TRANSABDOMINAL ULTRASONOGRAPHY IN STAGING OF WILMS TUMOR

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ABSTRACT

Objective: To determine the sensitivity and specificity of transabdominal ultrasonography (US) in staging of Wilms tumor, taking transabdominal contrast enhanced computed tomography (CT) of abdomen as gold standard.

Study Design: Cross sectional/validation study.

Place and Duration of Study: Radiology department, Children Hospital, Pakistan Institute of Medical Sciences, Islamabad, from Apr 2006 to Mar 2007.

Material and Methods: Thirty patients presenting with Wilms tumor underwent transabdominal ultrasound and CT abdomen with contrast for staging. All of them were evaluated for age, gender, presenting complaints, signs and symptoms. As patients were children so consent was taken from their parents. X-ray chest of all of the patients was done to exclude pulmonary metastasis.

Results: For stage-I: Ultrasound correctly staged 10 out of 15 cases of stage-I (66.6%) and over staged 5 out of 15 cases of stage-I (33.3%).

For stage-II: Ultrasound correctly staged 2 out of 8 cases of stage-II (25%) and incorrectly staged 6 out of 8 cases of stage-II (75%).

For stage-III: Ultrasound correctly staged 4 out of 7 cases of stage-III (57%) and incorrectly staged 3 out of 7 cases of stage-III (43%).

Conclusion: In children, ultrasound abdomen plays a vital role in cases of renal tumors for differential diagnosis, staging, monitoring of therapy and surgical planning. Diagnostic information obtained from CT and ultrasound examinations are complementary in many instances, however, computed tomography (CT) has been shown to be superior to ultrasound (US) in this regard.

Keywords: Computed tomography, Ultrasonography, Wilms tumor.

INTRODUCTION

The majority of abdominal masses in children arise from the kidneys. There are multiple causes of paediatric renal masses like polycystic renal disease, multicystic dysplastic kidneys, pelviureteric junction obstruction, infections and neoplasms[1]. Kidney tumors represent 6.2% of malignant tumors in children. History, clinical presentation and radiological findings are necessary components in differential diagnosis of renal tumors[2]. Different types of pediatric renal tumors are known, the commonest of which is Wilms tumor or nephroblastoma, other less common tumors are nephroblastomatosis, rhabdoid malignant tumor, clear cell sarcoma, congenital mesoblastic nephroma and multilocular cystic nephroma[3]. However, the diagnostic imaging features of all these neoplasms are very similar. Ultrasonography (USG) and spiral computed tomography (CT) currently have an established role in the diagnostic evaluation of these conditions as compared to conventional radiology[4].

Among the neoplasms, Wilms tumor is the commonest renal tumor of childhood representing approximately 10% of all childhood malignancies that arises from embryological precursors of renal parenchyma (metanephros) with a peak incidence between 3-4 years; it is uncommon above the age of 5 and is rare in neonates[1]. Most of the children having Wilms tumor typically presents with an asymptomatic

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mass[5,6] but occasionally abdominal pain, haematuria, fever and hypertension secondary to renal ischemia or increased renin production may occur[7-9].

The diagnosis of a Wilms tumor is one of the many challenges faced in the primary care setting[10]. Imaging plays a crucial role in the evaluation of the primary tumor, regional and metastatic disease[11]. The pervasive availability of abdominal ultrasound, computed tomography (CT) scanning and magnetic resonance imaging (MRI), has increased the chance of incidental diagnosis of renal tumors. With the detection of renal tumors at an earlier stage, partial nephrectomy and nephron-sparing surgery have evolved as effective alternatives to radical nephrectomy. Primary chemotherapy with delayed resection is now adopted as a preferred approach for large inoperable tumors, bilateral cases, and those with extensive intravascular involvements[12-15]. The primary clinical efficacy of CT in Wilms tumor is to detect multiple masses, determine the extent of tumor and evaluation of the opposite kidney, with more accurate staging leading to appropriate treatment and enhanced surveillance for recurrences after treatment[16].

Nephroblastomatosis is an abnormality of nephrogenesis and is characterized by incomplete maturation of primitive nephrogenic cells. There is a wide acceptance that nephroblastomatosisis a precursor lesion to Wilms tumor. Continued advances in imaging techniques have significantly improved the ability to detect Wilms tumor and its precursor, nephroblastomatosis, as well as its spread to other organs. The role of imaging in assessing the patients for neoplastic transfor-mation of nephroblastomatosis should be hence emphasized. Computed tomography (CT) has been shown to be superior to ultrasound (USG) in this regard. Even so, the low cost and lack of radiation of USG make it attractive for serial screening studies[17]. The rationale of this study was to determine the sensitivity and specificity of transabdominal ultrasonography in staging of Wilms tumor, taking transabdominal contrast enhanced CT abdomen as a gold standard.

MATERIAL AND METHODS

This cross sectional/validation study was done in the Radiology Department, Children Hospital, Pakistan Institute of Medical Sciences, Islamabad, from Apr 2006 to Mar 2007. Thirty patients presented with Wilms tumor were selected through Purposive non probability sampling technique. Children presented with Wilms tumor were included in this study while those patients in whom follow up was not possible or computed tomography cannot be

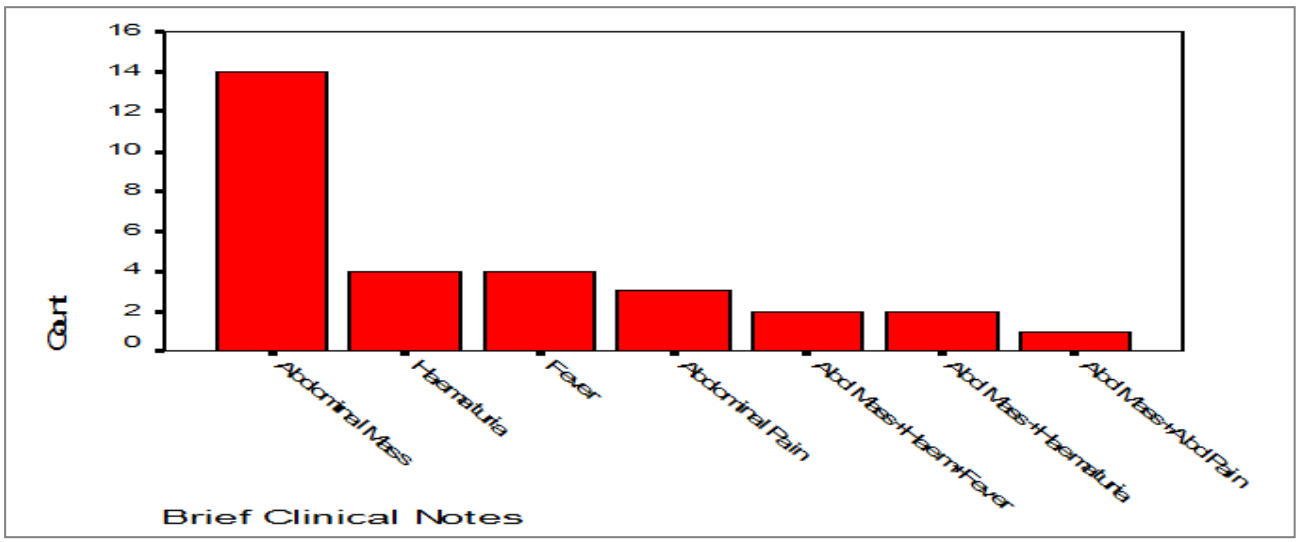

Figure: Showing the brief clinical presentations of the patients (n=30).

done were excluded from the study. All of the patients were evaluated according to their age, sex, signs, symptoms and other complaints. Brief clinical history was taken.

As patients were children so consent was taken from their parents. Ultrasonography of each child included in this study was done with Aloka SSD-500 with 3.5 MHz convex transducer. Afterwards each of them underwent CT abdomen with contrast. Images of both ultrasound and CT scan were obtained, and opinion was taken by consultant radiologist depending upon their appearance. No case of stage IV and V came during the study so they were not included.

Staging of tumor was done according to the imaging method adopted by national Wilms tumor study group in USA and children's cancer study group in UK.

Stage-I: Encapsulated tumor.

Stage-II: Extends beyond the kidney.

Stage-III: Tumor involving abdominal lymph nodes or renal/IVC invasion.

Stage-IV: Hematogenous metastasis (lung metastases on chest X- ray or on CT).

Stage-V: Bilateral tumors[18].

The data was collected and analyzed. Findings on transabdominal ultrasound were correlated with the final diagnosis provided by the CT scan. A true positive was defined as the stage determined on ultrasound and was confirmed on CT i.e. if it was stage I-III on ultrasound it was also stage I-III on CT respectively.

False positive was defined as if it was stage-I on ultrasound, it came out to be other than stage-I on CT, or if it was stage-II on ultrasound, it came out to be other than stage-II on CT, or if it was stage-III on ultrasound, it came out to be other than stage-III on CT. True negative was defined as if it was not stage I-III on ultrasound, it was also not stage I-III on CT respectively.

False negative was labeled as if it was other than stage-I on ultrasound but it was actually stage-I on CT, or if it was labeled as other than stage-II on ultrasound but it was actually stage-II on CT or if it was labeled as other than stage-III on ultrasound but it was actually stage-III on CT. No case of stage IV and V were reported during the study so these were not included.

Table-I: Showing the cases detected on Ultrasound Stage-I with their Sensitivity, Specificity, Predictive Values and Diagnostic Efficacy of ultrasound.

			Detected in CT (Gold Standard)	
			Stage-I	**Other two stages**
Detected in Ultrasound		Stage-I	10	4
		Other two stages	5	11
Sensitivity (%)	**Specificity (%)**	**PPV (%)**	**NPV (%)**	**Diagnostic Efficacy (%)**
66.6	73.3	71.4	68.7	70

PPV= Positive predictive value, NPV= Negative predictive value

Table-II: Showing the cases detected on ultrasound Stage- II with their sensitivity, specificity, predictive values and diagnostic efficacy of ultrasound.

			Detected in CT (Gold Standard)	
			Stage-II	**Other two stages**
Detected in Ultrasound		Stage-II	2	8
		Other two stages	6	14
Sensitivity (%)	**Specificity (%)**	**PPV (%)**	**NPV (%)**	**Diagnostic Efficacy (%)**
25	63.6	20	70	53.3

PV= Positive predictive value, NPV= Negative predictive value

Data Analysis Procedure

Data was entered and analysed on SPSS version 21 and plotted in 2x2 table taking CECT staging as Gold Standard. Analysis was carried out for each of the three stages (as no case for stage IV and V came during study period) separately and sensitivity, specificity, positive predictive value, negative predictive value and diagnostic efficacy has been reported in percentage formulae based on 2x2 table for stage I as under. Sensitivity, specificity, positive predictive value, negative predictive value and Diagnostic Efficacy were calculated separately for each of the three stages by performing ultrasound and using the formulae given below:

RESULTS

A total number of thirty patients having Wilms tumor with a mean age of 2.93 years with a standard deviation of 1.36 were included in this study. Figure is showing the brief presentations of the patients. For stage-I: Ultrasound correctly staged 10 out of 15 cases of stage-I (66.6%) and overstaged 5 out of 15 cases of stage-I (33.3%) (table-I). For stage-II: Ultrasound correctly staged 2 out of 8 cases of stage-II (25%) and incorrectly staged 6 out of 8 cases of stage-II (75%) (table-II). For stage-III: (table-III).

Ultrasound correctly staged 4 out of 7 cases of stage-III (57%) and incorrectly staged 3 out of 7 cases of stage-III (43%) (table-IV). No case of stage IV and V was reported during study.

DISCUSSION

History, clinical course and radiological findings are necessary elements in the differential diagnosis of the different renal tumors[10]. Radiological staging plays an important role in deciding further treatment and in operative planning of a tumor. In the case of nephroblastoma, chemotherapy is based solely on the radiological diagnosis without prior histology[2]. Diagnostic information obtained from CT and ultrasound examinations were complementary in many instances.

In this study, the staging of Wilms tumor was done on the basis of presence or absence of perinephric extension, adjacent organ invasion, regional lymph node involvement, invasion into renal vein and distant metastasis.

In current study the sensitivity of stage II (25%) was slightly lower as compared to another

Table-III: Showing the cases detected on Ultrasound Stage-III with their Sensitivity, Specificity, Predictive Values and Diagnostic Efficacy of ultrasound.

			Detected in CT (Gold Standard)	
			Stage-III	**Other two stages**
Detected in Ultrasound		Stage-III	4	2
		Other two stages	3	21
Sensitivity (%)	**Specificity (%)**	**PPV (%)**	**NPV (%)**	**Diagnostic Efficacy (%)**
57	91.3	66.6	87.5	83.3

PPV= Positive predictive value, NPV= Negative predictive value

Table-IV: Showing comparison between truly & falsely detected cases of patients having stage I & the other two stage.

		Detected in CT (Gold Standard)	
		Stage-I	**Other two stages**
Detected in Ultrasound	Stage-I	Truly detected Stage-I (a) TP	Falsely detected Stage-I (b) FP
	Other two stages	Falsely detected other two stages (c) FN	Truly detected other two stages (d) TN

Sensitivity = a/(a+c) x 100, Specificity = d/(b+d) x 100, Positive Predictive Value =a /(a+b) x 100, Negative Predictive Value = d/(c+d) x 100, Diagnostic Efficacy = (a+d)/(a+b+c+d) x 100

study which showed the sensitivity of adjacent organ invasion by ultrasound to be 28.5%[12]. Similar findings were present in another study in which computed tomographic (CT) scans and sonograms of 13 children with Wilms tumor were reviewed to determine the ability of each imaging test to characterize the tumor and define its extent[14]. Tumor necrosis and a pseudocapsule were detected more often on CT scans than sonograms. CT scanning also was more sensitive in assessing perinephric extension, lymph node involvement, and bilateral tumors[13]. Our study has also concluded the same results. In stage-I and II radical nephrectomy with en bloc resection of the kidney, perirenal fat and Gerotas fascia is the surgical treatment of choice, failure to visualize this extension does not affect treatment and show little prognostic difference[14].

In this study, stage III showed sensitivity of 57% and specificity of 91.3%. Bellmunt et al 2014 have demonstrated that the evaluation of inferior vena cava (IVC) by sonography is significantly more accurate than venography in the investigation of renal tumors. It has also been demonstrated that Wilms tumor can completely obstruct the IVC without invasion and since ultrasonography can very accurately evaluate the cava in multiple planes and degrees of obliquity, the ultrasonographer is better able to appreciate whether the tumor is simply compressing the cava, or actually invading it. Again since ultrasonography can be performed in multiple planes and particularly in the sagittal and parasaggital planes, it is more useful in the evaluation of the IVC than CT[15].

For the detection of lymphadenopathy, a study done by Motzer et al 2011 showed sensitivity of 63.6% by ultrasound which is comparable with our results[16].

Another study showed the relative accuracy of computed tomography and ultrasound in abdominal staging of renal cancer in 22 patients. CT is capable of detecting tumor invasion of perinephric fat and adjacent muscles, which cannot be shown by US. While both computed tomography and ultrasound demonstrate venous and retroperitoneal tumor extension, CT is more reliable since bowel gas infrequently obscures the retroperitoneum on ultrasonic scanning. However, ultrasound will often provide valuable information; and whenever a solid renal mass is detected abdominal scans should be obtained for staging pruposes[17]. Another study on 47 patients concluded that differentiation of stage-I and stage-II lesions could never be obtained by ultrasound; only CT gave this possibility. As regards the sensitivity of the two methods, in patients with stage-III or stage-IV disease, ultrasound showed relatively lower sensitivity in the diagnosis of lymph node metastases, but it was significantly less sensitive in the study of distant metastasis. On the contrary, the specificity of the two imaging methods was similar, and ultrasound gave better results in the evaluation of renal vein or inferior vena cava thrombosis[18].

CT is currently the technique of choice in the diagnosis and staging of renal masses in children, since it allows to recognize lesion's site, size and densitometric patterns and provides an excellent visualization of surrounding structures (vessels and lymph nodes). Synchronous lesions in the contralateral kidney and metastases to the liver and lungs can also be visualized[4].

CONCLUSION

In children, ultrasound abdomen plays a vital role in cases of renal tumors for differential diagnosis, staging, monitoring of therapy and surgical planning. Diagnostic information obtained from CT and ultrasound examinations are complementary in many instances, however, computed tomography (CT) has been shown to be superior to ultrasound (US) in this regard

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

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