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RADIOLOGICAL APPROACH TO NEPHROBLASTOMA IN CHILDHOOD

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Abstract

Nephroblastoma (Wilms' tumor) is the most common malignant kidney tumor in children, and the bilateral form occurs in approximately 5–10% of cases. It is an undifferentiated mesodermal tumor, containing a variable amount of embryonic renal elements (blastema, epithelium, and stroma).

In this paper, we present a case of a 4-year-old child with bilateral nephroblastoma, who underwent right-sided nephrectomy due to a dominant tumor mass and adjuvant chemotherapy according to the SIOP protocol. After completion of treatment, significant radiological and clinical regression of lesions in the remaining kidney was recorded. During the follow-up of several months after the end of therapy, no signs of relapse or new progression of the disease were observed.

The case emphasizes the importance of multimodal treatment and careful monitoring in patients with bilateral nephroblastoma with special emphasis on the current key role that imaging plays in preserving renal function and achieving a favorable outcome.

Keywords: nephroblastoma, bilateral, nephrectomy, regression, relapses

Introduction

The kidneys are formed during embryonic development from some progenitor cells. It is possible for some of these immature cells to remain in the kidneys even after birth. If the DNA of kidney progenitor cells mutates, the cell can acquire new properties that transform it into a cancer cell. This begins to multiply uncontrollably, causing Wilms' tumor. In most cases, this tumor affects only one of the two kidneys, but in rare cases, about 7 percent, both kidneys may be affected.

Nephroblastoma is an undifferentiated mesodermal tumor, which contains a variable amount of embryonic kidney elements (blastema, epithelium, and stroma) [1].

Nephroblastoma is more commonly known as Wilms' tumor after Dr. Max Wilms, the German surgeon who first described it in 1899. It is the most common renal and intra-abdominal malignancy of childhood and represents a total of 6% of malignancies in children [2]. It typically occurs in childhood with a peak incidence between 3-4 years of age.

Radiological evaluation of nephroblastoma

Since clinical symptoms are often nonspecific (abdominal mass, pain, hematuria), radiological methods are primary for initial identification and characterization of the tumor. Radiological evaluation plays a key role in the diagnosis, staging, treatment planning, and follow-up of nephroblastoma (Wilms' tumor) in children.

Ultrasound is the first line of diagnostic imaging because of its availability, safety (no radiation), and sensitivity for abdominal masses in children. It can differentiate nephroblastoma from cysts, hydronephrosis, and other solid tumors. US also allows assessment of vascularity with Doppler imaging.

Wilms' tumors are usually hyperechoic when compared to normal renal or hepatic parenchyma. Areas of necrosis and cysts, if present, are hypoechoic. The renal vein and inferior vena cava are carefully evaluated, with evaluation including use of color Doppler, to assess vascular extension of the tumor. The renal vein is involved in 15% of patients, and the inferior vena cava in 5% to 10%.

Sonography is more sensitive than computed tomography (CT) in evaluating vascular tumor extension. Involved vessels are focally enlarged and filled with echogenic tumor. Fixation of tumor

thrombus to the vascular wall suggests invasion. It may be helpful to scan the patient in the upright position to dilate the inferior vena cava. Adenopathy is carefully sought. Normal abdominal lymph nodes are rarely visualized by sonography in children. [3,4].

Non-enhanced CT will show a round, well-defined solid intrarenal mass that is less dense than normal renal parenchyma. The mass disrupts the renal parenchyma and collecting system. Calcification may be seen in up to 15% of cases. Areas of fat, necrosis, hemorrhage, and cyst formation may be evident. Enhancement is inhomogeneous and always less than normal renal parenchyma.

Central non-enhancing fluid collection suggests necrosis or hemorrhage. Tumor margins are well defined due to a pseudo capsule of compressed renal parenchyma. CT is superior to sonography in detecting perirenal extension, lymphadenopathy, and contralateral tumors by 10%.

CT evaluation of the chest should be performed concurrently: 8% to 15% of patients have pulmonary metastases. Non-enhanced magnetic resonance imaging (MRI) is as good or better than CT in evaluating renal masses, perinephric extension, contralateral kidney, and hepatic metastases. [5].

MRI more readily detects intravascular extension than CT. Wilms' tumors have longer TI and T2 relaxation times than normal renal parenchyma. Necrotic and cystic regions show significantly increased signal on T2-weighted images. Hemorrhage can be defined. The mass is of reduced signal than normal renal parenchyma (FA Hofer, personal communication). MRI is less sensitive than CT in detecting pulmonary metastases.[6]

PET-CT currently has no role in the initial diagnosis of Wilms' tumors because the overall prognosis is excellent, and radiation exposure should be minimized. In patients who relapse, routine PET-CT may be beneficial because their prognosis is more guarded, and the best chance of cure is at the first relapse.

Precise placement and detection of the full extent of metastatic disease would help survival.

Staging according to SIOP (International Society of Pediatric Oncology) or NWTS/COG (Children's Oncology Group) protocols are based on surgical, pathological, and radiological findings. Radiological images are necessary for correct preoperative staging and choice of therapy.[7]

Radiological methods are also used to monitor:

- Response to chemotherapy (change in size, vascularization)
- Other lesions in the contralateral kidney (in bilateral cases)
- Relapse detection

Differential diagnosis

Radiologically, nephroblastoma should be differentiated from:

- Nephrogenic hematoma (pre-tumor lesion)
- Multilocular cystic nephroma
- Neuroblastoma (for retroperitoneal masses)
- Lymphoma

Treatment

Unilateral Wilms' tumor is treated with nephrectomy. Neoadjuvant chemotherapy is useful for reducing the size of the tumor before surgery.

In children with bilateral disease, the therapeutic approach and philosophy are very different [8,4]. Surgery to preserve the kidneys becomes paramount. Preoperative chemotherapy is vital because each kidney is ultimately staged separately. Hemi-nephrectomy, wedge resections, and nephron-sparing surgery require accurate preoperative imaging. The surgical approach in bilateral disease is aimed at sparing any normal renal parenchyma where possible.

Case report

We present a 4-year-old male child (V.S.), without any complaints, who appears for examination due to abdominal asymmetry that the mother noticed while bathing.

The initial ultrasound examination detected a tumorous formation on the right paravertebral as well as prevertebral with a transverse diameter of 85 cm. It suppresses the right kidney, which has a dilated pyelocaliceal system.

It was recommended to perform a CT scan of the abdomen with contrast in order to confirm the origin of the tumor change, from which the following finding was obtained:

The upper part of the right kidney is followed by a larger clearly limited tumor change that originates from the renal parenchyma and distorts it. The change has dimensions of 67x62mm on axial sections and post-contrast shows heterogeneous irregular diffuse staining. It significantly suppresses the hepatic parenchyma. In the middle part and towards the medial side, another smaller tumor formation with dimensions of 35x29mm is observed.

The tumor change is in direct contact with the hepatoduodenal ligament and compresses both the head and body of the pancreas towards the anteromedial side. Portal venous system intact. In the lower part of the right kidney, another larger clearly limited heterodense tumor change originating from the kidney is observed, with distortion of the parenchyma and with dimensions of 90x61mm on axial sections and irregular diffuse post-contrast staining with medial compression of the adjacent intestinal loops without invasion of the adjacent structures.

The tumor changes, i.e. mostly the change originating from the lower part of the right kidney, also compress the vascular structures towards the left. On the CT scan, no invasion is observed in them, but they are in direct contact with them and cross the medial line.

In the upper part of the left kidney, in the renal parenchyma of the arterial phase, a smaller, clearly demarcated hypodense change is visualized in relation to the intensely stained parenchyma, with relatively homogeneous density and dimensions of 14x11mm (Fig. 1 and 2). According to the CT characteristics, the finding is most consistent with Polylobulated Bilateral Nephroblastoma.

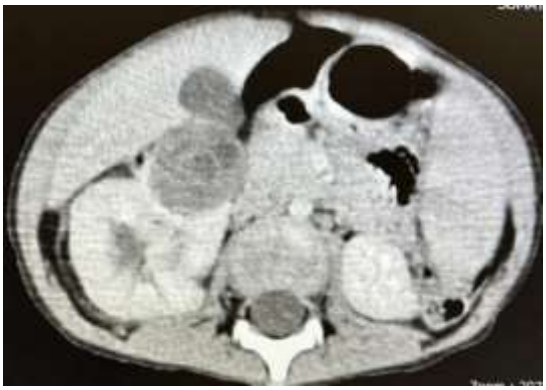

Fig. 1 Axial CT sections of Abdomen

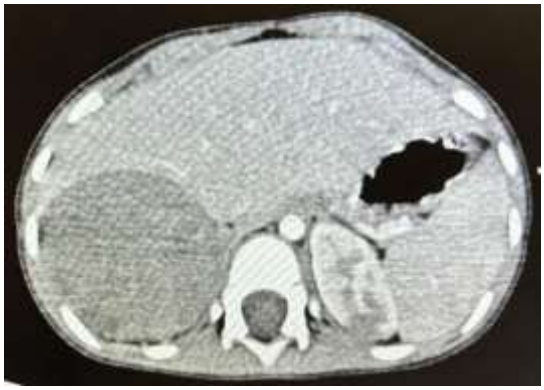

Fig 2. Axial CT sections of Abdomen

It is recommended to perform an MRI of the abdomen for a clearer distinction of the tumor margins and their infiltration with the surrounding abdominal adjacent structures.

The performed MRI of the abdomen and pelvis (native and post-contrast series in standard pulse sequences and planes, with the inclusion of DWI sequences), confirms what was detected by CT (Fig. 3 and 5). Extended laboratory tests with tumor markers were performed, without significant deviations from the reference frames. After analyzing all investigations, the Malignant Diseases Commission met. Given the clear radiological features that this is a neoplasm of renal origin (Nephroblastoma), the bilaterality of

the tumor substrates, the size of the right-sided tumor and its relationship to the hepatobiliary trunk, as well as the compression of the venous vessels through the midline, taking into account the European SIOP protocols for the treatment of bilateral Wilms' tumor. The Committee for Malignant Diseases concludes that neoadjuvant therapy should be initiated in the child, followed by surgical reevaluation after completion of an appropriate number of neoadjuvant therapy cycles, as prescribed by the hematooncologist.

Due to the rapid growth of the tumor, the parents decided to surgically treat the child at the Sistina Private Hospital, before initiating chemotherapy. The child underwent a right-sided tumor nephrectomy with lymphadenectomy. The histopathological finding confirmed the diagnosis of Nephroblastoma (Wilms tumor). According to the COG (Classification of Histological Risk), the disease is of intermediate histological risk. The patient is hospitalized to start chemotherapy according to the protocol.

A postoperative control MRI of the abdomen and pelvis was performed (in standard pulse sequences and planes, with the inclusion of DWI and post-contrast sequences), which showed an orderly post-operative course on the right, and a round TU change measuring 19 x 15 mm on axial sections was observed in the upper part of the left kidney, which discretely enhances the signal after post-contrast and gives a strong restriction of diffusion. The remaining part of the renal parenchyma has orderly MR signals, but several smaller cortical focal changes in the upper and lower parts are observed on the diffusion sequences, which give a restriction of diffusion (Fig. 4 and 6).

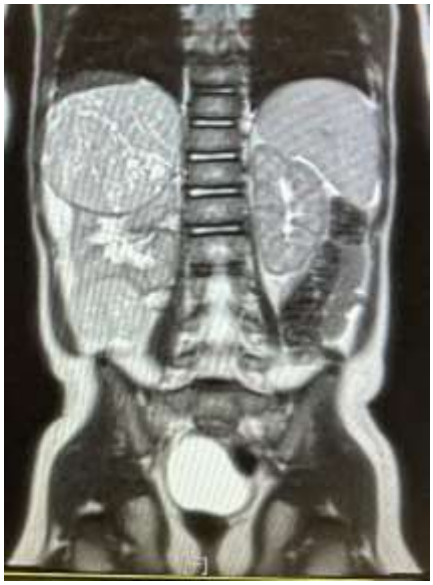

Fig. 3. Coronal MR section before surgery

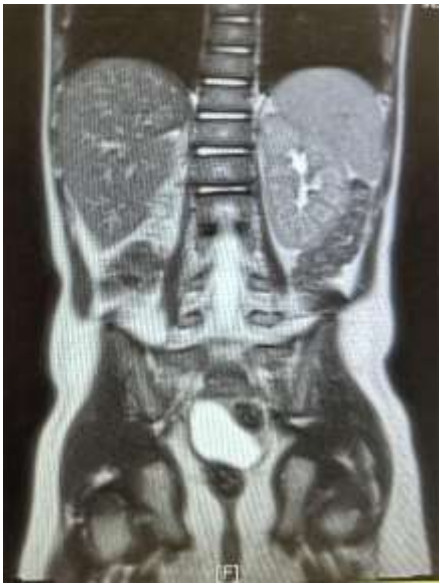

Fig. 4. Coronal MR section after surgery

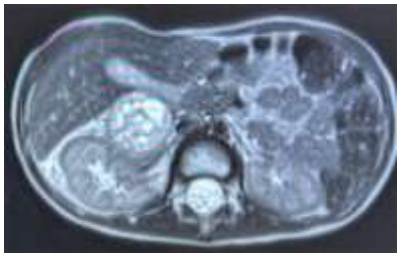

Fig. 5. Axial section of MR before surgery

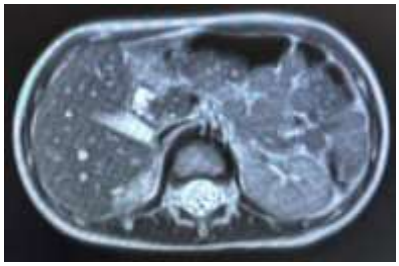

Fig. 6. Axial section of MR after surgery

The control postoperative CT also showed the presence of a small residual hypodense change 5x4mm in the upper part and posterior to the left kidney. The finding compared to the previous CT examination is in regression.

During the postoperative period, he was hospitalized several times in Oncology for chemotherapy.

The following control ECHO examinations, laboratory and microbiological findings were normal except for high values of indirect bilirubin.

The last control CT showed that there were no signs of recurrence/residue or enlarged local lymph nodes in the renal pelvis (Fig. 7.)

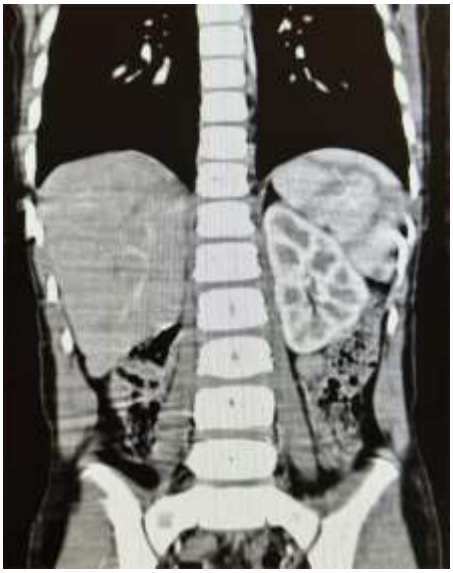

Fig. 7. Coronal section of control postoperative CT

Discussion

Radiological diagnostics play an essential role in the overall management of this disease – from initial detection to assessment of the extent and monitoring of the effect of treatment.

Nephroblastoma appears as a painless asymptomatic abdominal mass, which is detected incidentally [8,9]. Similarly, our patient that we studied and analyzed presents with an asymptomatic painless palpable abdominal mass that is discovered incidentally.

Only 10% of cases with nephroblastoma are accompanied by calcifications. The performed ECHO examination showed an intrarenal homoechoic clearly limited formation, which in Doppler shows vascularization and suppresses the affected kidney, without calcifications present [10].

The CT finding of the examined patient shows a round, clearly limited (with capsule), heterogeneous change with necrotic zones present, which is more contrast-stained. It suppresses the neighboring organs and crosses the medial line. Which fulfills all CT characteristics for nephroblastoma.

MR finding with solid components that give intense restriction of diffusion (hypersignal), T2-hypersignal T1- hyposignal. Tumor mass with extension towards caudal and medial, do not crosses the medial line and compresses the mesenteric vein and inferior vena cava, is typical for nephroblastoma.

Nephroblastoma can rarely metastasize, and in our patient no metastatic changes were identified.

Laboratory tests are within reference values except for high values of LDH, which is a non-specific laboratory finding, because it is known that there are no specific tumor markers that are routinely used for the diagnosis of nephroblastoma [11,12].

Conclusion

Radiological approach plays a key role in the diagnosis, staging and follow-up of nephroblastoma in children.

Accurate radiological assessment is essential for treatment planning, as well as for monitoring the response to therapy and timely detection of relapses. Modern radiological techniques contribute to increasing the accuracy of diagnosis and improving the clinical outcome of patients with nephroblastoma.

Modern treatments lead to a 5-year survival of over 90% in patients with favorable histology and localized disease (stages I and II). Patients with advanced stage (III or IV), metastases or unfavorable histology have a poorer prognosis, but with aggressive therapy survival remains high (70–85%). [10,11].

Nephroblastoma is one of the most successfully treated pediatric malignancies, with a high survival rate, especially when the disease is detected at an early stage. Prognosis is directly related to several clinical and pathohistological factors, among which radiological assessment plays a key role.

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