Mri and ultrasound guided prostate biopsy using the fusion imaging technique.

Poster No.: C-2333
Congress: ECR 2013
Type: Scientific Exhibit
Authors: A. Villa¹, F. Chiesa², I. Rosenberg³, A. Tagliafico⁴, M. Perinetti⁵, A. Del Prato⁵, ¹Genova, lt/IT, ²Genova (GE)/IT, ³Sarzana/IT, ⁴Genova/IT, ⁵Genoa/IT
Keywords: Pelvis, Genital / Reproductive system male, MR, Ultrasound, Biopsy, Cancer
DOI: 10.1594/ecr2013/C-2333

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR’s endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method ist strictly prohibited.
You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.
Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.
www.myESR.org
Purpose

Learning objectives

In detection of prostate cancer, transrectal ultrasound (TRUS) guided random biopsy is the "gold standard" in patients with high values of PSA (Prostatic Specific Antigen).

A new technique using MRI and US fusion imaging was considered by our institution to perform accurate targeted biopsies in highly suspicious areas of the peripheral prostate gland observed after MRI exam.

The aim of this study is to improve the accuracy of targeted biopsies and to increase the detection of prostatic cancer in patients with high PSA, negative digital rectal exploration and negative previous random prostate biopsy.

Background

Prostate cancer is the most common cancer and the second most common cause of cancer deaths among men in the western countries [1]. The management of prostate cancer is a complex issue because of the difficulty in accurate staging and in predicting the speed of disease progression [2]. The current methods of prostate cancer detection include digital rectal examination (DRE), serum prostate-specific antigen (PSA) level, and transrectal ultrasound with random biopsy. The role of MRI has evolved over the past decade with the development of newer techniques to localize, stage, and obtain functional information about the cancer.

Ninety-five percent of prostate cancers are adenocarcinomas that develop from the acini of the prostatic ducts. They are classified according to Gleason score.

The prostate gland can be divided into 3 zones: peripheral, central and transitional. These zones are defined histologically and therefore many prostatic diseases have a zonal distribution. 70% of adenocarcinomas arise in the peripheral zone, 20% of adenocarcinomas arise in the transitional zone, while only 10% of adenocarcinomas develop in the central zone [3].

Even in TRUS, prostate can be divided into the same three zones, but from echostructural point of view only two zones are well identified: peripheral and central zones. The central zone comprises the posterior part of the gland and is often commonly heterogeneous in echotexture. The peripheral zone forms most of the gland volume and it is described as isoechoic and homogeneous. The transitional zone is the central part of the gland and it is hypoechoic. The capsule is a hyperechoic structure that can be identified all around the prostate gland. [Fig.1].
In TRUS prostate cancer appears hypoechoic or isoechoic, but most of time is hypoechoic. Therefore, TRUS is used primarily to direct the physician to suspicious areas in the prostate or to guide the performance of prostate biopsies.

Transrectal ultrasound-guided biopsy is the universally accepted method of confirming the presence of prostate cancer. A randomized approach is used to obtain the biopsy samples because ultrasound has poor sensitivity for visualizing the tumor. The yield from this approach varies[4,5].

In MRI the zonal anatomy of the prostate cannot be distinguished on T1-weighted images because the prostate appears to be of uniform intermediate signal intensity. [Fig. 2]
**Fig. 2:** TSE T1-weighted Ax image of the pelvis.

**References:** "Department of Radiology, San Bartolomeo Sarzana, Medical Hospital of Sarzana 2013."

Figure 2: TSE T1-weighted Ax image of the pelvis.

However, the prostatic zones are well shown on T2-weighted images. [Fig 3]
The anterior fibromuscular stroma is of low T1 and T2 signal intensity. The peripheral zone has high T2 signal intensity similar to or greater than the signal of adjacent periprostatic fat. The anatomic or true capsule surrounding the peripheral zone appears as a thin rim of low signal intensity on T2-weighted images [3, 6]. The central and transitional zones are both of lower T2 signal intensity than the peripheral zone, possibly because of more compact smooth muscle and glandular elements. There is also an age-related modification in the T2 signal intensity of the peripheral zone [7]. Prostate adenocarcinoma in the peripheral zone shows low signal intensity that is easily distinguished from the normal high-signal peripheral zone. However, low signal intensity in the peripheral zone is nonspecific and may be seen in benign conditions.
such as biopsy-related hemorrhage, changes from hormone therapy, prostatitis, and postradiation fibrosis. Therefore, conventional MRI evaluation of prostate cancer, that involves a combination of anatomic T1- and T2-weighted images, is usually combined with one or more of several functional techniques such as diffusion-weighted imaging (DWI), dynamic contrast-enhanced MRI (DCE-MRI) and perfusion technique. DWI is based on the principle of random molecular motion of water in tissues [8]. Healthy prostate tissue exhibits signal loss, whereas areas of restricted molecular motion, such as in densely packed tumor cells, show higher signal and are therefore bright on the elevated b values DWI. DWI reflects changes at the cellular level about tumor cellularity and cell membrane integrity. The use of DWI enables the calculation of the apparent diffusion coefficient (ADC), which is a value that measures water diffusion in tissues. Movement of water is restricted in tumors, leading to a reduction in the ADC value [9, 10]. After the acquisition of DWI images, an ADC map, which shows the ADC value of each voxel, can be correlated with T2-weighted images. DWI scans are characterized by the b value (in s/mm²), which is a function of diffusion gradient strength. DCE-MRI is based on the principle of tumor angiogenesis. The values of contrast enhancement parameters such as mean transit time, blood flow, permeability of the surface area, and interstitial volume are significantly greater in cancerous tissue than in normal tissue [11-12]. Relative peak enhancement is highly suspicious for prostate cancer in the peripheral zone and central zone [13].
Methods and Materials

Imaging findigs OR procedure details

In our study we decided to perform MRI to patients that had previously negative DRE, negative TRUS random biopsy and high PSA values.

The MRI examination included sequences for study of general pelvis and special sequences for the study of prostate gland as T2 weighted high resolution sequences [Fig 4], diffusion weighted imaging [Fig 5] and perfusion technique. Suspicious areas, that were highlighted on axial T2 weighted images, were classified as high, moderate or low degree of cancer risk. Suspicious lesions were detected by radiologists with over 5 years experience in reading prostate MRI. The obtained data were transferred to a stereotactic biopsy system.
Fig. 4: TSE T2 high resolution weighted image of prostate

References: "Department of Radiology, San Bartolomeo Sarzana, Medical Hospital of Sarzana 2013."
Fig. 5: Image of prostatic gland DWI b=1200. A small nodular areas were observed in the left prostatic lobe. The low signal intensity in TSE T2 high resolution image and rapid wash in observed in the perfusion sequences categorized these lesions as high suspicious.

References: "Department of Radiology, San Bartolomeo Sarzana, Medical Hospital of Sarzana 2013."

Patients

From April to December 2012, 15 patients (mean age of 61 year) with mean PSA level of 7.6 ng/ml and mean prostate volume of 42 ml were stereotactically biopsied. All patients had already had a negative TRUS-guided biopsy and underwent 1.5 Tesla MRI with pelvic surface phased-array coil (PSFA) [Fig 6].
Fig. 6: Patient underwent 1.5 Tesla MRI with PSFA coil

References: "Department of Radiology, San Bartolomeo Sarzana, Medical Hospital of Sarzana 2013."

Prostate MRI scanning protocol:

- Achieva 1,5T MRI, Philips Healthcare;
- 18G cannula placed in a distal arm vein;
- Gd BOPTA (Multihance®) 0,1 mmol/Kg; v perfusion 4 ml/sec;
- Single scout: includes the pelvis;
- Sequences of our protocol:

<table>
<thead>
<tr>
<th>TR</th>
<th>TE</th>
<th>Slice thickness</th>
<th>Gap</th>
<th>TSE factor</th>
<th>NSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSE</td>
<td>T2</td>
<td>Shortest</td>
<td>70</td>
<td>5</td>
<td>0,5</td>
</tr>
<tr>
<td>SPAIR</td>
<td>cor</td>
<td>pelvis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TSE</td>
<td>T1</td>
<td>400-700</td>
<td>8</td>
<td>5</td>
<td>0,5</td>
</tr>
</tbody>
</table>
TSE T2 Ax pelvis  | Shortest | 95 | 5 | 0,5 | 21 | 4  
DWI pelvis     | Shortest | Shortest | 5 | 0,5 | maximum | 4  
TSE T2 sag pelvis | Shortest | 100 | 4 | 0,4 | 16 | 4  
TSE T2 Ax prostate | Shortest | 110 | 3 | 0,3 | 20 | 3  
DWI Ax prostate | Shortest | Shortest | 4 | 0,4 | maximum | 6  
Perfusion prostate | Shortest | Shortest | 1.4 x1.5 x3 | 0,4 | 44 | 4

Transrectal Ultrasound protocol

- Ultrasound system Esaote My Lab 70 ;
- 7.5 MHZ transrectal probe ;
- Scanning begins in the axial plane, and the base of the prostate and seminal vesicles were visualized first.; then the gland was examined by longitudinal plane. A small amount of urine in the bladder facilitates the examination.

MRI and ultrasound guided prostate biopsy using the fusion imaging technique

- Interruption of anticoagulants (such as warfarin, aspirin or clopidogrel), rectal enema and administration of antibiotics in previous days before the biopsy was used in order to prevent bleeding and infection.
- Patient needs to lie down on his left side and a transrectal approach was used. A small amount of anaesthesia was injected.
- To fuse T2 high resolution sequence to US image, the prostate gland apex or specific zones into prostate adenoma, such as calcifications or fluid area, were searched in both images. When the same image fusion was obtained, a coregistration was performed. [Fig.7]
- The suspicious areas, detected on the T2 weighted image, were automatically localized by a target on the ultrasound image. [Fig.8]
- The biopsy was finally performed on the localized target.
- At the end of the specific biopsies, a random biopsy was also executed.
- Possible complications are: post interventional hemorrhage or urinary tract infection.
Fig. 7: Ultrasound image and TSE T2 high resolution weighted image of prostate. A fluid area (yellow target) was searched in central adenoma on US image appearing as hypoechoic and the same image of high signal intensity in TSE T2 sequence was found. Under the upper images MPR images of prostate gland.

References: "Department of Radiology, San Bartolomeo Sarzana, Medical Hospital of Sarzana 2013."
Fig. 8: Upper images: Ultrasound image and TSE T2 high resolution weighted image of prostate. A low signal intensity area (blue target) was marked in TSE T2 image in the right prostatic lobe and the same area was identified on US by fusion imaging technique. Lower images: MPR images of prostate gland.

References: "Department of Radiology, San Bartolomeo Sarzana, Medical Hospital of Sarzana 2013."
Results

In our initial experience, using MRI and US image fusion technique, 6/15 patients were diagnosed with prostate cancer. Each lesion was categorized by multiparametric MRI in high, medium and low risk. When MRI lesion has been marked as highly suspicious, the detection rate was 100% (4/4); medium 33% (2/6) and low 0% (0/5). In only one patient prostatic cancer in the same lobe was found both in targeted and in random biopsy. In the latest case the target specimen had the highest Gleason score (3+4) versus the random biopsy (3+3). In all the 6 patients with a prostatic cancer diagnosed by targeted biopsy, disease was not found by random biopsy in the contralateral lobe. The Gleason score evaluated for each specimen had a higher value in targeted biopsies relative to random biopsies. Complications post procedures didn't occur.
Conclusion

The high sensibility of targeted biopsies, using MRI and US image fusion technique in those patients, who have had a prior negative biopsy, might be an accurate method in detection of prostate cancer.
References


Personal Information

Personal information

A.Villa¹, F. Chiesa¹, I. Rosenberg¹, A. Tagliafico², M. Perinetti², A. Del Prato².

1. Ospedale San Bartolomeo, Via Cisa 19038, Sarzana (SP), Italy

2. Università degli studi di Genova, Ospedale San Martino, Largo Rosanna Benzi 10, 16132, Genova, Italy.