REVIEW ARTICLE

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MRI fusion biopsy vs transrectal ultrasound guided biopsy – A literature review

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Abstract: *Introduction: Current diagnosis of prostate cancer is based on transrectal ultrasound guided random biopsies. These procedures alongside with the discovery of PSA lead to a tremendous improvement of prostate cancer diagnosis rate in the last decades. Random ultrasound guided biopsy has its minuses and several attempts were made to improve the detection rate of the disease. MRI-US fusion targeted biopsies is one of them.*
Aim: This paper is a literature review of several important European studies and tries to draw a conclusion for the usefulness of MRI-US image fusion prostate biopsy in improving prostate cancer detection
Material and methods: We have analyzed 5 papers published since 2013 which compare random ultrasound biopsies with MRI-US fusion. The analyzed parameters were clinical significant cancer detected as described by the study and any cancer detected
Results: All 5 papers show superiority in cancer detection rates for both clinically significant and any cancer.
Conclusions: MRI-US is a useful tool for improving detection rate of clinically significant prostate cancer.

INTRODUCTION

Prostate cancer is a serious public health matter, being the first cancer in men in terms of incidence and the second cause of cancer death in the U.S. Cancer, in general is taught to surpass in the following year cardiovascular diseases as the leading cause of mortality. Prostate cancer, in particular is becoming more and more important due population aging. [1]

While throughout the history prostate cancer was poorly understood, with few cases recorded due to the low life expectancy, during the XXth century groundbreaking discoveries were made in understanding, diagnosing and treating the disease.

Early diagnosis methods included open transperineal biopsies, blind transperineal needle biopsy and finger guided transrectal biopsy. First attempts to use transrectal ultrasound for prostate imaging were made by Takahasi and Ouchi in 1963 but they obtained poor images [2]. Watanabe in 1968 performed first clinical useful TRUS. In 1989 Hodge and al. started the modern era of standard sextant

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transrectal ultrasound guided needle biopsy. Stamey developed a technique which consisted in performing a biopsy without knowing the tumor location within the prostate. Stamey's method was a major advance over older methods in which biopsy needles were guided only by the examining finger.(2) During the late 1990's and early 2000's standard protocol was modified introducing extended and saturation biopsies. Nowadays it is estimated that several million biopsies are performed each year around the globe.

Ultrasound guided transrectal biopsies have 2 major disadvantages: detection of focal carcinomas with little or no clinical significance on one side and the important percentage of falsely negative biopsy cores.

MRI was invented in 1971 by Paul C. Lauterbur for which he was granted Nobel Prize for Medicine in 2003. MRI evolved as being the most important tool for prostate cancer staging, especially if performed in a multiparametric manner.

Prostate biopsies can be performed directly under IRM guidance or images may fused either in a cognitive manner, a method dependent on operator's experience, or MRI-US image fusion may be used. When using US-MRI fusion, standard transrectal ultrasound is performed and software is utilized to fuse the ultrasound images, at the time of the examination, with IRM images that were obtained before.

3D images of the prostate are obtained [3]. Fusion devices use a variety of technologies to perform image fusion. There are devices which perform robotic tracking via a mechanical arm with built-in encoders with commercial products: Artemis and BioJet. Electromagnetic tracking is used by the following UroNav and Hi-RVS. A 3D US probe is used for tracking and fusing images by Urostation. [4]

MATERIALS AND METHODS

We have analyzed 5 major studies which were performed since 2012 in terms of number of subjects, medium PSA level, overall cancer detection and clinically significant cancer detection rates. All 5 studies analyzed were paired cohort studies which compared transrectal standard biopsy with MRI-US fusion biopsy. The population analyzed was heterogenous. The only thing that was common to all patients was high PSA levels. One study, (Sonn GA et al, 2014)[5] had only patients with prior negative biopsy while the other 4 studies had mixed patients with or without prior negative biopsies. The percentage between patient with and without negative biopsies varied.

The number of patients varied between 30 (Fiard et al, 2013) [6] and 347 (Kuru et al, 2013) [7] with a total of 677 patients. Medium PSA recorded in each study varied between 6.3 ng/ml (Fiard et al, 2013) and 9.85 ng/ml (Kuru et al, 2013).

Clinically significant prostate cancer was defined by each study. Sonn et al defined clinical significance as Cancer positive cores with length 4 mm or more or Gleason 3+4.

Kuru et al used the NCCN (National Comprehensive Cancer Network) criteria. Fiard et al and Rud[9] et al considered clinical significance when Gleason 7 (3+4) or higher was recorded on biopsy cores while Rastinehad et al[8] used Epstein criteria for clinical insignificant tumors: clinical stage < T1c; PSA density < 0.15 ng/ml; fewer than 3 positive cores and less than 50% cancer on positive cores.

Clinically significant disease, defined as above, was diagnosed by means of transrectal ultrasound guided biopsy in 4.8% (Rud et al,2012) to 38% cases (Kuru et al, 2013) with a mean value of 25.26% and by means of MRI-US fusion biopsy in 21.7% (Son et al, 2014) to 50% cases (Rud et al, 2012) with a mean value of 40,76%.

The difference in diagnosing clinically significant disease varied between 7% to 41.4%. MRI-US fusion biopsy was more accurate in diagnosing clinically significant prostate cancer compared to US transrectal biopsy with an overall advance of 17.36%.

When analyzing all types of cancer both clinically significant and insignificant 4 out 5 studies showed superiority of MRI-US fusion biopsy ranging from 0.2% to 53.2%. Sonn GA et al reported 27.5% for

TRUS biopsy vs 23.7 % for MRI-US fusion. This difference in favor of TRUS is probably linked to the study design as it is the only cited study that enrolled only patients that had undergone a prior negative TRUS biopsy.

Table1: Prostate cancer both clinically significant and any cancer

Paper	Clinically significant TRUS	Clinically significant MRI-US fusion	Any cancer TRUS	Any cancer MRI-US fusion
Sonn GA et al	14,7%	21,7%	27,5%	23,7%
Kuru et al	41,1%	50,4%	50,4%	50,6%
Fiard et al	33,3%	50%	43%	55%
Rastinehad et al	32,4%	44,8%	48,6%	50,5%
Rud et al	4,8%	46,2%	14,3%	67,5%
Medium values	25,26%	42,62%	36,76%	49,46%

DISCUSSIONS

All studies show superiority for detecting clinically significant disease with a smaller number of biopsy cores for MRI-US fusion biopsy and all but one showed overall superiority in detection of prostate cancer.

The disadvantages of this review are the fact that there isn't a standardized definition of clinical significance, the lack of homogeneity of the analyzed population, the fact that some studies have enrolled both patients with prior biopsies and patients without biopsies, and the lack of standardized protocol for MRI-US fusion biopsy as there is a standard protocol for TRUS biopsy.

CONCLUSIONS

MRI-US fusion biopsy has proven to be more accurate in detecting clinically significant cancers but is still long way from becoming a standard procedure because of the complex technique required, the financial burden caused by the need of a prior MRI.

MRI is capable of accurately diagnosing prostate cancer, in assessing its extension, its aggressiveness. MRI is also a useful tool for following patients with prior diagnosis of prostate cancer and probably, in the future it will be the major tool for focal therapy of the tumor.

Transrectal ultrasonography still holds the crown for prostate cancer detection and will certainly remain the most used guidance technique for prostatic biopsies for long time with good results in the general population. Patients with negative biopsies and who experience a continuing rise in PSA levels, patients at risk when talking of hereditary antecedents of prostate cancer and some other risk categories may and will certainly benefit from the development of the MRI fusion technique.

References:

1. Cancer statistics, 2015Rebecca L. Siegel , Kimberly D. Miller and Ahmedin Jemal, *CA: A Cancer Journal for Clinicians* Article first published online: 5 JAN 2015 DOI: 10.3322/caac.21254

2. The Development of the Modern Prostate Biopsy Lehana Yeo, Dharmesh Patel, Christian Bach, Athanasios Papatsoris, Noor Buchholz, Islam Junaid and Junaid Masood Barts and the London NHS Trust U

3. MRI–ultrasound fusion for guidance of targeted prostate biopsy – Leonard Marks, Shelena Young, and Shyam Natarajan – *Curr Opin Urol*. 2013 Jan; 23(1): 43–50. doi: 10.1097/MOU.0b013e32835ad3ee

4. Geoffrey A. Sonn, M.D., Daniel J. Margolis, M.D., Leonard S. Marks, M.D.- Target detection: Magnetic resonance imaging-ultrasound fusion–guided prostate biopsy J UrolOnc August 2014 Volume 32, Issue 6, Pages 903–911

5. Sonn GA, Chang E, Natarajan S, et al. Value of targeted prostate biopsy using magnetic resonance-ultrasound fusion in men with prior negative biopsy and elevated prostate-specific antigen. *Eur Urol* 2014;65:809–15.

6. Fiard G, Hohn N, Descotes JL, Rambeaud JJ, Troccaz J, Long JA. Targeted MRI-guided prostate biopsies for the detection of prostate cancer: initial clinical experience with real-time 3-dimensional transrectal ultrasound guidance and magnetic resonance/transrectal ultrasound image fusion. *Urology* 2013;81:1372–8.

7. Kuru TH, Roethke MC, Seidenader J, et al. Critical evaluation of magnetic resonance imaging targeted, transrectal ultrasound guided transperineal fusion biopsy for detection of prostate cancer. *J Urol* 2013;190:1380–6.

8. Rastinehad AR, Turkbey B, Salami SS, et al. Improving detection of clinically significant prostate cancer: magnetic resonance imaging/ transrectal ultrasound fusion guided prostate biopsy. J Urol 2014;191:1749–54.

9. Rud E, Baco E, Eggesbo HB. MRI and ultrasound-guided prostate biopsy using soft image fusion. Anticancer Res 2012;32:3383–9.