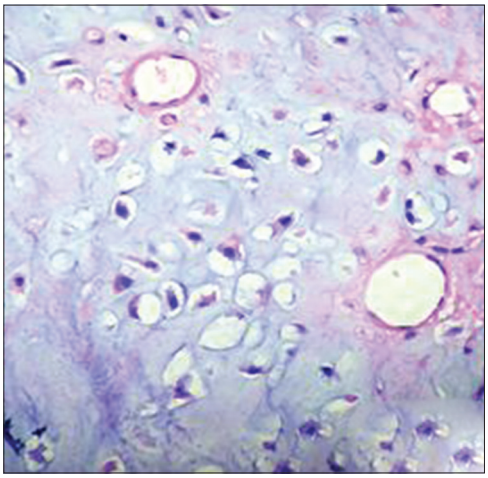

Figure 2: Chondroid chordoma; areas mimicking cartilage (H and E, ×400)

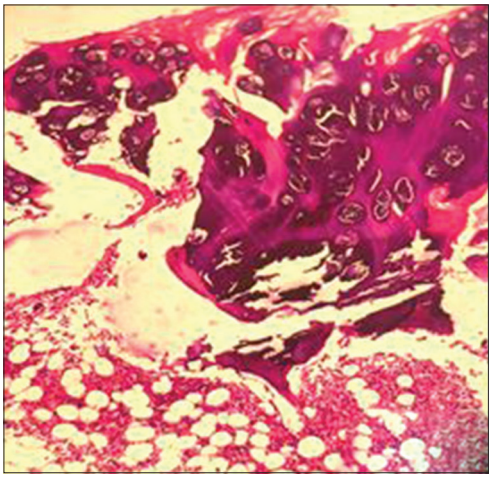

Figure 3: Osteochondroma; bony trabeculae with cartilage cap (H and E, ×400)

Four cases of Ewing sarcoma/peripheral primitive neuroectodermal tumors (pPNET), involving the cervical (C7) vertebra, body of lumbar (L3) vertebra, clivus, and petrous bone, were noted, showing fibrocollagenous tissue with dense

aggregates of tumor cells with round, densely hyperchromatic nuclei and scanty, focally clear cytoplasm [Figure 4].

Five cases of malignant hematopoietic tumors including four plasma cell myelomas and one case of non-Hodgkin lymphoma (NHL) were identified. Plasma cell myelomas affected the cervical (C5–C6) and dorsal spine (D5–D6), clivus, and parietal bone of the cranium. They showed sheets of closely packed round-to-oval tumor cells having eccentric nuclei with prominent nucleoli and abundant eosinophilic cytoplasm with distinct cell borders [Figure 5]. NHL occurred in the dorsal spine (D2) of a 30-year-old male.

Table 1: Age incidence of neoplastic and nonneoplastic lesions

Age group (years)	Neoplastic lesions (n=75)	Nonneoplastic lesions (n=48)	Total cases (n=123), n (%)
1-10	5	0	5 (4.06)
11-20	10	6	16 (13.01)
21-30	23	6	29 (23.58)
31-40	12	7	19 (15.45)
41-50	18	10	28 (22.76)
51-60	8	4	12 (9.76)
61-70	5	4	9 (7.32)
71-80	2	3	5 (4.07)

There were four cases of cavernous hemangiomas: two affecting body of the dorsal (D5 and D9) vertebrae and two affecting parietal bone of the cranium, showing thin-walled, dilated, endothelial lined vascular spaces on microscopy.

Giant cell tumor (GCT) of the bone affected the clivus and cervical (C7) spine. Microscopy showed a tumor composed

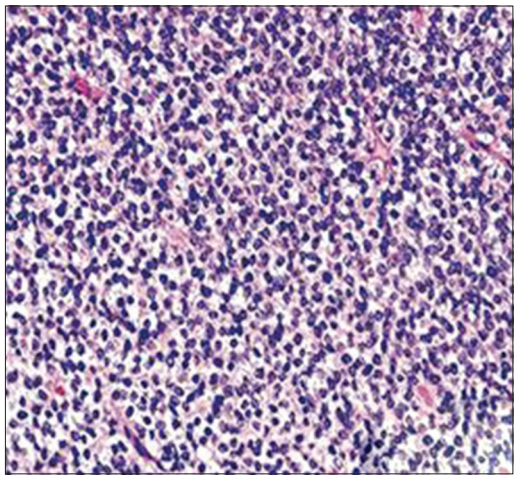

Figure 4: Ewing's sarcoma/peripheral primitive neuroectodermal tumors; uniform round cells with clear cytoplasm and round nuclei (H and E, ×400)

Table 2: Type, frequency, and gender distribution of neoplastic and nonneoplastic lesions

Type of lesion	n (%)	Male:female	Age (years)	Cranium	Spine
Neoplastic lesions	83 (67.48)	46:37	11-30	66	17
Chondrogenic tumors	5 (4.07)	3:2	11-30	3	2
Osteochondroma	1 (0.81)	1:0	11-20	0	1
Chondrosarcoma	4 (3.25)	2:2	11-30	3	1
Osteogenic tumors - osteoma	1 (0.81)	1:0	21-30	1	0
Ewing sarcoma/pPNET	4 (3.25)	4:0	1-20	2	2
Hematopoietic tumors	5 (4.07)	4:1	21-60	2	3
Plasma cell myeloma	4 (3.25)	3:1	41-60	2	2
Lymphoma	1 (0.81)	1:0	21-30	0	1
GCT	2 (1.63)	1:1	21-40	1	1
Notochordal tumors - chordoma	40 (32.42)	22:18	21-40	35	5
Vascular tumors - hemangioma	4 (3.25)	1:3	21-50	2	2
ABC	4 (3.25)	1:3	1-30	2	2
Simple cyst	1 (0.81)	1:0	31-40	1	0
Fibrous dysplasia	2 (1.63)	0:2	1-30	2	0
Langerhans' cell histiocytosis	1 (0.81)	0:1	41-50	1	0
Intraosseous meningioma	2 (1.63)	0:2	41-50	2	0
Pituitary adenoma with bony invasion	2 (1.63)	1:1	21-50	2	0
Metastatic malignancy	10 (8.13)	7:3	41-70	6	4
Nonneoplastic lesions - infections	40 (32.52)	24:16	31-50	9	31
Bacterial (acute osteomyelitis)	5 (4.07)	3:2	10-60	5	0
Mycobacterial (tuberculous)	30 (24.39)	16:14	21- 50	1	29
Fungal infection	2 (1.63)	2:0	32- 79	2	0
Parasitic (hydatid cyst)	1 (0.81)	1:0	31- 40	0	1
Chronic nonspecific inflammation	2 (1.63)	2:0	61- 70	0	2
Total	123 (100)	70:63	21- 50	75	48

GCT: Giant cell tumor, ABC: Aneurysmal bone cyst, pPNET: peripheral primitive neuroectodermal tumors

of evenly scattered osteoclast-like giant cells having vesicular nuclei with interspersed plump spindle cells [Figure 6].

Four cases of aneurysmal bone cyst (ABC) affecting the transverse and spinous processes of D4–D6 and L5 vertebrae, occiput, and sphenoid wing of the cranium were identified.

There were two cases each of fibrous dysplasia, intraosseous meningiomas [Figure 7a and b], and atypical pituitary adenomas with bone invasion. Single cases of osteoma involving the temporal bone, simple bone cyst involving the frontal bone, and Langerhans' cell histiocytosis (LCH) involving the parietal bone were noted.

There were ten cases of metastatic tumors: seven were implicated to result from hematological spread from the primary, whereas three from contiguous spread. Metastatic tumors affected the spine in elderly patients with primaries detected in the prostate, salivary gland, brain, kidney, and lung. Two carcinomas were encountered from unknown primaries. Metastasis of intracranial glioblastoma to the lumbar spine showed malignant cells with Glial fibrillary acidic protein positivity [Figure 8a and b]. Two out of three cases occurring due to contiguous spread from primary sinonasal teratocarcinosarcoma in a male child and high-grade epithelial sinonasal malignancy were noted in the clivus. The third case was a malignant neoplasm of undetermined histogenesis, which was located in the anterior skull base.

Among the inflammatory lesions, tuberculous osteomyelitis affected the spine (29/30) almost exclusively, with only one case affecting the cranium (clivus). Dorsal spine (12/30 cases) was affected most frequently. Caseating epithelioid cell granulomas, Langhans giant cells, and mixed inflammatory infiltrates were seen on microscopy [Figure 9]. Five cases were diagnosed as acute osteomyelitis in the cranium. Two cases of fungal osteomyelitis affecting the cranium showed broad aseptate hyphae with irregular branching (zygomycosis) in the clivus and narrow septate hyphae with acute angle branching (aspergillosis) in the pterygopalatine fossa. A single case of hydatid disease was identified in a 35-year-male affecting the dorsal (D9–D10) vertebrae. Histopathology showed a cyst wall composed of acellular lamellated eosinophilic layer (ectocyst) along with focally degenerated germinal layer (endocyst) [Figure 10].

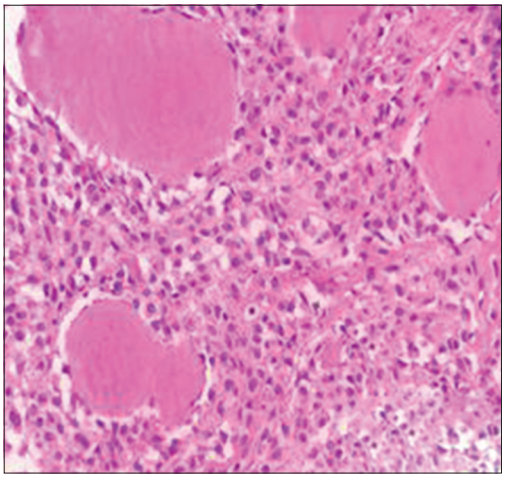

Figure 5: Plasmacytoma; cells with eccentric round or oval nuclei, with speckled chromatin and abundant cytoplasm (H and E, ×400)

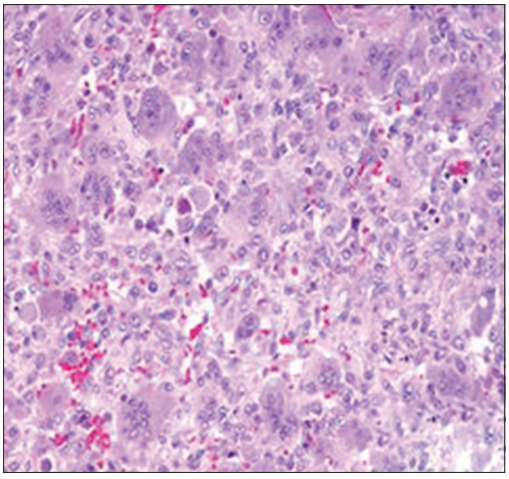

Figure 6: Giant cell tumor; many multinucleate giant cells and stromal cells (H and E, ×100)

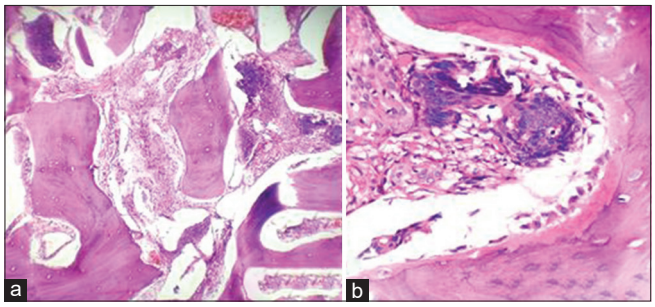

Figure 7: (a) Intraosseous meningioma; nests of meningothelial cells among the bony trabeculae (H and E, ×100). (b) Intraosseous meningioma (H and E, ×400)

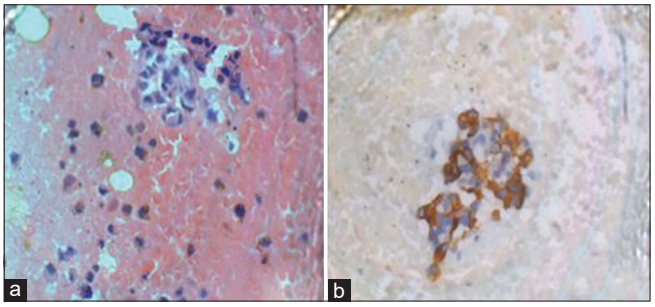

Figure 8: (a) Metastatic glioblastoma; neoplastic glial cells against hemorrhagic background (H and E, ×400). (b) Metastatic glioblastoma; GFAP-positive neoplastic glial cells (IHC, × 400)

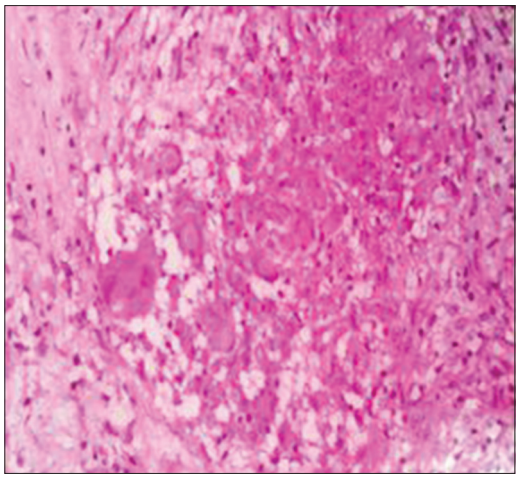

Figure 9: Tuberculous inflammation; epithelioid granulomas, Langhans giant cells, and aggregates of lymphocytes (H and E, ×400)

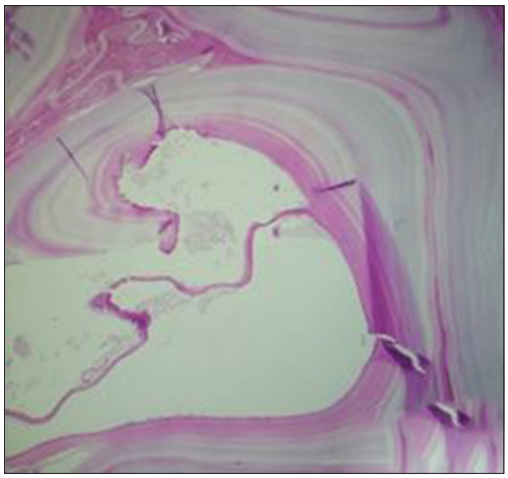

Figure 10: Hydatid cyst; eosinophilic lamellated ectocyst (H and E, ×400)

DISCUSSION

There are only a few studies in the literature that analyzed the relative frequency and nature of involvement of bone in neurosurgical practice. Kakkar *et al*. reported a series of 125 cases of skull bone tumors. Of these, malignant tumors (78.4%) were more common than benign (14.4%), chordoma was the most common neoplasm (34.4%), and base of the skull was the most frequent location.[1]

Chordomas develop in those areas where vestiges of the embryonal notochord remain. The site of origin for spheno-occipital or skull base chordomas is the clivus. Vertebral chordomas can develop anywhere along the spinal canal; however, they involve the lumbar, cervical, and thoracic regions, in this order of frequency. In a study of forty patients with spinal chordomas, the age of patients ranged from 20 to 80 years and male preponderance was seen.[2] In our study, most of the affected patients were aged between 21 and 40 years with a slight male preponderance.

Chondrogenic tumors are more common in the skull base than in the cranial vault, as the bones of the former are formed by enchondral ossification, while those of the latter are formed by intramembranous ossification. Osteochondromas are located frequently in the long bones and rarely involve the spine, representing only 2.6% of benign tumors of the spine. In our series, there was a single case of osteochondroma located in the C5–C6 region of spine.

Chondrosarcomas are rare neoplasms accounting for only 0.16% of all intracranial tumors, and majority of these occur at the base of the skull (petrous temporal bone, clivus, and temporo-occipital junction).[1] There were three cases of cranial chondrosarcomas with similar sites of occurrence. Spinal chondrosarcomas are rare and represent <10% of all chondrosarcomas. Most of them arise from the body and posterior elements of the thoracic spine followed by cervical region and are relatively rare in lumbar vertebra.[3] In our case, the tumor was seen arising from the body of D5 vertebra.

Primary spinal Ewing sarcoma/pPNET commonly involves sacrococcygeal region followed by thoracic, lumbar, and cervical regions.[4] It rarely occurs in the skull; only fifty cases have been reported in the English literature till 2019.[5] In our series, there were four cases of Ewing's sarcoma/pPNET, two of which involved the skull in the petroclival region and the other two involved the lumbar spine. According to the WHO, it shows a predilection for males, with nearly 80% of patients being younger than 20 years with peak incidence during the second decade of life. Similar findings were noted in our study.

Plasma cell myelomas generally affect bones that contain hematologic marrow in adults, such as vertebrae, ribs, skull, pelvis, femur, clavicle, and scapula. Many studies have reported the occurrence of plasmacytoma in the skull predominantly in the elderly in the sixth decade, with the most common location being the parietal bone of cranium.[6,7] In our study, two out of the four cases were in the cranium involving the clivus and parietal bone and two involved the cervical and dorsal spine.

Spinal lymphomas are relatively uncommon and account for 1%–2% of lymphomas.[8] They have been described in all age groups but mostly occur in the fifth to sixth decades of life and show a male predominance. NHL accounts for 85% of spinal lymphoma cases, with the majority being diffuse large B-cell lymphomas. These are most commonly located in the thoracic spine, followed by the cervical and less commonly in the lumbar spine. A single case of spinal lymphoma in our study showed all aforementioned features.

Intraosseous hemangiomas are relatively rare; spine is the most commonly involved site, followed by the skull bones, particularly the frontal and parietal bones. Hemangiomas of the skull represent 0.2% of all osseous tumors, and 10% of all the benign tumors of the skull.[9] Although cavernous hemangioma of the skull is more prevalent in middle-aged women, the exact gender distribution has not been clearly established. All the four cases of hemangiomas in our study were of cavernous type, affecting females. Two cases were located in the parietal calvarium and two involved the dorsal spine.

Osteomas are benign, slow-growing bony tumors, seen in young males. They arise in the craniofacial region, particularly in the paranasal sinuses and the jaw bones, and rarely affect the skull bones.[10] Osteomas are rare in the temporal bone (0.1%–1% of all benign tumors of the skull).[10] In our study, the osteoma was located in the temporal bone, making it a common tumor at a rare site.

Among GCTs of the bone, approximately 1% affects the bones of the skull and face, with the sphenoid bone being the most common location.[1] GCT of the spine is rare and is among the aggressive benign primary tumors of the spine, with a high predilection for recurrences. We identified two cases of GCT: one involving the clivus and the other C7 vertebra. Dahlin and Schwimer found peak incidence in the second and third decades with a wide range of occurrence (2–66 years), which was also observed in our cases.[11]

ABC is a benign cystic lesion that frequently presents before 20 years and commonly affects the long bones, but up to 20% occur in the spine, predominantly involving the posterior elements.[12] The involvement of skull is rare, accounting for 2.5%–6% of cases.[13] ABC may be primary or secondary to other bony lesions, such as fibrous dysplasia and chondroblastoma, which may have predisposed its development.[13] In our study, we found two cases of spinal ABCs affecting the dorsal and lumbar regions and two cases affecting the sphenoid wing and the occiput. One of the cases was associated with fibrous dysplasia and the other with GCT.

A simple bone cyst is a cystic lesion surrounded by a hard bony wall with no epithelial lining and no evidence of infection, with an unknown etiology, mainly seen in long tubular bones but rarely in calvarium.[14] We reported a single rare case of simple bone cyst in a 20-year-old male in the frontal bone.

Fibrous dysplasia affects skull and facial bones in 10%–25% of patients with monostotic and in 50% of patients with polyostotic fibrous dysplasia. In the skull base, ethmoid, sphenoid, frontal bone, and maxilla are involved in decreasing order.[15] In our study, fibrous dysplasia affected the parietal and orbital bones.

LCH arises from an abnormal proliferation of Langerhans' cells, commonly presenting as a solitary lesion in the skull, with femur, mandible, ribs, pelvis, and spine being the other common locations. In a series of 18 LCH cases of skull, there was an obvious male predominance; frontal bone was the most frequent affected location, followed by occiput, orbit, temporal, and parietal bones.[16] LCH can occur at any age, but mainly in children of 1–4 years old. The incidence of LCH in adults is 1–2 cases per million.[16] We reported a case of LCH affecting parietal bone in an adult male aged 41 years.

Intraosseous meningioma, a rare subtype of meningioma, accounted for <2% of all meningiomas. It was predominantly seen in women in the fifth and sixth decades of life.[17] Both the cases in our study affected females in their forties and showed meningothelial and transitional meningiomas on histology amidst bony trabeculae. Being a rare subtype, it sought a special attention.

In a large series of pituitary adenomas, out of 29 atypical pituitary adenomas, three showed infrasellar invasion with erosion of the base of the sella turcica.[18] We reported two pituitary adenomas with rare extensive bony invasion into the sphenoid bone.

The skeleton, after lungs and liver, is the third most common site of metastatic disease, and it is the most common malignancy of bone. Overall, the most common sites of bony metastases are the spine, pelvis, ribs, skull, and proximal femur and breast, lung, prostate, kidney, and thyroid constitute the common primary lesions in adults.[19] In our study, we identified a rare case of a metastatic glioblastoma in the lumbar spine from a known primary intracranial glioblastoma multiforme (GBM). Extracranial GBM metastases occur in only about 0.4%–2.0%.[20] However, in recent years, the number of cases of spinal metastasis from intracranial GBM seems to be increasing, which might be due to improved diagnostic tools, prolonged survival time due to improved therapy, or changes in the biological properties of tumors as a result of surgery, radiotherapy, and chemotherapy.[21] The most common sites for spinal GBM metastases are the lower thoracic, upper lumbar, and lumbosacral region. We also reported a rare cervical spine metastasis from salivary gland neoplasm.

Infections of cranium and spine form a major bulk of the nonneoplastic lesions. Tuberculosis (TB) is highly prevalent in

developing countries, with skeletal involvement seen in 10% of all patients with extrapulmonary TB.[22] In our study, dorsal spine was the most affected area followed by lumbar, with a male predilection, similar to other studies in literature.[22,23] Tuberculous osteomyelitis of skull is a very rare occurrence, accounting for 1% of skeletal TB.[24] Isolated TB of spheno-clival region is very rare; in the few reported cases, it was involved in contiguity, from the mastoids, paranasal sinuses, or adjacent meninges.[25] In our study, only one case of tuberculous osteomyelitis of clivus was found, illustrating its rare occurrence.

Postoperative craniotomy-related infections are the predominant source of cranial osteomyelitis in developed countries.[26] In our study, five cases were diagnosed as acute osteomyelitis in the cranium, of which three were seen in the postoperative period.

In our study, the occurrence of zygomycosis in the clivus in an elderly male and aspergillosis in the pterygopalatine fossa could be due to contiguous spread from the invasive fungal sinusitis in an immunocompromised state, as observed in the literature.[27]

Parasitic infections affect the bone infrequently. In a study pertaining to bone cystic echinococcosis in Serbian population, which is an endemic country for echinococcosis, thoracic spine was most commonly involved.[28] This was seen in our case too.

CONCLUSIONS

This study portrays a wide array of common and uncommon lesions of diverse etiology occurring at usual and unusual sites.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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