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Holohemispheric Prostate Carcinoma Dural Metastasis Mimicking Subdural Hematoma: Case Report and Review of the Literature

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Abstract

Prostate carcinomas are the most common malignancy to metastasize to the dura. These metastases can commonly mimic subdural hematomas and may similarly present with brain compression. The optimal management and outcomes after surgical management are not well characterized. We present a case of prostate carcinoma metastatic to the dura that was initially thought to be a large isodense subdural hematoma and was treated with surgical decompression. We also review the literature regarding prostate dural metastases mimicking subdural hematomas and discuss the relevant imaging findings, treatments, and outcomes. Dural metastasis should be considered when a patient with known metastatic prostate cancer presents with imaging evidence of a subdural mass.

Keywords
- prostate carcinoma
- dural metastasis
- subdural hematoma

Introduction

Although prostate carcinoma rarely metastasizes to the central nervous system, prostate is the most frequent primary carcinoma to metastasize to the dura mater.[1,2] There is wide variability in the presentation of dural metastases in terms of clinical manifestations as well as imaging characteristics. Furthermore, there is no consensus regarding the possible role of surgical management of this disease. Here we describe the case of a 45-year-old gentleman with a 3-year history of castrate-resistant prostate adenocarcinoma who presented with rapid neurologic decline in the setting of a holohemispheric isodense subdural mass. This was initially thought to represent a subacute subdural hematoma (SDH) and given his neurologic decline, he was taken emergently for surgical decompression. Intraoperatively, however, this lesion was found to be massive thickening of the dura and pathology and postoperative imaging ultimately revealed this to be a widespread prostate carcinoma dural metastasis. We discuss the imaging findings and management of this unusual pathology as well as review the literature related to dural prostate carcinoma metastases both mimicking and causing SDH.

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Case Report

Our patient was a 45-year-old gentleman with a 3-year history of prostate carcinoma with bony metastases. He had previously been treated with multiple modalities including prostatectomy, androgen deprivation therapy, leuprolide, radiation therapy to the prostate, and chemotherapy, including docetaxel and enzalutamide. He had also received radium therapy and abiraterone for his bony metastases. Despite his progressive disease, he had been living independently and was functional with activities of daily living.

He presented to our center with a 4-week history of progressive headaches and dizziness, as well as gait difficulty resulting in multiple falls. Noncontrast computed tomography (CT) of the head demonstrated an isodense right-sided holohemispheric extra-axial mass causing brain compression, effacement of the ventricles, and 1.2 cm of right-to-left midline shift (►**Fig. 1A**). Given his recent falls, this imaging finding was thought to be most consistent with a subacute SDH, although the borders between the extra-axial mass and cortex were noted to be non-distinct. While further imaging with magnetic resonance imaging (MRI) was considered, the patient soon exhibited rapid neurologic decline, including severe confusion and agitation. This rapid clinical change made treatment of the mass effect more urgent than when he initially presented and ruled out obtaining MRI as an unacceptable delay to treatment; in his agitated state, it was also unclear whether the patient would tolerate the positioning required for high-resolution MRI without intubation. Given the extent of mass effect and rapid neurologic change, as well as the suspicion that the underlying etiology was a subacute SDH, the option of surgical evacuation was discussed with the patient's family and he was ultimately taken to the operating room for a craniotomy for evacuation.

A large trauma craniotomy was performed and the dura was noted to be tense. Several small firm nodules were also noted to arise from the dura and the inner table of the the skull was irregular. A linear opening was made in the center of the dura revealing significant thickening of the dura consistent with dural tumor. Several specimen were sent to pathology. There was no evidence of underlying SDH and the decision was made to forego any further tumor resection. The dural defect was covered with a Duragen onlay (Integra LifeSciences, New Jersey, United States) and the myocutaneous flap was closed, leaving out the bone flap to allow for decompression. Postoperatively, the patient's neurologic exam improved. A postoperative head CT demonstrated partial decompression of the mass effect (►**Fig. 1B**) and review of the preoperative head CT bone windows revealed foci of patchy hyperostosis along the inner table (►**Fig. 1C**). A postoperative MRI confirmed extensive dural thickening and enhancement consistent with dural-based metastatic disease (►**Fig. 1D**). Histologic analysis of the epidural and dural specimen was consistent with metastatic adenocarcinoma with large glandular patterns consistent with prostate primary. Immunohistochemical stains were positive for prostate-specific antigen, prostate-specific membrane antigen, and NKX3.1 (►**Fig. 2**). Given the advanced status of his metastatic disease and inoperable nature of his dural metastasis, the decision was made to pursue palliative care and home hospice.

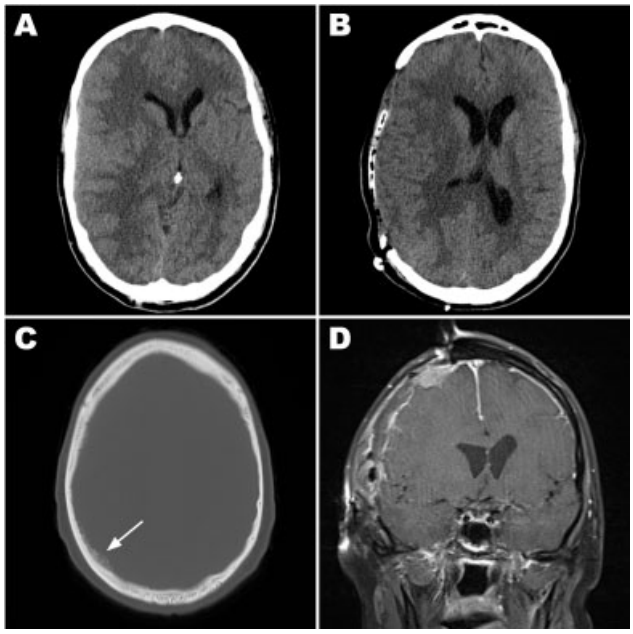

Fig. 1 (**A**) Preoperative noncontrast computed tomography (CT) of the head, axial view, showing a right-sided holohemispheric isodense mass causing significant mass effect. Note the indistinct borders between the mass and cerebral cortex. (**B**) Postoperative noncontrast CT of the head, axial view, showing partial decompression of the mass effect by hemicraniectomy. (**C**) Bone windows of the preoperative CT demonstrate patchy hyperostosis along the inner table of the calvarium (arrow). (**D**) Postoperative contrast-enhanced magnetic resonance imaging of the brain, coronal view, showing a holohemispheric right subdural mass with heterogeneous contrast enhancement.

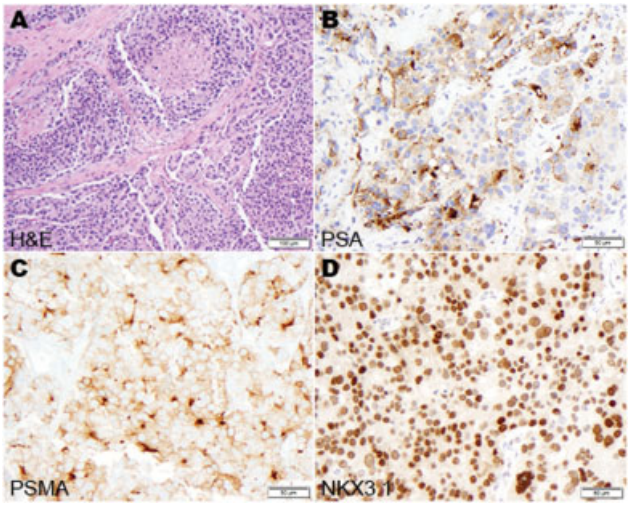

Fig. 2 Microscopic images of intraoperative specimens sent for pathological analysis. Hemotoxylin and eosin (H&E) staining (**A**) as well as immunostaining of the intraoperative specimens (**B–D**). Scale bars are indicated in the bottom right for each image. Microscopic evaluation reveals a metastatic adenocarcinoma with large glandular patterns and necrosis (**A**). The tumor cells are immunopostive for prostate-specific antigen (PSA), prostate-specific membrane antigen (PSMA), and NKX3.1, consistent with a prostate primary (**B–D**).

Discussion

Prostate adenocarcinoma is one of the most common primary cancers to metastasize to the dura, comprising 19.5% of cases reviewed by Laigle-Donadey et al.[1] Breast (16.5%), lung (11%), and stomach (7.5%) followed in prevalence. This is in contrast to intracerebral metastases, where prostate has been identified in less than 1% of cases.[3] Interestingly, there are several cases in the literature of a large prostate carcinoma dural metastasis mimicking SDH. We identified eight such cases in addition to our own (►**Table 1**).[4–11] The age at presentation of these cases ranged from 45 to 76 years (mean 63.9 years). The most frequent presenting symptom was headache (56%), followed by altered mental status/confusion (44%), motor deficits (44%), and gait ataxia (33%). One patient presented with seizures and one patient was neurologically intact on presentation. Regarding imaging characteristics, the most common CT finding was a hyperdense collection (44%) followed by a mixed density collection (33%). Isodense collections were relatively rare (22%) and there were no reports of hypodense collections in this group. Surgical management utilizing craniectomy, craniotomy, or burr holes was performed in all but one case. Three cases were started with burr holes but then converted to craniotomy upon encountering dural tumor instead of hematoma.[4,7,9] Medical management was elected in just one case where the diagnosis of metastatic dural-based tumor was made by contrast-enhanced MRI, as opposed to pathologic diagnosis in the other eight cases.[8] Neurologic improvement was reported in 44%, whereas neurological deterioration, no improvement, or no follow-up were reported for the remaining cases.

Prostate carcinoma is not the only primary cancer reported to mimic SDH. Catana et al recently reviewed mimics of SDH and reported cases of lung and breast cancer, lymphoma, and sarcoma.[12] An early study also detailed the surgical treatment of a pancreatic adenocarcinoma metastasis to the dura.[13] CT imaging characteristics are variable, with 40% of metastatic solid cancer presenting as a hyperdense lesion, 30% as an isodense lesion, 10% as a hypodense lesion, and 20% as a mixed density lesion.[12] Similar findings were seen with lymphoma and sarcoma, with a hyperdense extra-axial lesion as the most common CT finding.[12] Apart from the density of the lesion on CT, Nunno et al also pointed to the nodular character of the lesion on imaging, which may help distinguish SDH from a dural metastasis.[11]

There are several proposed mechanisms by which prostate carcinoma may metastasize to the dura. Direct extension from skull metastases was the most common cause of dural metastasis in the pathological series of Laigle-Donadey et al[1] and Nayak et al.[2] Metastatic tumor cells may spread hematogenously, either via the arterial circulation or through the venous system, such as Batson's plexus.[14] Transmission via the lymphatic circulation has also been suggested.[1] In the series of cases we identified, skull metastasis was not seen with a high frequency, suggesting that most of the dural metastases may have resulted from hematogenous spread or from occult bony metastases that were not apparent in surgery or on autopsy.

Interestingly, prostate dural metastases have also been associated with SDH (►**Table 2**). Multiple hypotheses have been proposed to explain this phenomenon, including hemorrhage from tumor vessels, effusion due to obstruction of dural vessels by tumor, and tumor-induced vascular and fibrous proliferation within the dura.[13] Cheng et al also hypothesized that perhaps the membrane that forms around a chronic SDH may serve as a conduit for metastatic cells to invade the dura.[15] Furthermore, the features that make the primary prostate carcinoma likely to metastasize also promote leakiness of both tumor blood vessels and the metastatic target tissue,[16] making a metastasis site on the dura potentially more susceptible to subdural hemorrhage. Hematoma formation is also more likely when these factors are compounded with the coagulopathy secondary to malignancy that is commonly found in these patients.[16]

The diagnostic ambiguity between dural metastasis and SDH (regardless of chronicity) is a common thread among several cases from the literature, including our own.[4–7,10] All of the cases of dural metastases that we identified presented with either a hyperdense, mixed density, or isodense lesion (►**Table 1**). In contrast, the majority of true SDHs that were associated with prostate metastases presented as a hypodense lesion (►**Table 2**), a difference that is statistically significant between these two small cohorts ($p = 0.004$, Fisher's exact test). Ascertaining lesion nodularity on CT imaging may be difficult, especially with isodense lesions as in our case. CT bone windows in our case also demonstrated patchy hyperostosis along the inner table of the skull, suggesting the presence of metastatic disease. Finally, contrast-enhanced MRI can better distinguish between hematoma and tumor. In our case, the patient's rapid neurologic decline and poor mental status combined with our suspicion for SDH led to surgical decompression without first obtaining an MRI.

In the series of all dural metastases mimicking SDHs by Catana et al, 71% (34 patients) were treated surgically.[12] Among these surgical patients, 65% had resolution of symptoms. Our results show that in a subset of prostate carcinoma patients treated surgically, 44% showed improvement (►**Table 1**). Catana et al also found that management strategy was not correlated with improved functional outcomes or with improved mortality.[12] This is also similar to our literature review of prostate cancer, in that the mode of surgical treatment did not ultimately affect outcomes. It is important to note that, as with our case, these patients were most often taken to surgery with the presumption that they had a SDH, and not extensive metastatic disease. Such metastatic disease is known to be a poor prognosis,[11] and distinguishing it from SDH may sway patients, families, and surgeons away from aggressive surgical management.

This mounting literature points to some new suggested practices for practitioners. In patients with prostate malignancy, even with a clear history of trauma, the differential diagnosis between SDH and extra-axial metastasis should always be considered. Prior groups have suggested that a CT with contrast should be performed in these circumstances.[5,15]

Table 1 Reported cases of prostate carcinoma dural metastases mimicking a subdural hematoma

Study	Age	Presentation	CT imaging	Management/approach	Surgical findings (management)	Outcome
Tomlin and Alleyne, 2002[4]	61	Progressive headache, fatigue, altered mental status, left hemiparesis	Hypo/isodense	Frontal burr hole expanded to craniotomy	Thickened, nodular dura, greyish tumor (partial resection), no hematoma	Died 3 months after surgery
Barrett et al, 2008[5]	59	Head trauma, neurologically intact	Hyperdense	Minicraniotomy	Thickened dura (biopsied), no hematoma	Not reported
Cheng et al, 2009[6]	72	Altered mental status, gait ataxia	Isodense	Craniectomy	Thickened dura with firm tumor (partial resection), brain invasion	Died 4 months postop
Patil et al, 2010[7]	71	Headaches, dizziness	Hypo/isodense	Two burr holes expanded to craniotomy	*En plaque* extra-axial mass (biopsied)	Improved neurologically, underwent whole brain radiotherapy
Yu et al, 2012[8]	62	Left arm weakness, partial seizures	Hyperdense	Whole brain radiotherapy	—	Not reported
Nzokou et al, 2015[9]	65	Headache, confusion, arm weakness	Hyperdense	Parietal burr hole expanded to craniectomy	*En plaque* subdural tumor (partial resection), no hematoma	Recovered strength, discharged home, died 5 months postop
Bourdillon et al, 2016[10]	76	Headaches, hemiparesis	Hypo/hyperdense	Burr hole	Fibrous lesion (biopsied), no hematoma	Clear neurological improvement, elected for palliative care postop
Nunno et al, 2018[11]	64	Altered mental status, headache, gait ataxia	Hyperdense	Bilateral frontotemproal craniotomies	Thickened dura under high pressure (partial resection)	Comfort care
Present study	45	Altered mental status, gait ataxia	Isodense	Craniectomy	Thickened, nodular dura (biopsied), no hematoma	Improved neurologically, elected for comfort care

Abbreviation: CT, computed tomography.

Table 2 Reported cases of prostate carcinoma dural metastases causing a subdural hematoma

Study	Age	Presentation	CT imaging	Management/approach	Surgical findings (management)	Outcome
Barolat-Romana et al, 1984[17]	62	Altered mental status, homonymous hemianopsia, hemiparesis	Hyperdense, ICH	Craniotomy	Large hematoma under pressure (evacuated), thickened subdural membrane (biopsied)	Resolution of neurological deficit, discharged home, doing well on 6 months follow-up
Bucci and Farhat, 1986[18] Case 1	62	Headache, lethargy, confusion	Isodense	Craniotomy	Hematoma (evacuated), membranes (biopsied)	No postop improvement, died POD6
Bucci and Farhat, 1986[18] Case 2	63	Confusion, lower extremity weakness	Hypodense	Surgical evacuation of SDH	Hematoma (evacuated), membranes (biopsied)	Mental status improved
Cheng et al, 1988[15]	64	Hemiparesis, gait ataxia	Hypodense	Craniotomy	Multilayered membranous hematoma with loculations (evacuated), hyperemic dura (biopsied)	Improved strength and gait, able to walk within 1 month, stable on 3 months follow-up
Cobo Dols et al, 2005[19]	54	Headache, facial palsy, altered mental status	Hypodense	High-dose steroids	—	No improvement, died day 7
Dorsi et al, 2010[20]	71	Progressive headache, aphasia, gait ataxia, hand apraxia	Hypodense	Parietotemporal craniotomy	Cyst with yellow proteinaceous fluid under extremely high pressure (evacuated), thickened dura (biopsied)	Immediate improvement in speech and strength, intact on follow-up
George et al, 2012[21]	72	Progressive worsening confusion, hemiparesis	Hypodense	Frontal burr hole, required reoperation	Dark fluid (evacuated), membranes (biopsied)	Failed to improve; died 1 week postop
O'Meara et al, 2012[16]	62	Epistaxis, anemia, thrombocytopenia, altered mental status	Hypodense	Parietal craniotomy and contralateral parietal burr hole	Thickened dura, subdural membranes (biopsied)	Recovered well but declined POD2, died POD4
Boukas et al, 2015[22]	75	Dysphasia, gait ataxia, falls	Hypodense	Two burr holes, reoperated POD5	Light brown hematoma under high pressure (evacuated), subdural membranes (biopsied)	Slow, fluctuating recovery; underwent whole brain radiotherapy, then comfort care, died 2 months postop
Caruso et al, 2017[23]	79	Cognitive-motor slowing	Hypodense	High-dose steroids	—	Not reported
Önen et al, 2017[24]	71	Altered mental status (coma), anisocoria, left hemiplegia	Not reported	Craniotomy	Hematoma (evacuated), extra- and intracalvarial and extra- and intradural metastases (biopsied)	Did not improve, died POD4
Lippa et al, 2017[25]	80	Comatose with unilateral blown pupil	Hyper/hypodense	Burr hole	Hematoma evacuated; bone fragments from burr hole sent to pathology	Rebled and died within 24 hours

Abbreviations: CT, computed tomography; ICH, intracerebral hemorrhage; POD, postoperative day; SDH, subdural hematoma.

In fact this was done in one case,[8] where the contrast-enhanced CT scan was diagnostic and was confirmed by subsequent MRI. Cheng et al, have also suggested that any brain hemorrhage in a patient with known metastatic prostate carcinoma should be investigated for dural and/or intracranial metastasis.[15] We agree that practitioners should be vigilant and keep dural metastasis on the differential when evaluating patients with imaging evidence of a SDH. If the patient is stable, contrast-enhanced MRI is a suitable next step after noncontrast CT, as it provides more detailed information regarding the nature of the lesion. Contrast-enhanced CT may provide a "quick look" in an otherwise unstable patient in which MRI is unsafe or not possible.

In conclusion, prostate carcinoma is the most common cancer to metastasize to the dura and can rarely manifest as a large, holohemispheric dural lesion that mimics acute or subacute SDH on CT imaging. Such metastatic disease should be on the differential diagnosis in patients with advanced prostate cancer presenting with extra-axial masses, and MRI can be obtained to distinguish between metastatic disease and hematoma. In our literature review, 44% of patients who underwent surgical decompression demonstrated neurological improvement. Surgical decompression may therefore be a reasonable palliative option in carefully selected patients with symptomatic mass effect from dural metastases of prostate carcinoma.

Conflict of Interest
None.

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