

BENIGN SKULL LESIONS

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OBJECTIVE: To document the epidemiologic and clinical features of benign skull lesions.

DESIGN: A case series.

SETTING: St. Michael's Hospital, a tertiary care facility affiliated with the University of Toronto.

PATIENTS: Thirty-one patients who had a neurosurgical consultation and were discharged from hospital after excision of a benign skull lesion during a 10-year period.

MAIN OUTCOME MEASURES: Patient demographics, clinical signs and symptoms, radiographic and pathological tumour characteristics, surgical procedure, length of hospital stay, outcome and follow-up.

RESULTS: The 31 patients (6 men, 25 women) had 32 lesions excised. The mean age of the patients was 41.9 years. Osteomas accounted for 63% of the tumours. The most frequent location was the parietal bone. Neurologic symptoms were absent in the majority of calvarial tumours. Useful diagnostic studies included plain skull radiography and computed tomography. Nuclear bone scanning was done in 7 patients. All patients underwent craniectomy, with cranioplasty in most cases. Three patients had new neurologic symptoms postoperatively and 1 patient had incomplete resolution of symptoms.

CONCLUSIONS: Benign skull lesions are infrequent, but they require neurosurgical intervention. When necessary, surgical excision can serve to confirm the diagnosis, improve cosmesis and retard the progression of neurologic dysfunction. Of primary importance is the recognition of such lesions by primary care physicians and referral to the surgeon so that an appropriate treatment plan can be made.

OBJECTIF : Documenter les caractéristiques épidémiologiques et cliniques des lésions bénignes au crâne.

CONCEPTION : Série de cas.

CONTEXTE : Hôpital St. Michael's, établissement de soins tertiaires affilié à l'Université de Toronto.

PATIENTS : Trente-et-un patients qui ont consulté en neurochirurgie et ont été libérés de l'hôpital après l'excision d'une lésion bénigne au crâne sur une période de 10 ans.

PRINCIPALES MESURES DES RÉSULTATS : Démographie des patients, signes et symptômes cliniques, caractéristiques radiographiques et pathologiques de la tumeur, intervention chirurgicale, durée de l'hospitalisation, résultats et suivi.

RÉSULTATS : On a procédé à l'excision de 32 lésions chez les 31 patients (6 hommes, 25 femmes). Les patients avaient en moyenne 41,9 ans. Les ostéomes, qui constituaient 63 % des tumeurs, étaient situés le plus souvent sur l'os pariétal. La majorité des tumeurs de la boîte crânienne ne présentaient aucun symptôme neurologique. La radiographie ordinaire du crâne et la tomographie par ordinateur étaient au nombre des études diagnostiques utiles. On a soumis sept patients à une scintigraphie nucléaire des os. Tous les patients ont subi une craniectomie et, dans la plupart des cas, une cranioplastie. Ces patients présentaient de nouveaux symptômes neurologiques après l'intervention et les symptômes ne sont pas tous disparus dans un cas.

CONCLUSIONS : Les lésions bénignes du crâne sont peu fréquentes, mais elles obligent à procéder à une intervention neurochirurgicale. L'excision chirurgicale peut servir au besoin à confirmer le diagnostic, à améliorer des aspects esthétiques et à ralentir la progression du dysfonctionnement neurologique. Il est crucial que les médecins de premier recours reconnaissent de telles lésions et dirigent comme il se doit le patient vers la chirurgie afin que l'on puisse établir un plan de traitement approprié.

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Skull neoplasms are not uncommon in the practices of many primary care physicians. Often presenting as a painless, palpable mass or as an incidental finding on radiographic studies, such lesions frequently require further investigation and consultation with a general, plastic or neurosurgeon to select a suitable treatment. Examination of the literature reveals very few studies, especially in the past 20 years in North America, that look at the patient demographics and characteristics of benign skull lesions. In response to this finding, we reviewed the 10-year experience of 4 neurosurgeons with respect to benign skull neoplasms.

METHODS

A patient record search was conducted in the medical records and pathology departments at St. Michael's Hospital in Toronto. From July 1, 1986, to July 1, 1996, 31 patients received neurosurgical consultation and had subsequent excision of 32 benign skull lesions. Their records, pathology slides, and radiographs were reviewed.

RESULTS

The age of the 31 patients at the time of presentation to a neurosurgeon ranged from 18 to 76 years (mean 41.9 years). Within this population, there was a marked predominance of women (female to male ratio 4.2:1).

The majority of patients had osteomas (18 patients). This was followed, in order of decreasing frequency, by meningiomas (5 patients), intraosseous hemangiomas (2 patients), fibrous dysplasia (2 patients), osteoid osteoma (1 patient), eosinophilic granuloma (1 patient), frontal sinus mucocele (1 patient) and hypertrophic bone (1 patient) (Table I).

The most common location of the

neoplasms was in the parietal bone (12 patients), followed by the frontal (10 patients), temporal (6 patients), greater wing of the sphenoid (2 patients) and occipital (1 patient) bones.

In 4 patients, the tumour was an incidental finding after CT or nuclear bone scanning. Six patients had a history of related tumours. Three patients with skull meningiomas had a history of dura-based meningioma resection. The patient with hyperostosis of the mastoid process had a similar bony overgrowth removed from the tibia. One patient was undergoing investigation for a hemangioma and osteoblastoma of the pelvis when her calvarial hemangioma was discovered. The neoplasms were unrelated in 2 patients: 1 had a history of breast adenocarcinoma and another had a history of cervical carcinoma in situ.

The symptoms were highly dependent on location. Lesions of the cranial vault with no significant intracranial extension were not generally associated with neurologic symptoms. Twenty-five patients reported a firm to hard immobile mass on the skull which had been noticed for an average of 3.1 years (range from 3 weeks to 33 years). Mild localized pain and tenderness were reported in 6 cases. Six patients reported nonspecific headaches and dizziness, accompanied by nausea and photophobia in 2 cases. Only 3 pa-

tients presented with definitive neurologic signs and symptoms. One patient who had a tumour of the greater wing of the sphenoid bone presented with a 6-month history of decreased visual acuity, visual fields, relative afferent pupillary defect, decreased conductive hearing and intermittent pain in the maxillary division of the trigeminal nerve, all of which were left sided. A patient with an occipital tumour near the foramen magnum presented with decreased gag reflex, bilateral upper extremity weakness, paraesthesias in all fingers, ataxia and a left-sided pronator drift. Finally, left ptosis and vertical diplopia were the clinical manifestations of a frontal sinus mucocele.

Radiologic investigations in all patients included plain film radiography of the skull and CT with bone and tissue-density imaging. Seven patients underwent nuclear bone scanning, and 3 patients had magnetic resonance imaging with gadolinium contrast. The dimensions of tumours found in the frontal, parietal, temporal and occipital bones, as determined by CT, ranged from 0.5 cm to 5.2 cm in maximal diameter (mean 3.4 cm) and from 0.8 cm to 2.7 cm in maximal height above the outer table of the skull (mean 1.3 cm). The 2 sphenoid bone tumours were 3.3 cm and 3.7 cm in maximal diameter.

All operative procedures were com-

Table I

Classification of Tumours by Sex in 31 Patients With Benign Skull Lesions

Type of tumour	Women, no.	Men, no.
Osteoma	16	3
Meningioma	4	1
Fibrous dysplasia	1	1
Hemangioma	2	0
Mucocele	1	0
Eosinophilic granuloma	0	1
Hypertrophic bone	0	1

pleted within the first year after presentation.

Tumour excision was attempted to confirm a diagnosis, to improve cosmesis and to halt or reverse neurologic dysfunction. Tumour resection was accompanied by acrylic cranioplasty in 27 cases.

The mean length of hospital stay was 3.6 days (mode 3 days, range from 2 to 7 days).

There were no complications in the month after operation. Removal of the sphenoid tumour left 1 patient with residual decreased visual acuity in the left eye, pain and decreased sensation in the maxillary division of the trigeminal nerve, and dizziness. A partial ptosis remained after excision of a mucocele from a frontal sinus. New postoperative symptoms included a left-sided hypoglossal nerve paralysis and paresis of cranial nerve 10 after excision of an occipital lesion and a mild frontal paresis after removal of a frontal eosinophilic granuloma.

The mean follow-up was 18 months (range from 6 months to 4 years). The patient with an osteoid osteoma had a recurrent tumour, which was excised.

DISCUSSION

Osteoma

Osteomas are slow-growing osteoblastic tumours arising in bones formed by intramembranous ossification. They are the most common primary bone tumour of the craniofacial skeleton.¹ We found 18 cases of osteoma arising in the calvarium. The ratio of women to men was 8:1 (16 women 2 men). This is greater than literature reports, which estimate the ratio as 3:1.² The mean age of these patients at presentation was 40.5 years (range from 21 to 76 years), marginally younger than the mean age for pa-

tients with benign skull tumours in general. The most common location for the neoplasm was in the parietal bone (9 patients), followed by the frontal bone (5 patients) and temporal bone (4 patients). None of the 18 patients had a neurologic deficit. However, 5 patients reported nonspecific headaches, associated with photophobia and nausea in 1 patient. Mild localized pain and tenderness were reported in 4 cases.

One patient presented after identification of an area of increased uptake on a nuclear bone scan whereas the remaining 17 patients presented with a hard, immobile mass that had been present for an average of 3.4 years. On plain radiographs, the neoplasms typically appeared as well-defined radiopaque lesions, arising from the outer table of the skull in 17 cases and from the inner table in 1 case. Characteristically, there was no involvement of the diploe. On CT, the bone density windows showed a homogeneously dense lesion with protrusion extracranially, except for the tumour that arose from the inner table of the skull, which showed minimal intracranial extension. Tumour dimensions averaged 3.3 cm in maximal diameter with a height of 1.2 cm, measured from the outer table of the skull. The tumour that arose from the inner table of the skull was 0.9 cm in height. Microscopically, these ivory osteomas consisted of tightly packed, irregular lamellar bone with a small amount of interspersed bone marrow.

Osteoid osteoma

Although osteoid osteomas account for 2.6% of excised primary bone tumours, they rarely occur in the skull.³ There was only 1 case in our series. A 35-year-old woman presented with a 2-year history of a hard, im-

mobile, tender mass over the left parietal eminence. She complained of local pain at night that was relieved by non-steroidal anti-inflammatory medications. This is the standard pain profile of an osteoid osteoma. There was no neurologic deficit. A plain film of the skull showed a $3.4 \times 3.0 \times 1.1$ cm density. CT with contrast revealed the same bony exostosis, which was nonenhancing. The lesion was excised 1 month later. Microscopic evaluation showed tightly packed irregular trabeculae with very little fibrous stroma surrounded by dense reactive sclerosis, consistent with an osteoid osteoma. Follow-up consisted of routine skull films and clinical evaluation at 6-month intervals. Twenty-five months after the first excision, a recurrence was noted radiographically and clinically. The $3.1 \times 2.3 \times 0.9$ cm lesion was excised. No further recurrence occurred during the ensuing 2 years.

Mucocele

Mucoceleles are benign, non-neoplastic epithelial cysts originating in the paranasal sinuses. Although commonly found in isolation, mucoceleles can develop after occlusion of the ostia by another growth. This occurs most commonly in the frontal sinus where an osteoma may be associated with the mucocele.⁴ Other lesions included in the differential of a primary mucocele and of the primary process leading to a secondary mucocele are fibrous dysplasia, encephalocele, meningioma, neurilemmoma, as well as primary and secondary malignant tumours.⁵

A 63-year-old woman presented to an otolaryngologist with a 1-month history of ptosis of the left eyelid, vertical diplopia and a feeling of pressure above the eyes. CT demonstrated a well-circumscribed homogeneous lesion occupying much of the left

frontal sinus with erosion of the posterior wall and extension through the orbital roof. In consultation with a neurosurgeon, it was agreed that the lesion was most likely a complex mucocele. After excision, microscopic examination showed a cyst lined with ciliated columnar epithelium filled with a viscid material. There was no associated bony disorder.

Hemangioma

Intraosseous hemangiomas account for 0.7% of all osseous neoplasms, with most of these seen in the vertebral column.⁶ The skull is the next most frequent site, where hemangiomas of bone constitute 10% of benign neoplasms, making them the second most common primary calvarial tumour.⁷ A predilection for the frontal and parietal bones has been noted.⁸ Only 2 cases were found in our 10-year review; both patients were women, aged 35 and 44 years, with frontal bone lesions.

The 35-year-old woman presented

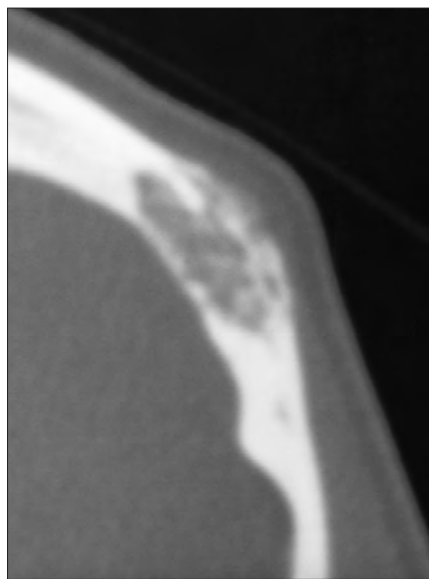


FIG. 1. Computed tomography scan of an intraosseous hemangioma showing involvement of the diploë and the outer table.

with a 4-year history of a painless mass over the left lateral forehead. Plain film radiographs of the skull demonstrated an osteolytic area measuring $3.2 \times 2.0 \times 0.8$ cm with central bony spiculation, indicative of the classic honeycomb appearance, and some surrounding sclerosis. CT, performed because nuclear bone scanning indicated an area of increased uptake in the frontal region, revealed an intradiploic lesion with a maximum diameter of 2.2 cm that had extended beyond the outer table of the skull (Figs. 1 and 2). Microscopic examination of the excised material showed an array of bony trabeculae with a conglomeration of blood vessels in the marrow spaces. The vessels were smooth walled with the appearance of veins and capillaries.

Fibrous dysplasia

Fibrous dysplasia may be considered a potentially premalignant bone-forming condition.³ It is a developmental anomaly of bone-forming mesenchyme in which woven bone does not properly mature to lamellar bone, accompanied by a surrounding

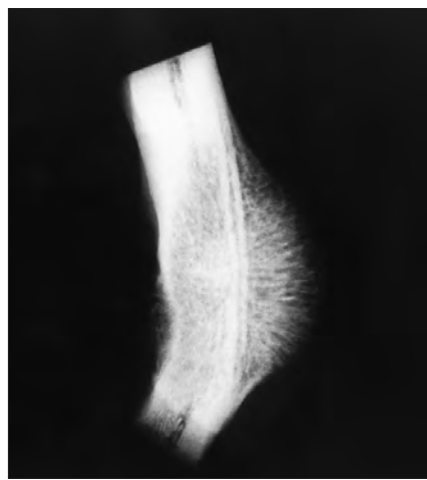


FIG. 2. Radiographic appearance of excised intraosseous hemangioma. Note the central bony spiculation.

overgrowth of well-vascularized fibrous stroma.⁹ The skull is involved in 27% of patients with monostotic fibrous dysplasia and in up to 50% of patients with polyostotic fibrous dysplasia.¹⁰ Malignant degeneration occurs in approximately 0.4% of cases.¹¹ Only 2 patients (an 18-year-old woman and a 42-year-old man) with fibrous dysplasia underwent surgery in the 10-year study period. Both had the monostotic form, involving the temporal and parietal bones.

The 18-year-old woman presented with a 6-month history of nonspecific headaches and dizziness, as well as a nontender, palpable swelling superior and anterior to the left pinna. There was no demonstrable neurologic deficit. CT showed a full-thickness lesion in the left temporal bone that was protruding slightly into the interior of the cranium as well as to the exterior of the cranium (Fig. 3). The lesion was intradiploic and multilocular and was separated by bony trabeculae. It showed increased uptake on nuclear bone scanning. A skull film demonstrated expanded diploë with surrounding sclerosis. Two months later, the lesion, which measured $2.9 \times$

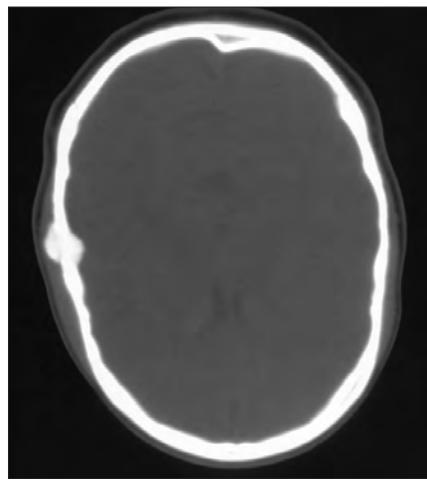


FIG. 3. CT scan of a patient with fibrous dysplasia showing a full-thickness lesion with both intra- and extracranial extension.

2.2 × 1.3 cm, was excised and an acrylic cranioplasty performed. Pathologically, the excised material showed prominent bony trabeculae with interspersed fibrosis of the bone marrow. There were no osteoblasts in the thickened region. When viewed under polarized light, random double refraction, indicative of immature woven bone, was visible. A lack of apparent involvement of other locations led to a presumptive diagnosis of monostotic fibrous dysplasia.

Meningioma

Three types of meningiomas were seen. The first type, seen in 3 women in this study, are meningiomas that secondarily invade the skull. This is not an uncommon finding given the intimate relationship of the dura to the skull. Typically, as neoplastic cells enter the skull, an osteoblastic response occurs, which can subsequently be identified as a palpable mass on the skull or, radiologically, as an area of hyperostosis.⁴ In 2 cases, the patient had a history of meningioma resection whereas in the last case an underlying meningioma was present at the time the skull lesion was diagnosed. Two patients were 54 years old at the time of presentation, the other was 66 years old. Lesions occurred in the occipital bone near the foramen magnum, the frontal bone and the greater wing of the sphenoid bone. Microscopic examination of the excised material revealed an infiltration of neoplastic cells into the bone with a whorled appearance and basophilic psammoma bodies. This was accompanied by an osteoblastic reaction as evidenced by the hyperostosis of the surrounding area.

The second type are intraosseous meningiomas. These are rare neoplasms in which the meningioma is confined entirely to the bone. It has

been postulated that such tumours arise from arachnoid cell rests within the bone. Further, 25% to 50% of reported cases have been located in the sphenoid bone.¹² We found 1 case of an intraosseous meningioma with no evidence of dural-based meningioma.

A 67-year-old man first presented to a general surgeon with a firm lesion in the left frontal region that he attributed to mild head trauma sustained 2 months before. His medical history was remarkable only for non-insulin-dependent diabetes mellitus. Radiographically, the osteolytic lesion was 3.3 cm in maximal diameter. The surgeon believed this was either a metastasis or a manifestation of hyperparathyroidism. Investigations revealed elevated fasting glucose and thyroid stimulating hormone levels. Curettage of the outer portion of the lesion was done under local anesthesia. Microscopic examination of the excised bone led to a diagnosis of malignant fibrous histiocytoma. The patient was referred to a neurosurgeon at St. Michael's Hospital. The slides were reviewed by the neuropathologist who believed the sample was more suggestive of a skull meningioma. This was supported by the finding of cells immunoreactive for epithelial membrane antigen. CT revealed an irregular lytic lesion, which had destroyed both the inner and outer tables of the skull (Fig. 4). A soft-tissue component was apparent but no significant intracranial extension was evident. Craniectomy and cranioplasty followed 1 month later. Microscopic examination revealed a fibroblastic meningioma, which arose in the bone and was infiltrating the dura and extending to the periosteum.

The third type are subgaleal meningiomas. There was 1 such case in this series. A 35-year-old woman with a history of left convexity meningioma resection presented to a neurosurgeon complaining of a hard mass in the left frontal region. On examination, the le-

sion was consistent with an osteoma. Plain radiographs of the skull were unremarkable, and the lesion was not evident on CT. The presumptive diagnosis was of a noncalcific osteoma. One year later on physical examination the lesion was found to have grown. However, skull radiographs remained unremarkable. The lesion, which was found to overlie the region of the previously resected meningioma, was excised. Microscopically, bony trabeculae were seen with some surrounding connective tissue in which were found small fragments of meningioma. The surrounding soft tissue showed evidence of chronic inflammation and a foreign-body type of granulomatous reaction but without tumour involvement.

Eosinophilic granuloma

Eosinophilic granuloma is defined as a proliferation of Langerhans cells accompanied by eosinophils, histiocytes, lymphocytes, neutrophils and scattered plasma cells.¹³ Thirty-four percent of such neoplasms occur in children younger than 4 years and 74% occur in patients younger than 20 years.¹⁴ Although any bone may be af-

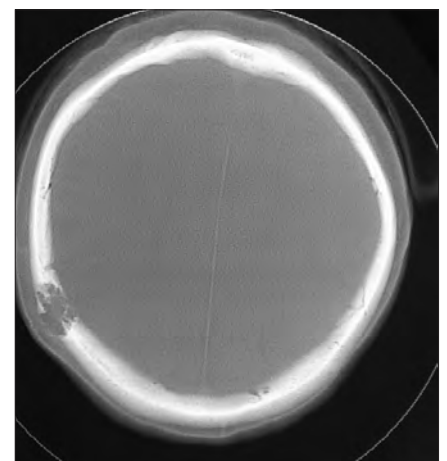


FIG. 4. CT of a patient with an intraosseous meningioma. An irregular lytic lesion is seen with destruction of the inner and outer tables of the skull.

ected, the skull is the most common site.³ Surgical excision of a solitary eosinophilic granuloma is commonly curative, although there is a risk that additional lesions may develop, usually within 6 months to 1 year after the initial diagnosis.¹³

Only 1 case of eosinophilic granuloma was noted in our study. An 18-year-old man presented to a neurosurgeon with a 3-week history of an enlarging, firm, nontender right frontal mass. This previously healthy man had no systemic complaints. Plain radiographs showed an erosive lesion of the right frontal bone near the midline and superior to the frontal sinus. Both the inner and outer tables of the skull were involved. The presumptive diagnosis of an eosinophilic granuloma was supported by CT, which further suggested dural involvement. The lesion was 5.0 cm in maximal diameter and 0.8 cm in height. During surgery, it was clear that the lesion involved the full thickness of bone, the periosteum and the dura, including part of the superior sagittal sinus. Microscopically, a mixture of large pleomorphic histiocytes with indented contours and smaller inflammatory cells, most conspicuous of which were eosinophils, were seen in the section. Several multinucleated giant cells were dispersed throughout. Focal areas of necrosis were apparent. Immunohistochemically, the histiocytes were positive for S100 protein. The diagnosis of an eosinophilic granuloma was thus confirmed.

Hyperostosis of bone

The final patient in our series had hyperostosis of the mastoid process. Though not a true neoplasm of the skull, hyperostosis of bone is important because its differential diagnosis includes true skull tumours, most notably osteomas. A 36-year-old man presented to a neurosurgeon with a

mass behind the right ear that was first noticed 15 years earlier. There was no associated discomfort or auditory symptoms. Plain film radiographs of the skull demonstrated a dense bony lesion protruding extracranially from the outer table of the skull (Fig. 5). CT showed a $4.5 \times 3.5 \times 1.0$ cm homogeneous, hyperdense lesion and confirmed a lack of involvement of the diploe (Fig. 6) and surgical excision was deemed appropriate. The preoperative diagnosis was osteoma. Microscopic examination of the excised material showed dense mature bone with no atypical features. It was deemed to be hypertrophic bone formation. Interestingly, on further questioning of the patient, a similar bony overgrowth had been excised from the right tibia many years previously.

SUMMARY AND CONCLUSIONS

As evidenced by the 31 cases in our series, benign skull lesions are not

common in neurosurgical practice. Osteomas accounted for 63% of the cases. Symptoms vary greatly, from neurologic dysfunction to a painless palpable mass or no overt manifestations. Craniectomy performed for such purposes is associated with a very low morbidity and no deaths in this series. Although the period of follow-up was relatively short, especially for patients treated in the mid-1990s, the recurrence rate appears to be low, as only 1 instance of recurrence was noted.

Frequently, the onus is on the family practitioner to initially identify these skull lesions. Hence, it is imperative that these professionals, as well as the otolaryngologist and plastic and general surgeons to whom such patients are often referred, are familiar with the features of skull neoplasms and recognize when neurosurgical consultation is indicated. Appropriate evaluation of skull lesions includes plain radiographs of the skull as well as bone and tissue density CT. The

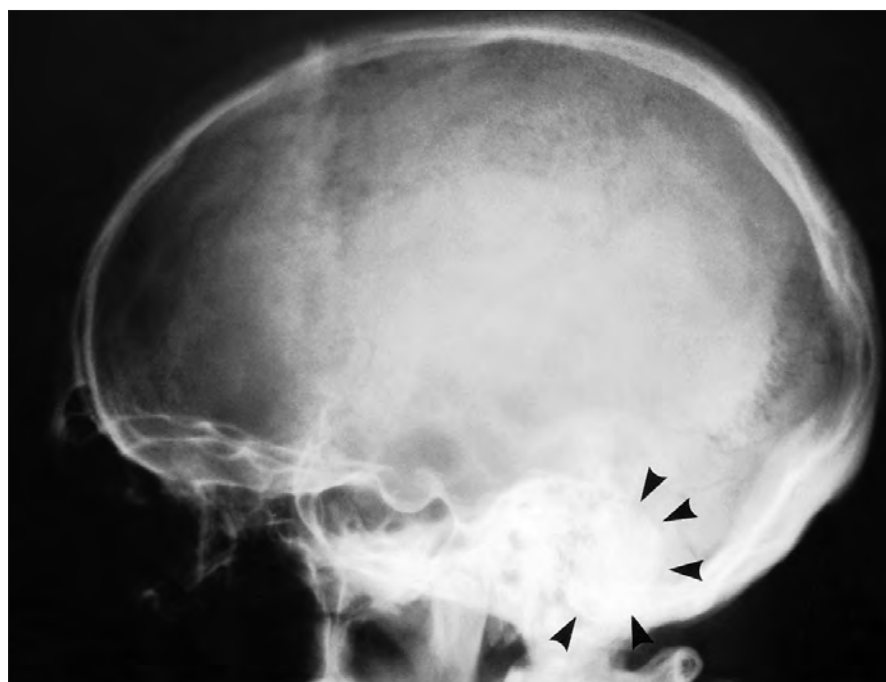


FIG. 5. Lateral plain skull radiograph showing an area of increased density (arrows) as seen in hyperostosis of bone.

goal of surgical excision is first to exclude the possibility of a malignant lesion. Neoplasms commonly appearing in the differential diagnosis include primary and secondary osteogenic sarcoma, fibrosarcoma, chondrosarcoma and bone metastases. However, these lesions, generally have a shorter course and radiographs that show less defined margins and minimal surrounding sclerosis. A history of other neoplasms or of radiotherapy may be elicited. Second, when neural structures have been compromised or are at risk, prompt resection will often halt progression of the process and, in some cases, may restore much of the lost

function. Finally, with appropriate intervention, cosmetic deformities may be corrected. However, surgical excision is only one option in the management of benign skull lesions. Careful observation may be appropriate when the diagnosis is almost certain, when neural structures are not at risk, when cosmetic deformity is not significant or is not of great importance to the patient and when concomitant medical ailments make the patient a poor surgical candidate.

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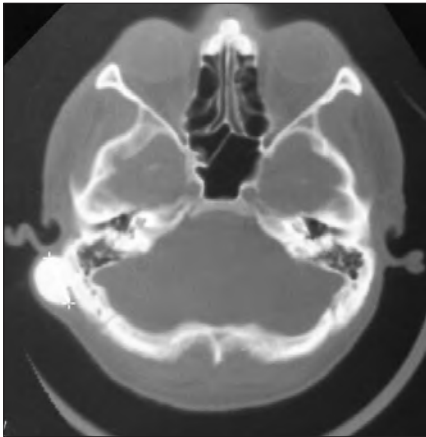


FIG. 6. CT scan of hyperostotic bone showing a homogeneous, hyperdense lesion.