Case Report

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Adrenocortical carcinoma in a 10-month-old infant: A literature review and a rare case report

Basel Al-Ghotani, MSc[a,b,*], Ebaa Alabdallah, MSc[a,b], Venus Shaaban, MD[a], Farah Nemer, MD[a,c], Amal Alsneeh, MSc[a], Fawaz AL Sharif, MD[a,d], Husam Dalati, MD[a,d], Marah Mansour, MD[e]

Introduction and importance: Adrenocortical carcinoma (ACC) in children is a rare condition. The annual incidence of ACC is extremely low, with only 0.2–0.3 cases per million children. The clinical presentations of ACC are numerous, such as terminal hair appearance, pubertal progress, hypercortisolism, enlarged clitoris, acne, systemic arterial hypertension, weight gain, and voice change.

Case presentation: A 10-month-old female infant presented by her parents to the Department of Endocrinology with a mass on the right adrenal gland and Cushing's syndrome symptoms. Surgery was performed. The death occurred after two times resuscitation due to sudden cardiac arrest.

Clinical discussion: The adrenal gland consists of two distinct parts. Different types of tumors arise from each part of the adrenal gland. The most common tumor in adrenomedullary tumors was neuroblastoma which accounted for 60.4% of adrenal tumors. ACC in children is a rare condition. The etiology of ACTs is unclear.

Conclusion: This case emphasizes that early diagnosis has a considerable role in preventing major complications. Also to advise considering ACC as a differential diagnosis when similar symptoms are found in an infant.

Keywords: adrenocortical carcinoma, case report, Cushing's syndrome, infant

Introduction

Adrenocortical carcinoma (ACC) in children is a rare condition. ACC accounts for only 0.2% of childhood and adolescent malignancies. The annual incidence of ACC is extremely low, with only 0.2–0.3 cases per million children[1,2]. In comparison worldwide, the incidence of ACC is higher than 10–15 times in Brazil (regions South and Southeast)[3,4]. Also, it has a female predominance with a 2 : 1 ratio[5–7]. The clinical presentations of ACC are numerous, such as terminal hair appearance, pubertal progress, hypercortisolism, enlarged clitoris, acne, systemic arterial hypertension, weight gain, and voice change[8]. Rosana Marques-Pereira *et al.*[9] have reported that the majority of patients presented with virilization or Cushing's syndrome (hypercortisolism). In addition, Sandrini and colleagues reported a case with an acute abdomen due to sudden tumor rupture. Sandrini and colleagues have defined the staging of ACC (Table 1). The most reliable diagnostic test is urinary 17-ketosteroids. Otherwise, urinary 17-hydroxycorticosteroid may be useful. Moreover, computed tomography (CT), ultrasonography (US), and MRI could be used for diagnosis[10]. There are several modalities to treat those patients according to the stagings of the tumor, such as surgery, surgery plus retroperitoneal lymph node dissection, cisplatin, etoposide, doxorubicin, and mitotane[5,11].

This case report has been reported in line with the SCARE Criteria[12].

HIGHLIGHTS

- Early diagnosis has a considerable role in preventing major complications.
- Surgical resection is the chosen procedure.
- Adrenocortical carcinoma in children is a rare condition.

[a]Faculty of Medicine, [b]Stemosis for Scientific Research, [c]Department of Anesthesia, Resuscitation and Intensive Care Unit, Faculty of Medicine, Damascus University, [d]Department of Pediatric Surgery, Children's University Hospital, Damascus and [e]Faculty of Medicine, Tartous University, Tartous, Syrian Arab Republic

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

*Corresponding author. Address: Faculty of Medicine, Damascus University, Damascus, Syrian Arab Republic. E-mail address: balghotane@gmail.com (B. Al-Ghotani).

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Table 1

Describes the stages of ACC.

Stage	Definition
I	Tumor totally excised, tumor volume 200 cm^3, absence of metastasis, normal hormone levels after surgery
II	Microscopic residual tumor, tumor volume 200 cm^3, tumor spillage during surgery, or persistence of abnormal hormone levels after surgery
III	Gross residual or inoperable tumor
IV	Distant metastasis

ACC, adrenocortical carcinoma.

Herein, space we present an extremely rare case of a 10-month-old infant with a mass on the right adrenal gland and Cushing's syndrome.

Case presentation

A 10-month-old female infant was presented by her parents to the Department of Endocrinology with a mass on the right adrenal gland and Cushing's syndrome symptoms. The infant was born to consanguineous parents after normal gestation and vaginal delivery. The birth weight was 3.5 kg. The medical history of congenital dislocation of the hip, gradual weight gain, cushingoid face, central obesity (Fig. 1), genital hirsutism, severe genital rash, increased appetite in the past 3 months, cough, hoarseness, dyspnea, and nasal congestion due to respiratory infection in the past week, no vomiting, no fever was reported, defecation of yellowish feces in the past week was mentioned. Medication history was enalapril 0.1 mg/kg, and albendazole 0.1 mg/kg. Physical examination revealed facial acne and vascular lesions by inspection, other Cushing's features such as striae and bruises were absent and a mass in the right flank by palpation, measured ($5 \times 5 \times 6$ cm) with no crossing of the median line. Mild wheezing and soft crackles in the lungs by auscultation were reported. The patient's body length was 64 cm (SD score: – 2.7), and weight was 11.5 kg (95% percentile, SD score: 2.21) (Fig. 1). Blood pressure was within normal limits. Laboratory findings were analyzed as shown in Table 2. Investigations revealed a high level of urine-free cortisol (443.8 µg/24 h) accompanied by serum adrenocorticotropic hormone (ACTH), levels of (6.2 pg/ml), serum progesterone levels of (1.8 ng/dl), and a normal level of vanillylmandelic acid of 1.9 mg/24 h. Blood glucose was mildly elevated (< 200 mg/dl). Chest radiography showed interstitial infiltrations in the inferior pulmonary lobes. The US abdomen revealed heterogeneous echotexture, with regular margins measuring ($5 \times 5 \times 8$ cm) in the right flank, compressing the upper pole of the right kidney and the liver, with isolated vascular perfusion. The cardiac echography showed thickened ventricular septum, measuring 9 mm. The multislice CT showed a large perfused mass located on the upper pole of the right kidney, pushing down, deviating the longitudinal axis of the kidney, and deviating the abdominal aorta and the inferior vena cava to the left with no invasion. The mass slightly crosses the median line, measuring ($6 \times 6 \times 7$ cm). Multislice CT also revealed several lymph nodes surrounding the abdominal aorta, the largest node measuring 10 mm. No free fluids or metastases in the abdomen or the pelvis were detected. The primary differential diagnosis based on the radial findings was right adrenal neuroblastoma. An echo-guided biopsy was obtained from the mass and reported atypical adrenal adenoma: the proliferation of large cuboidal cells with predominantly normal nuclei. However, one focus showed marked enlarged bizarre nuclei with hyperchromasia, and no mitosis was noted. Surgery was performed after the respiratory infection was fully treated. The mass was adhered to the right kidney, the inferior surface of the liver, and the diaphragm, the vena cava was not spared. By open abdominal approach, under general anesthesia, the mass was isolated from the adjacent organs with difficulty (Fig. 2). All organs were intact after the mass removal with no hemorrhage. A drainage tube was used. An amount of 200 ml of blood was transfused during surgery. Postoperation, a fixed amount of serosanguineous fluid was obtained from the drainage tube. The patient was transferred from the surgical ICU to the Department of Surgery the day after

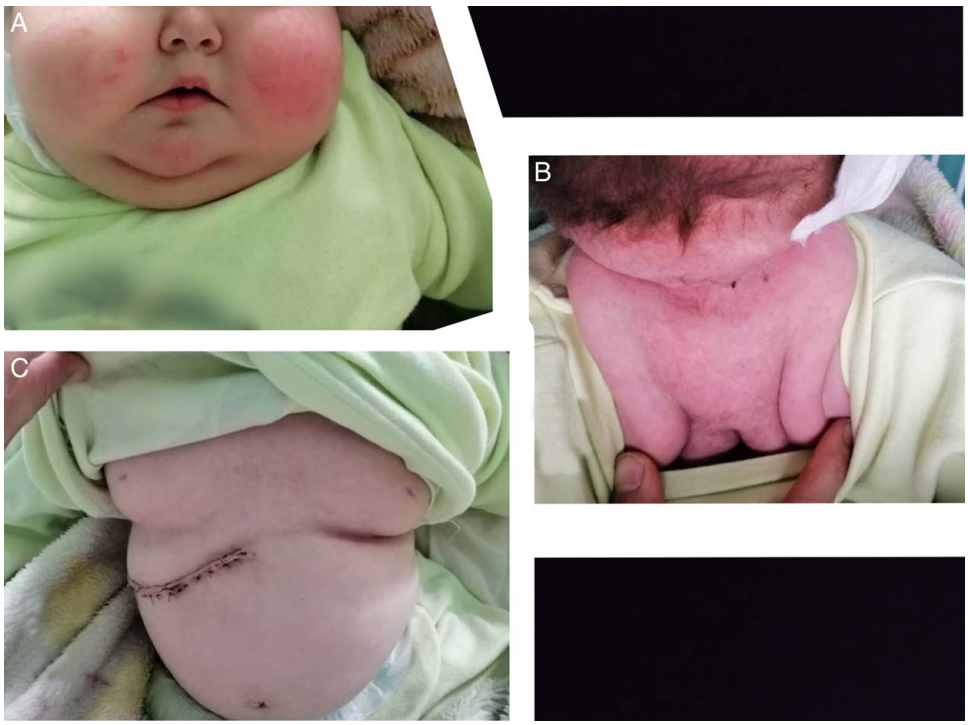

Figure 1. (A and B) The patient profile before the surgery (chubby cheeks, moon face, and weight gain around the middle and upper back). (C) The first adrenalectomy on the right side (image was taken after completion of the operation).

Table 2

The biochemical findings.

Biochemical findings	Parameter
White blood cell (WBC)	12 400 × 10^3/μl
Lymphocytes (%)	23
Neutrophils (%)	68
Hemoglobin	13.5 g/dl
Platelet	172 × 10^3/μl
MCV (mean cell volume)	79 fl
PT (prothrombin time)	12 s
PTT (partial thromboplastin)	24 s
AST (aspartate aminotransferase)	601 μ/l
C-reactive protein	0.08 mg/dl
Serum chloride	102 mmol/l
Serum calcium	10.4 mg/dl
Serum potassium	4.82 mmol/l
Serum sodium	141 mmol/l
Creatinine	0.41 mg/dl
Urea	17 mg/dl
VMA (vanillylmandelic acid)	1.9 mg/24 h
24 h urine-free cortisol	443.8 μg/24 h
Adrenocorticotropic hormone (ACTH)	6.2 pg/ml
Serum progesterone	1.8 ng/dl
Fasting blood glucose	128 g/ml
After operation	
C-reactive protein	79 mg/dl
Serum potassium	3.12 mmol/l
Serum calcium	0.98 mg/dl
Serum sodium	135.5 mmol/l
Day 6 and day 8 after operation	
Serum potassium	2.2 mmol/L
Day 13 after operation	
Serum sodium	129.5 mmol/l
Serum calcium	6.9 mg/dl
Day 16 after operation	
White blood cells (WBC)	1940 × 10^3/μl
Platelet	33 × 10^3/μl
Hemoglobin	10 g/dl

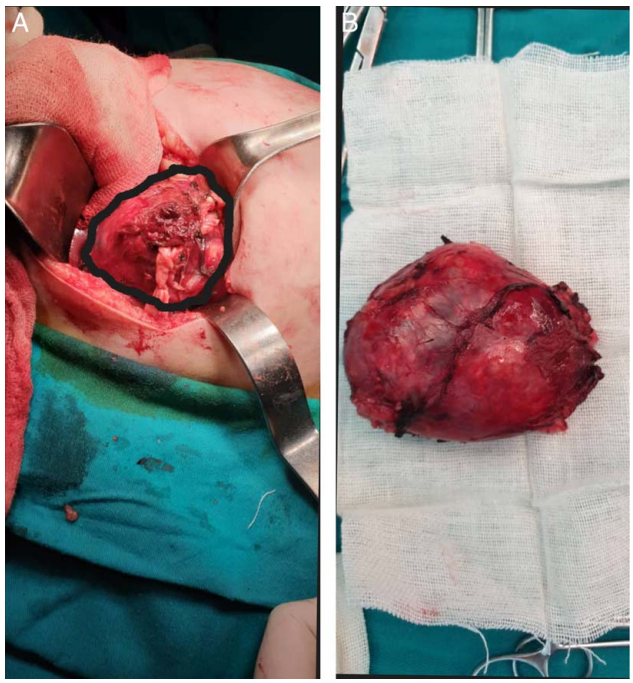

Figure 2. (A) The mass during surgery. (B) Surgical specimen of resected lobulated right adrenal mass.

the surgery. Two days after surgery, the patient developed a fever (38.5–39°), diarrhea of greenish mucosal feces five times a day, dyspnea of 40 times/m, and diffuse wheezing in the lungs. The infant was treated with linezolid, tazobactam, metronidazole, ciprofloxacin, and hydrocortisone. At 6 and 8 days after surgery, serum potassium levels were corrected due to potassium depletion. Ten days after surgery, a swab from the central venous catheter's entrance was obtained and reported multi-microbial colonies sensitive only to colistin. Hypertension of 110/70 mm Hg was detected and the antihypertensive drugs were adjusted and amlodipine was added. A 13-day after surgery, serum calcium, and potassium levels were corrected due to depletion. At 16 days after surgery, an excessive pulmonary hemorrhage accompanied by a decrease in oxygen saturation, bradycardia (80 times/m), severe dyspnea signs, central and peripheral cyanosis, and depletion of platelet and white blood cell counts and hemoglobin levels. A unit of platelet was transfused and atropine was administered. The death occurred after two times resuscitation due to sudden cardiac arrest with a 4-h interval in between. The direct cause of death was uncompensated circulation shock. Indirect causes of death were acute pulmonary hemorrhage, sepsis, disseminated intravascular coagulation, and adrenal carcinoma. Histopathological study showed adrenocortical neoplasm (Fig. 3). The product of adrenalectomy showed a well-encapsulated mass, measures 8 × 6 cm, and weighs 118 g. Cross-sections revealed a heterogeneous yellowish mass with regions of necrosis and hemorrhage. Microscopic examination revealed invasive proliferation of large clear, slightly eosinophilic cytoplasm with marked pleomorphism and bizarre hyperchromatic nuclei. Microfoci of capsular invasion was noted. No vascular invasion was reported. No significant mitotic activity or atypical mitotic figures were observed.

Discussion

The adrenal gland consists of two distinct parts: the cortex and the medulla. Different types of tumors arise from each part of the adrenal gland. Neuroblastoma, ganglioneuroblastoma, ganglioneuroma, and pheochromocytoma could arise from the adrenal medulla. Moreover, ACC and adenoma could arise from the adrenal cortex. According to a study that had 48 cases of the adrenal tumor, the ratio of medullary to cortical tumors was 4 : 1. Approximately 50% of adrenomedullary tumors could occur under the age of 1-year old. The most common tumor in adrenomedullary tumors was neuroblastoma which accounted for 60.4% of adrenal tumors. As well as, the most common tumor in adrenocortical tumors was cortical adenoma, followed by ACC. The male-to-female ratio of adrenomedullary tumors was 2 : 1, while adrenocortical tumors were 1 : 3[13]. ACC in children is a rare condition. ACC accounts for only 0.2% of childhood and adolescent malignancies. The annual incidence of ACC is extremely low, with only 0.2–0.3 cases per million children[1,2]. In comparison worldwide, the incidence of ACC is higher than 10–15 times in Brazil (regions South and Southeast)[3,4]. Also, it has a female predominance with a 2 : 1 ratio[5–7]. In 2006,

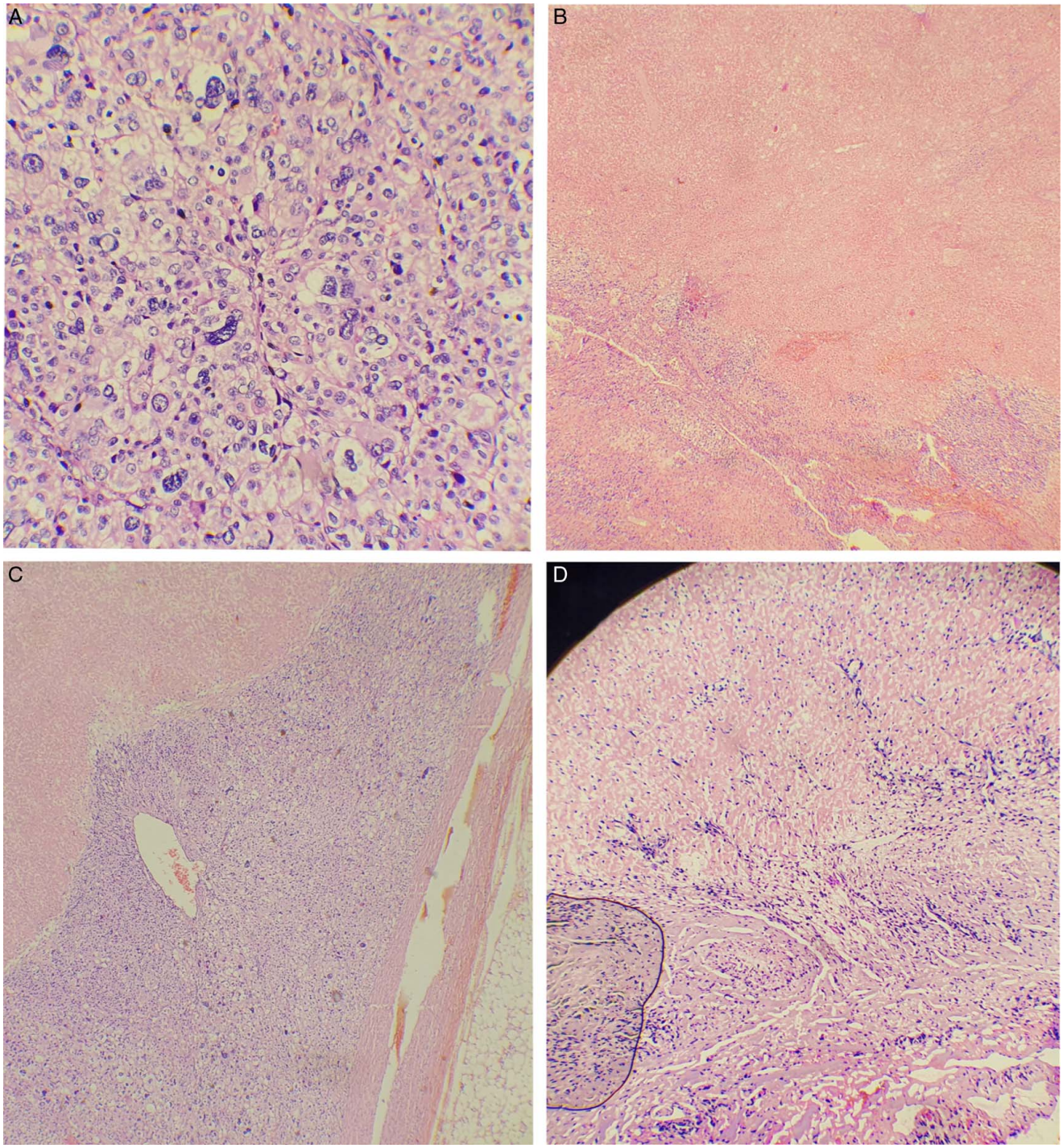

Figure 3. (A) Proliferation of variably sized nests and sheets of large cells showing high nuclear grade [hematoxylin and eosin (H&E) stain, ×200]. (B)Tumor is extensively necrotic (H&E stain, ×40). (C), No sinusoidal or venous invasion noted (H&E stain, ×40). (D) Focus of capsular invasion (H&E stain, ×100).

treatment guidelines have been created describing stages 1 and 2 patients who should only be treated surgically, while stages 3 and 4 have to receive adjuvant and neoadjuvant chemotherapy[14]. The etiology of ACTs is unclear. Mutations in the P53 gene are the most common inherited malformation. About 50–60% of cases involved in germline TP53 mutations and about 95% of cases in Brazil prevail in a cause of TP53p.R337H variant. Given the uncommonness of this finding, a registry of 254 children with adrenocortical tumors (International Pediatric Adrenocortical Tumor Registry) contributed greatly to understanding the nature of this disease. Although this series was limited by geographic bias for the reason that 79.5% of those patients came from Southern Brazil. It is presently perceived that these patients carry a common genetic disorder, the R337H allele of the TP53 tumor-

suppressor gene[15]. This allele shows some mysterious biochemical effects, which include PH-dependent loss of function and a wild-type activity in Nitro. Additionally, we discovered the basic role of TP53 in ACC when it was defined as a component tumor of the Li-Fraumeni syndrome[16]. Moreover, through all the families from the TP53 germline mutations, there are six common alleles (R175H, G245S, R248Q, R248W, R273H, and R282W), which are referred to as hotspot mutations that occur at a rate of 20%. Studies suggested that mutations in specific TP53 domains were related preferably to mutations in loops opposing protein-DNA contact[15]. Due to the unusual biochemical properties of the R337H mutation, a new mechanism has been proposed that during the prenatal period, remodeling is made within the adrenal cortex[16,17]. ACTs are usually related to Li-Fraumeni, Beckwith–Wiedeman syndromes, isolated hemihypertrophy syndromes, congenital anomalies of the kidney, and congenital adrenal hyperplasia[18]. Our patient had no clinical evidence of any of these associations. Adrenocortical tumors are more likely to form in children under the age of 5 years if they are virilized[19], exhibit symptoms of hormonal hypersecretion, Cushing syndrome, hypertension, weight gain, or voice changes[14], enlarged genitalia, hirsutism[7], increased height, moon face, osteoporosis[20], or muscle hypertrophy[14]. Clinical symptoms for females younger than 8 years old and males younger than 10 years old include growth spurts, bone age advancement, axillary sweating, odor, an increase in skin oiliness, the appearance of acne, and the beginning of secondary sexual characteristics like pubic hair, darkening of genital skin, and growth in the penile or clitoral corpus cavernous[21]. For those under the age of 14, the main clinical symptoms were fever, pain, and abdominal distention. Unlike adults, most children experience peripheral precocious puberty and endocrine syndrome[13]. However, older children have a fever or may not have any symptoms of a hormone imbalance[7]. In a few cases, clinical symptoms include polycystic ovaries, type 2 diabetes, hypertension, or osteoporosis[20]. Patients who have second-degree adrenocortical tumors have locoregional, mixed local or liver, or combined local or lung recurrence of the tumor, while patients with first-degree adrenocortical tumors may develop a precursor B-cell lymphoblastic leukemia[14]. Grade IV adrenocortical tumors are linked to metastases, and the most frequent sites for metastases are the liver[5], lung[15], or both[5], in addition to other sites[15]. Specifically in the Li-Fraumeni syndrome, positive for Tp53 mutations. In particular, it can raise the risk of cancer in the bone, soft tissue, brain, blood, and adrenal glands[22]. Relapses, poor growth, low bone density, and changes in body composition should all be watched for indications of therapy issues[20]. In pregnant females, ACC manifests with uncontrolled hypokalemia, acute heart failure, and preterm delivery[23]. A complication caused by the increased secretion of steroids due to an adrenocorticotropic tumor leads to a defect in the sex of the fetus resulting in ambiguous genitalia[24]. A disruption in the ovulation process, hypomenorrhea, irregular periods, or menopause are all consequences of the increased cortisol production, which prevents the pituitary gland from releasing gonadotropin[25], and Peripheral precocious puberty is more likely when there is an excess of estrogen[26]. Dehydroepiandrosterone sulfate, 17-hydroxyprogesterone, 11-deoxycortisol, androstenedione (A4), testosterone, and cortisol are the adrenal hormones used to measure basal secretion to diagnose adrenocortical tumors[3,7]. The abnormally increased serum levels of sexual corticosteroids were also one of the laboratory features of adrenocortical tumors[27]. The dexamethasone suppression test and 24-h urine-free cortisol measurement should be investigated[3,28]. Immunohistochemical research using p53 and Ki-67 antibodies[8]. Also, Tp53 mutation analysis makes accurate diagnosis possible[29]. Regarding radiographs, CT, which is the most helpful, is used to make the diagnosis in the first place[21]. CT scan helps determine the stage and location of the tumor and the treatment plan[27]. However, echocardiography of the adrenals is a possibility and requires a high level of experience and expertise[21]. Bone scintigraphy to look for metastases in the bones[8]. Analysis of high blood pressure and low potassium levels, together with an examination of the daily rhythm and cortisol level, are all helpful to establish the diagnosis of pregnant females with adrenocortical tumors. The ultimate diagnosis is determined by histology, despite radiological evidence indicating that both US and MRI are safe for the expectant mother and fetus[23]. For the diagnosis of the main tumor and the examination of abdominal metastases, an abdominal CT scan or MRI is considered[3,10,30]. In less severe cases, early symptoms of hyperandrogenism are frequent and are used to help differentiate them from adrenocortical malignancies such as congenital adrenal hyperplasia and idiopathic premature adrenarche[21]. The conditions chronic renal disease, pheochromocytoma, primary aldosteronism, renovascular hypertension, Cushing syndrome, and obstructive sleep apnea are all included in the differential diagnosis of hypertension secondary to adrenocortical tumors in pregnant females[23]. In addition, neuroblastoma, ganglioneuroma, ganglioneuroblastoma, and pheochromocytoma are among the possible diagnoses for adrenomedullary tumors[13]. Bilateral ACTH-dependent adrenal lesions are linked to a few conditions such as bilateral macronodular, adrenal hyperplasia, primary pigmented, nodular adrenal disease, and familial syndromes[31,32]. The most frequent cause of childhood Cushing's syndrome is increased secretion of cortisol in the serum[33], but Cushing's syndrome of endogenous origin is rare in children[34], however malignant adrenal carcinoma in children younger than 7 years of age is a frequent cause of the condition[35,36]. Overall, McCune–Albright syndrome (MAS) is the most common cause of bilateral macronodular adrenocortical illness in cases of ACTH-dependent Cushing's syndrome in children[37–41].

We have searched all articles on Pediatric Adrenocortical Carcinoma in the PubMed database, with filters applied: in the last 10 years, English. We used the following keywords: Cushing syndrome, adrenal cortex cancer, adrenal cortical carcinoma, infant, adrenalectomy, and suprarenalectomy. We have found 26 articles. We excluded articles with obvious irrelevance and finally acquired and reviewed 10 articles. The characteristics of these articles were summarized and compared with the whole ACC in Table 3. In (adrenal carcinoma in children: a longitudinal study in Minas Gerais, Brazil) the study, for the hormonal evaluation, some tests were performed in different laboratories before the patient was admitted to the institution. Therefore, the results were not specified[8].

According to Lin and colleagues' study, the most common symptoms of adrenocortical tumors were Cushing's syndrome, where the number this series covers around 28 males and 20 females. Adrenomedullary tumors were 37, including 24 cases of neuroblastoma, 10 cases of ganglioneuroma, and 2 cases of ganglia neuroblastoma. Adrenocortical tumors were 10: nine

Table 3

Describes the symptoms, diagnostic tests, findings, treatment and follow-up for reviewed articles.

References	Patients age (month)/ sex	Symptoms	Diagnostic tests	Findings	Treatment	Follow-up
Elnaw *et al.*[26]	53/F	Progressive bilateral breast enlargement, accelerated growth at 9 months	Wrist radiography, Lutein hormone, Estradiol E2, Dehydroepiandrosterone sulfate, AM cortisol, Abdominal US, CT, MRI	L wrist radiography: bone age 8-y, ↑ estradiol E2, dehydroepiandrosterone. sterone sulfate, AM cortisol, Abdominal US: R-sided hypoechoic suprarenal mass. Abdominal CT: 25 × 22 mm rounded focal lesion with smooth outline, at R adrenal gland level with homogeneous attenuation	Surgery	Six months, secondary sexual characters partial regression, 5 cm/ year growth velocity
Helena Vieira *et al.*[42]	23/F	Past 2 months: excessive weight gain, growth failure, hirsutism, acne, behavioral difficulties. Moon face, buffalo hump, facial and back hirsutism, facial acne, greasy hair, abdominal distension	Midnight cortisol, ACTH, 24 h cortisol, Urine steroid profile, urinary free cortisol, 11β-hydroxyandrosterone, Dexamethasone suppression, Abd US, MRI and CT	Abd US, MRI: R-sided mixed solid/cystic suprarenal mass	Laparoscopic surgery	One year: gradual improvement in height, weight. Stop glucocorticoid supplementation. No recurrence
Nasser Simforoosh *et al.*[43]	7/F	Cushing's syndrome symptoms	AM cortisol, urine-free cortisol, ACTH, Dexamethasone suppression, Abd-pelvic CT, 24 h urine-free cortisol and DHEAS	AM cortisol↑ , urine-free cortisol↑ , ACTH↓, abd-pelvic CT: mild enlargement of L adrenal gland, no clear tumor, 24 h urine-free cortisol↑ DHEAS↑	Laparoscopic adrenalectomy	Resolution of clinical, laboratory abnormalities
Deep Dutta *et al.*[44]	4/F	Weight gain past 3 months, fever past 1 month, respiratory distress past 5 days. Moon face, protruding abdomen, Striae, ↑ body hair, MAS stigmata, no cafe au lait spots	AM cortisol, ACTH, DHEAS and Fasting blood glucose	AM cortisol ↑, ACTH ↓, DHEAS: N, Abd CT (X contrast): 5.3 × 4.8 × 3.7 cm homogenous L adrenal mass, distinct borders	Adrenalectomy	Weight loss (9.6 kg)
Marret *et al.* [29]	2/F	Pubic hair development, precocious puberty, accelerated growth curve	Abd US, CT, MRI, Testosterone, Delta-4-androstenedione and TP53 mutation	Abd US, CT, MRI: R round adrenal mass 17 × 9.2 × 11 mm in size, calcifications. Testosterone, delta-4-androstenedione ↑	Laparoscopic adrenalectomy	Two months: N growth curve, no puberty signs
Adam L. Green *et al.*[45]	36/F	Pubic hair at 8 months, rapid weight gain, ↑appetite, puberty/virilization signs	Testosterone, 17-hydroxyprogesterone, DHEAS, Dehydroepiandrosterone, Dexamethasone suppression, abd US and CT (of the chest, abdomen, and pelvis)	Testosterone↑, CT of chest, abd, and pelvis: multiple, bilateral pulmonary nodules. Abd US: 5 × 6 × 5 cm calcified R suprarenal mass	R adrenal mass, wedge resections of pulmonary nodules in R lobes. Chemotherapy (cisplatin, etoposide, doxorubicin, mitotane) 8 cycles	Six months: laboratory tests, CT: undetectable androgen levels. No recurrence
Carlos Redriguez *et al.*[14]	78 ineligible patients <244 months (34.5%) M, (65.5%) F	NA	NA	NA	Adrenalectomy, retroperitoneal lymph node dissection, mitotane, chemotherapy	60 months
Monteiro *et al.* [8]	13 patients (76.9%) F, (23.1%) M	Terminal hairs appearance, pubertal progress, hypercortisolism symptoms, virilization, enlarged clitoris, acne, systemic arterial hypertension, cushingoid facies, weight gain, voice changes, abd pain, fever, muscle hypertrophy	Thorax and abd CT, abd US, MRI	NA	Laparoscopic, open adrenalectomy, chemotherapy	Five years of follow-up
Lin *et al.* [13]	48 patients <14 years/28 M, 20 F	Fever, pain, abdominal distention, hypertension, palpable mass, sexual precocity, Cushing syndrome	US, CT, MRI, hormonal tests serum and/or urine (vanillylmandelic acid VMA level and cortisol)	An elevated hormone level in serum and/or urine found in 18 (37.5%). Of 29 patients with neuroblastoma, 14 (48.3%) patients were positive with an abnormal urinary vanillylmandelic acid (VMA) level of 24 h. Only four patients with cortex tumors had a high level of serum cortisol	Laparoscopic, open adrenalectomy, chemotherapy	Three to six months: recovery of neuroblastomas, adrenal tumor patients, no relapse
Evanoff *et al.* [46]	49 patients <18 years/30 F,19 M	NA	NA	NA	Total/radical adrenalectomy ± lymph node dissection, chemotherapy	77 months (IQR: 32.9 – 115.9)

Abd, abdominal; ACTH, adrenocorticotropic hormone; CT, computed tomography; DHEAS, dehydroepiandrosterone sulfate; F, female; IQR, interquartile range; M, male; MAS, McCune–Albright syndrome; US, ultrasound.

cases of cortical adenoma and one case of cortical cancer[13]. Adrenocortical tumors are rare in children, with little data to guide management; however, surgery is still considered the cornerstone of successful treatment[47], bilateral adrenalectomy is the preferred method, which provides immediate relief from hypercortisolism, although patients will require lifelong replacement of glucocorticoids and mineralocorticoids because of the high risk of Nelson syndrome in children[20]. The laparoscopic approach has a shorter surgery duration (169 vs. 220 min) and hospitalization period (1.1 vs. 2.7 days) and reduces morbidity with similar clinical efficacy in comparison with open surgery; this seems to be a promising technique for the treatment[20,48,49]. Adjuvant treatment should be performed for patients with surgery contraindications or in case of not achieving remission[50]. Regarding medical treatment, adrenostatic drugs such as ketoconazole and metyrapone, adrenolytic drugs such as mitotane, and a glucocorticoid receptor antagonist (RU-486) are the main adrenal-directed medical management. Those are used in preoperative management to help restrain hypercortisolism and decrease the preoperative danger. Antihormonal therapy was used only to counter the actions of increased hormone production in patients who were unresponsive to antineoplastic therapy[51]. Although mitotane is the gold standard chemotherapy[52], there is evidence that there is no benefit of adjuvant mitotane in pediatric patients, so its benefit must be weighed against the risks and side effects[53]. Complications after chemotherapy include gastrointestinal distress and neurotoxicity[52]. Adjuvant therapy in the form of radiation was rare in the literature, and most patients underwent systemic adjuvant therapy[46]. Reasons for surgical mortalities were mostly due to infection, cardiac failure, and thromboembolic with a percentage less than 1%, and cure rates of 65–90%[54]. The survival rate in ACC is extremely inconsistent, meaning difficulty in comparison[51]. In a review by Cohn and associates, survival rates varied from 2.3 to 5 years after surgery[48]. The successful outcome is related to multiple factors, including envisioning the tumor by MRI, a noninvasive tumor, histopathological affirmation of the tumor, and postoperatively decreased serum cortisol levels[20]. There is a suggestion that the patient's age and tumor size affect the overall prognosis. A study showed that patients older than 4 years and patients with tumor sizes larger than 9 cm had lower survival rates. Also, younger children may have a better prognosis because of the early-presented signs of hormonal excesses such as hirsutism, enlarged genitalia, increased height, or the moon face, which bring them to medical attention earlier[46].

Conclusion

To summarize we aimed the study at presenting an extremely rare case of ACC in a 10-month-old infant. The right adrenalectomy showed a magnificent response, presenting an immediate decrease in serum cortisol levels. This case emphasizes that early diagnosis has a considerable role in preventing major complications. Also, consider ACC as a differential diagnosis when similar symptoms are found in an infant. Further investigations should be conducted.

Ethical approval

Not required for this case report.

Consent for publication

Written parental informed consent was obtained from the patient's parents for the publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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No funding was required.

Author's contribution

B.A.-G.: design of the study, data interpretation, and analysis, wrote the article's abstract, background, and part of discussion and conclusion, critical revision, drafting, approval of the final manuscript. E.A.: data interpretation, and analysis, wrote the background, and part of discussion, critical revision, drafting, approval of the final manuscript. V.S.: wrote the case presentation, and part of the discussion and conclusion, critical revision, drafting, approval of the final manuscript. F.N.: wrote the case presentation, and part of the discussion, critical revision, drafting, approval of the final manuscript. A.A.: wrote the background, and part of discussion, critical revision, drafting, approval of the final manuscript. F.A.S.: led the surgery, critical revision, drafting, approval of the final manuscript. H.D.: led the surgery and supervised the scientific and academic aspects of the manuscript preparation and submission, approval of the final manuscript. M.M.: supervised the scientific and academic aspects of the manuscript preparation and submission, critical revision, drafting, approval of the final manuscript.

Conflicts of interest disclosure

The authors declare that they have no conflicts of interest.

Research registration unique identifying number (UIN)

1. Name of the registry: NA.
2. Unique identifying number or registration ID: NA.
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Availability of data and materials

Not applicable. All patient data generated during this study is included in this published article and its supplementary information files.

Provenance and peer review

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