Case Report

Insights into Clinical Features and Outcomes of Adrenal Cortical Carcinosarcoma

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Abstract: Adrenal cortical carcinosarcomas are a rare and typically aggressive malignancy with few reported cases in medical literature. We present a case of a 78-year-old female who presented with complaints of fatigue and right shoulder pain. Imaging of the abdomen with computed tomography visualized a large mass in the right upper quadrant. The mass was radiologically described as a 22 × 17 × 13 cm heterogeneous mass with its epicenter in the area of the right adrenal gland, with medial and peripheral effacement of all structures in the right upper quadrant. Non-contrasted images demonstrated anterior mid-portion calcifications. The mass parasitized its blood supply from several surrounding structures, including the liver and right psoas muscle, and extensively invaded the psoas muscle. Resection of the mass was performed with pathology, which revealed a high mitotic index and nuclear atypia with two morphologically and immunophenotypically distinct components. One of these components stained positively for calretinin and inhibin, which is indicative of adrenal cortical carcinoma; the other exhibited strong expression of vimentin and desmin, which was concordant with sarcomatous change and confirmed the diagnosis of adrenal cortical carcinosarcoma. This unique histology with both carcinomatous and sarcomatous components presents a diagnostic challenge for clinicians. As such, adrenal carcinosarcomas should be kept on the differential when evaluating retroperitoneal masses. Additionally, this study includes a review of 34 previously reported cases of adrenal cortical carcinosarcomas along with a discussion about the future exploration of this pathology.

Keywords: adrenal carcinosarcoma; carcinosarcoma; adrenal cancer

1. Introduction

Adrenal cortical carcinosarcoma is an exceedingly rare malignancy of the adrenal gland. This pathology is so uncommon that knowledge and statistical evidence concerning it relies on case reports. It is the least common variant of adrenal cortical carcinoma [1]. Okazumi et al., described the first known case in 1987 [2]. This malignancy is notable for exhibiting both carcinomatous features and mesenchymal differentiation [3]. Prognosis is usually very poor [4]. Treatment begins with surgical resection; however, disease recurrence is common [1]. We present a case detailing a 78-year-old female with confirmed adrenal cortical carcinosarcoma to further progress medical knowledge concerning this rare pathology. We also performed a literature review of published cases to summarize current knowledge and to create discussion on the assessment and treatment of adrenal cortical carcinosarcomas.
2. Case Presentation

A 78-year-old African American female with a past medical history of long-standing hypertension and diabetes mellitus, coronary artery disease, and tobacco use presented with complaints of fatigue and right shoulder pain for two weeks. The patient also noted a palpable mass in her right upper quadrant that she had noticed two months previously. On arrival to the hospital, her vital signs were significant with a blood pressure of 175/90 mmHg, but was otherwise within normal limits. The patient’s white blood cell count was elevated to 23 thousand cells per cubic millimeter and alkaline phosphatase was elevated to 227 units per liter. The physical exam noted a palpable mass in the patient’s right upper quadrant. There were no obvious signs of hormone or endocrine dysfunction. The patient’s hypertension and diabetes mellitus had been present for many years. A contrast-enhanced computed tomography scan of the abdomen and pelvis was obtained and demonstrated a heterogeneous mass measuring 22 × 17 × 13 cm with its epicenter in the area of the right adrenal gland (Figure 1). Effacement was noted in the structures in the right upper quadrant, as well as in the right kidney and renal vein. Blood supply to the mass was parasitized from the right lobe of the liver, right inferior phrenic artery, inferior adrenal artery, and the capsular branches off the right kidney. The mass additionally invaded the right psoas muscle, extending from the level of the diaphragm to at least the level of the L3 vertebra. A diffuse soft tissue edema, likely the result of vena cava compression, was additionally noted. The left adrenal gland appeared normal. Serum tumor markers were checked. The patient was noted to have an elevated cancer antigen 125 (CA-125) at 62 U/mL (normal range 0.00–30.20 U/mL). Alpha-fetoprotein (AFP), carcinoembryonic antigen (CEA), and carbohydrate antigen 19-9 (CA 19-9) levels were within normal limits. Adrenocortical hormone levels and metanephrine assays were not assessed in this patient.

The patient was taken to the operating room for resection of the mass. Grossly, the mass measured 27 × 17 × 12 cm and weighed 3.3 kg. The serial section of the mass revealed a tan-yellow hemorrhagic and necrotic cut surface with an area of capsular disruption (Figure 2). The normal adrenal gland was not identified.

Figure 1. Contrast-enhanced CT scan of the abdomen and pelvis, axial view. Large heterogeneous mass visualized (arrow).
The patient was taken to the operating room for resection of the mass. Grossly, the mass measured 27 x 17 x 12 cm and weighed 3.3 kilograms. The serial section of the mass revealed a tan-yellow hemorrhagic and necrotic cut surface with an area of capsular disruption (Figure 2). The normal adrenal gland was not identified.

Figure 2. Gross image of tan-yellow mass with areas of hemorrhage and necrosis.

Histologically, the lesion revealed solid sheets of the tumor with heterogeneous components and necrosis. The carcinoma component of the tumor consisted of polygonal cells with abundant eosinophilic granular cytoplasm and round nuclei with an open chromatin pattern (Figure 3). The sarcoma component was comprised of pleomorphic spindle cells, eosinophilic cytoplasm, identifiable mitosis, and dark, pleomorphic, hyperchromatic nuclei (Figure 4).

Figure 3. (40×): Carcinoma component: epithelioid cells with abundant cytoplasm and round nuclei.
Figure 3. (40×): Carcinoma component: epithelioid cells with abundant cytoplasm and round nuclei.

Figure 4. (40×): Sarcoma component: pleomorphic spindle cells with nuclear hyperchromasia.

The carcinoma component shows positive staining for calretinin (cytoplasmic and nuclear staining), inhibin (cytoplasmic staining), and synaptophysin (diffuse cytoplasmic and membranous staining) (Figures 5, 6 and 7, respectively). The sarcoma component of the tumor was stained for vimentin (cytoplasmic staining) and desmin (cytoplasmic staining) (Figures 8 and 9, respectively).

Figure 5. (20×): Inhibin stain: diffuse cytoplasmic staining of carcinoma component. Immunohistochemistry (IHC) for comparison.

Figure 6. (20×): Calretinin stain: cytoplasmic and nuclear staining of carcinoma component.

Figure 7. (20×): Synaptophysin stain: diffuse cytoplasmic and membranous staining of carcinoma component.

Figure 8. (20×): Vimentin stain: cytoplasmic staining of sarcoma component.

Figure 9. (20×): Desmin stain: cytoplasmic staining of sarcoma component.
Figure 6. (20×): Calretinin stain: diffuse cytoplasmic and nuclear staining of carcinoma component. IHC for comparison.

Figure 7. (10×): Synaptophysin stain: cytoplasmic and staining of carcinoma component. IHC for comparison.

Figure 8. (10×): Vimentin stain: strongly positive sarcomatous component. IHC for comparison.
The tumor cells (both carcinoma and sarcoma component) were negatively stained for HMB-45, myogenin, Pax8, and pan-keratin. The complete list of staining is described in Table 1. Based on the morphology and pattern of immunohistochemical staining, the diagnosis of the carcinosarcoma was rendered.

**Table 1.** Immunohistochemical staining in carcinomatous and sarcomatous components. All of the antibodies used in the immunology lab are pre-diluted by the manufacturing company as listed in the table.

| Stain            | Carcinomatous Component | Sarcomatous Component | Company | Clone  |
|------------------|-------------------------|-----------------------|---------|--------|
| Calretinin       | Positive                | Negative              | Ventana | SP65   |
| HMB-45           | Negative                | Negative              | Ventana | HMB-65 |
| Inhibin Alpha    | Positive                | Negative              | Ventana | R1     |
| Synaptophysin    | Positive                | Negative              | Ventana | SP11   |
| Myogenin         | Negative                | Negative              | Ventana | F5D    |
| Vimentin         | Negative                | Positive              | Ventana | Vim 3B4|
| Desmin           | Negative                | Positive              | Ventana | DE-R-11|
| Pax8             | Negative                | Negative              | Ventana | MRQ-50 |
| Pan-keratin      | Negative                | Negative              | Ventana | AE1/AE3/PCK 26 |

The surgical resection had multiple serious complications, namely bleeding and hemorrhagic shock, which necessitated transfer to the surgical intensive care unit postoperatively. The patient required massive blood transfusion, multiple vasopressor support, and continued mechanical ventilation. At this time, the patient’s family made the decision to withdraw care and pursue inpatient hospice care with comfort measures only. The patient expired shortly after.

**3. Literature Review**

Our literature review discovered 35 cases describing adrenal cortical carcinosarcomas in medical literature thus far, including this case. PubMed was utilized to conduct the literature analysis. These cases are detailed in the table below (Table 2).
Table 2. Clinicopathologic features and outcomes of reported cases of adrenal cortical carcinosarcoma. Abbreviations: M, male; F, female; R, right; L, left; RUQ, right upper quadrant; RA, right atrium; RV, right ventricle; IVC, inferior vena cava.

| Author            | Age/Sex | Chief Complaint                          | Endocrine Dysfunction | Location | Metastasis at Presentation | Size (cm), Weight (g) | Sarcomatous Component | Treatment                          | Outcome                          |
|-------------------|---------|------------------------------------------|-----------------------|----------|-----------------------------|-----------------------|----------------------|-------------------------------|----------------------------------|
| Okazumi et al., 1987 [2] | 46/M   | Abdominal distention, back pain          | No                    | R        | Invasion of tumor emboli to RA, RV, IVC, and retroperitoneum | 14 cm, 880 g         | Spindle Cell          | Adrenalectomy and nephrectomy | Death at 6 months post-op        |
| Collina et al., 1989 [5] | 68/F   | Abdominal discomfort                     | No                    | L        | No                          | 11 cm, Not reported  | Spindle Cell          | Resection                     | Recurrence at 2 months, Death at 6 months post-op (7 months after diagnosis) |
| Decorato et al., 1990 [6] | 42/F   | Abdominal and flank pain                 | No                    | L        | No                          | 19 cm, 1400 g        | Rhabdomyosarcoma      | Resection                     | Death at 7 months post-op        |
| Fischler et al., 1992 [7] | 29/F   | Amenorrhea, fatigue, weight loss, body musculature, clitoromegaly, hirsutism | Yes                   | L        | No                          | 12.5 cm, 610 g       | Rhabdomyosarcoma      | Resection with adjuvant treatment with mitotane | Death at 8 months post-op        |
| Barksdale et al., 1993 [8] | 79/F   | Severe hypertension                      | Yes                   | R        | Invasion of IVC              | 9 cm, 199 g          | Osteosarcoma, chondrosarcoma | Not reported | Not reported |
| Lee et al., 1997 [9] | 61/M   | Flank and back pain                      | Yes                   | R        | Liver                       | 12 cm, no weight reported | Spindle cell         | Radical nephrectomy, right liver lobectomy | Death at 2 days post-op          |
| Chung et al., 1998 [10] | 48/F   | Abdominal distention                     | No                    | R        | No                          | Not reported         | Spindle cell         | Resection                     | Death 3 months post-op          |
| Somda et al., 2007 [11] | 58/F   | Asthenia and flank pain                  | No                    | R        | No                          | 13 cm, 760 g         | Leiomyosarcoma        | Adrenalectomy, nephrectomy, adjuvant treatment with mitotane | Alive without recurrence after 16 months |
| Sturm et al., 2008 [4] | 31/M   | Abdominal pain                           | No                    | L        | No                          | 12 cm, 620 gm        | Spindle Cell          | Resection with cisplatin and etoposide | Death at 3 months post-op        |
| Coli et al., 2010 [12] | 75/F   | Abdominal pain                           | No                    | L        | 15 cm, not reported         | Spindle cell         | Adrenalectomy and splenectomy | Death at 12 months post-op        |
| Author                  | Age/Sex | Chief Complaint                                      | Location | Metastasis at Presentation                                                                 | Size (cm), Weight (g) | Sarcomatous Component | Treatment                                      | Outcome                                      |
|------------------------|---------|-----------------------------------------------------|----------|-------------------------------------------------------------------------------------------|-----------------------|-----------------------|------------------------------------------------|----------------------------------------------|
| Sasaki et. Al., 2010   | 45/M    | Abdominal Pain, Fever, Nausea and vomiting          | No       | Left retroperitoneal invasion and bi-lobar liver metastasis                               | 17 cm, 2974 g         | Rhabdomyosarcoma       | Nephrectomy, splenectomy, partial colectomy, and pancreatectomy | Death at 3 months post-op                    |
| Feng et al., 2010      | 72/M    | Lumbar back pain                                     | No       | None from the primary adrenocortical carcinoma. This was a collision tumor with an adrenal metastasis of a rectal tumor | 7.1 cm, not reported  | Spindle cell           | Resection                                      | Not reported                                 |
| Bertolini et al., 2011 | 23/F    | Fatigue, decreased appetite, fixed mass in rectum   | No       | None from the primary adrenocortical carcinoma. This was a collision tumor with an adrenal metastasis of a rectal tumor | 14 cm, Not reported  | Osteosarcoma           | Adrenalectomy                                  | Death at 14 months post-op                  |
| Thway et al., 2012     | 45/M    | Bloating, back pain                                  | No       | Abdominal and retroperitoneal nodes, lung                                               | 24 cm, 6500 g         | Rhabdomyosarcoma       | Adrenalectomy, splenectomy, nephrectomy + combination high-dose palliative chemotherapy of vincristine, ifosfamide, doxorubicin, and etoposide, alternating with ifosfamide, carboplatin, and etoposide. | Death at 11 months post-op                  |
| Yan et al., 2012       | 72/M    | Flank pain                                           | No       | Pulmonary nodules                                                                         | 13 cm, not reported   | Spindle cell           | Adrenalectomy                                  | Death at 2.5 years post-op                  |
| Kao et al., 2013       | 45/M    | Abdominal pain, weight loss                          | No       | No                                                                                       | 15 cm, 760 g          | Spindle cell           | Partial nephrectomy and hepatectomy           | Death at 7 months post-op                   |
| Mark et al., 2014      | 58/M    | Flank pain                                           | No       | No                                                                                       | 12 cm, 573 g          | Spindle cell           | Adrenalectomy and nephrectomy                  | No evidence of metastatic adrenal disease at 17 months |
Table 2. Cont.

| Author                  | Age/Sex | Chief Complaint | Endocrine Dysfunction | Location | Metastasis at Presentation | Size (cm), Weight (g) | Sarcomatous Component | Treatment                          | Outcome                                                                 |
|-------------------------|---------|-----------------|-----------------------|----------|-----------------------------|-----------------------|----------------------|-------------------------------|------------------------------------------------------------------------|
| Shaikh et al., 2014     | 62/F    | RUQ pain        | No                    | R        | Not at presentation, Para-aortic lymph nodes, 3 months after adrenalectomy | 6.5 cm, 55 g         | Spindle cell          | Adrenalectomy               | Death at 4 months post-op, having declined adjuvant therapy            |
| Wei et al., 2015        | 63/F    | Fatigue, flank pain | No                   | L        | 8 cm, not reported          | Spindle cell          | Adrenalectomy               | No recurrence at one month post-op                                      |
| Wanis et al., 2015      | 68/F    | Incidental finding during follow-up of lung adenocarcinoma | No                   | Unspecified | 13 cm, not reported | Spindle cell | Radical nephrectomy | Death at 223 days post-op |
| Wanis et al., 2015      | 65/M    | Incidental finding during claudication work-up | No                   | Unspecified | 12.8 cm, not reported | Spindle cell | Radical nephrectomy | Alive at 4 months; unknown total survival |
| Zhu et al., 2016        | 59/M    | Asthenia and weight loss | No                   | R        | Lung                        | 5 cm, not reported | Spindle cell | Adrenalectomy | Alive at 6 months post-op, refused further treatment and follow up |
| Ishikawa et al., 2016   | 69/F    | General malaise and hypotension | Yes                  | Bilateral | R-5.5 cm, 20 g; L-7 cm 35 g | Not reported | Resection | 4 months post-op |
| Iyidir et al., 2016     | 53/F    | Abdominal and flank pain, weight loss | No                   | Bilateral | Liver                       | R-9 cm, 80 g; L-8.5 cm, not reported | Spindle cell | Bilateral adrenalectomy, splenectomy, cholecystectomy, partial hepatectomy and nephrectomy | Death 1 month post-op due to pancreatic fistula development and multiorgan failure |
| Papathomas et al., 2016 | 55/M    | Abdominal pain   | No                    | L        | 16 cm, not reported         | Spindle Cell          | Resection | Death at 4 months from diagnosis |
| Papathomas et al., 2016 | 70/F    | Abdominal pain, diarrhea | No                   | R        | 15 cm, not reported         | Osteosarcoma, Spindle cell | Resection and mitotane | Death at 8 months from diagnosis |
| Papathomas et al., 2016 | 52/M    | Abdominal pain, fatigue, malaise, weight loss | No                   | R        | Liver                       | 24 cm, 3020 g         | Spindle Cell | Resection and mitotane | Death at 4.5 months from diagnosis |
| Author                  | Age/Sex | Chief Complaint                                                                 | Endocrine Dysfunction | Location | Metastasis at Presentation | Size (cm), Weight (g) | Sarcomatous Component | Treatment                     | Outcome                           |
|-------------------------|---------|---------------------------------------------------------------------------------|-----------------------|----------|-----------------------------|----------------------|----------------------|--------------------------------|----------------------------------|
| Saeger et al., 2017 [26]| 53/F    | Hypertension                                                                    | Yes                   | R        | Liver                        | 13 cm, not reported  | Spindle cell         | Adrenalectomy and partial hepatectomy | Alive > 6 months post-op; alive at time of article but survival duration not clear |
| Sung et al., 2017 [27]  | 51/M    | “Nonspecific”                                                                  | No                    | R        | Liver, spleen, lung          | 15 cm, not reported  | Spindle cell         | Resection                      | Death at 1.7 months                |
| Yazir et al., 2019 [28] | 52/M    | Abdominal pain and distention, episodic hypertension                           | Yes                   | L        | Spleen                       | 14 cm, not reported  | Not reported         | Resection                      | Death at 1 day post-op              |
| Sabrine et al., 2020 [29]| 27/F    | Flank pain                                                                      | No                    | R        | No                           | 12 cm, 660 g        | Spindle cell         | Adrenalectomy                  | Alive at 6 months follow up without local recurrence |
| Rexwana et al., 2020 [30]| 37/F    | Facial swelling and flushing, weight gain, palpitations, RUQ abdominal pain, generalized weakness and lethargy | Yes                   | R        | No                           | 10 cm, not reported  | Osteosarcoma         | Adrenalectomy                  | Alive 5 months post-op, received 3rd cycle of chemotherapy |
| Rachh & Nilam, 2022 [31]| 78/F    | Severe back pain                                                                | No                    | Bilateral| Bone, lymph nodes, pleura    | R-4.6 cm; L-6.0 cm  | Spindle cell         | Not reported                   | Death within few months of diagnosis |
| Zhang et al., 2022 [32] | 53/M    | RUQ abdominal pain                                                              | No                    | R        | Mediastinal Lymph Node       | 7.2 cm              | Not reported         | Surgical resection of the mass + immune therapy | 6 months after diagnosis |
| Present Case            | 78/F    | Fatigue and shoulder pain                                                       | No                    | R        | No                           | 27 cm, 3307 g       | Spindle cell         | Radical nephrectomy and adrenalectomy, partial hepatectomy | Death at 7 days post-op |
4. Discussion

Adrenal cortical carcinosarcoma is an extremely rare pathology. The first reported case in scientific literature was in 1987 [2]. Its defining feature is a tumor that exhibits both carcinomatous and sarcomatous differentiation [31]. The sarcomatous component can differentiate into osteosarcoma, chondrosarcoma, or rhabdomyosarcoma, or present without any recognizable differentiation with a spindle cell morphology [4]. Clinically, these malignancies can present as either nonfunctioning or functioning. Functioning tumors can show signs of cortisol excess and Cushing’s syndrome, hyperaldosteronism, or sex hormone secretion with masculinization of females and feminization of males [23].

Per an extensive literature review, we have documented 35 cases in the literature, including the case we have presented. This is the most extensive literature review of adrenal carcinosarcoma cases to date, to our knowledge. The average age at diagnosis was 55 years old with a range of 23 to 79 years old. Cases were slightly more common in females compared to males with a female-to-male ratio of 1.19. Regarding tumor location, 18 cases arose from the right adrenal gland and 12 from the left. Three cases presented with bilateral adrenal disease. The average size of the tumors was 12.4 cm across their largest dimension with average weight of 1321 g. The most common presenting complaint was pain, including abdominal, flank, back, and shoulder pain. Pain was the chief complaint in 25 (71.4%) cases. Two cases were found incidentally. Seven cases had symptoms of endocrine dysfunction, which comprised 20% of cases. The most common sarcoma histology was spindle cell, accounting for 68.6% of the cases. On presentation, 40% of patients had evidence of distant metastasis, with the liver being the most common site. All of the patients that opted for treatment underwent surgical resection, and six of these patients also received chemotherapy. Median survival from beginning of treatment until death was 4.5 months. The longest documented survival in a case was a patient that lived 2.5 years after surgery before passing [17]. Of note, there were two documented cases with patients that were alive without recurrence after surgical resection at 16 and 17 months, respectively [11,19].

Our literature review affirms the poor prognosis and aggressive behavior of adrenal carcinosarcomas [1,4]. This poor prognosis could be a result of a delay in diagnosis. Most patients possess nonfunctioning carcinosarcomas and present with symptoms caused by mass effect from the tumor with abdominal, flank, shoulder, or back pain. As such, patients on initial presentation already have a sizable disease burden. Furthermore, more than a third of patients have distant metastasis at diagnosis, and most cases will develop recurrence after surgery [1]. Another factor to consider is the difficulty in confirming the diagnosis of these malignancies. Diagnosis requires careful examination of histology. Although most of these carcinosarcomas are nonfunctioning, it can be helpful to evaluate them for hormonal dysfunction and obtain an endocrine panel with cortisol, aldosterone, and sex hormone levels when attempting to establish a diagnosis. In the cases reported above, the vast majority of adrenal cortical carcinosarcomas were visualized using computed tomography. However, imaging may be unreliable in determining the origin of these kinds of tumors. For instance, the initial hypothesis for the patient in our case was a tumor of renal origin after initial imaging was obtained.

Surgical resection is the preferred approach to obtain tissue to confirm diagnosis because there is a concern for disease spread with needle biopsy [33]. Resection is the mainstay of treatment and every documented case that pursued treatment underwent resection [24]. Due to the rarity of this malignancy, there is no standardized treatment regimen; however, adjuvant chemotherapy is typically recommended as well [24,25]. The most common chemotherapy agent utilized was mitotane, with four of the cases using this agent. The remaining two cases that underwent chemotherapy used a regimen based on etoposide and a platinum agent. Of the cases that received chemotherapy, the longest survival was noted in a patient who received treatment with mitotane; this patient was noted to be alive at 16 months after diagnosis [11]. The other five cases that underwent chemotherapy expired between 3 and 11 months, with an average survival of 6.9 months.
Carcinosarcomas are not limited to the adrenal gland. They can arise from many different organs including the uterus, ovaries, breast, prostate, lung, liver, stomach, and esophagus [34]. Perhaps the most documented are those developed from uterine tissue. Uterine carcinosarcomas, much like adrenal carcinosarcomas, have poor survival rates and high recurrence rates, and are typically treated with surgery and chemotherapy [34]. As such, there have been efforts to explore the pathogenesis of carcinosarcomas to possibly discover other treatment modalities. As the name suggests, epithelial cell adhesion molecule-1 (EpCAM) promotes cell adhesion and plays a significant role in cell differentiation, proliferation, signaling, and migration [35,36]. It is notable for being highly expressed on the cell surface of multiple malignancies and has been used as a prognostic biomarker for carcinomas and carcinosarcomas [37–39]. There have been treatments developed that utilize monoclonal antibodies such as solitomab and edrecolomab to target EpCAM as a means of immunotherapy for different carcinomas. These treatments have demonstrated promising antitumor activity, but they have not yet been shown to affect overall survival [37,40,41]. Nevertheless, these treatments serve as examples in the exploration of immunotherapy as a treatment modality for carcinosarcomas including adrenal carcinosarcomas.

There is also ongoing work developing new treatment modalities for adrenocortical carcinomas in general. An advanced adrenocortical carcinoma carries a dismal prognosis, with a 5-year survival rate of less than 15% [42]. Typical treatment is surgical resection, if possible, along with mitotane as adjuvant chemotherapy [43]. Therapeutics for adrenocortical carcinoma are being considered that could target pathways such as insulin growth factor and mTOR signaling, vascular endothelial growth factor receptor (VEGF) pathway, epidermal, fibroblast, and epidermal-derived growth factor signaling, and steroidogenesis [44]. These pathways could serve as targets for treatment for adrenal carcinosarcomas as well.

Extra-gynecologic carcinosarcoma is exceedingly rare and the genomic profiling of adrenal carcinosarcoma is not readily available in the current literature. Studies performing genomic analysis in gynecologic carcinosarcomas have identified genomic aberrancies and molecular markers, which are associated with patient prognosis and can serve as potential therapeutic targets [45]. Similar studies in adrenal carcinosarcomas may identify targetable genomic alterations that can be exploited for a personalized therapy approach for the management of this aggressive malignancy.

5. Conclusions

Adrenal cortical carcinosarcomas are extremely rare neoplasms that are notable for exhibiting both carcinomatous and sarcomatous characteristics. There are 35 documented cases in the literature to our knowledge. Patients often present with a significant disease burden and the prognosis is usually dismal. Diagnosis can be difficult and includes complicated histology. Surgical resection is the first step in treatment and there is not a standardized treatment regimen at this time. This is the most extensive literature review of adrenal cortical carcinosarcomas to date. Continued investigations into pathogenesis are needed to explore potential treatment options. It is imperative to expand the knowledge base regarding this pathology to improve surveillance, diagnosis, treatment, and patient outcomes. Our hope is that this work can serve as a comprehensive resource and reference for other clinicians and researchers to advance research of this rare malignancy, particularly to better diagnoses and treatments.

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