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Quantitative Analysis of Bone Scans in Prostate Cancer Patients

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av

Reza Kaboteh

Fakultetsopponent:

Professor Sten Nilsson

Karolinska institutet, Stockholm

This thesis is based on the following studies, referred to in the text by their Roman numerals.

- I. **A Novel Automated Platform for Quantifying the Extent of Skeletal Tumour Involvement in Prostate Cancer Patients Using the Bone Scan Index.**
Ulmert D*, Kaboteh R*, Fox J , Savage C, Evans M , Lilja H, Abrahamsson P-A, Björk T, Gerdtsson A, Bjartell A, Gjertsson P, Höglund P, Lomsky M, Ohlsson M, Richter J, Sadik M, Morris M , Scher H , Sjöstrand K, Yu A, Suurküla M, Edenbrandt L, Larson S M
Eur Urol 2012, 62:78
- II. **Bone Scan Index: a prognostic imaging biomarker for high-risk prostate cancer patients receiving primary hormonal therapy.**
Kaboteh, R, Damber J-E, Gjertsson P, Höglund P, Lomsky M, Ohlsson M, Edenbrandt L.
EJNMMI Res 2013, 3:9 (Open access)
- III. **Progression of Bone Metastases in Patients with Prostate Cancer – Automated Detection of New Lesions and Calculation of Bone Scan Index.**
Kaboteh R, Gjertsson P, Leek H, Lomsky M, Ohlsson M, Sjöstrand K, Edenbrandt L.
EJNMMI Res 2013, 3:64 (Open access)
- IV. **Assessment of baseline and longitudinal bone scan index measures in the context of a randomized placebo-controlled trial of tasquinimod in the men with metastatic castration-resistant prostate cancer (mCRPC).**
Armstrong A.J*, Kaboteh R*, Carducci M.A, Damber J-E, Stadler W.M., Hansen M, Edenbrandt L, Forsberg G, Nordle Ö, Pili R, Morris M
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* Equal contribution

Handledare: Lars Edenbrandt, MD, Professor

Bihandledare: Peter Gjertsson, MD, PhD

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Reza Kaboteh

Department of Molecular and Clinical Medicine, Institute of Medicine
Sahlgrenska Academy at University of Gothenburg
Gothenburg, Sweden

ABSTRACT

Prostate cancer (PCa) is one of the most common diseases in the world. PCa can primarily disseminate to the bone, causing bone metastases, which in turn can lead to death. To treat the disease it is important to diagnose bone metastases as soon as possible. Bone metastases are diagnosed usually by bone scan imaging. However, interpretation of bone scan images is not always an easy task for physicians. One way of minimising the risk of misinterpretation is quantitative analysis of bone scan images in order to ascertain whether they show any metastatic lesions, and if so, to what extent. Quantification of the bone scan, i.e. the bone scan index (BSI) method, could be used for prognostication of survival, or to follow up the effect of treatment. The aim of the thesis was to develop and validate a fully automated method for the quantification of skeletal images in patients with prostate cancer based on the BSI method. This thesis is based on four papers. In *Paper I*, "**A Novel Automated Platform for Quantifying the Extent of Skeletal Tumour Involvement in Prostate Cancer Patients Using the Bone Scan Index**", we developed an automated BSI-quantification method, used it in a training group of 795 patients, compared it to a manual method and assessed the prognostic value of BSI in an evaluating group of 384 patients. The automated method showed a good correlation ($r=80\%$) with the manual method, and BSI was strongly associated with prostate cancer death. In *Paper II*, "**Bone Scan Index: a prognostic imaging biomarker for high-risk prostate cancer patients receiving primary hormonal therapy**", we found that BSI included prognostic information in addition to other clinical parameters such as "prostate-specific antigens". Patients with $BSI < 1$ had a much higher survival rate after 5 years than those with $BSI > 5$. In *Paper III*, "**Progression of Bone Metastases in Patients with Prostate Cancer - Automated Detection of New Lesions and Calculation of Bone Scan Index**", we further develop the automatic method to find new metastases using a training group of 266 patients. The method evaluated 31 patients who received chemotherapy. Patients with an increase in BSI during treatment had a lower two-year survival rate (18%) than those with a decrease in BSI (57%). In *Paper IV*, "**Assessment of baseline and longitudinal bone scan index measures in the context of a randomised placebo-controlled trial of tasquinimod in men with metastatic castration-resistant prostate cancer (mCRPC)**", we retrospectively calculated BSI at baseline and upon treatment in 85 patients from a clinical trial. We found that BSI and BSI change on-treatment were associated with survival. BSI correlated with known biomarkers of survival, but adds independent prognostic information. In conclusion, BSI calculated using an automated method contains prognostic information and can be used to evaluate treatment effects.

Keywords: Image analysis – Radionuclide imaging – Bone metastases – Prostate cancer – Automated detection – Computer assisted diagnosis – Bone scan index

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