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Ultrasonic Power Doppler Imaging for Prostatic Cancer: A Preliminary Report

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Okihara, K., Kojima, M., Naya, Y., Iida A., Watanabe, M. and Watanabe, H. *Ultrasonic Power Doppler Imaging for Prostatic Cancer: A Preliminary Report.* Tohoku J. Exp. Med., 1997, **182** (4), 277-281 —— This study was conducted to characterize Doppler blood flow signals in prostatic cancer using power Doppler imaging with a transrectal probe. Both the localization and vascularity of blood flow in the prostate were compared between patients with prostatic cancer and those with benign prostatic hyperplasia (BPH). The prominent accumulation of blood flow signals (hypervascular lesion) was recognized in all the cases with prostatic cancer, compared to only 2 (4%) of 47 with BPH ($p<0.001$). Power Doppler imaging is promising for the detection of prostatic cancer. ———— prostate; cancer; power Doppler imaging; hypervascular lesion; benign prostatic hyperplasia

In the last decade, color Doppler imaging has emerged as a valuable tool in the evaluation of prostatic cancer, and its clinical usefulness in the detection of prostatic cancer has been reported (Ian et al. 1993). Color Doppler imaging, however, has some shortcomings, such as aliasing, angle dependence and noise background. As a result, fine intratumoral blood flows in small cancer lesions were difficult to be evaluated precisely.

Recently, power Doppler imaging was developed in an attempt to overcome the drawbacks of conventional color Doppler imaging, allowing a three- to four-fold increase in sensitivity for blood flows (Rubin et al. 1994). In this study, preliminary results of power Doppler imaging in prostatic cancer were reported, and discussion was focused on the possible use of this new modality in the detection of prostatic cancer.

Materials and Methods

Power Doppler imaging was performed in 72 patients whose serum prostate specific antigen (PSA) were more than 4.0 ng/ml (Delfia PSA kitt), of whom 47

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(65±6.5 years) were diagnosed to have benign prostatic hyperplasia (BPH), as determined by transrectal ultrasonography (TRS) (Watanabe et al. 1975). The remaining 25 (75±7.5 years) had prostatic cancer. In all patients, either BPH or prostatic cancer was confirmed by both sextant systematic biopsy on gray scale and power Doppler guided biosy transperineally aiming the prominent accumulation of blood flow signals (Fig. 1). They had not received any treatment previously, and examined blood and urine test for the purpose of excluding acute prostatitis before biopsy. Of 25 patients with prostatic cancer, 6 were in Stage B (PSA range: 4.8−21.8, average: 12.5), 11 in Stage C (PSA range: 9.8–47.7, average: 20.5), and 8 patients in Stage D (PSA range: 96–5650, average: 434), respectively. Six cases (Stage B=5; Stage C=1) belonged to PSA gray zone area (4.0–10 ng/ml)

Power Doppler imaging was performed in the lateral decubitus position using an ultrasound equipment (SSD-2000; Aloka, Tokyo) with a transrectal probe (KAI-M83-747; Aloka). All imaging was performed by one experienced urologist (K.O.). Power Doppler gain was set to the point just below the threshold so that blood flows at neurovascular bundles were identified with the least background noise. Blood flow sampling was obtained from the inner and the outer glands on the transverse section of the prostate. Scanning to detect flow was continued for 10 minutes.

Fisher's exact value test was used to compare the proportion between prostatic cancer and BPH, and a p-value less than 0.05 was defined as statistically significant.

Results

With the use of power Doppler imaging, blood flow signals inside the prostate were detected as dots of red in all patients with either BPH (Fig. 2) or prostatic cancer. In addition to these dot-like signals, blood flow signals characterized with disorderly tangles and numerous sharp kinks were observed in all cases with prostatic cancer without exception (Fig. 3). These findings were designated as "hypervascular lesion" according to the description by Rifkin (1997). Hypervascular lesion was recognized in only 2 out of 47 cases (4%) of BPH, while in all 25 cases (100%) of prostatic cancer, demonstrating a sharp contrast among the two diseases ($p<0.001$). On the other hand, hypoechoic lesion on gray scale was recognized in 23 cases (49%) of BPH, while in 11 cases (44%) of prostatic cancer. A hypoechoic lesion including and/or surrounding hypervascular lesion (*hypo*(+) *and hypervascular*(+)) was depicted in 10 out of 11 cases (91%) of prostatic cancer (Table 1). Interestingly, the sign of *hypo*(+) *and hypervascular*(+) was found in all patients with prostatic cancer whose PSA belonged to gray zone area. In the remaining 14 cases who had hypervascular lesion without hypoechoic lesion, hypervascular lesions were characterized as diffuse anechoic pattern on gray scale and diffuse flow pattern on power Doppler imaging proposed by Rifkin (1997),

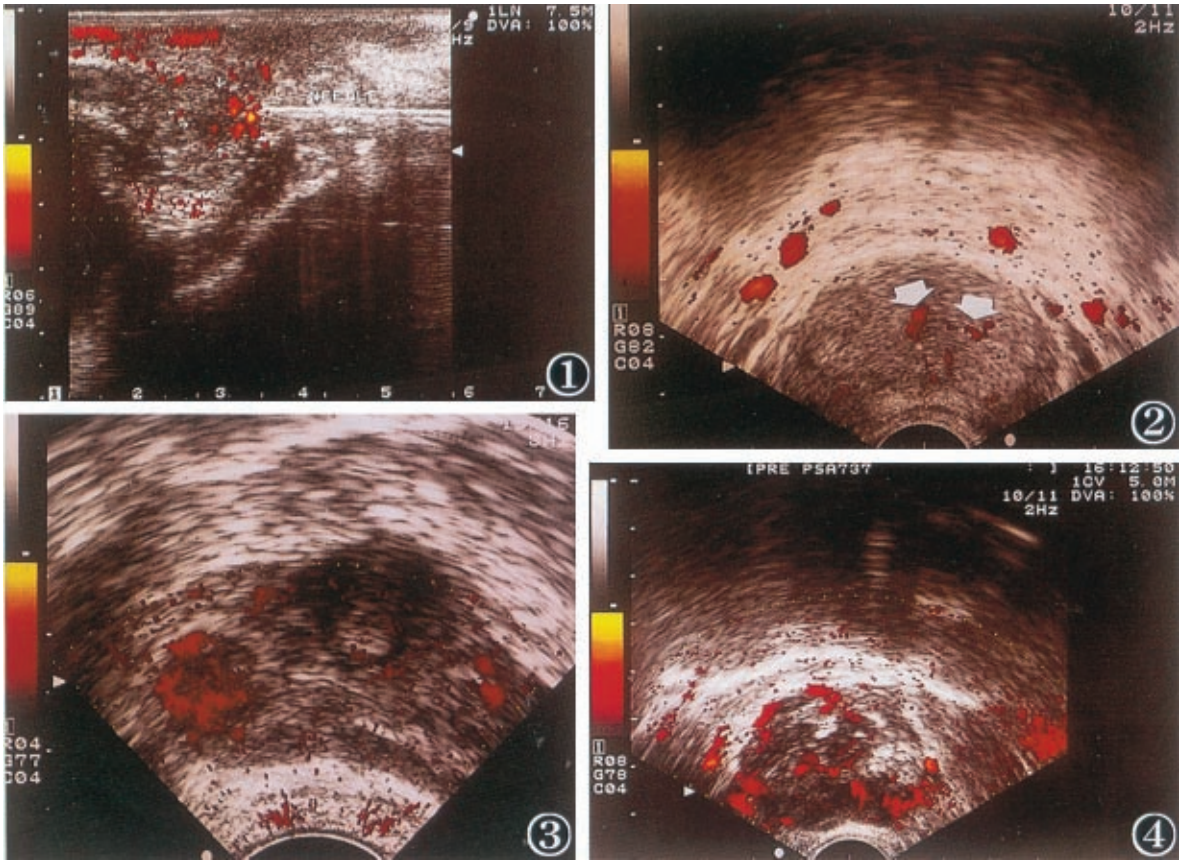

Fig. 1. Power Doppler guided biopsy. Biopsy needle was directed to the hypervascular lesion.

Fig. 2. Power Doppler imaging of benign prostatic hyperplasia, showing dot-like blood flows (arrow).

Fig. 3. Power Doppler imaging of prostatic cancer. Hypervascular lesion is recognized in the right lobe. Serum PSA was 7.8 ng/ml.

Fig. 4. Power Doppler imaging of prostatic cancer. Diffuse flow was depicted inside the prostate. Serum PSA was 737 ng/ml.

Table 1. *Positive hypoechoic and hypervascular lesions in BPH and prostatic cancer*

Disease	*n*	Hypoechoic lesion	Hypervascular lesion
BPH	47	23 (49%)	2 (4%)
Prostatic cancer	25	11 (44%)	25 (100%)

whose clinical stage were classified into Stage C (7 cases) and Stage D (7 cases) not including Stage B (Fig. 4).

Discussion

In an effort to decrease mortality due to prostatic cancer, much attention has been paid to its early detection. As is well known, the clinical utility of TRS in detecting prostatic cancer is limited at least based upon only the echogenecity of suspected lesions, because hypoechoic lesions on gray scale appearance are not

always cancer foci (Chodak and Schoenberg 1989). A novel modality to detect prostatic cancer with more reliability remains to be developed.

Recently, we reported that power Doppler imaging was of much use in the diagnosis of BPH (Kojima et al. 1997). This study is the first to make an application of power Doppler imaging to the prostate in terms of the the detection of prostatic cancer. The marked contrast in the frequency of hypervascular lesions between prostatic cancer and BPH are likely to encourage us to employ power Doppler imaging for the detection of prostatic cancer. A hypervascular lesion as demonstrated by power Doppler imaging suggests strongly the presence of cancer foci. Especillay, a hypoechoic lesion including and/or surrounding by hypervascular lesion also can be predicted the presence of cancer foci, and is considered to be useful finding for the detection of prostatic cancer in patients whose PSA belong to gray zone area (4.0–10 ng/ml). On the contrary, in patients with advanced prostatic cancer, vascular pattern was considered to be indifferent to the hypoechoic lesion on gray scale. Precise distinction of hypervascular lesion between BPH and prostatic cancer might be difficult. However, the first step for the distinction might be to know normal vasculature of the prostate well. Anatomically, gland of prostate is mainly fed by the inferior vesical artery, which is devided into two branches, either of capsular branches or urethral branches. Capsular branches surround the gland of prostate, and penetrate the inner gland. The reason why hypervascular lesion was also depicted in patients with BPH was considered that the hyperplastic tissue required increased flow as compared to normal tissue. This increased vascularity may be seen as the hypervascular lesion which is the dilated capsular and/or urethral branches with BPH. However, BPH is a benign disease, therefore, neoplastic growth of BPH is generally symmetric. The finding of symmetry is important to distinguish normal increased flow from hypervascular lesion in patients with BPH. Prostatic cancer requires angiogenesis like other neoplasms, resulting in neovascularity for growth. A hypervascular lesion might represent the neovascularity or increased perfusion of blood flows in cancer lesion. Power Doppler imaging might be used for the non-invasive evaluation of vascularity of prostatic cancer.

In conclusion, power Doppler imaging is promising as a detection tool for prostatic cancer. Further studies are needed to confirm its utility as an imaging modality for the investigation of prostatic cancer.

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