COMPARISON OF CT SCAN AND COLOUR FLOW DOPPLER ULTRASOUND IN DETECTING VENOUS TUMOUR THROMBOUS IN RENAL CELL CARCINOMA

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Background: Renal cell carcinoma has marked tendency to spread into renal vein, inferior vena cava and right side of heart. Extension of tumour thrombus into these veins will alter the surgical approach. We have compared the CT scan with Colour flow Doppler ultrasound in detecting venous tumour thrombus in renal vein and inferior vena cava. **Methods:** This cross-sectional study included 30 adult patients presenting with renal tumour. Patients of either gender were included in the study. Non probability convenience sampling was used. All patients underwent colour flow Doppler ultrasound and CT scan with contrast to asses the renal vein and inferior vena cava. The results were confirmed by intra operative findings and histopathology. The data was analyzed using SPSS version 12. **Results:** Out of 30 patients, 20 (66%) were males and 10 (34%) female. The tumour was predominantly on the right side (60%), as was renal venous tumour thrombus (44%). Inferior vena cava was involved in 4 cases predominantly due to right sided tumours. The sensitivity of Doppler ultrasound in detecting renal venous tumour thrombus (88% on right and 100% on left side) was higher than CT scan (63% on right and 60% on left side). Doppler ultrasound was also superior to CT scan in detecting vena caval thrombus. **Conclusion:** The overall sensitivity of Doppler sonography was higher than CT scan in detecting tumour extension into renal veins and inferior vena cava. Therefore, it can be used as a complementary tool in equivocal cases.

Keywords: Renal tumour thrombus, Renal vein, Inferior vena cava, Doppler ultrasound, CT scan

INTRODUCTION

Renal cell carcinoma is the most common primary renal cancer representing 2.5 to 3 % of all neoplastic processes.[1] The tumour is hyper vascular and tend to spread intravascularly leading to tumour thrombous in renal vein, inferior vena cava in 21–35% and 4–10% respectively which can reach up to the right side of heart.[2] Often non-specific clinical manifestations of renal carcinoma have lead to its description as the "great imitator" in medicine.[3] Imaging has a vital role in its management[4] as radical surgery remains the only treatment in localized and advanced tumors.[5] Although the extent of tumour thrombosis does not affect prognosis but it will change the surgical approach.[6] Involvement of right renal vein or lateral segment of left renal vein by tumour thrombus does not require approach modification. Involvement of medial segment of left renal vein or inferior vena cava will alter the surgical approach. Cardiopulmonary bypass is required if tumour thrombus extends up to right side of heart.[7]

CT scan, colour flow Doppler ultrasound, venacavography and MRI have been used in detecting tumour thrombus.[8] CT scan is the primary imaging technique due to the very high overall accuracy of up to 90%, colour flow Doppler ultrasound can be used as a complementary technique for assessing venous spread of renal tumour.[9] Doppler ultrasound is at least as accurate as CT in staging of RCC and may improve the CT findings.[10] The venous spread may look like on ultrasound as intra luminal echogenic nodules or thrombi. It can also be manifested as generalized caval dilatation with innumerable diffuse low amplitude echoes emanating from the lumen and partial or complete absence of flow.[5,11] However, anatomic variants, vessel displacement, collateral circulation, and neoplastic vessel infiltration are revealed more accurately by MR angiography than by colour Doppler sonography but it is costly and less easily available.[12]

The purpose of this study was to compare the sensitivity of CT scan and colour flow Doppler ultrasound in detecting tumour thrombus in renal vein and inferior vena cava in cases of renal cell carcinoma so that it can be used as a complementary investigation.

PATIENTS AND METHODS

This cross sectional study included 30 adult patients presenting in the Urology Department, Pakistan Institute of Medical Sciences Islamabad from February 2006 to December 2007.

All patients with renal cell carcinoma were included in the study after consent. Patients with previous history of DVT, advanced renal tumours, sensitivity to contrast media for CT scan and those unfit for surgery due to co-morbidities were excluded from the study. All patients underwent colour flow Doppler ultrasound and CT scan with contrast to asses the renal vein and inferior vena cava involvement by tumour thrombus. The results were confirmed by intra operative

findings and histopathology. The data was collected on structured proforma. Patients' demographic data, results of investigations and intra operative findings were entered in proforma in each case.

The data was analyzed using SPSS version 12. Descriptive statistics were used to calculate the mean age of patients. . Frequencies were calculated for the side of tumour and involvement of renal vein and inferior vena cava by tumour thrombus. Depending upon the surgical pathologic findings, the sensitivity, specificity, accuracy, positive and negative predictive values of CT scan and Doppler ultrasound were calculated for tumour thrombous extension into renal veins and inferior vena cava.

RESULTS

A total of 30 patients with renal cell carcinoma were evaluated. There were 20 (66.6%) male and 10 (33.4%) females with male to female ratio of 2:1. The age range was 25–71 years with mean age of 57. The tumour involved right side in 18 (60%) cases and left side in 12 (40%) cases.

We found 13 (43.3%) of 30 renal veins to have tumour thrombus extension by surgical and pathological findings. Eight (44%) out of 18 of right renal veins and 5 (41.6%) out of 13 left renal veins had tumour thrombus extension. In 4 cases thrombus involved inferior vena cava, due to right sided tumours in 3 cases and to left sided tumour in one case. Out of the 4 vena cava involved, tumour thrombus was below the level of hepatic venous confluence in 3 cases, whereas in one case it extended up to right atrium.

Table-1 shows the true and false positive and true and false negative results for tumour thrombus extension into renal vein and inferior vena cava.

All cases of vena caval involvement were revealed by Doppler ultrasound but CT scan missed one case. In 13 cases of renal vein involvement, colour Doppler revealed 12 cases with one false negative case. CT scan identified 8 cases of renal vein involvement with 5 false negative and 3 false positive cases.

The sensitivity, specificity, accuracy, positive and negative predictive values of CT scan and colour Doppler sonography for tumour thrombus extension into renal vein and inferior vena cava are shown in Table-2. It shows that the sensitivity of Doppler (100%) is higher than CT scan (75%) in inferior vena caval extension. It also shows that the sensitivity of CT scan in renal vein involvement is less than Doppler ultrasound but almost equal on both sides.

Table-1: Comparison of CT Scan and Colour Doppler ultrasound findings with surgical pathologic diagnosis of venous tumour thrombous in renal cell carcinoma

		Right renal venous involvement by surgical & pathologic findings		Left renal venous involvement by surgical & pathologic findings		Inferior vena caval involvement by surgical & pathologic findings	
		POSITIVE	NEGATIVE	POSITIVE	NEGATIVE	POSITIVE	NEGATIVE
Investigation	**RESULT**	8	10	5	7	4	26
CT Scan	Positive	5	1	3	2	3	0
	Negative	3	9	2	5	1	26
Doppler Ultrasound	Positive	7	0	5	1	4	0
	Negative	1	10	0	6	0	26

Table-2: Sensitivity, specificity, accuracy, positive and negative predictive values of CT scan and colour Doppler sonography for tumour thrombus extension into renal vein and inferior vena cava

	Right Renal Vein (%)		Left Renal Vein (%)		Inferior Vena Cava (%)	
Variable	***CT Scan***	***Doppler***	***CT Scan***	***Doppler***	***CT Scan***	***Doppler***
Sensitivity	63	88	60	100	75	100
Specificity	90	100	71	86	100	100
Positive predictive value	83	100	60	83	100	100
Negative predictive value	75	91	71	100	96	100
Accuracy	78	94	67	92	97	100

DISCUSSION

The renal cell carcinoma represents the 5th most common cancer in men with a rising incidence.[1] It has marked propensity to spread into renal vein, inferior vena cava and the right side of heart.[2] There are two divisions in the literature on the effects of venous involvement on prognosis with some studies showing poor prognosis, while others reporting no effect.[13] The preoperative imaging is essential tool for planning surgical management as the venous tumour extension will alter the surgical approach.[4]

The tumours with venous thrombus in right renal vein or lateral segment of left renal vein do not require approach modification.[2] Control of renal vein before nephrectomy is essential to prevent embolization. If tumour thrombus involves medial segment of left renal vein or inferior vena cava below the hepatic venous confluence, a chevron or rooftop incision is

required.[7,13] A combined thoracoabdominal approach is needed for venous tumour thrombus extension above the hepatic venous confluence, while involvement of right side of heart requires cardiopulmonary bypass. Therefore, a reliable and readily available technique is essential for venous tumour thrombus diagnosis.[5]

Initially, venography was considered as the best investigation for venous tumour thrombus diagnosis. It is invasive with morbidity of 2%.[14] Its diagnostic yield is less because of flow artefact of nonopacified blood of renal veins and inability to distinguish between intraluminal tumour thrombus from external compression. Also, the cephalic extent of tumour thrombus cannot be assessed by venography.[15] However, its use has declined because of emergence of MRI, Spiral CT scan and Doppler ultrasound.[5]

MR imaging is the investigation of choice to delineate venous tumour thrombus in renal cell carcinoma.[16] Major limitations to its use are less cost effectiveness, long study time and less frequent availability. With MRI, higher diagnostic accuracies, with positive predictive value of 100%, sensitivity of 82% and specificity of 97% have been reported.[12]

It is also superior in detecting full extent of tumour thrombus in inferior vena cava and in differentiating bland from tumour thrombus.[17] In our study, the results of colour flow Doppler ultrasound in detecting venous tumour thrombus are similar to MRI.

We observed that the tumour had predilection for right side (60%) and was predominant in males (66%). The tumour thrombus involved renal vein more on the right side (44%). These findings correlate with the study by Habboub *et al*.[5] The sensitivity of Doppler ultrasound in detecting renal vein thrombus observed in their study[5] (73% on the right and 80% on left) were less than observed in our study. However, results of Doppler ultrasound in our study (sensitivity of 100%) match with Habboub *et al* in detecting vena caval involvement by tumour thrombus.

London NJM *et al*[18] observed 79% overall accuracy of CT scan in detecting renal vein thrombus. However in our study, the overall accuracy of CT scan was low (73%) for renal vein thrombus. We observed that Doppler had higher overall accuracy (93%) than CT scan (73%) in renal vein assessment.

In our study, all cases of inferior vena caval involvement were detected by Doppler ultrasound, but CT scan missed one case. In this case of right sided tumour, the cephalic extent of tumour thrombus was 2 cm in the infrahepatic vena cava. The tumour was actually compressing the inferior vena cava which was clearly identified by the Doppler ultrasound. We believe that the sensitivity of colour Doppler sonography in detecting tumour thrombus in compressed veins is higher that CT scan. McGahan *et al*[19], found 89% sensitivity of colour Doppler sonography in inferior venal caval involvement and 100% for renal vein involvement in 19 patients. Our results match favourably with those of McGahan *et al*[19], however, our series includes higher number of patients (30) and shows higher accuracy for inferior vena caval involvement than renal vein.

Li XF *et al*[20] found MRI to be superior to CT in detecting venous tumour thrombus in inferior vena cava. In their study, MRI had sensitivity of 100% while CT scan missed 2 cases out of total 14 cases. The sensitivity of CT scan for caval thrombi in our study (75%) match favourably with them.[20] The sensitivity of Doppler ultrasound for caval thrombi in our study (100%), also matches with the sensitivity of MRI observed by Li XF *et al*.[20]

We also used Doppler sonography to asses the cephalic extent of tumour thrombus as it is important in surgical management. The cephalic extent was perfectly assessed by Doppler ultrasound in all the 4 cases. In one case of inferior vena caval involvement, the tumour thrombus extended up to right atrium with partial obstruction. This was clearly revealed both by Doppler and CT scan. Radical nephrectomy with tumour thrombus removal using cardiopulmonary bypass was done in this case. The patient was disease free at one year of surgery.

HUbsch P *et al*[11], in their study concluded that colour Doppler ultrasound can be readily used to distinguish bland from tumour thrombus. Doppler sonography also has the ability to differentiate inferior vena caval encasement from thrombus. Our data and that of McGahan *et al*[19] indicate that accuracy of colour Doppler ultrasound is superior to the CT scan and is comparable to MRI. It has advantages over CT that it is less expensive, readily available and has multiplanar capabilities. Venous thrombus extension generally does not affect prognosis, however venous wall invasion by thrombus has poor prognosis.[21]

Our study has one limitation. In one patient, CT scan showed renal veins to be free of tumour thrombus. This patient left the follow up and later Doppler done after 95 days of CT scan confirmed right renal vein involvement. This finding of involvement of right renal vein was confirmed by surgical and pathologic findings. We think that time lapse of 95 days between two studies was significant and tumour stage might have changed in this period. As this study was only less than 4% of examinations performed, we think that it would not have affected the overall accuracy of CT scan.

CONCLUSION

Colour Doppler sonography seems to be fairly accurate in assessing tumour thrombous extension into renal veins and inferior vena cava in patients with renal cell carcinoma. Although, CT scan is the primary imaging modality to stage the renal cell carcinoma, colour Doppler sonography can be used as complementary tool to asses venous extension in equivocal cases.

REFERENCES

1. Heidenreich A, Ravery V. Preoperative imaging in renal cell cancer. World J Urol 2004;22:307–15.
2. Davits RJAM, Blom JHM, Schrhder FH. Surgical management of renal carcinoma with extensive involvement of the vena cava and right atrium. Br J Urol 1992;70:591–3.
3. Pluzarev O, Budimlija Z. Ultrasonography and computerized tomography in the evaluation of tumour invasion in renal adenocarcinoma. Med Pregl 1999;52:455–8.
4. Clayman RV, Gonzalez R, Fraley EE. Renal cell cancer invading the inferior vena cava: clinical review and anatomical approach. J Urol 1980;l23:l57–63.
5. HK Habboub, MM Abu-Yousef, RD Williams, WA See, GD Schweiger. Accuracy of color Doppler sonography in assessing venous thrombus extension in renal cell carcinoma. Am J Roentgenol 1996;168:267–71.
6. Ficarra V, Righetti R, D'Amico A, Rubilotta E, Novella G, Malossini G, *et al*. Renal vein and vena cava involvement does not affect prognosis in patients with renal cell carcinoma. Oncology 2001;61:10–5.
7. Stewart JR, Carey JA, McDougal WS, Merrill WH, Koch MO, Bender HW Jr. Cavoatrial tumor thrombectomy using cardiopulmonary bypass without circulatory arrest. Ann Thorac Surg 1991;5l:717–21.
8. Hricak H, Thoeni RF, Carroll PR, Demas BE, Marotti M, Tanagho EA. Detection and staging of renal neoplasms: a reassessment of MR imaging. Radiology 1988;l66:643–9.
9. Welch TJ, LeRoy AJ. Helical and electron beam CT scanning in the evaluation of renal vein involvement in patients with renal cell carcinoma. J Comput Assist Tomogr 1997;21:467–71.
10. Scoutt LM, Zawin ML, Taylor KJW. Doppler US: Clinical applications. Radiology 1990;l74:309–19.
11. HUbsch P, Schurawitzki H, Susani M, Theyer G, Trainol O, Polzleitner D, *et al*. Color Doppler imaging of inferior vena cava: identification of tumor thrombus. J Ultrasound Med 1992;11:639–45.
12. Pfluger T, Czekalla R, Hundt C, Schubert M, Graubner U, Leinsinger, *et al*. MR angiography versus color Doppler sonography in the evaluation of renal vessels and the inferior vena cava in abdominal masses of pediatric patients. Am J Roentgenol 1999;173:103–8.
13. Hatcher PA, Anderson EE, Paulson DF, Carson CC, Robertson JE. Surgical management and prognosis of renal cell carcinoma invading the vena cava. J Urol 1991;145:20–4.
14. Goldfarb DA, Novick AC, Lorig R,Bretan PN, Montie JE, Pontes JE, *et al*. Magnetic resonance imaging for assessment of vena caval tumor thrombi: a comparative study with venacavography and computerized tomography scanning. J Urol 1990;144:1100–4.
15. Barnes PA. Bernardino ME, Thomas JL. Flow phenomenon mimicking thrombus: a possible pitfall of the pedal infusion technique. J Comput Assist Tomogr 1982;6:304–6.
16. Roubidoux MA, Dunnick NR, Sostman HD,Leder RA. Renal carcinoma: detection of venous extension with gradient-echo MR imaging. Radiology 1992;182:269–72.
17. Amendola MA, King LR, Pollack HM, Gefter W, Kressel HY, Wein AJ. Staging of renal carcinoma using magnetic resonance imaging at I .5 Tesla. Cancer 1990;66:40–4.
18. London NJM, Messios N, Kinder RB, Smart JG, Osborn DE, Watkin EM, *et al*. A prospective study of the value of conventional CT, dynamic CT, ultrasonography and arteriography for staging renal carcinoma. Br J Urol 1989;64:209–17.
19. McGahan JP, Blake LC, White RV, Gerscovich EO. Brant WE. Color flow sonographic mapping of intravascular extension of malignant renal tumors. J Ultrasound Med 1993;l2:403–9.
20. Li XF, Zhou FJ, Qiu SP, Liu ZW, Wu RP, Huang K, *et al*. Diagnosis and treatment of renal cell carcinoma with vena cava thrombi. Ai Zheng 2004;23:1074–6. [Article in Chinese]
21. Virdi JS, Kelly DG.Prognostic value of renal venous involvement in renal carcinoma. Br J Urol 1992;69:481–5.

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