

Value of Elastography in Prostate Cancer Diagnosis

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Prostate cancer is the most common cancer in men in the western world. It is expected that there will be a further increase in the incidence in the next few years due to the increasing age of the population in the western world¹⁾. As is known, the diagnosis of prostate cancer is based on PSA testing, the DRE and ultrasonography (US)-guided biopsy. Nowadays systematic biopsy with at least 10 cores is the method of choice. Standard grey-scale TRUS has limited specificity and sensitivity for prostate cancer detection because of its inability to detect isoechoic neoplasms. To increase its accuracy, research has been done using a number of alternatives, including colour Doppler TRUS imaging and power Doppler US, both of which have also been used latterly with intravenous contrast administration. Increased microvascularity accompanies cancer growth, and neovascularity may be detectable by colour Doppler TRUS and power Doppler US because of abnormal blood flow patterns in larger feeding vessels²⁾.

Key Words: Prostate Cancer, Elastography, Detecting Cancer

1. Introduction

Recently, Elastography has been introduced for prostate cancer imaging. Elastography is an imaging technique that evaluates the elasticity of the tissue. Krouskop et al. reported that cell density was greater in neoplastic tissue, which causes a change in tissue elasticity / stiffness³⁾. Ophir et al. first described the principle of this technique in 1991⁴⁾. To reduce the time-consuming calcula-

tions, Pesavento et al. developed a fast cross-correlation technique that is the basis for real-time Elastography⁵⁾. This method can be used to visualize displacements between US image-pairs of tissue under 'compression'. As most solid tumours differ in their consistency from the deriving tissue, real-time Elastography offers a novel tool for detecting cancer.

2. Value of Elastography for prostate cancer detection – first clinical results

In a study by Konig et al. in 2005, Elastography detected 84% of the 151 true positive cancer patients in a group of 404 investigated patients with suspected prostate cancer⁶. Konig et al. concluded that it is possible to detect prostate cancer with a high degree of sensitivity using real-time Elastography in conjunction with conventional diagnostic methods for guided prostate biopsies.

In 2006 Miyanaga et al. investigated 29 patients with untreated prostate cancer⁷. The sensitivity of Elastography, TRUS and digital rectal examination were 93%, 59% and 55%, respectively. Miyanaga et al. concluded that Elastography may be used for biopsy guidance of prostate cancer, as it has great potential to differentiation between cancerous and normal tissue.

In Jan 2007 Pallwein et al. reported in a review article about the value of contrast-enhanced ultrasound and Elastography in imaging of prostate cancer⁸. In his article Pallwein presented the preliminary results of a pilot study using Elastography. In this study patients with clinically localized prostate cancer who underwent radical prostatectomy were examined. Prior to surgery, these patients were examined with conventional gray-scale ultrasound as well as with real-time Elastography. Areas suspected of prostate cancer were depicted. After surgery, the histological specimens were compared with the transverse ultrasound images and with Elastography findings. Thirty-two foci of prostate cancer were present in the pathologic evaluation, with multiple foci of cancer in 13 of the 15 glands. Real-time Elastography detected 28 of the 32 cancer foci (sensitivity: 88%). Four of the sites were false positives with no pathological abnormality. The analysis by patient demonstrated that real-time Elastography detected at least one cancer foci in each of the 15 patients. Therefore, Pallwein concluded that real-time Elastography of the prostate is a sensitive new imaging modality for the detection of prostate cancer. In 78.3% of the cases, the Elastography findings correlated with the histological findings. The mentioned study was published later in 2007⁹.

In May 2007 Pallwein reported on the comparison of Elastography of the prostate with systematic biopsy findings in 492 patients¹⁰. Four hundred and ninety two PSA screening volunteers (mean age: 61.9+/-8.6) with a total PSA > 1.25ng/mL and a free to total PSA ratio of < 18% underwent Elastography (SE) of the prostate before 10 core systematic prostate biopsy. Tissue elasticity of the

peripheral zone was investigated only. Tissue elasticity was displayed from red (soft) to green (intermediate) and to blue (hard). Only hard lesions (blue) were considered to be suspicious for prostate cancer. The peripheral zone of the prostate was divided in 3 regions on each side: base, mid-gland, apex. A different investigator performed systematic biopsy, and the biopsy findings were compared with the SE findings.

In 125 of 492 patients (25.4%) systematic biopsy demonstrated prostate cancer. Cancer was detected in 321 of 2952 (11%) outer gland areas (74 in the base, 106 in the mid-gland, 141 in the apex). The Gleason score ranged from 3 to 10 (mean: 6.5). In SE 533 of 2952 (18.1%) suspicious areas were detected and 258 of these areas (48.4%) showed cancer. Most of the false-positive findings (275/533 areas; 51.6%) were associated with chronic inflammation and atrophy especially at the basal prostate areas. The sensitivity by entire organ was calculated with 86% and the specificity 72%. The analysis by outer gland areas showed the highest sensitivity in the apex (79%). The specificity by outer gland areas ranged between 85% and 93%. The correlation between SE findings and biopsy results was high ($p < 0.001$). Therefore Pallwein concluded that Elastography findings showed a good correlation with the systematic biopsy results. The best sensitivity and specificity was found in the apex region. Elastography seems to offer a new approach for differentiation of tissue stiffness of the prostate and may therefore improve prostate cancer detection.

3. Value of Elastography for targeted prostate biopsy

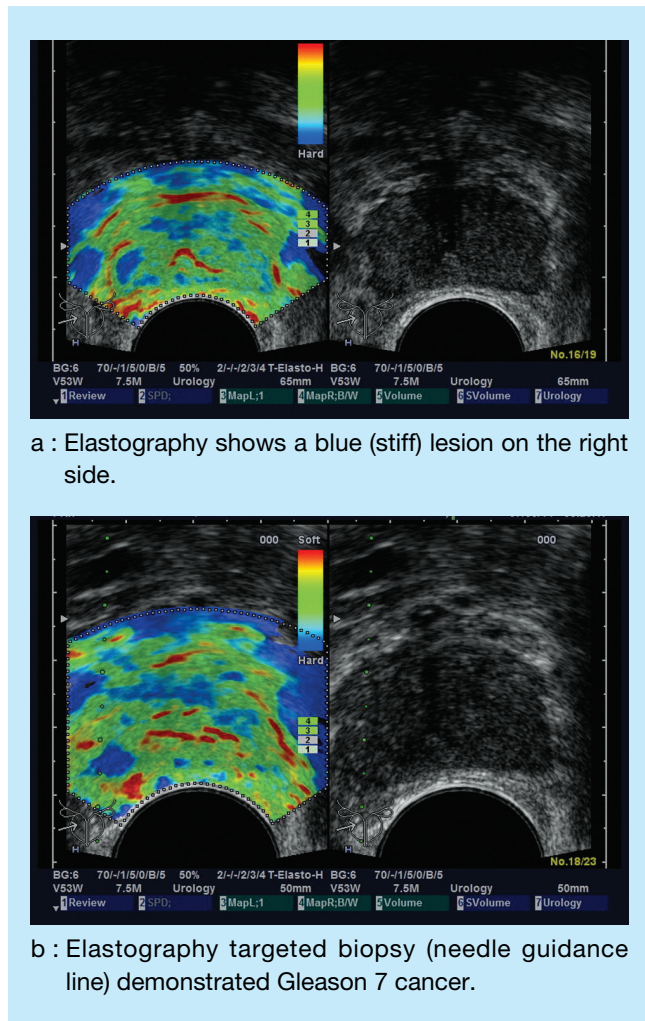
In another study relating to Elastography published in September 2007, Pallwein reported a prospective study to determine the value of Elastography (SE) targeted biopsy for prostate cancer (PCa) detection¹¹. A series of 230 male screening volunteers was examined. Two independent examiners evaluated each subject. One single investigator performed ≤ 5 SE targeted biopsies into suspicious regions in the peripheral zone only. Subsequently, another examiner performed ten systematic biopsies. Cancer detection rates of the two techniques were compared. Cancer was detected in 81 of the 230 patients (35%), including 68 (30%) by SE targeted biopsy and in 58 (25%) by systematic biopsy (Figs 1 and 2). Cancer was detected by targeted biopsy alone in 23 patients (10%) and by systematic biopsy alone in 13 patients (6%). The detection rate for SE targeted biopsy cores (12.7% or 135 of 1,109 cores) was significantly better than for systematic biopsy cores (5.6% or 130 of 2,300 cores, $P < 0.001$). SE targeted biopsy in a

patient with cancer was 2.9-fold more likely to detect PCa than systematic biopsy. Pallwein concluded that SE tar-

geted biopsy detected more cases of PCa than systematic biopsy, with fewer than half the number of biopsy cores in this prostate-specific antigen screening population.

4. Value of Elastography for staging prostate cancer

Recently we have used Elastography for local staging of prostate cancer. Elastography allows for excellent visualization of the prostate capsule - which is shown as a “soft rim” artefact. In 15 cases, Elastography was performed on patients with prostate cancer who underwent radical prostatectomy, to evaluate the absence or presence of extracapsular disease. In 14 of 15 cases Elastography correctly diagnosed the absence or presence of extracapsular disease. Therefore these preliminary data are very promising. (Figs 3, 4 and 5)



a : Elastography shows a blue (stiff) lesion on the right side.

b : Elastography targeted biopsy (needle guidance line) demonstrated Gleason 7 cancer.

Fig. 1 : Elastography images of a patient with prostate cancer

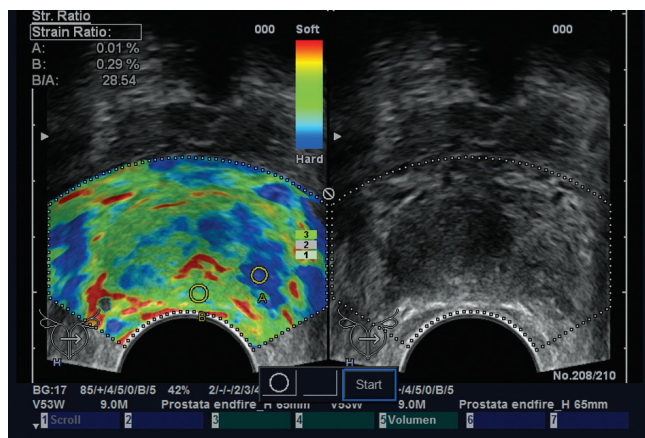


Fig. 2 : Elastography image of a patient with prostate cancer

Elastography shows a blue (stiff) lesion on the left side. The use of the strain ratio shows a value of 28.54 (preliminary data show that in case of cancer the value for the strain ratio is > 25). Targeted biopsy revealed cancer (Gleason 7).

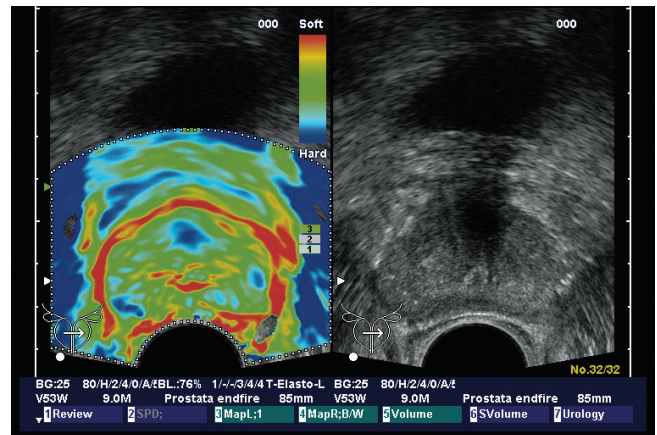


Fig. 3 : Elastography of the prostate
Elastography detected 2 cancer foci (right and left side). The capsule is clearly visualized as a “soft rim” (red), and no extracapsular disease was found on pathohistology.

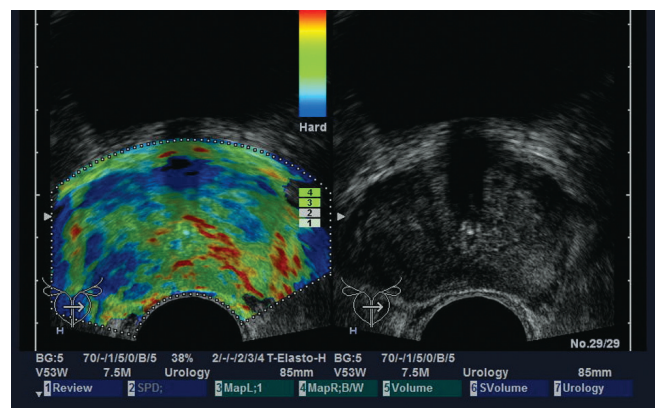


Fig. 4 : Elastography in a patient with prostate cancer
Elastography detected a cancer on the right side. The capsule cannot be visualized, as seen by the missing “soft rim” sign. Pathohistology demonstrated extracapsular disease on the right side.

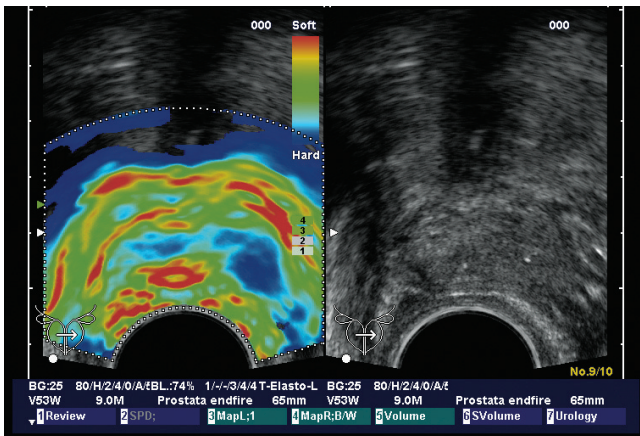


Fig. 5 : Elastography in patient with prostate cancer
Elastography detected cancer on the right side. The capsule cannot be visualized, as seen by the interruption of the “red soft rim” sign and pathohistology proved extracapsular extension on the left side.

5. Conclusions

The studies presented here have shown promising results for Elastography in prostate cancer imaging and detection. The latest reviews and articles about prostate cancer have reported the clinical value of elastography citing the published works by Pallwein et al.¹²⁾⁻¹⁴⁾. Further clinical trials are certainly needed and are already underway to determine the exact role that the advantages of Elastography imaging can play to TRUS in prostate cancer diagnosis.

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