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Case Report

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When Bone Grows Beyond Its Bounds: A Giant Exophytic Parieto-Occipital Osteoma - Case Report and Review of the Literature

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ABSTRACT

Background: Osteomas are benign, slow-growing, bone-forming neoplasms. Lesions exceeding 30 mm in maximum diameter, or exceeding 110g in mass, are conventionally classified as "giant", and those involving the cranial vault are exceptionally uncommon. We report a case of a massive exophytic parieto-occipital osteoma of extraordinary dimensions that, to our knowledge, ranks among the largest reported in the world literature.

Case Presentation: A 24-year-old woman presented with a slowly enlarging, painless, hard mass over the posterior cranium of more than ten years duration. Clinical examination revealed a massive, firm, non-tender, bosselated swelling occupying the parieto-occipital region, measuring 13 × 12 × 11.5 cm. Computed tomography (CT) of the head confirmed a densely sclerotic, ivory-type exostosis arising from the outer table of the calvarium without intracranial extension. The lesion was excised en bloc under general anaesthesia via a midline posterior craniectomy approach; intraoperative weight of the specimen was ~1800g. Histopathology confirmed a compact (ivory) osteoma. The patient made an uneventful recovery.

Conclusion: Giant calvarial osteomas, though histologically benign, pose significant surgical challenges due to their size, vascularity, and proximity to major dural sinuses. Complete surgical excision remains the definitive treatment. Our case exemplifies the importance of thorough preoperative planning, meticulous haemostatic technique, and multidisciplinary perioperative care in the management of extreme-sized skull osteomas.

Keywords: Giant Skull Osteoma, Craniectomy, Benign Bone Tumour, Case Report

Introduction

Osteomas are benign, hamartomatous or neoplastic bone-forming tumours composed of well-differentiated, mature lamellar bone. They arise almost exclusively from membranous bones of the craniofacial skeleton, with the paranasal sinuses, particularly the frontal and ethmoid sinuses, constituting the most common sites of origin [1,2]. Involvement of the cranial vault, though recognised, is distinctly uncommon, and lesions of sufficient size to merit the designation "giant" are encountered only sporadically in the world literature [3,4].

The term "giant osteoma" is applied to lesions with a maximum diameter exceeding 30 mm or a mass exceeding 110g [5,6]. Giant exostotic osteomas of the skull vault are the rarest subset; the literature is confined largely to isolated case reports and small retrospective series. In the landmark series by Yudoyono et al., which represents the largest published surgical cohort, 15 patients with giant skull osteomas ranging from 4 cm to 12 cm in diameter were managed over a four-year period, with size representing the principal determinant of surgical complexity [3].

Most cranial vault osteomas are asymptomatic and discovered incidentally; however, when they attain considerable size, they produce cosmetic deformity, headache, scalp pressure, alopecia secondary to mechanical compression of hair follicles, and rarely, neurological symptoms from cortical pressure or dural sinus compromise [4,7]. The aetiology of solitary osteomas remains incompletely elucidated; proposed mechanisms include embryological developmental aberrations, chronic periosteal irritation, prior trauma, and, less compellingly, inflammatory or infectious stimuli [2,8]. Gardner syndrome (familial adenomatous

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polyposis with extracolonic manifestations) should be excluded when multiple osteomas are identified [9].

We present a 24-year-old woman with a massive parieto-occipital exostotic osteoma of approximately 13 × 12 × 11.5 cm, a dimension that, based on an extensive review of the accessible literature, represents one of the largest calvarial osteomas ever excised and discuss its clinical features, imaging characteristics, operative strategy, histopathological findings, and outcomes in the context of a comprehensive review of the published literature.

Case Presentation

History and Clinical Findings

A 24-year-old woman presented to the Neurosurgical Outpatient Clinic with a ten-year history of a slowly enlarging, painless swelling on the back of her head. She denied any preceding head trauma, previous scalp infection, or family history of colonic polyps or multiple bony swellings. There was no history of epileptic seizures, focal neurological deficit, visual disturbance, or cerebrospinal fluid (CSF) rhinorrhoea. Review of systems was otherwise unremarkable.

Physical examination revealed an alert, oriented woman in no acute distress. Vital signs were within normal limits. Cranial examination demonstrated a massive, hard, non-tender, non-pulsatile, bosselated mass occupying the parieto-occipital region of the calvarium. The overlying skin and scalp were intact, without erythema, ulceration, or alopecia directly over the tumour; however, mild pressure-related thinning of the hair was evident at the tumour margins. The mass was fixed to the skull and did not transilluminate. No regional lymphadenopathy was identified. Neurological examination was entirely normal.

Based on direct clinical measurement employing a calibrated tape measure and comparative proportional analysis of the CT imaging, the mass was estimated to measure 13 cm in its largest craniocaudal dimension, 12 cm transversely, and 11.5 cm in anteroposterior projection, with a dome-shaped, nearly spherical morphology. The lesion appeared to account for the totality of the visible scalp deformity, without satellite nodules.

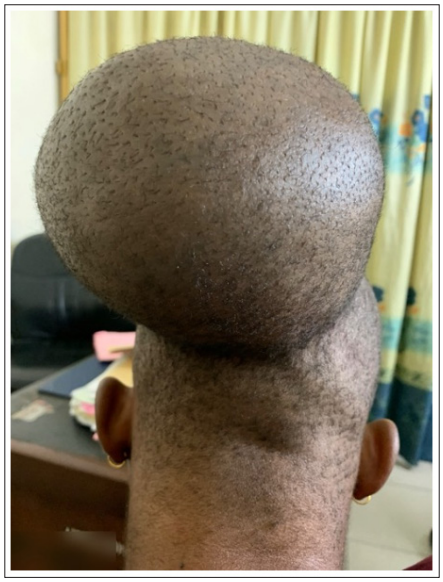

Figure 1A: Posterior view demonstrating the massive, dome-shaped exophytic osteoma occupying the parieto-occipital calvarium. The overlying scalp is intact with preserved hair coverage. The tumour projects prominently above the natural contour of the cranial vault.

Figure 1B: Lateral preoperative photograph demonstrating the near-spherical profile of the osteoma and its relationship to the remainder of the cranium. The lesion dwarfs the underlying calvarium in projection.

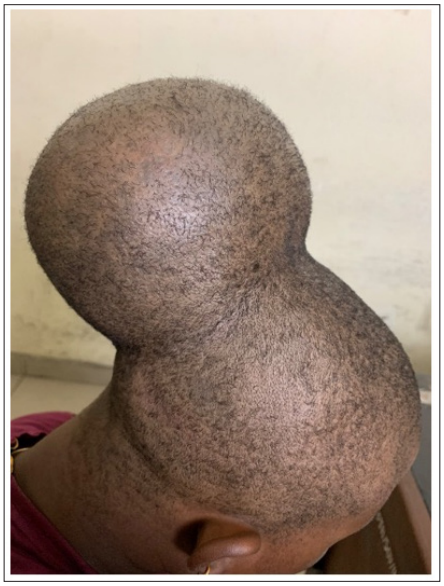

Figure 1C: Superior oblique view further illustrating the bilobed contour and extraordinary bulk of the lesion. The parietal region bears the primary mass, with slight right-sided predominance.

Radiological Investigations

Plain skull radiographs demonstrated a large, densely radio-opaque, homogeneous exostosis projecting from the posterior calvarium, consistent with compact (ivory) bone. There was no evidence of lytic destruction or periosteal reaction.

Non-contrast computed tomography (CT) of the head with bone-window reconstruction was the primary modality utilised for operative planning. CT demonstrated a massive, uniformly hyperattenuating (bone-density, Hounsfield units approximately +900 to +1200 HU), broadly based exostosis arising from

the outer table of the parieto-occipital calvarium. The lesion measured approximately 13 × 12 × 11.5 cm. The inner table of the skull was intact throughout; there was no intracranial extension, no epidural compression, and no distortion of the underlying cerebral parenchyma. The posterior third of the superior sagittal sinus (and torcular region) appeared displaced but patent. The tumour base was broad and continuous with the outer cortical table, demonstrating no perilesional oedema. No lytic foci, internal fat attenuation, or calcific matrix of a cartilaginous neoplasm were identified, confirming the homogeneously compact bony nature of the lesion [10].

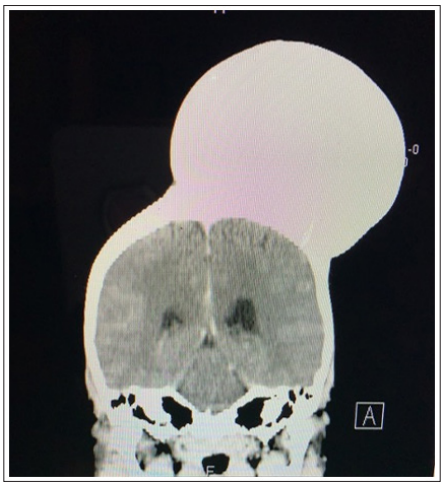

Figure 2: Coronal computed tomography (bone window). A densely sclerotic, homogeneously hyperattenuating exostosis arises from the outer table of the parieto-occipital calvarium. The lesion measures approximately 13 cm in craniocaudal height. The inner table is intact, with no intracranial extension. The cerebral hemispheres and posterior fossa structures appear normal.

Operative Management

After multidisciplinary review, informed consent, and thorough preoperative counselling including the risks of haemorrhage, dural sinus injury, and the need for cranioplasty, the patient was scheduled for elective surgical excision under general anaesthesia.

The patient was positioned prone with the head secured in a Mayfield three-pin head holder and the neck slightly flexed. The operative field was prepared and draped in standard neurosurgical fashion. A midline posterior scalp incision was made from above the vertex to the superior nuchal line, and bilateral subperiosteal flaps were elevated with care to identify and control multiple large emissary veins coursing between the osteoma and the underlying dural sinuses.

Exposure revealed the massive ivory-yellow, hard, osteoma firmly adherent to but not penetrating the outer cortical table of the calvarium. Intraoperative inspection confirmed gross continuity between the tumour base and the outer table. A full-thickness en bloc craniectomy was performed, with systematic bone cutting circumferentially around the tumour base and division of the involved bone through its full thickness. The tumour was carefully removed and haemostasis at the tumour base was secured with haemostatic agents; no dural sinus injury, CSF leak, or dural tear was encountered. The resulting craniectomy defect, approximately 12 × 10 cm, was assessed intraoperatively and prosthetic cranioplasty was performed at this operative sitting with methylmethacrylate.

Haemostasis was achieved by bone-wax application to the cut bony edges, bipolar electrocoagulation, and oxidised cellulose packing. Scalp closure was performed in anatomical layers over a closed suction drain, which was removed on the second postoperative day. Estimated intraoperative blood loss was approximately 800 mL; two units of packed red blood cells were transfused perioperatively.

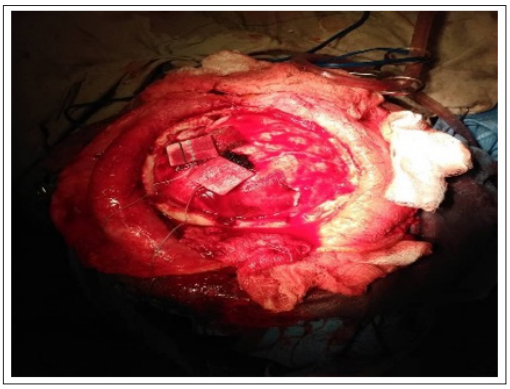

Figure 3A: Post-excision intraoperative view demonstrating the craniectomy defect following en-bloc removal of the osteoma. The dura mater is intact; haemostatic agents are in situ. The surrounding calvarium appears normal in density.

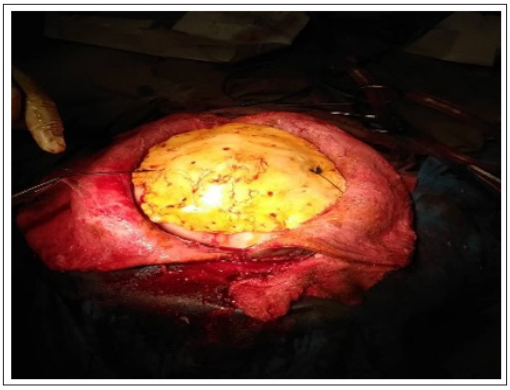

Figure 3B: Intraoperative photograph with craniectomy defect covered with molded methylmethacrylate.

Specimen and Histopathological Findings

The excised specimen (Figures 4A and 4B) was a rounded, hard bony mass measuring 13 × 12 × 11.5 cm and weighing approximately 1800 g on intraoperative scales. The outer surface was smooth; sectioning revealed dense, homogeneous compact (ivory) bone throughout, with no discernible marrow cavities, cystic spaces, cartilaginous tissue, or haemorrhagic zones.

Histopathological examination of representative sections demonstrated compact, mature lamellar bone with prominent cement lines, minimal intervening fibrovascular stroma, and an absence of nuclear atypia, mitotic figures, or evidence of sarcomatous change. Osteocytic lacunae were present but sparsely populated. These findings were consistent with a compact (ivory) osteoma, confirming the preoperative radiological diagnosis [11,12].

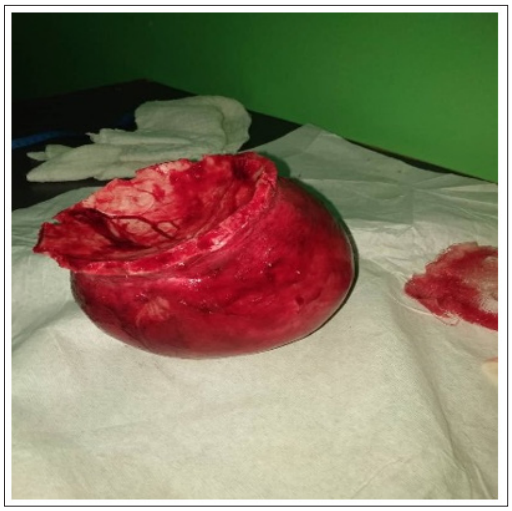

Figure 4A: Excised specimen- lateral view. The rounded, bony mass demonstrates a characteristic ivory-white compact outer surface. Scale estimated from intraoperative measurements: approximately 13 X 12 X 11.5cm, weight ~ 1800g.

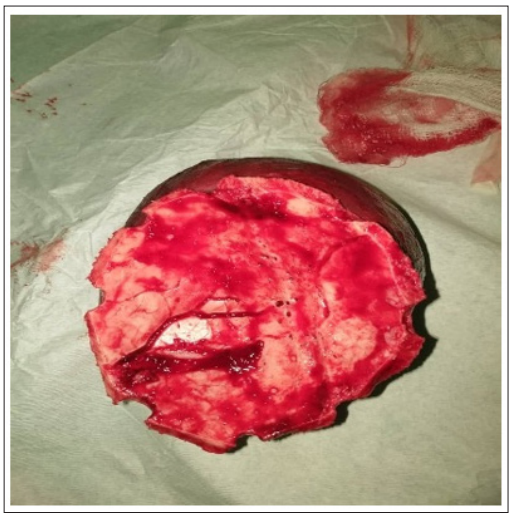

Figure 4B: Excised specimen- inner surface (base) view. The bony base shows the broad attachment footprint and the homogeneous compact bone composition throughout.

Postoperative Course

The immediate postoperative period was uneventful. The patient was extubated in theatre and recovered in the neurosurgical intensive care unit for 24 hours before transfer to the general ward. Serial neurological examinations remained normal. Wound inspection at 48 hours was satisfactory; the drain was removed. Perioperative antibiotics (cefuroxime) were administered for 72 hours per protocol [3].

At the time of outpatient review two weeks postoperatively, the incision was healing well and the patient reported significant symptomatic relief from the mechanical pressure effects and cosmetic burden of the mass. The sutures were removed.

Figure 5A: Postoperative posterior view at two-week follow-up demonstrating the well-healing midline scalp incision. The dramatic reduction in cranial profile compared with the preoperative state is evident.

Figure 5B: Postoperative lateral clinical photograph demonstrating restoration of a near-normal cranial contour following en-bloc excision. The patient reports no neurological deficits and considerable cosmetic improvement.

Discussion

Epidemiology and Classification

Osteomas account for approximately 0.43% of all tumours in the general population and are detected incidentally on 1% of plain skull radiographs and up to 3% of CT examinations [3,13]. The cranial vault subset is considerably rarer; the vast majority arise from the paranasal sinuses, with the frontal sinus being the predominant site. A female predominance has been documented in several large series of skull vault osteomas [3,7].

The most widely adopted classification system for cranial osteomas is that proposed by Haddad et al. in 1997, which

subdivides lesions into: (1) intraparenchymal; (2) dural; (3) skull base; and (4) skull vault, with the latter category further divided into exostotic (arising from the outer table) and enostotic (arising from the inner table) variants [4]. Our case represents a classic skull vault exostotic osteoma. Histologically, osteomas are further classified as compact (ivory), spongy (cancellous/trabecular), or mixed; the compact subtype, the variety present in our patient, is composed of dense lamellar bone with minimal marrow components and is the more common variant encountered in the calvarium [11,14].

The definition of "giant" in the osteoma literature is not uniformly standardised; however, the most widely cited threshold is a maximum diameter exceeding 30 mm, with some authors preferring a weight criterion of >110g [5,6]. Our specimen, measuring 13 × 12 × 11.5 cm and weighing approximately 1800g, exceeds both thresholds by a considerable margin and surpasses all but a handful of lesions documented in the world literature. In the largest reported surgical series, Yudoyono et al. described a range of 4 to 12 cm among 15 patients, placing our case above even their maximum observed dimension [3].

Pathogenesis

The precise aetiology of solitary skull vault osteomas remains a subject of debate. Three principal hypotheses have been advanced: (1) a developmental theory postulating failure of resolution of an embryological cartilaginous rest at suture lines; (2) a reactive hypothesis attributing osteoma formation to periosteal trauma, chronic infection, or foreign body stimulation; and (3) a neoplastic hypothesis, supported by the finding of clonal chromosomal abnormalities in some craniofacial osteomas [2,8,14]. The overwhelming predilection for membranous (intramembranous ossification) bones as opposed to endochondral bones supports the developmental theory. In our patient, the absence of any precipitating trauma, infection, or family history of Gardner syndrome suggests a sporadic developmental origin [9].

Gardner syndrome, the triad of familial adenomatous polyposis, multiple osteomas (particularly of the jaw and calvarium), and soft-tissue tumours, must always be considered in the differential diagnosis when multiple osteomas are identified or in a younger patient [9,15]. In our patient, a single lesion was identified, and thorough history and clinical examination revealed no features of Gardner syndrome. Genetic counselling and colonoscopic evaluation were offered but not undertaken at the time of reporting.

Clinical Presentation and Natural History

As in the majority of reported cases, our patient's lesion was characterised by a protracted, indolent course of growth over approximately a decade before clinical presentation.3,6 Skull vault osteomas grow at an estimated rate of 1.6 - 6 mm per year; the eventual attainment of a 13 cm maximum dimension therefore implies either a sustained growth period of several decades or episodic acceleration, the latter not well documented in the literature [16]. Reported symptoms attributable to giant lesions include cosmetic deformity (the predominant concern in our patient), tension headache from scalp distension, alopecia, and, rarely, manifestations of raised intracranial pressure from direct compression of the superior sagittal sinus or cortical surface [3,7].

Notably, despite the extraordinary tumour bulk in our case, neurological examination was normal and CT demonstrated no intracranial extension or cortical compression. This preserved neurological status likely reflects the slow pace of growth allowing for gradual cerebrovascular autoregulatory compensation and the predominantly exophytic growth pattern of the compact ivory variant.

Imaging

CT is the imaging gold standard for skull osteomas, providing unambiguous characterisation of the osseous nature, internal architecture, relationship to the inner table and dura, and dimensions of the lesion [10,17]. On CT, compact osteomas appear as uniformly dense, homogeneously hyperattenuating masses (typically in the range of 800-1400 HU) in continuity with the outer cortical table, without perilesional oedema. Trabecular osteomas display lower attenuation with a trabecular internal architecture. Our CT demonstrated the classic ivory osteoma appearance: uniform high attenuation (+900 to +1200 HU in our patient), smooth outer margins, broad-based outer table origin, and intact inner table, precisely the features that distinguish benign exostotic osteoma from other differential diagnoses including osteosarcoma, Paget disease, and meningioma en-plaque [14,17]

Magnetic resonance imaging (MRI) was not performed preoperatively, as CT provided sufficient diagnostic information. MRI is generally of limited additional value in compact osteomas, the dense bone yields low signal on all sequences, but may be useful in atypical cases to evaluate intracranial soft-tissue extension or dural involvement [10].

Surgical Technique and Considerations

The universally accepted definitive treatment for symptomatic skull vault osteomas is surgical excision [1,3,4]. Asymptomatic small lesions may be managed with watchful waiting and periodic radiological surveillance. Operative indications in our patient included progressive cosmetic deformity, mechanical scalp pressure symptoms, and patient preference.

Operative planning is critically important for giant lesions. Key preoperative considerations include: (i) volumetric assessment to anticipate blood loss; (ii) mapping of the relationship of the tumour base to the superior sagittal sinus, transverse sinuses, and emissary veins; (iii) evaluation of the inner table integrity to determine whether dural repair is likely to be required; and (iv) planning for cranioplasty [3,4]. Preoperative cross-matching of blood and anaesthetic preparation for major haemorrhage is essential, as giant osteomas are highly vascular structures with extensive intraosseous sinusoidal channels and multiple large emissary communications to the intracranial venous system. Our estimated intraoperative blood loss of 800 mL, necessitating perioperative transfusion, underscores this risk.

The operative technique involves wide periosteal elevation, circumferential drilling and osteotomy around the tumour base, and en-bloc removal where feasible; piecemeal resection is an

alternative for very large or deeply embedded tumours [3]. Bone wax, haemostatic agents, and bipolar diathermy are required for haemostasis. Inadvertent dural sinus injury, reported in one of 15 patients by Yudoyono et al [3]. represents the most serious intraoperative risk and should be anticipated in lesions with a broad posterior parietal base overlying the superior sagittal sinus. In our case, no dural tear or sinus injury was encountered.

Regarding cranial reconstruction: in cases where the tumour base necessitates sacrifice of the inner table or where a substantial craniectomy defect results, cranioplasty with either autologous bone, polymethylmethacrylate (as with our patient), or custom-manufactured titanium mesh is recommended [3,18].

Histopathology and Oncological Behaviour

Osteomas are uniformly benign lesions with no documented malignant transformation potential [6,19]. The histological confirmation of compact lamellar bone without nuclear atypia, mitotic activity, or pleomorphism in our specimen is entirely consistent with the published literature on compact (ivory) osteoma. Prominent cement lines, reflecting episodic bone remodelling, and the paucity of marrow spaces are the defining microscopic features [11,12]. Recurrence following complete excision is rare; isolated cases of regrowth have been attributed to incomplete removal at the tumour base [6].

Comparison with Reported Giant Osteomas

A tabulated comparison of selected giant skull vault osteoma cases from the literature is presented in Table 1. Our case is distinguished by the exceptionally large size of the lesion (13 × 12 × 11.5 cm, 1800g), the parieto-occipital location (the frontal skull is the most commonly reported site), and the complete neurological preservation despite the remarkable tumour burden [3,4,7,20].

Table 1: Selected reported cases of giant skull vault osteoma in the literature compared with the present case

Author (Year)	n	Location	Size (cm)	Histology	Treatment	Outcome
Haddad et al. (1997)	1	Convexity (enostotic)	7 × 5 × 4	Compact	Craniectomy	Good; no recurrence
Yudoyono et al. (2017)	15	Frontal (60%), frontoparietal	4-12	Compact / Mixed	Craniectomy ± cranioplasty	All satisfactory
Lapras et al. (2016)	1	Left parietal (exo + endo)	9 × 7 × 6	Mixed	En-bloc + cranioplasty	Excellent
Aggarwal et al. (2022)	1	Frontal	8 × 7 × 6	Compact	Craniectomy	Uneventful
Present case (2026)	1	Parieto-occipital (exostotic)	13 × 12 × 11.5CM	Compact (Ivory)	Craniectomy + cranioplasty	Excellent; neurologically intact

Conclusion

Giant exophytic osteomas of the calvarium are rare, histologically benign, and potentially curable with complete surgical excision. Our case is exceptional in that the lesion, measuring 13 × 12 × 11.5 cm and weighing approximately 1800 g, represents one of the largest skull vault osteomas documented in the medical literature, and one of the very few arising from the parieto-occipital calvarium. Despite the extraordinary tumour burden, neurological integrity was fully preserved, reflecting the indolent growth kinetics and purely exophytic nature of compact ivory osteomas.

The key messages from this case are: (1) clinicians in resource-limited settings should maintain awareness that benign bony neoplasms may achieve extraordinary dimensions when patients present late; (2) thorough preoperative CT-based planning is indispensable for anticipating surgical risks, particularly haemorrhage from emissary veins and dural sinus proximity; (3) en-bloc craniectomy with adequate haemostatic preparation achieves complete resection and excellent neurological outcomes; and (4) cranioplasty represents a pragmatic approach to cranial reconstruction in the setting of a large bony defect.

Further prospective multicentre registries of giant skull osteomas are needed to better define optimal management algorithms, particularly regarding the indications for primary versus staged cranioplasty and the role of adjunct intraoperative technologies such as neuronavigation and 3D-printed patient-specific implants.

Patient Consent

Written informed consent was obtained from the patient for publication of this case report and the accompanying clinical, intraoperative, and radiological images. All images have been anonymised; no patient identifiers are visible in the figures presented. The study adheres to the principles of the Declaration of Helsinki.

Conflict of Interest

The authors declare no conflicts of interest. No external funding was received in support of this work.

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