Physica Medica xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Physica Medica

journal homepage: http://www.physicamedica.com

Technical note

A new method to gently place biopsy needles or treatment electrodes into tissues with high target precision

Hans Wiksell [a,*], Lars Löfgren [b], Kai-Uwe Schässburger [a], Karin Leifland [c], Karin Thorneman [d], Gert Auer [e]

[a] Department of Molecular Medicine and Surgery, Karolinska Institutet, Karolinska University Hospital, (L1:00), 171 76 Stockholm, Sweden
[b] Department of Surgery, Capio Sankt Göran Hospital AB, 112 81 Stockholm, Sweden
[c] Department of Medical Imaging, Stockholm South General Hospital, 118 83 Stockholm, Sweden
[d] Department of Medical Imaging, Capio Sankt Göran Hospital AB, 112 81 Stockholm, Sweden
[e] Department of Oncology-Pathology, Karolinska Institutet, Karolinska University Hospital, (Z1:01), 171 76 Stockholm, Sweden

ARTICLE INFO

Article history:
Received 5 February 2016
Received in Revised form 17 April 2016
Accepted 18 April 2016
Available online xxxx

Keywords:
Micro-pulses
Fourier-method
Electrode-precision-placement
Anti-seeding

ABSTRACT

We present a new core needle biopsy and treatment electrode precision placement technique which, regardless of needle size, target lesion hardness and elasticity, makes it possible to precisely place an image guided device inside the abnormal tissue. Once inside the abnormal lesion, multiple tissue samples can be collected using a dedicated trocar and collecting system. Our unique "Fourier" driver substitutes the commonly used spring-loaded device or complements the jerky insertion technique used by experienced interventional physicians. It enables the physician to precisely and with extreme tactility maneuver even large diameter core needles or treatment-electrodes into the lesion using only a diminutive external force. This is achieved by applying supporting servo-controlled mechanical high-acceleration micro-pulses, proportional to the average vector directed by the physician. The Fourier-needle or Fourier-electrode stands completely non-moving when the system automatically goes into full idling. This means that the angle of attack successively and arbitrary can be aligned to hit the target, becoming successively symmetrically inserted into even small tumors to be treated as well as exactly hit any point outlined by real time ultrasound guiding. This kind of biopsy needle or treatment electrode placement results in a uniquely accurate and less traumatic procedure. Due to the risk of disseminating viable tumor cells the precision placement device can be combined with a computer controlled anti-seeding system, denaturizing tumor cells detached during penetration of the biopsy needle or treatment electrode.

1. Introduction

Currently, diagnosis of solid lesions, e.g. in the breast or prostate, is dependent on diagnostic tissue sampling procedures guaranteeing a representative cell- or tissue-sample. The most frequently used method is the core needle biopsy (CNB) technique [1–3] with needles from approximately 1.2 mm to more than 3 mm outer diameter, equipped with a spring-loaded device to create inertia stabilization of the tissues during penetration. In order to get material which is representative of a specific lesion multiple shots are generally performed because the path and stop point cannot be exactly controlled at the substantial velocity used (in the order of 4–8 m/s). This highly traumatic multi-procedure – especially when using needles with more than 2 mm outer diameter is needed because of the lack of precise placement of the tissue sampling needle regarding each shot. The use of side-cut needles also forces the operator to penetrate smaller tumors all the way up to the rear side, which contribute to substantial cell displacement. The "Fourier" needle takes samples using a simple right-angled distal cut with no need of over-intercepting the tumor. Another important example of a serious medical problem is the exact placement of treatment electrodes used in palliative or curative radio frequency ablation treatment of metastatic (e.g. liver metastasis) or primary (e.g. breast cancer) malignancies [4,5]. The general success rate of representative tissue sampling and RFA treatment is dependent on the possibility to place the tissue sampling needle or treatment electrode with supreme precision.

In the present paper we describe a new biopsy technique which can significantly improve lesion representative tissue sampling or local ablative treatment and at the same time reduce the extent of tissue destruction, inflammation and bleeding, in turn diminishing local and distant tumor cell dissemination [6,7]. Initial results from studies in both experimental model devices and clinical

* Corresponding author.
E-mail address: hans.wiksell@comair.se (H. Wiksell).

http://dx.doi.org/10.1016/j.ejmp.2016.04.007
1120-1797/

Fig. 1. Demonstration of system precision on a melon seed.

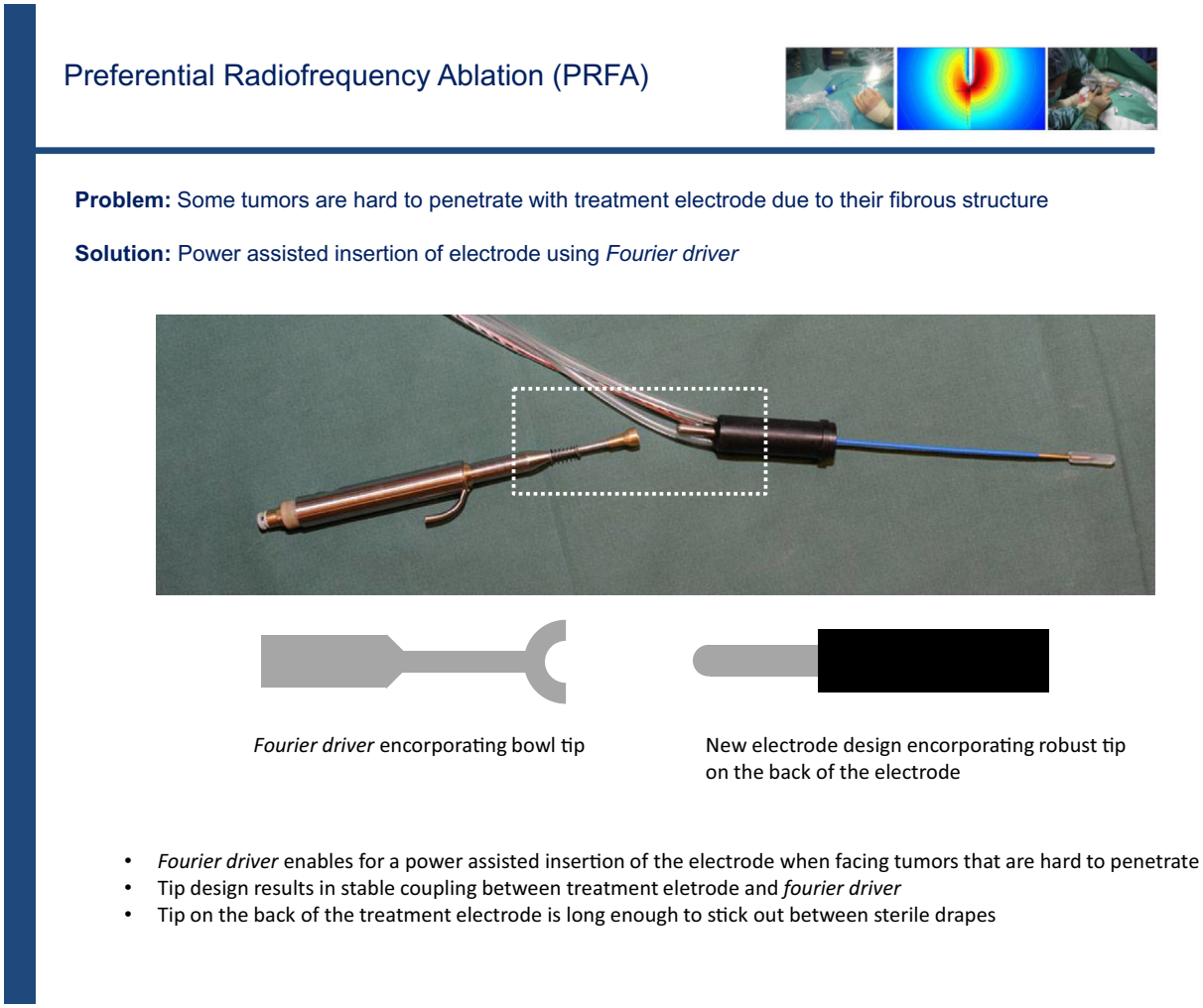

Fig. 2. Preliminary method to connect micro-pulse driver to treatment electrode.

Please cite this article in press as: Wiksell H et al. A new method to gently place biopsy needles or treatment electrodes into tissues with high target precision. Phys. Med. (2016), http://dx.doi.org/10.1016/j.ejmp.2016.04.007