Case Report

Metastatic Prostate Cancer to the Left Temporal Bone: A Case Report and Review of the Literature

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Breast, lung, and prostate cancers are the three most common malignancies to metastasize to the temporal bone. Still, metastatic prostate cancer of the temporal bone is a rare finding, with approximately 21 cases reported in the literature and only 2 cases discovered more than 10 years after initial treatment of the primary. This disease may be asymptomatic and discovered incidentally; however, hearing loss, otalgia, cranial nerve palsies, and visual changes can all be presenting symptoms. We present the case of a 95-year-old man with history of primary prostate cancer treated 12 years earlier that was seen for new-onset asymmetric hearing loss and otalgia. The tympanic membranes and middle ears were normal; however, based on radiologic findings and eventual biopsy, the patient was diagnosed with extensive metastatic prostate cancer to the left temporal bone. This case (1) demonstrates that a high index of suspicion for unusual etiologies of seemingly benign symptoms must be maintained in elderly patients having prior history of cancer and (2) substantiates the value of temporal bone imaging when diagnosis may be unclear from history and physical exam.

1. Introduction

Prostate cancer is the most common cancer diagnosed in American men [1]. Approximately 233,000 new cases occur annually [2]. The highest incidence (60–70%) of prostate cancer is seen in men who are in their seventh decade of life [3]. In addition to age, other risk factors include African American race, family history, and diets high in protein and fats and low in fruits and vegetables [4, 5]. Patients are typically asymptomatic due to early detection by prostate-specific antigen (PSA) testing and digital rectal exams (DRE) but may present with outflow obstruction, hematuria, lower leg edema, and bone pain [1]. The 5-year survival rate for patients diagnosed with early-stage, local prostate cancer is almost 100% [2, 6]. Those patients diagnosed with late-stage, metastatic prostate cancer have a 5-year survival rate of only 28–30% [3, 6, 7]. Prostate cancer metastasizes in only a small number of patients and typically involves the bones, with the skull being the sixth most common bone affected [2, 7, 8].

The temporal bone, with rich blood supply and sluggish blood flow, provides a hospitable environment for hematogenous seeding of tumor cells [9–12]. Still, involvement of the temporal bone in metastatic adenocarcinoma is rare. In 1986, Kobayashi et al. performed a review of the world literature revealing 9 cases of prostatic metastases to the temporal bone [13]. Since that time, only 12 additional cases have been reported in the literature (Table 1). Patients with metastatic cancer of the temporal bone may be asymptomatic [14–16]. However, hearing loss, facial palsy, and/or signs similar to mastoiditis (e.g., otalgia, ear drainage, and vertigo) can be seen [17–19]. Due to the low incidence of cases of metastatic prostate cancer, the infrequent involvement in the skull, and the nonspecific symptoms patients present with, metastatic prostate cancer of the temporal bone may be difficult to...
Table 1: Reported cases of prostatic metastases to the temporal bone.

| Source                        | Age | Presenting symptom(s)                      | Prior history of prostatic carcinoma | Radiologic findings of TBM | Histologic findings of TBM | Treatment/follow-up                                                                 | PSA levels (0–4.0 ng/mL) |
|-------------------------------|-----|-------------------------------------------|--------------------------------------|---------------------------|---------------------------|-------------------------------------------------------------------------------------|------------------------|
| Janczewski and Fujita, 1972   | 77  | Generalized bone pain, vertigo, ataxia, left 8th nerve paralysis | Yes (4 yr priorly, hormonal therapy given) | NR                        | NR                        | Died of extensive metastatic prostatic carcinoma                                      | NR                     |
| Helcl and Malec, 1973         | 57  | Tinnitus, hearing loss, temporomandibular joint pain | No (4 mo later vertebral lesions developed, primary site found on search) | Destruction of apex of right pyramidal bone | NR                        | Irradiation, hormonal therapy: NR                                                    | NR                     |
| Applebaum and Dolsky, 1977    | 64  | Ear pain                                  | No (primary site found on search)     | Destructive lesion in petrous apex | Poorly differentiated adenocarcinoma | Hormonal therapy, died of tumor after 4 mo                                            | NR                     |
| Coppola and Salanga, 1980     | 50  | Left-sided ear pain, preauricular tenderness, hearing loss | Yes (4 yr priorly, well-differentiated treated by TURP) | Erosion of left temporal bone | Poorly differentiated adenocarcinoma | Irradiation, alive with stable disease 1 yr after TBM                                 | NR                     |
| Schrimpfl et al., 1982        | 81  | Dizziness, right-sided ear pain, hearing loss | No (1 yr later prostate biopsy revealed well-differentiated carcinoma) | Dense sclerosis of mastoid bone, a defect in petrous bone | Moderately differentiated adenocarcinoma | Hormonal therapy, alive with stable disease 1 yr after TBM                            | NR                     |
| Castaldo et al., 1983         | 67  | Left jaw pain and facial weakness         | 4 years earlier he was admitted to hospital for bladder outlet obstruction | CT scan showed metastatic lesion of the left temporal bone invading the left temporal lobe | NR                        | 3000 rad whole brain radiation                                                        | NR                     |
| Jung et al., 1986             | 75  | Facial palsy with CN V and XII involvement | NR                                   | NR                        | Undifferentiated carcinoma of the prostate gland                                      | NR                     |
| Svar et al., 1988             | NR  | CNVIII involvement                        | NR                                   | Skull X-ray showed right temporal bone lesion | NR                        | Radiotherapy                                                                         | NR                     |
| Sahin et al., 1991 [30]       | 69  | Dizziness, right-sided temporal pain, hearing loss | Yes (3 yr priorly, stage, irradiation given) | Osteoblastic lesion in the temporal bone with epidural extension | Poorly differentiated adenocarcinoma with immunoreactivity for PAP and PSA | Irradiation, chemotherapy alive with stable disease 6 months after TBM               | 62.8 ng/mL             |
| Sahin et al., 1991 [30]       | 73  | Right-sided ear pain, tinnitus, hearing loss | No (found on search)                  | Osteolytic destructive mass in petrous bone with soft tissue component | Moderately differentiated adenocarcinoma with immunoreactivity for PAP and PSA | Hormonal therapy, alive 4 yr after TBM                                                 | NR                     |
| Source                  | Age | Presenting symptom(s)                                                                 | Prior history of prostatic carcinoma | Radiologic findings of TBM                                                                 | Histologic findings of TBM | Treatment/follow-up                                                                 | PSA levels (0–4.0 ng/mL) |
|------------------------|-----|-------------------------------------------------------------------------------------|--------------------------------------|------------------------------------------------------------------------------------------|---------------------------|--------------------------------------------------------------------------------------|-------------------------|
| Pringle et al., 1993   | 50  | Sudden onset left-sided deafness and tinnitus associated with pain in his left ear, around his left eye and radiating into the back of the head | Prostate cancer in 1988 and treated with transurethral resection | MRI revealed a large enhancing lesion on the right side adjacent to the internal auditory meatus | Metastatic prostatic carcinoma | Local radiotherapy and goserelin. Eighteen months after treatment patient was alive | NR                      |
| Hellier et al., 1997   | 60  | Two-month history of a progressive loss of function of the left CNVII-XII, pulsatile tinnitus and left-sided deafness | Rectal examination revealed a rock hard smooth prostate compatible with prostatic carcinoma | Vascular mass eroding the intralabyrinthine portion of the temporal bone and extending into the petrous apex | Metastatic prostatic adenocarcinoma | Radiotherapy plus anti-androgen treatment | NR                      |
| Messina et al., 1999   | 75  | 6-month history of progressive weight loss, initial visual impairment and paraphasia | Yes (15 yr priorly, underwent radical prostatectomy and treated with external-beam radiation therapy) | Extra-axial osteoblastic lesion arising from the left petrous and occipital bones | Immunohistochemical staining positive for prostate-specific acid phosphatase | Temporal, occipital, and parietal bone resection with external-beam radiation and bicalutamide therapy | 26 ng/mL                |
| Schwetschenau et al., 2001 | 60  | Right-sided ear pain, vertigo, hearing loss, watery otorhea, forehead parathesis | CT scan showed sclerotic bones of the anterior canal fossa | Immunohistochemical staining positive for prostate-specific acid phosphatase | Radiation therapy | 1200 ng/mL | |
| McAvoy et al., 2002    | 64  | 1-day history of binocular horizontal diplopia | 1-week history of diagnosed prostate cancer | CT scan showed bony destruction of the right petrous apex and paraclavicular region | NR | Hormonal therapy and alive 1 year later | NR                      |
| McDermott et al., 2004 | 68  | Facial droop (CNVII) | Metastatic disease present at time of the original diagnosis of prostate carcinoma | MRI showed petrous bone involvement | NR | Treated with a course of external beam radiation therapy | NR                      |
| McDermott et al., 2004 | 68  | Facial droop (CNVII) | Yes | MRI showed clivus and temporal bone involvement | NR | Treated with a course of external beam radiation therapy | NR                      |
Table 1: Continued.

| Source            | Age | Presenting symptom(s)                                                                 | Prior history of prostatic carcinoma           | Radiologic findings of TBM                                                                 | Histologic findings of TBM | Treatment/follow-up                                                                 | PSA levels (0–4.0 ng/mL) |
|-------------------|-----|-------------------------------------------------------------------------------------|------------------------------------------------|------------------------------------------------------------------------------------------|---------------------------|-------------------------------------------------------------------------------------|-------------------------|
| Malloy, 2007      | 66  | Four-day history of blurred vision that was worse when he looked left and medial deviation of the left eye without pain or other neurologic deficits | Recent diagnoses of prostate cancer for which he was being treated | Two masses were found on MRI. One was $1.6 \times 2.4 \times 1.8$ in size within the mid and left clivus and involving the left cavernous sinus. A secondary mass was found in the left temporal lobe | NR                        | Radiotherapy and chemotherapy. The patient was alive 2.5 years after initial presentation | NR                     |
| Mitchell et al., 2008 | 55  | Progressive onset left-sided facial weakness and occipital and neck pain              | No (found on search)                            | CT showed permeative bone destruction in the left skull base, involving the lower petrous temporal bone | NR                        | Luteinizing hormone-releasing hormone agonist treatment with anti-androgen cover with palliative radiotherapy | 88.9 ng/mL              |
| Alvo et al, 2012 [17] | 63  | 3-month history of headache, right-sided hearing loss, and instability, without vertigo, nausea, or otalgia | 11 years priorly the patient was diagnosed with prostate cancer and had undergone prostatectomy plus radiotherapy | CT and MRI showed infiltrative mass in the right petrous apex and clivus, compromising the internal auditory canal | NR                        | Hormonal therapy with leuprolide and radiotherapy and was stable six months later       | 63.2 ng/mL               |
diagnose. Diagnosis relies on appropriate imaging studies and eventual biopsy for histologic and immunohistochemical staining [5]. Treatment in these patients is primarily palliative and may include surgery, chemotherapy, and/or radiation [6, 20].

To date, only 2 cases of metastatic prostate cancer to the temporal bone presenting >10 years after treatment of the primary tumor have been reported in the literature. Here, we present the 3rd such case and discuss implications for workup.

2. Case Report

A remarkably alert and functional 95-year-old man with long standing history of bilateral, symmetric, age-related hearing loss developed new-onset asymmetric hearing loss in the left ear along with sharp unilateral ear pain. The pain was intermittent but sharp and intense. He did not have vertigo, tinnitus, aural pressure, drainage, or facial weakness. Past medical history was significant for prostate cancer diagnosed in 2002 (12 years prior to presentation) and treated with neoadjuvant androgen deprivation therapy (ADT) as well as radioactive seed implant. Other medical problems included Parkinson's disease, hypertension, diabetes mellitus type II, and gout.

The patient was initially seen at an outside hospital where his symptoms were attributed to Eustachian tube dysfunction or perhaps temporomandibular joint arthritis. He was prescribed ciprofloxacin otic drops, Flonase, and Tylenol. An MRI of the brain with internal auditory canal protocol was offered for the asymmetric and presumed-sudden hearing loss; however, the patient declined. He was seen in our otology practice two weeks later for a second opinion. By that point, the ear pain had resolved but asymmetric hearing loss persisted. On physical exam, the ear canals, tympanic membranes, and middle ears were within normal limits. An audiogram showed bilateral sensorineural hearing loss with poorer threshold in the left ear than the right (Speech Recognition Threshold: right ear (RE) 40 dB HL, left ear (LE) 55 dB HL; Speech Discrimination: RE 88% 85 dB HL, LE 80% 90 dB HL). There was a significant decrease in thresholds seen in a previous audiogram performed in 2012 (Speech Recognition Threshold: RE 35 dB HL, LE 35 dB HL; Speech Discrimination: RE 96% 70 dB HL, LE 84% 70 dB HL). Steroid treatment for the hearing loss was discussed; however, the patient declined stating he did not want to take on the risks of high-dose steroids at his advanced age. Review of laboratory testing found PSA values (0–2.5 ng/mL) of 4.22, 4.82, and 6.43 for the years 2012, 2013, and 2014 respectively. Alkaline phosphatase was 92 (40–150) and lactate dehydrogenase was 204 (125–243).

The patient was hesitant about obtaining an MRI because his ear pain had resolved; however, due to persistent asymmetry in hearing and prior history of cancer, we encouraged him to proceed with the imaging study as a precaution. The MRI revealed an extensive tumor involving the skull base, including the clivus and petrous temporal bone with extension into the posterior-inferior mastoid air cells (Figure 1). The tumor also bordered the posterior and medial portion of the foramen lacerum, obliterated the left jugular foramen, and involved the hypoglossal canal. A fine-cut, CT scan of the temporal bones was performed to evaluate extent of bony involvement and for operative planning. This confirmed presence of an infiltrative bony lesion involving the skull base (Figure 2).

Differential diagnosis included metastatic multiple myeloma, glomus tumor, and (most likely) metastatic disease. The patient’s primary care physician recommended a bone marrow biopsy to the patient as a first step towards diagnosis because she felt that this was less invasive than temporal bone surgery and would rule out multiple myeloma. Bone marrow biopsy and laboratory panel were negative for multiple

| Figure 1: MRI scan of the head, 7/9/2014. (a) Axial T1 image shows a large posterior skull base mass. Note the normal bright fatty marrow (short green arrow) compared to darker signal from the mass (long green arrow). (b) Axial T1 image shows the mass (red oval) involving both the jugular foramen and the hypoglossal canal. Note the normal position of the contralateral jugular foramen (short red arrow) and the hypoglossal canal (long red arrow) for reference. (c) Axial T2 image shows involvement of the petrous temporal bone (blue oval) extending into the posterior inferior mastoid air cells, with bright reactive mastoid fluid (blue arrow). |  |  |
myeloma; therefore, the patient was taken to the operating room for left posterior petroectomy and debulking/biopsy of his temporal bone lesion.

Biopsy confirmed metastatic prostate carcinoma—the tissues staining for pan keratin (Figure 3) and PSA (Figure 4). To complete a metastatic workup, a technetium 99m scintigraphy was performed, which demonstrated intense radiotracer uptake in the left temporal bone consistent with biopsy-proven metastatic prostate carcinoma (Figure 5). It also showed localization in the upper thoracic spine (T5), which was suspicious for metastasis, as well as uptake in the mid cervical and upper lumbar spine consistent with degenerative changes. The patient has started palliative radiotherapy to the temporal bone and has begun treatment with neoadjuvant Lupron injection (LHRH analog), antiandrogen therapy, and Degarelix. Most recent CT head showed increased interval of metastatic disease. He remains alive at 8 months with no changes in hearing and no recurrence of his left-sided ear pain.

3. Discussion

We present the case of a 95-year-old man with history of primary prostate cancer treated 12 years earlier that was seen for new-onset asymmetric hearing loss and otalgia. The tympanic membranes and middle ears were normal; however, based on radiologic findings and eventual biopsy, the patient was diagnosed with extensive metastatic prostate cancer to the left temporal bone. This case (1) demonstrates that a high index of suspicion for unusual etiologies of seemingly benign symptoms must be maintained in elderly patients having prior history of cancer and (2) substantiates the value of temporal bone imaging when diagnosis may be unclear from history and physical exam.

Metastatic cancer involving the temporal bone is often asymptomatic and may be underreported; however, the incidence appears to be rising due to an aging population and better diagnostic modalities that spur improved recognition [13, 19, 21, 22]. Approximately 21 cases of prostate cancer metastases to the temporal bone have been reported in the literature; however, our report is only the 3rd case of metastasis
Table 2: Imaging characteristics of temporal bone lesions.

| Lesion                  | CT scan       | MRI, T1 weighted imaging | MRI, T2 weighted imaging | MRI, gadolinium                  |
|-------------------------|---------------|--------------------------|--------------------------|----------------------------------|
| Schwannoma              | Intermediate  | Intermediate (cysts may be low, hemorrhage high) | Intermediate (cysts high, hemorrhage variable) | Avid, homogenous enhancement     |
| Mucocele                | Expansile, no bony destruction | Variable, typically low | High | No enhancement |
| Acute petrous apicitis  | Air-fluid levels in air cells without bony destruction | Low | High | Mild |
| Cholesterol granuloma   | Expansile     | High | Variable, usually high | No enhancement |
| Cholesteatoma           | Bony erosion, remodeling | Intermediate to low intensity | High | No enhancement |
| Chondrosarcoma          | Bony erosions and mineralized matrix | Intermediate to low intensity | High +/- some heterogeneity if calcified matrix | Avid enhancement |
| Meningioma              | Intermediate density | Intermediate (cysts may be low, hemorrhage high) | Intermediate (cysts high, hemorrhage variable) | Avid, homogeneous enhancement |

The nonspecific features of temporal bone malignancy can make diagnosis difficult; therefore, considering a broad differential diagnosis is important. Possible causes of symptoms that may mimic malignancy are multiple myeloma, chondrosarcoma, chordoma, invasive meningiomas, schwannomas, and petrous apicitis (Table 2) [17, 19, 25]. Making the diagnosis requires imaging and eventual biopsy. Four imaging modalities are commonly employed to aid in the diagnoses of temporal bone tumor: CT, MRI, radionuclide bone scan, and a FDG-PET scan. CT and MRI have the greatest sensitivity and are extremely useful in detecting metastasis [10, 26]. These two modalities complement each other as the CT shows bony involvement and MRI outlines the soft tissues of the internal auditory canal [17]. The addition of radionuclide bone scan with MRI and/or CT scans increases the overall sensitivity and may improve detection by detecting distant bone metastases and assessing response to therapy [10].

An elevated PSA (prostate specific antigen) in patients with history of primary prostate cancer should increase suspicion for metastatic disease [27]. PSA levels typically rise with metastasis and correlate to tumor volume; however, PSA levels may remain low to normal in patients with early prostate cancer metastasis, as seen in our patient. This reasoning is unclear [10, 28].

Treatment with surgery, radiation, and chemotherapy is aimed at palliation [19]. Surgery is usually required for tissue diagnosis and may be used for debulking and symptomatic patients. Overall, survival in patients with metastatic cancer of the temporal bone is low, with average survival time after diagnosis being <2 years [26]. Patients presenting with cranial nerve palsies typically survive <6 months [10, 26]. New systemic treatment options have become available for metastatic prostate cancer, including hormonal, chemotherapeutic, and immunotherapeutic agents, bone-targeted therapies, and radiopharmaceuticals. Although androgen deprivation therapy remains the first line for treatment for metastatic
disease, a standardized sequence of treatment has not yet been developed [29].

4. Conclusion
Clinicians must maintain a high index of suspicion for metastatic disease in high-risk patients of advanced age or those having a prior history of malignancy. Early imaging may help prevent a delay in diagnosis. Early diagnosis and treatment is essential to maximize therapeutic responses.

Conflict of Interests
The authors collectively have no secondary interest related to publication of this paper and disclose no potential conflict of interests that would threaten research validity.

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