International Journal of Medical Imaging
2021; 9(2): 117-122
http://www.sciencepublishinggroup.com/j/ijmi
doi: 10.11648/j.ijmi.20210902.14
ISSN: 2330-8303 (Print); ISSN: 2330-832X (Online)

The Role of Transrectal Power Doppler Ultrasonography in Detection of Prostate Cancer

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To cite this article:
Saiful Islam, Tarikul Islam, Halima Khatun, Anisur Rahman. The Role of Transrectal Power Doppler Ultrasonography in Detection of Prostate Cancer. *International Journal of Medical Imaging*. Vol. 9, No. 2, 2021, pp. 117-122. doi: 10.11648/j.ijmi.20210902.14

Received: February 22, 2021; **Accepted**: April 26, 2021; **Published**: June 3, 2021

Abstract: *Introduction:* Prostatic cancer is the fourth most common male malignancy worldwide. It is the commonest human cancer found at autopsy in 30% of men at age of 50 and almost 90% at age 90. To decrease the mortality caused by prostate cancer much attention has given to its early detection. power Doppler imaging (PDI) appeared to increase the sensitivity and help identify appropriate sites for biopsy. *Aim of This Study:* The aim of this study was to determine the role of Transrectal Power Doppler ultrasonography in the diagnosis of prostate cancer. *Methods:* This was a cross-sectional study and was conducted in Urology Department of Bangladesh Institute of Research and Rehabilitation of Diabetes, Endocrine and Metabolic Disorders (BIRDEM), Bangabandhu Sheikh Mujib Medical University (BSMMU) and Dhaka Medical College hospital (DMCH), Bangladesh during the period from July 2005 to June 2007. 36 patients were included in the study. Statistical analysis of the results was done by computer software devised in the statistical packages for social scientist (SPSS-10) and MS excel-16. *Result:* In total 36 patients Among the 36 patients, 16 cases were benign and 20 cases were malignant lesion detected by histopathological findings. In our study we found the validity of Transrectal power Doppler in detecting prostate cancer were evaluated by calculating sensitivity 90.0%, specificity 75.0%, accuracy 83.3%, positive and negative predictive values were 81.8% and 85.7% respectively. *Conclusion:* As the histopathological diagnosis of the present study significantly correlate with Transrectal power Doppler findings and the validity tests are almost identical as observed by other researchers of different study, it can be concluded that Transrectal power Doppler ultrasonogram is useful diagnostic modality in the discrimination of benign and malignant lesions in the prostate.

Keywords: Prostatic Cancer, Male Malignancy, Transrectal Power Doppler

1. Introduction

Prostatic cancer is the fourth most common male malignancy worldwide. It is the commonest human cancer found at autopsy in 30% of men at age of 50 and almost 90% at age 90. Unlike lung and colon cancer, prostatic cancer and the second most frequent cause of death from cancer in American man. Prostatic cancer is predominantly a disease of elderly men with more than 75% of new prostate cancers being diagnosed in men older than 65 years. [1] As in the United States, the incidence of prostatic cancer in increasing in our country. Although the specific causes of prostate cancer initiation and progression are not yet known, considerable evidence suggests that both genetics and environment play a role in the evolution of this disease. Classic and molecular epidemiology studies have identified a number of potential risk factors associated with the development of prostatic cancer. [1] Carcinoma of the prostate beings, usually as an adenocarcinoma with varying grades of differentiation; 20% of cases originate in the central zone. More than 95% of prostatic malignancies are adenocarcinoma but rarely, a squamous or transitional cell neoplasm is found and very rarely, a sarcoma (0.1-0.2%). [1] Prostate cancer rarely causes symptoms early in the course of the disease because the majority of adenocarcinomas arise in

the periphery of the gland, distant from urethra. Recently power Doppler imaging (PDI) has been developed in an attempt to overcome the drawbacks of CDI; allowing a three to four-fold increase in sensitivity for blood flow. Transrectal Power Doppler imaging is likely to contribute to the better characterization of hypoechoic lesions in the peripheral zone. [8] Transrectal Power Doppler is more sensitive to slow flow and is less angle dependent than color Doppler imaging. Sakarya et al. (1998) [8] concluded that Power Doppler imaging (PDI) appeared to increase the sensitivity and help identify appropriate sites for biopsy. Power Doppler is more sensitive to slow flow and is less angle dependent than color Doppler imaging. Transrectal Power Doppler sonography is more useful in detection of prostate cancer. [9] Results of several smaller studies have suggested that transrectal power doppler sonography may be useful in detection of prostatic cancer. On the other hand, the main emphasis of prostate examinations with transrectal power doppler ultrasonography has long been the differentiation of prostate cancer from benign processes such as benign prostatic hyperplasia (BPH) and prostatitis by focusing on the tumour vascularity, rather than investigating the capability of the modalities to detect the changes in the vascular architecture secondary to the aforementioned disease processes. [2]

The present study is aimed at determining the role of Transrectal Power Doppler ultrasonography in the diagnosis of prostate cancer.

2. Objectives

To find out the accuracy, sensitivity, specificity, positive & negative predictive values of Power Doppler transrectal ultrasonography in the detection of prostate cancer.

3. Methodology & Materials

This was a cross-sectional study and was conducted in Urology Department of Bangladesh Institute of Research and Rehabilitation of Diabetes, Endocrine and Metabolic Disorders (BIRDEM), Bangabandhu Sheikh Mujib Medical University (BSMMU) and Dhaka Medical College hospital (DMCH), Bangladesh during the period from July 2005 to June 2007. The study was attempted on 52 male patients aged 40-70 years. They were suspected of having prostate cancer clinically and referred to the Radiology and Imaging department of BIRDEM for proper evaluation of prostate, whether benign or malignant by transrectal power doppler sonography before treatment planning & further management. During transrectal power doppler sonographic examination ten of these patients were diagnosed normal and confirmed by follow up clinical and biochemical findings and were excluded from the study group. Finally, 36 patients were included in the study. Consecutive, non-randomized cases diagnosed clinically and who were finally referred to the department of Radiology Imaging BIRDEM for proper evaluation. Further statistical analysis of the results was done by computer software devised in the statistical packages for social scientist (SPSS-10) and MS excel-16.

4. Result

In the study, the patients were divided included into three age groups. The age ranged from 45 to 70 years and the maximum patients were found in the age group of 60-70 years. The mean age was 56.7 years with standard error of mean (SE)±1.7 years in benign lesions whereas in malignant lesions the mean age was 59.6 years with standard error of mean (SE) 1.4 years according to histopathological findings [Figure-1]. Among the 36 patients, 16 cases were benign and 20 cases were malignant lesion detected by histopathological findings. It was observed that 9(25.0%) cases were benign prostatic hyperplasia (BPH), 5(13.9%) cases were prostatitis, 2(5.6%) cases were dysplasia and 20(55.6%) case was carcinoma in histopathological evaluation [Figure-2]. Prostate volume of these benign lesions varied from 28 to 42 cc and the meant of these lesions was 34.9t1.03 cc. Majority (76.0%) of the prostate volume was found between 31-40 CC. According histopathology size of these benign lesions varied from 5.9 to 8.4 mm and the mean± SE of these lesions was 6.93±0.75 mm. Majority (37.4%) size of lesions was not detected. Echogenicity of these lesions were observed in which 6(37.4%) cases were isoechoic, 5(31.3%) cases were hypoechoic and rest 5(31.3%) cases were hyperechoic. parenchymal calcification these lesions were observed in which 10(62.5%) cases had presence of parenchymal calcification and rest 6(37.5%) had no parenchymal calcification. Site was localized in benign lesion evaluated by histopathology was found that the peripheral zone involved in 9(56.3o) cases, transition zone was none and in between two zone (no identifiable zone) 7(43.7%) cases. Distribution of patients according to serum PSA in benign lesions confirmed by histopathology were observed. PSA value of these benign lesions evaluated by histopathology varied from 4.9 to 11.4 ng/ml and the mean±SE of these lesion was 6.590.38 ng/ml. Majority (50.0%) of the PSA value was found between 6.1 - 10.0 ng/ml. Vascularity of the lesions in histopathological diagnosed cases on the findings of transrectal power doppler was observed that 12(75.0%) cases were grade 0, 4(25.0%) cases were grade 1 and none was in grade 2. Resistive index of the lesions in histopathologically diagnosed benign cases were observed. Resistive index (RI) was divided into five groups. The resistive index (RI) ranged from 0.54 to 0.67 and the maximum number was found between 0.61-0.69 group in benign lesion. The mean resistive index (RI) of benign was 0.61±0.01. Resistive index of the lesions in histopathologically diagnosed benign cases were observed. Resistive index (RI) was divided into five groups. The resistive index (RI) ranged from 0.54 to 0.67 and the maximum number was found between 0.61-0.69 group in benign lesion. The mean resistive index (RI) of benign was 0.61±0.01 [Table-1]. Among them 20 cases were malignant prostate volume of these malignant lesions varied from 28 to 45 cc and the mean± SE of these lesion was 34.8±1.19 cc. Majority (55.0%) of the prostate volume was found between

31-40 cc. Size of lesion was observed. According to histopathology size of these malignant lesions varied from 3.4 to 9.8 mm and the mean±SE of these lesions was 7.02±0.36 mm. Majority (45.0%) size of lesions was not detected. Echogenicity of the lesions was observed. In which 2(10.0%) cases were isoechoic, 17(85.0%) cases were hypoechoic, and 1(5.0%) case was hyperechoic. Among them 20 cases were malignant. Parenchymal calcification of the lesions was observed. In which 17(85.0%) cases had presence of parenchymal calcification and rest 3(15.0%) had no parenchymal calcification. Site was localized in malignant lesion diagnosed by histopathology. It was found that the peripheral zone involved in 18(90.0%) cases, transition zone 1(5.0%) cases and in between Wo zone (no identifiable zone) 1(5.0%) cases. PSA value of these malignant lesions evaluated by histopathology varied from 4.9 to 12.4 ng/ml and the mean±SE of these lesion was 8.42± 0.49 ng/ml. Majority (50.0%) of the PSA value was found between 6.1 - 10.0 ng/ml. Vascularity of the lesions in histopathological examination observed. In which 2(10.0%) cases were grade 0, 7(35.0%) cases were grade 1 and rest 11(55.0%) case was grade 2. Resistive index (RI) malignant lesions diagnosed by histopathology was Resistive index (RI) were divided into five groups. The resistive index (RI) ranged from 0.72 to 0.86 and the maximum number was found between 0.70 0.79 group in malignant lesion. The mean resistive index (RI) of benign was 0.80t0.01 [Table-2]. The patients having prostatic lesions suspected as malignant or benign by transrectal power doppler sonography were correlated histopathological diagnosis following collection of reports from the Transrectal respective cases. Out of the 36 cases 20(55.6%) cases were malignant and 16 (44.4%) cases were benign in histopathological findings. Of the total 36 cases, 22(61.1%) cases were suspected as malignant and rest of the 14(38.9%) cases were suspected as DET in transrectal power Doppler sonography. Among the 22 cases, which were suspected as benign in transrectal power Doppler. Among the 22 cases, which were suspected as malignant by power Doppler ultrasonography, 18 cases were malignant and 4 cases were found to be benign in histopathological examination. On the other hand, 2 cases were found as malignant and 12 cases were found as benign in histopathology among the suspected 14 benign cases, which were diagnosed by Transrectal Power Doppler ultrasonography [Table-3]. The validity of Transrectal Power Doppler sonography was evaluated by calculating sensitivity 90.0%, specificity 75.0%, accuracy 83.3%, positive and negative predictive values were 81.8% and 85.7% respectively. [Figure 3].

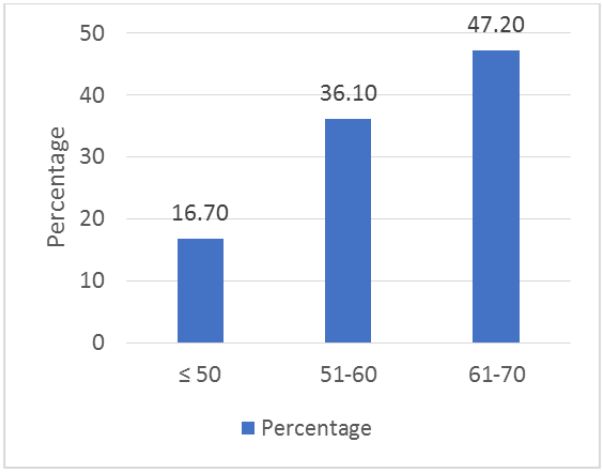

Figure 1. *Distribute the patients according to their age (N=36).*

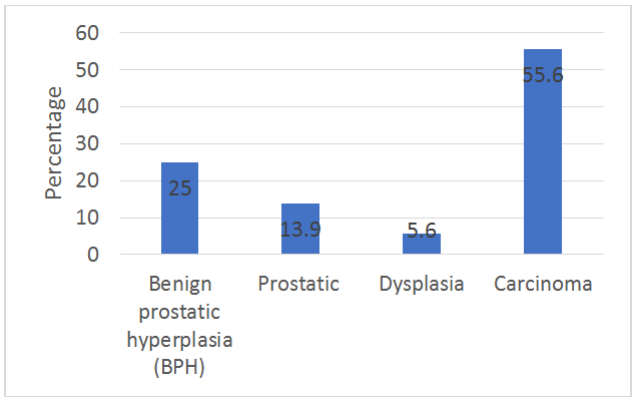

Figure 2. *Bar diagram shows the Histopathological findings (N=36).*

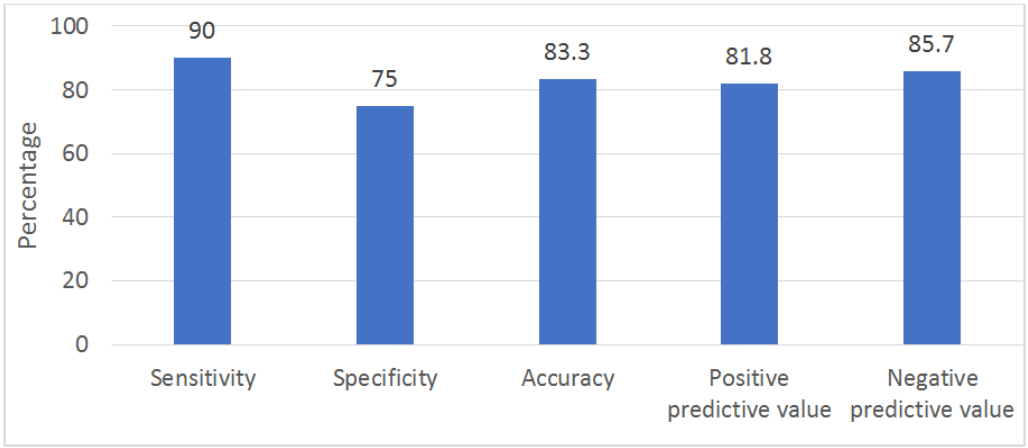

Figure 3. *The Sensitivity, specificity, positive and negative predictive values of transrectal power Doppler in diagnosis of prostatic lesions.*

Table 1. *Benign lesions in histopathological diagnosis (N=16).*

Benign lesions in histopathological examination		n	%
prostate volume (cc)	Up to 30	2	12.5
	31-40	12	75
	41-45	2	12.5
Size of lesion	<.5	4	25
	5.0-7.0	3	18.8
	> 7	3	18.8
Echogenicity of the lesion	Not detected	6	37.4
	Isoechoic	6	37.4
	Hypoechoic	5	31.3
	Hyperechoic	5	31.3
Parenchymal calcification	Present	10	62.5
	Absent	6	37.5
site of lesion	Peripheral zone	9	56.3
	Transition zone	0	0
	In between two zone/ No identifiable zone	7	43.7
PSA vlue(ng/ml)	Up to 6	7	43.8
	6.1-10	8	50
	> 10	1	6.3
Transrectal Power doppler findings	Grade 0	12	75
	Grade 1	4	25
	Grade 2	0	0
RI	Below 0.49	0	0
	0.5-0.59	5	31.3
	0.6-0.69	11	68.7
	0.7-0.79	0	0
	Above 0.8	0	0

Table 2. *Malignant lesions in histopathological diagnosis (N=20).*

Malignant lesions in histopathological examination		n	%
prostate volume (cc)	Up to 30	6	30
	31-40	11	55
	41-45	3	15
Size of lesion	< 5	1	5
	5.0- 7.0	8	40
	> 7	9	45
Echogenicity of the lesion	Not detected	2	10
	Isoechoic	2	10
	Hypoechoic	17	85
	Hyperechoic	1	5
Parenchymal calcification	Present	17	85
	Absent	3	15
Site of lesion	Peripheral zone	18	90
	Transition zone	1	5
	In between two zone/ No identification	1	5
PSA vlue(ng/ml)	Up to 6	4	20
	6.1- 10	10	50
	> 10	6	30
Transrectal Power doppler findings	Grade 0	2	10
	Grade 1	7	35
	Grade 2	11	55
RI	Below 0.49	0	0
	0.5-0.59	0	0
	0.6-0.69	0	0
	0.7-0.79	11	55
	Above 0.8	9	45

Table 3. *Transrectal Power Doppler Imaging and histopathological correlation of prostatic lesions (n=36).*

Power Doppler Imaging	Histopathological diagnosis		Total
	+ ve for Malignancy	- ve for Malignancy	
Suspected for Malignant	18	4	22
Suspected for benign	2	12	14
Total	20	16	36

5. Discussion

Prostate cancer, which basically penetrates the prostate gland wordily is a typical disorder. Numerous benign syndromes too can seem as diffuse prostatic lesions. Even though serum PSA, PSAD, and DRE could be helpful in recognizing diffuse prostate cancers. [10, 11] This cross sectional study was carried out with an objective to elucidate the correlation of Transrectal Power Doppler findings with histopathological diagnosis of prostatic lesions, evaluate the resistive index (RI) in benign and malignant prostatic lesions and also to find out the correlation between serum prostatic specific antigen (PAS) level and transrectal power Doppler findings in different prostatic lesions. A total of 36 patients age ranged from 45 to 70 years clinically suspected prostatic cancer were included in the study who were referred in the department of Radiology and Imaging of BIRDEM and underwent Transrectal Power Doppler study and patients biopsy or surgery was done followed by histopathological examination during July 2005 to June 2007.

In the study of Sakarya [8] et al. (1998) they have observed the mean age of the patients with prostate cancer was 66.4±7.7 years ranged from 45 to 70 years. Likewise, Halpern and Strup (2000) have witnessed in their study on 251 patients, the mean age was 64.6 years ranged from 37 to 87 years. [3] On the other hand, Lavoipierre et al. (1998) has observed identical mean age of the patients having prostate cancer, which was 64.0 years with ranged from 37 to 87 years on 256 consecutive patients. [4] In another study Shigeno et al. (2000) has observed on 278 patients with mean age 71.2 years range from 48 91 years. The higher age range of their study may be due to increased life expectancy in their country[5]. In the present study, the patients were divided into three age groups. The maximum patients were found in the age group of 60-70 years. According to histopathology 16(44.4%) cases were benign lesions and 20(55.6%) cases were malignant lesions. The mean age was 56.7 years with standard error of mean (SE) ± 1.7 years in benign lesions with ranged from 46 68 years and the maximum 8(50.0%) patients were found in the age group of 51-60 years. In malignant lesions the mean age was 59.6 years with standard error of mean (SE) ± 1.4 years with ranged from 46 -70 years and the maximum 12(60.0%) patients were found in the age group of 61-70 years. Ihee result obtained in the present study is consistent with the above mentioned studies.

Some previous studies recommended that, tumor volume, serum PSA and PSAD levels, and Gleason score were significant prognostic factors. [12-15] An association with PSA level and tumour sono-visibility has been observed.[15] If the PSA level is >20 ng ml^{-1}, >75% of tumours are seen, while <30% are seen at a PSA level <10 ng ml^{-1}. In the present study the mean± SE PSA value of benign lesions evaluated by histopathology was 6.59Ł0.38 ng/ml varied from 4.9 to 11.4 ng/ml and majority 8(50.0%) of the patients having PSA value was found between 6.1 10.0 ng/ml. In malignant lesions mean± SE of PSA value was 8 42:0.49 ng/ml ranged from 4.9 to 12.4 ng/ml and majority 10(50.0%) or patients belongs to 6.1 10.0 ng/ml Okihara et al. (2000) observed prostate cancer was 12.0% of 107 patients with a serum PSA level of 4.1 -10.0 ng/mL[6]. In another study Newman et al. (1995) found in their study in 22 patients, PSA values ranges from 0.7 to 14.5 ng/mL with mean 7.5 ng/mL, which is comparable with the present study. [7]

In this study it was observed that 14 cases were benign and 22 cases were malignant lesion diagnosed by transrectal power Doppler study. All benign lesions were grade 0, whereas in malignant lesion 11 (50.0%) were grade 1 and rest 11(50.0%) were grade 2. In histopathology, 16 benign lesions were found, out of which 12(75.0%) were grade 0 and rest 4(25.0%) were grade 1. In 20 malignant cases diagnosed by histopathology 2(10.0%6) cases were grade 0, 7(35.0%) were grade 1 and rest 11(55.0%) were grade 2. Sakarya et al. (1998) found 20 cases carcinoma where the Power Doppler Imaging(PDI) grade was 2 in 50.0% patients, grade 1 in 40.0% patients and grade 0 in 10.0% patients. The value of Doppler Imaging (PDI) grade obtained in the present study closely support the above investigators. In the present series the resistive index (RI) of prostatic cancer in 14 suspected benign lesion evaluated by transrectal power doppler. The mean resistive index (RI) of benign lesion was 0.62±0.02 ranged from 0.54 to 0.78 and the maximum patients Resistive Index (RI) was found between 0.60- 0.69 RI group. In 22 suspected malignant lesions the mean resistive index (RI) was 0.77±0.01 ranged from 0.62 to 0.86 and the maximum patients' Resistive Index (RI) was found between 0.70-0.79 and > 0.80 RI group. The mean resistive index (RI) was 0.61±0.01 ranged from 0.54 to 0.67 and the maximum patients Resistive Index (RI) was found between 0.61-0.69 RI group in benign lesion diagnosed by histopathology. The mean resistive index (RI) of malignant lesion was 0.80±0.01 ranged from 0.72 to 0.86 and the maximum patients' Resistive Index (RI) was found between 0.70 -0.79 RI group in malignant lesion. Neumaier et al. (1995)[7] found the mean value of resistive index was 0.639 for urethral arteries with normal range values was 0.54 to 0.75 and mean value of resistive index for capsular arteries was 0.628 with normal range 0.52 to 0.71. The value of Rl obtained in the present study slightly higher than the above. In this study out of 36 patients, 16 cases were benign and 20 cases were malignant lesion detected by histopathological examination. It was observed that 9(25.0%) cases were benign prostatic hyperplasia (BPH), 5(13.9%) cases were prostatitis, 2(5.6%) cases were dysplasia and 20(55.6%) case was carcinoma in histopathological evaluation. Okihara [6] (2000) found the PDI characterized by high sensitivity (98.0%) and negative predictive value 99.0% in detecting prostate cancer, which is resemble with the present study. The validity of transrectal power Doppler were evaluated by calculating sensitivity 90.0%, specificity 75.0%, accuracy 83.3%, positive and negative predictive values were 81.8% and 85.7% respectively. In another study done by Sakarya[8] et al. (1998) found the sensitivity of power Doppler was 90.0%, specificity 75.0% and positive predictive value 82.0% for diagnosis of prostate cancer, which is strongly support the

present study. Lavoipierre [4] et al. (1998) found the sensitivity 76.0%, specificity 38.0%, positive predictive value 44.0% and negative predictive value 71.0% in transrectal power doppler evaluation Same author found in gray scale evaluation in detecting prostate cancer the sensitivity 75.0%, specificity 40.0%, positive predictive value 45.0% and negative predictive value 72.0%.

Limitations of the study

Small sample size due to slightly expensive and semi invasive modality. The study was conducted in one tertiary hospital, hence may not represent the whole population.

6. Conclusion and Recommendations

As the histopathological diagnosis of the present study significantly correlate with transrectal power Doppler findings and the validity tests are almost identical as observed by other researchers of different study, it can be concluded that transrectal power Doppler ultrasonogram is useful diagnostic modality in the discrimination of benign and malignant lesions in the prostate. However, further studies can be under taken by including large number of patients.

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